Transactions of the Wisconsin Academy of Sciences, Arts and Letters. volume XXII 1926

Madison, Wis.: Wisconsin Academy of Sciences, Arts and Letters, 1926

https://digital.library.wisc.edu/1711.dl/B44YAM2CN6YXH8B

TRANSACTIONS

OF THE

WISCONSIN ACADEMY

OF

SCIENCES, ARTS AND LETTERS

VOL. XXII.

NATURALE SPECIES RATIOQUE

MADISON, WISCONSIN
1926

Vol. XXII of the Transactions of the Wisconsin Academy of Sciences, Arts, and Letters is issued under the editorial supervision of the Secretary.

CHANCEY JUDAY,
Secretary.

TRANSACTIONS

OF THE

WISCONSIN ACADEMY

OF

SCIENCES, ARTS AND LETTERS

VOL. XXII.

MADISON, WISCONSIN
1926

CONTENTS

STAGECOACH AND TAVERN DAYS IN THE BARABOO REGION

H. E. COLE

"Whoe'er has travell'd life's dull round,
Where'er his stages may have been,
May sigh to think he still has found
The warmest welcome at an inn."

Baraboo and the vicinity about is especially favorable for a study of stagecoach travel and of taverns, for the reason that the railroad did not penetrate the picturesque and rugged region until 1871. Prior to this date stagecoaches of various types were familiar objects in the locality and a convenient means of transportation.

When the writer came into the state, some of the drivers of coaches were still active and able to impart information regarding their routes and the places of entertainment. At one time eight stages left the village of Prairie du Sac daily. None is now making trips, this primitive activity having been entirely supplanted by other modes of travel.

On the old Concord coaches and kindred vehicles, the driver was the important personage of the equipage, the autocrat of his day. Everybody of note in the locality was known to him and at meal-time at the tavern, it was the driver who presided at table where the passengers on the coaches were hurriedly refreshed at the reasonable price of twenty-five cents per person. His aspect was usually rougher than a close acquaintance with him as an individual revealed. A flannel shirt, corduroy breeches stuffed into high boots, a well-worn hat or cap and a fur or leather coat in inclement weather made up his usual costume. In personal appearance he might be tall and lean or short and stout. In either case he was always alert to meet the exigencies that were likely to arise as he traveled the country roads. In speech he was more picturesque than grammatical, often voicing choice bits of humor or arguments that were graphic and convincing.

Artists of a century ago frequently pictured the horses of the stage-coach as prancing, fire-breathing steeds, but upon investigation it is found that much of this picturesqueness was imaginative. It required highly practical teams to pull the coaches loaded with passengers and baggage, and the long journeys conspired to produce conspicuous ribs, pronounced backbone and other indications of arduous toil.

It was the custom of the time for the driver, when he gathered up his lines in front of the tavern, to crack his whip with a flourish for the start from the hostelry. With a great hurrah and whirring of wheels they would set out, then often would creep along when muddy stretches or sandy wastes were encountered. As the destination drew near there was again a great flurry on the part of the driver, as he brought his horses to a stop before the tavern.

Besides looking after the welfare of his passengers and caring for his horses, the driver often had packages entrusted to his care, a weighbill accompanying, the landlord collecting when delivered to the person addressed. To tip the driver with coin was rarely or never known but a drink was usually accepted when it was offered.

Among the passengers, when the stage lines were opened, were lawyers, doctors, preachers, newspapermen, lumbermen and settlers seeking places of abode in the new country. There came, too, the homeseeker from across the sea in singular garb, clinging tenaciously to his queer looking baggage. In the fifties and sixties many raftsmen floated down the Wisconsin River to various snubbing-posts along the stream, seeking the highway with its convenient stagecoach upon their return. During the Civil War, soldiers were often passengers from the railway station to their homes in the interior, bringing many a thrilling tale of the sanguniary conflict in the southland and not infrequently an empty sleeve or trouser's leg. In this region during the frenzied hop-period, pickers arriving at Kilbourn and Mazomanie by the car load, were conveyed to the hopyards by the stagecoach. Of hoppole pullers there were also not a few.

Not infrequently suspicious characters would seek transportation. Of this class, however, few had an eye on the passengers or stage property. As to horses, there were many more spirited steeds to be had in the open pasture or in unlocked stalls. D. Joseph Johnson, who drove the stage between Prairie du Sac and Mazomanie for a number of years after his return from

Southern battlefields at the close of the Civil War, brought more than one traveler into Prairie du Sac whom he never saw again, who probably rode a horse into Illinois to be sold to some unsuspecting purchaser.

Besides those mentioned there were the peddlers with their packs and that group of idlers known as speculators, in prosperous dress, shrewd of eye and clever in trades.

Prescott Brigham, brother of Ebenezer Brigham of Blue Mounds, established the first stage line between Madison and Sauk County, the route terminating at Sauk City and Prairie du Sac. He drove the first stagecoach into the county in 1844, as proprietor, jehu, mail and express man, four years before Wisconsin passed into statehood.

After the line was opened between Madison and Sauk, the name given the two villages on the Wisconsin river, a network of lines spread to all parts of the county, every hamlet enjoying the visits of the stage.

A great variety of vehicles have been used in transporting passengers, mail and baggage over the Baraboo region. The most imposing was the Concord coach with its painted body and plush seats. One of these employed on the Lodi-Madison route was known as the Prairie Queen. Various names were used to designate these coaches, each of which accommodated nine persons in the interior, with room on the driver's seat for one or two who might prefer to ride outside.

The question has occasionally been asked, what became of these famous vehicles when they passed to worthless property with the advent of the railroad? Concerning some of these faithful friends of our forefathers, the Concord coaches, W. W. Warner of Madison, in his youth a resident of Baraboo, wrote as follows:

"This was, I should say, about 1868–69. Who among the boys who participated in that famous escapade, may ever forget? Be it known there were fifteen or twenty antique, superannuated Concord stagecoaches which had been one after another placed, so to speak, in dry dock and out of commission, having outlived their further transportational usefulness, and thus they were housed in a rambling series of sheds, just back of the present city hall. We young chaps, the day after a Fourth of July celebration, conceived the idea of decorating Oak Street with the dilapidated vehicles. Some of the chariots, I remember, bore euphoneous names, such as Argosy, Prairie Queen and Western Monarch. Those who remember the onetime resplendent coaches, gorgeous beyond the dreams of a Ringling circus creation, will recall that they were integers connecting Baraboo with relatively near-by points of the outside world, such as Madison, Mazomanie, Portage and Kilbourn.

* * *

"It was long after midnight when we scamps, as expeditiously and as quietly as possible, hauled forth a score of the nondescript vehicles from their moorings, to the Western Hotel street corner, and thence made an imposing string of them, reaching almost to the present post office site, and a fine spectacle they presented early next morning. Not many citizens of Baraboo were aware that such antediluvian chariots were in existence, much less that they were right here in Baraboo. The general astonishment, therefore, may well be imagined. What opportunities were lost in their destruction shortly after this, their last appearance, for securing matchless museum antiques."

There is a flavor of romance about old time taverns. Clinging to these primitive places of entertainment in this locality are rich memories of the middle nineteenth century. They followed closely the advancing rim of pioneer life as it spread over the section north and west of the Wisconsin River in the forties and fifties, when the Baraboo country was a railroadless region, when the snail-like mode of travel of the stagecoach made it necessary for places of entertainment to be within brief distances of each other that the traveler might be conveniently refreshed.

Some of these old hostelries were crude and queer, and the bonifaces who presided over them often seemed a kind of reflection in appearance and character of the strange architecture of the buildings. These early landlords did not confine their responsibility to the physical comfort of their guests, but were a never failing thesaurus on politics, crops, the weather and the gossip of the country roundabout. They were also prone to join their guests in the drinking of intoxicating liquors which was the besetting sin in the early days of the region. Many of the settlers seem to have been perpetually athirst. Frequently there was an "eye-opener" upon arising in the morning, an appetizer before the noonday and evening meals, afterwards a little stimulant to aid digestion, and a "nightcap" before retiring.

At barn raisings, husking bees, and other gatherings a jug was always in evidence and occasionally there was tippling at funerals. Little wine was used; whisky made from corn or rye at a distillery near at hand was the popular beverage.

An example of the crude hospitality extended to early travelers at the tavern is given in "Merrell's Narrative," in the Wisconsin Historical Collections. Merrell and Captain Harris were journeying from Fort Winnebago to Galena and stopped at Rowan's tavern near Madison. Merrell says:

"The first night we stopped at Rowan's celebrated house, thirty-five miles from the fort. I had heard much of this inn and found it filled the bill. It consisted of two log buildings with an open space between, all under the same roof. After taking care of our horses and getting something to eat, we enquired where we could sleep, and Madam told us in the other house so we went in and concluded we should do very well as there was nothing in the room but a bed, and one or two three-legged stools. After lying down and by the time we were ready to go to sleep, there was an unearthly squeal and grunt of hogs in the open space between the two rooms, only a partition of logs between our heads and them. I was told that Governor Doty once stayed there, and after supper, as was the custom, rolled himself in his blanket on the floor. The family all lived, cooked and slept in one room; and in the night the governor felt something poking about him and found it was a pet pig the children had running about the house. The governor felt of the puncheons of the floor, and found one loose, which he raised carefully, and grabbing the pig thrust him under, and was relieved of his company that night."

In none of the pioneer taverns was there bathing facilities, except for the face and hands, as bathtubs were unknown in the region prior to the coming of the railroads. For cleansing the face and hands a sink with a small wash-basin was provided. Near by was a dish of soft soap, a roller towel and a comb which frequently had lost not a few of its teeth.

Sleeping rooms were small and heatless and without ventilation except that which was afforded by a door or undersized window. The foundation of the bed was a tick filled with straw thrown upon a corded bedstead, the ropes running backward and forward from pins in the rails and end-pieces. For illumination at night, tallow candles were used before the advent of the kerosene lamp. Circular lanterns of tin or square ones with parts of the sides of glass, a candle for the interior, were common up to and through the Civil War period. During very cold weather a warming pan was occasionally used to heat the beds to a comfortable temperature. This was a receptacle with a long handle in which live coals were placed, and served its purpose very well

The food served in the taverns was abundant but usually simple. Plenty of bread and butter, meat, potatoes, gravy, beans and other staples were provided. Fruit and game were served in season. Conservation wardens were unknown; the bag limit of quail, pigeons, partridge, rabbit, prairie chicken, deer, bear or fish was unlimited. Buckwheat cakes were in evidence in the morning with the accompaniment of coffee. Crackers were about the only ingredient of a meal that came from a bakery and were usually purchased by the barrel. Maple syrup was on the menu in the spring and sorghum during the remainder of the year. Sour milk and saleratus, or home-made yeast were the sources of raised breads and biscuits made from wheat flour and corn bread made from ground maize.

Cooking facilities were of course more or less primitive. The first stoves for kitchens did not appear on the market until about 1840, just prior to the opening of the first taverns in the Baraboo region. These were brought from Milwaukee and sold by those outfitting the new settlers. They had elevated ovens but not reservoirs for water as later models had. The kitchens were equipped with a limited number of iron pots and spiders and earthern vessels.

Cooks were often at their wits-end to find material for the interior of pies; green tomatoes, dried pumpkin, dried apples and like substitutes for fresh fruit were used. To reduce apples and pumpkins to a state where they could be preserved for indefinite periods, slices were hung in festoons about the fire and dried.

Dances were frequent in many of these old time taverns. There sat the fiddler and as he played "his head swung time, his body rocked time, his feet patted time, his eyes winked time, and his teeth ground time. The good women laughed for joy, and men winked at each other and popped their fists." Of course the company danced. In the very early places of entertainment there was a rough floor but in the later ones great ball rooms were provided at the top of the building, so constructed as to vibrate with the movements of the merry dancers. In that day it was the lively minuet, the graceful waltz or the old fashioned quadrille.

Many amusing incidents in connection with the early days in the region are affiliated with these old taverns. In the Empire House at Prairie du Sac, afterwards operated by Oscar E. Briggs, a relative of the famous cartoonist, there once was a diverting occasion. A circus reached the village early one Sunday morning and no sooner were the circus folk at liberty than they plunged into the broad Wisconsin River, the surface of which gleamed in the June sunshine. After enjoying a plunge in its cool waters, they threw themselves on the bank to hear the martial strains of a brass band borne on the air. They were informed there was a picnic a mile away and they joined the procession.

The day lay before the showman. The circus would not exhibit until Monday and the "kinkers," "wind-jammers," freaks, sword-swallowers, "dog-boys," and sideshow barkers bounded along with rising spirits to the place of revelry and entertainment.

As the spigots turned and the amber fluid began to flow, the crowd increased faster than Falstaff's "men in buckram." One cooling draught and the acrobats fell to performing marvelous feats and their agility tickled as well as shocked their audience.

The drummer of the brass band had placed his instrument on its circular dimension, slightly at one side of the hilarious throng. Noticing the drum, a devilish idea entered the maudlin brain of one of the "kinkers." Quicker than a flash, flipping one foot in the air, he flopped the instrument on its side and with a bound, turned a somersault upon it, thrusting both feet through the tightly stretched head in the operation. This feat ended the acrobatic performance at the grove. Gathering themselves together, the merry Andrews marched gaily, if not in soldierly manner, toward the Empire House in Prairie du Sac, emitting a continuous "oomp, oomp, oomp," as though beating an aggregation of imaginary drums as they staggered along. And thus they filed into the old tavern. The leader, looking neither to the right nor left, marched straight into the dining-room, turned partly about the movable seat at the end of the table, and stepped waveringly upon the chair. Then, without hesitation, he strode the length of the table amid a din of rattling, breaking dishes, every inebriated individual in his train following.

Dining-room girls dashed to the open and their cries brought the tavern loafers to the scene of devastation.

Having delivered themselves of this inurbane incivility, the erstwhile picnickers, now unable to distinguish the hour on the face of the tavern clock, dropped into insensibility. Later they paid for the damage and departed from the quiet village of Prairie du Sac declaring they had never so enjoyed themselves.

A STATISTICAL STUDY

OF

LEAD AND ZINC MINING IN WISCONSIN

SELMA LANGENHAN SCHUBRING, Ph. D.

I

Location and Area. The lead and zinc mines of Wisconsin are in Grant, Iowa, and Lafayette counties, and comprise the most important part of the ore deposits of the Upper Mississippi Valley region. The whole region embraces the southwest corner of Wisconsin and adjacent portions of Illinois and Iowa, i. e.: Jo Daviess County in Illinois, and an irregular narrow belt of territory in Clayton, Allamakee, and Dubuque Counties in Iowa, parallel with the Mississippi River. The extreme length of this region, from east to west, is eighty-seven miles; and its greatest width, from north to south, fifty-four miles.[1] In Wisconsin the region comprises an area of about 2,000 square miles and is bounded on the north by the northern outcrop of the Galena limestone, running parallel with the main watershed from the Mississippi to the Blue Mounds; on the east by the Sugar River; on the south by the State line, and on the west by the Mississippi River. The area thus included is that of the Galena limestone, which covers about 1,776 square miles.[2] The productive area is somewhat triangular in shape, and the center of productiveness lies a little to the south of the center of geographical distribution.[3]

Ores. The ores from which lead and zinc are obtained are galena, the sulphide of lead; sphalerite or zinc blende, the sulphide of zinc; smithsonite or zinc carbonate; and (to a small degree) calamine, a hydrous zinc silicate. The galena is non-argentiferous and the zinc ores are free from cadmium.

[1] Owen, D. D., Report of a Geological Exploration of part of Iowa, Wisconsin and Illinois, made in 1839. Document No. 239, House of Representatives, 26th Congress, First Session. p. 26.

[2] Strong, Moses, Geology and Topography of the Lead Region, Chamberlin's Geology of Wisconsin, 1873–79, Vol. 2, p. 689.

[3] Chamberlin, T. C., Geology of Wisconsin 1873–79, Vol. 4, p. 398.

II.

The Upper Mississippi Valley Region.

Exhibit I of this study is a table which shows statistics of annual lead production of the Upper Mississippi Valley from 1821 to 1916, inclusive. In parallel columns and in chronological order appear data as presented by the several authorities who have compiled production statistics.

Accompanying the table is a bibliography with explanatory notes analyzing in detail the contribution made by each authority. Accredited sources are enumerated; the nature of the product is indicated: whether it is metallic lead or, as in some instances, lead ore; and the specific region of production is defined. Statistics for the Upper Mississippi Valley usually include production from Wisconsin, Iowa, and Illinois, although sometimes they include also the production of Kentucky and of Virginia. On the other hand, southern Illinois is sometimes excluded because of different mineralogical and structural environment which relates southern Illinois to the Kentucky-Illinois fluorspar district rather than to the soft lead region. In these cases Upper Mississippi Valley production comprises only lead from Wisconsin, Iowa, and northern Illinois, all of which is non-argentiferous, or soft, lead. Other information is contained in the notes, and the bibliography should be used in connection with the table.

Exhibit II is a similar table giving statistics of annual zinc production of the Upper Mississippi Valley from 1860 to 1916, inclusive. Accompanying the table is a bibliography with explanatory notes analyzing in detail the figures presented.

III.

The Rise and Decline of Lead Production and the Rise of Zinc Production.

The history of lead mining has been closely interwoven with that of zinc mining since the earliest development of zinc production. The ores are found in the same region and are often obtained from the same openings. As a lead district, the region has been known from the earliest settlement days, but zinc did not become important until the building of smelters near by

EXHIBIT I. *Lead production of the Upper Mississippi Valley.*

Year	1		2		3			4	5			6		7			8			9			10	11	Year
	1903— Wisconsin Historical Collections		1840, 1844 D. D. Owen		1854 E. W. Daniels			1854 J. D. Whitney	1859 Hunt's Merchants' Magazine			1877 Moses Strong		1883— Mineral Resources of the United States			1892— The Mineral Industry			1894 Arthur Winslow			1911 O. C. Gillett	1920 S. L. Schubring	
														Mississippi V.	Missouri-Kas	Up. Miss. V.	Miss. Valley	Missouri	Up. Miss. V.						
Year	Pounds	Short Tons	Pounds	Pigs	Short Tons	Pounds	Short Tons	Tons	Pigs	Pounds	Short Tons	Pigs or Pounds	Tons	Tons	Tons	Tons	Short Tons	Short Tons	Short Tons	Tons	Tons	Tons	Short Tons	Short tons of Metal (1862–1871 is ore-Wis.)	Year
1821–1823									(a) 4,790	335,130	168														1821–1823
1823	(a) 425,000	213	(a) 335,130		168	(a) 335,180	168	(a) 150					(a) 150							(a) 168			(a) 150	(a) 150	1823
1824			175,220		88	175,320	88	78	2,503	175,220	88		78							87			78	78	1824
1825	(b) 439,473	220	664,530		332	664,520	332	297	9,490	664,530	332		297							332			297	297	1825
1826	1,560,536	780	958,842		479	958,842	479	428	13,700	958,842	479		428							479			428	428	1826
1827	6,824,389	3,412	5,182,180		2,591	5,182,180	2,591	2,313	74,130	5,182,180	2,591		2,313							2,590			2,313	2,313	1827
1828	12,957,100	6,479	11,105,810		5,553	11,105,810	5,553	4,958	158,655	11,105,810	5,553		4,958							5,552			4,958	4,958	1828
(1st quarter	2,494,444)	(1,247)																							
1829	(c) 12,000,000	6,000	13,343,150		6,672	13,343,150	6,672	5,957	190,620	13,343,150	6,672		5,957							6,671			5,957	5,957	1829
1830						"Here follows a period of eleven years for which we have no statistics owing to a change in the mining regulations."		5,331	119,060	8,323,998	4,162		5,331							5,970			5,331	5,331	1830
1831								5,369	91,170	6,381,793	3,191		5,369							6,013			5,369	5,369	1831
1832								5,401	61,164	4,281,876	2,141		5,401							6,049			5,401	5,401	1832
1833								6,068	113,440	7,941,792	3,971		6,068							6,796			6,068	6,068	1833
1834								7,699	113,648	7,971,579	3,986		7,699							8,622			7,699	7,699	1834
1835								8,469	158,330	11,083,100	5,542		8,469							9,485			8,469	8,469	1835
1836								11,390	191,750	13,422,500	6,711		11,390							12,756			11,390	11,390	1836
1837								9,708	219,360	15,355,200	7,678		9,708							10,872			9,708	9,708	1837
1838								10,811	200,465	14,032,550	7,016		10,811							12,108			10,811	10,811	1838
1839			(b) 30,000,000		15,000			11,976	357,785	25,044,950	12,522		11,976							13,413			11,967	11,967	1839
1840								11,987	317,845	22,249,150	11,125		11,987							13,425			11,987	11,987	1840
1841	(d) 20,000,000	10,000	(c) 32,438,280	463,404	16,219	(b) 31,696,980	15,848	14,150	458,163	32,071,410	16,036		14,150							15,848			14,150	14,150	1841
1842			33,158,930	473,699	16,579	31,653,330	15,827	13,992	447,909	31,353,680	15,677		13,992							15,671			13,992	13,992	1842
1843			40,889,170	581,131	20,445	39,148,276	19,574	17,477	558,261	39,148,270	19,574		17,477							19,574			17,477	17,477	1843
1844						43,729,540	21,865	19,521	524,672	43,726,040	21,863		19,521							21,863			19,521	19,521	1844
1845	(e) 700,000 49,000,000	Pigs 24,000				54,497,860	27,249	(b) 24,328	778,408	54,494,850	27,247		24,328							27,247			24,328	24,328	1845
1846						51,368,210	25,684	23,513	732,404	51,268,219	25,634		23,513							26,334			23,513	23,513	1846
1847						54,634,450	27,317	24,145	772,556	54,085,920	27,043		24,145							27,042			24,145	24,145	1847
1848						47,737,830	23,869	21,312	684,969	47,737,830	23,869		21,312							23,869			21,312	21,312	1848
1849						44,605,380	22,303	19,654	628,934	44,025,380	22,013		19,654							22,012			19,654	19,654	1849
1850						39,801,130	19,901	17,768	568,859	38,801,230	19,401		17,768							19,900			17,768	17,768	1850
1851						33,188,056	16,594	14,816	474,115	33,188,050	16,594		14,816							16,593			14,816	14,816	1851
1852						28,703,960	14,352	12,770	408,628	28,603,960	14,302		12,770							14,302			12,770	12,770	1852
1853						29,806,980	14,903	13,307	425,814	29,806,980	14,903		13,307							14,903			13,307	13,307	1853
1854									423,617	29,653,190	14,827													(b) 14,827	1854
1855									430,365	30,125,550	15,063													15,063	1855
1856									435,654	30,495,780	15,248													15,248	1856
1857									485,475	34,183,250	17,082													17,082	1857
1858																								(c)	1858
1859																									1859
1860									(b) 349,330	24,453,100	12,227													(d) 12,227	1860
1861												Ore, Pounds, Wis. alone	Ore, Wis. alone							Wis. alone				(e) Ore, Wis.alone	1861
1862												(b) 17,037,912	(b) 8,519							(b) 8,519			(b) 8,519	(f) 8,519	1862
1863												15,105,577	7,553							7,553			7,553	7,553	1863
1864												13,014,201	6,507							6,507			6,507	6,507	1864
1865												14,337,895	7,169							7,169			7,169	7,169	1865
1866												14,029,192	7,015							7,014			7,014	7,015	1866
1867												13,820,784	6,910							6,911			6,911	6,910	1867
1868												13,869,619	6,935							6,934			6,934	6,935	1868
1869												13,426,721	6.713					(b) 6,480		6,714			6,714	6,713	1869
1870												13,754,159	6,877					7,060		6,877			6,877	6,877	1870
1871												13,484,210	6,742					6,840		6,743			6,743	6,742	1871
1872												Pigs (c) 200,000	(c) 7,000					10,220		5,812	(c) 7,000		7,000	(g) 7,000	1872
1873												200,000	7,000	(b) 22,381	(a) 15,045	(á) 7,336	(a) 22,381	13,840	(c) 8,541	4,959	7,000	(d) 7,336	7,000	(h) 7,336	1873
1874												150,000	5,400			5,400	Est. 23,000	15,160	7,840	4,813	5,400		5,400	5,400	1874
1875												150,000	5,400	24,699	19,099	5,600	24,730	16,480	8,250	4,589	5,400	5,600	5,400	5,600	1875
1876												To Oct. 125,000	ToOct. 4,500	26,421	19,225	7,196	26,421	22,550	3,871	ToOct. 4,374	ToOct. 4,500	7,196	4,500	7,196	1876
1877														31,152	15,422 9,312	6,418	31,152	24,680	6,472			6,417	6,417	6,418	1877
1878														26,770	11,761 10,517	4,492	26,770	23,112	3,658			4,492	4,492	4,492	1878
1879														28,130	14,182 11,158	2,800	28,130	22,386	5,744			2,800	2,800	2,800	1879
1880														27,690	15,780 7,970	3,940	27,690	24,850	2,840			(e) 2,884	2,884	3,940	1880
1881														(c) 30,770			30,770	25,630	5,140				(c) 5,140	(i) 5,140	1881
1882														29,015			29,019	23,870	5,149				5,149	5,149	1882
1883														21,600			21,800	18,390	3,410				3,410	3,410	1883
1884														18,140			19,932	14,330	5,602				5,600	5,602	1884
1885														21,268			21,975	20,916	1.059				1,059	1,059	1885
1886														22,460			20,800	22,780							1886
1887														27,958			25,148	16,720	8.428				8,428	8,428	1887
1888														31,252			29,090	22,610	6,480				6,480	6,480	1888
1889														27,400			29,258	31,590				(f) 1,851			1889
1890														33,840			31,351	28,840	2.511				2,411	2,511	1890
1891														29,763			34,000	31,000	3.000				3,000	3,000	1891
1892														32,895			37,000	32,260	4.740				4,740	4,740	1892
1893														32,859			38,241						3,000	(j)	1893
1894														46,300											1899
1895														53,596											1895
1896														51,887											1896
1897														56,542											1897
1898														54,469											1898
1899														54,444											1899
1900																									1900
1901														67,172											1901
1902														79,445											1902
1903														86,597											1903
1904														92,275											1904
1905														104,058											1905
1906																(d) 2,595							(d) 2,595	(k) 2,595	1906
1907																(e) 4,202							4,571	(l) 4,202	1907
1908																4,363							4,486	4,363	1908
1909																3,818							(e) 4,722	3,818	1909
1910																4,534							5,638	4,534	1910
1911																4,038								4,038	1911
1912																3,331								3,331	1912
1913																2,519								2,519	1913
1914																1,986								1,986	1914
1915																(f) 2,817								(m) 2,817	1915
1916																(g) 3,519								(n) 3,519	1916

(a) (b) (c) etc. These letters refer to notes on accompanying Bibliography of Statistics of Lead Production of the Upper Mississippi Valley.

Note.—The figures in bold face type represent arithmetical operations by the writer, such as conversion of pigs into short tons on a basis of 70 lbs. a pig; conversion of pounds to short tons; addition of several parts to make a whole; subtraction of one quantity from another.

Exhibit II. *Zinc production of the Upper Mississippi Valley.*

	1							2				3	4			5							6	7
	1877 Moses Strong							1883 Mineral Resources of the United States				1892 The Mineral Industry	1894 Aurthur Winslow			1902 E. T. Hancock							1907 H. F. Bain	1911 O. C. Gillett
	Smithsonite (Carbonate) "Dry Bone"		Sphlaerite (Sulphide) Blende "Black Jack"		Zinc Ores (Concentrates)	Metallic Zinc (Spelter)		Concentrates	Concentrates	Spelter	Spelter	Ores	Smithsonite	Blende	Ore	Wenona Zinc Co. Ore	Mineral Pt. Zinc Co. Ore	Waukegan Zinc Co. Ores	Matthiessen & Hegeler Zinc Co. Calamine	Blende	Ores	Wisconsin Ores Smelted by four Companies***	Ore	Metallic Zinc
Year	Pounds	Short Tons	Pounds	Short Tons	Short Tons	Pounds	Short Tons	Short Tons	Short Tons	Short Tons	Short Tons	Short Tons	Tons	Tons	Tons	Tons (Estimates)	Tons	Tons	Tons	Tons	Tons	Tons	Tons	Tons
1860	(a) 320,000	160			160								(a) 160											(a) 56
1861	266,000	133			133								133											47
1862																								
1863	1,120,000	560			560								560											196
1864	3,173,333	1,587			1,587								1,586											455
1865	4,198,200	2,099			2,099								2,099											732
1866	7,373,333	3,687			3,687								3,687											1,268
1867	5,181,445	2,591	841,310	421	3,012	103,400	51.7						2,590	420										1,155
1868	4,302,383	2,151	3,078,435	1,539	3,690	701,210	355.6						2,151	1,539										1,290
1869	4,547,971	2,274	6,252,420	3,126	5,400	630,580	315.3						2,274	3,127										1,890
1870	4,429,585	2,215	7,414,022	3,707	5,922								2,215	3,707	5,912									2,033
1871	16,618,160	8,309	9,303,625	4,652	12,961								8,309	4,652	12,961									4,370
1872	27,694,574	13,847	16,256,970	8,128	21,975								13,848	8,128	21,796									6,700
1873	20,538,946	10,269	15,089,514	7,545	17,814								10,269	7,545	17,814									6,120
1874	15,123,050	7,562	19,500,465	9,750	17,312								7,562	9,751	17,313									5,950
1875	11,878,210	5,939	20,538,190	10,269	16,208								5,393	10,269	16,208									5,626
1876	12,168,540 To Oct. 1	6,084	17,181,490 To Oct. 1	8,591	14,675								6,085	8,590	14,675				(a) 1,849	3,180	5,029	5,029		5,130
Total	138,933,130	69,467	115,456,441	57,728	127,195																			
													The Mineral Industry											
1877																			916	3,539	4,455	4,455		(b) 1,560
1878																			977	3,554	4,531	4,531		1,590
1879													(b) 9,000		16,000									
1880													to 10,000	7,500	to 17,000				2,593	4,191	6,784	6,784		2,470
1881													(c)		7,617				2,079	2,418	4,497	4,497		1,575
1882																			3,320	2,243	5,563	5,563		1,945
1883																			4,465	2,201	6,666	6,666		2,550
1884																			6,880	3,604	10,484	10,484		3,670
1885																			6,197	3,151	9,348	9,348		2,654
1886								(a) 2,990											3,812	3,637	7,449	7,449		2,861
1887																			4,708	3,450	8,158	8,158		2,149
1888																			2,839	3,330	6,169	6,169		2,450
1889								(b) 24,831							(d) 25,282				3,699	3,308	7,007	7,007		2,450
1890																			6,314	2,630	8,944	8,944		3,130
1891																			4,922	4,471	9,393	9,393		3,280
1892												(a) 3,780							1,620	4,160	5,780	5,780		2,220
1893												3,895	(b) 6,900†			900			5	3,760	3,760	4,660		1,660
1894												(c) 3,500			(e) 3,500	Out				3,727	3,727	3,727		1,349
1895																Out				3,633	3,633	3,633		1,271
1896																Out		200. From	June	3,544	3,544	3,744		1,320
1897																Out	10,300	593.69		2,809	2,809	13,703		4,810
1898																Out	9,740	1,491.5		2,803	2,803	14,035		4,870
1899																900	11,400	2,843.91		2,855	2,885	18,029		5,980
1900																900	12,199	529.375		2,324	2,324	15,952		5,680
1901												(d) 15,000				900	10,977	1,035.05		1,230	1,230	14,142		4,950
1902																1,200	14,200	1,192.578		2,427	2,427	19,020		6,290
1903																600 To Apr. 26th		463.873 To Apr. 30th						
1904								(c) 19,300				(e) 19,300											(a) 450,000	
1905								33,000				(f) 32,690											33,000	
1906								(d) 38,021*				42,130	(g) 42,129											(c) 15,550
1907								(e) 53,149		(f) 19,372		53,011	49,778											16,939
1907								56,658		20,318		58,135												18,332
1909								75,857		25,350		69,000												21,056
1910								104,617		29,572		(h) 51,383												21,343
1911								110,009		33,939		71,565												
1912								120,451		37,115		90,762												
1913								106,931		32,346		89,662												
1914								128,047		35,924		**74,331												
1821–1914									(k) 1,278,319		(l) 395,706													
1915								(g) 162,029		(h) 46,937		90,128												
1916								(f) 220,777		(j) 60,228		(i) 205,481												

(a) (b) (c) etc. These letters refer to notes on accompanying Bibliography of Statistics of Zinc Production of the Upper Mississippi Valley.
Note.—The figures in **bold face type** represent arithmetical computations by the writer, such as conversion of pounds to short tons; addition of several parts to make a whole; subtraction of one quantity from another.
* 76,042,911 pounds ** Incorrectly given as 71,331. † 13,800,000 pounds.
*** Wisconsin ore purchased annually by Page Krauss & Co. estimated at 2,500 tons.

made it possible to separate the spelter. The production of spelter in the United States began in an experimental way in 1858, and regular production began in 1860. Prior to this time the zinc ores of Wisconsin were thrown on the dumps and spread over the roads,[4] from which they were gathered later when their value had become known, and shipped to smelters. The first zinc ore to be mined was the carbonate found in association with the lead above ground-water level. It was known that the carbonate gave place to zinc blende and that lead existed below the water table, but it was deemed unprofitable to mine them. The higher price of zinc about 1900 led to the opening of some of the deposits below water level, and since that time zinc mining has increased until Wisconsin ranks among the largest of the producing states. Lead is still mined with the zinc, but its production is of small importance when compared with that of zinc. As a lead producer Wisconsin is now unimportant.

Figure 1, representing the output of metallic lead in the Upper Mississippi Valley by decades 1821–1900, and 1907–1916, shows the rise and decline of lead production. The decade of maximum production was 1841–1850. Annual statistics as presented in Exhibit I show an increase of production, with slight fluctuations, from 1821 to the years 1845–7, after which a marked decline set in. These minor variations in output were due in the main to the unsettled character of the country, the migratory habits of the settlers, and Indian disturbances. The military operations of the Black Hawk War (1831–2) removed the barrier of hostile tribes and made the region known for its rich farming lands.[5] The resulting influx of population is reflected in the increased lead production which reached its height in 1847, as above stated. The decline which set in in 1848 and continued permanently until a few years ago when, as a by-product of zinc, lead showed a slight revival, was said to be due to the rush to the California gold fields in 1848; to the enlistment of miners as soldiers in the Mexican War; and to the growing importance of agriculture and industry. Whitney[6] in 1854 stated that the decline was due partly to the superior at-

[4] Buckley, E. R., in The Mineral Industry, Vol. 9, p. 665.

[5] Libby, O. G., Transactions Wisconsin Academy of Sciences, Arts and Letters, Vol. 13.

[6] Whitney, J. D., Metallic Wealth of the United States, p. 423.

tractions of the California gold fields, but still more to the exhaustion of the lead deposits. Daniels[7] in the First Annual Report on the Geological Survey of Wisconsin took exception to this statement and said that injury had been done the mining interests by the report of exhaustion of the mines. He stated that the real causes of diminished production were, first, the announcement of the discovery of gold in California, which drew off one-third of the whole mining force; second, the prevalence

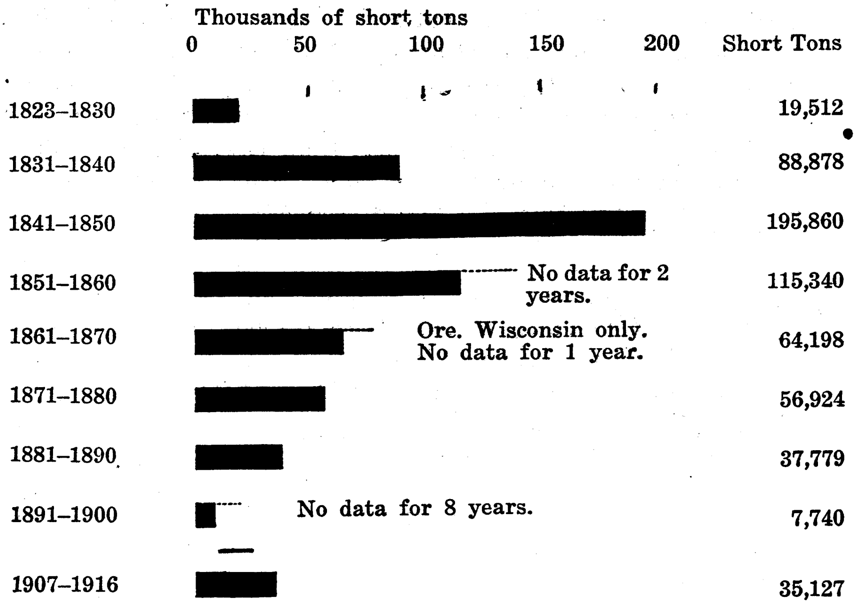


FIG. 1. Production of metallic lead in Upper Mississipi Valley. Data from Exhibit I, column 11.

of an irregular and inefficient method of working the veins; and, less important, the illiberality of non-resident land owners, who in some localities demanded exorbitant rents, and desired to throw all risks upon the miners, thus discouraging production. Daniels pointed out some ill effects of the system of individual mining which then prevailed, and said that such working answered well enough as long as there was surface ore enough to pick up; but that when the superficial deposits were ex-

[7] Daniels, Edward, First Annual Report on the Geological Survey of Wisconsin, 1854, pp. 40 ff.

hausted it was inadequate, and a falling off in the product could not fail to follow. The working of the mines by single individuals or small and temporary combinations, with little capital at their command, was entirely with a view to immediate results. The working of veins at any considerable depth involved an expenditure too large for any except companies with large capital. Moreover, single individuals could not afford to work through the unproductive portions which separated productive leads; and thus veins remained undiscovered. The system of individual mining was also a serious obstacle in the way of drainage. Owing to the limited size of claims, one mine often could not be drained by a pump or level without receiving the water from several others belonging to various owners. This fact retarded operations, for there was no co-operation and no one was willing to bear the whole expense of drainage where all shared its benefits. Daniels pointed out that individual mining could be profitable for short periods only and that "mining, like manufacturing, requires for its successful prosecution, systematic, comprehensive, and long continued application of labor and capital." He pronounced the mines, in 1854, to be in a transition state, and adds:

> They have passed through the period of excitement, when chance rewarded the fortunate with rapid gains, to a more quiet and settled condition, in which rude and individual attempts at mining are attended with frequent failure and occasional success. They now await the period of organization to which their full treasures are to be surrendered.

The production statistics of subsequent years bear out the statements of both of these writers. As far as lead was concerned, Whitney's statement was correct. The mines were practically exhausted. On the other hand, the conclusions of Daniels were verified, too; for, with the availability of capital for the building of smelters near by, it became possible to utilize the zinc ores, and the mining industry revived. Still later, with the institution of more scientific methods and the organization and consolidation of capital, the industry began to thrive with zinc as the principal source of revenue.

Whitney and Daniels made their reports in 1854. That a lull in the mining region ensued is borne out by the statistics of lead production. About fifteen years later interest in mining was somewhat stimulated by the legislative provision of 1870 for a survey of the lead region. This act originated in a desire on the part of people of the lead district for a "more careful and full examination into the reasons which induced Prof. J. D. Whitney, of the late Geological Commission to discourage the hope of making deep mining successful."[8] John Murrish was commissioned to make the survey and it was hoped that his report would warrant, at least in part, a reversal of the judgment pronounced by Whitney. Murrish[9] reported that up to that time mining had been confined mostly to that portion of the strata above water where mining operations could be carried on at a trifling expense; that this portion of the strata was almost exhausted; and that a new system of mining would have to be introduced in order to work the deeper mines. His conclusion, that a new system of mining must be introduced, combining capital and skill, was in accord with the conclusion reached by Daniels fifteen years previous to that time. In the Annual Report made to the Governor of the state in January, 1872, on the industrial condition of the state, J. W. Hoyt stated that the re-survey of the lead region by John Murrish had "done something to quicken the interest in lead-mining, since the conclusions reached by him are favorable to the opinion that large deposits of mineral will be found in the lower Magnesian limestone."[10] It is to be noted that the interest was still exclusively in lead, and in a hope for the revival of lead production. This hope was destined not to be realized. The zinc output of 1870 was about equal to that of lead. In the next year it exceeded lead production, and the increased mineral production which occurred from 1871 to 1876 was due to zinc output and not to lead. The latter remained stationary and gradually decreased. However, the desired combination of capital and skill had not yet been made. The increased production which occurred from 1871 to 1876, and probably for some years later, was due to the fact that the water table had lowered itself. This was noted by Moses Strong in 1876 when he made a report on the Geology and Topography of the Lead Region:[11]

The large streams of the Lead Region contain a much smaller amount of water than heretofore. Several places were seen where

---

[8] Hoyt, J. W., Annual Report on Mining; Trans. Wis. State Ag. Soc., Vol. 9, 1870, p. 51.

[9] Murrish, John, Report on the Geological Survey. Appendix in Trans. Wis. State Ag. Soc., Vol. 10. 1871.

[10] Trans. Wis. State Ag. Soc., Vol. 10, 1871.

[11] Chamberlin, T. C., Geology of Wisconsin, 1873–79, Vol. 2, p. 657.

old mills, formerly operated by water-power, had been abandoned, on account of a diminished and final failure of the supply.

The diminution is not confined to surface water, spring, streams and the like, but is true, to a greater or less extent, of all mining ground of the region. In many instances this circumstance alone has led to the reopening and profitable working of mines which years ago were abandoned on account of water, with ore 'going down' in the crevices.

Strong stated that the chief cause of this decrease in water supply was the cultivation of the land, since a much greater amount of surface was thus exposed, and evaporation took place more rapidly and in larger quantities. Agriculture may thus be said to have been influential in increasing the mineral output at this time. The influence of agriculture on mining will be spoken of later.

Unfortunately Strong's data stop with the year 1876, and after that date zinc statistics become scattered and incomplete. That the next ten years did not see the devolpment of deep mining is shown by the following statement made in 1886 by Thomas H. McElroy, editor of the Southwestern Local, of Shullsburgh.[12]

There has been quite a revival of mining in the region. It is proposed to sink a test shaft to determine the possibility of profitable deep mining, the greatest depth reached thus far being about 160 feet. The average depth of the mines being worked in the Wisconsin lead and zinc region is not over 50 feet, and there are still 300 feet of the upper lead-bearing Magnesian limestone unexplored.

McElroy called the district the "lead and zinc" region, thus recognizing the importance of zinc.

The relation of agriculture to mining in the Wisconsin region is interesting, for it in turn stimulated and retarded lead and zinc production. In the early days when almost every farmer was his own miner, an increase in the agricultural population resulted in increased lead production. As agriculture developed and mining became more difficult because the surface ores had been removed, farmers turned their attention more and more to the profits of agriculture, to the neglect of mining. Thus agriculture was in part responsible for diminished lead output. However, as a result of extensive cultivation of the land, the water table was lowered and individual mining was again made possible. Thus agriculture stimulated mining. Not only did agriculture affect mining, but mining affected agriculture as well. In 1853 a writer, referring to the circumstances under which Wisconsin began her civil career, says:[13]

[12] Mineral Resources of the United States, Vol. 1886, p. 148.

[13] Hunt's Merchants' Magazine, Vol. 28, p. 447.

The mineral resources of Wisconsin attracted the attention of the first settlers, and, although this fact retarded the progress of agriculture, by drawing a large proportion of the earlier emigrants to the more exciting life of the miner, yet it must at the same time, have created a home market of some extent, and thus given an impulse to agriculture. As in all new States, the want of a market most prolongs the state of incipiency in agriculture, so this need was but slightly alleviated by the market which the mining and lumbering districts afforded.

From the standpoint of agriculture, the mines, by proving more attractive to first settlers, retarded agriculture; but at the same time the miners furnished a market for agricultural products, and this stimulated agriculture. The inter-relation between mining and agriculture in Wisconsin was referred to by Blake in 1893.[14] He said that the demand for lead was one of the early and potent factors determining the settlement of southwestern Wisconsin and the development of its mining and agricultural resources, and made the following statement:

The mines of that section, together with those of Missouri and the Mississippi Valley, may be said to have been the cradle of mining in the Western United States. The deposits of ore being at or near the surface and being numerous and widely distributed, afforded to poor men an opportunity to mine on their own account with little or no capital. The "diggings" which have often been termed "poor men's mines" soon attracted a large population. Laborers and miners were drawn thither from Cornwall and other mining centers, and those not bred to the use of the pick, gad, and windlass soon gained an experience in the use of tools and methods most useful to them in the new fields of the great west and in the mountain ranges sloping to the Pacific.

Mining thus stimulated agriculture, but it also made miners out of agriculturists, some of whom later went farther west. This suggests another factor affecting lead and zinc production: the development of richer mines farther west which attracted miners from Wisconsin just as the California gold fields attracted them in 1848.

The exact extent to which agriculture affected mineral production, either favorably or unfavorably, it is impossible to state. The two were closely related; and owners of the land are still mostly farmers. However, they now lease the ore-bearing areas to mining companies.[15]

---

[14] Blake, William P., The Mineral Deposits of Southwestern Wisconsin; Paper delivered before International Engineering Congress in August, 1893; p. 558.

[15] Rickard, T. A., The Valuation of Metal Mines." Paper No. 151, American Institute of Mining Engineers at International Engineering Congress, 1915.

Nor is it possible to state exactly what effect the general prosperity of the nation had upon lead and zinc mining in Wisconsin. Periods of financial depression must necessarily have their effect upon mining, as well as other industries, and yet the statistics of production do not always reflect that depression. For example, the year 1893 was one of exceptionally low prices for lead, to which the uncertainties of the tariff and the financial situation largely contributed. In this year Kirchoff reported that the lead mining industry in the United States shared in the general depression of business.[16] He stated, further, that the statistics for the second half of 1893 strikingly illustrated the stress put upon the zinc industry through the financial panic, the older Illinois and Eastern producers having borne the strain most successfully. No separate statistics are available for lead production in Wisconsin for the years immediately following 1893, but the incomplete figures for zinc production show only a slight variation in output. Again, in 1907,[17] while the output for the latter half of the year suffered severely, still the impetus gained from the previous prosperous year carried the industry along until the middle of 1907, and the total output of the whole region during that year and the year following showed an increase in both lead and zinc production. Siebenthal reported "much activity both in mining and in prospecting in the Upper Mississippi Valley" in the year 1907.[18] Nor was the Wisconsin production unfavorably affected, either in lead or zinc. In Missouri the zinc output declined somewhat but lead was not affected. The newer regions of production, on the other hand, Idaho, Utah, and Colorado, showed a definite response to the panic of 1907.

The price of metals has always been a potent factor in production. Whitney in 1854 quoted prices of lead in order to throw some light on fluctuations in production. The demand for lead, as evidenced by prices, was usually followed by increased production; and it was the high price of zinc in 1900 that led finally to the introduction of organized capital into the district; and the consequent development of the region has made Wisconsin one of the important zinc-producing States.

[16] Kirchoff, Charles; Mineral Resources of the United States, 1894, Pt. III of 16th Annual Report of the U. S. Geol. Survey, p. 359.

[17] Kirchoff, C., The Mineral Industry, 1893, p. 104.

[18] Siebenthal, C. E., Mineral Resources of the United States, 1907, Pt. 1, p. 659.

In 1899 the American Smelting and Refining Company was formed[19] and the first modern mill was put in active operation in the southwestern zinc field.[20] By 1905 there were from twenty to thirty large dividend-paying mines and many smaller ones, as against only two or three a few years before that time. The chief causes for improvement were the high prices for ore and the perfecting of the system of magnetic separation.[21] This enabled the separation of marcasite from the blende. Owing to the nearness in specific gravity of these two ores, it had been difficult to separate them cleanly by hydraulic methods.

In 1907, the panic year, about fifty new concentrating plants were erected, many of them of large size.[22] In 1908 occurred the consolidation of light and power companies[23] and during the following year a large central power station was constructed to supply light and power all over the district.[24] The year 1909 was also signalized, aside from the development of individual companies, by the initiation of a policy of expansion by three of the larger mining companies, and the feature of the year 1910 was the extension of holdings by the leading operating companies in the district.[25] In 1911 the large companies continued to add to their holdings by purchase and lease, and most of the increased output was due to their operations.[26] The concentration of the mining properties of the district into the hands of fewer interests continued during 1912,[27] and in 1913 the large mining interests continued to add to their holdings by lease or purchase, and increased the scope of their operations by acquiring new fees or leases.[28] In 1915 several new mines were operated with local capital, and outside capital was invested in the district, but the increased production and development was mainly due to the extension of operations by the large companies.[29] The interest now is entirely in the mining of zinc.

---

[19] Mineral Resources of the United States, 1899–1900, Pt. VI, 21st Annual Report of the U. S. Geol. Survey, p. 229.

[20] Moore, E. W., The Mineral Industry, Vol. 15, p. 765.

[21] Ibid., Vol. 14, pp. 574–6.

[22] Dunlop, J. P., Mineral Resources of the United States, 1910, Pt. 1, p. 670.

[23] Siebenthal, C. E., Mineral Resources of the United States, 1908, Pt. 1, p. 640.

[24] Siebenthal, C. E., Ibid, 1909, Pt. 1, p. 531.

[25] Siebenthal, C. E., Ibid., 1910, Pt. 1, p. 273.

[26] Dunlop, J. P., Ibid., 1911, Pt. 1, p. 866.

[27] Siebenthal, C. E., Ibid., 1912, Pt. 1, p. 387.

[28] Dunlop, J. P. Ibid., 1918, Pt. 1, p. 162.

[29] Dunlop J. P., Ibid., 1915, Pt. 1, p. 130.

The relative values of the two industries are shown in tables and charts which follow.

Siebenthal, in speaking of the Upper Mississippi Valley region makes the following statement:[30]

> The mines were at first worked exclusively for lead, but since 1860 the production of zinc ore has predominated over that of lead ore, with which the zinc ore is associated in many mines.

This statement is not accurate, for while the zinc ores first began to be utilized in 1860, the output was very small, and it was not until some years later that the tonnage of zinc exceeded that of lead. For Wisconsin this occurred in the year 1871, when the production of zinc ores amounted to 12,961 tons and of lead ore, 6,742 tons. In 1860 the output of zinc ore from the region was 160 tons, whereas the output of metallic lead was 12,227 tons.

The statistics of zinc production are so fragmentary that no fair comparison can be made between the two industries except for the ten-year period 1866–1875, when Moses Strong collected data which he considered to be fairly complete, and the ten-year period 1907–1916, for which annual statistics appear in Mineral Resources of the United States. These two ten-year periods are discussed in the pages which follow. Discussion of lead production covers the same two periods. Moses Strong collected data for the earlier decade which make possible the representation of lead production in Wisconsin by producing districts; and the United States Geological Survey has published similar data beginning with the year 1907. Exhibits I and II show annual production of lead and zinc, respectively, for the Upper Mississippi Valley, whereas the charts and accompanying text which follow deal with the production of Wisconsin only.

[30] Siebenthal, C. E., Mineral Resources of the United States, 1910, Pt. 1, p. 235.

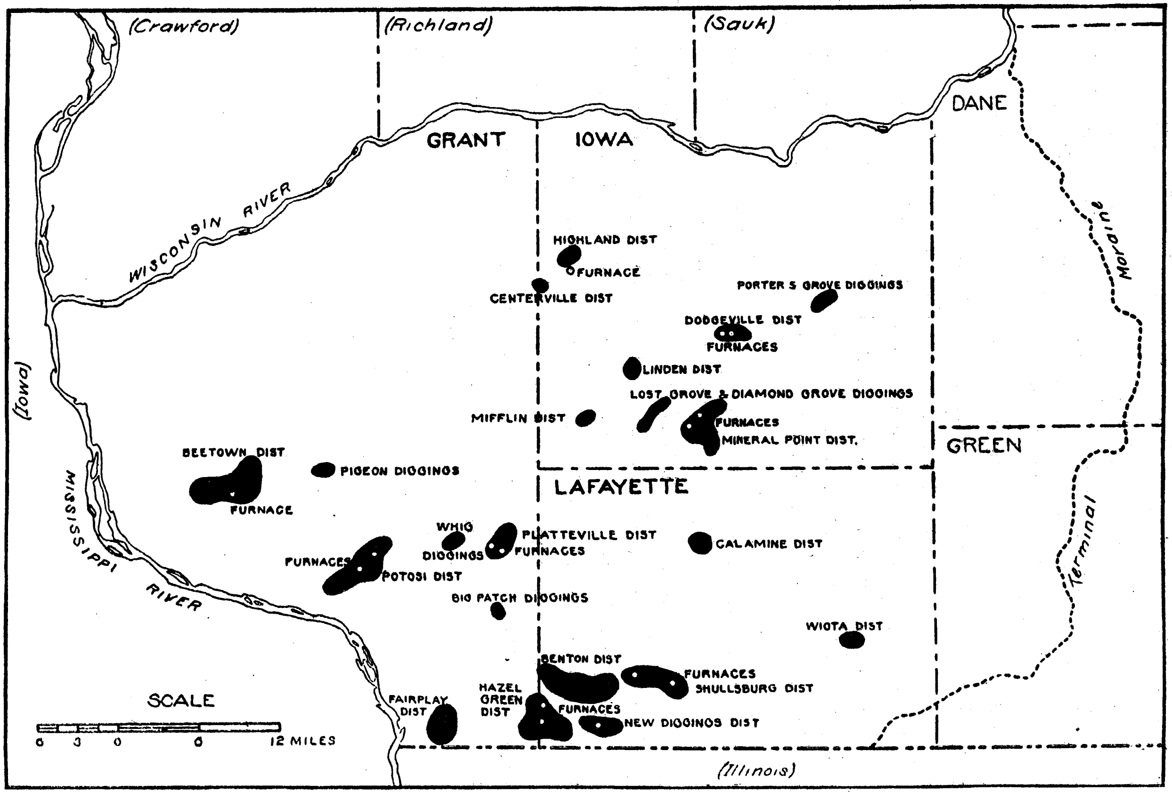


FIG. 2. Mining Districts and Furnaces in the Wisconsin Lead Region in 1876
From Chamberlin's Geology of Wisconsin 1873–79

IV.

Wisconsin Lead Production.

Mining Districts and Furnaces in Wisconsin in 1876. In 1876 Grant, Iowa, and Lafayette counties each had five furnaces. (Fig. 2). Two districts in each county had two furnaces each, i. e.: Dodgeville and Mineral Point in Iowa County; Potosi and Platteville in Grant County; and Shullsburg and Hazel Green in Lafayette County. The Hazel Green district included portions of Grant and of Lafayette counties, but the furnaces were located in Lafayette County. The village of Hazel Green, on the other hand, is across the line in Grant County. The following districts had one furnace each. Highland in Iowa County; Beetown in Grant County, and New Diggings in Lafayette County. The number of districts having furnaces was nine: Mineral Point, Dodgeville, Highland, Beetown, Potosi, Platteville, Hazel Green, New Diggings, and Shullsburg.

Production. The amount of lead ore smelted by furnaces in these nine districts is shown in diagramatic form in figures 3a, 3b, and 3c, which represent respectively production of the five-year period 1866–1870; production of the five-year period 1871–1875, and production of the ten-year period 1866–1875. In the first period mentioned, the five years from 1866 to 1870, Potosi had the largest production, 7,300 tons, while New Diggings and Mineral Point came second, with 5,900 and 5,588 tons respectively. Shullsburg, Dodgeville, and Hazel Green came next in the order of production, while Platteville, Beetown, and Highland produced the smallest amounts. Estimated production for Highland was 1,250 tons.

In the five-year period from 1871 to 1875, inclusive, the production for each district decreased with the exception of Dodgeville and Beetown. These districts had an increase of about 35% each, the production of Dodgeville increasing from 2,965 tons in the earlier period to 4,023 tons in the period 1871–1875; and the production of Beetown increasing from 1,800 tons to 2,425 tons. Potosi, which formerly occupied first place, produced at this time less than Mineral Point, Dodgeville, Shullsburg, or New Diggings. In the five year period under discussion Mineral Point had the largest production, 4,510 tons.

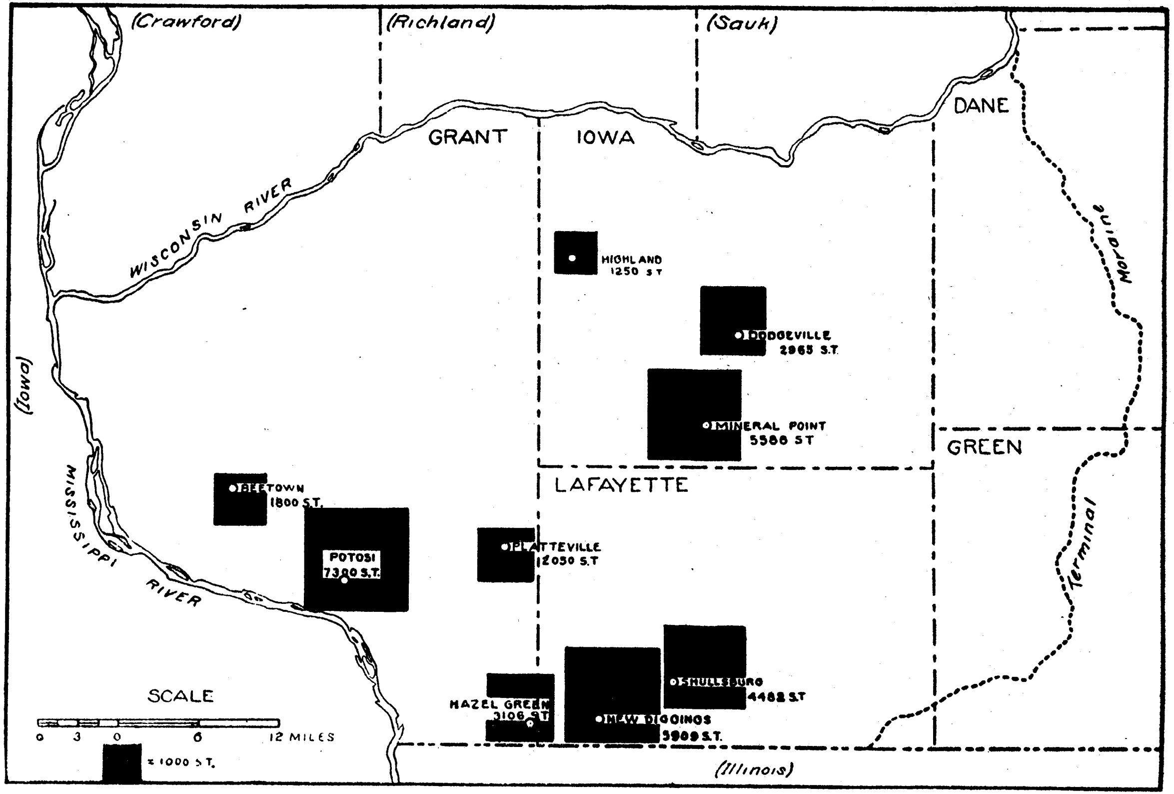


FIG. 3a. Production of Lead Ore 1866–1870, Inclusive
Data from Chamberlin's Geology of Wisconsin 1873–79

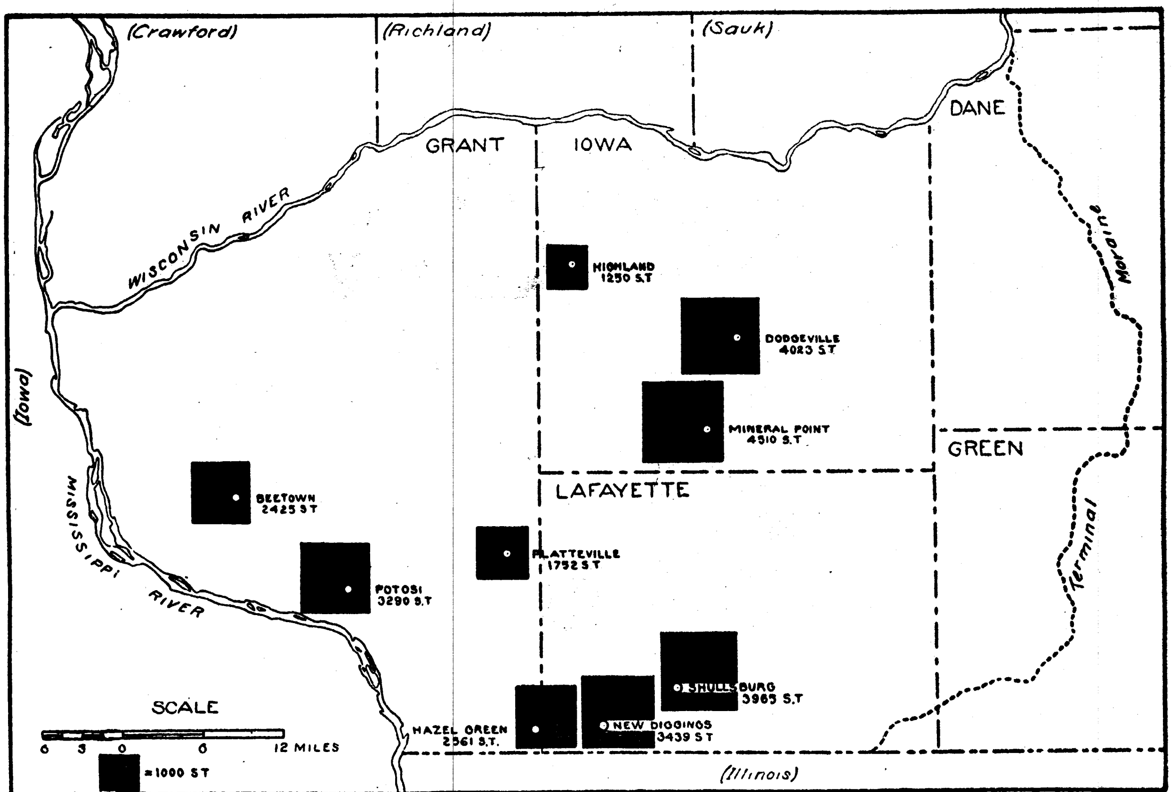


FIG. 3b. Production of Lead Ore 1871–1875, Inclusive
Data from Chamberlin's Geology of Wisconsin 1873–79

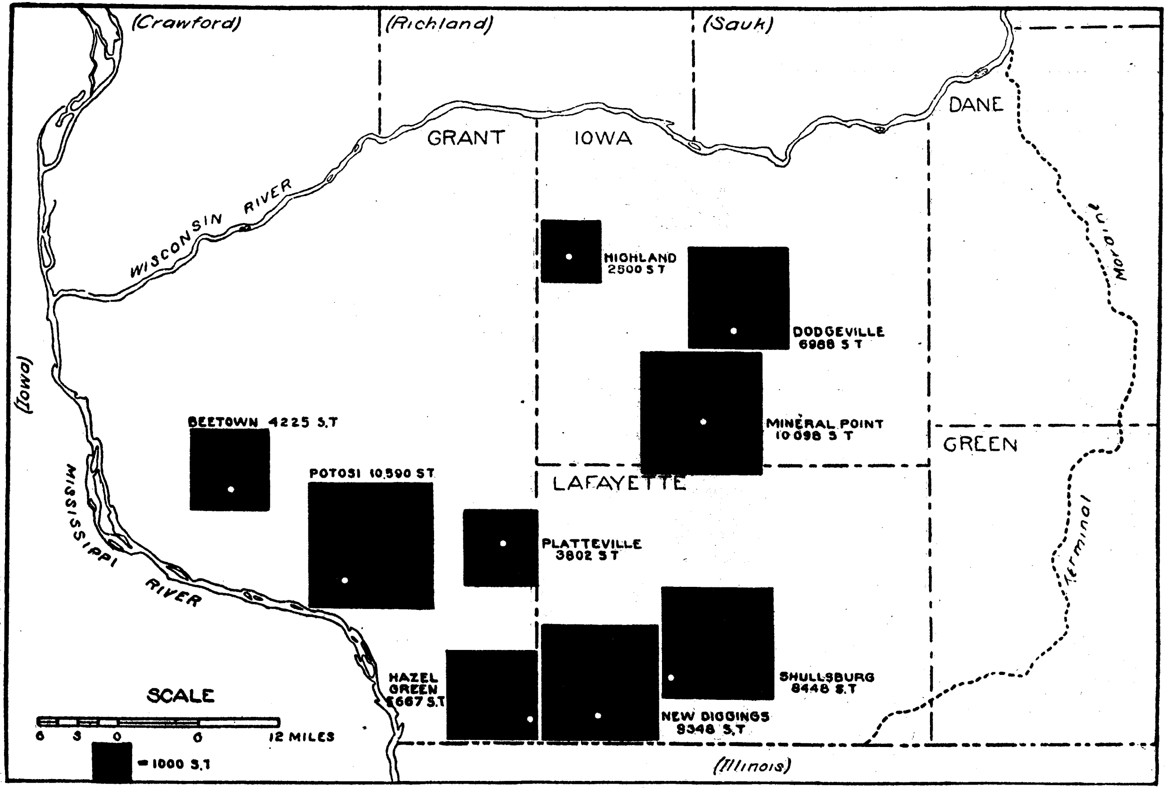


FIG. 3c. Production of Lead Ore 1866–1875, Inclusive
Data from Chamberlin's Geology of Wisconsin 1873–79

Dodgeville and Shullsburg each produced about 4,000 tons, and New Diggings, Potosi and Beetown produced lesser amounts. Hazel Green, Platteville and Highland produced the least. The production of Highland is 1,250 tons as in the former five-year period, the reason being that the production of Highland was an estimate of 500,000 pounds per annum. The total production in the state (see table 2) shows a decrease of 21%, from 34,450 tons in 1866–1870 to 26,216 tons in 1871–1875.

Figure 3c shows production of lead ore by furnace districts for the ten-year period 1866–1875, inclusive. If Hazel Green is assigned to Lafayette County because her furnaces were located there, each of the three counties comprising the lead region in Wisconsin smelted about the same quantity of ore, in the neighborhood of 20,000 tons. Lafayette smelted 23,463 tons; Iowa 19,586; and Grant 18,617. The highest individual output was by the Potosi district, 10,590 tons. The lowest, 2,500 tons, was by Highland. This amount, as above stated, was an estimate. Not far behind Potosi were Mineral Point, 10,098 tons; New Diggings, 9,348 tons, and Shullsburg, 8,448 tons. Next in order of rank came Dodgeville, 6,988 tons, and Hazel Green 5,667 tons, followed by Beetown and Platteville with 4,225 tons and 3,802 tons, respectively.

Figures 4a, 4b and 4c show production of lead ore for the following periods: the five years 1907–1911, inclusive; the five years 1912–1916, inclusive, and the ten years 1907–1916, inclusive. These charts have the same scale as the series showing production of lead ore from 1866 to 1875, and may be directly compared as to quantity of production. In making comparisons it should be borne in mind that the earlier series show the amount of lead ore smelted by the fifteen furnaces then located in nine of the producing districts, whereas the later charts show the output of each of the producing districts. In 1876 the New Diggings District included the mines in the vicinity of Benton, and the furnaces of the Mineral Point district smelted the ores produced by the Mifflin and Linden districts.[31] The output of Mifflin and Linden should therefore be added to the amount produced by Mineral Point when comparison is made with the furnace production of Mineral Point.

A study of the two sets of charts reveals, first of all, a notable

[31] Chamberlin's Geology of Wisconsin, 1873–78, v. 2, p. 746.

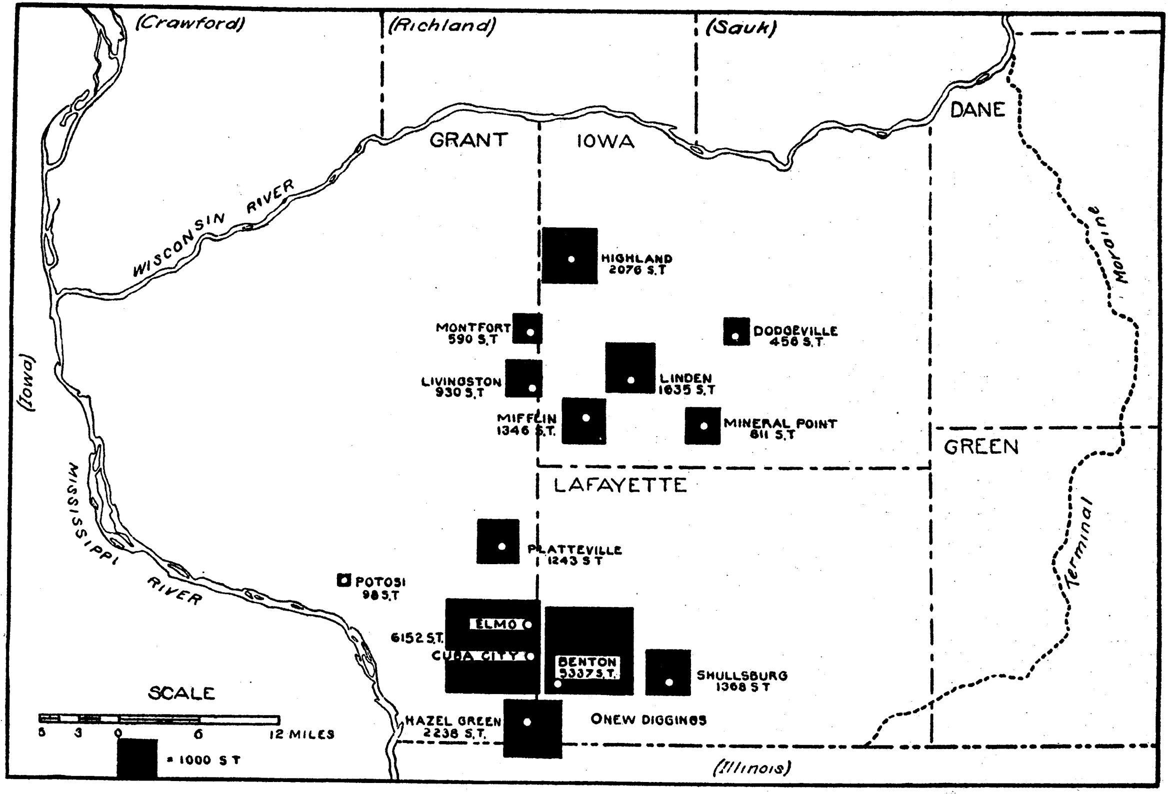


FIG. 4a. Production of ead Ore 1907–1911, Inclusive
Data from Mineral Resources of the United States

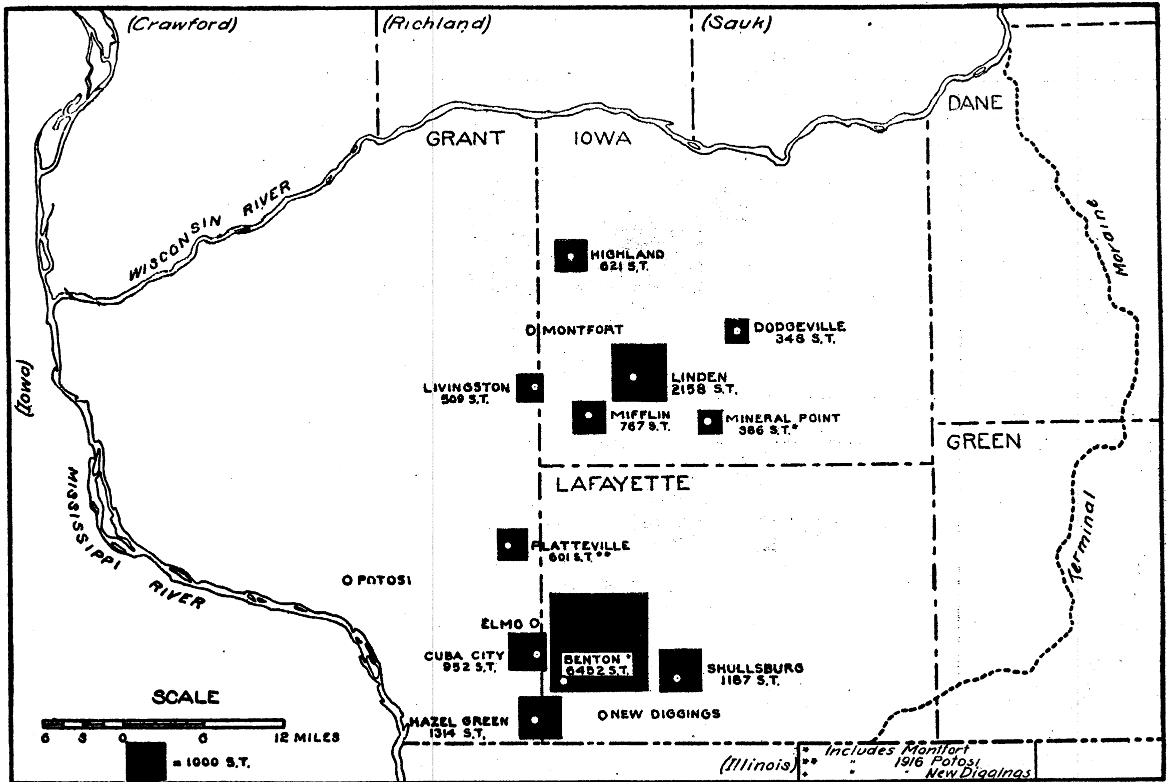


FIG. 4b. Production of Lead Ore 1912–1916, Inclusive
Data from Mineral Resources of the United States

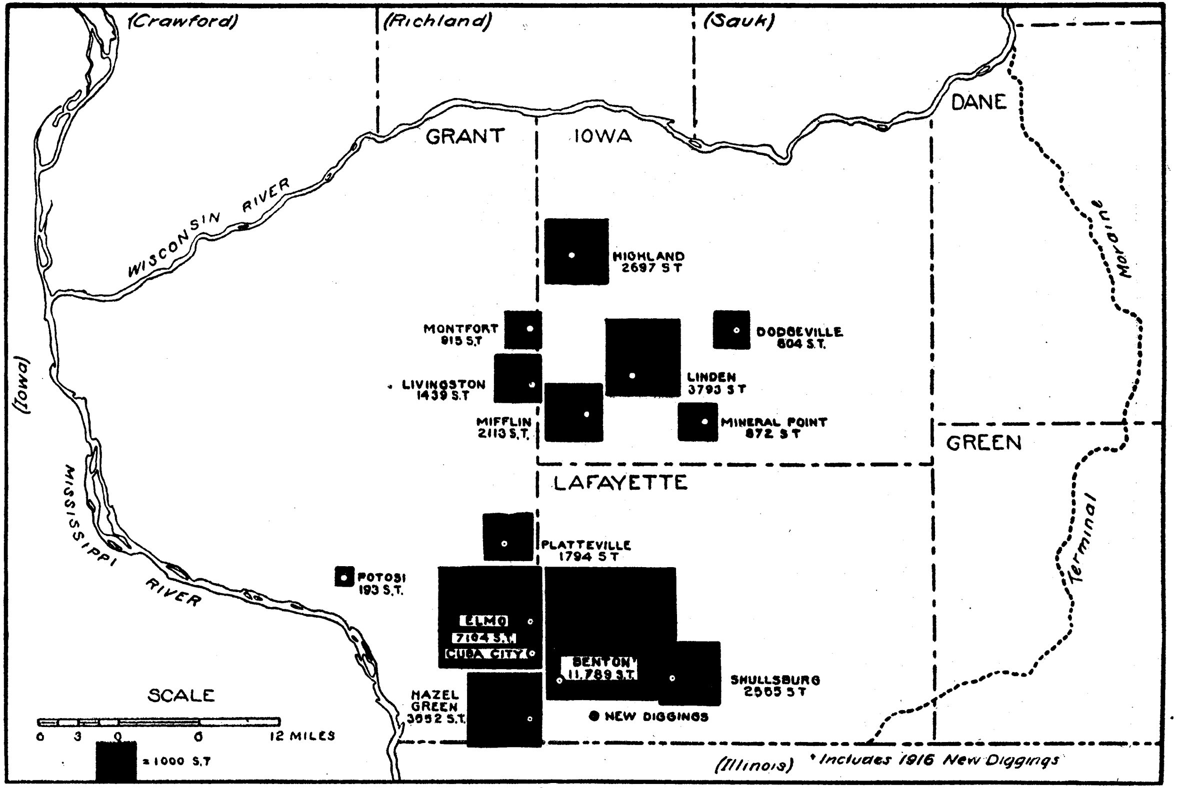


FIG. 4c. Production of Lead Ore 1907–1916, Inclusive
Data from Mineral Resources of the United States

decrease of production in the district as a whole. The total amount of lead ore produced in the ten years 1866–1875 was 61,666 tons, (see table 2) whereas the total amount produced in the ten years 1907–1916 was 39,575 tons, (see table 3). This is a decrease of 35.8%. Compared with the decade of maximum production 1841–1850, inclusive, (see fig. 1) the production of 1907–1916 shows a 79% decrease. Notable also is the change of production in Grant County. The Beetown district, which formerly ranked with the Platteville district, shows no production whatever in the ten years 1907–1916. Potosi, formerly the greatest producing district, (figs. 3a, 3b, 3c), is now one of the least, (figs. 4a, 4b, 4c). Her 1916 production was included with the production of Platteville. Platteville shows a decrease in production of over 50%, (from 3,802 tons for the ten years 1866–1875 to 1,794 tons for the ten years 1907–1916). It is to be remembered that the two sets of charts are not exactly comparable. It is probable that the production of Cuba City-Elmo includes ore which formerly was sent to Platteville to be smelted. The Cuba City-Elmo district is located in Grant County between Platteville and Hazel Green. In 1876 the Big Patch Diggings were located northwest of the present village of Elmo, and the production of Big Patch Diggings was sent to the Platteville furnaces.[32] The production of this new district Cuba City-Elmo was the highest in the state for the five years 1907–1911, 6,152 tons, but in the next five years, 1912–1916, Elmo produced nothing, and the production of Cuba City fell to less than one thousand tons.

In Iowa county there seems at first glance to have been a shifting of production from the eastern to the western part of the county, and Mineral Point and Dodgeville which formerly were large producers seem now to be producers of small importance. It should be remembered that the production of Linden and Mifflin was included in the Mineral Point production of 1866–1875. The output of Highland (for the years 1907–1916) is slightly greater than the estimate made for Highland in 1866–1875.

In Lafayette County in the ten years 1866–1875 Shullsburg and New Diggings produced almost equal amounts of ore, with New Diggings slightly in the lead. The New Diggings district

[32] Chamberlin's Geology of Wisconsin, 1873–78, v. 2, p. 744.

included mines in the vicinity of Benton.[33] Of late years New Diggings has decreased in importance. Its 1916 output was included with the output of the Benton district which has come to be the largest producer in the state. Shullsburg whose production slightly exceeded that of New Diggings-Benton in the five years 1871–1875, shows a steady decline. Shullsburg furnaces smelted 8,448 tons of lead ore in the ten years 1866–1875, and the district produced 2,002 tons of lead ore in the ten years 1907–1916. With the decline of the Cuba City-Elmo production, which in 1907–1911 exceeded the Benton-production, the Benton district assumes first rank.

The Benton-New Diggings district produced 11,789 tons of lead ore in the years 1907–1916. This is a larger amount than was smelted by Potosi in the ten years 1866–1875, and Potosi was at that time the largest producer, her output for the ten years having been 10,590 tons.

The trend of production in recent years is shown in figures 7a and 7b. The whole region produced 24,280 tons of lead ore from 1907 to 1911, inclusive, and 15,295 tons from 1912 to 1916, inclusive, (see table 3). This was a 37% decrease in production. The only two districts which showed an increase of production in 1912–1916 over the five-year period immediately preceding were Linden and Benton. The output of Linden increased 32%, from 1,635 tons to 2,158 tons, and the output of Benton 21%, from 5,337 tons to 6,452 tons.

Quantity of metallic lead by producing districts is charted in figures 5a, 5b and 5c, showing production for the five years 1907–1911, inclusive; for the five years 1912–1916, inclusive; and for the ten years 1907–1916, inclusive. These figures are drawn to the same scale as the figures already discussed and are directly comparable with them. Data were not obtainable for production of metallic lead for the years 1866–1875.

The relative ranks of the lead producing districts in Wisconsin are indicated in figures 6a, 6b, 6c, and 7a, 7b, 7c, which indicate by bar graphs the following: Quantity of lead smelted by furnace districts in the five years 1866–1870, the five years 1871–1875, and the ten years 1866–1875; quantity of lead ore produced in the five years 1907–1911, the five years 1912–1916, and the ten years 1907–1916. The quantity of metallic lead obtained from the ores is indicated in the last three periods men-

[33] Chamberlin's Geology of Wisconsin, 1873–78, v. 2, p. 746.

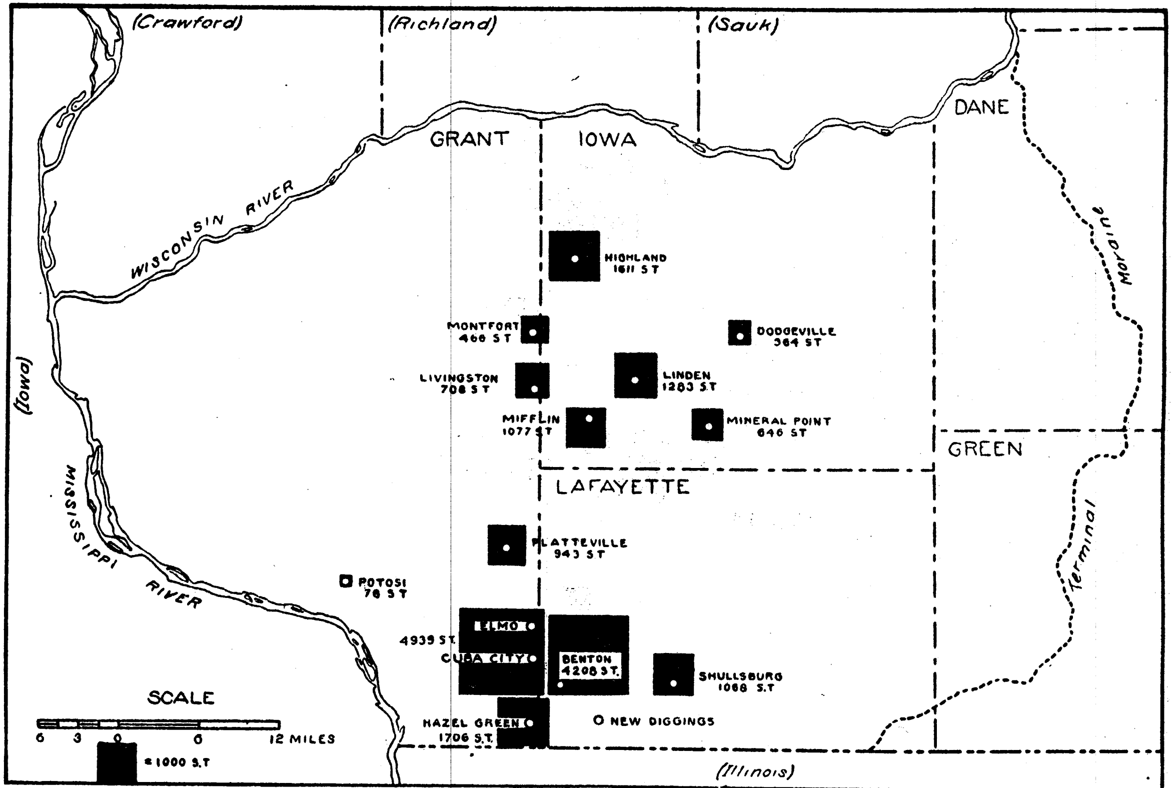


FIG. 5a. Production of Metallic Lead 1907–1911, Inclusive
Data from Mineral Resources of the United States

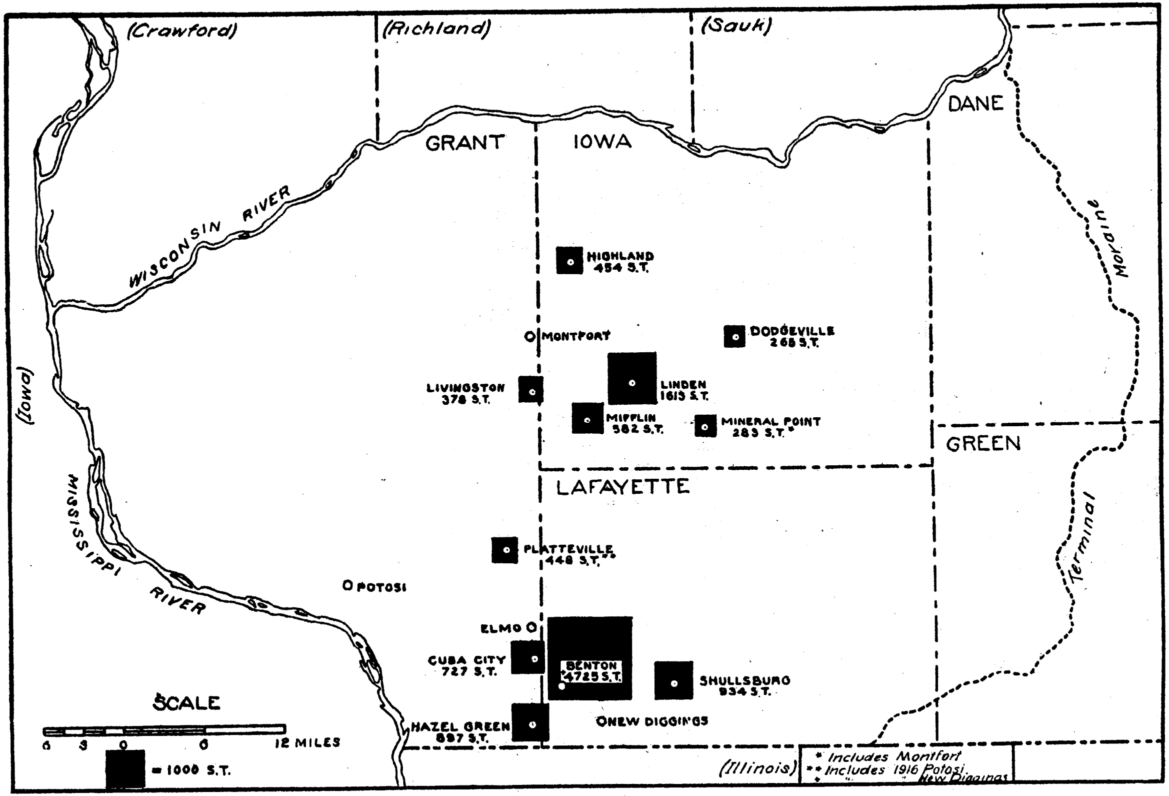


FIG. 5b. Production of Metallic Lead 1912–1916, Inclusive
Data from Mineral Resources of the United States

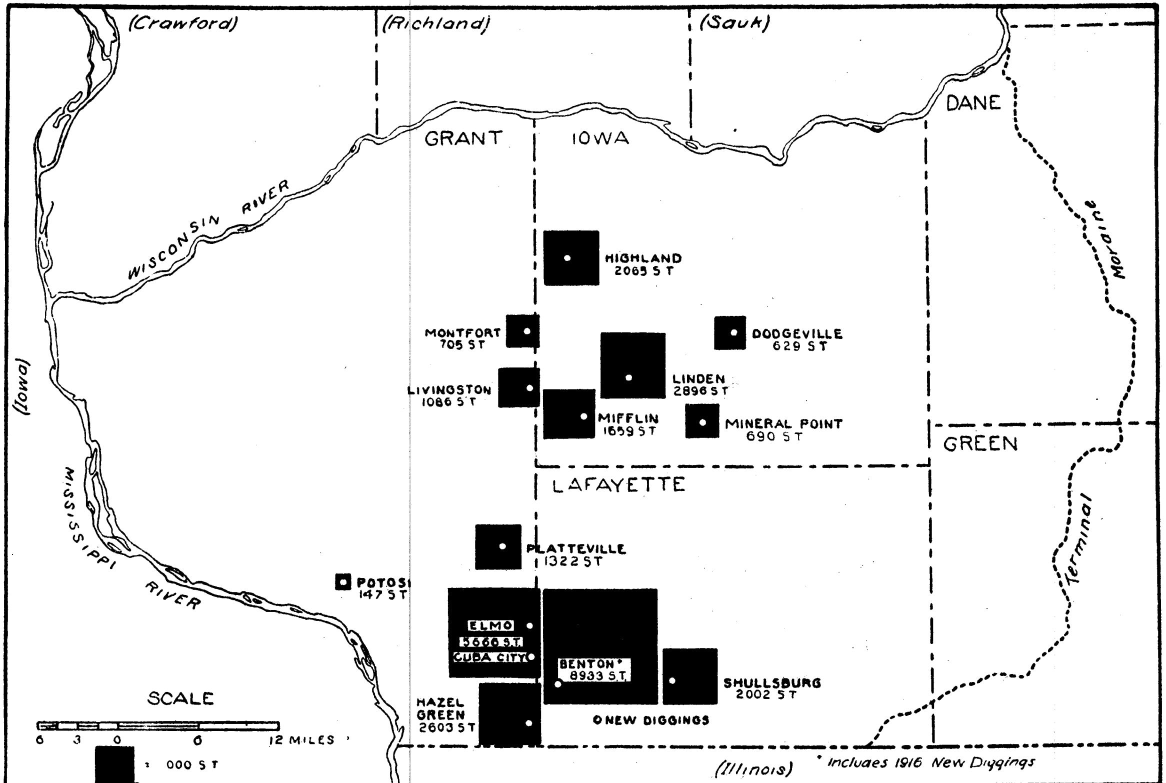


Fig. 5c. Production of Metallic Lead 1907–1916, Inclusive
Data from Mineral Resources of the United States

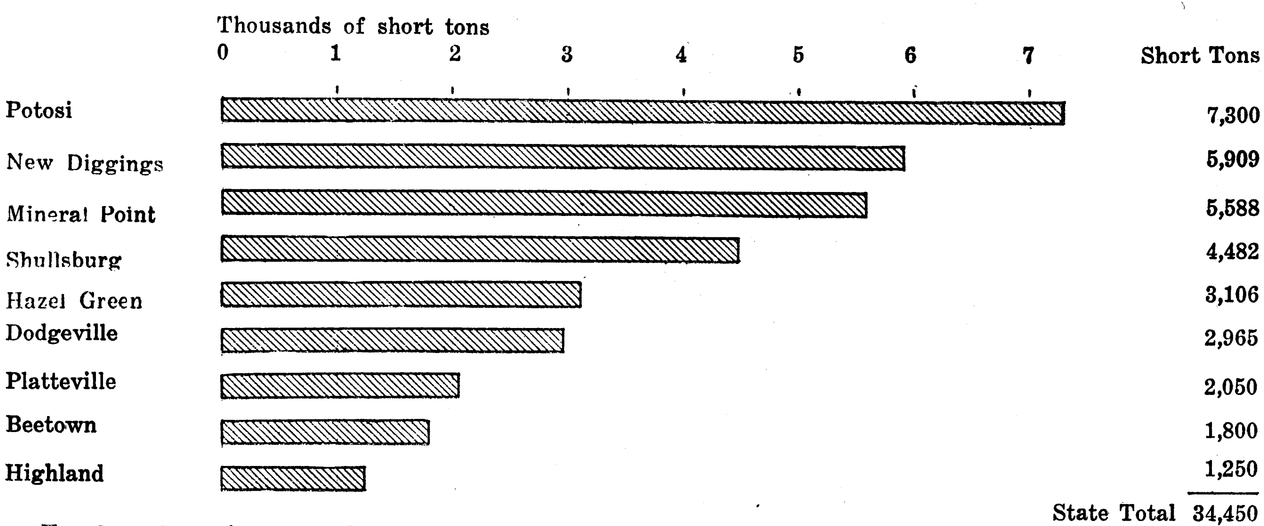


FIG. 6a. Quantity of lead ore produced in Wisconsin 1866–1870, inclusive, by furnace districts. Data from Chamberlin's Geology of Wisconsin, 1873–1879.

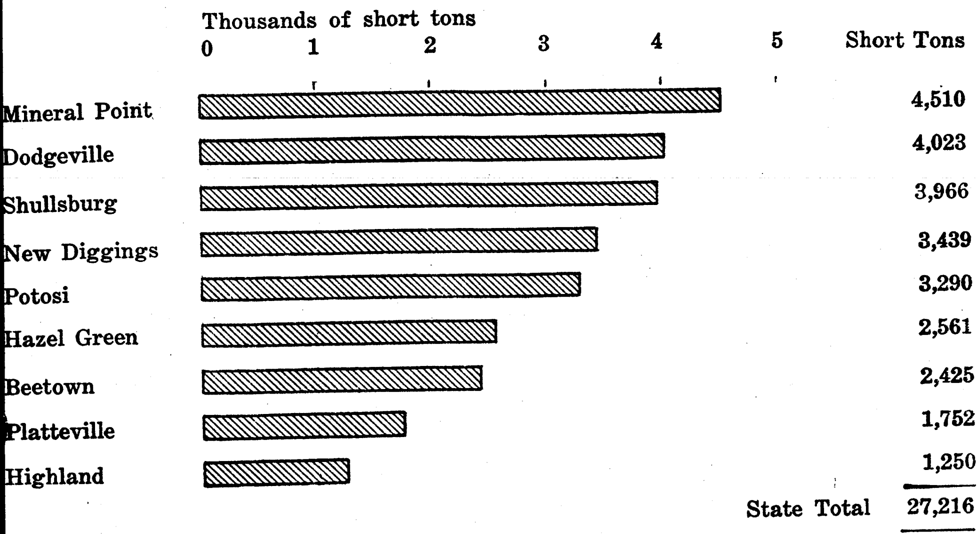


FIG. 6b. Quantity of lead ore produced in Wisconsin 1871–1875, inclusive, by furnace districts.
Data from Chamberlin's Geology of Wisconsin, 1873–1879.

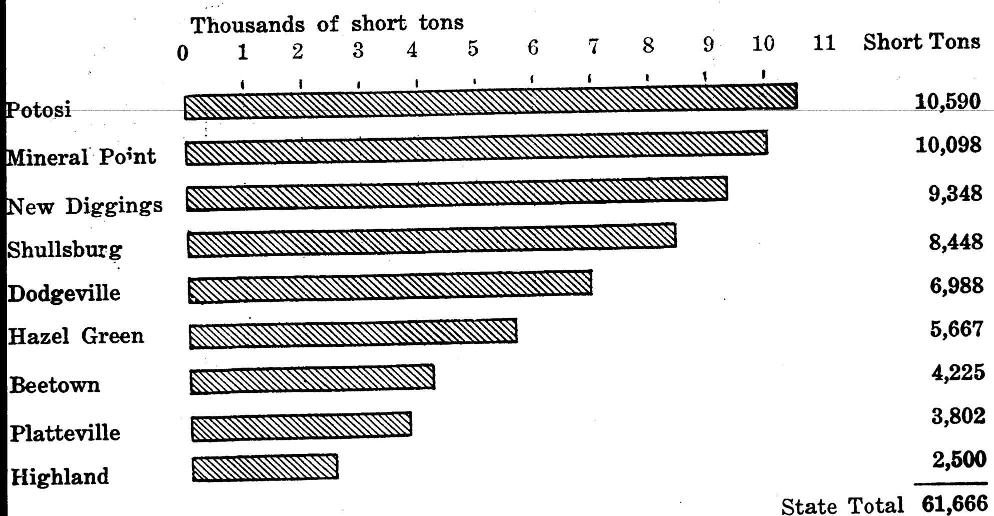
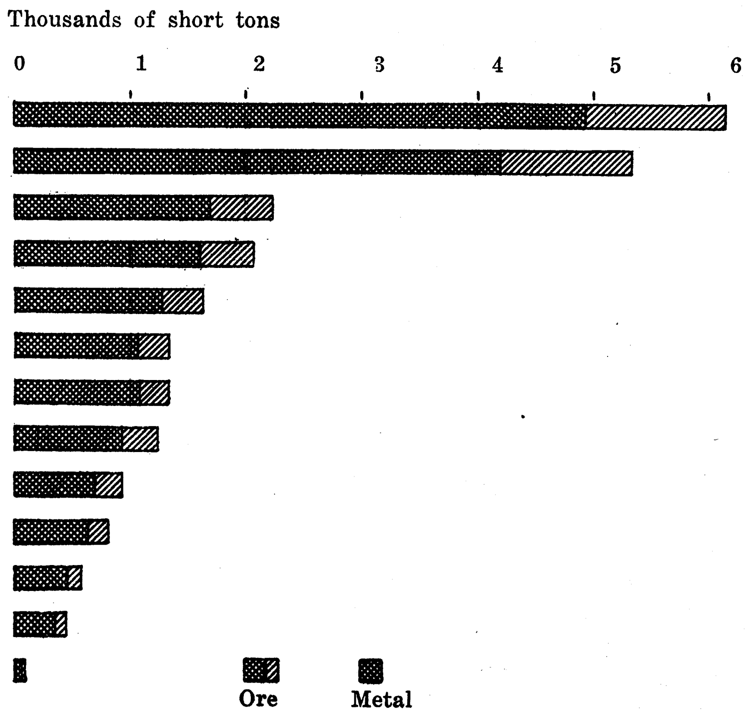
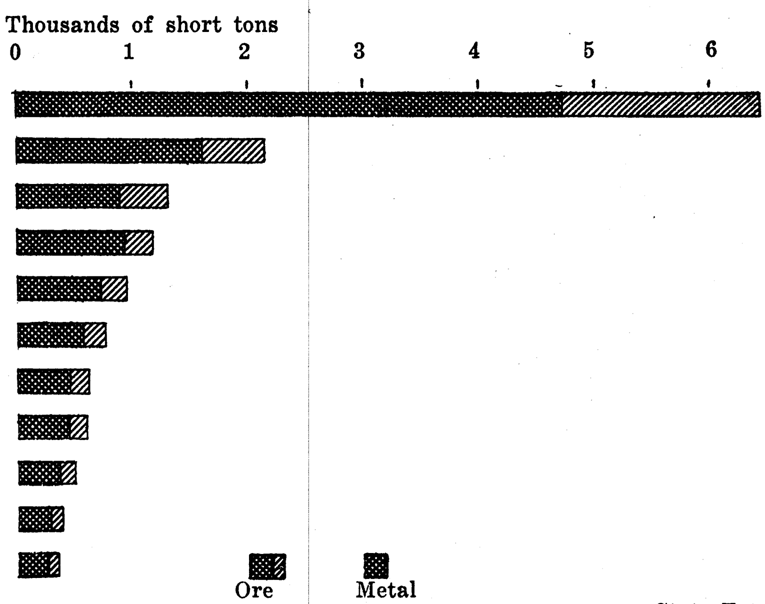


FIG. 6c. Quantity of lead ore produced in Wisconsin 1866–1875, inclusive, by furnace districts.
Data from Chamberlin's Geology of Wisconsin, 1873–1879



		Metal	Ore
		Short Tons	
Cuba City–Elmo	80.2%	4,939	6,152
Benton	79.0%	4,208	5,337
Hazel Green	76.4%	1,706	2,238
Highland	77.7%	1,611	2,076
Linden	78.6%	1,283	1,635
Shullsburg	78.1%	1,068	1,368
Mifflin	80.0%	1,077	1,346
Platteville	75.8%	943	1,243
Livingston	76.1%	708	930
Mineral Point	79.6%	646	811
Montfort	79.0%	466	590
Dodgeville	79.8%	364	456
Potosi	79.6%	78	98
State Total	78.6%	19,097	24,280

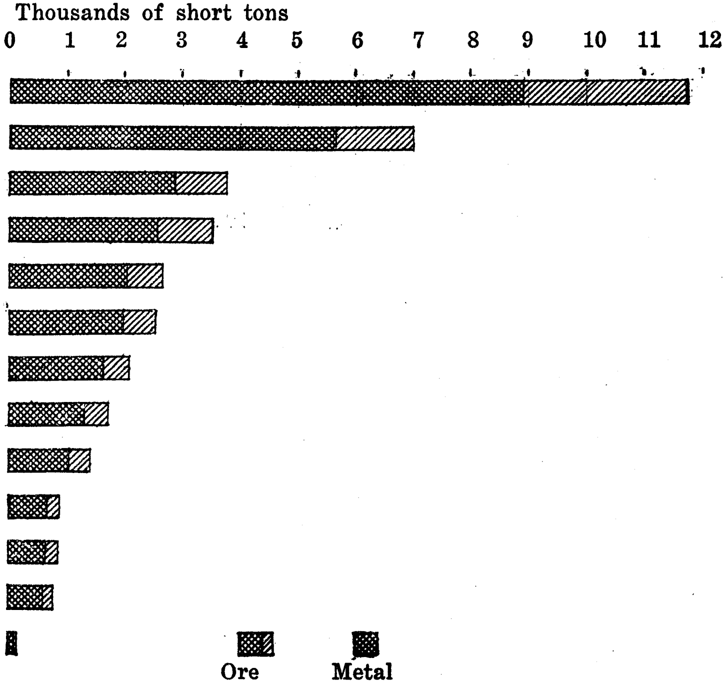
FIG. 7a. Quantity of lead produced in Wisconsin 1907–1911, inclusive.
Data from Mineral Resources of the United States.



		Metal	Ore
		Short Tons	
Benton*	73.2%	4,725	6,452
Linden	74.9%	1,613	2,158
Hazel Green	68.3%	897	1,314
Shullsburg	78.6%	934	1,187
Cuba City	76.4%	727	952
Mifflin	75.9%	582	767
Highland	73.1%	454	621
Platteville**	74.5%	448	601
Livingston	74.3%	378	509
Mineral Point–Montfort	73.4%	283	386
Dodgeville	76.1%	265	348
State Total	73.9%	11,306	15,295

*Includes 1916 New Diggins.
**Includes 1916 Potosi.

FIG. 7b. Quantity of lead produced in Wisconsin 1912–1916, inclusive.
Data from Mineral Resources of the United States.



		Metal	Ore
		Short Tons	
Benton*	75.8%	8,933	11,789
Cuba City–Elmo	79.6%	5,666	7,104
Linden	76.3%	2,896	3,793
Hazel Green	73.4%	2,603	3,552
Highland	76.6%	2,065	2,697
Shullsburg	78.4%	2,002	2,555
Mifflin	78.5%	1,659	2,113
Platteville	75.6%	1,322	1,749
Livingston	75.5%	1,086	1,439
Montfort	77.0%	705	915
Mineral Point	79.1%	690	872
Dodgeville	78.8%	629	804
Potosi	76.2%	147	193
State Total	76.9%	30,403	39,575

* Includes 1916 New Diggings.

FIG. 7c. Quantity of lead produced in Wisconsin 1907–1916, inclusive.
Data from Mineral Resources of the United States.

tioned and something of the tenor of the ore is thus shown. Percentages are recorded on each chart. For the earlier period, 1866–1875, data for metallic lead were not available.

Consideration of the five-year periods in succession, 1866–1870, 1871–1875, 1907–1911, and 1912–1916, shows that Potosi moved successively from first place to fifth, to thirteenth, and finally to insignificance. New Diggings (with the Benton production included) moved from second place to fourth; back to second under the name, now, of Benton, and finally to first place (with 1916 New Diggings included in Benton production). Shullsburg occupied successively fourth, third, sixth, and fourth place. Mineral Point moved from third place in 1866–1870 to first in 1871–1875 and thereafter it declined. Her production when third in rank was 5,588 tons, a larger amount by 1,000 tons than she produced when occupying first rank. The Linden and Mifflin ores were smelted by the Mineral Point furnaces in 1866–1875, as already indicated. The production of the whole lead region decreased successively as follows in the five-year periods under discussion: 34,450 tons, 27,216 tons, 24,280 tons, 15,295 tons.

The quality of the ore is indicated by the percentages which appear on the charts. This information was obtainable for the years 1907–1916 but not for the earlier period 1866–1875. For the state as a whole the quality of the ore seems to have declined, for in the five years 1907–1911 24,280 tons of lead ore produced 19,097 tons of metallic lead, showing that the metal content of the ore was 78.6%, whereas in the five years 1912–1916 11,306 tons of metal were obtained from 15,297 tons of ore, indicating a 73.9% metal content. The percentages range from 80.2% for the Cuba City-Elmo district when it ranked as first producer in the years 1907–1911, to 68.3% for the Hazel Green district in the years 1912–1916. The quality of the ore does not remain constant in a given district, as is shown by the fact that Cuba City in 1912–1916 produced only a 76.4% grade. This is rather low as compared with its 80.2% former grade, but it is a high percentage when compared with the output of the other districts during the same five-year period. In that period, 1912–1916, only one district produced ore of a better quality, namely Shullsburg, which showed a percentage of 78.6. The remaining districts range from 76.1% to 68.3%. The lowest figure belonged to Hazel Green, but Hazel Green in the five years im-

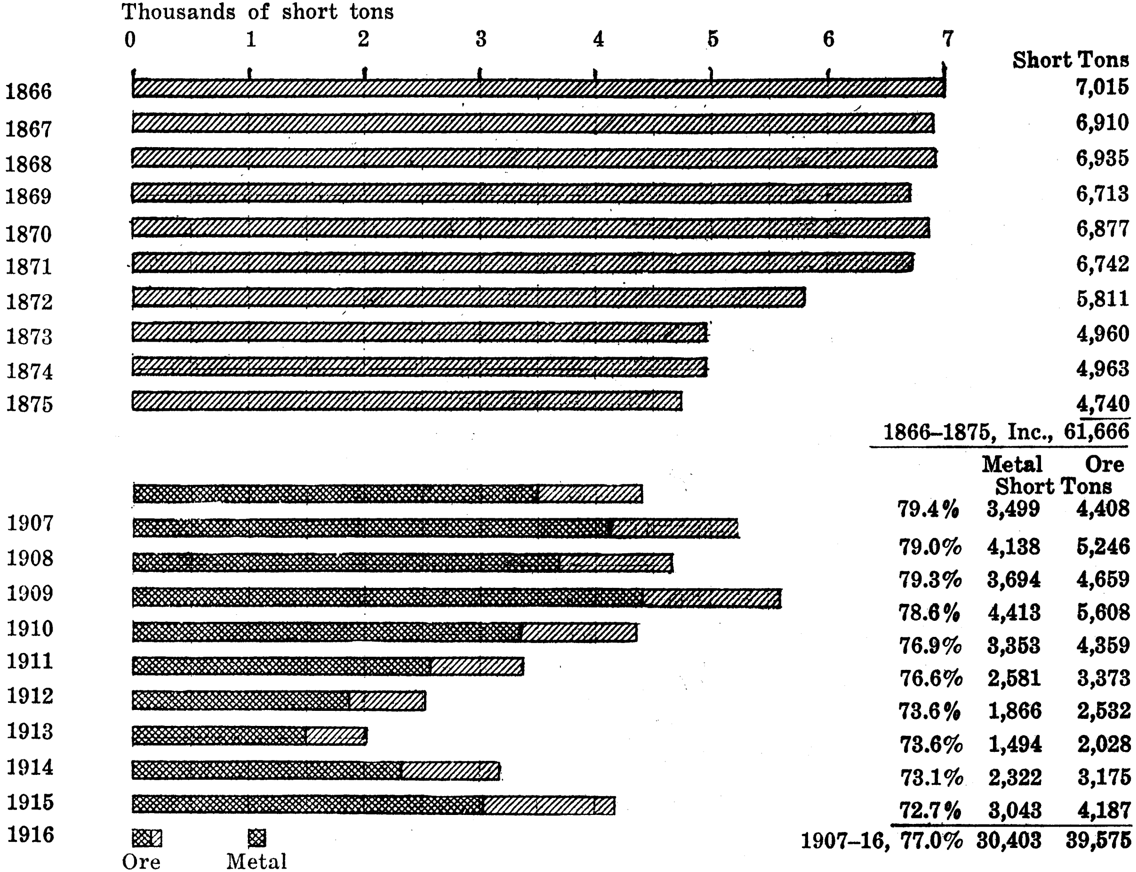


FIG. 8. Quantity of lead produced in Wisconsin annually, 1866–1875, inclusive, and 1907–1916, inclusive.
Data from Chamberlin's Geology of Wisconsin, 1873–1879, and Mineral Resources of the United States.

mediately preceding produced a 76.4% ore. Every district with the exception of Shullsburg showed a decrease in the quality of ore. Shullsburg shows a slight increase, from 78.1% in 1907–1911 to 78.6% in the five years 1912–1916.

The production thus far considered has been for individual districts in the lead region of Wisconsin. Total state production is shown in fig. 8. This chart gives the quantity of lead produced annually from 1866 to 1875, inclusive, and annually from 1907 to 1916, inclusive. For the ten years 1866–1875, only ore statistics were available, but the ten years 1907–1916 show not only the quantity of ore produced each year, but the metal obtained from the ore. The percentages indicate the quality of the ore.

In the ten years 1866–1875 the production remained fairly constant for the first six years. Then it decreased for two years, after which it again remained about the same. From 1866, in which year production amounted to 7,015 tons of lead ore, to 1875, when the output amounted to 4,740 tons, there was a decrease in annual production of about 33%.

In the ten years 1907–1916 there was greater fluctuation than in the earlier period considered. The highest point in the production of the last ten years was reached in 1910, when 5,608 tons of ore were produced. After 1910 there was a continuous decline until 1914 when the output of lead ore amounted to 2,028 tons. In 1915 and 1916 there was a decided percentage increase —an easy accomplishment when the tonnage is so small. The 1916 output was again a little over 4,000 tons, as in the years 1907, 1909, and 1911. 1908 and 1910 were the only years when production surpassed the 5,000 ton mark.

State production of lead ore for the ten years 1866–1875 was 61,666 tons, and for the ten years 1907–1916 the output was 39,575 tons. This is a decrease of 35.8%.

The quality of the ore declined steadily. In 1907 79.4% of the lead ore was metallic lead, while in 1916 only 72.7% of the ore was metal. For the whole period, from 1907 to 1916, inclusive, 30,403 tons of metal were obtained from 39,575 tons of concentrates, or 77%.

The value of the lead produced in the several districts in Wisconsin (a) in the five years 1907–1911, inclusive; (b) in the five years 1912–1916, inclusive; and (c) in the ten years 1907–1916, inclusive, is shown in figs. 9a, 9b, 9c, and figs. 10a, 16b, 10c.

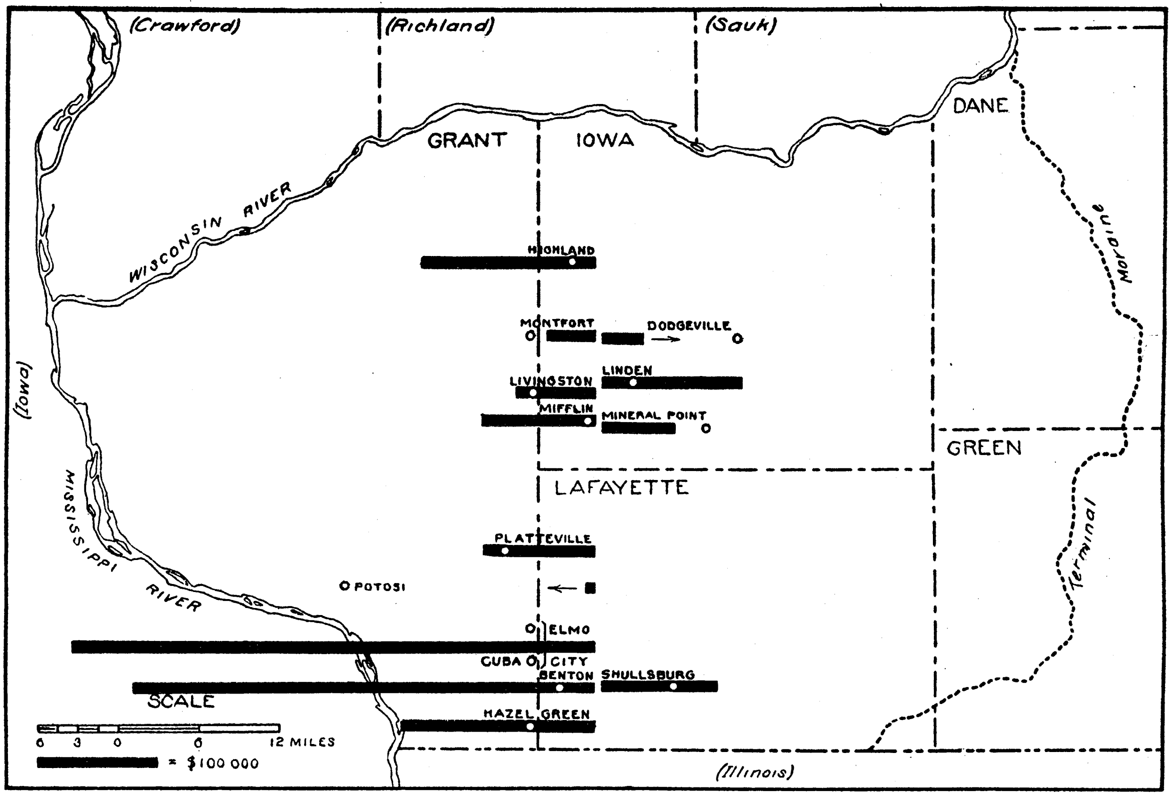


Fig. 9a. Value of Metallic Lead Produced 1907–1911, Inclusive
Data from Mineral Resources of the United States

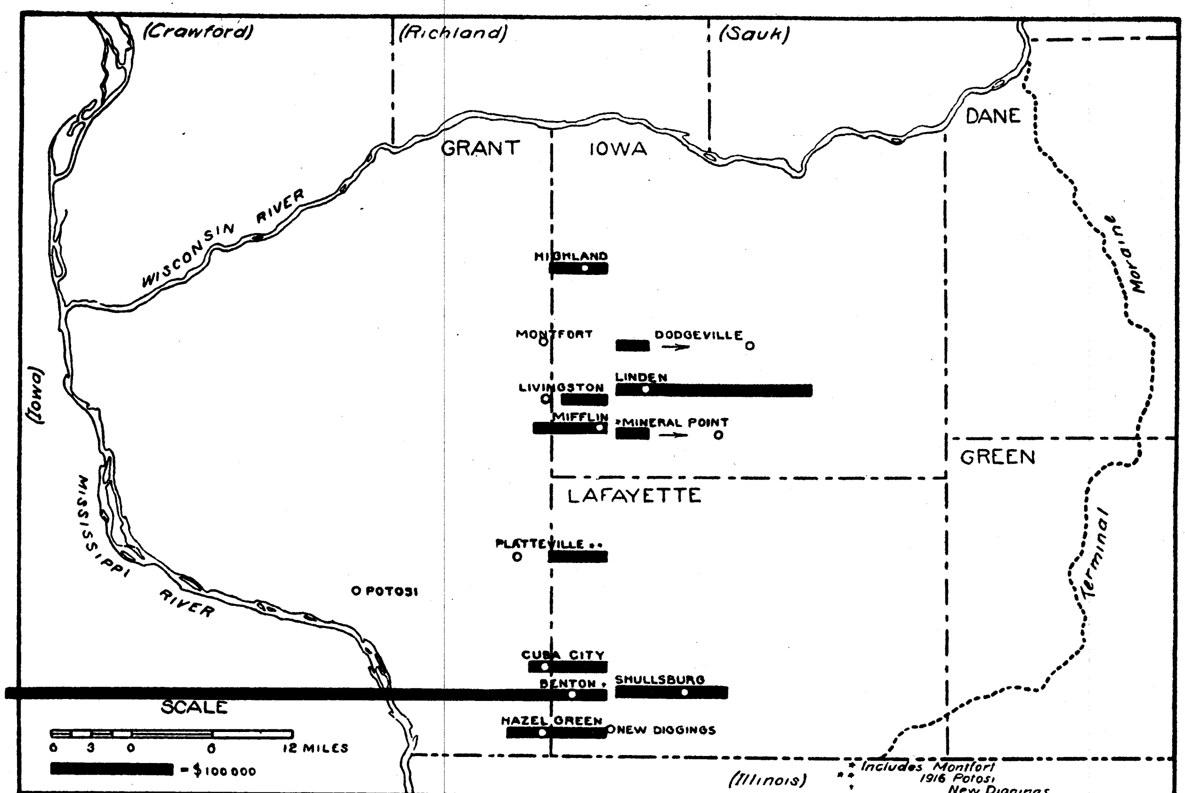


Fig. 9b. Value of Metallic Lead Produced 1912–1916, Inclusive
Data from Mineral Resources of the United States

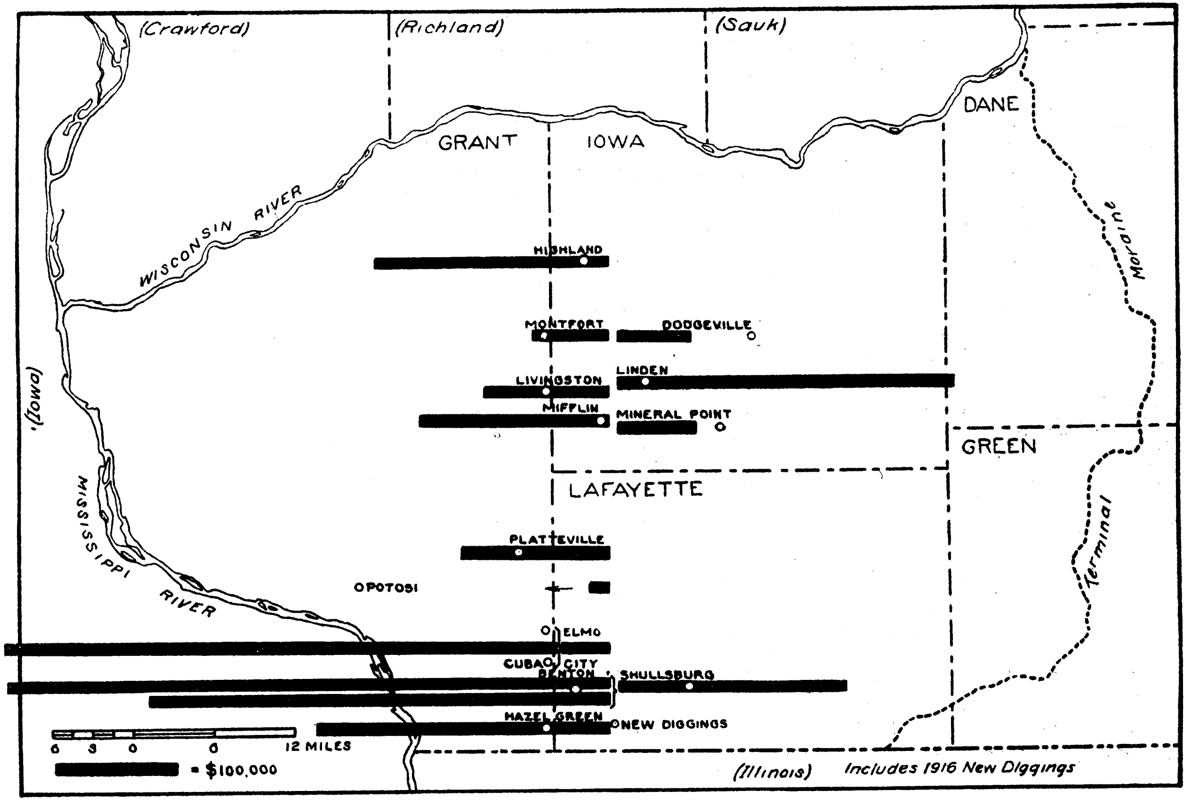
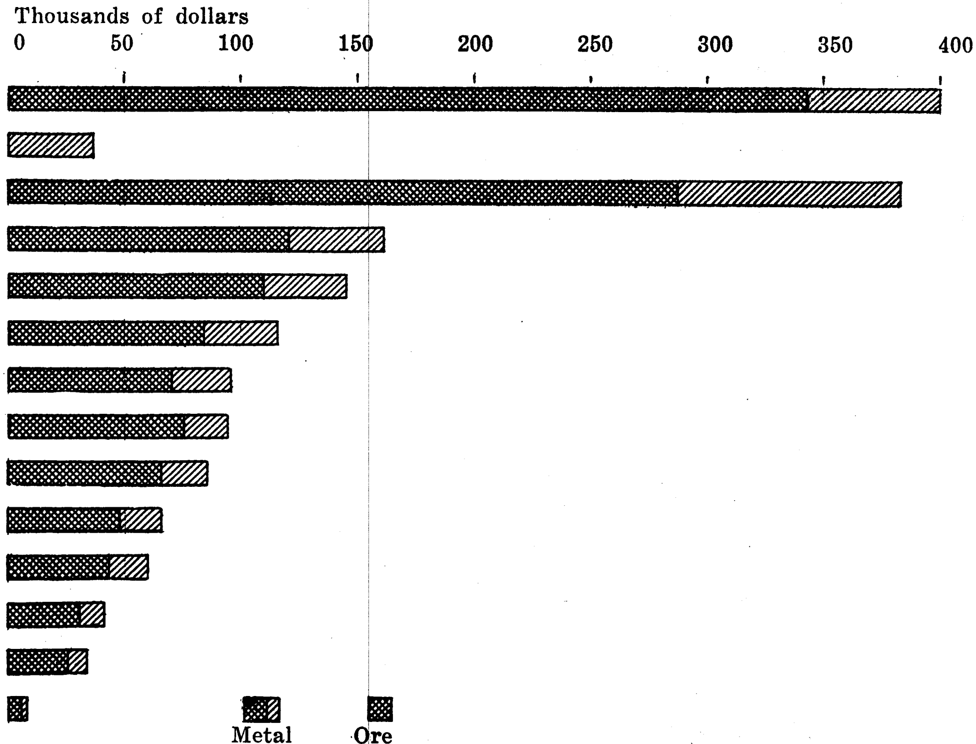


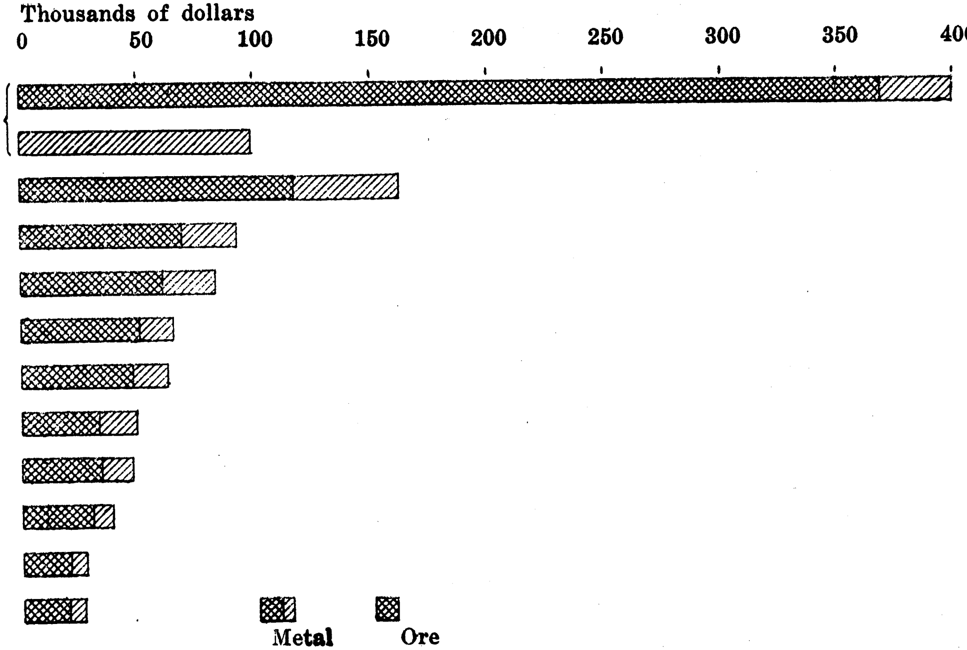
FIG. 9c. Value of Metallic Lead Produced 1907–1916, Inclusive
Data from Mineral Resources of the United States



	Ore	Metal
Cuba City–Elmo	$343,038	$436,918
Benton	287,190	383,404
Hazel Green	121,668	160,650
Highland	110,690	145,026
Linden	84,045	116,494
Shullsburg	71,514	96,190
Mifflin	75,288	94,850
Platteville	65,984	85,122
Livingston	48,685	65,670
Mineral Point	43,377	59,886
Montfort	30,930	41,092
Dodgeville	25,802	33,578
Potosi	6,066	7,404
State Total	$1,314,277	$1,726,284

FIG. 10a. Value of lead produced in Wisconsin 1907–1911, inclusive.

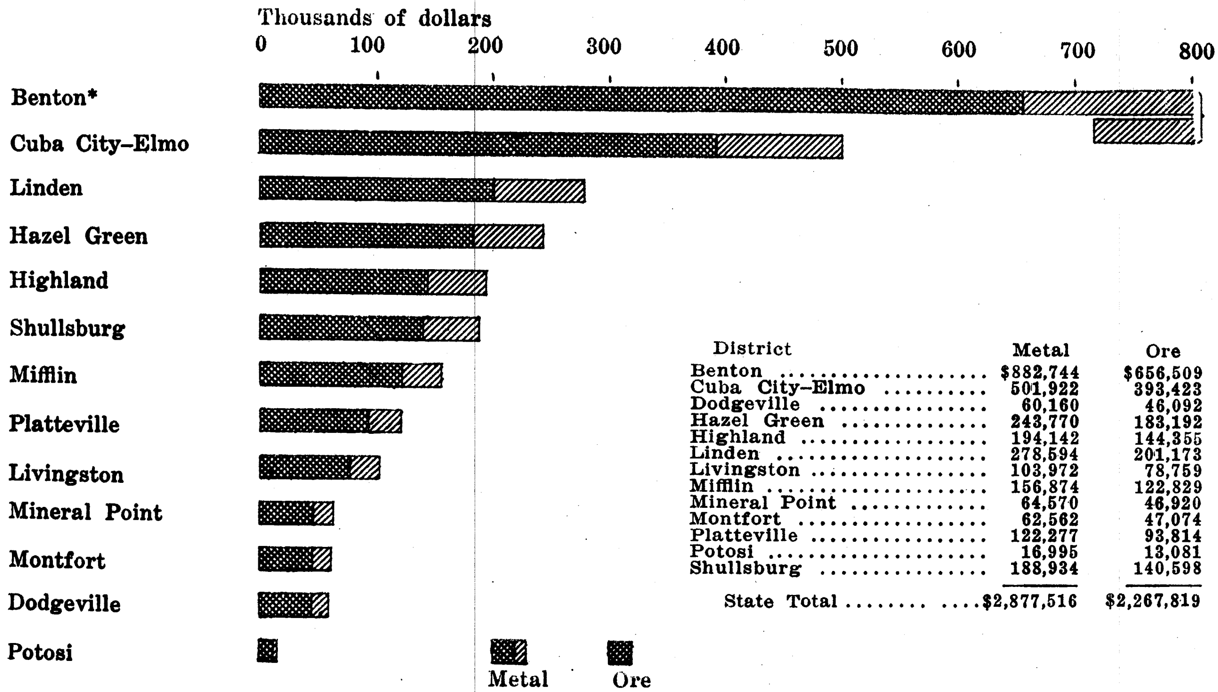
Value of metal is calculated from average daily quotations at New York and value of ore is that received by the producer. Data from Mineral Resources of the United States.



	Ore	Metal
Benton*	$369,319	$499,340
Linden	117,128	162,100
Shullsburg	69,084	92,744
Hazel Green	61,524	83,120
Cuba City	50,385	65,004
Mifflin	47,541	62,024
Highland	33,665	49,116
Platteville**	34,845	46,746
Livingston	30,074	38,302
	20,290	26,582
Dodgeville Mineral Point–Montfort	19,687	26,154
State Total	$853,542	$1,151,232

*Includes 1916 New Diggings.
**Includes 1916 Potosi.

FIG. 10b. Value of lead produced in Wisconsin 1912–1916, inclusive.
Value of metal is calculated from average daily quotations at New York and value of ore is that received by the producer. Data from Mineral Resources of the United States.



District	Metal	Ore
Benton	$882,744	$656,509
Cuba City–Elmo	501,922	393,423
Dodgeville	60,160	46,092
Hazel Green	243,770	183,192
Highland	194,142	144,355
Linden	278,594	201,173
Livingston	103,972	78,759
Mifflin	156,874	122,829
Mineral Point	64,570	46,920
Montfort	62,562	47,074
Platteville	122,277	93,814
Potosi	16,995	13,081
Shullsburg	188,934	140,598
State Total	$2,877,516	$2,267,819

*Includes 1916 New Diggings.

FIG. 10c. Value of lead produced in Wisconsin 1907–1916, inclusive.
Value of metal is calculated from average daily quotations at New York and value of metal is that received by the producer. Data from Mineral Resources of the United States.

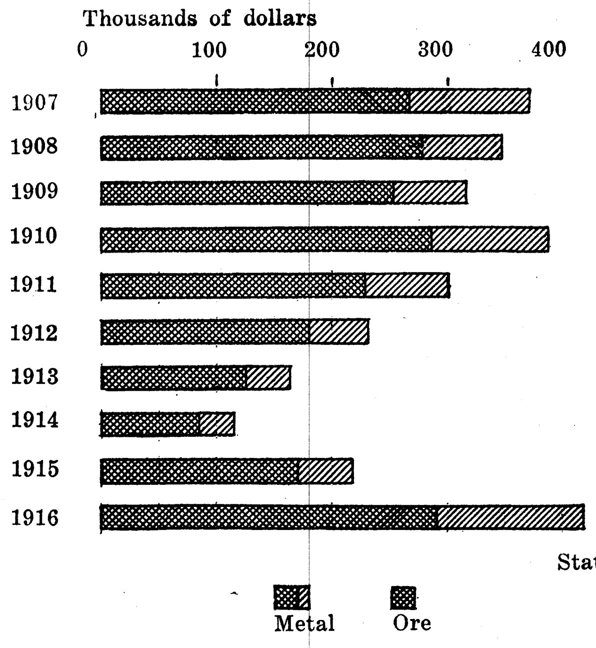
In the first of these sets of charts bars representing value in dollars extend eastward and westward from north and south lines which run through the central part of the mining district. This method was adopted in order to make comparison of values easier. The bars extend to, and beyond, the respective cities whose production is represented. In some cases, however, the bar falls short of reaching the city, either because production was small or because the city is located unusually far east or west of the central meridional lines chosen. In these cases arrows indicate the cities to which the production is to be credited.

In the second of these sets of charts (figs. 10a, 10b, and 10c) the value of the metal and the value of the ore is shown in the same figure, and the respective amounts indicated. In making a comparison of these values, it should be borne in mind that the value of the metal is calculated from average daily quotations at New York, whereas the value of the ores is that received by the producer.

In the two five-year periods under discussion (1907–1911, and 1912–1916) the Benton district and the Cuba City–Elmo district received the largest sums of money for lead production. In the period 1907–1911, inclusive, the amount received by the Cuba City–Elmo district was $343,038 for galena and $436,918 for metallic lead. Benton, the next largest producer, received in the same five-year period $287,190 for galena and $383,404 for metallic lead. In the five years 1912–1916, inclusive, Benton took first place with $369,319 for ore and $499,340 for metal. The ten-year period, 1907–1916, shows Benton first with $656,509 for ore and $882,744 for metal; and Cuba City–Elmo second with $393,423 for ore and $501,922 for metal.

The amount received in the state in each of the five-year periods was in the neighborhood of one million dollars for lead concentrates and somewhat more than a million dollars for metallic lead. In the ten years 1907–1916, the amount received by Wisconsin producers of lead concentrates was $2,267,819; and the value of the metallic lead, as calculated from average daily quotations at New York, was $2,877,516.

The value of lead produced in Wisconsin annually 1907–1916, inclusive, is shown in fig. 11. Amounts received for galena varied from one hundred thousand dollars to about three hun-



	Ore	Metal
1907	$266,471	$370,894
1908	277,334	347,592
1909	254,514	317,684
1910	286,493	388,344
1911	229,465	301,770
1912	180,661	232,290
1913	125,197	164,208
1914	85,196	116,532
1915	171,091	218,268
1916	291,397	419,934
State Total	$2,267,819	$2,877,516

FIG. 11. Value of lead produced in Wisconsin annually 1907–1916, inclusive.

Value of metal is calculated from average daily quotations at New York and value of ore is that received by the producer. Data from Mineral Resources of the United States.

dred thousand dollars. The smallest amount, $85,196, was received in 1914, and the largest, $291,397, was received in 1916. This is not much more than was received ten years before. In 1907 the amount received was $266,471. The value of metallic lead was $116,532 in 1914, $419,934 in 1916, and $370,894 in 1907.

V.

Wisconsin Zinc Production.

The quantity of metallic zinc produced by the several districts in Wisconsin (a) in the five years 1907–1911, inclusive; (b) in the five years 1912–1916, inclusive; and (c) in the ten years 1907–1916, inclusive, is shown in figures 12a, 12b and 12c. The zinc production so far exceeded the lead production in Wisconsin during the years under consideration that a much smaller scale had to be used. The two sets of charts are therefore not directly comparable. The zinc charts are comparable with each other for they are drawn to the same scale for ores and metal, for five-year periods and ten-year periods.

Table 5 shows that small amounts of zinc carbonate were produced by each of the zinc-producing regions with the exception of Hazel Green which did not report any production of zinc carbonate in the ten years 1907–1916, inclusive. Most of the amounts were less than one hundred tons for the ten years and they do not appear on the charts.

Highland was the greatest producer of zinc carbonate in the state, far out-ranking Mineral Point and Benton, the only other two regions whose carbonate production is represented on the charts. In the five years 1907–1911, inclusive, Highland produced 17,649 short tons of zinc carbonate, and in the five years 1912–1916, inclusive, 13,618 short tons, making a total of 31,267 short tons for the ten years. Mineral Point produced 4,194 short tons in the ten years and Benton 2,650 short tons, the two together producing somewhat more than a fifth as much as Highland. The zinc production of Highland is unique in this respect; that its production of zinc carbonate exceeds its production of sphalerite, or zinc sulphide. The output of sphalerite from Highland for the ten years 1907–1916, inclusive, was 8,510 short tons, or about one-fourth the carbonate output. Mineral

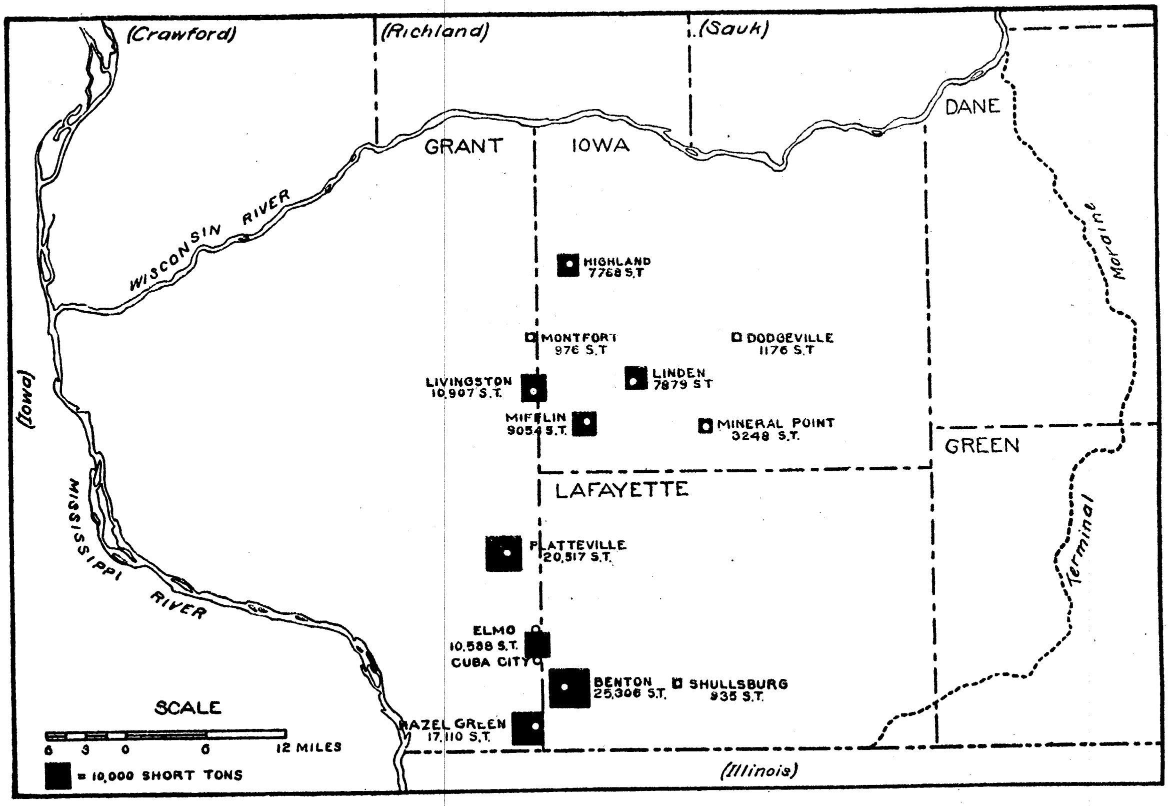


Fig. 12a. Production of Metallic Zinc 1907–1911, Inclusive
Data from Mineral Resources of the United States

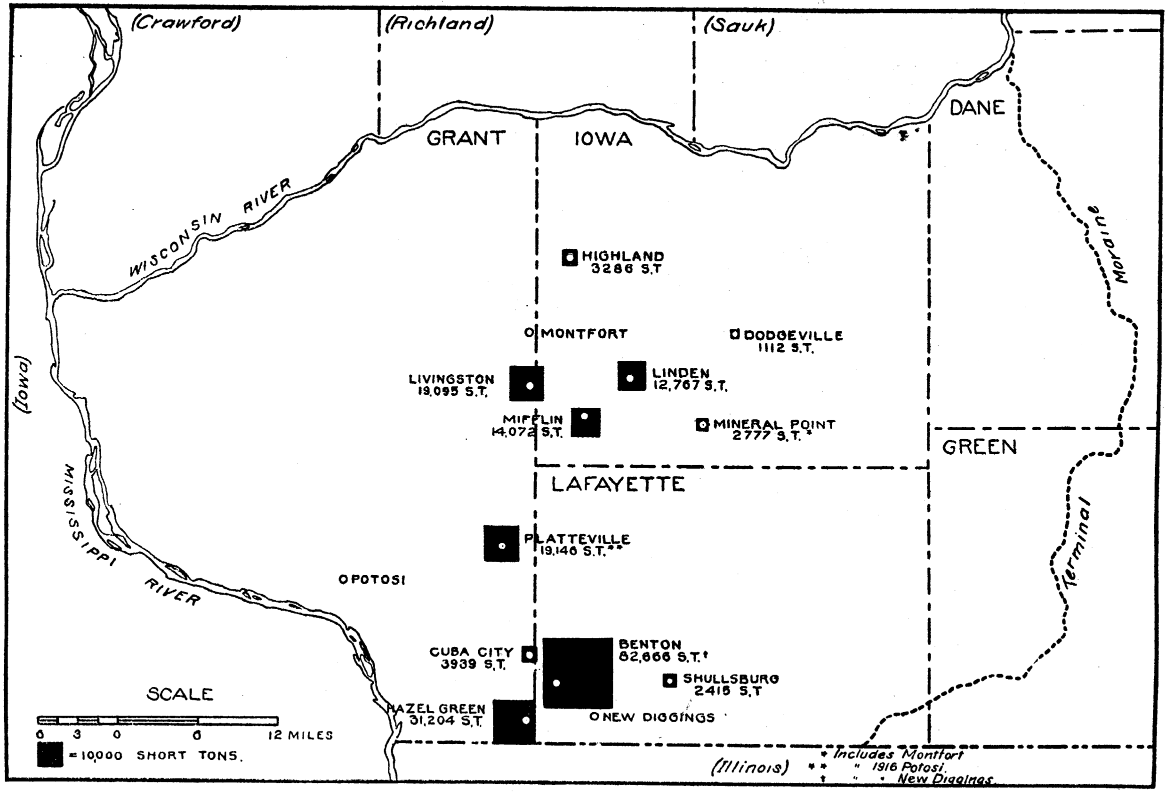


FIG. 12b. **Production of Metallic Zinc 1912–1916, Inclusive**
Data from Mineral Resources of the United States

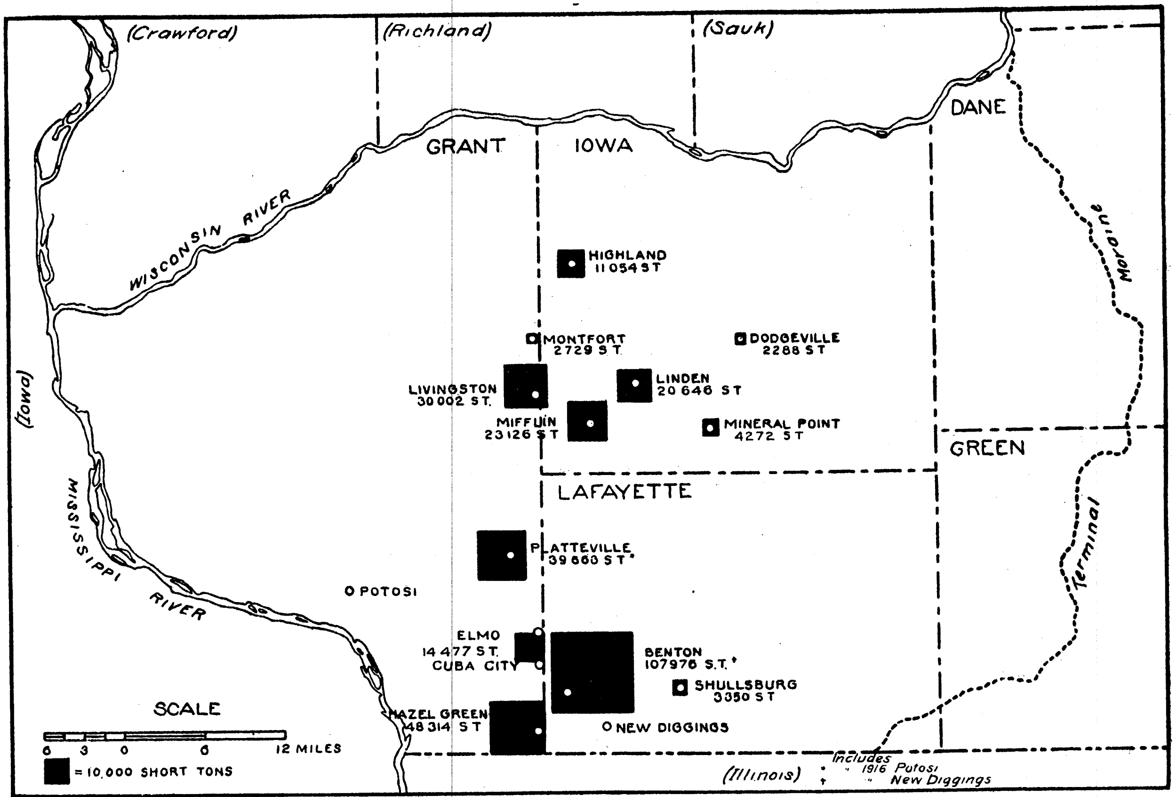


FIG. 12c. Production of Metallic Zinc 1907–1916, Inclusive
Data from Mineral Resources of the United States

Point, on the other hand, produced more than twice as much sphalerite as carbonate, and Benton, in the same ten years produced 368,713 tons of sphalerite and only 2,650 tons of carbonate. The production of carbonate in the Benton district is relatively so small as to be negligible.

In the five years 1907–1911, inclusive, Benton stands out as the principal producer of sphalerite, with Platteville and Hazel Green not far behind. The amounts produced were respectively 87,095 short tons, 62,346 short tons, and 56,458 short tons. Dodgeville produced the smallest amount, 2,606 tons, while Shullsburg and Montfort produced amounts almost as small. Total state production in the five years was 344,022 short tons of sphalerite and 21,705 short tons of carbonate, (see table 5).

The five years 1912–1916, inclusive, showed a decrease in zinc carbonate production in the state, but a notable increase in the production of sphalerite. Total production of carbonate was 17,120 short tons, and of sphalerite 646,908 short tons, (see table 5).

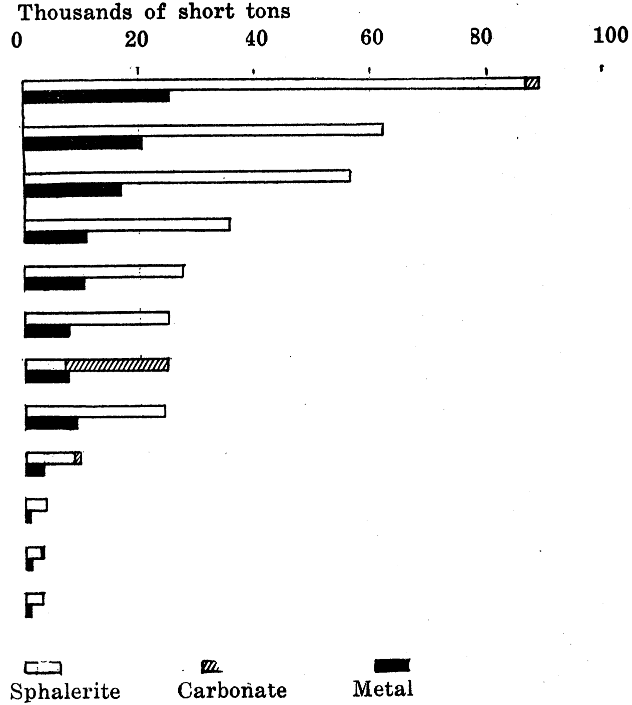
Benton had a tremendously increased production for the five years 1912–1916, inclusive; from 87,095 tons in 1907–1911, to 281,618 tons in 1912–1916. This is an increase of more than 230%. Both Hazel Green and Livingston forged ahead of Platteville, leaving Platteville fourth in the order of production. The output of Platteville decreased to 52,422 tons in 1912–1916, from 62,346 tons in the five years immediately preceding. Besides Platteville, the districts which showed decreased production were Cuba City-Elmo, Highland, Mineral Point, and Montfort. The production of Dodgeville remained practically stationary, having been 2,817 short tons in the five years 1912–1916, inclusive, and 2,606 short tons in the five years immediately preceding. Shullsburg showed an increased production of more than 100%, but the tonnage involved, 2,840 tons in the five years 1907–1911, and 6,340 tons in 1912–1916, is negligible. Mifflin and Linden each showed an increased tonnage of about 20,000, representing almost a doubled output. Livingston had an increased tonnage of over 40,000; Hazel Green of over 50,000, and Benton of almost 200,000. The combined increased production of the three last named almost make up the total increase of production in the state, as is shown in the following table:

	1907–1911 Short tons Sphalertie	1912–1916 Short tons Sphalerite	Increase in 1912–1916 Short tons Sphalerite	
State of Wisconsin	344,022	646,908	---------	302,886
Benton	87,095	281,618	194,523	
Hazel Green	56,458	110,921	54,463	
Livingston	35,896	77,256	41,360	
Combined increased tonnage of Benton, Hazel Green, and Livingston				290,346

For the ten years 1907–1916, inclusive, Benton produced 368,713 short tons of sphalerite, more than twice as much as the next greatest producer, Hazel Green, which produced 167,379 short tons. Platteville and Livingston produced almost identical amounts, the former 114,768 tons and the latter 113,152 tons. Linden and Mifflin each produced in the neighborhood of 70,000 short tons, and the Cuba City-Elmo district produced 45,126 tons. The smallest producers of sphalerite were Mineral Point, Shullsburg, Highland, Montfort, and Dodgeville, which ranked in the order named, and produced from 10,000 to about 5,500 tons respectively. The carbonate production of Benton, Mineral Point, and Highland has been discussed. The combined production of carbonate and sphalerite for Highland places that district in the rank occupied by the Cuba City-Elmo district, rather than in the rank of smallest producers.

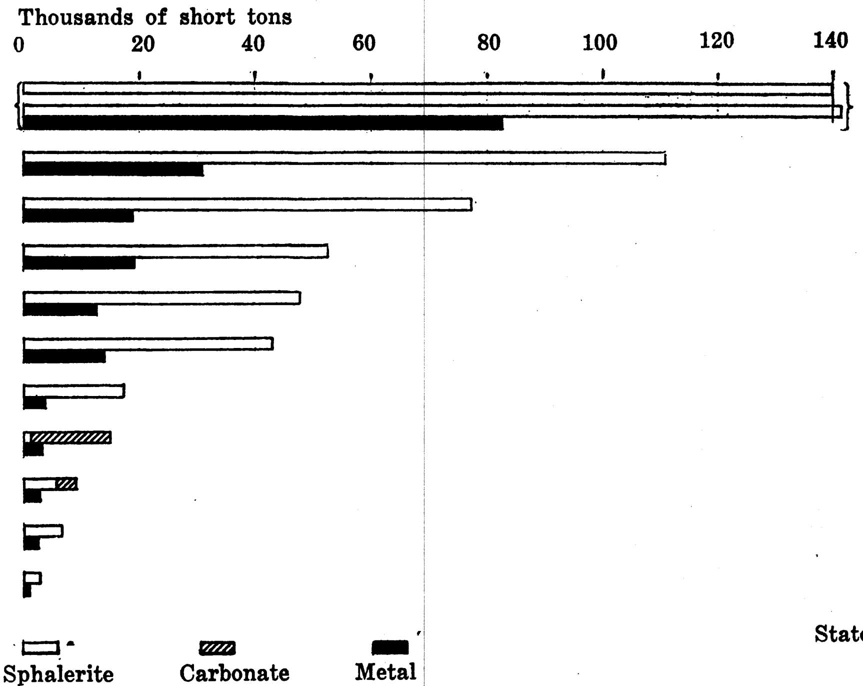
The relative ranks of the zinc-producing districts in Wisconsin are shown in figs. 13a, 13b, 13c, which represent by bar graphs the following: quantity of zinc ores produced by each of the several districts (a) in the five years 1907–1911, inclusive, (b) the five years 1912–1916, and (c) the ten years 1907–1916, inclusive. The quantity of metallic zinc obtained from the ores is indicated, and the quality of ores thus shown. Percentages are recorded on each chart.

Benton, Hazel Green, Platteville, and Livingston were the greatest producers in the years under consideration, with Benton always in the lead. The Cuba City-Elmo district ranked fifth in the five years 1907–1911, but production fell off considerably in next five-year period so that for the ten years 1907–1916 this district ranked seventh in the order of production. In the five years 1907–1911 Linden occupied sixth place and Mifflin eighth, in the production of zinc ores, Highland occupying seventh. However, Mifflin obtained a greater amount of metallic zinc from its ores than Highland and Linden, and was entitled to sixth place in the years 1907–1911. In the next



	Metal Short	Ores Tons	Percent. Metal
Benton	25,306	89,497	28.3
Platteville	20,517	62,346	32.9
Hazel Green	17,110	56,458	30.4
Livingston	10,907	35,968	30.4
Cuba City–Elmo	10,538	27,893	37.8
Linden	7,879	25,353	31.0
Highland	7,768	24,741	31.4
Mifflin	9,054	24,293	37.3
Mineral Point	3,248	9,603	33.8
Montfort	976	3,333	29.3
Dodgeville	1,176	2,937	39.8
Shullsburg	935	2,900	32.2
Buncombe	81	385	21.0
State Total	115,495	365,727	31.6

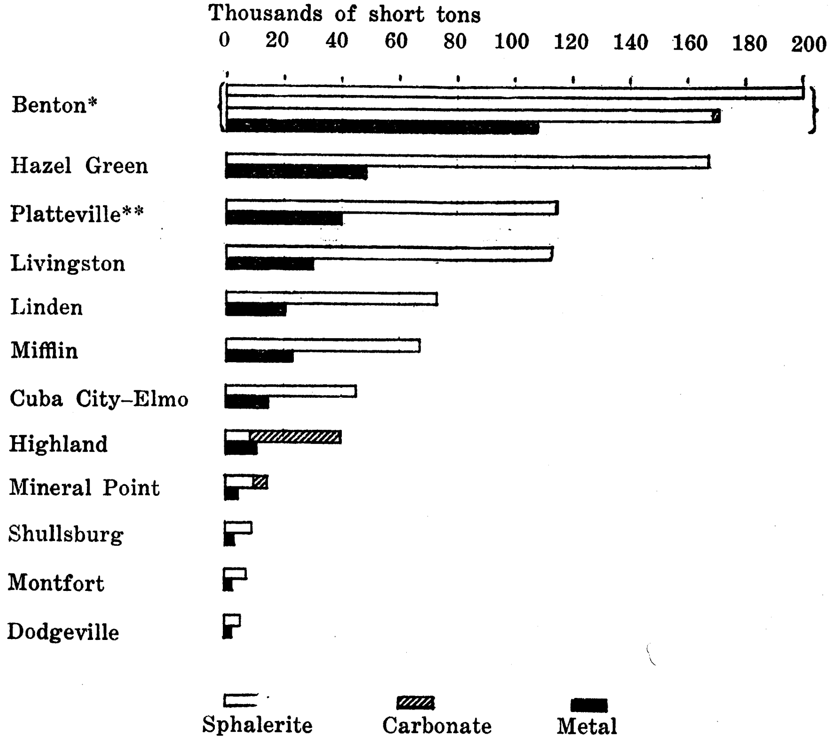
FIG. 13a. Quantity of zinc produced in Wisconsin 1907–1911, inclusive.
Data from Mineral Resources of the United States.



	Metal Short Tons	Ores Tons	Percent. Metal
Benton*	82,666	281,866	29.4
Hazel Green	31,204	110,921	28.2
Livingston	19,095	77,256	24.7
Platteville**	19,146	52,477	36.6
Linden	12,767	47,867	26.7
Mifflin	14,072	43,136	32.6
Cuba City	3,939	17,260	22.8
Highland	3,286	15,036	21.8
Mineral Point–Montfort	2,777	8,966	30.9
Shullsburg	2,415	6,370	37.9
Dodgeville	1,112	2,873	38.8
State Total	192,479	664,028	29.0

*Includes 1916 New Diggings.
**Includes 1916 Potosi.

FIG. 13b. Quantity of zinc produced in Wisconsin 1912–1916, inclusive.
Data from Mineral Resources of the United States.



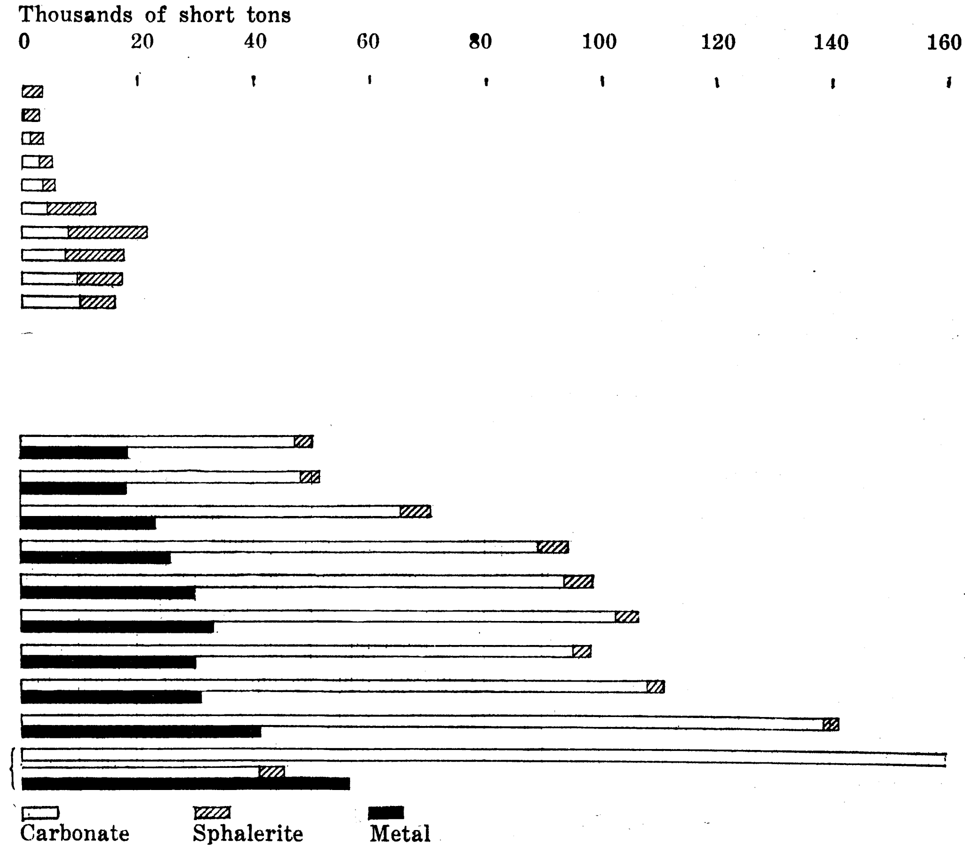
	Metal Short Tons	Ores Short Tons	Percentage Metal
Benton*	107,972	371,363	29.0
Hazel Green	48,314	167,379	28.8
Platteville**	39,663	114,823	34.6
Livingston	30,002	113,224	26.5
Linden	20,646	73,220	28.2
Mifflin	23,126	67,429	34.3
Cuba City–Elmo	14,477	45,153	32.0
Highland	11,054	39,777	27.8
Mineral Point	4,272	14,168	30.1
Shullsburg	3,350	9,270	36.1
Montfort	2,729	7,734	35.3
Dodgeville	2,288	5,830	39.2
Buncombe	81	385	21.0
State Total	307,974	1,029,755	29.9

FIG. 13c. Quantity of zinc produced in Wisconsin 1907–1916, inclusive.
Data from Mineral Resources of the United States.

*Includes 1916 New Diggings.
**Includes 1916 Potosi.

five years Highland fell to eighth place, which is also the position of Highland in the ten year period 1907–1916. Consequently Linden and Mifflin occupied respectively fifth and sixth places in the production of zinc ores, with Mifflin in the lead in the production of metallic zinc.

The quality of the ores is indicated by the percentages which appear on the charts. For the state as a whole the quality of the ores seems to have declined somewhat, for in the five years 1907–1911 365,727 tons of zinc ores produced 115,495 tons of metallic zinc, showing that the metal content of the ores was 31.6%; whereas in five years 1912–1916 664,028 tons of ores produced 192,479 tons of metal, indicating a metal content of 29%. The percentages range from 39.8, tenor of ores from Dodgeville in the five years 1907–1911, to 21.8, percentage of metallic zinc obtained from ores produced by Highland in the five years 1912–1916, inclusive. The reason for the low percentage of metallic zinc from Highland is that the greater proportion of ores from Highland is zinc carbonate which does not yield so high a percentage of metal as does the sulphide. In the five years 1907–1911, the percentage for Highland was 31.4, and in that period a smaller amount of zinc carbonate was produced relatively to the amount of sphalerite than in the five years immediately following. Leaving Highland out of consideration, and comparing the percentages of districts producing mainly sphalerite, Cuba City produced the lowest grade of ore in the five years 1912–1916, with a percentage of 22.8. This is a great reduction in percentage from the previous five years when the metal content of ores produced by the Cuba City-Elmo district was 37.8. In the same period other producers of high grade ores were Mifflin with a percentage of 37.3, and Dodgeville, 39.8%, which is the highest percentage indicated on the charts. The tonnage put out by Dodgeville, however, is very small. In the five years 1912–1916, highest grades of ores were produced by the following: Dodgeville, 38.8%, Shullsburg, 37.9%, Platteville, 36.6%. For Dodgeville the percentage is a decrease, indicating that its ores were of lower grade than in the five years immediately preceding. For Shullsburg and Platteville the percentages are increases. The tonnage for Shullsburg is not large, hence the increase in percentage is not so important as in the case of Platteville. In the five years 1907–1911 Platteville



	Short Tons Ores:
1866	3,687
1867	3,012
1868	3,690
1869	5,400
1870	5,922
1871	12,961
1872	21,975
1873	17,814
1874	17,312
1875	16,208
	107,981

	Short Tons Metal	Short Tons Ores	Percentage Metal
1907	18,490	50,316	36.7
1908	18,206	51,361	35.4
1909	23,152	70,551	32.8
1910	25,927	94,501	26.7
1911	29,720	98,988	30.0
1912	33,050	106,987	30.9
1913	30,110	98,663	30.5
1914	31,113	111,322	27.9
1915	41,403	141,575	29.2
1916	56,803	205,481	27.6
	307,974	1,029,755	29.9

FIG. 14. Quantity of zinc produced annually in Wisconsin 1866–1775, inclusive, and annually 1907–1916, inclusive. Data from Chamberlin's Geology of Wisconsin, 1873–1879, and Mineral Resources of the United States.

produced 62,345 tons of ores, from which 20,517 tons of metallic zinc were obtained, indicating a metal content of 32.9%. In the next five years Platteville produced 52,477 tons of ores, from which 19,146 tons of metal were obtained, showing a percentage of 36.6. The quality of ores had improved to such an extent that practically the same amount of metal was obtained from much less ore, the difference in ore tonnage being about 10,000 tons. Only Shullsburg, Platteville, and Benton, showed a better quality of ores in the five years 1912–1916 than in the previous five years, Benton's increase in percentage having been somewhat less than the increase shown by the other two. Benton, the greatest producer, put out 28.3% ores in 1907–1911 and 29.4% ores in the years 1912–1916, inclusive. Hazel Green, ranking third in the order of production in 1907–1911, and second in 1912–1916, produced ores whose percentages of metallic zinc were respectively 30.4 and 28.2. Livingston, ranking fourth as a producer in 1907–1911 and third in 1912–1916, showed a marked decline in quality of ores produced. In 1907–1911 the percentage was 30.4 and in 1912–1916 only 24.7.

For the ten years 1907–1916, inclusive, Dodgeville ranked first, with a percentage of 39.2 and Highland lowest, with a percentage of 27.8. The percentages of the four most important producers were as follows: Benton, 29.0; Hazel Green, 28.8; Platteville, 34.6; Livingston, 26.5.

The production thus far considered has been for individual districts in the zinc-producing region of Wisconsin. Total state production is shown in fig. 14. This chart gives the quantity of zinc ores produced annually from 1866 to 1875, inclusive, and annually from 1907 to 1916, inclusive. For the ten years 1866–1875 only ore statistics were available, but the ten years 1907–1916 show not only the quantity of ores produced each year, but the metal obtained from the ores. Percentages indicate the quality of the ores.

Zinc carbonate was produced before sphalerite, and in the early years of zinc production more carbonate was produced than sphalerite. The chart shows this, as well as the steady increase in sphalerite production. In only two of the years shown on the chart was there a decrease in sphalerite production from the previous years, i. e.: in 1873 and in 1913. The production of carbonate was greatest in the year 1872, which was also the

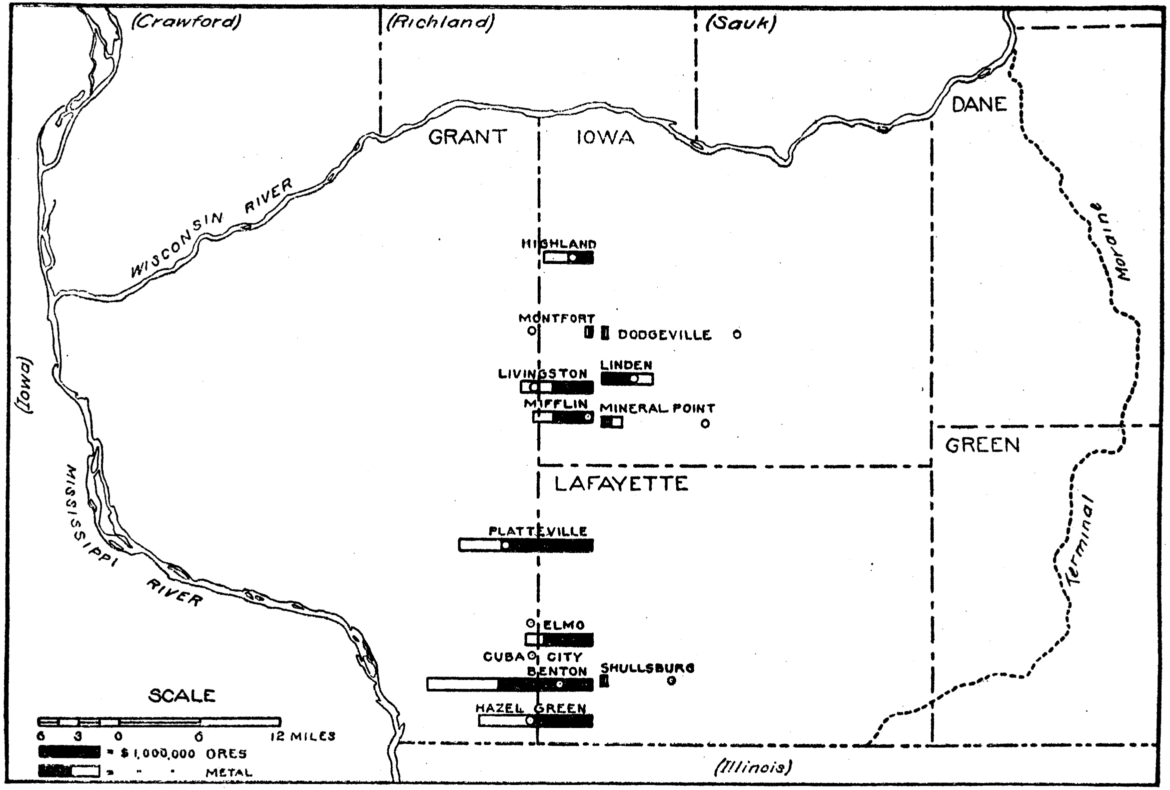


FIG. 15a. Value of Zinc Produced 1907–1911, Inclusive
Data from Mineral Resources of the United States

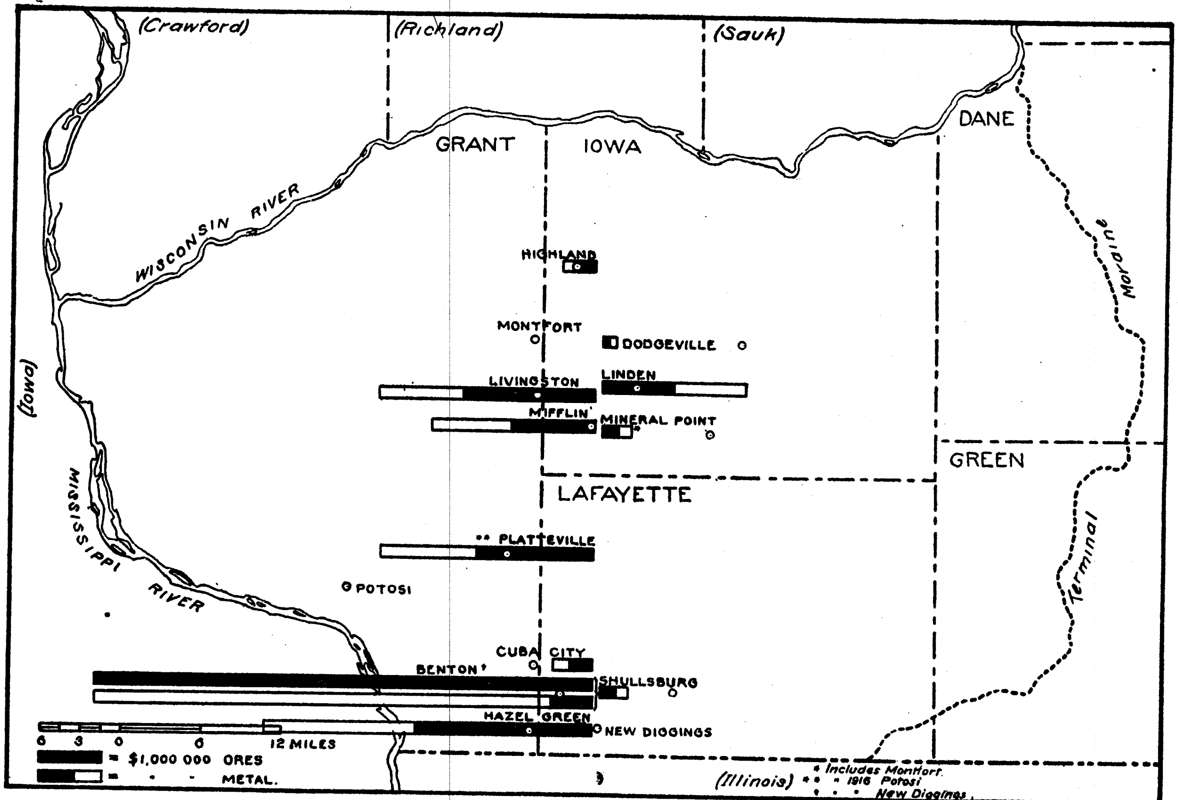


FIG. 15b. Value of Zinc Produced 1912–1916, Inclusive
Data from Mineral Resources of the United States

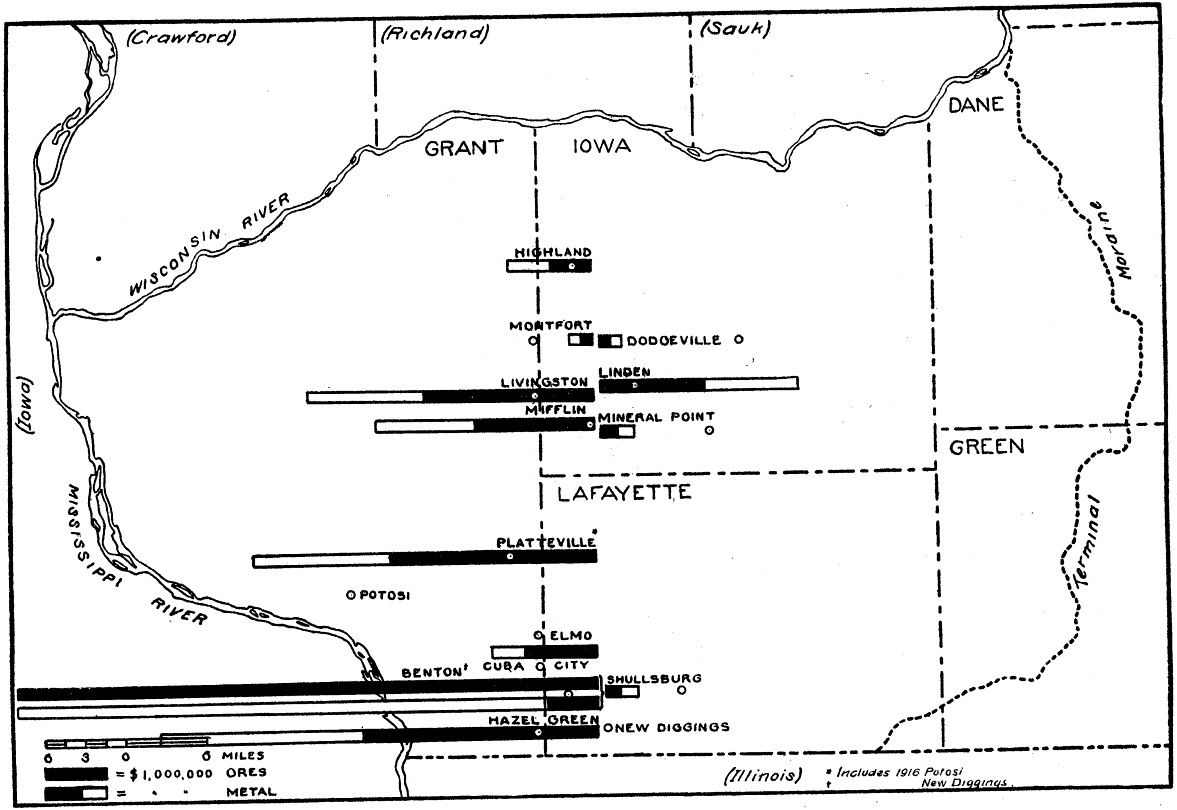
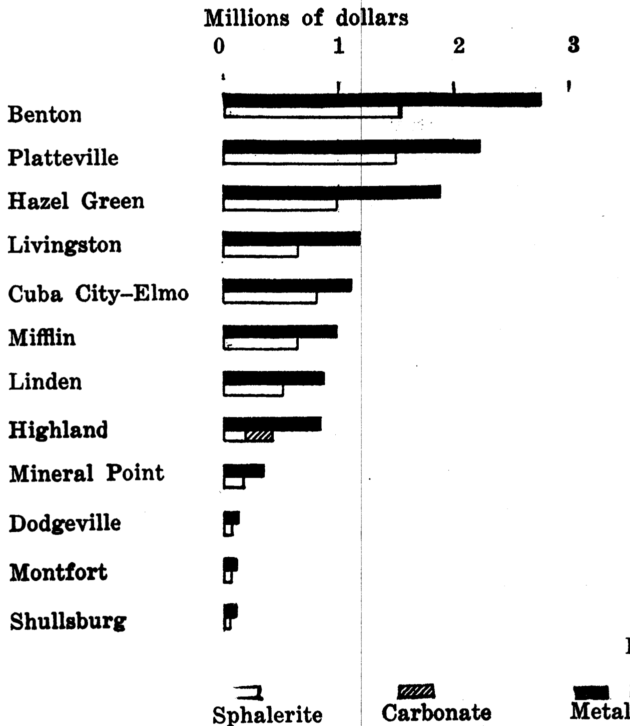


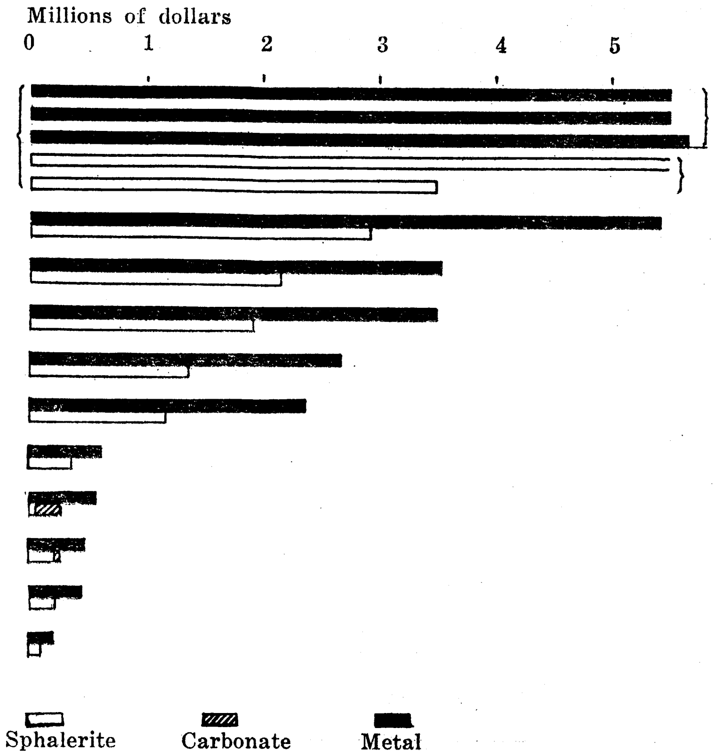
FIG. 15c. Value of Zinc Produced 1907–1916, Inclusive
Data from Mineral Resources of the United States



	Ores	Metal
Benton	$1,550,031	$2,764,008
Platteville	1,507,309	2,227,318
Hazel Green	993,237	1,893,422
Livingston	651,682	1,183,028
Cuba City–Elmo	810,348	1,115,852
Mifflin	642,399	987,454
Linden	514,572	872,160
Highland	414,097	838,232
Mineral Point	181,047	348,812
Dodgeville	73,135	129,130
Montfort	63,690	108,120
Shullsburg	58,418	105,512
Buncombe	5,650	8,748
State Total	$7,465,615	$12,581,796

FIG. 16a. Value of zinc produced in Wisconsin 1907–1911, inclusive.

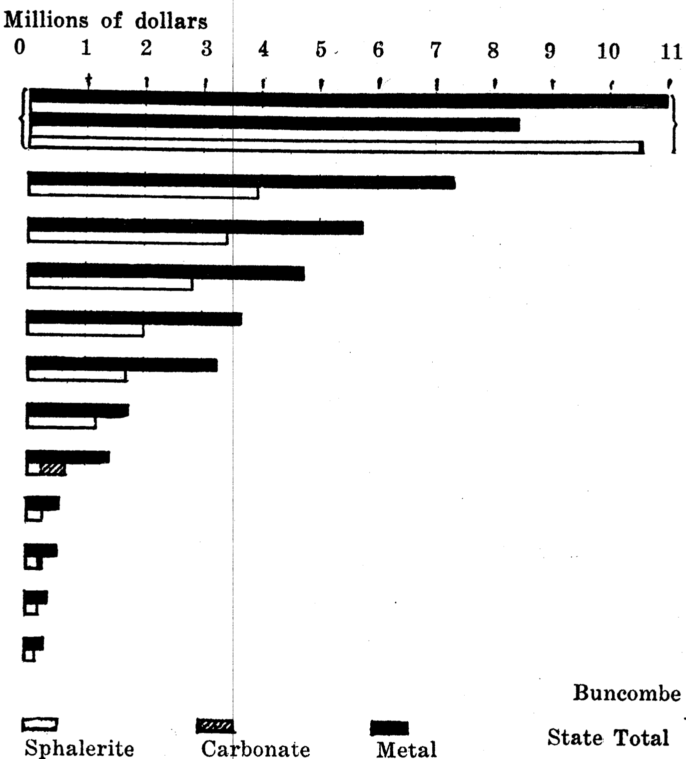
Value of metal is calculated from average daily quotations at New York and value of ores is that received by the producer. Data from Mineral Resources of the United States.



	Ores	Metal
Benton*	$9,013,548	$16,655,266
Hazel Green	2,945,197	5,442,036
Livingston	2,173,283	3,548,842
Platteville**	1,927,966	3,511,160
Mifflin	1,376,985	2,692,758
Linden	1,188,657	2,387,534
Cuba City	368,260	631,970
Highland	268,499	577,300
Mineral Point–Montfort	268,462	481,722
Shullsburg	229,537	461,318
Dodgeville	113,259	207,988
State Total	$19,873,653	$36,597,894

FIG. 16b. Value of zinc produced in Wisconsin 1912–1916, inclusive.
Data from Mineral Resources of the United States.

*Includes 1916 New Diggings.
**Includes 1916 Potosi.



	Ores	Metal
Benton*	$10,563,579	$19,419,274
Hazel Green	3,938,434	7,335,458
Platteville**	3,435,275	5,738,478
Livingston	2,824,965	4,731,870
Mifflin	2,019,384	3,680,212
Linden	1,703,229	3,259,694
Cuba City–Elmo	1,178,608	1,747,822
Highland	682,596	1,415,532
Shullsburg	287,955	566,830
Mineral Point	290,550	545,764
Montfort	222,649	392,890
Dodgeville	186,394	337,118
Buncombe	5,650	8,748
State Total	$27,339,268	$49,179,690

FIG. 16c. Value of zinc produced in Wisconsin 1907–1916, inclusive.
Data from Mineral Resources of the United States.

* Includes 1916 New Diggins.
**Includes 1916 Potosi.

year of greatest production of zinc ores for the ten-year period 1866–1875. In that year 21,975 tons of zinc ores were produced, 13,847 tons of which were zinc carbonate and 8,128 tons sphalerite. In 1916, when the production of sphalerite was greatest, 205,481 tons of zinc ores were produced, of which 4,261 tons were zinc carbonate and 201,220 tons sphalerite, (see table 5). The percentage of carbonate in 1872 was more than 60, and in 1916 less than 2.

Total production of zinc ores in Wisconsin for the years 1866–1875, inclusive, was 107,981 short tons, and for the years 1907–1916, inclusive, 1,029,755 short tons, or about ten times as much.

The quality of zinc ores deteriorated. In 1907 36.7% of the ores was metal, and in 1916 the percentage was only 27.6. In 1910 it was less than this, 26.7%, but in all other years of the ten from 1907–1916 the percentage was higher than in 1916. For the whole period 1907–1916, inclusive, 307,974 short tons of metal were obtained from 1,029,755 short tons of ores, or 29.9%.

The value of zinc production in Wisconsin is shown in figs. 15a, 15b, 15c, and 16a, 16b, 16c. Each chart shows the value of zinc ores produced, as well as the value of the metallic zinc obtained from the ores. In making a comparison of these values, it should be borne in mind that the value of the metal is calculated from average daily quotations at New York, whereas the value of the ores is that received by the producer.*

In the five years 1907–1911 only two districts received more than one million dollars for zinc ores, namely: Benton and Platteville, each of which received about one and one-half million dollars. The value of the metal output of the Benton district was $2,764,008, and of the Platteville district $2,227,318. Hazel Green, Livingston, and Cuba City-Elmo each produced over one million dollars worth of metal. In the five years 1912–1916 six districts received more than one million dollars each for ores, and the value of the metal obtained from the ores was more than two million dollars for each district. Benton received $9,013,548 for its zinc ores, and the value of the metallic zinc was $16,655,266. Hazel Green, the next highest producer, received $2,945,197 for its zinc ores; and the value of the metal was $5,442,036. The value of ores produced by Livingston was

*In 1915 and 1916 the value of metallic zinc was calculated from the average sales price of all grades reported by smelters.

a little more than two million dollars, and the value of ores produced by Platteville was a little less than two million dollars. The value of metallic zinc for each of these districts was about three and one-half million dollars. Linden, the only other district receiving over a million dollars for its ores, produced metal worth $2,387,534.

For the ten years 1907–1916, inclusive, seven districts received over a million dollars for their ores, the Cuba City-Elmo district being added to the districts mentioned above. Highland, which received $682,596 for its ores, produced metallic zinc valued at $1,415,532, and should be added to the foregoing list of districts producing zinc worth more than a million dollars in the ten years 1907–1916, inclusive. In this period the value of Benton ores was $10,563,579, and the value of the metal obtained therefrom was $19,419,274. Hazel Green, the next greatest producer of zinc, had ores valued at $3,938,434; and the values of the metal obtained from them was $7,335,458. Platteville, Livingston, Mifflin, Linden, Cuba City-Elmo, and Highland ranked in the order named.

The amount received by Wisconsin producers in each of the five-year periods was as follows: In 1907–1911, inclusive, about seven and one-half million dollars for ores, and twelve and one-half millions for metallic zinc; in 1912–1916, inclusive, almost twenty millions for ores and 36.5 millions for metallic zinc. In the ten years 1907–1916, inclusive, Wisconsin producers received $27,339,268 for zinc ores, whereas the value of the metal obtained from then was $49,179,690. It will be remembered that the amount received for lead in each of the five-year periods was in the neighborhood of one million dollars, (figs. 10a, 10b) and that in the ten years 1907–1916, the amount received by Wisconsin producers of lead concentrates was $2,267,819; and the value of the metallic lead, as calculated from average daily quotations at New York, was $2,877.516, (fig. 10c).

A comparison of figures 10c and 16c shows that some of the districts rank higher as lead producers than as zinc producers, although in no case does the value of lead output exceed that of the zinc. The relative ranks of the two industries is indicated in the statistics contained in the foregoing paragraph.

For example, the Cuba City-Elmo district, which ranked seventh in the value of zinc produced, ranked second in lead

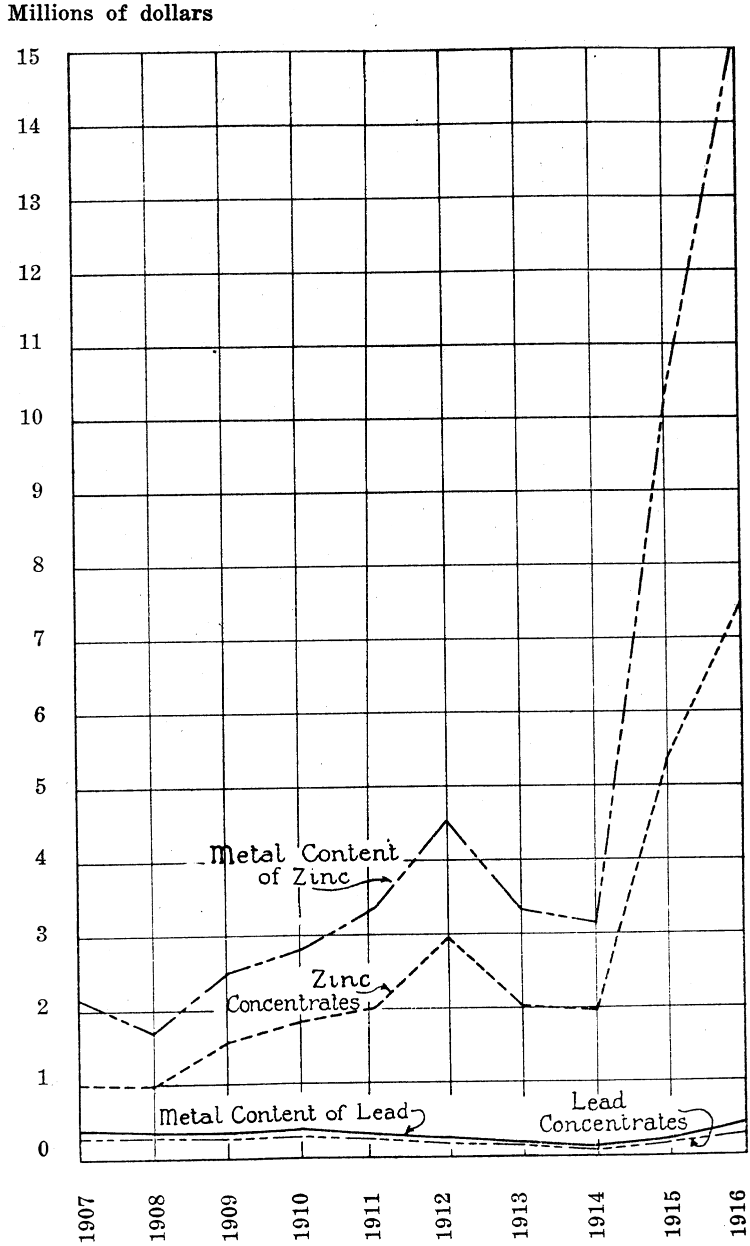


FIG. 17. Value of lead and zinc produced in Wisconsin 1907–1916, inclusive.
Data from Mineral Resources of the United States.

production. Benton occupied first place in both industries. Linden, which ranked sixth in the value of zinc production, ranked third in the value of lead production. Platteville occupied third place in the zinc industry, but eighth in the lead industry; and Livingston, with fourth place in the zinc industry, occupied ninth place in the production of lead. Mifflin was fifth in zinc, and seventh in lead. Highland and Shullsburg occupied more important places in the lead industry than in the zinc industry, whereas Mineral Point, Dodgeville, and Potosi were among the smallest producers in both industries during the ten years under consideration.

In comparing the production of metallic lead with the production of metallic zinc, it should be noted that in calculating the metal content of the ores from assays allowance was made for smelting and contraction losses in the case of zinc but not in the case of lead.

The relative importance of the two industries in Wisconsin in the ten years 1907–1916 is shown in fig. 17 which gives the value of lead and of zinc produced annually. From 1907 to 1910 the value of the lead remained fairly constant. Then it declined steadily until 1914, after which it again rose. In 1916 the value of the metallic lead was somewhat greater than in 1910.

The amounts involved in lead values are all less than five hundred thousand dollars, (table 7). The highest figure is for metallic lead production in 1916, $419,934. The lowest is for lead concentrates produced in 1914, $85,196. The lowest figure for zinc production, on the other hand, is over a million dollars, received for concentrates produced in 1907 and again in 1908. The highest figure for zinc is $15,223,204, value of metallic zinc produced in 1916. In 1907 the value of metallic zinc was $2,181,820. It dropped to 1.7 millions in 1908 and then rose steadily until 1912 when it was over 4.5 million dollars. In the next two years there was a decline to about 3 million dollars. Then followed a very great increase. In 1915 the value of metallic zinc rose to more than 10 million dollars, and in 1916 to $15,223,204.

In 1907 producers received $266,471 for lead concentrates and $1,037,549 for zinc concentrates, whereas in 1916 they received $291,387 for lead concentrates and $7,464,153 for zinc concentrates. The amount received for lead was about the same in 1907 as ten years later in 1916, but the amount received for zinc was seven times as great as formerly. And whereas in 1907 the value of zinc concentrates was less than four times as great as the value of lead concentrates, in 1916 it was more than twenty-five times as great.

The bar graphs for zinc appearing in this paper are all on a scale one-twentieth as large as the scale used for similar graphs for lead.

VI.

Wisconsin Lead and Zinc Production.

RANK IN THE UNITED STATES.

Mine production of metallic lead in the United States, by states, is shown in figs. 18a, 18b, 18c, for the following periods: (a) the five years 1907–1911, inclusive; (b) the five years 1912–1916, inclusive; (c) the ten years 1907–1916, inclusive. Similar data for the production of metallic zinc are shown in figs. 19a, 19b, 19c.

The states are arranged in the order of their rank. Fig. 18a shows that Wisconsin ranked fifth in lead production for the five years 1907–1911, with an output of 19,097 short tons of metal. This amount was somewhat more than was produced by Nevada, Arizona, Kansas, Oklahoma, Montana, and New Mexico. In the next five years, 1912–1916, (fig. 18b) the production of each of the states just named, and also the production of California, was greater than that of Wisconsin, whose output fell to 11,306 short tons for the five-year period. Thus Wisconsin changed from fifth to eleventh place in lead production. For the ten years 1907–1916, Wisconsin's place was ninth, (fig. 18c). The large producers were Missouri, Idaho, Utah, and Colorado, ranking in the order named.

In the production of metallic zinc Wisconsin ranked fourth in the five-year period 1907–1911, with an output of 115,495 short tons (fig. 19a) and fifth in the five years 1912–1916, with an output of 192,479 tons. For the ten years 1907–1916, inclusive, Wisconsin occupied fifth place, with an output of 307,974 short tons.

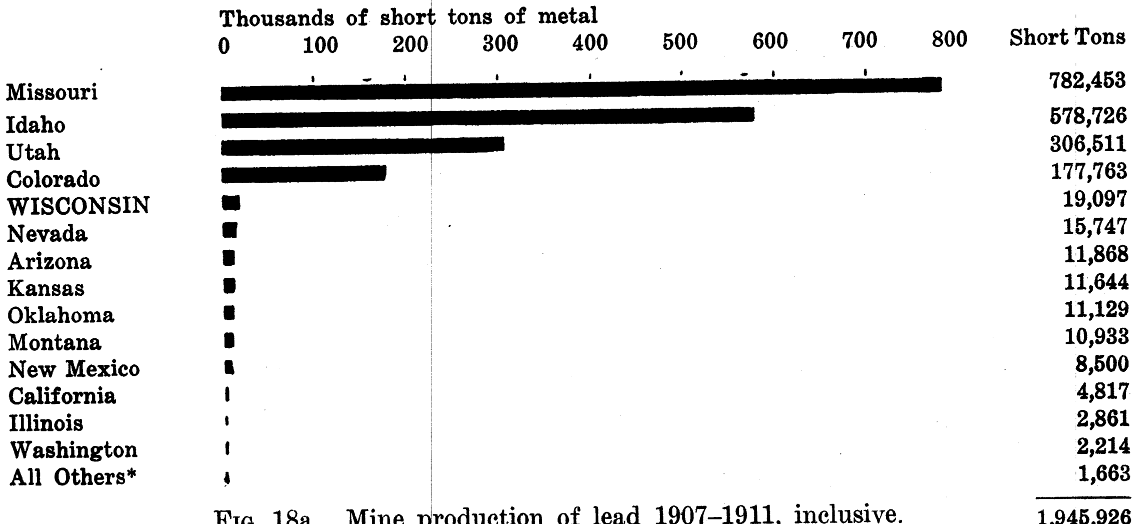
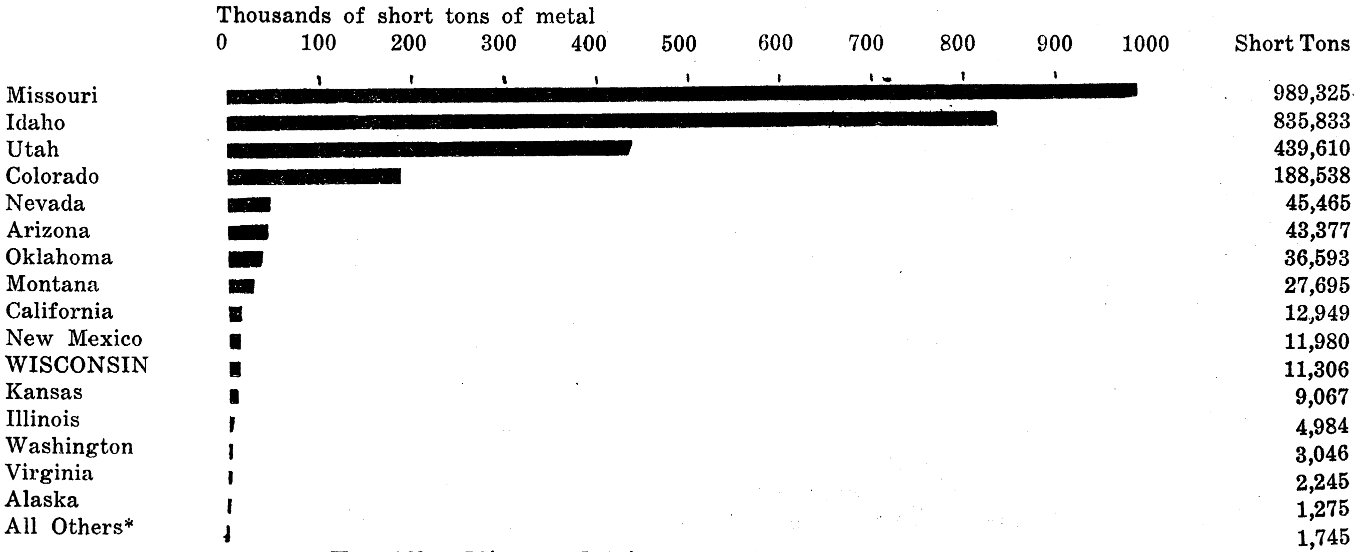


FIG. 18a. Mine production of lead 1907–1911, inclusive.
Data from Mineral Resources of the United States.

*Virginia, Iowa, Texas, Arkansas, South Dakota, Kentucky, Alaska, Oregon.



Total 2,665,033

FIG. 18b. Mine production of lead 1912–1916, inclusive.
Data from Mineral Resources of the United States.

*Kentucky, Arkansas, Texas, Iowa, Oregon, New Hampshire and Pennsylvania, North Carolina, South Dakota, Tennessee.

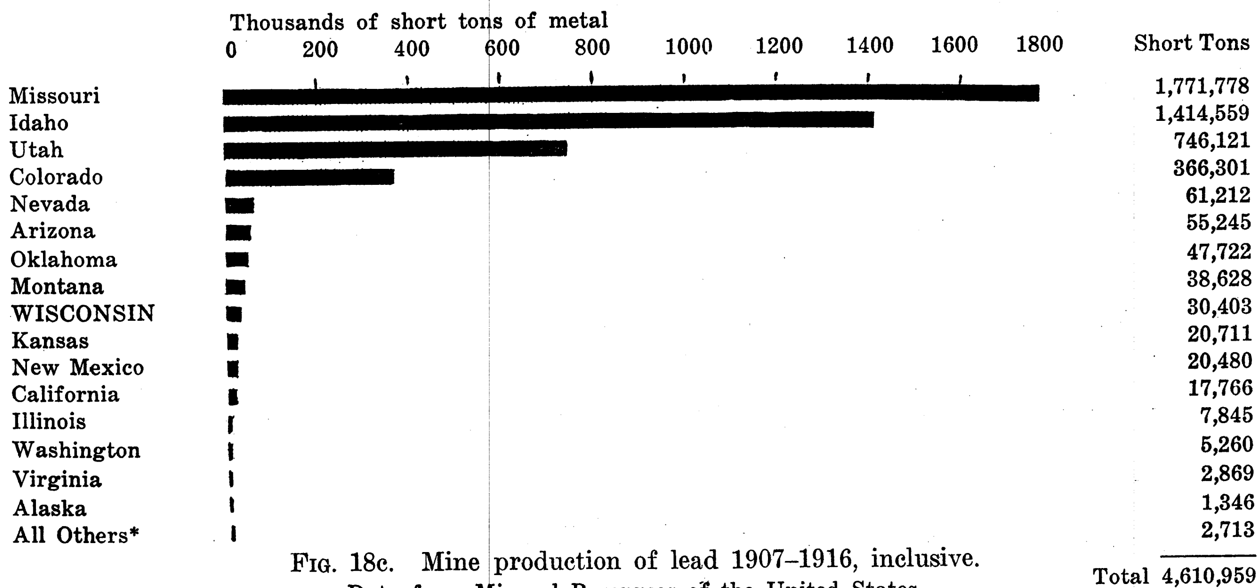


FIG. 18c. Mine production of lead 1907–1916, inclusive.
Data from Mineral Resources of the United States.

*Kentucky, Arkansas, Iowa, Texas, South Dakota, Oregon, New Hampshire and Pennsylvania, North Carolina, Tennessee.

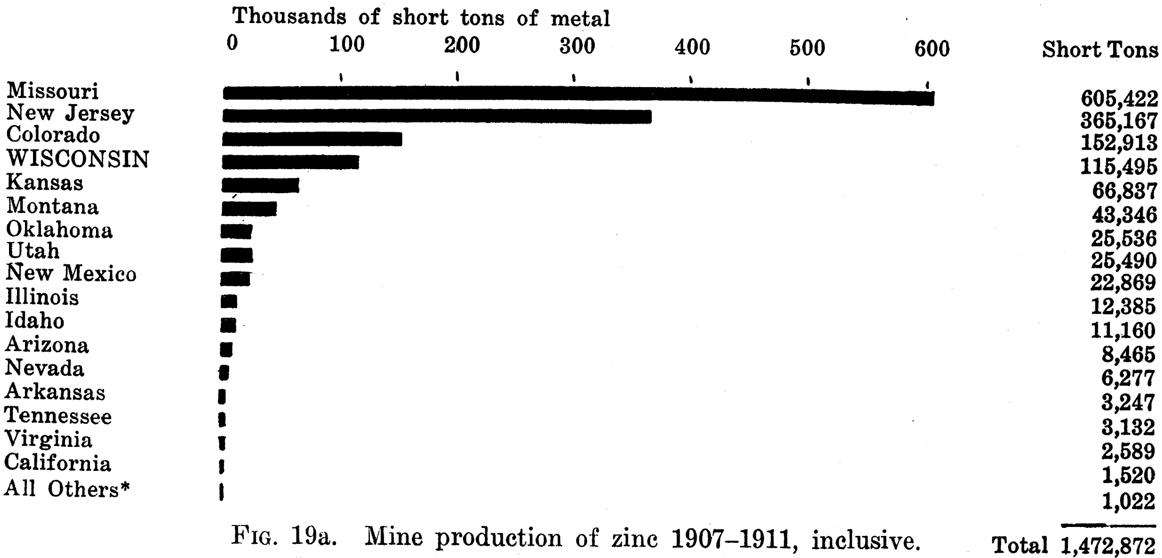
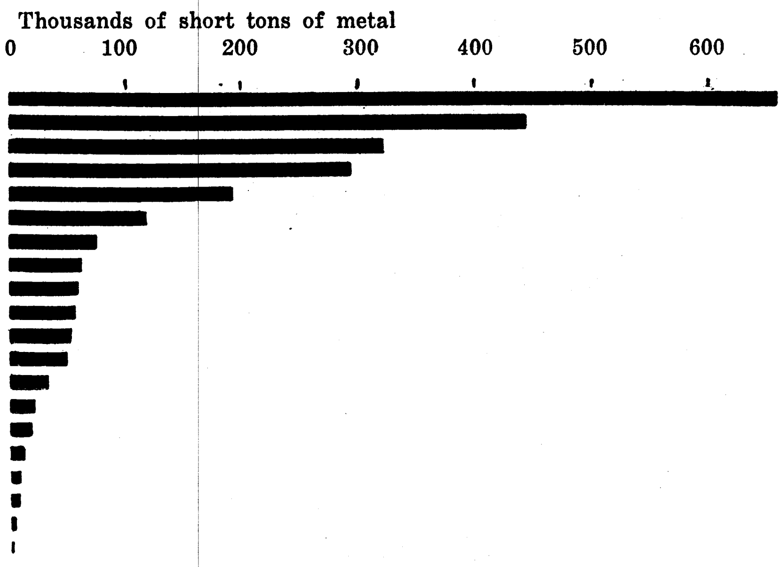


FIG. 19a. Mine production of zinc 1907–1911, inclusive.
Data from Mineral Resources of the United States.

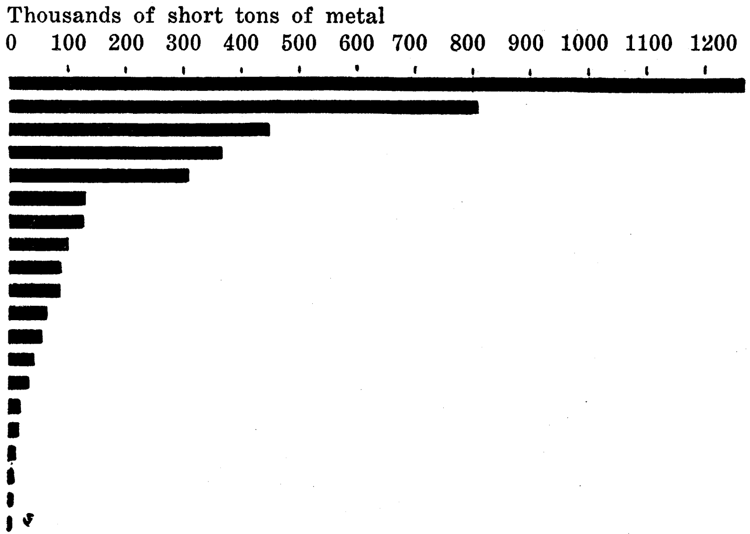
*Iowa, Kentucky, New York, Texas, Washington.



	Short Tons
Missouri	659,768
New Jersey	443,480
Montana	321,789
Colorado	293,611
WISCONSIN	192,479
Idaho	117,876
Oklahoma	74,493
Tennessee	61,088
Kansas	58,818
New Mexico	55,234
Utah	52,890
Nevada	48,771
Arizona	32,938
Illinois	20,050
California	17,072
Arkansas	11,858
New York	6,962
Virginia	6,685
Kentucky	2,908
All Others*	1,907
Total	2,480,677

FIG. 19b. Mine production of zinc 1912–1916, inclusive.
Data from Mineral Resources of the United States.

*Washington, Texas, North Carolina, New Hampshire, Iowa.



	Short Tons
Missouri	1,265,190
New Jersey	808,647
Colorado	446,524
Montana	365,135
WISCONSIN	307,974
Idaho	129,036
Kansas	125,655
Oklahoma	100,029
Utah	78,380
New Mexico	78,103
Tennessee	64,220
Nevada	55,048
Arizona	41,403
Illinois	32,435
California	18,592
Arkansas	15,105
Virginia	9,274
New York	7,043
Kentucky	3,128
All Others*	2,628
Total	3,953,549

FIG. 19c. Mine production of zinc 1907–1916, inclusive. Data from Mineral Resources of the United States.

*Washington, Texas, Iowa, North Carolina, New Hampshire.

Wisconsin's position relative to the greatest single producing state and to the United States, in both lead and zinc production, is shown in fig. 20, which gives the annual production of lead and zinc 1907–1916, inclusive, for Wisconsin, Missouri, and the United States. Missouri produced more lead than zinc during those years, whereas Wisconsin produced more zinc than lead. The United States produced more lead than zinc until 1915 when zinc production exceeded that of lead. In 1916 the United States produced 701,995 short tons of metallic zinc and 622,975 short tons of metallic lead. Missouri's output for 1916 was 233,088 tons of metallic lead and 155,960 tons of spelter. Wisconsin's lead production remained practically stationary, at about 3,000 short tons annually for the ten years, but its zinc production increased to 56,803 short tons of spelter in 1916.

The position of Wisconsin as a zinc producer is higher than its position as a lead producer, as is shown in figs. 21 and 22. Fig. 21 shows the amounts of metallic lead produced annually 1907–1916 by the four largest producers and by Wisconsin. Fig. 22 gives similar data for zinc. Missouri and Idaho are the largest producers of lead, and Missouri and New Jersey are the largest producers of zinc, in the United States. In lead production four states stand out pre-eminently: Missouri, Idaho, Utah, and Colorado, ranking in the order named, (figs. 18a, 18b, 18c). Wisconsin is one of a number of states next in importance, but producing very much less lead. In zinc production Wisconsin is one of the first five states, (figs. 19a, 19b, 19c). J. P. Dunlop, in Mineral Resources of the United States,[34] makes the statement that "Wisconsin in 1911 and 1912 stood third and in 1913 and 1914 fourth in rank among zinc-producing states." This statement is not borne out by the statistics appearing in Mineral Resources o fthe United States.[35] In 1911 and 1912 Wisconsin's rank was fourth, and in 1913 and 1914, fifth, (fig. 22). In only one year during the years under consideration (1907–1916) did Wisconsin rank third, and that was in 1908 when Colorado had temporarily dropped from third place to fourth. In 1909 Colorado regained its place as third largest producer, and maintained it until Montana took it away in 1914. In 1916 Montana occupied second place, followed by New Jersey, Colorado, and Wisconsin.

---

[34] 1914. Part 1, p. 116.
[35] 1916, Part 1, p. 814.

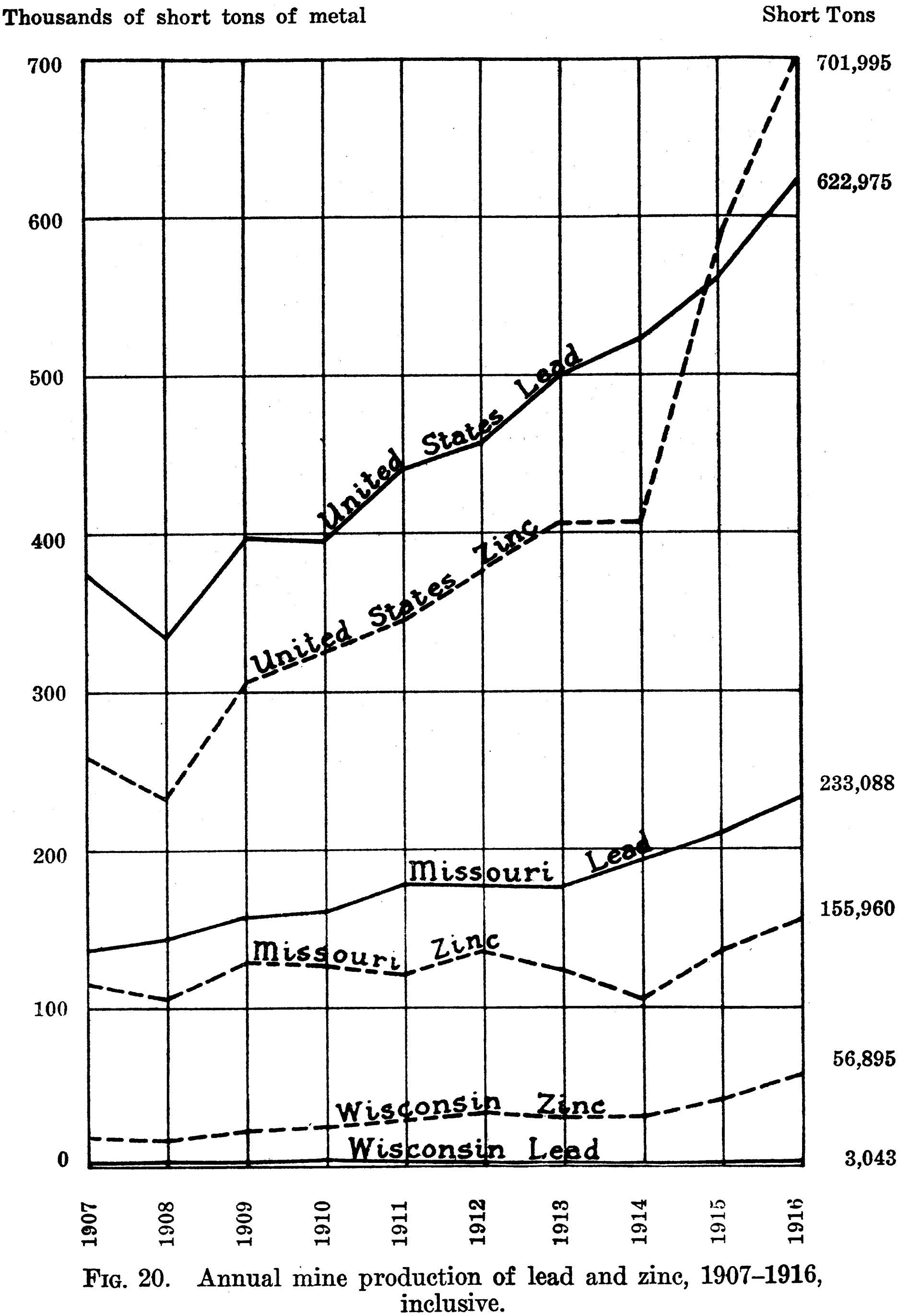


FIG. 20. Annual mine production of lead and zinc, 1907–1916, inclusive.
Data from Mineral Resources of the United States.

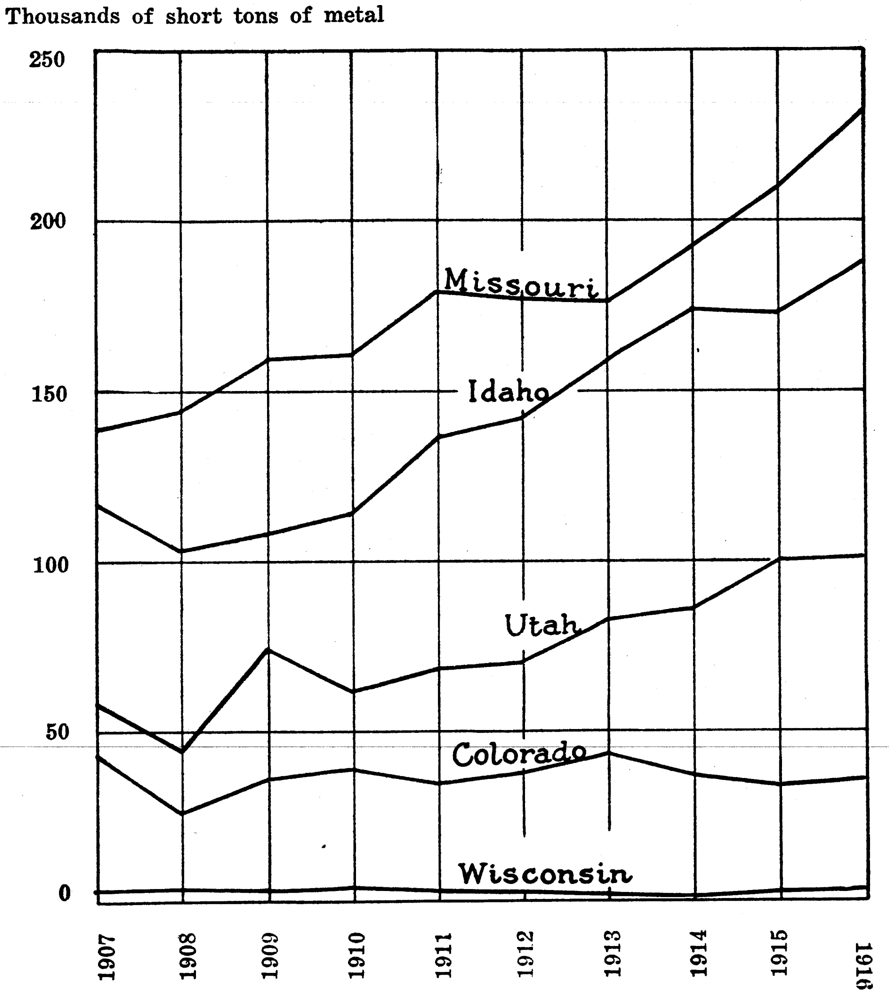


FIG. 21. Annual mine production of lead, 1907–1916, inclusive.
Data from Mineral Resources of the United States

Thousands of short tons of metal

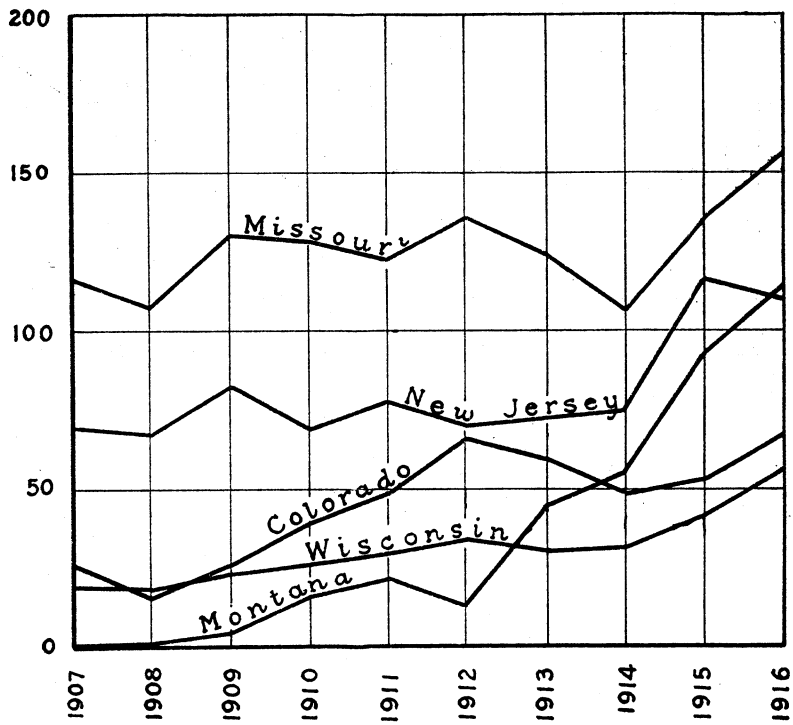


FIG. 22. Annual mine production of zinc, 1907–1916, inclusive. Data from Mineral Resources of the United States

The lead production of Wisconsin, which played so important a part in the early history of the state, is now of small importance; but the zinc industry, which sprang up after the decline of lead production had set in, has steadily grown until it has become of great importance in the state and of considerable importance in the United States.

Lead Production of the Upper Mississippi Valley

BIBLIOGRAPHY OF STATISTICS

1. 1903. Wisconsin Historical Collections.

a. For 1823: v. 6, p. 290.
Article by Moses Meeker.
Figures are for "Lead product" for
"Wisconsin Lead Region."

Also v. 8, p. 250.
Article by Moses M. Strong.
Figures are for "Lead produce."

b. For 1825–1828, inclusive: v. 8, p. 250.
Map published by R. W. Chandler of Galena.
Figures are for "Manufactured lead" from
"Lead Region of the Upper Mississippi."

c. For 1829: v. 10, p. 79.
Article by James David Butler.
Figures, credited to U. S. Census, are for
"Lead harvest" at
"Galena."

d. For 1841: v. 13, p. 318.
Letter of Governor Doty to Governor Seward
Figures are for "Lead" from
"Our mines."

e. For 1845: v. 13, p. 297.
Article by Orin Grant Libby.
Figures are for "Pigs" from
"Galena, Wisconsin, and Iowa."
(Converted by the writer to short tons on basis of 70 lbs. a pig.)

2. 1840, 1844, D. D. Owen.

Report of a Geological Exploration of part of Iowa, Wisconsin and Illinois made under instructions from the Secretary of the Treasury of the United States in the Autumn of the year 1839, by David Dale Owen, M. D., Principal Agent to explore the Mineral Lands of the United States.
Document No. 239, House of Representatives, 26th Congress, First Session.

Report of Geological Exploration of part of Iowa, Wisconsin and Illinois made from instructions from the Secretary of the Treasury of the United States in the Autumn of the year 1839; with charts and illustrations, by David Dale Owen, M. D., Principal Agent to explore the Mineral Lands of the United States.

Ordered to be printed by the Senate of the United States June 11, 1844.

Document No. 407, Senate, 28th Congress, First Session.

---

a. For 1823–1829, inclusive: p. 37 of House Document No. 239; p. 46 of Senate Document No. 407.
Figures, credited to Mr. Legate, are for
"Lead produce based on smelters' returns" from
"Wisconsin, then called Fever River, Mines."

b. For 1839: p. 35 of House Document No. 239;
p. 44 of Senate Document No. 407.
Figures are for
"Lead" produced from lead mines of
"Iowa, Wisconsin, and Northern Illinois."

c. For 1841–1843, inclusive: p. 48 Senate Document No. 407.
Figures, credited to "Register kept at Galena since 1841" are for
"Pigs" and "Pounds" from
"Upper Mississippi Mines."

---

3. 1854.

Edward Daniels, First Annual Report on the Geological Survey of the State of Wisconsin, published 1854.

---

a. For 1823–1829, inclusive: p. 39.
Figures, credited to "report of Dr. Owen, made to the general government in 1840," are for
"Lead" from the
"Lead district of Wisconsin, Illinois, and Iowa."

b. For 1841–1853, inclusive: pp. 39, 40.
Figures, credited to Capt. Chas. Beebe, of Galena, are for
"Lead" from the
"Lead district of Wisconsin, Illinois, and Iowa."

---

4. 1854.

Josiah Dwight Whitney, The Metallic Wealth of the United States, described and compared with that of other countries; Philadelphia, 1854.

---

a. For 1823–1838, inclusive: p. 421.
Figures, credited to W. H. Bell, Report on Mineral Lands of have been obtained from records of Messrs. Collier and the Upper Mississippi, stated (presumably by Bell) to Kennet, are for
"Metallic lead" from the
"Upper Mississippi Mines."

b. For 1845–1853, inclusive, p. 421.
Figures, credited to Capt. Beebe of Galena, are for "Metallic lead" from the "Upper Mississippi Mines."

---

5. 1859.

The Merchants' Magazine and Commercial Review, Conducted by Freeman Hunt.

---

a. For 1821–1857, inclusive: v. 40, p. 244.
Figures, credited to E. H. Beebe in Galena Advertiser, are for "Pigs" and "Pounds" of lead from the "Galena River Mines."

b. For 1860: v. 44, p. 703.
Figures are "Pigs" and "Pounds" of "Lead" from the "Upper Mississippi Lead Mines located in Illinois, Wisconsin and Iowa."

---

6. 1877.

Moses Strong.

Chamberlin, Geology of Wisconsin, 1873–79, v. 2, Pt. 4, pp. 645–752. Moses Strong, Geology and Topography of the Lead Region.

---

a. For 1823–1853, inclusive: v. 2, Pt. 4, p. 750.
Figures, credited to J. D. Whitney, are for "Metallic lead" from the "Upper Mississippi Lead Mines."

b. For 1862–1871, inclusive, p. 749.[1]
Figures are for total product of "Lead ore" of the "Wisconsin Lead region."

c. For 1872–Oct. 1, 1876, inclusive: p. 750.
Figures, credited to N. Corwith & Co., of Galena, are for "Pigs" and tons of lead from the "Upper Mississippi Lead Mines."
(Footnote states: "The weight of a pig of lead is about 72 pounds." S. L. S. Figures for 70 lb. pigs for 1872 and 1873, and for 72 lb. pigs for 1874, 1875 and to October, 1876.)

---

7. 1883.

Mineral Resources of the United States.
Department of the Interior, U. S. Geological Survey.

---

[1] The table is for 1862 to Oct. 1, 1876. Figures after 1871 are omitted and the Corwith data substituted because the latter are for metal and for entire Upper Mississippi Valley.

a. For 1873–1880, inclusive: v. 1910, Pt. 1, p. 225.
Article by C. E. Siebenthal.
Figures are for "soft lead" from (a) Missouri; and from (a) "Wisconsin and Illinois" (called the "Galena District"),[3] v. 1893 and '84, p. 426, article by C. Kirchoff, Jr.)

b. For 1873–1880, inclusive: v. 1883 and '84, p. 426.
Article by C. Kirchoff, Jr.
Figures are for "non-argentiferous lead" from the Mississippi Valley, comprising "Missouri, Kansas, Illinois, and Wisconsin."

c. For 1881–1905, inclusive: v. 1910, Pt. 1, p. 225.
Article by C. E. Siebenthal.
Figures are for "soft lead" from the "Mississippi Valley." (Production from the Mississippi Valley from 1894–1905, inclusive, comprises lead content of ores from Missouri, Kansas, Illinois, Wisconsin, Iowa, Virginia, and Kentucky. See v. 1905, p. 364.)

d. For 1906, v. 1910, Pt. 1, p. 228.
Article by C. E. Siebenthal.
Figures are for "soft lead" from Wisconsin, Iowa, and Illinois, separately given.

e. For 1907–1914, inclusive: v. 1914, Pt. 1, p. 44.
Article by J. P. Dunlop.
Figures are mine figures for lead (metal) from the "Upper Mississippi Valley." (Upper Mississippi Valley comprises Wisconsin, Iowa, and Northern Illinois.)[4]

---

[3] The term "Galena District" is applied also to mines in the Missouri-Kansas District, and care must be taken that the two are not confused.

Examples showing that the term "Galena District" is applied to Illinois and Wisconsin:

v. 1883, p. 312:

"Output of the Galena district, embracing the production of Illinois and Wisconsin."

	Gross Tons
1873,	6,550
1875,	5,000
1876,	6,425
1877,	5,730
1878,	4,011
1879,	2,500

v. 1883 and '84, p. 426:

"Production of non-argentiferous lead in Missouri, Kansas, Illinois and Wisconsin."

Short tons.

	Southwest District	Galena District	Total
1873,	15,045	7,336	22,381
1875,	19,099	5,600	24,699
1876,	19,225	7,196	26,421
1877,	24,734	6,418	31,152
1878,	22,278	4,492	26,770
1879,	25,330	2,800	28,130

v. 1910, Pt. 1, p. 225, under the heading "Illinois and Wisconsin" gives the figures here given under "Galena District."

Examples showing that the term "Galena District" is applied to mines in the Missouri-Kansas district:

v. 1892, p. 124 gives ores of Joplin district and includes "Galena."
v. 1893, p. 95 shows "Galena" as being in Cherokee County, Kansas.
v. 1900, p. 195: "Lead ores in the zinc-lead mines of Southwestern Missouri and Southeastern Kansas known as the Joplin-Galena district."
v. 1903 p. 245, Missouri has (1) Joplin-Galena district, comprising Southwestern Missouri and Southeastern Kansas, and (2) Southeastern Missouri.
v. 1895, p. 151, "Kansas, Galena District."

[4] v. 1914, Pt. 1, p. 38: "The lead and zinc deposits of Illinois fall into two distinct regions marked by different mineralogical and structural environment. Those of Southern Illinois belong to the Kentucky-Illinois fluorspar district; those of Northern Illinois belong to the Upper Mississippi Valley region."

The amount given for the Upper Mississippi Valley for 1914 (v. 1914, Pt. 1, p. 44) is 1,986 short tons, which may be analyzed as follows:

Wisconsin	1,494	(1915, Pt. 1, p. 126)
Iowa	None	(1915, Pt. 1, p. 63)
Northern Illinois,	492	(1914, Pt. 1, p. 37)
	1,986	

f. For 1915: v. 1915, Pt. 1, pp. 59, 63, and 126.
Article by J. P. Dunlop.
Figures are mine figures for lead (metal) from
Wisconsin, Iowa, and Northern Illinois, separately given.[5]

g. For 1916: v. 1916, Pt. 1, p. 59.
Article by J. P. Dunlop.
Figures are mine figures for lead (metal) from the
"Upper Mississippi Valley." (Upper Mississippi Valley comprises Wisconsin, Iowa, and Northern Illinois."[6]

8. 1892.

The Mineral Industry, Its Statistics, Technology and Trade, in the United States and other Countries. Statistical Supplement of the Engineering and Mining Journal. Founded by Richard P. Rothwell.

---

a. For 1873–1893, inclusive: v. 2, p. 386.
Article by Walter Renton Ingalls.
Figures are for "lead production" of the
Mississippi Valley, comprising Southeastern Missouri, Southwestern Missouri, Wisconsin, Iowa and Northwestern Illinois.

b. For 1869–1892, inclusive: v. 2, p. 387.
Article by Walter Renton Ingalls.
Figures, credited to "Geology and Mineral Products of Missouri by Arthur Winslow," are for
"Lead production" in
Missouri.

---

c. For 1873–1892, inclusive:
By subtracting the second set of figures from the first, above referred to, statistics are obtained for the Upper Mississippi Valley, comprising Wisconsin, Iowa, and Northwestern Illinois.[7]

---

9. 1894.
Arthur Winslow.

The Missouri Geological Survey, v. 6, Sec. 1, pp. 135–151. Lead and Zinc Deposits of the Mississippi Valley, by Arthur Winslow.

a. For 1823–1853, inclusive: p. 146–7.

---

[5] The 1915 amount for Upper Mississippi Valley is made up as follows:

Wisconsin	2,322 short tons	(v. 1915, Pt. 1, p. 125)
Iowa,	None	(v. 1915, Pt. 1, p. 63)
Northern Illinois,	495	(v. 1915, Pt. 1, p. 59)

[6] The amount given for the Upper Mississippi Valley for 1916 (v. 1916, Pt. 1, p. 59) is 3,519 short tons, which may be analyzed as follows:

Wisconsin,	3,043	(v. 1916, Pt. 1, p. 57)
Iowa,	14	(v. 1916, Pt. 1, p. 57)
Northern Illinois	462	(v. 1916, Pt. 1, p. 70)
Upper Mississippi Valley	3,519	(v. 1916, Pt. 1, p. 59)

[7] Note.—Ingalls, in Mineral Industry, v. 2, p. 387, makes the following comment: "It will be noted that the product reported for Missouri in the preceding table is in a few cases greater than that stated for the Mississippi Valley in the general table of production of Lead in the United States. More or less of the Missouri ore is shipped to silver-lead smelters, by whom it is reported as 'desilverized', and it is not credited to the States producing it, except since 1890, when the reports made by the smelters to The Mineral Industry have been divided so that the production could be traced to its true source."

Figures, credited to Whitney "234, p. 421,"[8] are for
"Tons of lead, produced by the
"Whole region."[10]

b. For 1862–Oct. 1, 1876, inclusive: p. 146.
Figures are for tons of "lead ore" produced in
"Wisconsin.[11]

c. For 1872–October, 1876: p. 147.
Figures, credited to Mr. Strong, "39, vol. ii, p. 750"[9] are for
"Tons of lead."
(Region not specified)[12]

d. For 1873–1879, inclusive: p. 147.
Figures, credited to "Mineral Resources of the United States for 1882" are for
"Tons of lead."
(Region not specified.)[13]

e. For 1880: p. 147.
Figures, credited to "Census of 1880," are for
"Tons of lead ore" from
Wisconsin, Illinois, and Iowa.[14]

f. For 1889: p. 148.
Figures for "Census year of 1889" are for
"Tons of lead ore" from
Wisconsin, Illinois, and Iowa (No production).[14]

---

10. 1911.

O. C. Gillett, Lead and Zinc Production of the Upper Mississippi Valley, B. A. Thesis at University of Wisconsin, 1911; Approved by C. K. Leith.

---

a. For 1823–1853, inclusive; p. 9.
Credited to J. D. Whitney, Metallic Wealth of the United States.

b. For 1862–1880, inclusive; p. 10.
Credited to "Winslow's Geology of Missouri."

c. For 1881–1892, inclusive: p. 10.
Credited to W. R. Ingalls, Mineral Industry.

d. For 1893–1906, inclusive: p. 10.
Estimated by Gillett at 1,500 annually.

---

[8] The first number of the quotation refers to the Winslow's bibliography, No. 234 being D. Whitney's Metallic Wealth of the United States.

[9] The first number of the quotation refers to the Winslow's bibliography, No. 39 being Chamberlin's Geology of Wisconsin, 1873-79.

[10] J. D. Whitney's Metallic Wealth of the United States, p. 421, gives figures for 1823-1853, for tons of metallic lead produced by the Upper Mississippi Mines. The figures do not correspond with those given by Winslow. By adding 12% to each of Whitney's metallic lead figures, amounts are obtained identical with Winslow's.

It may have been Winslow's intention to convert Whitney's metallic lead into ore.

[11] These are figures converted by Winslow from pounds of lead ore produced in Wisconsin 1862 to Oct. 1, 1866, as given by Moses Strong, p. 749 Geology of Wisconsin 1873-'79, v. 2., Pt4.

[12] These figures, credited to Strong, are called by Winslow "Tons of Lead." Strong's figures. v. 2, p. 750, Geology of Wisconsin, 1873-'79, are for pigs and tons produced in the Upper Mississippi Mines. The lead here referred to is therefore metal.

[13] v. 1883 and '84, of Mineral Resources, p. 426, identifies these figures as "non-argentferous-lead" from Wisconsin and Illinois. Also v. 1910, Pt. 1, p. 225, where the lead is designated as "soft lead." These statistics are therefore for metal.

[14] Winslow designates the amounts for 1880 and 1889 as being lead ore.

e. For 1906–1908, inclusive: p. 11.
Credited to Mineral Resources.

f. For 1909–1910, inclusive: p. 11.
Credited to J. E. Kennedy, Platteville.

11. 1920.

Compilation by S. L. Schubring.

a. For 1823–1853, inclusive:
J. D. Whitney, The Metallic Wealth of the United States, p. 421.
Whitney's compilation is made up as follows:

For 1823–1838, inclusive:
Figures, credited to W. H. Bell, Report on Mineral Lands of the Upper Mississippi, stated by Bell to have been obtained from records of Messrs. Collier and Kennet, are for
"Metallic lead" from the
"Upper Mississippi Mines."

For 1839–1844, inclusive:
Figures are for
"Metallic lead" from the
"Upper Mississippi Mines."

For 1845–1853, inclusive:
Figures, credited to Capt. Beebe of Galena, are for
"Metallic lead" from the
"Upper Mississippi Mines."

b. For 1854–1857, inclusive:
Hunt's Merchants' Magazine and Commercial Review, v. 40, p. 244.
Figures, credited to E. H. Beebe in Galena Advertiser, are for
"Pigs" and "Pounds" of lead from the
"Galena River Mines."

c. 1858–1859, inclusive: No data.

d. For 1860:
Hunt's Merchants' Magazine and Commercial Review, v. 44, p. 703.
Figures are for "Pigs" and "Pounds" of lead from the
"Upper Mississippi Lead Mines located in
Illinois, Wisconsin and Iowa."

e. 1861. No data.

f. For 1862–1871, inclusive:
Chamberlin: Geology of Wisconsin, 1873–'79, v. 2, Pt. 4, p. 749–750.
Moses Strong, Geology and Topography of the Lead Region.
Figures are for "total product of lead ore" of the
"Wisconsin lead region."

(11. Compilation by S. L. Schubring, continued.)

g. For 1872: Ibid, p. 750.
Figure, credited by Strong to N. Corwith & Co., is for "Lead" from the
"Upper Mississippi Lead Mines."
(Note.—Since the figure is given also in "pigs," this is metallic lead.)

h. For 1873–1880, inclusive:
Mineral Resources of the United States, v. 1910, Pt. 1, p. 225.
Figures are for "Soft lead" produced by
Wisconsin and Illinois.

i. For 1881–1892, inclusive:
The Mineral Industry, Statistical Supplement of the Engineering and Mining Journal, v. 2, pp. 386, 387.

Missouri "lead production" credited to Geology and Mineral Products of Missouri by Arthur Winslow.

By subtracting Missouri product from production of the Mississippi Valley, statistics are obtained for
"Lead production" of the
Upper Mississippi Valley, comprising Wisconsin, Iowa, and Northwestern Illinois.

j. 1873–1905. No data.

k. For 1906: Mineral Resources of the United States, v. 1910, Pt. 1, p. 228.
Article by C. E. Siebenthal.
Figures are for "soft lead" from
Wisconsin, Iowa, and Illinois, separately given.

l. For 1907–1914, inclusive: Ibid., v. 1914, Pt. 1, p. 44.
Article by J. P. Dunlop.
Figures are mine figures for lead (metal) from
"Upper Mississippi Valley." (Upper Mississippi Valley comprises Wisconsin, Iowa, and Northern Illinois.)[15]

m. For 1915: Ibid., v. 1915, Pt. 1, pp. 59, 63, and 126.
Article by J. P. Dunlop.
Figures are mine figures for lead (metal) from
Wisconsin, Iowa, and Northern Illinois, separately given.[16]

[15] v. 1914, Pt. 1, p. 38: "The lead and zinc deposits of Illinois fall into two distinct regions marked by different mineralogical and structural environment. Those of Southern Illinois belong to the Kentucky-Illinois fluorspar district; those of Northern Illinois belong to the Upper Mississippi Valley region."

The amount given for the Upper Mississippi Valley for 1914 (v. 1914, Pt. 1, p. 44) is 1,986 short tons, which may be analyzed as follows:

Wisconsin,	1,494	(1915, Pt. 1, p. 126)
Iowa,	None	(1915, Pt. 1, p. 63)
Northern Illinois,	492	(1914, Pt. 1, p. 37)
	1,986	

[16] The 1915 amount for Upper Mississippi Valley is made up as follows

Wisconsin,	2,322 short tons	(v. 1915, Pt. 1, p. 125)
Iowa	None	(v. 1915, Pt. 1, p. 63)
Northern Illinois,	495	(v. 1915, Pt. 1, p. 59)

n. For 1916: Ibid., v. 1916, Pt. 1, p. 59.
Article by J. P. Dunlop.
Figures are mine figures for lead (metal) from "Upper Mississippi Valley." (Upper Mississippi Valley comprises Wisconsin, Iowa, and Northern Illinois.)[17]

SUMMARY

Year	Nature of Product	Region of Production
1823–1853, Inc.,	Metallic Lead	Upper Mississippi Mines
1854–1857, Inc.,	Metallic lead (Converted pigs)	Galena River Mines
1858–1859, Inc.,	No Data	
1860,	Metallic lead (Converted pigs)	Upper Mississippi Mines located in Illinois, Wisconsin and Iowa.
1861,	No Data	
1862–1871, Inc.,	Lead ore	Wisconsin Lead Region
1872,	Metallic lead (Converted pigs)	Upper Mississippi Lead Mines
1873–1880, Inc.,	Metallic lead (Soft lead)	Wisconsin and Illinois
1881–1892, Inc.,	"Lead"	Upper Mississippi Valley (Comprising Wisconsin, Iowa and Northwestern Illinois.)
1893–1905, Inc.,	No Data	
1906,	Metallic lead (Soft lead)	Wisconsin, Iowa and Illinois
1907–1916, Inc.,	Metallic lead (Soft lead)	Upper Mississippi Valley (Comprising Wisconsin, Iowa and Northern Illinois.)

Zinc Production of the Upper Mississippi Valley

Bibliography of Statistics.

1. 1877.

Moses Strong.

Chamberlin, Geology of Wisconsin, 1873–79, v. 2, Pt. 4, pp. 645–752.
Moses Strong, Geology and Topography of the Lead Region.

a. For 1860–Oct. 1, 1876; v. 2, Pt. 4, pp. 742, 843.
Statistics, prepared from the books of the four zinc manufacturing companies at La Salle, Ill., are for
Smithsonite and Blende from
Mineral Point, Platteville, Council Hill, and Galena.

[17] The amount given for the Upper Mississippi Valley for 1916 (v. 1916, Pt. 1, p. 59) is 3,519 short tons, which may be analyzed as follows:

Wisconsin,	3,043	(v. 1916, Pt. 1, p. 57)
Iowa,	14	(v. 1916, Pt. 1, p. 57)
Northern Illinois,	462	(v. 1916, Pt. 1, p. 70)
Upper Miss. Valley	3,519	(v. 1916, Pt. 1, p. 59)

2. 1883—

Mineral Resources of the United States, Department of the Interior, United States Geological Survey.

---

a. For 1886: v. 1886, p. 156.
Article by C. Kirchoff, Jr.
Statistics, credited to Thos. H. McElroy, are for ores shipped from
Shullsburg and Benton:

From Shullsburg -------	506	short tons "Drybone"
	209	short tons "Black Jack"
From Benton ----------	2,275	short tons both classes.
	2,990	short tons

b. For 1889: v. 1889 & 1890, p. 88.
Article by C. Kirchoff.
Statistics, credited to census report covering calendar year 1889 are for zinc ore produced in Wisconsin.

c. For 1904 and 1905: v. 1905, Pt. 1, p. 384.
Article by H. Foster Bain.
Statistics are estimates for ore produced by
Wisconsin, Illinois, and Iowa.

d. For 1906: v. 1906, Pt. 1, p. 473.
Article by J. M. Boutwell.
Statistics are for zinc ores produced in Wisconsin.

e. For 1907–1914, inclusive: v. 1914, Pt. 1, p. 44.
Article by J. P. Dunlop.
Statistics are for zinc concentrates produced in the
Upper Mississippi Valley region.

f. For 1907–1914, inclusive: v. 1914, Pt. 1, p. 44.
Article by J. P. Dunlop.
Statistics are for metallic zinc produced in the
Upper Mississippi Valley region.

g. For 1915: v. 1915, Pt. 1, pp. 59, 63, 125.
Article by J. P. Dunlop.
Statistics are for zinc concentrates from
Wisconsin, Iowa, and Northern Illinois, separately given.[18]

h. For 1915: v. 1915, Pt. 1, pp. 59, 63, 126.
Article by J. P. Dunlop.
Statistics are for metallic zinc from
Wisconsin, Iowa, and Northern Illinois, separately given.[19]

---

[18] The 1915 amount for Upper Mississippi Valley is made up as follows:

Wisconsin,	sphalerite,	138,996 S. T.	(v. 1915, Pt. 1, p. 125)
	carbonate,	2,579 S. T.	(v. 1915, Pt. 1, p. 125)
Northern Illinois,	sphalerite,	20,454 S. T.	(v. 1915, Pt. 1, p. 59)
Iowa,		None	(v. 1915, Pt. 1, p. 63)
		162,029	

[19] The 1915 amount for Upper Mississippi Valley is made up as follows:

Wisconsin,	41,403 S. T.	(v. 1915, Pt. 1, p. 126.)
Northern Illinois,	5,534 S. T.	(v. 1915, Pt. 1, p. 126.)
Iowa,	None	(v. 1915, Pt. 1, p. 63.)
	46,937	

i. For 1916: v. 1916, Pt. 1, p. 58.
Article by J. P. Dunlop.
Statistics are for metallic zinc produced in the
Upper Missisippi Valley. (Upper Mississippi Valley comprises Wisconsin, Iowa, and Northern Illinois.[20]

j. For 1916: v. 1916, Pt. 1, p. 58.
Article by J. P. Dunlop.
Statistics are for metallic zinc produced in the
Upper Mississippi Valley. (Upper Mississippi Valley comprises Wisconsin, Iowa, and Northern Illinois.[21]

k. Total for 1821–1914, inclusive: v. 1914, Pt. 1, p. 44.
Article by J. P. Dunlop.
Statistics are for zinc concentrates produced in the
Upper Mississippi Valley, comprising Wisconsin, Iowa, and Northern Illinois.

l. Total for 1821–1914, inclusive: v. 1914, Pt. 1, p. 44.
Article by J. P. Dunlop.
Statistics are for metallic zinc produced in the
Upper Mississippi Valley, comprising Wisconsin, Iowa, and Northern Illinois.

3. 1892—

The Mineral Industry, Its Statistics, Technology and Trade, in the United States and other countries. Statistical Supplement of the Engineer and Mining Journal. Founded by Richard P. Rothwell.

---

a. For 1891, 1892: v. 2, p. 625.
Statistics, credited to Prof. W. H. Seamon in the Seventh Annual Report of the State Mine Inspector of Missouri, p. 160, are for
Zinc ore produced in
Wisconsin.

b. For 1892, v. 1, p. 132.
Article by C. Kirchoff.
Statistics, credited to Prof. W. P. Blake, are for
Shipments from Benton, the principal ore-shipping station.

c. For 1893: v. 2, p. 625.
Statistics, credited to W. P. Blake, are for
Zinc ore produced in
Wisconsin.

d. For 1900: v. 9, p. 666.
Article by E. R. Buckley.

---

[20] The amount given for the Upper Mississippi Valley for 1916 (v. 1916, Pt. 1, p. 58) is 220,777 short tons, which may be analyzed as follows:

Wisconsin,	carbonate,	4,261 S. T.	(v. 1916, Pt. 1, p. 146.)
	sphalerite,	201,220 S. T.	(v. 1916, Pt. 1, p. 146.)
Iowa,	sphalerite,	85 S. T.	(v. 1916, Pt. 1, p. 75.)
Northern Illinois,	sphalerite,	15,211 S. T.	(v. 1916, Pt. 1, p. 70.)
		220,777	

[21] The amount given for the Upper Mississippi Valley for 1916 (v. 1916, Pt. 1, p. 58), is 60,228 short tons, which may be analyzed as follows:

Wisconsin,	56,803 S. T.	(v. 1916, Pt. 1, p. 70a.)
Iowa,	21 S. T.	(v. 1916, Pt. 1, p. 53a.)
Northern Illinois,	3,404 S. T.	(v. 1916, Pt. 1, p. 70 .)
	60,228	

Statistics are for zinc ore shipped from the more important centers of the region.

e. For 1904, v. 19, p. 674.
Statistics, credited to Bain, are for
Zinc ore produced in
"Wisconsin."[22] (Probably Upper Mississippi Valley.)

f. For 1905–1910, inclusive: v. 19, p. 674.
Statistics are for
Zinc ore produced in
"Wisconsin."[23] (Probably Upper Mississippi Valley.)

---

g. For 1906, 1907: v. 16, p. 915.
Article by J. E. Kennedy.
Statistics are for
Zinc ore from
Wisconsin, Illinois, and Iowa.

h. For 1910–1915, inclusive: v. 24, p. 720.
Article by R. L. Bartlett.
Statistics are for
Zinc ores received by smelters[24] from
Wisconsin, including Illinois and Iowa.

i. For 1916: v. 26, p. 750.
Article by Jesse A. Zook.
Statistics are for zinc ores produced in
Wisconsin.

---

4. 1894.

Arthur Winslow.

The Missouri Geological Survey, v. 6, Sec. 1, pp. 135–151. Lead and Zinc Deposits of the Mississippi Valley, by Arthur Winslow.

---

a. For 1860–1876, inclusive: pp. 148, 149.
Statistics, credited to Moses Strong, are for
Zinc ores from
Wisconsin and Illinois.

b. For 1879: p. 149.
Statistics, credited to Irving are estimates for
Zinc ores from
"the region."

---

[22] Bain gives this figure for Upper Mississippi Valley.

[23] In v. 16, p. 915 J. E. Kennedy gives identical 1905 production and says it is for Wisconsin Illinois, and Iowa.
In v. 22, p. 781, 1910 production (same amount as here given) is for "Wisconsin, including Illinois and Iowa."

[24] Does not include the production of ore exported or what was taken by the manufacturers of zinc oxide. For 1910 and 1911 reports missing from three small smelters.
v. 24, p. 720 incorrectly gives 1914 production as 71,311 short tons. The correct amount is 74,311. (See v. 23, p. 770.)

c. For 1880: p. 149.
Statistics, credited to the "Census", are for
Zinc ore from
Wisconsin and Illinois.

d. For 1889: p. 149.
Statistics "for the census year 1889," are for
Zinc ore from
Iowa and Wisconsin.

e. For 1893: p. 149.
Statistics, credited to Blake, are for
Zinc ore.

---

5. 1902.

E. T. Hancock.

Tenth Biennial Report of the Bureau of Labor and Industrial Statistics. State of Wisconsin 1900–1901. Halford Erickson, Commissioner, pp. 1075–1093. The Lead and Zinc Industry of Southwestern Wisconsin. Prepared by Eugene T. Hancock, University of Wisconsin.

a. For 1876–1901, inclusive: p. 1090–1.
Statistics, prepared from reports of smelters, are for
Zinc ores produced in
Wisconsin.

---

6. 1907.

H. Foster Bain.

Zinc and Lead Deposits of the Upper Mississippi Valley, Wisconsin Geological and Natural History Survey, Bulletin No. xix, Economic Series, No. 12.

---

7. 1911.

O. C. Gillett, Lead and Zinc Production of the Upper Mississippi Valley, B. A. Thesis at University of Wisconsin, 1911; Approved by C. K. Leith.

a. For 1860–1876, inclusive:
Statistics, credited to "Winslow's Geology of Missouri" are for metallic zinc[25] from the
Upper Mississippi Valley.

b. For 1877–1901, inclusive:
Statistics, credited to E. T. Hancock, Report for Bureau of Labor Statistics, 1902, are for
Metallic zinc[25] from the
Upper Mississippi Valley.

c. For 1906–1910, inclusive:
Statistics, credited to C. E. Siebenthal of the United States Geological Survey, are for
Metallic zinc from the
Upper Mississippi Valley.

---

[25] Converted from ores on the basis of 35%.

TABLE 1. *Summary of lead production of the Upper Mississippi Valley, stated in short tons of metallic lead.*

1. Statistics from various authorities as indicated in Exhibit I.

	1821–1830	1831–1840	1841–1850	1851–1860	1861–1870	1871–1880	1881–1890	1891–1900	1901–1910	1911–	
1	------------	5,369	14,150	14,816	N. D.	(b) 6,742	5,140	3,000	N. D.	4,038	------------
2	------------	5,401	13,992	12,770	(b) 8,519	7,000	5,149	4,740	N. D.	3,331	------------
3	(a) 150	6,068	17,477	13,307	(b) 7,553	7,336	3,410	N. D.	N. D.	2,519	------------
4	78	7,699	19,521	14,827	(b) 6,507	5,400	5,602	N. D.	N. D.	1,986	------------
5	297	8,469	24,328	15,063	(b) 7,169	5,600	1,059	N. D.	N. D.	2,817	------------
6	428	11,390	23,513	15,248	(b) 7,015	7,196	------------	N. D.	2,595	3,519	------------
7	2,313	9,708	24,145	17,082	(b) 6,910	6,418	8,428	N. D.	4,202	------------	------------
8	4,958	10,811	21,312	N. D.	(b) 6,985	4,492	6,480	N. D.	4,363	------------	------------
9	5,957	11,976	19,654	N. D.	(b) 6,718	2,800	------------	N. D.	3,818	------------	------------
0	5,331	11,987	17,768	12,227	(b) 6,877	3,940	2,511	N. D.	4,534	------------	------------
Total	19,512	88,878	195,860	115,340	(b) 64,198	56,924	37,779	7,740	19,512	18,210	623,953

(a) Probably 1821-1823, 150 tons.
(b) Ore. Wisconsin only.

2. Statistics from O. C. Gillett: Lead and Zinc Production of the Upper Mississippi Valley.

1	------------	5,369	14,150	14,816	N. D.	6,743	5,140	3,000	1,500	------------	------------
2	------------	5,401	13,992	12,770	8,519	7,000	5,149	4,740	1,500	------------	------------
3	150	6,068	17,477	13,307	(d) 7,533	7,000	3,410	3,000	1,500	------------	------------
4	78	7,699	19,521	N. D.	6,507	5,400	5,600	Est. 1,500	1,500	------------	------------
5	297	8,469	24,328	N. D.	7,169	5,400	1,059	Est. 1,500	1,500	------------	------------
6	428	11,390	23,513	N. D.	7,014	4,500	------------	Est. 1,500	2,595	------------	------------
7	2,313	9,708	24,145	N. D.	6,911	6,417	8,428	Est. 1,500	4,571	------------	------------
8	4,958	10,811	21,312	N. D.	6,934	4,492	6,480	Est. 1,500	4,486	------------	------------
9	5,957	(c) 11,967	19,654	N. D.	6,714	2,800	------------	Est. 1,500	4,722	------------	------------
0	5,331	11,987	17,768	N. D.	6,877	2,884	(e) 2,411	Est. 1,500	5,638	------------	------------
Tot l	19,512	88,869	195,860	40,893	64,178	52,636	37,677	21,240	29,512	------------	550,377

(c) Should be 11,976 (d) Should be 7,553 (e) Should be 2,511.

3. Statistics from H. F. Bain: Zinc and Lead Deposits of the Upper Mississippi Valley.

Total	23,244	55,718	215,979	161,334	84,700	49,000	10,000	10,000	To 1904 4,000	------------	611,975 Should be 613,975

TABLE 2. *Production of lead ore by furnace districts, stated in pounds. Taken from Chamberlin's Geology of Wisconsin, Vol. 2, Part 4, pp. 645–752.*

	Beetown District	Dodgeville District	Hazel Green District	Highland District	Mineral Point District	New Diggings District (Including Jefferson furnace)	Platteville District	Potosi District	Shullsburg District	State Total Pounds	State Total Short Tons
1866	----------	1,154,298	797,421	500,000	2,154,058	2,173,415	850,000	4,400,000	2,000,000	14,029,192	7,015
1867	----------	1,191,939	1,334,640	500,000	2,043,608	2,200,597	850,000	3,500,000	2,200,000	13,820,784	6,910
1868	800,000	1,046,081	1,541,670	500,000	2,252,710	2,629,158	1,800,000	2,600,000	1,700,000	13,869,619	6,935
1869	1,100,000	1,162,718	1,315,970	500,000	2,532,710	2,615,323	800,000	2,200,000	1,200,000	13,426,721	6,713
1870	1,700,000	1,374,617	1,228,250	500,000	2,192,306	2,200,000	800,000	1,900,000	1,863,986	13,754,159	6,877
Total, Lbs.	3,600,000	5,929,653	6,212,951	2,500,000	11,175,392	11,818,493	4,100,000	14,600,000	8,963,986	68,900,475	34,450
Total, S. T.	1,800	2,964.8	3,106.4	1,250.	5,587.6	5,909.2	2,050.	7,300.	4,481.9	34,450.	
1871	1,300,000	1,932,259	1,230,917	500,000	1,990,672	1,700,000	950,000	2,230,000	1,650,362	13,484,210	6,742
1872	900,000	1,836,320	1,278,524	500,000	1,661,372	1,650,000	950,000	1,400,000	1,446,448	11,622,664	5,811
1873	850,000	1,441,999	1,046,626	500,000	1,518,888	1,128,000	600,000	1,500,000	1,334,221	9,919,734	4,960
1874	1,000,000	1,595,000	830,174	500,000	1,850,000	1,200,000	500,000	750,000	1,700,000	9,925,174	4,963
1875	800,000	1,240,000	735,395	500,000	2,000,000	1,200,000	504,000	700,000	1,800,000	9,479,395	4,740
Total, Lbs.	4,850,000	8,045,578	5,121,636	2,500,000	9,020,932	6,878,000	3,504,000	6,580,000	7,931,031	54,431,177	27,216
Total S. T.	2,425.	4,022.7	2,560.8	1,250.	4,510.4	3,439.	1,752.	3,290.	3,965.5	27,216.	
1866–1875 Short tons	4,225	6,988	5,667	2,500	10,098	9,348	3,802	10,590	8,448	61,666	

TABLE 7. *Annual production of lead and zinc in Wisconsin, 1907–1916, inclusive. The quantity is stated in short tons and the value in dollars. In calculating the metal content of the ores from assays, allowance has been made for smelting and concentration losses in the case of zinc, but not in the case of lead. The value given for ore is that actually received by the producer and the value of the lead is calculated from the average daily quotations at New York. The zinc price used for 1915 to 1916 is the average sales price of all grades reported by smelters. Data from Mineral Resources of the United States, 1914, Pt. 1, p. 115; 1915, Pt. 1, pp. 125, 126; 1916, Pt. 1, p. 146.*

Year	ORE								METAL CONTENT			
	Lead Concentrates (Galena)		Zinc Concentrates						Lead		Zinc	
	Quantity	Value	Sphalerite		Carbonate (Silicates included)		Total Zinc Concentrates					
	Short Tons	Dollars	Quantity Short Tons	Value Dollars	Quantity Short Tons	Value Dollars	Quantity Short Tons	Value Dollars	Quantity Short Tons	Value Dollars	Quantity Short Tons	Value Dollars
1907	4,408	266,471	47,251	997,127	3,065	40,422	50,316	1,037,549	3,499	370,894	18,490	2,181,820
1908	5,246	277,334	48,155	998,734	3,206	36,579	51,361	1,035,313	4,138	347,592	18,206	1,711,364
1909	4,659	254,514	65,421	1,505,752	5,130	63,603	70,551	1,569,355	3,694	317,684	23,152	2,500,416
1910	5,608	286,493	89,232	1,750,574	5,269	69,558	94,501	1,820,132	4,413	388,344	25,927	2,800,116
1911	4,359	229,465	93,963	1,929,123	5,035	74,143	98,998	2,003,266	3,353	301,770	29,720	3,388,080
1907–11	24,280	1,314,277	344,022	7,181,310	21,705	284,305	365,727	7,465,615	19,097	1,726,284	115,495	12,581,796
1912	3,373	180,661	102,617	2,908,892	4,370	72,800	106,987	2,981,692	2,581	232,290	33,050	4,560,900
1913	a)2,532	125,197	95,540	2,053,341	3,123	30,769	98,663	2,084,110	1,866	164,208	30,110	3,372,320
1914	2,028	85,196	108,535	1,924,126	2,787	38,033	111,322	1,962,159	1,494	116,532	31,113	3,173,526
1915	a)3,175	171,091	138,996	5,333,316	2,579	48,223	141,575	5,381,539	2,322	218,268	41,403	10,267,944
1916	4,187	291,397	201,220	7,395,609	4,261	68,544	205,481	7,464,153	3,043	419,934	56,803	15,223,204
1912–16	15,295	853,542	646,908	19,615,284	17,120	258,369	664,028	19,873,653	11,306	1,151,232	192,479	36,597,894
1907–1916	39,575	2,167,819	990,930	26,796,594	38,825	542,674	1,029,755	27,339,268	30,403	2,877,516	307,974	49,179,690

(a) Includes a few tons of lead carbonate.

TABLE 3. *Annual production of lead ore (concentrates) from 1907 to 1916, inclusive, by districts. The quantity is stated in short tons and the value in dollars. The value of the ore is that received by the producer. From Mineral Resources of the United States, 1907, Pt. 1, p. 544; 1908, Pt. 1, p. 639; 1909, Pt. 1, 529; 1910, Pt. 1, p. 668; 1911, Pt. 1, p. 865; 1912, Pt. 1, p. 510; 1913, Pt. 1, p. 160; 1914, Pt. 1, p. 115; 1915, Pt. 1, p. 125; 1916, Pt. 1, p. 146.*

	Benton		Cuba City		Elmo		Dodgeville		Hazel Green		Highland		Linden		Livingston		Mifflin		Mineral Point		Montfort		Platteville		Potosi		Shullsburg		State Total		Year
Year	Short Tons	Dollars	Short Tons	Dollars	Short Tons	Dollars	Short Tons	Dollars	Short Tons	Dollars	Short Tons	Dollars	Short Tons	Dollars	Short Tons	Dollars	Short Tons	Dollars	Short Tons	Dollars	Short Tons	Dollars	Short Tons	Dollars	Short Tons	Dollars	Short Tons	Dollars	Short Tons	Dollars	
1907......	1,250	67,702	598	37,706	----------	----------	145	9,666	819	53,526	340	23,033	347	17,441	248	15,401	46	2,256	265	16,290	----------	----------	205	14,520	48	305	(g) 97	5,880	4,408	266,471	1907
1908......	1,560	83,783	1,426	78,802	----------	----------	176	9,135	601	30,260	332	15,719	328	16,188	66	3,493	275	15,381	194	9,547	----------	----------	248	12,570	40	245	----------	----------	5,246	277,334	1908
1909......	911	97,335	1,319	73,666	364	23,236	57	2,880	28	1,416	568	30,099	427	23,259	149	7,780	285	15,692	125	6,557	95	4,954	223	11,454	10	56	98	5,626	4,659	254,514	1909
			3,343	190,174	364	23,236																									
1910......	625	35,385		Short Tons 1,844	Dollars 97,253		8	241	243	11,061	630	30,731	328	16,871	286	13,646	263	14,452	187	8,983	340	17,748	299	14,152	----------	----------	555	25,970	5,608	286,493	1910
1911......	991	52,985		601	32,375		70	3,880	547	25,405	206	11,108	205	10,286	181	8,365	477	27,507	40	2,000	155	8,228	268	13,288	----------	----------	618	34,038	4,359	229,465	1911
				2,445	129,628																										
Total 1907–1911	5,337	287,190		Short Tons (b) 6,152	Dollars (b) 343,038		456	25,802	2,238	121,668	2,076	110,690	1,635	84,045	930	48,685	1,346	75,288	811	43,377	590	30,930	1,243	65,984	98	606	1,368	71,514	24,280	1,314,277	Total 1907–1911
1912......	1,079	57,003	743	40,005	----------	----------	105	6,840	299	16,476	160	8,707	163	8,381	68	3,685	91	4,845	----------	----------	129	6,986	162	8,529	----------	----------	374	19,204	3,373	180,661	1912
1913......	823	39,997	189	9,403	----------	----------	33	1,662	276	12,636	51	2,790	413	21,038	70	3,285	44	2,291	37(d)	1,700	90	4,050	138	6,724	----------	----------	368	19,621	2,532	125,197	1913
1914......	687	27,578	20	977	----------	----------	12	532	322	12,600	104	3,862	569	26,319	82	3,469	56	2,545	----------	----------	82	3,265	32	1,280	----------	----------	62	2,769	2,028	85,196	1914
1915......	1,681	95,712	----------	----------	----------	----------	128	6,610	243	10,048	(c) 68	2,166	390	19,000	164	7,977	307	18,736	(d) 37	1,700	301	14,301	78	4,282	----------	----------	110	6,200	3,175	171,091	1915
1916......	(a) 2,182	149,029	----------	----------	----------	----------	70	4,646	174	9,764	238	16,140	623	42,390	125	11,658	269	19,124		Short Tons 6	Dollars 360		410	20,815			273	21,290	4,187	291,397	1916
																				42	3,326										
																				48	3,686			Short Tons 191	Dollars 14,03						
Total 1912–1916	6,452	369,319	952	50,385	----------	----------	348	20,290	1,314	61,524	621	33,665	2,158	117,128	509	30,074	767	47,541		(e) 386	(e) 19,687		(f) 601	(f) 34,845			1,187	69,084	15,295	853,542	Total 1912–1916
1907–1916	11,789	656,509	Cuba City-Elmo: 7,104	393,423			804	46,092	3,552	183,192	2,697	144,355	3,793	201,173	1,439	78,759	2,113	122,829	(h) 872	(h) 46,920	(h) 915	(h) 47,074	1,749	93,814	193	13,081	2,555	140,598	39,575	2,167,819	1907–1916

(a) 1916 production is for Benton-New Diggings.

(b)

	S. T.	Dollars
Cuba City 1907–1909	3,343	190,174
Elmo, 1907–1909,	364	23,236
Cuba City-Elmo, 1910-1911,	2,445	129,628
Cuba City-Elmo 1907-1911,	6,152	343,038

(c) Includes a small quantity of lead carbonate.

(d) Includes a few tons of lead carbonate

(e)

	S. T.	Dollars
Mineral Pt., 1912-14,	37	1,700
Montfort, 1912-14,	301	14,301
Mineral Pt. & Montfort 1915–16	48	3,686
Mineral Pt & Montfort 1912–16	386	19,687

(h) The joint production of Mineral Point-Montfort is arbitrarily divided equally in computing five-year totals for each of these regions.

(f) 1916 production (for Platteville-Potosi) is arbitrarily divided equally, in computing five-year totals.

(g) The production of single mines at Buncombe, Calamine and Montfort is included with the production of Shullsburg (1907) to avoid disclosing individual production.

TABLE 4. *Annual production of Metallic lead from 1907 to 1916, inclusive, by districts. The quantity is stated in short tons and the value in dollars. The value is calculated from the average daily quotations at New York and St. Louis. From Mineral Resources of the United States, 1907, Pt. 1, p. 544; 1908, Pt. 1, p. 639; 1909, Pt. 1, p. 529; 1910, Pt. 1, p. 668; 1911, Pt. 1, p. 863; 1912, Pt. 1, p. 510; 1913, Pt. 1, p. 160; 1914, Pt. 1, p. 115; 1915, Pt. 1, p. 126; 1916, Pt. 1, p. 146.*

	Benton		Cuba City		Elmo		Dodgeville		Hazel Green		Highland	
Year	Short Tons	Dollars	Short Tons	Dollars	Short Tons	Dollars	Short Tons	Dollars	Short Tons	Dollars	Short Tons	Dollars
1907	994	105,364	475	50,350	----------	----------	115	12,190	651	69,006	270	28,620
1908	1,236	103,824	1,123	94,332	----------	----------	139	11,676	479	40,236	257	21,588
1909	703	60,458	1,067	91,762	302	25,972	44	3,784	20	1,720	437	37,582
1910	496	43,648	2,665	236,444	302	25,972	6	528	176	15,488	497	43,736
1911	779	70,110		Short Tons 1,489	Dollars 131,032		60	5,400	380	34,200	150	13,500
				483	43,470							
				1,972	174,502							
1907–1911	4,208	383,404		Short Tons (b) 4,939	Dollars (b) 436,918		364	33,578	1,706	160,650	1,611	145,026
1912	797	71,730	594	53,460	----------	----------	83	7,470	217	19,530	122	10,980
1913	603	53,064	117	10,296	----------	----------	26	2,288	195	17,160	40	3,520
1914	495	38,610	16	1,248	----------	----------	8	624	228	17,784	69	5,382
1915	1,241	116,654	----------	----------	----------	----------	96	9,024	155	14,570	35	3,290
1916	[a]1,589	219,282	----------	----------	----------	----------	52	7,176	102	14,076	188	25,944
1912–1916	4,725	499,340	727	65,004	----------	----------	265	26,582	897	83,120	454	49,116
1907–1916	8,933	882,744	Cuba City-Elmo:		5,666	501,922	629	60,160	2,603	243,770	2,065	194,142

	Linden		Livingston		Mifflin		Mineral Point		Montfort	
Year	Short Tons	Dollars	Short Tons	Dollars	Short Tons	Dollars	Short Tons	Dollars	Short Tons	Dollars
1907	276	29,256	197	20,882	37	3,922	211	22,366	----------	----------
1908	251	21,084	50	4,200	223	18,732	155	13,020	----------	----------
1909	341	29,326	119	10,234	228	19,608	100	8,600	76	6,536
1910	261	22,968	213	18,744	211	18,568	150	13,200	272	23,936
1911	154	13,860	129	11,610	378	34,020	30	2,700	118	10,620
1907–1911	1,283	116,494	708	65,670	1,077	94,850	646	59,886	466	41,092
1912	124	11,160	50	4,500	71	6,390	----------	----------	98	8,820
1913	311	27,368	49	4,312	34	2,992	26	2,288	66	5,808
1914	446	34,788	60	4,680	43	3,354	----------	----------	57	4,446
1915	278	26,132	123	11,562	241	22,654	26	2,288	221	19,074
1916	454	62,652	96	13,248	193	26,634		Short Tons 4	Dollars 376	
								32	4,416	
								36	4,792	
1912–1916	1,613	162,100	378	38,302	582	62,024		Short Tons (c) 283	Dollars (c) 26,154	
1907–1916	2,896	278,594	1,086	103,972	1,659	156,874	(f) 690	(f) 64,570	(f) 705	(f) 62,562

	Platteville		Potosi		Shullsburg		Total		
Year	Short Tons	Dollars	Short Tons	Dollars	Short Tons	Dollars	Short Tons	Dollars	Year
1907	158	16,748	38	4,028	(e) 77	8,162	3,499	370,894	1907
1908	193	16,212	32	2,688	----------	----------	4,138	347,592	1908
1909	167	14,362	8	688	82	7,052	3,694	317,684	1909
1910	225	19,800	----------	----------	417	36,696	4,413	388,344	1910
1911	200	18,000	----------	----------	492	44,280	3,353	301,770	1911
1907–1911	943	85,122	78	7,404	1,068	96,190	19,097	1,726,284	Total 1907–1911
1912	123	11,070	----------	----------	302	27,180	2,581	232,290	1912
1913	101	8,888	----------	----------	298	26,224	1,866	164,208	1913
1914	24	1,872	----------	----------	48	3,744	1,494	116,532	1914
1915	61	5,734	----------	----------	88	8,272	2,322	218,268	1917
1916	309	27,564			198	27,324	3,043	419,934	1916
		Short Tons 139	Dollars 19,182						
1912–1916	(d) 448	(d) 46,746			934	92,744	11,306	1,151,232	Total 1912–1916
1907–1916	1,322	122,277	147	16,995	2,002	188,934	30,403	2,877,516	1907–1916

(a) 1916 production is for Benton-New Diggings.

(b)	S. T.	Dollars
Cuba City 1907–1909,	2,665	236,444
Elmo 1907–1909	302	25,972
Cuba City-Elmo 1910–1911	1,972	174,502
Cuba City-Elmo 1907–1911,	4,939	436,918

(c)	S. T.	Dollars
Mineral Point 1912-14,	26	2,288
Montfort 1912-14,	221	19,074
Mineral Pt. & Montfort 1915-16,	36	4,792
Mineral Pt. & Montfort 1912-16,	283	26,154

(d) 1916 production for (Platteville-Potosi) is arbitrarily divided equally in computing five-year totals.

(e) The production of single mines at Buncombe, Calamine and Montfort is included with the production of Shullsburg (1907) to avoid disclosing individual production.

(f) The joint production of Mineral Point-Montfort is arbitrarily divided equally in computing five-year totals for each of these regions.

TABLE 5. *Annual production of zinc ore (concentrates) from 1907 to 1916, inclusive, by districts. The quantity is stated in short tons and the value in dollars. The value of the ore is that received by the producer. From Mineral Resources of the United States, 1907, Pt. 1, p. 544; 1908, Pt. 1, p. 639; 1909, Pt. 1, 529; 1910, Pt. 1, p. 668; 1911, Pt. 1, p. 863; 1912, Pt. 1, p. 510; 1913, Pt. p. 160; 1914, Pt. 1, p. 115; 1915, Pt. 1, p. 125; 1916, Pt. 1, p. 146.*

	Benton				Cuba City				Elmo		Dodgeville			
	Sphalerite		Carbonate		Sphalerite		Carbonate		Sphalerite		Sphalerite		Carbonate	
Year	Short Tons	Dollars	Short Tons	Dollars	Short Tons	Dollars	Short Tons	Dollars	Short Tons	Dollars	Short Tons	Dollars	Short Tons	Dollars
1907*	8,259	148,715	1,445	18,118	3,057	99,387	22	725	------	------	949	25,692	104	1,709
1908*	11,490	189,741	786	5,292	6,258	163,227	5	67	------	------	393	7,285	16	298
1909	12,836	230,384	------	------	9,841	318,262	------	------	213	4,269	503	15,430	156	1,248
1910	22,117	407,855	40	600	19,156	580,876	27	792	213	4,269	498	13,001	15	308
1911	32,453	546,872	131	2,454					Sphalerite Short Tons 6,312 2,185 8,497	Dollars 171,502 52,909 224,411	263	7,084	60	1,080
1907–11	87,095	1,523,567	2,402	26,464	Cuba City, carbonate 27, $792			(b) 27,866	(b) 809,556		2,606	68,492	351	4,643
1912	35,017	1,065,631	229	4,488	4,683	85,042	------	------	------	------	608	22,536	33	700
1913	30,800	680,815	19	181	4,176	84,404	------	------	------	------	250	5,772	------	------
1914	45,869	764,631	------	------	2,264	39,676	------	------	------	------	705	13,609	------	------
1915	66,685	2,580,675	------	------	2,145	57,055	------	------	------	------	654	39,800	23	480
1916	(a) 103,247	(a) 3,917,127	------	------	3,992	102,083	------	------	------	------	600	30,362	------	------
1912–16	281,618	9,008,879	248	4,669	17,260	368,260	------	------	------	------	2,817	112,079	56	1,180
1907–16	368,713	10,532,446	2,650	31,133	------	------	Cuba City-Elmo:		45,126	1,177,816	5,423	180,571	407	5,823

	Hazel Green		Highland				Linden				Livingston			
	Sphalerite		Sphlaerite		Carbonate		Sphalerite		Carbonate		Sphalerite		Carbonate	
Year	Short Tons	Dollars	Short Tons	Dollars	Short Tons	Dollars	Short Tons	Dollars	Short Tons	Dollars	Short Tons	Dollars	Short Tons	Dollars
1907*	11,819	186,731	1,815	28,555	1,300	16,387	6,496	142,409	4	77	4,189	76,762	50	1,000
1908*	9,016	132,266	1,706	46,151	2,143	27,467	2,422	72,371	50	500	6,070	87,163	22	311
1909	1,944	41,948	2,374	67,996	4,274	53,355	3,337	88,944	------	------	7,060	130,195	------	------
1910	13,047	215,194	1,116	34,488	5,148	67,450	4,727	85,784	------	------	10,590	200,754	------	------
1911	20,632	417,098	81	3,013	4,784	69,235	8,317	124,487	------	------	7,987	155,497	------	------
1907–11	56,458	993,237	7,092	180,203	17,649	233,894	25,299	513,995	54	577	35,896	650,371	72	1,311
1912	19,617	491,988	157	4,446	4,108	67,612	7,664	164,912	------	------	9,624	224,904	------	------
1913	18,499	377,226	------	------	2,088	16,957	10,715	160,393	------	------	11,940	232,627	------	------
1914	25,547	438,112	276	7,598	2,118	29,689	6,470	120,373	------	------	16,347	274,503	------	------
1915	24,847	865,179	118	7,879	2,034	39,643	7,275	287,401	------	------	20,070	728,826	------	------
1916	22,411	772,692	867	45,000	3,270	49,675	15,743	455,578	------	------	19,275	712,423	------	------
1912–16	110,921	2,945,197	1,418	64,923	13,618	203,576	47,867	1,188,657	------	------	77,256	2,173,283	------	------
1907–16	167,379	3,938,434	8,510	245,126	31,267	437,470	73,166	1,702,652	54	577	113,152	2,823,654	72	1,311

	Mifflin				Mineral Point				Montfort		Platteville			
	Sphalerite		Carbonate		Sphalerite		Carbonate		Sphalerite		Sphalerite		Carbonate	
Year	Short Tons	Dollars	Short Tons	Dollars	Short Tons	Dollars	Short Tons	Dollars	Short Tons	Dollars	Short Tons	Dollars	Short Tons	Dollars
1907*	2,398	63,416	------	------	2,346	47,285	140	2,406	------	------	4,865	155,061	------	------
1908*	2,878	69,529	9	105	2,126	42,115	175	2,539	------	------	5,856	188,886	------	------
1909	6,576	169,982	------	------	1,210	30,799	700	9,000	335	9,802	18,406	383,817	------	------
1910	5,712	157,485	------	------	2,156	36,089	66	1,200	1,431	25,360	20,471	384,120	------	------
1911	6,720	181,882	------	------	684	9,614	------	------	1,567	28,528	12,748	395,425	------	------
1907–11	24,284	642,294	9	105	8,522	165,902	1,081	15,145	3,333	63,690	62,346	1,507,309	------	------
1912	8,413	253,005	------	------	258	4,729	------	------	1,155	46,650	13,835	507,137	------	------
1913	4,461	105,672	------	------	278	3,728	1,016	13,631	1,300	30,000	11,774	330,406	------	------
1914	6,915	171,993	------	------	------	------	614	7,694	1,031	28,958	2,665	54,037	55	650
1915	8,499	364,459	------	------	536	8,457	1,630	21,325	3,486	105,608	7,966	365,596	------	------
1916	14,848	481,856	------	------	Short Tons Sphalerite 81 1,750 1,831	Dollars 5,200 101,503 106,703	Short Tons Carbonate 522 961 1,483	Dollars 8,100 18,269 26,369			(f) 16,182	670,140	------	------
1912–16	43,136	1,376,985	------	------	Short Tons (c) 5,853	Dollars (c) 220,768	Short Tons (c) 3,113	Dollars (c) 47,694			52,422	1,927,316	55	650
1907–16	67,420	2,019,279	9	105	(d) 9,974	(d) 227,711	(e) 4,194	(e) 62,839	(d) 7,734	(d) 222,649	114,768	3,434,625	55	650

	Shullsburg				Buncombe		State Total				
	Sphalerite		Carbonate		Sphalerite		Sphalerite		Carbonate		
Year	Short Tons	Dollars	Short Tons	Dollars	Short Tons	Dollars	Short Tons	Dollars	Short Tons	Dollars	Year
1907*	1,058	23,114	------	------	------	------	47,251	997,127	3,065	40,422	1907
1908*	------	------	------	------	------	------	48,155	998,734	3,206	36,579	1908
1909	401	8,274	------	------	385	5,650	65,421	1,505,752	5,130	63,603	1909
1910	1,055	18,942	------	------	------	------	89,232	1,750,574	5,269	69,558	1910
1911	326	6,714	60	1,374	------	------	93,963	1,929,123	5,035	74,143	1911
1907–11	2,840	57,044	60	1,374	385	5,650	344,022	7,181,310	21,705	284,305	Total 1907–11
1912	1,586	37,912	------	------	------	------	102,617	2,908,892	4,370	72,800	1912
1913	1,347	42,298	------	------	------	------	95,540	2,053,341	3,123	30,769	1913
1914	446	10,636	------	------	------	------	108,535	1,924,126	2,787	38,033	1914
1915	656	31,246	------	------	------	------	138,996	5,333,316	2,579	48,223	1915
1916	2,305	106,845	30	600	------	------	201,220	7,395,609	4,261	68,544	1916
1912–16	6,340	228,937	30	600			646,908	19,615,284	17,120	258,369	Total 1912–16
1907–16	9,180	285,981	90	1,974	385	5,650	990,930	26,796,594	38,825	542,674	1907–1916

(a) 1916 production is for Benton-New Diggings.
* Silicate included with carbonate for 1907 and 1908.

(b)

	Sphalerite Short Tons	Sphalerite Dollars
Cuba City 1907–09,	19,156	580,876
Elmo 1907–09,	213	4,269
Cuba City-Elmo 1910–11	8,497	224,411
Cuba City-Elmo 1907–11	27,866	809,556

(c)

	Sphalerite Short Tons	Sphalerite Dollars	Carbonate Short Tons	Carbonate Dollars
Mineral Point 1912-14	536	8,457	1,630	21,325
Montfort1912-14	3,486	105,608	------	------
Mineral Pt.-Montfort 1915-16	1,831	106,703	1,483	26,369
Mineral Pt.-Montfort 1912-16	5,853	220,768	3,113	47,694

(d) The joint production of Mineral Point-Montfort is arbitrarily divided equally in computing five-year totals for each of these regions.
(e) The "joint production" of carbonate, Mineral Point-Montfort is not divided because Montfort statistics for previous years show no carbonate production.

(f) 1916 Production is for Platteville-Potosi.

TABLE 6. *Annual production of metallic zinc from 1907 to 1916, inclusive, by districts. The quantity is stated in short tons and the value in dollars. In calculating the metal content of the ores from assays, allowance has been made for smelting and concentration losses. The value from 1907 to 1914, inclusive, is calculated from the average daily quotations at New York and St. Louis. For 1915 and 1916 the average sales price reported by the smelters has been used. Data from Mineral Resources of the United States, 1907, Pt. 1, p. 544; 1908, Pt. 1, p. 639; 1909, Pt. 1, p. 529; 1910, Pt. p. 668; 1911, Pt 1, p. 863; 1912, Pt. 1, p. 510; 1913, Pt. 1, p. 160; 1914, Pt. 1, p. 115; 1915, Pt. 1, p. 126; 1916, Pt. 1, p. 146.*

	Benton		Buncombe		Cuba City		Elmo		Dodgeville		Hazel Green		Highland		Linden		Livingston		Mifflin		Mineral Point		Montfort		Platteville		Shullsburg		State Total		
Year	Short Tons	Dollars	Short Tons	Dollars	Short Tons	Dollars	Short Tons	Dollars	Short Tons	Dollars	Short Tons	Dollars	Short Tons	Dollars	Short Tons	Dollars	Short Tons	Dollars	Short Tons	Dollars	Short Tons	Dollars	Short Tons	Dollars	Short Tons	Dollars	Short Tons	Dollars	Short Tons	Dollars	Year
1907	3,487	411,466	------	------	1,147	135,346	------	------	383	45,194	4,410	520,380	1,041	122,838	2,425	286,150	1,577	186,086	895	105,610	915	107,970	------	------	1,815	214,170	395	46,610	18,490	2,181,820	1907
1908	3,833	360,302	------	------	2,740	257,560	------	------	176	16,544	2,597	244,118	1,340	125,960	1,040	97,760	1,797	168,918	1,053	98,982	866	81,404	------	------	2,764	259,816	------	------	18,206	1,711,364	1908
1909	3,838	414,504	81	8,748	3,636	392,688	75	8,100	273	29,484	565	61,020	2,313	249,804	1,269	137,052	2,280	246,240	2,456	265,248	651	70,308	133	14,364	5,432	586,656	150	16,200	23,152	2,500,416	1909
1910	5,856	632,448	------	------	7,523	785,594	75	8,100	218	23,544	3,238	349,704	1,801	194,508	1,222	131,976	2,843	307,044	2,081	224,748	649	70,092	391	42,228	5,168	558,144	293	31,644	25,927	2,800,116	1910
1911	8,292	945,288	------	------		Short Tons 2,167 773	Dollars 234,036 88,122		126	14,364	6,300	718,200	1,273	145,122	1,923	219,222	2,410	274,740	2,569	292,866	167	19,038	452	51,528	5,338	608,532	97	11,058	29,720	3,388,080	1911
						2,940	322,158																								
1907-11	25,306	2,764,008	81	8,748		Short Tons (b) 10,538	Dollars (b) 1,115,852		1,176	129,130	17,110	1,893,422	7,768	838,232	7,879	872,160	10,907	1,183,028	9,054	987,454	3,248	348,812	976	108,120	20,517	2,227,318	935	105,512	115,495	12,581,796	Total 1907–1911
1912	11,311	1,560,918	------	------	1,026	141,588	------	------	259	35,742	5,703	787,014	1,033	142,554	1,908	263,304	2,439	336,582	2,833	390,954	58	8,004	393	54,234	5,579	769,902	508	70,104	33,050	4,560,900	1912
1913	9,946	1,113,952	------	------	1,163	130,256	------	------	77	8,624	5,696	637,952	374	41,888	2,655	297,360	3,081	345,072	1,443	161,616	302	33,824	442	49,504	4,382	490,784	549	61,488	30,110	3,372,320	1913
1914	12,606	1,285,812	------	------	609	62,118	------	------	231	23,562	6,935	707,370	609	62,118	1,947	198,594	4,042	412,284	2,560	261,120	128	13,056	382	38,964	891	90,882	173	17,646	31,113	3,173,526	1914
1915	19,231	4,769,288	------	------	389	96,472	------	------	300	74,400	6,973	1,729,304	481	119,288	2,430	602,640	4,997	1,239,256	3,009	746,232	488	54,884	1,217	142,702	3,160	783,680	275	68,200	41,403	10,267,944	1915
1916	(a) 29,572	(a) 7,925,296	------	------	752	201,536	------	------	245	65,660	5,897	1,580,396	789	211,452	3,827	1,025,636	4,536	1,215,648	4,227	1,132,836		Short Tons 158 914	Dollars 39,184 244,952		(e) 5,134	(e) 1,375,912	910	243,880	56,803	15,223,204	1916
																						1,072	284,136								
1912-16	82,666	16,552,266			3,939	631,970	------	------	1,112	207,988	31,204	5,442,036	3,286	577,300	12,767	2,387,534	19,095	3,548,842	14,072	2,692,758		Short Tons (c) 2,777	Dollars (c) 481,722		19,146	3,511,160	2,415	461,318	192,479	36,597,894	Total 1912–1916
1907-16	107,972	19,419,274	81	8,748	Cuba City-Elmo: 14,477 1,747,822				2,288	337,118	48,314	7,353,458	11,054	1,415,532	20,646	3,259,694	30,002	4,731,870	23,126	3,680,212	(d) 4,272	(d) 545,764	(d) 2,729	(d) 392,890	39,663	5,738,478	3,350	566,830	307,974	49,179,690	1907–1916

(a) 1916 production is for Benton-New Diggings.

(b)

	Short Tons	Dollars
Cuba City 1907-1909	7,523	785,594
Elmo 1907-1909	75	8,100
Cuba City-Elmo 1910-1911	2,940	322,158
Cuba City-Elmo 1907-1911	10,538	1,115,852

(c)

	Short Tons	Dollars
Mineral Point 1912-14	488	54,884
Montfort 1912-14	1,217	142,702
Mineral Pt.-Montfort 1915-16	1,072	284,136
Mineral Pt.-Montfort 1912-16	2,777	481,722

(e) 1916 production is for Platteville-Potosi.

(d) The joint production of Mineral Point-Montfort 1915-16 is arbitrarily divided equally in computing five-year totals for each of these regions.

TABLE 8. *Mine production of lead by states from 1907 to 1916, inclusive, stated in short tons of metallic lead. Data for mine production of lead are not available for all states before 1907. These figures of mine production are obtained from mine operators and not from smelters. From Mineral Resources of the United States, 1914, Pt. 1, p. 810; 1915, Pt. 1, p. 731; 1916, Pt. 1, p. 845.*

Year	Alaska	Arizona	Arkansas	California	Colorado	Idaho	Illinois	Iowa	Kansas	Kentucky	Missouri	Montana	Nevada	New Hampshire	New Mexico	North Carolina	Oklahoma	Oregon	South Dakota	Tennessee	Texas	Utah	Virginia	Washington	Wisconsin	Total
1907	--------	2,330	12	1,313	42,703	116,912	830	242	2,555	34	138,675	1,874	3,136	--------	1,905	--------	532	--------	--------	--------	12	57,969	70	410	3,499	375,013
1908	--------	1,504	15	619	26,100	103,414	399	51	2,518	--------	144,459	2,298	3,623	--------	437	--------	1,781	1	12	--------	33	44,389	38	575	4,138	336,404
1909	19	1,549	24	751	36,084	107,993	295	36	1,300	10	159,435	1,492	4,920	--------	2,515	--------	3,427	--------	59	--------	46	74,243	--------	144	3,694	398,036
1910	28	1,348	63	1,435	38,036	114,129	373	20	2,412	41	161,016	2,053	2,436	--------	2,160	--------	2,888	--------	7	--------	33	61,662	99	661	4,413	395,313
1911	24	5,137	64	699	34,840	136,278	964	60	2,859	--------	178,868	3,216	1,632	--------	1,483	--------	2,501	--------	32	--------	61	68,248	417	424	3,353	441,160
1907–11	71	11,868	178	4,817	177,763	578,726	2,861	409	11,644	85	782,453	10,933	15,747	--------	8,500	--------	11,129	1	110	--------	185	306,511	624	2,214	19,097	1,945,926
1912	--------	3,403	31	572	37,621	142,093	1,282	63	2,371	106	177,069	3,723	9,750	--------	2,747	46	3,388	20	11	--------	33	70,156	235	64	2,581	457,365
1913	18	8,072	18	1,757	43,949	158,936	959	65	2,427	22	176,116	5,468	8,172	--------	1,973	--------	6,228	44	5	--------	113	83,063	816	101	1,866	500,188
1914	--------	7,502	41	2,126	37,106	174,263	717	--------	1,409	16	192,612	4,828	6,405	--------	882	--------	7,556	8	2	--------	75	85,662	127	33	1,494	522,864
1915	437	10,869	63	2,290	34,405	173,000	954	--------	1,212	251	210,440	6,878	8,319	(b) 9	2,271	--------	7,306	31	2	1	110	99,984	339	148	2,322	561,641
1916	820	13,531	272	6,204	35,457	187,541	1,072	14	1,648	(a) 153	233,088	6,798	12,819	47	4,107	--------	12,115	14	18	16	25	100,745	728	2,700	3,043	622,975
1912–16	1,275	43,377	425	12,949	188,538	835,833	4,984	142	9,067	548	989,325	27,695	45,465	56	11,980	46	3 6,593	117	38	17	356	439,610	2,245	3,046	11,306	2,665,033
1907–16	1,346	55,245	603	17,766	366,301	1,414,559	7,845	551	20,711	633	1,771,778	38,628	61,212	56	20,480	46	47,722	118	148	17	541	746,121	2,869	5,260	30,403	4,610,959

(a) By-product from unknown quantity fluorspar.
(b) Includes Pennsylvania.

TABLE 9. *Mine production of zinc by states from 1907 to 1916, inclusive, stated in short tons of metallic sinc. From Mineral Resources of the United States, 1916, Pt. 1, p. 814.*

Year	Arizona	Arkansas	California	Colorado	Idaho	Illinois	Iowa	Kansas	Kentucky	Missouri	Montana	Nevada	New Hampshire	New Jersey	New Mexico	New York	North Carolina	Oklahoma	Tennessee	Texas	Utah	Virginia	Washington	Wisconsin	Total
1907	114	474	116	26,394	3,493	737	145	17,772	--------	116,752	122	1,084	--------	69,369	375	--------	--------	1,657	109	22	2,726	--------	--------	18,490	259,951
1908	339	605	--------	15,065	19	1,717	395	14,119	--------	107,404	820	558	--------	67,165	1,788	--------	--------	4,529	344	18	730	705	--------	18,206	234,526
1909	2,989	510	--------	25,605	676	2,163	35	11,445	56	130,162	4,680	1,507	--------	82,510	6,543	--------	--------	7,806	596	--------	4,930	58	--------	23,152	305,423
1910	2,742	994	--------	38,545	2,802	3,549	96	13,229	6	128,589	15,819	1,354	--------	68,678	9,044	--------	--------	6,394	966	--------	8,184	794	--------	25,927	327,712
1911	2,281	664	1,404	47,304	4,170	4,219	--------	10,272	158	122,515	21,905	1,774	--------	77,445	5,119	81	--------	5,150	1,117	--------	8,920	1,032	10	29,720	345,260
1907–11	8,465	3,247	1,520	152,913	11,160	12,385	671	66,837	220	605,422	43,346	6,277	--------	365,167	22,869	81	--------	25,536	3,132	40	25,490	2,589	10	115,495	1,472,872
1912	4,379	748	2,173	66,111	6,953	4,065	--------	10,633	491	136,551	13,459	6,661	--------	69,755	6,783	--------	142	5,769	2,191	119	8,534	249	--------	33,050	378,816
1913	4,714	478	529	59,673	11,587	2,236	--------	10,088	327	124,963	44,337	7,210	15	72,156	8,262	--------	10	11,664	5,583	326	9,429	2,719	--------	30,110	406,416
1914	4,896	608	195	48,387	21,006	4,811	--------	11,284	230	105,994	55,790	6,490	6	74,253	9,202	--------	--------	13,992	10,425	108	7,995	174	--------	31,113	406,959
1915	9,110	3,209	6,547	52,297	35,077	5,534	--------	14,365	764	136,300	93,573	12,188	24	116,618	12,702	2,455	--------	14,314	16,461	15	12,146	1,267	122	41,403	586,491
1916	9,839	6,815	7,628	67,143	43,253	3,404	21	12,448	1,096	155,960	114,630	16,222	36	110,698	18,285	4,507	--------	28,754	26,428	116	14,786	2,276	847	56,803	701,995
1912–16	32,938	11,858	17,072	293,611	117,876	20,050	21	58,818	2,908	659,768	321,789	48,771	81	443,480	55,234	6,962	152	74,493	61,088	684	52,890	6,685	969	192,479	2,480,677
1907-16	41,403	15,105	18,592	446,524	129,036	32,435	692	125,655	3,128	1,265,190	365,135	55,048	81	808,647	78,103	7,043	152	100,029	648220	724	78,380	9,274	979	307,974	3,953,549

FAUNA OF THE GALENA LIMESTONE NEAR APPLETON

JOHN W. OCKERMAN

The region under discussion, namely Appleton and the near by cities of Neenah, Menasha, Mackville and Kaukauna, lies in the belt of Galena Limestone that cuts the state from north to south. This rock has been quarried in large amounts in this region and there are many quarries, some being worked extensively and others remaining as evidence of former operations.

The Neenah, Menasha and Kaukauna quarries are the most important of the quarries that are being worked at present. The quarry near Mackville has not been worked for several years, its ledges being greatly weathered during that time. There are also several quarries near Neenah and Appleton that have been in disuse for a number of years.

The Neenah quarry is located near the southern limits of the city of Neenah. It has been worked for a large number of years and is at present being worked by the city of Neenah. The limestone is massive and the layers are quite thick. The limestone is underlaid with blue shale beds. At the joints and bedding planes there is considerable mineralization and the rock has much Galena and Fluorite. The surface of the Galena is covered with glacial till. This quarry has had considerable weathering and so yields some good specimens, there being an abundant and varied fauna there.

The Mackville quarry is located near Mackville and is much smaller than the Neenah quarry. As has been stated the quarry has been in disuse for a long period of time and so has been greatly weathered. The Galena here is thin bedded and has been used in the past as road metal. The large amount of weathered surface and the extent of the weathering both go to make this an excellent source of fossil remains. It has a great variety and number of fossils and has yielded some very fine specimens.

The quarry at Kaukauna is a very large one and is extensively worked. The limestone is massively bedded in layers from six to twenty inches in thickness. Owing to the widely separated joint planes slabs of large dimension can be extracted. This quarry, although abundant in fossil remains, does not produce many because of the lack of weathered surfaces and the very massive character of the rock. There is one unusual feature of the quarry and that is the ripple marked bottom. The ripple marks are at least six inches deep and widely spaced in sinuous curves. The water was evidently deep but because of a strong current and powerful waves the sediment was laid down in curved bands. There are other ripple marked limestones in northern Wisconsin, as the Niagara Limestone, near Marblehead but none is as pronounced as the Galena at Kaukauna.

The Menasha quarry is located about half way between Appleton and Menasha. It is a large quarry and at present is being worked to a large extent. The limestone is massively bedded and is very compact. The older workings of this quarry are shallow and considerably weathered but are not abundant in fossil remains. The pit being worked yielded only a few fossils, these being found on exposed bedding planes.

The dredgings at Kimberly are a thin bedded limestone and shaly material and yielded a considerable number of Graptolites.

The Galena Limestone formation that underlies the Fox River valley strikes north 27 degrees east and has a horizontal width of about 18 to 20 miles. The formation extends entirely across the state from its northern exposure at Green Bay to Illinois passing between Lake Geneva on the east and just east of Beloit on the west. The formation dips very gently to the southeast about 20 feet to the mile in this region in a monoclinal fashion and as a consequence varies in thickness at different points on the outcrop. Even along the strike it is not uniform in thickness. At Neenah, according to artesian well records, it is 62 feet thick, at Appleton 65 feet, Kimberly 127 feet and at Kaukauna 176 feet. The reports of the Wisconsin Geological Survey give the thickness of the Galena as 125 to 250 feet.

The formation consists of a coarse gray and blue magnesian limestone the proportion of magnesia varying in different localities, but never being quite the percentage of a theoretical dolomite. In this locality the Galena is excellent material for road work and for concrete and building material. The rock is usually quite thickly bedded but in some places it is interbedded with layers of blue shale and shelly limestone. In such cases it requires a great deal of sorting and rejection of quite a large amount of the rock quarried.

The color of the Galena is normally a clear light gray to almost white but as a rule the Galena is a bluish gray due to some alumina clay content. Upon weathering the Galena has a dull gray color and is very soft if the surface has been exposed a long time. Often the fossils weather entirely out of the rock, this being the case at Mackville.

The Galena Limestone of this area has offered not only a great abundance of fossils but also a great variety. All of the quarries have abundant and varied fossil remains, which are as a rule in a good state of preservation. Nearly every group of animal life is found here. The Protozoa are not present nor are the Vermes. The Cystoidea and Echinoidea of the Echinodermata are absent and the Pelecypoda of the Mollusca likewise, but the remaining groups are found in this region.

Protozoa are not present. The Coelenterata are represented by sponges, corals and the Graptolites.

Only four specimens of the Porifera were found and in practically all cases the specimens were poorly preserved. Mackville was the chief source of the sponges, but they are found in the other quarries rarely.

The Anthozoa that were found in this region are typical of the Ordovician strata. Streptelasma was the prevalent type and three species were found more or less abundant and well preserved. One species of the Tabulata was found at Neenah but that was poorly preserved.

The Graptolites have been found abundantly at Kaukauna and at Kimberly and were all well preserved. Their carbonized skeletons are very well adapted to fossilization. Four species of the Diprionidae have been found and these have been discussed by Dr. R. M. Bagg in his report of 1923 ("Recent Discovery of Wisconsin Graptolites.")

Of the Echinodermata only the Crinoidea are present. Five species were found, being fairly abundant and well preserved. Heterocrinus was the most abundant type and found chiefly at Neenah and Mackville, but occurring in the other quarries rarely. The specimens were stem fragments and were usually very small.

Both groups of the Molluscoidea were found abundantly in this region; the Bryozoa were not as abundant as the Brachiopoda, but were found in all of the quarries more or less abundantly. Six species were found but were not well preserved, the internal structure being obliterated and often the external structure as well.

The Brachiopoda were found in great abundance at all the quarries, especially at Mackville and Neenah. Twenty-four species were identified and all were well preserved. Some of the types were rare, as the Lingula, while others were very abundant, as the Rhynchotrema. The valves were usually found together but often single shells were found showing both the internal and external structure.

The Gastropoda were very abundant, eighteen species being found all of which were preserved as a cast of the shell. None of the species were abundant with the exception of *Murchisonia gracilis.* All of the quarries revealed several types of Gastropoda.

The Cephalopoda were found fairly abundant at all of the quarries but often they were so weathered that they did not offer an opportunity of study and identification. Four species were identified, some of them being well preserved.

The Trilobites were rare and found chiefly at Mackville, although Neenah has a few. They are usually well preserved but rarely are they in complete form. Usually either a head shield or tail shield is found, as is the case of Illaenus, only head shields being found.

This work has been done to make more clear the paleontological side of the geology of this region and the writer has taken great pleasure in making this as complete and accurate as possible.

Coelenterata

Subkingdom Porifera

Order Hexactinellidae

Sponges are polycellular organisms beginning in the Cambrian and continuing until the present time. They are sessile animals and are practically all marine, although there are a few types of fresh water sponges. They are remarkable for the variety of size and form, varying from the size of a pinhead to one meter. Sponges are usually poorly preserved and for this reason they have not been very thoroughly worked. Defrance in 1827 discussed the Receptaculitidae in the Dictionnaire de Science Naturelles t. 45, p. 5 atlas, pl. 68 and in this country Ferd Roemer discussed the sponges in 1860 (Silurische Fauna des Westlichen Tennessee.)

The sponges are now classified under two heads; Calcarea, and Non-Calcarea. Formerly they were classified as Silicispongide and Calcispongiae. The Hexactinellidae belong to the Non-Calcarea group and they possess six-spined spicules. These spicules are composed of colloidal silica, the silica being in alternate layers with the organic matter. There are two other types of spicules as to composition, those built up of calcareous material and those composed of a horny fiber. The siliceous sponges are the best preserved as fossils and in the Galena of this region the writer has found four types of sponges and these are all species of the Hexactinellidae.

These sponges are composed of calcareous material due to the replacement of the colloidal silica of which the spicules are composed. The replacement process works both ways and often the calcareous spicules are silicified.

The siliceous sponges are found as fossils in the Cambrian but are greatest in the Jurassic and Cretaceous times.

The writer has found specimens of *Receptaculites oweni* in the Neenah, Kaukauna and Mackville quarries. They are fairly abundant especially at Mackville, and in practically all cases are in a fair state of preservation. *Ischadites iowensis* is not as abundant as the *Receptaculites oweni* but nearly so. In a few of the specimens the preservation was good, showing the external structure plainly. *Receptaculites occidentalis* and *Hindia parva* are both very rare and poorly preserved and their identification is rather uncertain.

Receptaculites oweni Hall.

Plate I, figure 1.

Receptaculites oweni Whitfield. Geol. Wisconsin 4, 1882, p. 239, pl. 10.

Receptaculites oweni Winchell and Schuchert. Geol. Minnesota, 3,1893, p. 57, pl. F, fig. 1–4.

Description. The body of the organism is thin centrally but widens as it approaches the margin. It is built of cell-like perforations perpendicular to the plane of the disk, arranged in concentric rows. The specimens vary from one-fourth inch to two and one-half inches in diameter and one-sixteenth to one-half inch in thickness.

This sponge is found at Neenah, Mackville, and Kaukauna and is usually in a fair state of preservation. Because of the calcareous composition these fossils are often badly weathered but still preserve the perforations as slight indentations.

Ischadites iowensis (Owen)

Plate I, figure 2.

Receptaculites iowensis Winchell and Schuchert. Geol. Minnesota, 3, 1893, p. 64, pl. F, fig. 5–6.

R. (Ischadites) iowensis Grabau and Shimer. N. A. Index Fossils, 1, 1906, p. 19, fig. 30.

Description. The base is concave while the upper surface is flatly domed with the center a hollow cavity. It is built up of small rhombohedral cells which are arranged in curved rows. The specimens that the writer studied vary from one to two inches in diameter and about one-half inch in thickness.

This species is found fairly abundant at the Mackville quarry but is rare at the Neenah and Kaukauna quarries. In all cases the specimens were in a fair state of preservation.

Receptaculites occidentalis Salter.

Receptaculites neptuni Hall. Pal. New York, 1, 1847, p. 68, pl. 24, fig. 3a–d.

Receptaculites occidentalis Salter. Canadian Org. Rem. Geol. Survey Canada. Dec. 1, 1859, p. 45, pl. 10, fig. 1–7.

Description. This species is either suborbicular or hemispherical, being depressed in the central surface and having a series of quadrangular cells. The only specimen studied was such a poor specimen that its identification is rather doubtful. The section which was found at the quarry near Menasha was about three inches in diameter and about one-half inch in thickness and depressed at the center.

Hindia parva Winchell and Schuchert.

Hindia parva Winchell and Schuchert. Geol. Minnesota, 3, 1893, p. 79, pl. G.

Description. A tiny spheriodal, free sponge having an even rounded surface which seemed to be marked by numerous tiny apertures.

The few specimens were very poorly preserved and measured about one quarter inch in diameter.

Coelenterata

Subkingdom Cnidaria

Order Anthozoa

The anthozoa or corals are marine organisms, a type of sessile polyps, always living in tropical seas and usually in shallow water, their customary limitation being about 50 fathoms. However, there are some found in water as deep as 1,500 fathoms.

Very few corals have permanently soft bodies, the majority having a calcareous or horny skeleton or structure, the corallum. This corallum is either simple or compound.

The number of internal partitions, the septa, vary and are important both in number and arrangement in the study and identification of these fossils. This arrangement will be discussed more fully in conjunction with the classification. In some cases the septa are twisted at the center forming a columella. In some cases the septal center is very low, being about one-half of the distance between the top and bottom of the coral, while in other cases the septal center extends even above the top of the coral.

The outer wall or theca varies considerably and is marked in some cases by concentric lines while in others the lines are longitudinal. There are a few species with a smooth surface.

The corals began in the Cambrian and continued on through to the recent. Practically all the Paleozoic forms are extinct and those of the Cenozoic and Mesozoic were similar to living forms.

The corals are classified under four heads which are as follows; Tetracoralla, Hexacoralla, Octocoralla, and Tabulata.

The Tetracoralla has its septa arranged in a tetrameral system, all the septa being arranged around the four primary ones. This group appeared in the Ordovician and had its maximum development in the Silurian, becoming extinct at the end of the Paleozoic.

The Hexacoralla has, as the name indicates, six primary septa around which the remaining septa are developed. In some cases the coral has twelve primary septa instead of six. This group appeared in the Cambrian and continued on through the Paleozoic having its maximum development in the Trias.

The Octocoralla is a rather small group which made its appearance in the Ordovician. As the name suggests, this group has its septa arranged in an octameral order.

The Tabulata has often been considered as a sub-order of the Hexacoralla but now it is generally considered as a group in itself. It was originally given this name because of the great number of tabulae in corals of this type. Its range is from the Ordovician through the Carboniferous.

The calcareous or horny structure of the corals is very adaptable to fossilization and practically all the specimens the writer has studied were well preserved. Often the horny skeleton is replaced when it is fossilized. The Tetracoralla were very abundant in the Ordovician and Silurian and are characteristic of these two ages. The Hexacoralla are characteristic of the Trias while the Tabulata are markers of the Silurian.

The corals were found very abundantly in this region at all the quarries. The Tetracoralla were found most abundantly and one specimen of the Tabulata was found. Three species of Streptelasma were found, namely, *Streptelasma profundum, Streptelasma corniculum, Streptelasma corniculum* var. *parvula. Produndum* was the most abundant and best preserved. *Corniculum* was nearly as abundant and the variety, *parvula,* is rather rare but well preserved.

The one species of Tabulata, *Lichenaria typa,* is very rare and only a few poorly preserved specimens were found at Neenah.

STREPTELASMA Hall

Streptelasma Hall. Pal. New York, 1, 1847, p. 17.
Streptelasma Grabau and Shimer. N. A. Index Fossils. 1, 1906, p. 54.

Description. The Streptelasma are simple conical corals belonging to the Tetracoralla. These corals are usually curved and have a funnel-shaped calyx. The calyx varies in depth in different species, some being quite deep while others are numerous. In a few cases they are twisted at the center forming a columella.

Streptelasma profundum (Owen)

Plate I, figure 5.

Streptelasma profundum Hall. Pal. New York, 1, 1847, p. 49, pl. 12, fig. 4a-d.
Streptelasma profundum Grabau and Shimer. N. A. Index Fossils, 1, 1906, p. 54, fig. 76a-b.

Description. This coral is often slightly curved at the base, expanding more or less abruptly upward. The calyx is usually deep, this fact serving as the chief means of separation from S. corniculum. This species usually has a small number of septa, ranging from 36 to 60 as a general rule. The septa are never twisted at the center in *profundum* as they are in *corniculum.*

This species of Streptelasma proved to be the most abundant in this locality and many well preserved specimens were found at Mackville, Neenah, Kaukauna, and Menasha. They vary in size from three quarters to one and one-half inches in length.

Streptelasma corniculum Hall.

Plate I, figure 4.

Streptelasma corniculum Hall. Pal. New York, 1, 1847, p. 69, pl. 25, fig. la-e.
Streptelasma corniculum Grabau and Shimer. N. A. Index Fossils, 1, 1906, p. 55, fig. 76c-d.

Description. This coral is turbinate, curved very decidedly at the base. In all cases this species has a very shallow calyx and the septa are usually long and twisted at the center into a columella.

These corals were in considerable abundance in the Neenah and Mackville quarries and some were found in the Kaukauna and Menasha quarries also. They vary from ½ to 2 inches in length and in most cases were well preserved.

Streptelasma corniculum var. *parvula* Hall.

Streptelasma parvula Hall. Pal. New York, 1, 1847, 71, pl. 25, fig. 4a-c.

Description. These are very small corals of the Streptelasma ranging in size from 3/16 to ¼ inch. They are turbinate, slightly curved and have a smooth surface in most cases.

Found rarely at Neenah and Mackville. These were as a rule not as well preserved as the others of the Streptelasma.

Lichenaria typa Winchell and Schuchert.

Plate I, figure 3.

Lichenaria typa Winchell and Schuchert. Geol. Minnesota 3, 1895, p. 83, pl. G, fig. 10–13.

Description. This is a colonial coral composed of small irregular hemispherical colonies. The corallum has thin walls with round cells if free, otherwise they have a polygonal outline due to the lateral crowding of the adjacent cells.

Only a few poorly preserved specimens were found at Neenah but they were easily identified by their external structure. The size of the corallites was about ⅛ inch on an average in diameter.

COELENTERATA

Subkingdom HYDROZOA

Order CAMPANULARIA Allan.

Suborder. GRAPTOLITOIDEA Lapworth.

At the close of the Cambrian there appeared in the seas a group of colonial organisms which developed extensively in the Ordovician and became extinct at the close of that period. These organisms resemble in their fossilization Greek writing upon rock and it is because of this that they were given the name of graptolites by Linnaeus in 1736 from graptolithus Greek writing. These organisms are very unusual in their rapid development and their sudden extinction.

The graptolites formed floating colonies in shallow muddy waters being free swimming animals in most cases, although some seem to have been fastened to drifting seaweed or some object to keep them up, but it can be generally said that they were free swimming. That they were not attached to the bottom is proven by the fact that they do not extend vertically through several beds but are always confined to one bedding plane.

The graptolites are derived from succession of buddings from a primal hydrotheca or cell, known as the sicula. The hydrothecae in which the individual organisms lived, are arranged in longitudinal rows on one or two sides of the stem or polypary, thus producing the serrate edge so characteristic of the graptolites. The skeleton secreted by the organism is composed of carbonized chitin and is preserved as a thin carbonaceous film.

It is only recently that the graptolites have been classified as a single group. Because of the fact that they were the first organisms to become developed and then extinct there has been much confusion as to their real character and at first they were confused with various groups, as plant remains, horny sponges, etc. In 1843 Portlock classified them as being a group under the Campanularia.

As an individual group the graptolites are classified into two groups, according to the arrangement of the hydrotheca; those with the hydrotheca along one side of the polypary are the Monoprionidae and those with the hydrotheca along both sides are the Diprionidae.

The carbonized chitin is very adaptable to fossilization and it is because of this that we have the graptolites so well preserved. In practically all cases they are found flattened in bedding planes and associated in groups. They are found in practically all kinds of rocks of sedimentary origin, being most abundant and best preserved in fine grained carbonaceous shale. The writer has found his specimens in the bedding planes of the Galena.

Lapworth states that the graptolites are distributed vertically through six horizons and only six. The first is the Upper Cambrian, the second, third and fourth are identical with the Ordovician, and the fifth and sixth are Silurian. It is because of this limitation that they are so important as horizon markers. They reached their greatest development in the Ordovician and were so abundant that the Ordovician is called the "Age of graptolites."

The writer has found specimens at the quarries of Kaukauna, Neenah and Kimberly. All belonged to the class Diprionidae. *Climacograptus typicalis* was the most abundant and best preserved. *Climacograptus bicornis* was rather rare but well preserved. Both *Diplograptus foliaceus* and the variety, *acutus,* were very rare, and *Lasiograptus mucronatus* also was very rare.

Climacograptus typicalis Hall.

Climacograptus typicalis Winchell and Schuchert. Geol. Minnesota, 3, 1895, p. 27, pl. A, fig. 1–9.

Climacograptus typicalis Grabau and Shimer. N. A. Index Fossils, 1, 1906, p. 32, fig. 5 lb.

Description. The hydrothecae are parallel to the axis and have their outer margin also parallel to the axis. This species varies from bicronis in that the lower edge of the hydrotheca has a slight lip-like extension and the serratures are more horizontal. Often old specimens of *typicals* have these points broken off and resemble *bicornis.*

This species was found abundantly both at Kaukauna and Kimberly and many of the specimens were in a good state of preservation. The number of hydrotheca varies from 40–50 to the inch. The cross section shows an oval shape about 1 mm. in narrowest diameter.

Climacograptus bicornis Hall.

Graptolithus bicornis Hall, Pal. New York, 1, 1847, p. 268, pl. 73, fig. 2.

Climacograptus bicornis Grabau and Shimer. N. A. Index Fossils, 1, 1906, p. 32, fig. 1, a-c.

Description. Hydrothecae parallel, their outer margin being straight and parallel to the axis of the stem. The hydrothecae are rectangular and the serratures are slightly oblique, extending about half way to the axis. There is a gradual widening upward and the base has two diverging forks.

This species was found at Kaukauna and Kimberly but was rare; in many cases it consisted of small fragments only fairly preserved. It is about the same size as *typicalis* and has about the same number of hydrothecae to the inch.

Diplograptus foliaceus (Murchison.)

Graptolithus pristis (Part) Hall Pal. New York, 1, 1847, p. 265, pl. 72, fig. 1a-c.

Diplograptus foliaceus Grabau and Shimer. N. A. Index Fossils, 1, 1906, p. 33.

Description. Linear, with two rows of alternating oblique hydrothecae. This species differs from the variety *acutus* in that the hyrothecae are larger and the serratures are wider. The hydrothecae are less oblique in this species.

This species was found at Neenah and was in such small, poorly preserved fragments that its identification is rather uncertain.

Diplograptus foliaceus acutus Lapworth.

Graptolithus pristis Hall. Pal. New York, 1, 1847, p. 265, pl. 73, fig. 1p–d.

Description. This species has the hydrothecæ arranged as *Diplograptus foliaceus* but it is distinguished by having more and more oblique hydrothecæ. Only one poorly preserved specimen was found either at Kaukauna or Kimberly and its identification was difficult.

Lasiograptus mucronatus Hall.

Graptolithus mucronatus Hall. Pal. New York, 1, 1847, p. 268, pl. 73, fig. 1a–d.

Description. This species has the hydrotheca arranged similar to *Diplograptus foliaceus* but is distinguished by the mucronate points on the hydrotheca. These points are about one-half the length of the hydrotheca.

This too is rare and only one poor specimen was found at Kimberly. It was so small that its character could not be studied.

Echinodermata

Subkingdom Crinoidea

The crinoids were a group of marine invertebrates that lived in colonies and were usually local in distribution. They resembled a lily in complete form, having usually a long stalk and a more or less globular calyx. In a few instances they were non-pedunculate and sessile. They inhabited shallow waters as a rule but are known to exist to a depth of 3,000 fathoms. They seemed to be gregarious in habit as is indicated by the fact that their skeletons constitute the major part of great masses of limestone (crinoidal limestone), especially in the Devonian and Mississippian periods.

These organisms began in the Ordovician and have continued to the present, but they were most abundant in the upper Paleozoic strata.

The first attempt at classification was made by Miller in 1821. At present the classification is as follows: Larviformia, Fistulata, Camerata, Flexibila, and Articulata.

The organism was built up of three parts, the calyx, the arms, and the stalk. The calyx, usually having the form of a cup-shaped or globular capsule, was made up of regularly arranged plates. These plates and their arrangement are very important in the study of crinoids. The arms were attached to the plates but as these could not be preserved as fossils they are not of great importance.

The stalk is very long in some cases, very short in others, and in rare cases when the crinoid is non-pedunculate the stalk is entirely lacking, the calyx being fastened directly to the base. The stalk is built up of segments of various thickness, size and shape according to the species. Some are circular in cross-section while others are elliptical or angular, the pentagonal form being common. Some have rounded edges some are marked by fine lines and these variations serve as a means of identification of the various species of Crinoidea. The stem segments are very important because they are the parts of the crinoids that are usually found as fossils.

The crinoids are unfavorable for preservation in a perfect and complete form because of the delicate structure and the looseness with which the plates and segments are fastened together.

The perfect calyx is rare but often the individual plates are found. However, the chief fossil remains of the Crinoidea are the stalk fragments.

The writer has found only a few fragmental stalks in his search through the quarries of this vicinity and often these were very small, some consisting of but a single stem segment.

Four species of Crinoidea have been found in this region. *Schizocrinus nodosus, Dendrocrinus alternatus, Heterocrinus heterodactylus,* and *Heterocrinus pentagonus.*

Schizocranus nodosus is very abundant in all the quarries and usually the stem fragments were well preserved. *Dendrocrinus alternatus* is rare and only a few small specimens were found at Neenah. *Heterocrinus heterodactylus* is also rare and poorly preserved, being found at Mackville. *Heterocrinus pentagonus* is very rare and only one segment was found at Neenah. It is well preserved and the external and internal structure of the stem is easily studied.

Schizocrinus nodosus Hall.

Plate I, figure 7.

Schizocrinus nodosus Hall. Pal. New York, 1, 1847, p. 81, pl. 27, fig. 1a–b.

Schizocrinus nodosus Emmons. Amer. Geol. 1, 1855, p. 224.

Description. The body or calyx is cup shaped and obtusely pentagonal. The column is round, composed of joints of unequal thickness and diameter. The segments are well marked with fine concentric lines and the cross section shows numerous radial lines.

This species is very abundant in all the quarries and as a general rule is well preserved. In some cases of extreme weathering the central part of the stem is gone, but usually even the linear markings of the segments are visible. The specimens range from 1/8 to 1/2 inch in diameter and are of different lengths, from a single segment to a fragment nearly 3 inches long.

Dendrocrinus alternatus (Hall).

Plate I, figure 9.

Poteriocrinus alternatus Hall. Pal. New York, 1, 1847, p. 83, pl. 28, fig. 1f.

Description. The column is very slender and is composed of thickened plates with rounded edges which alternate in size. The segments are very uniform in this alternation.

This species is found only rarely in this region and only two poorly preserved specimens were found at Neenah. The diameter of the stem is about 1/16 inch and one specimen is about 2 inches long.

Heterocrinus heterodactylus Hall.

Plate I, figure 8.

Heterocrinus heterodactylus Hall. Pal. New York, 1, 1847, p. 279, pl. 76, fig. 1a–o.

Description. The body is short and nearly round. The column is built up of thick pentagonal plates which are all nearly the same size with a slight rounding at the edges. The plates are usually divided by five partitions and the column is usually rather slender.

This species is very rare in this region and only two small, poor specimens were found at Mackville. They range from 1/8 to 3/16 inch in diameter and are about 1/2 inch long.

Heterocrinus pentagonus Hall.

Plate I, figure 6.

Description. The diameter of this species is about 3/16 inch and the plate is about 1/16 inch thick, rounded at the edges. There are tiny radial markings at the edge. The central opening is pentagonal, its sides corresponding to the outer sides, the stem being a pentagonal one. There are five small penagonal openings located midway between the external faces and those of the central openings.

Only one segment of this species was found at Neenah and the writer has called it *pentagonus* although he has not had access to any description of *pentagonus;* the pentagonal structure is so pronounced, however, that it undoubtedly belongs to this species.

MOLLUSCOIDEA

Subkingdom BRYOZOA

The Bryozoa appeared in the Lower Ordovician and were usually colonial and encrusting animals. They are chiefly marine but in some cases they are fresh water. The name arose out of their moss like appearance, coming from the Greek, bryon moss and zoon animal.

The body wall of each individual animal was made hard by means of calcerous or horny material and forms the only part of the animal capable of being preserved in a fossil state.

The small animals formed variously shaped colonies, some being moss like tufts, some in branching stems, and usually encrusting shells and other foreign material.

The classification that is generally accepted is as follows: Ctenostomata, Cyclostomata, Trepostomata, Cryptosotamata, and Chilostomata.

The writer has found the Bryozoa to be in considerable abundance in this region and as a general rule the specimens are well preserved as far as external structure is concerned. Because of the lack of sufficient material on the Bryozoa the writer has not gone into a detailed discussion of this group and has been limited in the identification of the various species.

Several types have been found at the various quarries in this vicinity and they are generally well preserved. *Rhombotrypa quadrata, Lioclemella solidissima, Escharopora subrecta, Calloporella lens,* Stictoporella sp. and *Rhinidictya mutabilis* are the species that have been identified in this region.

Rhombotrypa quadrata is fairly abundant and very characteristic of the Ordovician of this region and is found at all the quarries. *Lioclemella solidissima* is slightly more abundant than *Rhombotrypa quadrata,* but is not as well preserved. Only one specimen of *Escharopora subrecta* was found, but it was in a good state of preservation.

Calloporella lens was fairly abundant in the quarries but was usually poorly preserved. Only a few small specimens of *Stictoporella* sp. were found and they, too, were poorly preserved. *Rhinidictya mutabilis* was rare, but good specimens were obtained.

Rhombotrya quadrata (Rominger).

Plate I, figure 10.

Monticulipora multituberculata Whitfield, Geol. Survey Wisconsin, 4, 1882, p. 250, pl. 11, fig. 9–10.

Monotrypella quadrata. Grabau and Shimer. N. A. Index Fossils, 1, 1906, p. 131.

Description. A colonial form, being a flat expansion of upright parallel tubes of calcareous material. The tubes are thick walled, the walls being non-porous. The openings of the tubes are polygonal or round. The surface is made irregular by the elongation of groups of individual tubes. This gives the surface a very characteristic roughness. The stems are usually strong and more or less flattened.

This species is fairly abundant at Mackville but more rarely in the other quarries. Some of the specimens were over ¼ inch in width and as long as 2 inches.

Lioclemella solidissima (Whitfield).

Plate I, figure 11.

Fistulipora solidissima (Whitfield). Geol. Survey. Wisconsin, 4, 1882, p. 255, pl. 11, fig. 18, 19.

Description. A bryozoan forming strong cylindrical branches which often attain a diameter of about ¼ of an inch. The surface is usually covered with minute elongate-oval or sometimes rounded cells.

This species is found abundantly in all the quarries of this vicinity and is fairly preserved. The specimens vary in size and range up to ¼ inch in width.

Escharopora subrecta Ulrich.

Plate I, figure 12.

Escharopora subrecta Ulrich. Geol. Minnesota, 3, 1893, p. 168, pl. 12, figure. 5–29.

Escharopora subrecta Grabau and Shimer. N. A. Index Fossils, 1, 1906, p. 156, fig. 208f.

Description. A simple, flattened, straight or curved subcylindrical bryozoan. The cell openings are elongate-elliptical, sometimes almost acute at the ends. The cells have a very pronounced longitudinal arrangement although in some cases the diagonal rows are as regular and as evident as the longitudinal ones.

Only one specimen was found by the writer and it showed the external structure very plainly. The specimen is about one inch long and 3/16th inch wide. The one specimen was found at Neenah.

Calloporella ? lens Whitefield.

Fistulipora lens Whitfield. Geol. Survey Wisconsin, 4, 1882, p. 256, pl. 11, fig. 5, 6.

Description. A bryozoan growing in small discoidal or plano-convex button-shaped bodies. The under surface is more or less concave and is marked by fine radiating striae. The upper surface is covered with round or polygonal apertures, the partition walls being thin.

This species is abundant at Neenah and Mackville, but the specimens are poorly preserved. The specimens vary in size from ¼ to 1½ inches in diameter.

Stictoporella sp. Ulrich.

Very rare in this region and only a few poor specimens were found; the writer is not certain as to their identification. The small size seemed characteristic, as the specimens were only 1/16 inch in diameter.

Rhinidictya mutabilis Ulrich.

Rhinidictya mutabilis Ulrich. Geol. Minnesota, 3, 1893, p. 125, pl. 6, fig. 1–6.

Rhinidictya mutabilis Grabau and Shimer. N. A. Index Fossils, 1, 1906, p. 158, fig. 208i.

Description. Branches commonly small, being usually 2–3 mm. in diameter. There are usually 14 or 15 rows of cells which are arranged longitudinally.

Fairly abundant in this region at all the quarries; the cell arrangement was in evidence in practically all specimens.

Brachiopoda

The brachiopods are marine organisms that appeared in the Lower Cambrian. They secreted a shell made up of two parts, the pedicle valve and the brachial valve. They are most prolific in warm waters, and are usually found in shallow waters although they have been found in water as deep as 3000 fathoms. These organisms are gregarious in habit and are often attached to one another. As a general rule the brachiopods are attached to some foreign material by a fleshy stalk, which is known as the pedicle. It is only in the larval stage that they are free floating and it is in this period that they are distributed.

The brachiopods attained their maximum development in the Silurian and Devonian times. They are very numerous and there are over six thousand fossils species of this group and about 140 recent species.

In 1792 Cuvier distinguished the Brachiopoda from the Acephala and put them as a fourth family in his class of Mollusca. It was Dumeril, in 1806, that gave them the name of Brachiopoda, meaning arm-footed animals. This name has been changed often but has not been supplanted.

The Brachiopoda are divided into two large groups according to the presence and absence of teeth. The Inarticulata have no teeth the valves being held together by muscles. The Articulata have the valves articulated by teeth and sockets. These two groups are subdivided on the nature of the pedicle opening and the stages of shell growth into the Atremata and Neotremata of the Inarticulata and the Protremata and Telotremata of the Articulata.

The two valves are eqilateral, but not equivalved, and vary greatly as to shape. In some cases both valves are convex, in others they are nearly flat and again some have a convex pedicle valve and a concave brachial valve. The pedicle valve derived its name from the fact that the pedicle came from that valve. It is usually the larger of the two valves. These valves are composed of calcareous or phosphatic material or both.

The external markings are of two kinds, concentric lines of growth and plications radiating from the region of the beak. Often when the plication are small they are referred to as striations. These vary greatly, some being simple, some bifid, some trifid, and some alternating in size with the others. Frequently there is a larger fold or plication on the brachial valve, known as the median fold, and a median depression on the pedicle valve, known as the medial sinus.

The writer has found the brachiopods in great abundance in this region and many of them well preserved.

LINGULA Bruguiere.

Lingula Winchell and Schuchert. Geol. Minnesota, 3, 1893, p. 338.

Lingula Grabau and Shimer. N. A. Index Fossils, 1, 1907, p. 194.

Description. Elongate-ovate, equivalved, with a thin glistening shell. The shell is usually smooth or with fine concentric lines and rarely with a fine striae. Broad anteriorly, parallel sided, or tapering posteriorly.

Lingula hulburti Winchell.

Plate II, figure 2.

Lingula hulburti Winchell and Schuchert. Geo. Minnesota, 3, 1893, p. 347, pl. 29, fig. 13–14.

Description. Shell ovate, pointed posteriorly, being broadest in the anterior half. The convexity is moderate and regular. The exterior is marked by sharply elevated concentric plications which are fewer near the beak.

Found rarely in this region, only one specimen being found at Neenah. This was well preserved and the size of it was 7/16 inch long and 5/16 inch wide.

Lingula obtusa Hall.

Plate II, figure 4.

Lingula obtusa Hall. Pal. New York, 1, 1847, p. 98, pl. 30 fig. 7.

Description. Broad, ovate, obtuse at the apex and broadly rounded below. Depressed in front, with a prominent but not terminal beak. Fine concentric lines and radiating striae mark the surface.

This species is rare in this vicinity and only one specimen was found at Neenah. It was 5/16 inch at the greatest width.

Lingula elderi Whitfield.

Plate II, figure 1.

Lingula elderi Whitfield. Geol. Survey Wisconsin, 4, 1882, p. 345, pl. 27, fig. 1–5.

Lingula elderi Grabau and Shimer. N. A. Index Fossils, 1, 1907, p. 196,

Description. An oblong, sub-quadrangular shell, the margins being nearly parallel. The valves are slightly convex, having nearly a smooth surface, which in some cases is marked by fine concentric lines.

Only one specimen was found. It was well preserved and is ½ inch wide and ¾ inch long.

Lingula iowensis (Owen).

Plate II, figure 3.

Lingual iowensis Winchell and Schuchert. Geol. Minnesota, 3, 1893, p. 349, pl. fig. 19–22.

Lingulella iowensis Whitfield. Geol. Survey Wisconsin, 4, 1882, p. 242, pl. 9, fig. 1.

Description. A large shell, broadly ovate, subquadrate in outline. The sides are gently rounded and the bottom is moderately rounded. The valves are convex, the pedicle valve being more convex. The surface is marked by strong irregular lines of growth and fine flattened angular striae.

This species is rare in this region and only one well preserved specimen was found at Neenah. It was ⅝ inch wide and ⅞ inch long.

Rafinesquina Hall and Clarke.

Rafinesqwina Winchell and Schuchert. Geol. Minnesota, 3, 1893, p. 400.

Refinesquina Grabau and Shimer. N. A. Index Fossils. 1, 1907, p. 211.

Description. The shells are normally concavo-convex, the pedicle valve being convex and the brachial valve being concave. The shell is semi-oval, with a straight hinge line. The surface is marked by radiating striae of alternating size crossed by finer concentric lines.

The Rafinesquina began in the Calciferous and died out in the Clinton.

Rafinesquina alternata (Emmons).

Plate II, figure 5.

Leptaena alternata Hall. Pl. New York, 1, 1847, p. 102, pl. 31, fig. 1.

Rafinesquina alternata Winchell and Schuchert. Geol. Minnesota, 3, 1893, p. 404, pl. 31, fig. 32–34.

Rafinesquina alternata Grabau and Shimer. N. A. Index Fossils, 1, 1907, p. 211, fig. 251.

Description. The shell is large, the breadth being greater than the length. Broadly semi-oval, the lateral margins being slightly convex, rounding forward to a front. The pedicle valve is medium convex and is flattered near the cardinal extremities. The brachial valve is gently concave in central and anterior regions and has a small beak. The surface of both valves is ornamented with numerous radiating striae which alternate very noticeably. Fine concentric lines cross the striae.

Rafinesquina minnesotaensis inquassa.

Rafinesquina minnesotaensis Grabau and Shimer. 1, 1907, p. 212, fig. 252.

Description. Very similar to *Rafinesquina alternata* in form and surface features but usually is distinguishable by the smaller size and the greater convexity of *minnesotaensis.* Sometimes it is considered as a small variety of *Rafinesqina alternata.*

Found rarely in the region under discussion. One specimen measuring 1 inch across was found at Neenah. Fairly well preserved.

STROPHOMENA (King).

Strophomena Winchell and Schuchert. Geol. Minnesota, 3, 1893, p. 384.

Strophomena Grabau and Shimer. N. A. Index Fossils, 1, 1907, p. 222.

Description. The shells are transversely sub-semicircular, the greatest width being at the hingeline. The shell is concavo-convex, being similar to Rafinesquina but with the convexity of the valves reversed. The surface is marked by fine radiating striae which are equal or alternating in size.

Strophomena planumbona (Hall).

Plate II, figure 6.

Strophomena planumbona Hall. Pal. New York, 1, 1847, p. 112, pl. 31, fig. 4.

Strophomena rugosa Winchell and Schuchert. Geol. Minnesota, 3, 1893, p. 390, pl. 31, fig. 4–5.

Description. A medium sized shell which is wide at the hinge line, the brachial valve being evenly convex, the pedicle valve being quite concave. The surface is marked by fine radiating striae, usually with several smaller ones between two larger ones, the smaller ones being shorter. These are crossed by a number of fine concentric lines and a few imbricating lines of growth at the free margins.

Found rarely in this region but fairly well preserved. One specimen found at Neenah is slightly over 1 inch at the hinge line.

Strophomena emanciata Winchell and Schuchert.

Plate II, figure 7.

Strophomena emanciata Winchell and Schuchert. Geol. Minnesota, 3, 1893, p. 399, pl. 31, fig. 22–4.

Description. A small shell, depressed, bi-convex, semi-circular in outline, the hinge line being slightly longer than the width of the shell. The pedicle valve is depressed, convex, with a shallow sinus that has its origin near the beak. Numerous angulated striae. Rare in this region. Found at Neenah. Good specimen, ¾ inch at hinge line.

PLECTAMBONITES Pander.

Plectambonites Winchell and Schuchert. 3, 1893, p. 413.

Plectambonites Grabau and Shimer. N. A. Index Fossils, 1, 1907, p. 225.

Description. A very small shell, the pedicle valve being convex and the brachial valve concave. The hinge line is the greatest width of the shell. The surface markings are fine striae which often alternate in size.

Plectambonites sericeus (Sowerby).

Plate II, figure 8.

Leptaena sericea Hall. Pal. New York, 1, 1847, p. 110, pl. 31B, fig. 2.

Plectambonites sericea Winchell and Schuchert. Geol. Minnesota, 3, 1893, p. 414, pl. 32, fig. 10–12.

Plectambonites sericea Grabau and Shimer. N. A. Index Fossils, 1, 1907, p. 227, fig. 274a–b.

Description. The shell is small, semi-oval, approaching semicircular. The brachial valve is concave, the pericle valve is moderately convex, nearly even in most cases. The surface is often shiny and is marked by numerous minute, closely arranged, equal striae, every fourth, fifth or sixth one being more prominent.

Found abundantly in this region and generally well preserved. They range from ¼ to ½ inch in width at the hinge line.

ORTHIS Dalman.

Orthis Winchell and Schuchert. Geol. Minnesota, 3, 1893, p. 417.

Orthis Grabau and Shimer. N. A. Index Fossils, 1, 1907, p. 250.

Description. The brachial valve is very flat and the pedicle valve is very convex, with an elevated and incurved cardinal area. The surface is marked by comparatively strong, sharp plications which are usually simple.

Orthis costalis, Hall.

Plate II, figure 9.

Orthis costalis Hall. Pal. New York, 1, 1847, p. 20, pl. 4Bis. fig. 4a.

Orthis Costalis Grabau and Shimer. N. A. Index Fossils, 1, 1907, p. 250, fig. 300a–5.

Description. The pedicle valve is very convex, while the brachial valve is flat. The surface is marked by about 32 distinct, strong, rounded striae which are continuous and enlarge near the margin. This series resembles *Dalmanella testudiniaria* but is more convex above and the striae are coarser and less numerous.

It is found abundantly in this region and usually well preserved. The specimens average about ¼ inch along the hinge line.

Plectorthis Hall and Clarke.

Plectorthis Winchell and Schuchert. Geol. Minnesota, 3, 1893, p. 435.

Plectorthis Grabau and Shimer. N. A. Index Fossils, 1, 1907, p. 251.

Description. This differs from Orthis in that it has subequal and convex valves, coarse plications and concentric lines crossing the striae.

Plectorthis plicatella (Hall).

Plate II, figure 10.

Orthis plicatella Hall. Pal New York, 1, 1847, p. 122, pl. 32, fig. 19.

Plectorthis plicatella Grabau and Shimer. N. A. Index Fossils, 1, 1907, p. 252, fig. 301d–f.

Description. A broadly semi-oval shell, with both valves slightly convex, their convexity being nearly equal. The surface is marked by strong radiating plications which are usually simple. They range from 20 to 28 on each valve. These are crossed by simple elevated concentric lines which are often obscure on weathered surfaces.

This is found rarely at Mackville and the specimens range up to ¾ inch at the greatest width.

Plectorthis plictella (Hall).

Plate II, figure 11.

Orthis fissicosta Hall. Pal. New York, 1, 1847, pl. 121, 32 fig. 8.

Plectorthis fissicosta Grabau and Shimer. N. A. Index Fossils, 1, 1907, p. 252, fig. 300c–d.

Description. Semioval, the pedicle valve being moderately convex, the beak extended and slightly incurved. The surface is marked by angulated striae, numbering 19–20, which become bifid and trifid towards the margin of the shell.

Found rarely in this vicinity in well perserved specimens. Mackville was the only place that they were found. The specimens measured 3/4 inch across.

Plectorthis dichotoma Hall.

Plate II, figure 12.

Orthis dichotoma Hall. New York, 1, 1847, p. 125, pl. 32, fig. 10.

Description. A small suborbicular shell, with the valves nearly equally convex, the pedicle valve being equally and uniformly convex. There are about 26 well defined rounded striae which bifurcate about half way to the margin.

This form is rare and poorly preserved; only one specimen was found at Mackville which measured about 1/2 inch across.

Plectorthis sordida (Hall).

Plate II, figure 13.

Orthis sordida Hall. Pal. New York, 1, 1847, p. 148, pl. 33, fig. 16.

Description. A small circular shell, the valves being equally convex, the beak of the pedicle valve extending beyond the brachial valve. The radii are coarse and simple. The pedicle valve has a slight medial sinus.

This species is rare and poorly preserved; one specimen was found at Mackville measuring 1/4 inch in diameter.

DINORTHIS Hall and Clarke.

Dinorthis Winchell and Schuchert. Geol. Minnesota, 1, 1893, p. 420.

Dinorthis Grabau and Shimer. N. A. Index Fossils, 1, 1907, p. 252.

Description. This genus varies from Orthis in that the brachial valve is convex and the pedicle valve is elevated at the umbo. It has strong simple, rarely bifurcating, striae.

Dinorthis meedsi Winchell and Schuchert.

Plate II, figure 14.

Dinorthis meedsi Winchell and Schuchert. Geol. Minnesota, 3, 1893, p. 427, pl. 32, fig. 39–42.

Dinorthis meedsi Grabau and Shimer. N. A. Index Fossils, 1, 1907, p. 253, fig. 303e-h.

Description. The shell is suborbicular with a straightening along the hinge line. Pedicle valve is convex with a distinct but not greatly elevated beak. The brachial valve is flat with a slight elevation at the beak. The striae are coarse and simple, the furrows being about the same width as the striae. This species is similar to *pectinella* but has a shorter hinge line.

Found rarely in this region, in a fair state of preservation. The specimens found at Mackville measured from 3/8 to 7/8 inch across.

Dinorthis pectinella (Emmons).

Plate II, figure 15.

Dinorthis pectinella Winchell and Schuchert. Geol. Minnesota, 3, 1893, p. 424, pl. 32, fig. 10.

Dinorthis pectinella. Grabau and Shimer. N. A. Index Fossils, 1, 1907, p. 253, fig. 303i–1.

Description. Semi-oval, the width and length being as 9 to 12. The pedicle valve is regularly convex, the brachial valve is subconvex near the beak. Broad depression along the center. There are 21–30 prominent, rounded striae which are bifid or trifid towards the margin. Rare, poorly preserved, 3/4 inch in diameter. Mackville.

HERBERTELLA Hall and Clarke.

Herbertella Winchell and Schuchert. Geol. Minnesota, 3, 1893, p. 432.

Herbertella Grabau and Shimer. N. A. Index Fossils, 1, 1907, p. 254.

Description. The pedicle valve is depressed, convex, but less convex than the brachial valve. The greatest width of the shell is at the cardinal area. The surface is marked by numerous closely crowded, fine rounded striae which are crossed by concentric lines of growth.

Herbertella (Orthis) occidentalis Hall.

Plate III, figure 3.

Orthis occidentalis Hall. Pal. New York, 1, 1847, p. 127, pl. 32, fig. 2.

Herbertella occidentalis Grabau and Shimer. N. A. Index Fossils, 1, 1907, p. 225, fig. 304f–h.

Description. A semi-oval shell, the greatest width being at the cardinal line. The brachial valve is strongly convex with a slight depression along the center. The pedicle valve is convex towards the beak. The brachial valve has a high incurved beak which extends slightly beyond the hinge line. The striae are elevated and sub-angular and are crossed by fine concentric lines of growth.

This species is found rarely in this region and only one specimen was found at Mackville. This was about ½ inch in width.

Herbertella (Orthis) bellirugosa (Conrad).

Plate II, figure 16.

Orthis bellirugosa Hall. Pal. New York, 1, 1847, p. 118, pl. 32, fig. 3.

Herbertella bellirugosa Grabau and Shimer. N. A. Index Fossils, 1, 1907, p. 255, fig. 304d–e.

Herbertella bellirugosa Winchell and Schuchert. Geol Minnesota, 3, 1893, p. 434, pl. 33, fig. 1–4.

Description. Semi-oval and biconvex, the valves are nearly equal in convexity. The brachial valve has a conspicuous mesial sinus and in some cases the pedicle valve has a sinus. The pedicle valve is strongly convex, with the greatest elevation at the umbo. The striae are prominent, linear, bifurcating near the margin. There are numerous strongly imbricating concentric lines of growth.

This is found rarely in this region, a few being found at Mackville; the specimens vary from ½ to ¾ inch in length.

PLATYSTROPHIA King.

Platystrophia Winchell and Schuchert. Geol. Minnesota, 3, 1893, p. 454.

Platystrophia Grabau and Shimer. N. A. Index Fossils, 1, 1907, p. 257.

Description. This shell has a spiriferoid hinge line which is long and straight. Both valves are convex, the brachial valve being more so. There is a strong medial fold on the brachial valve, and a strong sinus on the pedicle valve. The surface is marked by strong sharp plications.

This type ranges from the Ordovician to the Silurian.

Platystrophia (Orthis) lynx (Eichwald)

Plate III. figure 1.

Dethyris lynx Hall. Pal. New York, 1, 1847, p. 133, pl. 32D, fig. 1.

Platystrophia lynx Grabau and Shimer. N. A. Index Fossils, 1, 1907, p. 258 fig. 308c–d.

Description. The shell is often nearly as thick as long, the length and the width being as 5 to 9 or equal. The surface is marked with strong angulated plications; 3 or 4 mark the sinus and 4 or 5 are on the elevated mesial lobe. Fine semi-imbricating, flexuous lines cross the plications.

Found rarely in this vicinity. The specimen studied by the writer measured ¾ inch along the hinge line.

Platystrophia biforata Schlothiem.

Plate III, figure 2.

Platystrophia biforata Winchell and Schuchert. Geol. Minnesota, 3, 1893, p. 455, pl. 33, fig. 51–54.

Platystrophia biforata. Grabau and Shimer. N. A. Index Fossils, 1, 1907, p. 258.

Description. Transversely semi-elliptical. The pedicle valve is strongly convex with a wide deep medial sinus which commences at the extremity of the beak and widens to the front. The surface is marked by a large number of radiating triangular ribs, 1 to 5 in the medial sinus. The valves are crossed by numerous concentric raised lines.

This species is fairly abundant in this region, but the specimens are not well preserved. They vary in sie from 1/4 to 1 inch in width at the hinge line.

Dalmanella Hall and Clarke.

Dalmanella Winchell and Schuchert. Geol. Minnesota, 3, 1893, p. 439.

Dalmanella Grabau and Shimer. N. A. Index Fossils, 1, 1907, p. 194.

Description. Plano-convex or subequally convex, with a semicircular outline. The pedicle valve has an elevated cardinal area. The surface is marked by fine rounded bifurcating striae which curve from the umbo to the sides of the valve. The hinge line is generally shorter than the greatest width of the shell.

Dalmanella testudinaria (Dalman).

Plate III, figure 4.

Orthis testudinaria Hall. Pal. New York, 1, 1847, p. 117, pl. 32, fig. 1.

Orthis testudinaria Whitfield. Geol. Survey Wisconsin, 4, 1882, p. 258, pl. 12, fig. 5–7.

Dalmenella testudinaria Grabau and Shimer. N. A. Index Fossils, p. 260, fig. 311a–e.

Description. Suborbicular, the pedicle valve being convex and elevated towards the beak, with an elevated ridge down the center. The brachial valve is flat. The surface is covered with fine radiating striae which are crossed by fine concentric lines.

This species is found abundantly in this region in all the quarries and in practically all cases the specimens were well preserved. They vary in size, but are usually about 3/8 inch in width, some being 1/2 inch.

Rhynchotrema Hall.

Rhynchotrema Winchell and Schuchert. Geol. Minnesota, 3, 1893, p. 458.

Rhynchotrema Grabau and Shimer, 1, 1907, p. 281.

Description. Rostate and thick shelled. The pedicle has its apex closely incurved over that of the brachial valve. The cardinal process is very prominent. This is an extensive genus.

Rhynchotrema increbescens Hall.

Plate III, figure 5.

Atrypa increbescens Hall. Pal. New York, 1, 1847, p. 146, pl. 33, fig. 13a–h.

Rhynchotrema inaequivalvis Winchell and Schubert. Geol. Minnesota, 3, 1893, p. 459, pl. 34, fig. 12–14.

Rhynchotrema inaequivalvis Grabau and Shimer. N. A. Index Fossils, 1, 1907, p. 281, fig. 243a–d.

Description. A spheroidal or gibbous shell, the length and the breadth being nearly equal. There is a broad deep sinus in the brachial valve. There are 12–25 plications which are never subdivided transversely. These are crossed by elevated imbricating lines and delicate concentric zigzag lines.

Found in considerable abundance in this region, chiefly at Mackville where they are weathered out. The specimens vary from ¼ to ½ inch in width and are well preserved.

Rhynchotrema capax (Conrad).

Plate III, figure 6.

Rhynchonella capax Whitfield. Geo. Survey Wisconsin, 4, 1882, p. 263, pl. 12, fig. 26–27.

Rhychotrema capax Winchell and Schuchert, 3, 1893, p. 462, pl. 34, fig. 30, 34.

Rhynchotrema capax Grabau and Shimer. N. A. Index Fossils, 1, 1907, p. 282, fig. 343h–k.

Description. Medium sized, with both valves very convex, the brachial valve being slightly the stronger. The medial sinus is very pronounced, being deep and never reaching the front of the beak. There are always three simple angulated plications in the bottom of the sinus. The lateral slopes are occupied by 5 to 7 simple plications. The entire surface of both valves is marked by numerous regularly zigzag sublaminar lines of growth. These are often obsolete in old or weathered specimens.

This species is found abundantly in a well preserved state in all of the quarries and the specimens vary from ½ to 1 inch in width.

ZYGOSPIRA Hall.

Zygospira Winchell and Schuchert. Geol. Minnesota, 3, 1893, p. 465.

Zygospira Grabau and Shimer. N. A. Index Fossils, 1, 1907, p. 307.

Description. A very small shell, subcircular and biconvex. There is a plicated medial fold on the pedicle valve and a medial sinus on the brachial valve. The surface is sharply plicate.

Zygospira modesta Hall.

Atrypa modesta Hall. Pal. New York, 1, 1847, p. 141, pl. 33, fig. 15.

Zygospira modesta Winchell and Schuchert. Geol. Minnesota, 3 1893, p. 467, pl. 34, fig. 42–44.

Zygospira modesta Grabau and Shimer. N. A. Index Fossils, 1, 1907, p. 308, fig. 375f–i.

Description. Suborbicular or planoconvex. The width is a little greater than the length. The shell is very small. The pedicle valve has an elevated ridge along the center which is composed of 4 plaits that are stronger than the others. The beak is prominent and incurved. The brachial wave is less convex and has a wide, ill-defined sinus. There are about 18–20 plications on each valve.

This species is found rarely in this region, but the few specimens are well preserved. They are about 3/16 inch in width.

MOLLUSCA

Subkingdom GASTROPODA

The Gastropoda or snails are marine, fresh-water or terrestrial mollusks. They are chiefly marine and usually inhabit shallow waters, seldom being found below 500 fathoms, but in rare cases exist at 2000 and even 3000 fathoms.

The shell is a secretion of the mantle and consists of carbonate of lime in practically all cases. The shell is essentially a spirally wound, elongated, conical tube, the coils or whorls being in most cases in contact and tightly cemented where they join. Sometimes the shells are coiled in nearly the same plane and are discoidal as in many of the Euomphalidae. More generally the whorls are wound about an axis in an oblique manner, a true spiral being formed. The last whorl is known as the body whorl and the ones above are what constitute the spire. The line or groove marking the junction of the whorls is known as the suture. The shell is imperforate when the axis is solid as in Fusispira or is perforate when the axis is hollow as in Trochonema, in which case the axial cavity is called the umbilicus. The only external markings are the lines of growth and these are usually distinguishable except in cases where it is a cast of the shell that is found.

The form of the shell varies greatly but is very constant within the limits of the species. Three types of shells are distinguished in the large number of species. The tabular, straight, or only slightly curved forms occur among the Scaphopoda and Peteropoda. The symmetrical forms have the shell either conical, patelliform, or involute as in Bellerophon. The spiral is the typical form of gastropod and the most common of the three types.

The fossil fauna of this region includes many types of the Gastropoda; all of the quarries are fairly abundantly supplied with casts of snails. Kaukauna and Mackville yielded the largest number but Menasha had some very good specimens. Eighteen species were found in the search of these quarries, all being casts and usually poorly preserved.

PROTOWARTHIA Ulrich and Scofield.

Protowarthia Ulrich and Scofield. Geol. Minnesota, 3, pt. 2, 1897, p. 848.

Protowarthia Grabau and Shimer. N. A. Index Fossils, 1, 1907, p. 611.

Description. Bellerophron shells with the aperture large, but not abruptly expanded. The outer lip is bilobate, but never slit. Umbilicus usually closed.

Protowarthia pervoluta Ulrich and *Scofield.*

Protowarthia pervoluta Ulrich and Scofield. Geol. Minnesota, 3, pt. 2, 1897, p. 871, pl. 63, fig. 21–27.

Protowarthia pervoluta Grabau and Shimer. N. A. Index Fossils, 1, 1907, p. 611, fig. 817d–f.

Description. Small, rather globose in form. Volutions uniformly rounded. Lateral lobes of lips rounded. No surface markings.

Found rarely at Mackville. Poor specimens. They measure about ¾ inch in diameter.

RAPHISTOMA Hall.

Raphistoma Ulrich and Scofield. Geo. Minnesota, 3, pt. 2, 1897, p. 931.

Raphistoma Gabau and Shimer. N. A. Index Fossils, 1, 1907, p. 627.

Description. Shell sublenticular or plano-convex, the spire flat, and the sutures close. The volutions are triangular in section, sharply angulate. Aperture turned back abruptly.

Raphistoma rotuloides (Hall).

Pleurotomaria rotuloides. Hall. Pal. New York, 1, 1847, p. 173, pl. 37.

Description. The shell is depressed, conical, the spire being composed of 4 volutions. The outer volution is angular at the edge. Small umbilicus, subquadrate aperture.

Rare and poorly preserved. One from Mackville, ¾ inch wide.

RAPHISTOMINA Ulrich and Scofield.

Raphistomina Ulrich and Scofield. Geol. Minnesota, 3, pt. 2, 1897, p. 932.

Raphistomina Grabau and Shimer. N. A. Index Fossils, 1, 1907, p. 629.

Description. Shell lenticular to depressed conical, umbilicated volutions sharply angular and carinate at the periphery. Aperture subrhombical.

Raphistomina modesta Ulrich.

Plate III, figure 11.

Raphistomina modesta Ulrich and Scofield. Geol. Minnesota, 3, pa. 2, 1897, p. 943, pl. 68, fig. 14–17.

Description. Shell is small, with a discoidal shape. Nearly always has a small umbilicus. The four volutions are gently convex on the upper side. Sutures are not very deep. Very short spire.

Cast found at Mackville, poorly preserved, about ½ inch in diameter.

LOPHOSPIRA Whitfield.

Lophospira Ulrich and Scofield. Geol. Minnesota, 3, pt. 2, 1897, pl. 952.

Lophospira Grabau and Shimer. N. A. Index Fossils, 1, 1907, p. 631.

Description. Shells with more or less elevated spires, the whorls being closely coiled throughout. Whorls are angular. Umbilicus is nearly always present. Outer lip notched.

Lophospira angustina minnesotaensis Ulrich and Scofield.

L. angustina minnesotaensis. Ulrich and Scofield. Geol. Minnesota, 3, pt.. 2, 1897, p. 988, pl. 71, fig. 3–4.

Description. About four whorls in the cast. These are strongly convex and angular above. Often confused with *Hormotoma major,* but is shorter and less slender.

Found rarely at Kaukauna. The specimen measures about 2¼ inches at greatest diameter and is about 3 inches long.

Liospira Ulrich and Scofield.

Liospira Ulrich and Scofield. Geol. Minnesota, 3, pa. 2, 1897, p. 953.

Liospira Grabau and Shimer. N. A. Index Fossils, 1, 1907, p. 640.

Description. The shell is sublenticular, with a low spire, depressed conical, the sutures being scarcely distinguishable. The volutions are subrhombical, being flat or gently above. The aperture is deeply notched and the umbilicus is usually filled by the extension of the lip.

Liospira micula (Hall).

Plate III, figure 7.

Liospira micula Ulrich and Scofield Geol. Minnesota, 3, pt. 2, 1897m p. 994, pl. 68, fig. 24–29.

Liospira micula Grabau and Shimer. N. A. Index Fossils, 1, 1907, p. 640, fig. 871a–d.

Description. A small shell with the whorls flattened and continuous in the spire, the sutures being scarcely depressed. There are about four volutions. The umbilicus is filled by reflex callosity of the lip.

Fairly abundant at Mackville, but the casts were poorly preserved. The specimens were about ½ inch thick at greatest diameter.

Liospira progne (Billings).

Liospira progne Ulrich and Scofield. Geol. Minnesota, 3, pt. 2, 1897, p. 996, pl. 68, fig. 38–40.

Liospira progne Grabau and Shimer. N. A. Index Fossils, 1, 1907, pl. 640, fig. 871e–g.

Description. A small shell, composed of four volutions. These volutions are flattened and the sutures are scarcely depressed. The umbilicus is filled by reflex callosity of the lip.

This species is found rarely in this region, but is poorly preserved. Those from Mackville measured ½ to 1 inch in diameter.

Plate III, Fig. 8.

Liospira vitruvia Ulrich and Scofield. Geol. Minnesota, 3, pt. 2, 1897. p. 995, pl. 69, fig. 3–8.

Liospira vitruvia Grabau and Shimer. N. A. Index Fossils, 1, 1907, p. 641, fig. 871h–k.

Description. Small, with the spire depressed, the heighth being not quite one-half the width. Scarcely four volutions, these being flattened above. The umbilicus has an angular margin.

This species is rarely well preserved, but a considerable number of specimens were found at Mackville. The average width was about ¾ inch.

Liospira obtusa Ulrich and Scofield.

Plate III, figure 13.

Liospira obtusa Ulrich and Scofield. Geol. Minnesota, 3, pt. 2, 1897, p. 997, pl. 68, fig. 30–34.

Description. Small, composed of four or five volutions which are slightly convex above. Periphery rounded.

Very rare in this region. The only cast was found at Mackville and measured ¾ inch in width and was fairly well preserved.

CLATHOSPIRA Ulrich and Scofield.

Clathospira Ulrich and Scofield. Geol. Minnesota, 3, pt. 2, 1897, p. 954.

Clathospira Grabau and Shimer. N. A. Index Fossils, 1, 1907, p. 644.

Description. Shell depressed conical. Base more or less convex. Umbilicus very small or wanting. Few volutions which are often strongly angular near mid-height.

Clathospira subconica (Hall).

Pleurotomaria subconica Hall. Pal. New York, 1, 1847, p. 174. pl. 37.

Clathospira subconical Ulrich and Scofield. Geol. Minnesota, 3, pt. 2, p. 1006, pl. 69, fig. 47–50.

Description. Short conical spire, the width and height being nearly equal. Volutions art flattened above and distinctly marked by a band.

Found very rarely in this region. One was found at Neenah, but it was very poorly preserved. It measures ½ inch in diameter.

HORMOTOMA (MURCHISONIA) Salter.

Hormotoma Ulrich and Scofield. Geol. Minnesota, 3, pt. 2, 1897, p. 959.

Hormotoma Grabau and Shimer. N. A. Index Fossils, 1, 1907, p. 648.

Description. Shell elongate, composed of 8 to 14 rounded or subangular whorls. The outer lip has a deep broad notch. The aperture is subovate, narrow and more or less prolonged below.

Hormotoma (Murchisonia) gracilis (Hall).

Murchisonia gracilis Hall. Pal. New York, 1, 1847, p. 181, pl. 39, fig. 4a.

Hormotoma gracilis. Ulrich and Scofield. Geol. Minnesota, 3, pt. 2, 1897 p. 1015, pl. 70, fig. 18–21.

Description. A small slender shell, very elongate, composed of numerous volutions which are usually rounded, but are sometimes slightly angulated. The shell is loosely coiled. The sutures are simple and deep.

The casts of this species are fairly abundant in this region and a considerable number of specimens were found at Mackville.

Hormotoma bellicincta (Hall).

Murchisonia bellicincta Hall. Pal. New York, 1, 1847, p. 179, pl. 39, fig. 1a–b.

Hormotoma bellicincta Ulrich and Scofield. Geol. Minnesota, 3, pt. 2, 1897, p. 1017, pl. 70, fig. 15–17.

Description. Elongate, the spire being composed of 8 or more volutions which are regularly convex and enlarge rapidly from the apex. The length and width are as 2 to 1. The volutions are marked upon the center by a flat spiral band. The aperture is rounded. The pillar lip is nearly straight.

Casts of this species are found rarely and are poorly preserved. Those from Mackville measured from 1 to 1⅜ inches in length.

Hormotoma ? Major (Hall).

Plate III, figure 14.

Hormotoma ? major Ulrich and Scofield. Geol. Minnesota, 3, pt. 2, 1897, p. 1018, pl. 71, fig. 5–7.

Hormotoma major Grabau and Shimer. N. A. Index Fossils, 1, 1907, p. 650, fig. 889.

Description. A large shell, medium elongate. The sutures are deep and there is a slight angulation on the upper side of the whorls. The apical angle is about 25°. The whorls embrace far up on the preceding ones.

This species has been found at Kaukauna and the casts are well preserved. They usually consist of about four whorls. The casts are about 2 inches in diameter and 3 to 3½ inches long.

Maclurea (Lesueur).

Maclurea Ulrich and Scofield. Geol. Minnesota, 3, pt. 2. 1897, p. 1038.

Maclurea Grabau and Shimer. N. A. Index Fossils, 1, 1907, p. 664.

Description. The shell is thick and discoidal. Composed of few whorls. It is reversed, the under side being flat or nearly so and exposing all the whorls. The upper side is convex and deeply perforated in the center.

Maclurea (Maclurina) cuneata Whitfield.

Plate III, figure 10.

Maclurea cuneata Whitfield. Geol. Survey Wisconsin, 4, 1882, p. 246, pl. 9, fig. 5–6.

Maclurina cuneata Ulrich and Scofield. Geol. Minnesota, 3, pt. 2, 1897, p. 1042, pl. 76, fig. 1–3.

Description. The shell is medium size, ranging up to 3 inches in diameter. Composed of two or more volutions which increase very rapidly in size. The upper side of the shell is flat or very slightly concave between the suture lines. The outer margin is slightly cuneate.

This is rare in this region and only one specimen was found. This is not a well preserved cast. The diameter is 2½ inches.

FUSISPIRA *Hall.*

Fusispira Ulrich and Scofield. Geol. Minnesota, 3, pt. 2, 1897, p. 1075.

Fusispira Grabau and Shimer. N. A. index Fossils, 1, 1907, p. 697.

Description. Shell fusiform, spire elevated. The whorls are generally convex, with distinct sutures, but they are sometimes nearly flat with shallow sutures. Elongate, narrow aperture.

Fusispira subfusiformis (Hall).

Murchisonia subfusiformis Hall. Pal. New York, 1, 1847, p. 180, pl. 39, fig. 2a–b.

Fusispira subfusiformis Ulrich and Scofield. Geol. Minnesota, 3, pt. 2, 1897, p. 1077, pl. 81, fig. 38–39.

Description. Slender, the whorls gradually enlarging and very moderately convex. The body whorl is not proportionally large. The spire ascends rapidly and is composed of 6 or more volutions. The aperture is oval and acutely extended below.

Casts are found rarely and are usually poorly preserved. Neenah and Mackville have produced a few specimens. They measured 2 inches long and 1 inch wide.

Fusispira angusta Ulrich and Scofield.

Fusispira angusta Ulrich and Scofield. Geol. Minnesota, 3, pt. 2, 1897, p. 1079, pl. 81, fig. 28–31.

Fusispira angusta Grabau and Shimer. N. A. Index Fossils, 1, 1907, p. 697, fig. 1002c.

Description. Slender, the whorls usually high, very slightly convex, almost flat, and separated by very oblique, deep, open sutures, indicating a rather thick shell.

Cast found rarely in poorly preserved specimens at Mackville. They vary from 1 to 2½ inches in length.

Fusispira vittata (Hall).

Plate III, figure 12.

Murchisonia vittata Hall. Pal. New York, 1, 1847, p. 181, pl. 39, fig. 3.

Description. Elongate, fusiform, slender, the volutions being oblique, Aperture extremely elongate.

Very rare in this region. Found poorly preserved at Mackville, the specimens measuring ½ inch in diameter and 1 inch long.

Fusispira elongata Hall.

Plate III, figure 15.

Fusispira elongata Whitfield, Geol. Survey Wisconsin, 4, 1882, p. 245, pl. 9, fig. 3.

Description. Shell elongate-fusiform, spire slender and much elevated, consisting of six volutions which are long and only slightly convex. Suture strongly marked. Aperture obliquely elongate-ovate. Surface apparently smooth.

Very rare in this region. One specimen was found at Mackville, is poorly preserved; it is 3/4 inch in diameter and 2 inches long.

TROCHONEMA Salter.

Trochonema Ulrich and Scofield. Geol. Minnesota, 3, pt. 2, p. 1045.

Trochonema Grabau and Shimer. N. A. Index Fossils, 1, 1907, p. 669.

Description. Shell turbinate, umbilicated, 4–8 whorls, which are strongly angulated. Always two more or less prominent ridges between which lies a flat peripheral space. Aperture usually oblique.

Trochonema umbilicatum (Hall).

Plate III, figure 9.

Trochonema umbilicatum Ulrich and Scofield. Geo. Minnesota, 3, pt. 2, 1897, p. 1047, pl. 77, fig. 1–8.

Trochonema umbilicatum Grabau and Shimer. N. A. Index Fossils, 1, 1907, p. 669, fig. 926.

Description. Short spire and gradually ascending. Shoulder of volutions flat or slightly concave, occupying about one-third of the width of the upper side.

Found rarely in this region. Some found at Kaukauna in a fair state of preservation and measuring about 1/2 inch across.

BIBLIOGRAPHY

Geological and Natural History of Minnesota. Vol. III Part I and II.

Geology of Wisconsin. 1873–1879. Vol. IV.

Natural History of New York. Part VI. Paleontology, Vol. I. Hall.

North American Index Fossils. Invertebrates, Vol. I and II, Grabau & Shimer.

Introduction to the Study of Fossils. Shimer.
Text book of Paleontology. Zittel. (Eastman Translation).
North American Geology and Paleontology. Miller.
Bibliographic Index of American Ordovician and Silurian Fossils.
Smithsonian Bul. 92, Vol. I and II. Bassler.

Explanation of Plates.

PLATE I.

FIG. 1. *Receptaculites oweni.*
2. *Ischadites iowensis.*
3. *Lichenaria typa.*
4. *Streptelasma corniculum.*
5. *Streptelasma profundum.*
6. *Heterocrinus pentagonus.*
7. *Schizocrinus nodosus.*
8. *Heterocrinus heterodactylus.*
9. *Dendrocinus alternatus.*
10. *Rhombotrypa quadrata.*
11. *Lioclemella solidissima.*
12. *Escharopora subrecta.*

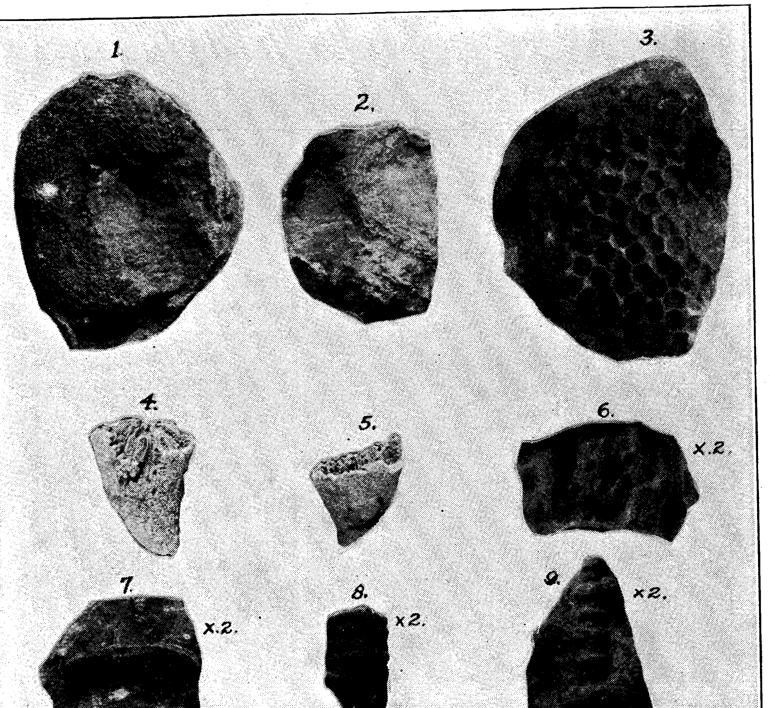
PLATE II.

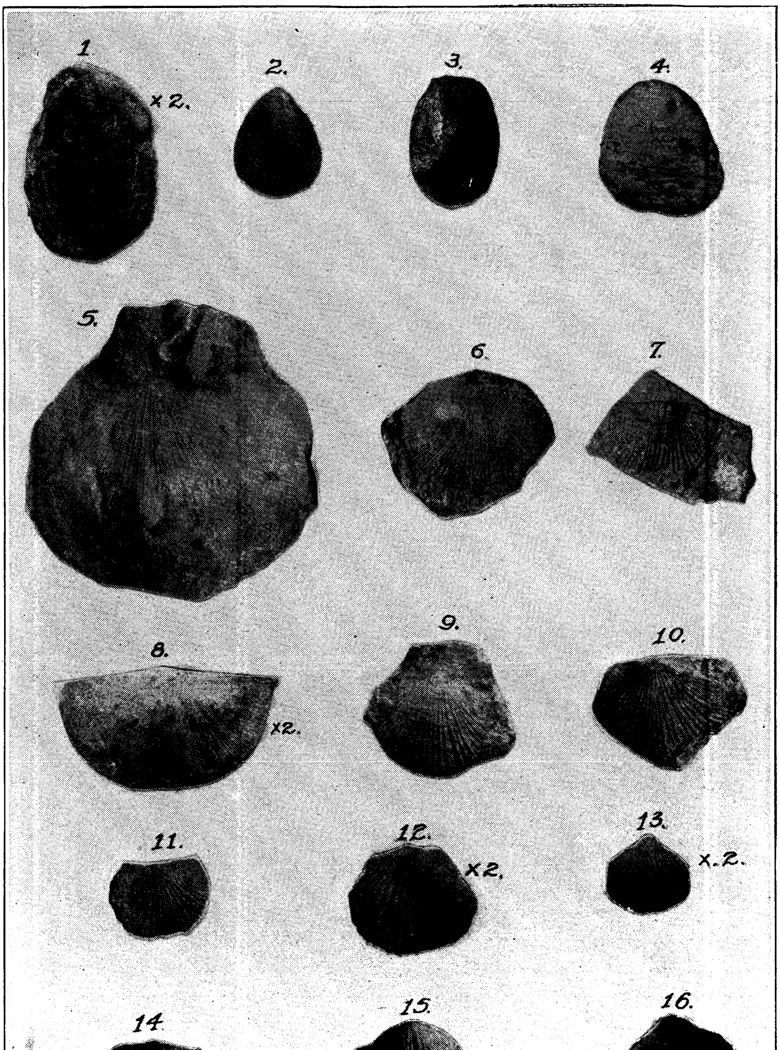
1. *Lingula elderi.*
2. *Lingula hulburti.*
3. *Lingula iowensis.*
4. *Lingula obtusa.*
5. *Rafinesquina alternata.*
6. *Strophomena planumbona.*
7. *Strophomena emanciata.*
8. *Plectambonites sericeus.*
9. *Orthis costalis.*
10. *Plectorthis plicatella.*
11. *Plectorthis fissicosta.*
12. *Plectorthis dichotoma.*
13. *Plectorthis sordida.*
14. *Dinorthis meedsi.*
15. *Dinorthis pectinella.*
16. *Herbertella bellirugosa.*

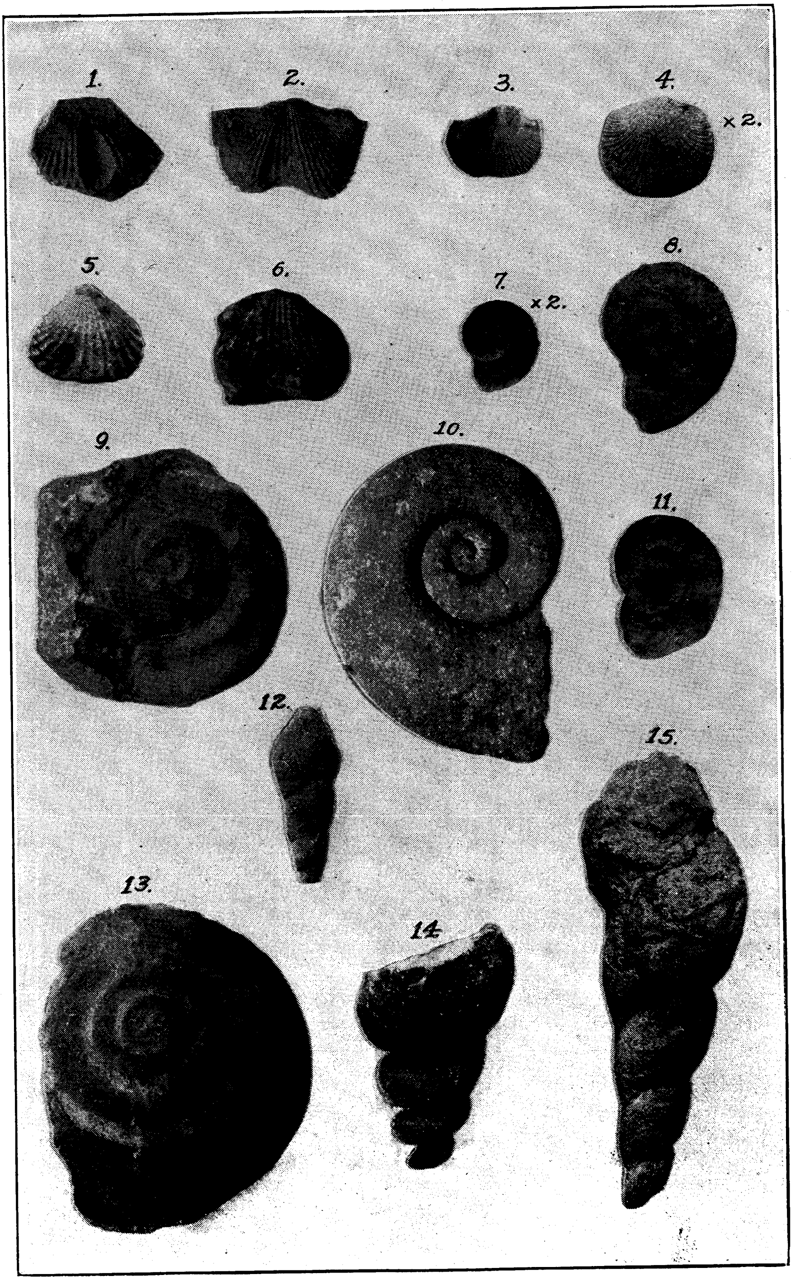
PLATE III.

FIG. 1. *Platystrophia lynx.*
2. *Platystrophia biforata.*

3. *Herbertella occidentalis.*
4. *Dalmanella testudinaria.*
5. *Rhynchotrema increbescens.*
6. *Rhynchotrema capax.*
7. *Liospira micula.*
8. *Liospira vitruvia.*
9. *Trochonema umbilicatum.*
10. *Maclurea cuneata.*
11. *Raphistomina modesta.*
12. *Fusispira vitata.*
13. *Liospira obtusa.*
14. *Hormotoma major.*
15. *Fusispira elongata.*


1.
2.
3.
4.
5.
6.
x.2.
7.
x.2.
8.
x2.
9.
x2.
10.
x2.
11.
x2.
12.
x6.


1
x 2.
2.
3.
4.
5.
6.
7.
8.
x2.
9.
10.
11.
12.
x2,
13.
x.2.
14
15.
16.


1.
2.
3.
4.
× 2.
5.
6.
7.
× 2.
8.
9.
10.
11.
12.
13.
14.
15.

SOME CHARACTERISTICS OF THE BACTERIA OF LAKE MENDOTA

LAETITIA M. SNOW AND E. B. FRED

Notes from the Department of Agricultural Bacteriology, University of Wisconsin and from the Biological Laboratory of the Wisconsin Geological and Natural History Survey. XXIV.

In water, there exists a group of microorganisms which may be termed the true water bacteria. These forms of life are quite different from the bacteria commonly isolated and studied by the students of water hygiene. The methods used in a sanitary study of water are so specialized that those forms related to diseases are favored, while the indigenous flora is largely suppressed.

Instead of trying to study in detail the characters of a few organisms, the object of this report was to investigate the various groups of bacteria normally found in lake water. It was realized early in this work that the bacteria in water are so varied that it is practically impossible to separate all of the different forms and describe their functions. In order to apply the results of soil studies to this work on lake flora, the culture media and many of the methods described by the soil biologist have been employed. As will be shown later, the flora of soil and of water have many points in common. Before taking up these characters of the water flora some of the methods used will be given:

The medium used for plate counts throughout this work was Nährstoff-Heyden or sodium caseinate agar.[1] All plates were incubated at 20° to 22°C., and counted after 15 days of incubation.

The results of many comparative studies on the number of water bacteria which develop in different solid culture media indicate clearly the superiority of Nährstoff-Heyden and nutrose, or sodium caseinate, agar as compared with beef-peptone agar and gelatin, lake water agar and gelatin, soil extract agar and gelatin. Many counts made at different times of the year on these media show that Nährstoff-Heyden and sodium caseinate agars give the highest numbers and are also easy to prepare. A few representative counts are given in table 1.

The two rich nitrogenous media, beef-peptone agar and gelatin, which are commonly employed in standard methods of water analysis, supported the growth of spreaders and liquefiers and did not give the constancy of results obtained with the Nährstoff-Heyden or sodium caseinate. Not only was the number of colonies on these two media far in excess of the number on the bee-peptone media, but the development of typical slowly growing water bacteria was also favored.

Similar results were reported by Hesse and Niedner, 1898. They found that for water counts, Nährstoff-Heyden, an albuminous substance, generally gave twenty times as many colonies as the nutrient agar. Several years later Müller, 1912, repeated the work of Hesse and Niedner and found that water samples plated on this Nährstoff-Heyden medium gave very much higher counts than those on meat-extract peptone gelatin. Additional data on this subject are given by Winslow and Prescott, 1924.

Comparison of the direct microscopic count and the plate count—It is well known that plate counts furnish only an estimate of the actual number of bacteria present in any material containing a varied bacterial flora such as milk or water. Attempts were made to use the direct microscopic method to determine the number of bacteria in lake water. Unfortunately the methods worked out in detail for the direct counts have been for substances rich in micro-organisms and must be modified before they can be used for counting the bacteria in water. It is necessary first to concentrate the bacteria in water to such a number that the mathematical error involved in computing from the number per microscopic field to the number per cubic centimeter is reduced as much as is practicable.

The concentration of bacteria in a solution of low bacterial content has been tested by Vallet, 1901; Müller, 1912; Allen, 1915; Schuster, 1919; and others, but with varying degrees of success. Colloidal iron, aluminum and copper, as well as sodium thiosulphite and lead nitrate have been used as flocculating substances. Aluminum hydroxide was used as the flocculating substance in the direct counts on Lake Mendota water. This method is based on the fact that a water suspension of this salt will carry down any bacteria in the suspension when this is centrifuged. The supernatant water, which is free of bacteria, is drawn off and the aluminum hydroxide containing the bacteria is readily transferred to a glass slide and stained. Its value as a precipitant of bacteria from water was tested on water which contained a known number of bacteria and it was found that more than 95 per cent of the bacteria were thrown down. This is in agreement with the work of Müller who found 97 to 98 per cent of the bacteria carried down in the precipitate.

The water of Lake Mendota generally contains such a small number of organisms in one cubic centimeter that it was necessary to concentrate the organisms from ten volumes of the water to one volume and to prepare the microscopic film from this concentrated portion.

Since a great variety of types of bacteria are present in lake water and will not be stained by one simple stain, it was found best to use a combination of stains to bring out the greatest possible number of bacteria. Of the stains tested, the most satisfactory one was prepared as follows: distilled water 40 c.c., alcoholic methylene blue 5 c.c., and alcoholic fuchsin 0.8 c.c. Mounts were stained for three minutes.

Considerable time was spent in trying to perfect a direct microscopic method for lake water which would be practicable and reliable Perhaps the greatest difficulty was the presence of debris, thrown down with the collodial suspension, which stained and could only with difficulty be distinguished from the bacterial cells.

As many as 50 samples were counted by the two methods. Table 2 gives a few typical results. The average increase in the number of bacteria resulting from all the direct counts was ninefold. Such an increase is in agreement with the results of most workers. The figures obtained with this method are probably a more accurate measure of the actual number of bacteria in the lake than is obtained with the plate method, but its disadvantages more than outweighed its advantages for this work.

Beginning in the spring of 1917 and continuing to the end of 1922, with an interruption of 2 years, from August, 1917 to July, 1919, plate counts were made of the water of Lake Mendota at least every month and generally once a week.[1] Samples were taken from a definite location and at specified depths in the lake, usually 1, 10, and 20 meters. Almost an equal number of counts were made at the surface, 15 and 22 meters, but deviations from the counts at 1, 10 and 20 were not sufficiently great to be of any significance. A specially devised apparatus, a modification of the Russell sampler (Wilson 1920), was used for collecting all samples.

Kinds of Micro-organisms Found on Agar Plates

If the colonies from the typical water plates are examined it will be noted that the majority of the micro-organisms are short rods and that many are motile. According to their occurrence the organisms on plates may be divided into two groups, the normal and the abnormal flora. The normal flora consists of bacteria, usually rods and a few cocci, and a small number of yeasts. The abnormal flora is represented by actinomycetes, molds and certain typical soil bacteria. From 60 to 80 per cent of the colonies from plates may be grouped as small rods, 10 per cent as large rods with rounded ends, and 10 per cent as cocci.

Some of the Characteristics of the Bacteria from Lake Mendota Water

The bacteria of lake water, taken far out from the shore, show certain well defined characteristics. The kind of micro-organisms present in the water is more or less constant. These indigenous forms are present at all seasons and at all depths. As compared with the organisms commonly studied, the majority of them grow slowly on the ordinary culture media and on plate cultures appear as punctiform colonies. About 10°–25°C. is the optimum temperature for their growth. In general they do not form acid or gas from sugars, as was shown by fermentation tests on agar slants containing 1 per cent of the various sugars plus a suitable indicator. They do not curdle milk and the majority of the true lake forms liquefy gelatin slowly. A considerable proportion are chromogenic, but long incubation at comparatively low temperatures is necessary to bring out the deep color. It is in respect to pigment production that the typical water flora of Lake Mendota is most easily recognized. A large number of pure cultures were selected from well isolated colonies on plates poured during the winter, when the true water bacteria were more prevalent. The characters of some of the organisms have been studied and the results presented in table 3.

Chromogenic Bacteria in Lake Water

Except during the period of gross contamination the chromogenic forms make up a high percentage of the indigenous flora. Their average distribution is shown in table 4. The average percentage distribution of colored bacteria for all counts, except for March 14 and April 4, 1922, is given as follows:

1. White and cream colored colonies—52 per cent.
2. Yellow and orange colored colonies—35 per cent.
3. Pink and red colored colonies—11 per cent.

In addition to the yellow, orange, pink and red forms, brown, fluorescent green and a few purple and black colonies are sometimes seen.

The addition of lactose, or glucose, to agar resulted in a higher percentage of chromogenic colonies than with Nährstoff–Hayden agar alone. The total count on these sugar media is usually lower, but the percentage of chromogens is higher.

Although no definite relation was noted between color and season, the percentage of chromogenic colonies was somewhat smaller in the colder months and the chief colors represented were yellow and brown. According to color production, the bacteria at a depth of one meter during the fall were found to have practically the same distribution as given for all counts in table 4. They ranked as follows:—

1. White to cream colored colonies.
2. Yellow and orange, sometimes brown, colonies.
3. Pink and red colonies.
4. Blue and violet colonies found only in small numbers.
5. Green colonies, found only in small numbers, fluorescent bacteria and algae.
6. Black colonies, very rare.

Of the various chromogens the yellows are at all seasons present in the greatest numbers. Plate I shows the color production of some typical chromogenic water bacteria. Some of the characteristics of the forms shown in plate I were studied and are given in table 5.

General Distribution of Chromogenic Bacteria

While there is an extensive literature upon chromogenic bacteria, dealing chiefly with the attempt to control the production of pigment, very little work has been done upon the distribution of the various colors in the group. Otto Rahn made a statistical study of the group, in the progress of which he ascertained the number and percentage of white and colored forms in the various genera. A summary of his figures may be made as follows: In 11 genera of the Eubacteria, containing 1194 species (omitting the phosphorescent forms) he found 855 or 72 per cent of colorless or white, 198 or 17 per cent of yellow and brown, 70 or 6 per cent of red, 14 or 1 per cent of blue, 51 or 4 per cent of fluorescent green (all Pseudomones), 2 or 2 per cent of green, and 4 or 0.3 per cent of black.

In an effort to get a general idea of the distribution of colored forms, the species given in Bergey's Manual of Determinative Bacteriology 1923, were arranged in table 6. In making this table the color given on nutrient agar was chosen, when that was stated. When it was not recorded, the medium most nearly like plain agar was selected as the standard. Forms that were stated as probably the same as others were omitted. The percentages are not of species, for when several habitats were listed, each entry was counted. A chance isolation different from the habitat was omitted. For many forms there was no color given, often no description whatsoever; these were classified as "Undesignated." Habitats having less than 10 entries were omitted. "Fresh water" includes all kinds of water but the sea. "Sea water" includes one entry from "Salt fish and sea salt". In a few cases, where the forms produced a color in the medium different from that of the colony, only the color of the bacteria is recorded. Summarizing the data for the water habitats we find out of 198 entries, of which only 21 are from salt water, 76 (38.4 per cent) are white, grey, colorless, or undesignated, 45 (22.7 per cent) are pink or red, 44 (22.2 per cent) are yellow, orange or brown, 18 (9.1 per cent) are violet, 9 (4.5 per cent) green or fluorescent, 2 (1.0 per cent) each are blue, black and iridescent. It is exceedingly interesting to note the high percentage of red and pink forms. Violet and black forms are, with the exception of one entry for violet in soil, confined exclusively to water habitats.

In connection with the distribution of colors among the bacteria, it is interesting to note that, in the few papers dealing with the distribution of colors in flowering plants. white is reported to be the most prevalent, with yellow second in importance. Lovell in two papers gives statistics regarding colors in flowers. These figures may be summarized as follows: In 4,020 species the flowers of 1,244 (30.9 per cent) were green, 956 (23.8 per cent) were white, 801 (19.9 per cent) were yellow, 257 (6.4 per cent) were red, 437 (10.9 per cent) were purple and 325 (8.1 per cent) were blue. In a later article he eliminates the wind pollinated flowers and finds of the 2,972 species remaining, 955 (32.1 per cent) were white, 790 (26.6 per cent) yellow, 519 (17.4 per cent) blue, 366 (12.3 per cent) red, 223 (7.5 per cent) green and 119 (4 per cent) purple. Miss Mark states that she found 1,500 flowering species in Ohio (omitting the grasses and sedges) and gives numbers and percentages of the different colors. The sum of her figures is 1,828, however, which leaves the reader uncertain whether some species have been reported under more than one head. In either case the order of their abundance is the same, although the percentages are different. White flowers were the most abundant, 29.4 per cent (using the 1,828 total), yellow and orange 21.9 per cent, purple and violet 19.8 per cent, red and pink 12.5 per cent, green 8.7 per cent, blue 7.4 per cent. Kerner and Oliver (Vol. II p. 182) give the following per cents for the colors found in the Baltic flora: white 33 per cent, yellow 28 per cent, red 20 per cent, blue 9 per cent, violet 8 per cent, brown 2 per cent. Drummond, noting colors of flowers blooming in the various months of the year, reports 539 plants of Ontario and Quebec with 913 entries, showing that nearly all forms bloom during two months. Of these 913 entries 37 per cent were white flowers, 26 per cent yellow, 15 per cent purple and violet, 11 per cent blue, 7 per cent green, and 4 per cent red or pink. It appears therefore, from the data at hand, that white is the dominant color both among flowering plants and the bacteria, with yellow a close second, while red, green, blue, and violet show decided variations.

Conclusions

The kinds of bacteria found in Lake Mendota water, regardless of depth are remarkably uniform. The colonies are usually punctiform and grow slowly. Small motile and non-motile rod forms predominate. Sodium caseinate agar incubated at 20°C. is especially favorable for the growth of these organisms.

Direct counts show that the number of bacteria in lake water is much greater than is indicated by plate counts.

The normal flora of Lake Mendota is characterized by a great number of chromogenic forms, although white forms predominate.

Of the colors, various tones of yellow are the most prevalent.

Red, violet, black, blue, green, fluorescent and iridescent forms are also found.

Among flowering plants there is also a dominance of white, followed by yellow as next in importance.

Bibliography

1. **Fred, E. B., Wilson, F. C. and Davenport, Audrey.** Ecology. 5: 322. 1924.
2. **Allen P. W.** J. Inf. Dis., 22: 245. 1918.
3. **Müller, P. Th.** Arch. f. Hyg., 75: 189 and 321. 1912.
4. **Schuster.** Zeit. f. Hyg., 88: 402. 1919.
5. **Vallet.** Arch. d. med. exper. et d'anatom. Pathol. Juillet, 1901.
6. **Wilson, F. C.** J. Bact., 5: 103. 1920.
7. **Prescott, S. C., andWinslow, C. E. A.** Elements of Water Bacteriology, New York, 1924.
8. **Bergey.** Manual of Determinative Bacteriology. Baltimore, 1923.
9. **Kerner, A. and Oliver, F. W.** The Natural History of Plants. New York, 1895.
10. **Mark, Clara G.** Ohio Nat., 7: 57. 1907.
11. **Lovell, John H.** Amer. Nat., 33: 493. 1899.
12. ——— Amer. Nat., 36: 203. 1902.
13. ——— Amer. Nat., 37: 365, 443. 1905.
14. ——— The Flower and the Bee. Chap. XIV. New York, 1918.
15. **Rahn, Otto.** Centrbl. f. Bakt. etc., Abt. II, 46: 4. 1916.
16. **Drummond, A. T.** Can. Record of Sci., 5: 280. 1892–3.

DEPARTMENT OF AGRICULTURAL BACTERIOLOGY,
UNIVERSITY OF WISCONSIN.

TABLE 1. *Comparison of the number of bacteria in Lake Mendota water on different media. Number in one cubic centimeter of water.*

Date	Medium	Depth in Meters 1	10	20
July 21, 1917	Nährstoff-Heyden agar	2,740	1,820	1,190
	Soil extract gelatin	270	200	240
July 19, 1919	Nährstoff-Heyden agar	96	73	112
	Beef-peptone agar	36	12	34
Aug. 9, 1919	Nährstoff-Heyden agar	392	148	214
	Soil extract gelatin	83	60	65
	Lake water agar	130	114	71
Dec. 1, 1919	Nährstoff-Heyden agar	143	149	152
	Soil extract gelatin	80	66	73
April 15, 1920	Nährstoff-Heyden agar	339	650	1,222
	Beef-peptone, lactose agar	304	154	279
Feb. 2, 1921	Nährstoff-Heyden agar	176	191	179
	Sodium caseinate agar	175	200	169
Oct. 25, 1921	Nährstoff-Heyden agar	870	1,870	276
	Soil extract agar	253	857	182
Nov. 4, 1921	Nährstoff-Heyden agar	2,200	3,470	1,360
	Lake water gelatin	1,000	880	810
Dec. 21, 1921	Nährstoff-Heyden agar	1,070	1,090	790
	Sodium caseinate agar	1,130	1,420	690

TABLE 2. *Comparison of the plate method with the direct microscopic method of counting bacteria in lake water.*

No.	Date	Depth in meters	Number of bacteria in one cubic centimeter of water: Plate count	Direct count	Increase	Times increased
1	Feb. 26	10	160	2,200	2,040	12
2	Feb. 26	15	150	1,480	1,330	9
3	Mar. 3	20	90	740	650	7
4	Mar. 12	10	160	2,200	2,040	12
5	Apr. 24	15	570	6,600	6,030	11
6	May 7	5	1,130	9,600	8,470	7
7	June 22	15	3,300	32,600	29,300	9
8	July 6	10	3,400	29,000	25,600	8
9	Aug. 3	5	2,200	23,700	21,500	10
10	Aug. 30	20	620	5,900	5,288	9
11	Sept. 14	10	530	5,100	4,570	9
12	Nov. 4	15	210	2,200	1,990	9
13	Dec. 18	5	400	3,700	3,300	8
14	Jan. 7	15	160	1,480	1,321	8
15	Feb. 2	20	180	1,480	1,301	7
16	Mar. 11	10	50	740	690	14
17	Apr. 8	5	110	1,480	1,370	12

TABLE 3. *Showing the characteristics of some of the water bacteria.*

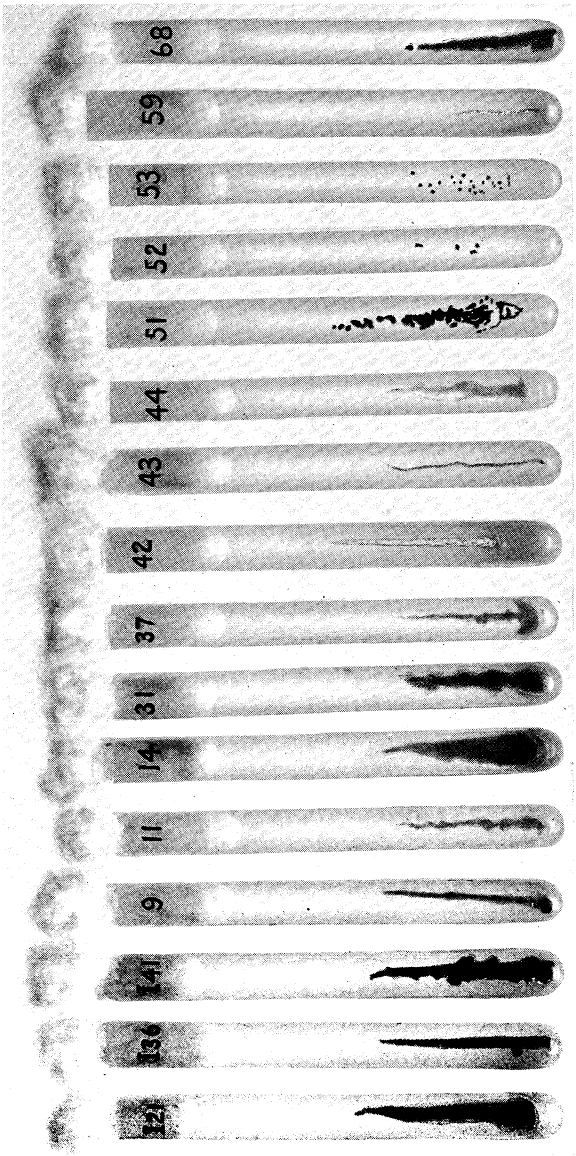
No.	Pigment formation in Nährstoff-Heyden agar	Spores	Catalase	Gelatin liquefaction	Milk	
					Reaction	Peptonized
1	red	—	+	+	alk.	+
2	orange	—	+	+	alk.	+
3	brown	—	+	+	unchanged	
4	brown	—	+	+	alk.	+
5	yellow	—	+	+	unchanged	
6	orange	+	+	+	unchanged	
7	white	+	+	+	unchanged	
8	yellow	+	+	+	alk.	—
9	yellow	+	—	—		
10	cream	+	+	—	alk.	—
11	orange	+	+	+	alk.	+
12	white	—	+	—	alk.	+
13	yellow	—	—	+	alk.	—
14	white	+	+	+	alk.	+
15	white	+	+	+	alk.	+
16	white	+	+	+	alk.	+
17	white	—	+	+	alk.	+
18	white	+	+	+	alk.	+
19	white	+	+	+	alk.	+
20	orange	—	+	+	unchanged	
21	pink	—	+	+	alk.	+
22	pink	—	+	+	alk.	+
23	orange	—	+	—	unchanged	
24	pink	—	+	+	acid	+
25	white	+	+	+	alk.	+
26	white	+	+	—	no record	
27	white	+	+	+	alk.	+
28	white	—	+	+	alk.	+
29	white	+	+	+	alk.	+
30	white	—	+	—	acid	—
31	cream	+	—	—	acid	+
32	white	—	—	—	unchanged	
33	white	—	+	+	acid	+
34	yellow	—	—	—	alk.	+
35	white	+	+	+	alk.	+
36	white	+	+	+	alk.	+

+ Positive. Almost without exception these organisms liquefy gelatin slowly.
— Negative.

TABLE 4. *Showing the number of chromogenic colonies in Lake Mendota water.*

Date	Depth in Meters	Bacteria in 1 cc. of water	Percentage distribution of colored colonies		
			White and cream	Yellow and orange	Pink and red
Oct. 8, 1921	1	1,510	65	32	3
	10	3,143	32	66	2
	20	3,290	44	53	3
Oct. 27, 1921	1	2,200	63	28	9
	10	3,470	84	14	2
	20	1,360	74	14	12
Mar. 14, 1922	10	4,700*	92	7	1
	20	2,370*	88	11	1
April 4, 1922	1	8,400*	64	28	8
	10	5,200*	69	28	3
May 2, 1922	20	780	38	18	41
May 17, 1922	1	82	40	35	15
	10	180	50	30	20
	20	360	38	50	12
May 27, 1922	1	145	59	34	7
	10	58	31	60	9
	20	75	46	47	7
Oct. 24, 1922	1	400	54	14	14
	20	414	58	30	10

* Heavy rain and much soil washed into lake.



SNOW AND FRED.—CHROMOGENIC BACTERIA FROM LAKE MENDOTA.

COCKAYNE BOSTON

TABLE 5. *Showing some of the characteristics of chromogenic forms found in Lake Mendota water.*

No.	Shape	Gram's stain	Color on agar	Liquefaction of gelatin	Litmus milk		
					Reaction	Peptonized	Reduced
9	Short rod	—	Primrose yellow	—	neutral	—	slight
11	Short rod	+	Primrose yellow	—	neutral	—	slight
14	Short rod	+	Buttercup yellow	+	neutral	—	slight
37	Short rod	—	Yellow lake	+	neutral	++	+
42	Short rod	—	Amber white	—	neutral	—	—
44	Short rod	—	Buttercup yellow	—	alkaline	+	+
53	Short rod	—	Coral red	—	neutral	—	—
68	Short rod	?	Dark violet	+	?	++	+
43	Medium rod	—	Mauve rose	—	alkaline	—	—
31	Long rod	—	Rosy pink	+	neutral	—	slight
59	Long rod	—	Orange cadmium	—	neutral	—	—
52	Coccus	+	Tomato red	—	neutral	—	—

TABLE 6. *Showing percentage of chromogens from various habitats. (Compiled from Bergey's Manual of Determinative Bacteriology).*

Color	Soil	Water		Air dust	Dairy products	Ferment-ing matter	Plants	Lower animals	Human body	Per cent of total
		Salt	Fresh							
	Per cent	Per cent	Per cent	Per cent	Per cent	Per cent	Per cent	Per cent	Per cent	Percent
White or cream	30	14	11	10	30	13	21	13	21	18
Grey or greyish white	24	5	12	6	30	19	20	25	26	21
Yellow	22	5	18	52	13	10	40	6	7	16
Orange	0.5	-----	4*	13	3	-----	-----	2	0.5	2
Brown	6	-----	2*	-----	3	2	5	2	3	3
Red or pink	3	19	23	10	3	11	-----	12	1	9
Violet	0.5	5*	10	-----	-----	-----	-----	-----	-----	2
Black or blue-black	-----	5*	0.6	-----	-----	-----	-----	-----	-----	0.2
Blue or bluish grey	0.5	-----	1	3	3	8	1	2	1	2
Green or greenish flourescence	3	-----	5	-----	1	2	5	-----	3*	3
Iridescent, opalescent*	0.5	-----	1	-----	-----	2	1	2	0.5	2
Colorless	2	5	6	6	3	8	1	10	10	6
Undesignated	8	43	7	-----	11	25	5	25	26	15
Totals	100	101	100.6	100	100	100	99	99	99	99.2

* No other color indicated.

NOTES ON PARASITIC FUNGI IN WISCONSIN—XII

J. J. DAVIS

In "Notes" V, p. 63, *Artemisia ludoviciana* was given as a host of *Plasmopara halstedii* (Farl.) Berl. & De Toni. This was an error as the mildew in the collection is *Peronospora leptosperma* DBy. It has also been collected on a host referred to *Artemisia serrata* at Jump River and Caryville.

The Peronospora on *Cerastium nutans* recorded in the provisional list under the name *P. alsinearum* Casp. is referred to *P. tomentosa* Fckl. by Gaeumann (*Beitr. z. Krypt. fl. d. Schweiz* **54**:61) with the statement that it is biologically distinct. As far as observed it is confined to the single species of host in Wisconsin.

For the ascigerous species having Fusicladium as the conidiophorous stage the genus Endostigme has been proposed by H. Sydow (*Ann. Mycol.* **21**: 173).

The reference of *Montagnella heliopsidis* (Schw.) Sacc. to Rosenscheldia by Theissen & Sydow (*Ann. Mycol.* **13**: 649. *taf.* IV, *fig.* 7) was probably based on examination of immature material. When fully developed the stromata containing the locules are approximately spherical as stated by Ellis & Everhart (*North American Pyronomycetes*, p. 252). Collections of this parasite are usually sterile as stated by Trelease in the Preliminary List or immature. In material on *Aster Tradescanti* collected at Blue River September 15 some of the locules contain uniseptate spores about 20–24 x 4μ, but asci were not seen.

In "Notes" VII, p. 208 it was stated that traces of *Taphrina ulmi* (Fckl.) Johans. had been seen in Wisconsin. It was collected in 1923 on *Ulmus americana* at Avoca and in more abundance at Edgerton and scantily developed at Wyeville. This has since been found at Avoca and Madison.

All specimens of Septoria on Polygonum that have been collected in Wisconsin have been referred to *S. polygonorum* Desm. They agree better with the description given by Dr. Martin in "Enumeration and Description of the Septorias of

North America" (*Journ. Mycol.* **3**: 68) than with those of European authors. The sporules vary from 23–63 x 1–2μ and the colored border of the spots is purple, brown or nearly or quite absent. The accompaniment of the Septoria on *Polygonum cilinode* by the mucedine referred to in "Notes" VIII, pp. 415–6 suggests that it may be distinct.

A Septoria on Diervilla was recorded under the name *S. diervillicola* Ell. & Evht. in the provisional list. Both Ellis and Everhart and Peck had described it as a new species giving the binomial *Septoria diervillae.* Saccardo preserved *S. diervillae* Pk. and changed *S. diervillae* E. & E. to *S. diervillicola* (*Syl. Fung.* **10**: 356) evidently taking Peck's publication to be the prior one. In the *Journal of Mycology* **3**: 51, Dr. Martin stated that Peck's 38th Report, in which the publication was made, was not issued until 1886 although it is dated Dec. 31, 1884,while Ellis & Everhart published their description in 1885. It appears therefore that *Septoria diervillae* E. & E. is the proper designation as used by Dr. Martin in *Septorias of North America.*

In "Notes" III, p. 254, it was stated that *Quercus alba* should be eliminated from the provisional list as a host of *Leptothyrium dryinum* Sacc. In July 1923, however, the parasite was collected on that species of host at Caryville. In this collection the pycnidia are borne on suborbicular greyish spots having a reddish brown border, 2–5 mm. in diameter which resemble those caused by *Phyllosticta phomiformis* Sacc. The clypei are epiphyllous 60–100μ in diameter, the sporules elliptical to ovate, brown tinted, 12–17 x 7–10μ. The small spots and the small pycnidia would deter one from referring this to *L. maculicolum* Wint. with which the size of the sporules would seem to ally it.

Piggotia fraxini B. & C. is referred to Asteromella by Petrak in *Annales Mycologici* **21**: 269.

In the provisional list *Steironema ciliatum* was given as a host of *Ramularia lysimachiae* Thuem. with question. There is much difference in the appearance of Ramularia on this host. Early in the season on young leaves the infected area is not delimited but spreads over a large portion or all of the leaf which dies. Later in the season on mature leaves there is definite spotting. In a specimen collected at Madison in September the tufts are epiphyllous with black tubercular bases. In all of the specimens the conidiophores and conidia are like those on Lysimachia.

A collection of *Cercospora sedoides* E. & E. on *Penthorum sedoides* made at Blue River in September shows conidiophores sometimes densely fasciculate, tortuous, occasionally branched, up to 50 μ long. The well developed conidia are 80–90 μ long, 7–septate.

The epiphyllous Cylindrosporium referred to in "Notes" VIII, p. 428, as occurring on *Spiraea densiflora* in Idaho was collected in 1923 on *S. salicifolia* at Cornucopia where the hypophyllous form also occurred. In the epiphyllous form the sporules are 40–70 x 3μ. It was referred to *Cylindrosporium salicifoliae* (Trel.) Davis, a species which Petrak has referred to the dubious genus Phleospora (*Ann. Mycol.* **20**: 210).

The conidiophores of *Piricularia parasitica* E. & E. were described as being simple or bifid. When fully developed however they may be dichotomously branched. Occasionally opposite branches are produced. The character of the conidiophores, the comparatively narrow conidia and the habitat make this an aberrant species. It has been found only on Elymus and Hystrix in connection with the species of Phyllachora that is referred to *Ph. graminis* (Pers.) Fckl.

Of a collection on *Lathyrus venosus* referred to *Cercospora viciae* Ell. & Hol. it was noted "conidiophores up to 50$^{\mu}$, conidia up to 70$^{\mu}$ long."

All of the specimens of *Cercospora euonymi* Ellis that I have seen are devoid of color throughout.

All specimens of Cercospora on Vernonia collected in Wisconsin have been referred to C. *vernoniae* Ell. & Kell. *C. oculata* Ell. & Kell. being considered to be a form of that species.

Because of failure to secure spore germination and the peculiar habitat *Doassansia zizaniae* Davis (*Bot. Gaz.* **26**: 353, 1898) was recorded under Sclerotium in the provisional list. In *North American Ustilagineae* (*Contributions from the Cryptogamic Laboratory of Harvard University* No. 57) it was placed in the list of excluded species and was omitted from *North American Flora* 7:1. Prof. W. H. Davis informs me that he observed germination in July 1923 of the Tilletia type with sporidia 16x4$^{\mu}$ of overwintered material sent from Wisconsin. There is an error in the description due to the appearance of sections that were not strictly equatorial. There is but a single layer of spores under the cortical layer instead of "two or three."

ADDITIONAL HOSTS

Specimens on young seedling plants of *Artemisia biennis* from Herbster are tentatively referred to *Synchytrium aureum* Schroet. They occurred within a few feet of infected Petasites. On the leaves of the latter the galls (epiphyllous) are sometimes flattened in a vertical plane and are sometimes confluent in lines forming ridges. On some leaves of Petasites the scattered galls are nearly black recalling the form on Aster for which the name *Synchytrium nigrescens* was proposed in "Notes" X.

Albugo candida (Pers.) Kuntze.

On *Sisymbrium altissimum.* Edgerton.

Peronospora parasitica (Pres.) Tul.

On *Arabis laevigata.* Wyeville. The binomial, as used here, applies to a congery of host-adapted races having doubtless a common origin and with but little or no morphological differentiation. There are two hypotheses as to the origin of such a group. According to one it was derived from a generalized form that occurred indiscriminately on the various hosts but which underwent physiological changes adapting it to the particular host upon which it was growing until the generalized ancestral form was lost. According to the other hypothesis variants of parasite and hosts occur and unusual conditions arise allowing passage from one genus or species of host to another and followed by physiological changes that result in adaptation to the new host. Following the first hypothesis the process is now a closed one and no new races will arise, those that fail to survive will not be replaced and the number of races will remain as at present or diminish unless present races are subdivided. The second hypothesis would indicate a continuing process with new races arising from time to time.

Agrimonia gryposepala should have been recorded as a host of *Peronospora potentillae* DBy. which has been collected on that species at Blair, Wild Rose, and Lone Rock.

In "Notes" XI it was stated that what was thought to be *Peronospora myosotidis* DBy. had been seen in very small quantity on *Myosotis laxa.* In 1923 the mildew was collected on

M. virginica at Avoca in sufficient quantity for determination and with oospores in stems and branches.

Phyllachora occurs in Wisconsin on *Cinna latifolia* but no mature material has been collected.

Ascochyta thaspii Ell. & Evht. On *Cicuta maculata.* Haugen. The largest sporule measured was 33 x 6 μ.

Ascochyta compositarum Davis. On *Eupatorium purpureum.* Blue Mounds (Gilbert & Davis). In this collection the spots, which become pale in the center, are apparently formed by confluence of small, dark, angular, intervenular areas some of which are distinct. The pale brown or amber-colored pycnidia are depressed globose, 140–180 μ in the horizonal diameter and the sporules 20–27 x 5–6 μ. Biseptate sporules occur very rarely. The collection was made in October.

Septoria gei Rob. & Desm. On *Geum virginianum,* Wyeville. *G. strictum,* Hixton and Two Rivers. *G. canadense,* Glen Haven. The sporules range up to 50 μ long, the pycnidia often imperfectly developed.

Septoria violae West. On *Viola lanceolata.* Avoca. (Gilbert & Davis). The sporules are not well developed in this collection.

Septoria lycopi Pass. A collection on *Lycopus uniflorus* was referred to this species in "Notes" X with the statement that the sporules were about 30 x 1½ μ. Of a subsequent collection the following notes were made: Spots at first indefinite and olivaceous becoming orbicular and cinereous above with a definite margin and sometimes a purple border; pycnidia amphigenous, globose, ostiole papilliform, 50–80 μ in diameter; sporules straight, continuous, 20–30 x 1 μ. On leaves of *Lycopus americanus.* Blue River, October 29, 1923.

Gloeosporium septorioides Sacc. On *Quercus alba.* Blue Mounds. (Gilbert & Davis). Although a septum was not seen in the sporules this is doubtfully distinct from *Marssonina martini* (S. & E.) Magn. The spots are mostly 4–6 mm. in diameter and the acervuli multiple. The collection was made in October and the development was probably from infection late in the season. The sporules are 12–17 x 2–2½ μ.

Marssonina potentillae (Desm.) Magn. var. *tormentillae* Trail. On *Potentilla canadensis,* Wyeville. The sporules are 15–20 x 4–6 μ.

Septogloeum salicinum (Pk.) Sacc. On *Salix humilis.* Iron River and Brule.

Ramularia pratensis Sacc. On *Rumex persicarioides.* Madison.

In a collection on *Ranunculus acris* made at Cornucopia and referred to *Ramularia aequivoca* (Ces.) Sacc. the conidiophores are about 20 μ long, the conidia 27–43 x 2–2½ μ cylindrical, obtuse, continuous or 3-septate. Of a collection on the same host from Herbster it was noted: Conidiophores 12–17 μ long, conidia 20–40 x 2½–3 μ, 3-septulate.

Ramularia actaeae Ell. & Hol. On *Actaea rubra neglecta.* Cornucopia.

Ramularia barbareae Pk. On *Barbarea stricta.* Wyeville. The short (10 μ) conidiophores do not seem to be branched but rather developed in small tufts from a common base. Many of the conidia are somewhat less than 3 μ in diameter.

Ramularia arvensis Sacc. On *Potentilla canadensis.* Wyeville.

Ramularia asteris (Phil. & Plowr.) Bubak. On *Aster sagittifolius,* Cornucopia. *A. azureus.* White Lake. *A. Tradescanti,* Caryville. *A. paniculatus,* Blue River. The conidiophores and conidia are sometimes more slender (3–4 μ) than the descriptions indicate.

Cercospora zebrina Pass. On *Trifolium dubium.* Mazomanie. The publication of this name seems to antedate that of *Cercospora helvola* Sacc.

There occurs sparingly on leaves of *Eupatorium purpureum* a parasite that I have referred to *Cercospora perfoliata* E. & E. although it lacks the brown color of that species.

Entyloma compositarum Farl. On *Rudbeckia laciniata.* Sauk City. (Kuntz & Davis).

Puccinia graminis Pers. Uredo and telia on *Cinna latifolia.* Blue River.

Lycopus uniflorus is the most common host of the aecial stage of *Puccinia angustata* Pk. in Wisconsin.

Puccinia peckii (De Toni) Kell. Aecia on *Oenothera pumila.* Wyeville and Arena.

Additional Species

The Report of the Geological Survey of Wisconsin, 1873–9 contains a list of Fungi prepared by A. F. Bundy. In this list *Peronospora nivea* Unger was included but hosts were not given. Nothing further was known of this mildew, now known as *Plasmopara nivea* (Ung.) Schroet., in Wisconsin until 1923 when it was found in small quantity at Haugen on leaves of *Cicuta maculata.* [This occurred on a single leaf at Balsam Lake in 1924.]

Phyllosticta steironematis Dearn. & House. On *Steironema ciliatum.* Blue River. Not well developed in this collection; perhaps because of the dry season.

Phyllosticta lappae Sacc. On *Arctium minus.* Haugen. Some of the specimens that have been referred to *Ph. decidua* E. & K. are much like this.

Of a collection on leaves of *Lactuca canadensis* made at Blue River, September 16, 1923, the following notes were made: Stroma superficial, black, composed of small polygonal fuligenous cells, following the veinlets, anastomosing and becoming confluent on leaf areas 1–5 cm. in diameter which become dead, mostly epiphyllous, sometimes hypophyllous. No spore bodies seen. This has been labeled *Asteroma lactucae* nom. herb. It may be that it is not distinct from *Asteroma atratum* Chev.

Septoria margaritaceae Pk. On *Anaphalis margaritacea,* Iron River. In this collection the prominent pycnidia are up to 200 μ in diameter, the wall of the distal half more or less imperfect. A collection from Herbster bears well developed pycnidia.

Septoria erechtitis Ell. & Evht. On *Erechtites hieracifolia.* Blue River.

Of a collection on lower leaves of *Lepachys pinnata* made during a dry season the following notes were made: Spots circular to elliptical or sometimes oblong, sordid white, definite with a narrow dark border, 1–3 mm. in diameter; pycnidia epiphyllous, sometimes prominent, small (50–75 μ), black; sporules hyaline, curved, continuous, 30–50 x 1–1½ μ. Avoca, June 19, 1923. Where the spots are numerous the leaf area dies and becomes brown. This is provisionally considered to be a state of *Septoria infuscata* Wint.

Cylindrosporium triostei Kell. & Sw. On *Triosteum perfoliatum.* Haugen. Conidia mostly 35–50μ long.

Ovularia decipiens Sacc. On *Ranunculus acris.* Bayfield. I have seen no mention of the occurrence of this parasite in America.

Ramularia melampyri Ell. & Dearn. On *Melampyrum lineare.* Cornucopia. In these collections there is little or no deformation or discoloration of the infected leaves. The conidia range up to 30 μ in length.

Cercospora simulata Ell. & Evht. On *Cassia marylandica.* Avoca. (Gilbert & Davis).

Cercospora leptandrae n. sp. Hypophyllous on angular areas limited by the veinlets, 2–3 mm. in diameter which are blackened by the mass of conidiophores, upper leaf surface unaltered; conidiophores scattered or in small tufts, dark brown, more or less flexuose and denticulate, pluriseptate, sometimes branched, 75–135 x 5μ; conidia subfuligenous, obclavate, straight or slightly curved, becoming 3–5 septate, 40–60 x 5μ. On leaves of *Veronica (Leptandra) virginica,* Blue River, Wisconsin, September 14, 1923.

Tilletia corona Scribner. On *Leersia virginica, L. oryzoides* and *L. lenticularis.* Blue River.

Uromyces seditiosus Kern. Telia on *Aristida tuberculosa.* Avoca. (Gilbert & Davis).

Puccinia jussiaeae Speg. Aecia and telia on *Ludvigia polycarpa.* Blue River. In these collections the aecia are in small scattered groups and the telia on stems, branches, petioles, occasionally on midribs, but especially on fruiting calyces.

Puccinia antirrhini Diet. & Hol. This occurs in Wisconsin on *Antirrhinum majus* (cult.).

Aecidium myosotidis Burrill. On *Myosotis virginica.* Dane County opposite Sauk City. (Kuntz & Davis and Welles & Davis.)

A few years ago a concrete road was built through a marsh in a suburb of Madison. In the fall *Ustilago sphaerogena* Burr. and *Puccinia flaccida* B. & Br. appeared on *Echinochloa crusgalli* along the road where, however, they were not found subsequent years. The inference that the road builders had brought their equipment from further south and introduced the parasites therewith seems a fair one. The further inference that neither the smut or the rust are able to withstand the rigor of Wisconsin winters may be drawn.

Herbarium of the University of Wisconsin,
March, 1924

NOTES ON PARASITIC FUNGI IN WISCONSIN—XIII

J. J. DAVIS

Petrak considers *Asterina rubicola* E. & E. and *Coccochora rubi* Davis as forms of a single species which he designates *Stigmatea rubicola* (E. & E.) Theiss. (*Ann. Mycol.* **22**: 109 *et seq.*). That they are closely related phylogenetically seems clear. As far as observed the dothidial form referred to Coccochora occurs on blackberries only, the Asterina on raspberries only. To determine their degree of relationship will require inoculation experiment.

Petrak rejects the genus Didymellina Hoehn. and refers the ascigerous stage with which *Heterosporium gracile* Sacc. is connected to Didymella and refers *Mycosphaerella pinodes* (Berk. & Blox.) Niessel to the same genus. He also suggests that *Mycosphaerella lethalis* Stone should be referred to Didymella (*Ann. Mycol.* **22**: 17–18).

Wolf refers *Mollisia earliana* Sacc. to Diplocarpon which he now places in Phacidiaceae (*Journ. Elisha Mitchell Scientific Society*).

Leaves of *Corylus rostrata* bearing immature Mamiania were taken at Bruce on which were orbicular light brown to cinereous spots 10–15 mm. in diameter. Each spot bore in its center a Mamiania stroma and on the remainder scattered acervuli of *Gloeosporium coryli* (Desm.) Sacc. *Leptothyrium corylinum* Fckl. is reported to be a conidial stage of *Mamiania coryli* Batsch.) DeNot. The fungus referred to *Gloeosporium coryli* (Desm.) Sacc. somewhat resembles Leptothyrium, the cuticular covering of the acervuli being black and clypeoid. The sporules however are not like those of *L. corylinum* but are similar to those of *L. coryli* Lib. In the desbription of *Gloeosporium coryli* (Desm.) Sacc. it is stated that the acervuli are on the lower surface of the spots, seldom on the upper. The reverse is the case in Wisconsin.

Phacidium taxi Fr. was recorded in "Notes" X as occurring on *Taxus canadensis* in Wisconsin. The record was based on immature material in which no spores had formed. Another collection on this host was made at Appolonia in September 1924 but this also is immature. However a few spores were found but they probably were not mature. The following notes were made: Ascomata hypophyllous, biseriate, cinerous when dry, dull black then wet, orbicular, about ⅓ mm. in diameter with thick black walls and a central stellate opening; hymenium discoid, sometimes extending past the acute sulcus on to the lower surface of the epithecium where however the development of asci is rudimentary; asci crowded, straight, cylindrical, 40–60 x 4–6 μ; spores obliquely uniseriate, hyaline, fusiform, straight, 6–10 x 2–3μ; paraphyses slender, filiform, lax. Usually all of the leaves on the twig bore the ascomata. Whether or not this is the Friesian species is an open question.

In the classification of the Hypodermataceae proposed by Dearness the shape of the apothecia is ignored and to the genus Hypodermella, as amended, is referred *Lophodermium amplum* Davis ("Notes" V, pp. 695–6), which thus becomes *Hypodermella ampla* (Davis) Dearn. (*Mycologia* **16**: 152).

Phyllosticta renouana Sacc. & Roum. of the provisional list is *Ph. typhina* Sacc. & Malbr. which is the prior name.

In Notes V, p. 701, record was made of pycnidia in the loculi of Phyllachora on Elymus for which the binomial *Cytodiplospora elymina* was proposed with the suggestion that it occurred in the life cycle of Phyllachora. Petrak is of the opinion that this bears a parasitic relation to the Phyllachora and has proposed for it a new genus, Davisiella (*Ann. Mycol,* **22**: 133–4). A similar development has been observed two or three times in loculi of Phyllachora on *Calamagrostis canadensis* but not in sufficient abundance to secure a specimen. On this host the sporules are about twice the length of those on Elymus, 10–20μ.

The genus Sacidium is being dropped by mycologists following von Hoehnel. The parasite on leaves of Betula described by Peck under the name *Septoria microsperma* and referred to Sacidium in "Notes" I, pp. 88–9, is placed in von Hoehnel's proposed genus Cylindrosporella by Petrak (*Ann. Mycol.* **22**: 42–3).

What is probably a form of *Cercospora varia* Pk. has been found on *Viburnum pubescens* (Lewis, Aug. 1, 1924) in which the conidiophores are hyaline and the conidia slender, tapering, sometimes exceeding 100 μ in length. This would fall in Cercosporella if taken by itself.

Septoria gratiolae Sacc. & Speg. of the provisional list is the parasite to which Ellis & Martin gave the same name for which Berlese & Voglino substituted *Septoria ellisii.* Although there has been no opportunity for comparison it has been assumed that these are conspecific. The Wisconisn specimens bear sporules 25–50 x $\frac{3}{4}$–$1\frac{1}{2}\mu$ more or less curved and tapering to the attenuate apex.

Ramularia waldsteiniae Ell. & Davis was collected at Hayward in 1924. In this collection the spots are dark purple above, more or less elongated parallel to the veins and often limited by the veins. On the lower surface the spots are pale brown and less sharply limited.

Ramularia magnusiana (Sacc.) Lindau as it has been seen in Wisconsin on *Trientalis americana* bears conidia that are seldom septate, 10–33 x $1\frac{1}{2}$–3 μ the shorter ones fusoid. The conidiophores spring from scattered black tubercles 25–40 μ in diameter and are mostly fuligenous tinted, 20–60 x 2–3 μ. The spots are usually angular, limited by the veinlets and immarginate, light brown becoming paler in the center. While this departs widely from the type it nevertheless appears to be a variant of that parasite.

Glomerularia corni Pk. was recorded in the provisional list on *Cornus canadensis, Lonicera canadensis* and *L. oblongifolia. Glomerularia lonicerae* (Pk.) Dearn. & House has been used as a designation of the parasite on Lonicera but no distinguishing characters are given. *(N. Y. State Museum Bulletin: Report of the State Botanist for 1921,* p. 85).

In some notes by von Hoehnel published after his death by Weese *(Centralb. f. Bakt. etc.* **60**) the suggestion is made that the genus Fusicladium be restricted to conidial forms of Venturia and that the species that have been referred to that genus but which have Mycosphaerella (Carlia) as their ascigerous state be referred to Passalora. *Fusicladium depressum* (B. & Br.) Sacc. on Angelica he therefore designated *Passalora depressa* (B. & Br.) Hoehn. and *Cercospora platyspora* Ell. & Hol. on Taenidia *Passalora punctiformis* (Wint.) Hoehn. *Fusicladium punctiforme* Wint. and *Cercospora platyspora* Ell. & Hol. based upon the same parasite, were published in *Hedwigia* number for January and February 1887 and the *Journal of Mycology* number for February 1887 respectively and it would probably now be impossible to determine which has priority in time of publication. To this species von Hoehnel also referred *Cercospora sii* E. & E. on Sium which is certainly very similar. He further suggested that it might be merely a short-spored form of *Passalora depressa* (B. & Br.) Hoehn. In the same publication *Scolecotrichum graminis* Fckl. is also referred to Passalora while *Scolecotrichum maculicola* Ell. & Kell. is referred to Cladosporium with the suggestion that it may be *C. phragmitis* Opiz. For the much named *Passalora fasciculata* (C. & E.) Earle the genus Cercosporidium Earle (*Muhlenbergia* **1**: 16) which had been abandoned by its author (*Torreya* **2**: 160), is revived and the binomial *Cercosporidium fasciculatum* (C. & E.) Hoehn. added to its generous nomenclature.

Comparison of American specimens of *Cercospora subsanguinea* E. & E. with European specimens of *Ramularia rubicunda* Bres. indicates that they are conspecific. As stated in "Notes" I, p. 83, the plant is referable to Ramularia rather than to Cercospora. *Cercospora subsanguinea* E. & E. was published in 1887, *Ramularia rubicunda* Bres. in 1896. If the older specific name is preserved a new binomial is necessary. *Ramularia rubicunda* Bres. is in general use in Europe. All references to the plant in Europe are under that name and all European specimens are so labeled. As it is necessary to change the designation of the species as it occurs in America it seems to me best to adopt the name used in Europe. I have therefore labeled the Wisconsin specimens *Ramularia rubicunda* Bres. This obviates any change in Europe and reduces to synonymy but one name instead of two. This may be taken as an illustration of the fact that rigid adherence to the rule of priority may cause more trouble than it cures.

Gloeosporium equiseti E. & E. was considered by Bubak to be identical with *Septoria detospora* Sacc. and was made the type of new genus becoming *Titaeospora detospora* (Sacc.) Bubak. (*Ann. Mycol.* **14**: 345 (1916).

Through the kindness of Dr. House I have had opportunity to examine authentic material of *Vermicularia Violae-rotundifoliae* (Sacc.) House. As a result I conclude that the parasite on *Viola scabriuscula* recorded in "Notes" XI, p. 297, under the name *Colletotrichum violarum* n. sp. is conspecific therewith. They seem to be referable to Colletotrichum.

Colletotrichum salmonicolor O'Gara is united with *Gloeosporium fusarioides* Ell. & Kell. by Dearness who proposes the combination *Colletotrichum fusarioides* (E. & K.) O'Gara (*Mycologia* **16**: 169) with the suggestion that it is a conidial state of *Glomerella cingulata* (Stonem.) Sp. & V. Schr. If that proves to be the case of course the combination will fall into synonymy.

With the record of *Cylindrosporium vermiforme* Davis as occurring on *Alnus crispa* in Wisconsin was the statement that the sporules in the collection on that species of host were but about 3 μ in diameter. Material on *A. crispa* collected at Hayward by Gilbert & Davis has normally developed sporules.

For the microconidial state of *Cylindrosporium betulae* Davis the name *Gloeosporium betulae-papyriferae* Dearness & Overholts has been proposed (*Mycologia* **16**: 167).

Entyloma linariae Schroet. var. *gratiolae* Davis was collected in 1923 at Haugen on the same host. In neither of the localities was Entyloma found on Veronica.

Peridermium coloradense (Diet.) Arth. & Kern was recorded in the 4th supplementary list as occurring on *Picea mariana* in Wisconsin but it was not included in the provisional list. This is now thought to be *Peridermium elatinum* A. & S. the aecial stage of *Melampsorella caryophyllacearum* Schroet, the further stages of which have not been collected in Wisconsin. The aecial stage on Picea has been observed at but one station in the state the usual host being *Abies balsamea*.

Additional Hosts

Plasmopara geranii (Pk.) Berl. & De Toni. On *Geranium Bicknellii*. Spooner.

Peronospora sordida B. & Br. On *Scrophularia leporella*. Blue River.

Colletotrichum graminicolum (Ces.) G. W. Wilson. On leaves of *Calamagrostis longifolia*. Port Wing.

Ascochyta pisi Lib. On *Lathyrus palustris*. Madison (Gilbert & Davis).

Rubus triflorus should be added to the hosts of *Septoria rubi* West. in Wisconsin.

Septoria psilostega Ell. & Mart. On *Galium boreale.* Hayward.

Ramularia reticulata Ell. & Evht. recorded in the provisional list as a parasite of *Osmorhiza Claytoni* occurs on *O. longistylis* as well, as one would expect.

Cercosporella nivea Ell. & Barth. On *Solidago uliginosa.* Brule. On *Solidago juncea scaberrima.* Lewis. The collections have been referred to this species in spite of the leaf spotting. The following notes were made from examination of the collection from Brule: Spots angular, white or yellowish white below becoming yellow then reddish brown above, 1–3 mm. in diameter; conidiophores more abundant below, fasciculate, 14–33 x 3 μ; conidia straight or curved, cylindrical to obclavate-cylindrical, 25–80 x 4 μ mostly 40–65 x 3 μ, becoming septate. On *Solidago juncea* the spots become purple above. On one leaf of *S. uliginosa* the coloring of the spots is reversed. In neither of the collections are the conidia abundant.

Cercospora viciae Ell. & Hol. On *Lathyrus ochroleucus.* Danbury.

Cercospora clavata (Ger.) Pk. On *Asclepias tuberosa.* Lewis.

The leaf parasite on *Carpinus caroliniana* recorded in "Notes" II, p. 106 under the name *Fusarium carpineum* n. sp. was collected on the same host at Balsam Lake in July 1924. The cellular base from which the conidia spring is usually simpler in this collection and many of them do not suggest a sporodochium. The spots are circular, about ½ cm. in diameter, scattered and not nervisequent. The spots are not brown until death of the leaf cells takes place when by confluence irregular brown areas may be formed. The conidia are not uniformly biseptate but develop 1–4 septa. This was found also, in small quantity, on *Carya cordiformis* growing with infected Carpinus.

Puccinia graminis Pers. Uredinia on *Poa annua* collected at Black Earth by McFarland & Davis are referred to this species. The uredospores are 17–24 x 13–17 μ. This appears to be the first collection that has been made on this species of Poa.

ADDITIONAL SPECIES

Mamiania fimbriata (Pers.) Ces. & DeNot. On *Carpinus caroliniana*. Danbury and Balsam Lake. The collections were made in September and are not mature.

Sclerotinia geranii Seaver & Horne. On *Geranium maculatum*. Madison.

Phyllosticta negundinis Sacc. & Speg. has been collected at several widely separated localities in Wisconsin. I see no morphological distinction between this and Ph. *minima* (B. & C.) E. & E.

Septoria flagellifera Ell. & Evht. On *Pisum sativum* (cult.). While this species appears to be common in Europe it has not been previously found in America. This raises the question as to whether it is indigenous or introduced. The clump of willows on which it was abundant were close to a highway but it was found later at Danbury on the same species of willow.

Septoria flagellifera Ell. & Evht. On *Pisum sativum* (cult.). Horicon (M. B. Linford). Apparently a species of northern range. The type was from North Dakota and it occurs in Manitoba.

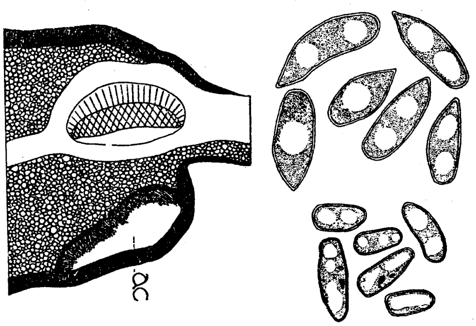
While collecting at Bruce immature ascomata of *Rhytisma prini* Schw. were observed which appeared to have burst with protrusion of the white content which constrasted strongly with the black cortex. Going a little further ascomata of *Rhytisma salicinum* (Pers.) Fr. were found having the same appearance. On examination however it was found that the appearance was due to acervuli on the "tar spots" which had discharged snow white masses of sporules.

Gloeosporium niveum n. sp. Acervuli under the cortex of the Rhytisma stroma, plano-convex, varying in diameter up to 3/4 mm.; conidia filling the acervulus, apparently produced by abstriction of erect hyphae springing from the base, hyaline, oblong with rounded ends to ovoid, continuous, 7–13 x 3μ. On immature ascomata of *Rhytisma prini* on leaves of *Ilex verticellata*. Bruce, Wisconsin, September 4, 1924.

Acervuli similar to the preceding, conidia oblong to subclavate, usually acute at one end, hyaline, continuous, 1–3 guttulate, 13–20 x 5–6 μ. On immature ascomata of *Rhytisma salicinum* on leaves of *Salix petiolaris*. Bruce, Wisconsin, September 4, 1924. The disk of cytoplasm between the guttulae often resembles a septum, especially when stained. This appears to be distinct from *Melasmia salicina* Lev. which Tulasne considered to be a spermogonial state of *Rhytisma salicinum* and which he described and figured in *Carpologia* III, p. 119, tab. XV, fig. 15–17. The question as to whether these collections represent one species or two is left open for the present.

[In 1925 numerous collections were made on various species of Salix agreeing with the description given above the conidia being acute at one end suggesting a boat in their shape. No collection was made on Ilex in 1925. The appearance of ascomata of *Rhytisma nemopanthis* Pk. sometimes suggested this fungus but this was due to development of *Ramularia nemopanthis* Pk. at the periphery of the ascomata.

The collection on Salix petiolaris is taken as the type of the species. I am indebted to President Dearness for the information that this was issued in *Fungi Columbiani*, 2593 under the name *Tuberculina davisiana* Sacc. & Trav. which belongs to a very different plant.



Gloeosporium niveum n. sp.
Left; Portion of a section of an immature ascoma of *Rhytisma prini* and of an acervulus, ac, from which the conidia have fallen. Upper right; 6 Conidia from *Rhytisma salicinum*. Lower right; 6 Conidia from *Rhytisma prini*.
Drawn with the aid of camera lucida by Lenette M. Rogers.

On leaves of *Betula alba* from Port Wing are large dead areas on the upper surface of which are acervuli bearing fuligenous sporules 9–10 x 6 μ on hyaline conidiophores. The fungus is probably saprophytic and has been referred to *Melanconium bicolor* Nees.

Cylindrosporium triostei Kell. & Swingle. On *Triosteum perfoliatum.* Haugen and Bruce. In the collection from Bruce the acervuli are nearly all epiphyllous.

In May and June 1924 collections of a Mucedine on leaves of *Cynoglossum officinale* were made at Madison and Cross Plains. The following notes were made from these collections: Spots dark brown, definite, circular to oval, 5–15 mm. in diameter; conidiophores mostly epiphyllous, fasciculate, hyaline, continuous or septate, 30–60 x about 3 μ; conidia hyaline, cylindrical to fusoid, mostly acute, straight, continuous or sometimes with a more or less distinct median septum, catenulate, 10–30 x $2\frac{1}{2}$–$3\frac{1}{2}\mu$. This is near *Ramularia cynoglossi* Lindr. from which it differs especially in the slender acute conidia. It appears to be conspecific with the parasite that occurs in Wisconsin on leaves of *Lappula virginiana* which was recorded in "Notes" I, p. 89 under the name *Ovularia asperifolii* Sacc. var. *Lappulae* Davis. It is perhaps better to consider the form that occurs in Wisconsin on Lappula and Cynoglossum as a species distinct from those that occur in Europe on related Boraginaceae and I have labeled these collections **Ramularia lappulae** (Davis) n. comb.

Ramularia gracilipes n. sp. Spots orbicular to subquadrangular, dark purple above, lighter below, 5–10 mm. in diameter with a sharply delimited white central portion 1–3 mm. in diameter; conidiophores hypophyllous on the central white portion, fasciculate from a prominent tubercular base, hyaline, slender, usually straight, often septate, sometimes denticulate below the apex, 40–75 x 2–3 μ; conidia hyaline, straight, cylindrical to fusoid-cylindrical, often more or less acute at one or both ends, frequently with a median septum, 20–40 x $3\frac{1}{2}$ μ. On leaves of *Cornus alternifolia.* Bruce, Wisconsin, September 4th, 1924.

Ramularia artemisiae n. sp. Spots brown, of the width of the leaf lobe and 3–5 mm. long the entire lobe usually becoming dead and brown; conidiophores on either surface, densely fasciculate from a more or less prominent light brown base, hyaline, erect or assurgent, lax, 35–80 x $1\frac{1}{2}$–3 μ; conidia hyaline, straight, cylindrical to fusoid, usually more or less acute, 0–3 septate, 12–30 x 2–4 μ. On leaves of *Artemisia caudata* or related species. Lewis, Wisconsin, August 2, 1924.

Cercoseptoria minuta n. sp. Spots pale, extending to the midrib, immarginate, ½–2 cm. in length; fasciculi hypophyllous, scattered, penicillate, composed of condia arising from a small, apparently substomatal, tubercle or plexus, hyaline, straight or somewhat curved, 50–60 x 1 μ. On leaves of *Campanula aparinoides,* Wyeville, Wisconsin, July 7, 1923. The generic name is used in the sense suggested in "Notes" VII, p. 401. A very delicate species. Possibly a state of the parasite occurring on this host that develops pycnidia and that was recorded in the provisional list under the name *Septoria campanulae* (Lev.) Sacc.

Because of a prior use of Septoriopsis as a generic name by Fragoso and Paul, Petrak has proposed Cercoseptoria to replace Septoriopsis Stevens & Dalbey. (*Ann. Mycol. 23:* 69).

NOTES ON DISTRIBUTION AND ABUNDANCE.

USTILAGINALES

USTILAGO OSMUNDAE Pk. Not frequent or abundant. Collections have been made in 5 localities. Two of them are in the central portion of the state, the others in the northwestern portion where it develops more abundantly.

USTILAGO ZEAE (Beckm.) Unger. Common and often abundant in corn fields.

USTILAGO RABENHORSTIANA Kuehn. This appears to be rare in Wisconsin but may be abundant where it occurs.

USTILAGO SPHAEROGENA Burr. This has been collected at Millville and Madison only, in the southern part of the state. It probably does not maintain itself in Wisconsin but is occasionally introduced.

USTILAGO NEGLECTA Niessl. Usually common and abundant.

USTILAGO STRIAEFORMIS (West.) Niessl. Sometimes abundant in meadows on *Phleum pratense,* less so on *Agrostis alba.* There are two collections on *Poa pratensis.* All are from the southern portion of the state. *Elymus canadensis* was given as a host in the provisional list but I find no specimen on that plant.

USTILAGO CALAMAGROSTIDIS (Fckl.) Clint. But a single specimen collected by A. B. Stout in southern Wisconsin.

USTILAGO AVENAE (Pers.) Jensen.

USTILAGO LEVIS (Kell. & Sw.) Magn. The oat smuts are found more or less abundantly throughout the state.

USTILAGO PERRENNANS Rostr. There is but one Wisconsin specimen in the herbaria.

USTILAGO LONGISSIMA (Sow.) Tul. Rather common on *Glyceria grandis* throughout the state.

USTILAGO LONGISSIMA MACROSPORA Davis. The variety occurred abundantly at the type station on *Glyceria septentrionalis* (then known as *G. fluitans*) which was long since destroyed because of the needs of agriculture. It is not known to be present in the state at the present time. It has been collected in Canada by Dearness and is reported to be distributed through central Europe. Bauch has reported interesting differences in the germination of the spores of the variety and of the type. (*Zeitschr. f. Bot.* **15**: 241–279 [1923]).

USTILAGO SPERMOPHORA B. & C. This has been seen in the southern part of the state only where it is rare.

USTILAGO MACROSPORA Desm. Reported by Clinton as occurring in Wisconsin but it has not been seen by the writer nor are there Wisconsin specimens at Madison.

USTILAGO TRITICI (Pers.) Rostr.

USTILAGO HORDEI (Pers.) Swingle.

USTILAGO NUDA (Jensen) Kell. & Sw. are more or less common in grain fields in Wisconsin as elsewhere.

USTILAGO LORENTZIANA Thuems. This has been collected at Madison but is rare.

USTILAGO OLIVACEA (Dc.) Tul. This was collected in 1902 at the outlet of Lost lake in Vilas county which abuts on the northern peninsula of Michigan. It has not been seen in the state since.

USTILAGO UTRICULOSA (Nees) Tul. Not a rare species in Wisconsin and not restricted in range.

USTILAGO OXALIDIS Ell. & Tracy. The collection by Tracy in southwestern Wisconsin in the only one known to have been made in the state.

SPHACELOTHECA CRUENTA (Kuehn) Potter. This was collected at Madison by Trelease according to Potter.

SPHACELOTHECA SORGHI (Lk.) Clint. This is sometimes abundant in sorghum fields.

SPHACELOTHECA HYDROPIPERIS (Schum.) DBy. Not uncommon. Most frequently seen in the northern half of the state.

CINTRACTIA CARICIS (Pers.) Magn. Throughout the state. Like most smuts this varies much in abundance. Some years it is frequently observed and abundant while in other seasons it may not be seen at all.

CINTRACTIA SUBINCLUSA (Koern.) Magn. Observed at but one station which was in southeastern Wisconsin and where it was fairly abundant.

CINTRACTIA JUNCI (Schw.) Trel. Usually abundant where it occurs but in some years it is not seen. The collections are from the southern portion of the state.

SCHIZONELLA MELANOGRAMMA (Dc.) Schroet. A common and abundant species in southern Wisconsin. There are no specimens from the northern part.

SOROSPORIUM PANICI-MILIACEI (Pers.). Takahashi. This was collected at Madison in 1911 and 1912 and at Baraboo in 1918. It was referred to the following species in the Provisional List.

SOROSPORIUM SYNTHERISMAE (Pk.) Earl. Common and abundant where the host occurs on sandy lands in southern Wisconsin.

TILLETIA FOETENS (B. & C.) Trel.

TILLETIA TRITICI (Bjerk.) Wint.

With the revival of wheat growing in Wisconsin during the world war bunt became common, usually the latter species.

TUBURCINIA CLINTONIAE Kom. Rare. The three localities where it has been seen are in the southeastern, southern and northwestern parts of Wisconsin. In each case the host is *Streptopus roseus* the citation of *Smilacina stellata* being erroneous.

UROCYSTIS OCCULTA (Rabh.) Wallr. This occurs occasionally in rye fields but does little damage.

UROCYSTIS AGROPYRI (Preuss) Schroet. This occurs in southern Wisconsin on Elymus. A collection on *Hordeum jubatum* was made by Toole and Bennet in northeastern Wisconsin.

UROCYSTIS CEPULAE Frost. Occurs in onion fields in the southeastern part of the state.

UROCYSTIS ANEMONES (Pers.) Schroet. Common in the southern portion of the state.

UROCYSTIS WALDSTEINIAE Pk. Collected in two localities in northern Wisconsin in 1893. It has not been seen since.

ENTYLOMA LINEATUM (Cke.) Davis. Common and abundant in the southern half of the state.

ENTYLOMA CRASTOPHILUM Sacc. This has been collected in southern Wisconsin only except for the collection on *Glyceria pallida* in the northern portion.

ENTYLOMA PARVUM Davis. This inconspicuous species probably occurs throughout the state.

ENTYLOMA NYMPHAEAE (Cunn.) Setch. Throughout the state. Sometimes abnudant, sometimes scarce.

ENTYLOMA MICROSPORUM (Ung.) Schroet. Frequent in southern Wisconsin on *Ranunculus septentrionalis* only.

ENTYLOMA RANUNCULI (Bon.) Schroet. Frequent and abundant in northern Wisconsin on *Ranunculus pennslyvanicus* only.

ENTYLOMA THALICTRI Schroet. Generally distributed and sometimes abundant.

ENTYLOMA MENISPERMI Farl. & Trel. Common in the southern half of the state.

ENTYLOMA FLOERKEAE Holw. This has been seen in southeastern Wisconsin only where it was locally abundant.

ENTYLOMA SANICULAE Pk. A rare species in Wisconsin. Collections have been made at Racine (1892 & '94) and Madison (1924) only, the latter on *Sanicula gregaria*.

ENTYLOMA AUSTRALE Speg. Common and abundant throughout.

ENTYLOMA LINARIAE VERONICAE Wint. Usually common and abundant at least in the southern portion.

ENTYLOMA LINARIAE GRATIOLAE Davis. This has been found in two localities in northern Wisconsin. As it has been but recently recognized it may be that it will be found to have a wider distribution.

ENTYLOMA LOBELIAE Farl. Variable in frequency and abundance from year to year.

ENTYLOMA COMPOSITARUM Farl. A common and abundant species but some of the host adapted races of which it appears to be composed are rather rare. It is most common on Lepachys and Ambrosia, least so on Senecio. It is sometimes very abundant locally on *Eupatorium urticaefolium* while in other years it is not seen on that host.

Entyloma polysporum (Pk.) Farl. Not uncommon on *Ambrosia artemisiaefolia* and *Rudbeckia hirta,* rare on other hosts. hosts.

Burrillia pustulata Setch. Not frequent but usually abundant where it occurs.

Doassansia zizaniae Davis. This has been collected at Racine and Madison only. As the spore balls are formed in the central cavity of the lower internodes without external manifestation it is recognized only by splitting open the culms. It appears late in the season and has not been looked for at that time in the northern part of the state.

Doassansia martianoffiana (Thuem.) Schroet. Infrequent. It has been collected only on plants emersed by the recession of the water.

Doassansia sagittariae (West.) Fisch. Throughout the state.

Doassansia sagittariae confluens Davis. Also throughout the state.

Doassansia opaca Setch. This has been seen in the southern part of the state only where it is rare.

Doassansia intermedia Setch. This has been found in the northern half of the state only. It is not frequent.

Doassansia deformans Setch. This is one of the commoner species of the genius ih Wisconsin and occurs throughout.

Doassansia furva Davis. This has been collected in several localities none of which are in the southern portion. It is usually fairly abundant where it occurs.

Doassansia alismatis (Nees) Cornu. This was formerly the species most often seen but of late years it has not been so frequent. A cycle of abundance will probably come again.

Doassansia ranunculina Davis. This was thought to have disappeared from the state but it was found in very small quantity, barely enough to show its presence, at Shiocton in eastern Wisconsin and at Blue River in the southwestern part of the state. It may therefore again become abundant when conditions are favorable for successive years.

TRACYA LEMAE (Setch.) Syd. This has been collected in three widely separated localities. As it is very inconspicuous it probably has not a restricted range in the state and occurs more frequently than the collections would indicate.

COLEOSPORIUM SONCHI-ARVENSIS (Pers.) Lev.

UNIVERSITY OF WISCONSIN HERBARIUM,
MADISON, WISCONSIN, MARCH, 1925

NOTES ON PARASITIC FUNGI IN WISCONSIN—XIV

J. J. DAVIS

A large part of the collections of 1925 were made in the "cut-over" regions in the northern part of the state. The cumulative effect of successive dry seasons was in evidence. The effect of the removal of the trees on the moisture content of soil and air is marked in its relation to fungus parasites. It is with surprise that one observes as he walks over dry ground the presence of such plants as Iris, Caltha, Comarum, etc. To one who has known the forest floor the difference is striking. The effect of the dryness is especially evident in the later stages of development of the parasites. Leaf spots may be abundant but spore bodies few, imperfect, and with little or no formation of normal spores. A large proportion of the collections in this region were discarded.

In "Notes" V it was stated that a trace of *Bremia lactucae* Regel had been observed on *Krigia amplexicaulis.* In July 1925 it was found on this host at Altoona in sufficient quantity to furnish a herbarium specimen. Apparently infection occurs but seldom on this host. One might infer that this is not a race adapted to Krigia but that infection occurs exceptionally.

In "Notes" IX, p. 251, reference was made to the occurrence of mycelium and conidia supposed to be those of *Sphaerotheca humuli* (DC.) Burr. on *Rubus allegheniensis* at Madison early in the season. In late July, 1925, similar material was collected at Eau Claire on leaves of blackberry, species undetermined. Very few developed conidia were present. *Rubus triflorus* is the only species of the genus that bears perithecia commonly or abundantly in Wisconsin.

What may be the growth described and figured by Tulasne as a spermatiophorous state (*Melasmia salicina* Lev. *Carpologia* III, p. 119, tab. XV) has been rarely seen in the examination of immature ascomata of *Rhytisma salicinum* (Pers.) Fr. In one case instead of the cylindrical spermatia a small globular spermatium about 2μ in diameter was developed at the summit of each of the slender, straight, congested conidiophores. Nothing comparable to the "stylospores" described and figured by Tulasne has been seen. As the covering of the spore body is merely the cortex of the ascoma it does not seem to be properly referred to Leptostromaceae. It is perhaps microconidial.

Phyllosticta fatiscens Pk. is evidently the same as *Ph. nupharis* Allesch. (*Phoma westendorpii* Tosq. & West.) as that species is represented in Petrak, *Fungi Bohemiae et Moraviae*, series II, no. 1744. Peck's name appears to have precedence in time.

Septoria malvicola Ell. & Mart. is now recognized as the proper designation of the species on *Malva rotundifolia* that was recorded in the provisional list under the name *Septoria heterochroa* Desm.

A collection made in June on leaves of a narrow-leaved Aster (*A. salicifolius?*) and referred to *Septoria atropurpurea* Pk. bears sporules 33–66 x 2–3μ.

In a collection on leaves of *Ambrosia trifida* from Hollandale (June 17, 1925) the spots are not white and arid but are slightly paler portions of larger brown spots. The pycnidia are sometimes prominent and occasionally imperfect and even acervulous. The sporules are 17–30 x 1μ acute at one end. It is believed to be a state of *Septoria bacilligera* Wint.

Because of previous use of Septoriopsis as a generic name by Fragoso and Paul, Petrak has replaced Septoriopsis Stevens & Dalbey as amended in "Notes" VII, p. 401, by Cercoseptoria (*Ann. Mycol.* **23**:68). The two Wisconsin species referred to Septoriopsis therefore became *Cercoseptoria longispora* (Pk.) Petr. and *C. leptosperma* (Pk.) Petr.

Bayliss—Elliott and Stanfield find the ascigerous stage of *Polythrincium trifolii* Kze. to be referable to Dothidella and describe it as *Dothidella trifolii* n. sp. (*Trans. Brit. Myc. Soc.* 9:227 [1924]). They also observed a pycnidial state in autumn.

In transferring the description of *Cercospora pontederiae* Ell. & Dearn. to the *Sylloge Fungorum*, Saccardo queried if it were not a Cercosporella. The query seems justified and Wisconsin specimens are labeled *Cercosporella pontederiae* (Ell. & Dearn.). The development is sometimes amphigenous and the conidia longer (up to 75μ) than indicated by the description. It has been found in Wisconsin only in the northern part.

In examining a collection of the fungus referred to *Cercospora euonymi* Ellis made in late September, conidia were observed up to 140μ in length. The conidiophores are hyaline as in previous Wisconsin collections.

For the reception of *Gloeosporium balsameae* Davis ("Notes" VII, p. 409, pl. 30) Petrak has proposed the genus Rhabdogloeopsis (*Ann. Mycol.* **23**: 52). There are those who would not consider the characters to be of generic value and who deprecate the multiplication of genera founded upon slight differences as a disservice to mycology. This is especially true where life histories are unknown. To such Cryptocline, Rhabdogloeum and Rhabdogloeopsis would constitute a subgeneric group.

The parasite recorded in the supplementary and provisional lists under the name *Cylindrosporium thalictri* (E. & E.) is the one described in the *Journal of Mycology* **3**: 130 as *C. ranunculi* (Bon.) *f. thalictri* E. & E. It bears no relation to *C. ranunculi* (Bon.) Sacc. or to Entyloma and is quite distinct from *C. clematidis* E. & E. The acervuli are usually confined to a sharply delimited angular portion of the arid spot.

The parasite of *Carpinus caroliniana* recorded in "Notes" II, p. 106 as *Fusarium carpineum* n. sp. was found on the same host at Balsam Lake in July, 1924. The cellular base from which the conidia spring is usually simpler in these collections and many of them do not suggest a sporodochium. The spots are circular, scattered, not nervisequent, about ½ cm. in diameter. They are not brown until death of the leaf cells takes place when by confluence irregular brown areas may be formed. The conidia are not uniformly biseptate but develop 1–4 septa. This was found also, in small quantity, on *Carya cordiformis* growing with infected Carpinus. It was noted that on this host the conidia are smaller, 20–30 x 1½–2μ and not septate. Perhaps this might better be placed in Cercoseptoria as that genus has been treated in these notes under Septoriopsis.

In 1925 Entyloma on *Thalictrum dasycarpum* bearing conidia was collected at Armstrong Creek and at Tripoli. As it occurred in the latter locality a hyphal mat was formed on the lower surface of the spots much as in *E. menispermi* Farl. & Trel. There seems to be no good reason for attempting to keep *E. ranunculi* (Bon.) Schroet. and *E. thalictri* Schroet. separate, although they may be distinct in their host relations as is the way with smuts. On Ranunculus Entyloma has been found in Wisconsin on *R. pennsylvanicus* only but it is not infrequent on that species, especially northward, 10 collections being represented in the herbaria. It was found on *Anemone quinquefolia* at Racine in 1888 but has not been seen on that host since and I have seen no record of its occurrence elsewhere.

Collections of leaves of *Sagittaria heterophylla* have been made that bear both *Doassansia sagittariae confluens* Davis and *D. furva* Davis the spore balls of both being sometimes present in the same section.

Uredinopsis atkinsonii Magn. is united with *U. copelandi* Syd. by Arthur in *North American Flora* 7: 684.

Potentilla canadensis has been collected at Madison bearing Phragmidium and Darluca and in addition black sclerotioid bodies. This seems to be of the same character as the growth which has been called *Sphaeria solidaginis* Schw.

While *Uredo muelleri* Schroet. is considered to be aecial in character it is sometimes attacked by *Darluca filum* (Biv.) Cast., a common parasite of uredinia but not of aecia.

In June 1913 *Aecidium falcatae* Arth. occurred at Wyalusing in southwestern Wisconsin near the Wisconsin river. In looking about for a possible alternate host a coarse grass was found that had borne telia the preceding year. This was probably *Andropogon furcatus.* In 1920 another collection of the Aecidium was made at Prairie du Chien in the same region. In June 1924 it was found in abundance at Blue River in southwestern Wisconsin and in August at Danbury in the northwestern part of the state. The stations were noted and later in the season both localities were visited for the purpose of getting a clue to the alternate host. In each case *Andropogon scoparius* and *A. furcatus* were the only rusted plants in the immediate vicinity. In the spring of 1925 development of aecia on *Amphicarpa monoica* was secured in the greenhouse from infection from telia on Andropogon. Some years ago *Aecidium lupini* Pk. was observed to be abundant at Millston. The stations were noted and visited later in the year and Andropogon found to be the rusted host that seemed to be associated with it but no infection experiments were made. In *North American Flora* 7: 625–6, Arthur has united *Aecidium falcatae* Arth. *Ae. lupini* Pk. and described species on other genera of Leguminosae. It seems probable that there is a rust on Andropogon that develops on various Leguminosae. How much differential host adaptation there is remains to be seen. Andropogon seems to be a complacent host for rusts.

In "Notes" XI, pp. 301–2, reference was made to the occurrence of *Puccinia punctiformis* Diet. & Hol. in Wisconsin with the suggestion that it was "presumably a waif in Wisconsin and perhaps will not be able to maintain itself in this climate". In 1925 uredinia were found beside the railroad at Madison about a mile from where it had been noticed in 1922.

Additional Hosts

Microsphaera alni (Wallr.) Wint. On *Rhamnus alnifolia.* Pembine.

Ascochyta thaspii saniculae Davis. On *Sanicula gregaria.* Argyle.

Melasmia ulmicola B. & C. On *Ulmus racemosa.* Ingram.

Colletotrichum graminicolum (Ces.) Wils. On *Bromus pugans.* Balsam Lake.

What appears to be an imperfectly developed state of *Marssonina kriegeriana* (Bres.) Magn. was collected at Argonne on *Salix balsamifera.*

Cylindrosporium triostei Kell. & Swingle. On *Triosteum aurantiacum.* Spring Valley. In this collection the acervuli are epiphyllous.

Microstroma juglandis (Bereng.) Sacc. On *Carya cordiformis.* Balsam Lake.

Ramularia vaccinii Pk. was collected on *Vaccinium pennsylvanicum* at Wausaukee in 1913 but not recorded. It was found on *V. canadense* at Ogema in 1925.

Cercospora dubia (Riess) Wint. On *Chenopodium hybridum.* Danbury.

Puccinia gentianae (Strauss) Lk. Uredinia and telia on *Gentiana puberula.* Taylor.

Puccinia patruelis Arth. Aecia on *Lactuca villosa* and *Hieracium canadense.* Hollandale.

Additional Species

A collection on living leaves of *Betula pumila* from Danbury corresponds with immature specimens of *Dothidella betulina* (Pers.) Sacc. This was referred to Phyllachora by Fuckel and to Euryachora by Schroeter and by Theissen & Sydow.

In August 1920 a trace of *Taphrina struthiopteridis* Nishida was found at Spooner on *Onoclea Struthiopteris.* In late July 1925 it was again found at Weyerhaeuser in sufficient quantity to furnish a herbarium specimen and warrant recording. The infected pinnae resemble those attacked by Uredinopsis.

At Millston in September 1924 many leaves of *Rubus hispidus* showed orbicular dead spots, cinereous with a purple border, about 5 mm. in diameter. In the center of the spots on the upper surface were remains of old sori of *Uredo muelleri* while on the lower surface were scattered pycnidia of *Coniothyrium fuckelii* Sacc. Presumably the latter had developed on tissue that had been injured by the rust.

Ascochyta baptisiae n. sp.

Spots suborbicular, dull black, more or less argillaceous zoned, 3–6 mm. long, nearly alike on both surfaces; pycnidia epiphyllous, somewhat prominent, argillaceous, subepidermal, globose, ostiolate, 85–150μ in diameter; sporules hyaline, cylindrical with rounded ends, straight or nearly so, uniseptate or occasionally with 2 or 3 septa, 12–30 x 4–7μ. On leaves of *Baptisia leucantha.* Avoca, Wisconsin, October 8, 1924.

Stagonospora petasitidis Ell. & Ev.

On *Petasites palmatus.* Tripoli. In this collection, made in mid-August, the areas over which the pycnidia are scattered are mostly brown and dead. On these dead areas the pycnidia are, for the most part, empty or contain but few more or less imperfect sporules.

In late August and early September collections were made in several localities in northeastern Wisconsin of a parasite of *Populus balsamifera.* On examination these showed numerous epiphyllous pycnidia on indefinitely limited brown spots in which however sporules had not developed. I am indebted to President Dearness for an opportunity to examine a portion of the type of *Phyllosticta brunnea* Dearn. & Barth. on leaves of *Populus angustifolia* from Colorado and for the suggestion that the Wisconsin collections are of that species, a suggestion that is borne out by the comparison. Material collected later in the season would perhaps have shown further development.

Graphium sorbi Pk.

On *Pyrus americana.* Armstrong Creek. In this collection the synnemata are few and the conidia immature, corresponding to the rule in collections of the year 1925.

Puccinia ambigua (A. & S.) Lagh.

Aecia and telia on *Galium Aparine.* Spring Valley.

Coleosporium helianthi (Schw.) Arth.

Uredinia and telia on *Helianthus strumosus*. A single collection made at Madison.

Notes on Distribution and Abundance in Wisconsin

Melampsoraceae

Including Coleosporium

Melampsora farlowii (Arth.) Davis.

This has been observed in the northeastern corner of the state only.

Melampsora bigelowii Thuem.

Common and abundant throughout the state.

Melampsora humboldtiana Speg.

This has been so confused with the preceding species that its range or abundance is not well known. The aecial stage has been collected in the northeastern and northwestern sections only.

Melampsora medusae Thuem.

Common and abundant.

Melampsora populi tsugae Davis (M. abietis-canadensis (Farl.) C. A. Ludwig)

Known only from the north eastern part of the state accompanying *M. farlowii* (Arth.) Davis.

Melampsora lini (Pers.) Desm.

Occurs in flax fields and also on *Linum sulcatum* on which it is sometimes abundant in the western part of the state.

Melampsora cerastii (H. Mart.) Schroet.

Aecia were formerly rather common in northern Wisconsin but are now rare according to my experience. Uredinia or telia have not been recognized in Wisconsin.

Melampsoridium betulinum (Pers.) Kleb.

Apparently a rare species in Wisconsin. But one collection of aecia has been made, but they were abundant at that station which was in the northwestern part of the state. Two collections of uredinia have been made in the southern part of the state and one in the northern.

Calyptospora goeppertiana Kuehn.

Very rare in Wisconsin. But a single collection.

CHRYSOMYXA PIROLAE (Dc.) Rostr.

Occurs throughout the state.

CHRYSOMYXA LEDICOLA (Pk.) Lagh.

The telia of this and cognate species are formed so early in the season that they disappear before the localities are visited. One collection of telia referred to this species was made in northeastern Wisconsin. Uredinia have not been seen. A few collections of aecia have been made in the northern part of the state.

CHRYSOMYXA LEDI (A. & S.) DBy.

Common northward. Telia have not been seen. Aecia have not been recognized; perhaps they have been confused with those of the next species.

CHRYSOMYXA CASSANDRAE (Pk. & Cl.) Tranz.

Common and abundant in the spruce bogs but telia have not been collected. Aecia on *Picea mariana* are common and abundant.

CHRYSOMYXA CHIOGENIS Diet.

A rare species collected only in a somewhat limited region in the northern part of the state. No collection has been made since 1903. Moist, mossy, well shaded logs with Chiogenes trailing over them are not abundant since deforestation and forest fires.

CHRYSOMYXA CHIOGENIS Diet.

Of still more restricted range in the northern part of the state.

PUCCINIASTRUM PUSTULATUM (Pers.) Diet.

Common and abundant on the larger species of Epilobium. The telia are most abundant on *Epilobium angustifolium.*

PUCCINIASTRUM PYROLAE (Pers.) Diet.

The uredinia occur on various species of Pyrola throughout the state except that there are no collections from the southeastern portion. But one collection has been made on Chimaphlia. Aecia and telia have not been seen.

PUCCINIASTRUM MYRTILLI (Schum.) Arth.

Aecia are sometimes abundant. Urelinia are usually sparsely developed. Telia have been seen in two collections. Because of the intracellular position of the teliospores, this is considered to be generically distinct by some authors who designate it Thecopsora.

HYALOPSORA ASPIDIOTUS Pk.

This has been collected in the extreme northeastern portion of the state only.

HYALOPSORA POLYPODII (Dc.) Magn.

Common in southern and eastern Wisconsin.

UREDINOPSIS PHEGOPTERIDIS Arth.

The least common of the species of the genus in Wisconsin. It occurs in the northern part of the state only.

UREDINOPSIS COPELANDI Syd. (U. atkinsonii Magn.)

Not uncommon but often poorly developed apparently from early death of the infected tissue.

UREDINOPSIS MIRABILIS (Pk.) Magn.

The most common and abundant species of the genus often at long distance from the aecial host.

UREDINOPSIS STRUTHIOPTERIDIS Stoermer.

Common and abundant northward.

UREDINOPSIS OSMUNDAE Magn.

Common and abundant especially northward. The aecial stage of the species of this genus, *Peridermium balsameum* Pk., is common where the host occurs but no segregation has been made. All of them develop teliospores, the first and last most abundantly.

PUCCINIASTRUM POTENTILLAE Kom.

With the range of the host which is northwestern but extending south considerably below the middle. No telia have been found.

PUCCINIASTRUM AMERICANUM (Farl.) Arth.

Throughout the state on the single species of host *Rubus idaeus aculeatissimus.* Telia are frequent.

PUCCINIASTRUM ARCTICUM (Lagh.) Tranz.

Throughout the state on *Rubus triflorus* only. No telia have been seen. It is more abundant northward.

PUCCINIASTRUM AGRIMONIAE (Schw.) Tranz.

Common and abundant throughout. No telia seen.

CRONARTIUM COMPTONIAE Arth.

All of the stages occur somewhat abundantly in northern Wisconsin.

CRONARTIUM QUERCUS (Brondeau) Schroet.

A common species throughout the range of the aecial host, *Pinus Banksiana.* The telia occur most frequently and abundantly on *Quercus velutina.*

CRONARTIUM COMANDRAE Pk.

The aecial stage appears to be but sparsely developed but the later stages are much more common and abundant, often at long distance from the aecial host.

CRONARTIUM RIBICOLA FISCH.

Still occurs to some extent in northwestern Wisconsin.

CRONARTIUM OCCIDENTALE Hedge, Bethel & Hunt.

Reported as having been collected on Ribes at two stations in northern Wisconsin in the course of the white pine blister rust survey.

CEROTELIUM URTICASTRI Mains.

Probably of wide range in the state. Aecia have been collected in the southern part only probably because more northern territory has not been visited early enough in the season.

COLEOSPORIUM RIBICOLA (C. & E.) Arth.

Collected in northern Wisconsin in 1918 in the course of the white pine blister rust survey. I have not seen it myself in the field.

COLEOSPORIUM VIBURNI Arth.

Not uncommon and sometimes rather abundant in the southern and eastern portions of the state.

COLEOSPORIUM CAMPANULAE (Pres.) Lev.

This species was included in the state flora on the basis of a fragmentary specimen on *Campanula rotundifolia* bearing uredinia collected at Prairie du Sac in 1891 by H. F. Lueders. By some error the host was given in the list as *C. americana*. Nothing further was known of the occurrence of this rust in the state until 1922 when uredinia were found on *Campanula aparinoides* at Blue River in the south western part of the state and in 1923 on the lake Superior shore.

COLEOSPORIUM SOLIDAGINIS (Schw.) Thuem.

Common and abundant throughout the state. But few collections of aecia have been made.

COLEOSPORIUM HELIANTHI (Schw.) Arth.

The first and only collection was made at Madison in 1925.

This has been found in but a single locality in northeastern

COLEOSPORIUM SONCHI-ARVENSIS (Pers.) Lev.

Wisconsin.

UNIVERSITY OF WISCONSIN HERBARIUM.
MADISON, WISCONSIN, APRIL, 1926.

INDEX TO HOSTS AND PARASITES

Referred to in "Notes" XII, XIII, and XIV.

The names of parasites are in *italics.*

NOMENCLATORIAL NOTES ON AMERICAN FRESH WATER MOLLUSCA*

FRANK COLLINS BAKER

During the preparation of a monograph of the fresh water mollusks of Wisconsin for the Wisconsin Geological and Natural History Survey, certain new genera and other groups have been observed and some changes in current nomenclature have been noted. As the publication of this monograph will be somewhat delayed it has seemed advisable to publish the salient points in nomenclature brought out by the investigation, as well as certain notes concerning other matters of interest observed. A full discussion, with illustrations of the anatomical features, will appear in the monograph mentioned.

PLEUROCERIDAE

Since the time of William Stimpson (1864) apparently no additional observations have been made concerning the genitalia of the snails belonging to this family. Half a hundred specimens of *Goniobasis livescens* and *Pleurocera acuta* have been examined without finding any notable features not recorded by Stimpson. There is no external organ of generation and there appears to be no external feature for determining the sexes, excepting the pit or sinus on the neck between the right tentacle and the operculigerous lobe, which appears to be present only in the female. There is a long canal on the right side of the rectum, formed by two narrow laminae, about as broad as the rectum, placed close together. This canal opens into the mantle cavity at the angle formed by the mantle and body wall. Posteriorly the two laminae become a single tube which enters the gonads (ovaries or testes) which lie near the stomach. The study of this family is worthy of serious attention, the anatomical features offering novelties of interest and value.

*Contribution from the Museum of Natural History, University of Illinois, No. 35.

VIVIPARIDAE

Many years ago, Gill divided the Viviparidae into two groups which he later distinguished as subfamilies, the distinctions being based on the difference in the lingual teeth. The genitalia also give additional characters and the division seems to be a natural one. They are redefined below.

Subfamily VIVIPARINAE Gill, 1871

Shell usually large with rounded or carinated whorls; operculum wholly concentric, the inner margin folded in some groups; foot not much longer than shell, not extending beyond the tentacles; cervical lappets large, forming tubular conduits for respiratory purposes, the right lappet the larger; radula with broad central tooth, the reflection broad and multicuspid, the center cusp usually wide and blunt; lateral and marginal teeth longer than wide, the reflections wide and multicuspid; penis forming an elongated, thick, sausage-shaped sac, behind which the prostate is placed, without a long intervening vas deferens, the latter being short and narrow.

This subfamily includes the typical genera, Viviparus, Tulotoma, Taia, Margarya, and perhaps some other groups which agree in genitalia, radula, and general form.

Subfamily LIOPLACINAE Gill, 1871

Shell turreted, whorls rounded or subcarinated; aperture subangulated, sinuous or incurved at the base; operculum wholly concentric or with subspiral nucleus; cervical lappets small, not forming tubular conduits for respiratory purposes; foot very large, truncated before, rounded behind; radula with narrower teeth than in the Viviparinae, the reflection with sharp cusps, none being wide or blunt, the marginals very long and narrow, wide at the base; penis forming a long, narrow, more or less convoluted tube opening at the end of the right tentacle, which is larger than the left tentacle; prostate placed immediately behind the penis (Lioplax), or midway of the vas deferens (Campeloma), either sac-like (Campeloma), or made up of several large convolutions (Lioplax).

The narrow, sharp-pointed cusps of the radula, the large foot, the thin, tube-like penis, the differentiation in the position and form of the prostate, the absence of the conduit form of cervical lappets, together with the more or less sinuated aperture, are sufficient characteristics for separating these snails as a subfamily of Viviparidae. Gill separated these shells on account of the supposed absence of cusps on the reflection of the radula teeth, but an examination of these with high powers shows that cusps are present in all species, though they are small and difficult to see. The group appears to be wholly American, and of more or less restricted distribution. Hannibal's family Lioplacidae is wholly untenable, being founded on a mistaken assumption that the operculum of Campeloma has the same subspiral nucleus as Lioplax. There are but two genera, Lioplax and Campeloma.

Family Amnicolidae

Genus Amnicola Gould and Haldeman

Subgenus Marstonia nov.

Apex of shell acute, nuclear whorl not flat-topped, emerging well above the second whorl; the nuclear whorl is only half the size of that of typical Amnicola. Central tooth of radula about two-thirds as large as that of Amnicola; basal ridge with but one large denticulation; reflection usually with more than 9 denticulations; lateral teeth without a distinct lobe at the inner ventral border which is replaced by a broad swelling. All cusps usually longer and sharper than in typical Amnicola. The second marginal is peculiarly expanded on the lower part of the body of the tooth, differing from that in *limosa.* This group will include *Amnicola lustrica, gelida, oneida, walkeri, pilsbryi,* and *winkleyi,* and possibly others not examined. Named in honor of Mr. Geo. T. Marston, who lived for many years in eastern Wisconsin and accumulated a large collection of state mollusks.

Type: *Amnicola lustrica* Pilsbry.

Genus Hoyia nov.

The genus is based on the peculiarities of the radula. The teeth are all very small, about a third the size of those of

Amnicola limosa; center tooth with 7 denticulations and 4 basal denticulations; lateral tooth with a quadrangular-shaped body from which a rather narrow peduncle, almost twice as long as the body, extends laterally in an almost straight direction, but slightly bent downward; reflection very wide and low with about 30 very small cusps of equal size; first marginal falcate, with a rather wide body and a heavy central ridge, reflection wide and low with about 30 denticulations, which are twice as large as those of the lateral; second marginal narrower than first with about 40 very small, equal cusps.

Type: *Amnicola sheldoni* Pilsbry.

The radula of *Amnicola sheldoni* is quite unlike that of any other American amnicoloid observed or published. The genus most nearly resembling Hoyia is Potamopyrgus Stimpson, in which the central tooth has four basal denticles and the reflection is 9-cuspid. However, the lateral teeth of Hoyia differ from the type of Potamopyrgus in the far greater number of cusps. The genus is dedicated to Dr. P. R. Hoy, a pioneer naturalist and molluscan student of Wisconsin.

Genus Birgella nov.

The characteristics of the genus are based on the animal. Verge compressed, the penis being much longer than the flagellum sheath which is short and conical or compressed; head wide, tentacles rather short and flattened, pointed; rostrum wide, squarely truncated. Central tooth of radula with a long, pointed central cusp which reaches nearly to the base of the tooth, the lateral ridge with but one large denticle and two smaller ones below; lateral teeth with a large rounded lobe on the inner base of the body, with a wide peduncle and a reflection with about 8 denticulations; marginal teeth with relatively few denticulations (10–12).

Type: *Paludina subglobosa* Say.

Birgella differs from Somatogyrus in the denticulation of the center and second marginal teeth, and in the form of the lateral. It is nearest to Gillia in the denticulation of the lateral ridge of the center tooth, but differs in other respects, as well as in the form of the verge.

The genus is dedicated to Dr. Edward A. Birge, President Emeritus of the University of Wisconsin and Director of the Wisconsin Geological and Natural History Survey.

Family Pomatiopsidae Stimpson

Pomatiopsinae would seem to rank as a family rather than as a subfamily of Amnicolidae. The sinuses of the foot, the radula with its few cusps of large size and the two large denticles on the base of the central tooth, as well as its terrestrial habits, all mark this genus as separable taxonomically from the Amnicolidae. The verge, also, is simple without flagellum sheath, and is of large size. Gill in 1871 and Pilsbry in 1906 raised the group to family rank, but without indicating the reasons for so doing.

Family Physidae Dall

A study of the animals of Physa from Europe and America indicate that the name Physa cannot be applied to the American forms of these shells. The type of Physa is the *Bulla fontinalis* of Linn. The animal of this species has a mantle which partly envelops the shell, not only on the parietal and columella side, but on the outer lip area as well. The mantle of the left side extends well over the shell to the center of the dorsal side; the lower part is composed of one large lobe, while the upper part, which is digitate, covers the spire. The part of the mantle over the lip is digitate and extends well over this side of the shell. In the mantle of the American Physae the digitate mantle is reflected only over a small part of the parietal wall and columella region, and the outer lip mantle is simply thickened and is not digitate or extended over the shell. The center tooth of *fontinalis* is also different from that of the American species, having a large number of small denticulations on each side of the center cusp, and the reflection is also wider than in the American species.

In view of this difference between the type of the genus Physa and the American species, it seems necessary to place these species in a separate genus. Rivicola Fitzinger, 1833, is founded on the same type, *Physa fontinalis*.

In 1842, Haldeman defined two groups of Physa; Physella, with the type *P. globosa,* and Physodon, the type being *P. microstoma.* While the characters given by Haldeman are trivial, the names seem available for the division of the group with a digitate mantle partly covering the shell on the columella side and without any sign of digitations on the outer lip side. Haldeman's first generic name, Physella, is therefore here redefined to include these American species. Physodon is reserved for a group of Physae which differ somewhat from Physella in the genitalia and in the form of the shell.

Before giving the diagnosis of this and other groups of fresh water pulmonates it seems desirable to briefly discuss some of the features of the male genital system in this suborder of the Pulmonata. The male organ consists of a more or less cylindrical, sac-like body, the proximal end of which contains the male penial aperture; back of this is a smaller, more or less tube-like body which contains the male intromittent organ; the vas deferens enters the distal end of this body. Simroth (Bronn's Tier-Reich, III, Mollusca, p. 502, 1912), following Buchner, advances a nomenclature of the male organ for the different types of Planorbis, and it would seem feasible to enlarge this to include all of the fresh water pulmonates, as the same types are found in all genera thus far examined. Modifying the German names to the needs of English readers, the following terms may be employed: lower cylindrical body, the praeputium, or 'grosse penisscheide'; the smaller body above, the penis sheath or 'kleine penisscheide'; the intromittent organ within this body is the penis; in some groups there may be a large papilla surrounding the penial stylet. In all groups there are one or more accessory organs or appendages, such as a flagellum, a sarcobelum, etc.

Pilsbry (Nautilus, XXV, p. 10, 1911) has suggested that the penis-sac (penis sheath) of the writer's Lymnaea monograph is comparable to the epiphallus of the land Pulmonata. An examination of sections of the male organ of that and other families would seem to indicate that the name is not quite synonymous. The epiphallus is described as an enlarged portion of the vas deferens before that tube enters the cavity containing the male intromittent organ. As the body called the penis sheath contains the male organ and is retracted by a powerful muscle it cannot be comparable to the epiphallus of the land snails. In all of the groups of fresh water snails thus far examined (Physella, Planorbis, Lymnaea, Ferrissia) the combination of parts of the male system indicated above have been found. In some Lymnaeas and Planorbis, the vas deferens has been noted to be rather enlarged before entering the penis sheath, and this may be homologous with the epiphallus of the land shells. The function of this organ, however, appears to be performed by other organs in the fresh water snails.

Subgenus PHYSELLA (Haldeman 1842) Baker, emend. 1926

The male system of the genitalia of Physella consists in part of a large, cylindrical praeputium and a longer, narrower, cylindrical penis sheath, which contains the very long and slender penis. The penis sheath may be modified to form a lower part which is very thick-walled, in which the penis is very slender, almost needle-like, and an upper part with very thin walls in which this part of the penis is much thicker and even the vas deferens canal is of larger diameter. At the distal end of the praeputium there is always a rounded, more or less heart-shaped body which seems to be comparable to the sarcobellum of land snails and performs the office of an excitory organ. It is cleft in the center for the passage of the male intromittent organ. There is, also, near the center or upper part of the praeputium a peculiar gland-like body, hollow, with its open end facing the cavity of the praeputium. This may be a blind sac comparable to the flagellum of land snails and used to form the spermatophore. There are two retractor muscles.

The genus Physella appears divisible into two groups or subgenera.

Subgenus PHYSELLA *Sensu stricto*

The genitalia as described above. The shell is usually thin, with a distinct plait on the columella.

There are two longitudinal muscular pillars in the praeputium one of which connects with the large gland.

Type: *Physa globosa* Haldeman.

Subgenus PHYSODON (Haldeman 1842) Baker, emend. 1926

In this group the shell is usually thick and solid, the columella smooth and without a distinct plait, although there may be one or two small denticles on the columella; male system with a large praeputium and a penis sheath somewhat shorter than in Physella, which is not divided into a thin-and thick-walled portion. There is but one large longitudinal muscular pillar extending the whole length of the praeputium, there being none to connect with the gland.

Type: *Physa microstoma* Haldeman.

The group of Physellae typified by *integra* and *walkeri* appears to form a natural subdivision of the genus. The genitalia only of *integra* and *walkeri* are known, but the form of the shell suggests the inclusion of *microstoma* and *anatina* in the same assemblage, thus avoiding the coining of an additional group name. The approximation must necessarily be tentative until the anatomy of *microstoma* is known.

Family PLANORBIDAE H. & A. Adams

It is believed that the family should be restricted to include the orb-like snails. Pompholaginae and Isidorinae should probably be raised to family rank, based on peculiarities of genitalia, shell, and radula. Simroth, in Bronn's Tier-Reich, 1912, p. 502 has divided the male organ of Planorbis into four types, all but one of which are totally unlike any of the types founded in America (thus far examined). If it be conceded that Montfort, in 1810, was the first author to definitely assign the type of Müller's genus Planorbis (*Helix cornea* Linn.), and it would seem that under the rules of the code this is perfectly clear, then the typical genus is not found in America, as far as known. Certainly the large species typified by *trivolvis* cannot be included. In this group the male system consists of a large sac-like praeputium and a penis sheath about half as long, roundly swollen at the summit and containing a cylindrical, pyriform penis. There are two retractor muscles. In addition there is a large gland-like body situated at the upper part of the praeputium, in a large swelling. A long, folded duct leads from this gland to the base of the penis sheath.

Nothing like this combination is recorded for any group of *Planorbis* at present known and its presence marks these large American species as belonging to a very distinct group of the family. Indeed, should the division prove to include only these large snails, it might be considered of higher group value and constitute a subfamily HELISOMINAE. This organ was first noted in 1911 (Lymnaeidae of North and Middle America, p. 121) in the discussion concerning the separation of the Planorbidae from the Lymnaeidae. The genital system was not at that time sufficiently well studied to make out the true character of the organ, though the figure (plate xiii, fig. A) indicates the gland on the praeputium (called penis) and the duct which is shown as entering the base of the penis sheath (called penis appendage). A section of the male system shows the gland to be a somewhat cup-shaped organ, the opening of the 'cup' facing the interior of the praeputium. The duct leads from the hinder end of this 'cup' through the wall of the praeputium, and after coiling somewhat on the outside of the praeputium, enters the lower part of the penis sheath at a point above the muscular ring (sarcobellum) separating praeputium from penis sheath. The section is totally unlike anything figured by Simroth or any other author.

Just what is the function of this peculiar gland and its duct is not perfectly clear. It may be homologous with the flagellum of the land snails, and may be for the purpose of forming the spermatophore, as in this group of snails. It is probably also to be correlated with the flagellum of the Ancylidae. That it should be present in some groups of the family and not in others is noteworthy. It has been found in all of the species of the large planorbes examined (*trivolvis, pseudotrivolvis, truncatus, binneyi, antrosus* and varieties, *campanulatus*). The peculiar gland like body has been observed in all groups excepting Gyraulus.

The aggregation of characters embraced in the large planorbes of America is quite different from typical Planorbis of Europe, and the group should be known as :

Genus Helisoma Swainson, 1840

The shell is usually sinistral, few whorled, the whorls are carinate above and often below, the base funicular, and the aperture suddenly expanded and thickened; the lateral teeth of the radula are tricuspid while those of *Planorbis corneus* are bicuspid, and there are more teeth in a row than in any American species. Genitalia with a large gland-like body in the praeputium connecting with the penis sheath by a long duct. Two retractor muscles, placed on opposite sides of praeputium. The genus is divisible into three groups or subgenera.

Subgenus HELISOMA s. s.

Shell ultra dextral with funicular base and spire, the whorls carinated above and below. Genitalia with large praeputium and short, very wide penis sheath; the penis is strikingly pyriform, extending well into the praeputium; gland large but duct very short and thin. The shell is carried at right angles, tilted to the left side.
Type: *Planorbis bicarinatus* Say (=*antrosus* Conrad).

Subgenus PIEROSOMA Dall, 1905

Shell sinistral, large, high, with few whorls, the early ones carinated and flattened above, funicular below, in the adult shell the apical whorls are slightly depressed below the upper plane of the spire; the aperture is suddenly expanded and thickened within. Genitalia with very large praeputium and small, narrow penis sheath attached to the distal end of the praeputium or on the side between base and summit; penis short, not entering the praeputium; gland very large and duct very long and of large diameter. The shell is carried almost perpendicularly by the animal in life.
Type: *Planorbis trivolvis* Say.

Subgenus PLANORBELLA Haldeman, 1842

Shell sinistral, depressed, whorls more numerous than in Helisoma; apex not depressed below the level of the spire; base funicular; body whorl constricted behind the campanulate aperture; genitalia with a large praeputium and a small penis sheath as in Pierosoma. The shell is carried perpendicularly by the animal.
Type: *Planorbis companulatus* Say.

The genitalia of Planorbella and Pierosoma are almost identical and the only reason for the separation of the two groups is in the form of the aperture. There are also, some small differences in the radula. In these two groups, the penis sheath may be placed at the distal end of the praeputium or it may be found on the side between base and summit. This latter condition is usually found during the breeding season, at which time the upper part of the praeputium is much swollen and the gland distended. A specimen of *trivolvis* examined in July had the gland filled with a flocculent mass of mucus-like material, among which were many objects resembling spermatophores.

Genus PLANORBULA Haldeman, 1842

In both genitalia and radula the Planorbula group differs rather radically from the Segmentina of Europe and Asia. The penis sheath lacks the wing-like blind sac shown in Simroth's figure, besides possessing the peculiar gland present in Helisoma, though lacking the duct of that genus. The radula is also different, the laterals being as in Gyraulus and some Helisoma, tricuspid, not multicuspid, as in the European Segmentina. The jaw is also segmented in Segmentina, while it is in three pieces in Planorbula, a large superior and two small lateral pieces. These differences are sufficiently well marked to remove Planorbula from Segmentina and give it a generic place in the family. The shell is carried almost flat by the animal, much as in Gyraulus, which the animal greatly resembles.

Type: *Planorbis armigerus* Say.

It is to be noted that Germain, in his Catalogue of the Planorbidae in the Indian Museum (Records of Indian Museum, XXI, p. 179), raised this group to generic rank, but based the distinction entirely on shell characters, principally those of the lamellae in the aperture.

Genus MENETUS H. & A. Adams, 1855

The genitalia of *Menetus exacuous* most nearly resemble those of *Planorbula armigera.* There is a conspicuous gland but no duct, the penis is very long, narrow, and extends well into the space of the praeputium. There are two vertical muscular ridges in the lower part of the praeputium, the latter being divided into two compartments by a muscular ring, the upper part containing the gland and the lower part the vertical ridges. There is one large retractor muscle at the distal end of the praeputium, which is bifurcated, one branch attached to the penis sheath and one to the upper part of the praeputium, and another on the side of the praeputium. There appears to be a small, triangular stimulating body or appendage at the end of the penis, just below the outlet of the sperm canal.

Type: *Planorbis opercularis* Gould.

If Anandale's remarks on Hippeutis (Records Indian Museum, XXIV, p. 359, 1922) are correct, Menetus cannot be included in it, if *opercularis* is like *exacuous* in its genitalia and radula. The praeputium is not sharply differentiated from the penis sheath in Hippeutis, the whole male organ forming a long cylindrical apparatus narrowing toward the distal end, as shown in Simroth's type III. The lateral teeth, also, are arranged in pairs in Hippeutis, a feature not observed in *exacuous*. The group seems quite distinctive enough to stand as a separate genus.

Genus Gyraulus Agassiz, 1837

In the absence of a gland or duct on the praeputium, the presence of a horny stilet at the end of the long, narrow penis, which is surrounded in the head of the praeputium by a fleshy papilla (sarcobellum), and in the strongly fragmented jaw, this group of planorbes stands easily as a well recognizable genus. There are two well developed vertical muscular pillars in the praeputium, similar to those in Physella and Lymnaea. The genus is divisible into several subgroups, more or less well characterized.

It is to be noted that Annandale and Prashad in 1919 (Records Indian Museum, XVIII, p. 52) gave the anatomical characteristics of this group and indicated its right to hold generic rank.

Subgenus Gyraulus s. s.

In the typical group the penis sheath is longer than the praeputium and much swollen toward the distal end. The shell is usually more or less hirsute and strongly spirally marked. The American *Planorbis deflectus* is the same in structure of genitalia as the European *Planorbis albus* Müller, the type of the genus.

Subgenus Torquis Dall, 1905

Whorls of shell less distinctly striated, not hirsute, the base deeply and regularly excavated; male system with penis sheath and praeputium forming a regularly cylindrical shape, the penis

sheath much longer than the praeputium, not swollen at the distal end. There is a single retractor muscle attached to the distal end of the praeputium.
Type: *Planorbis parvus* Say.

Subgenus Armiger Hartmann, 1840

This group is characterized by the costate whorls, the costae projecting at the periphery. Fresh material has not been available for anatomical examination and it is not now known how closely this feature may approximate with the other groups mentioned.
Type: *Nautilus crista* Linn.

Family Ancylidae

Subfamily Ferrissiinae Walker 1917

The genitalia of Ferrissia differs radically from those of *Pseudancylus (Ancylus) fluviatilis* as figured by Simroth. The praeputium is long and cylindrical, the penis sheath smaller but cylindrical and a trifle more than half as long as the praeputium, the flagellum enters the praeputium at the junction of the penis sheath with that body, and is short, enlarging at its distal end to form a large, more or less fan-shaped, gland-like organ. The genitalia seem to differ from the other members of this family to the same degree that the radula and shell do, showing that the whole organism agrees in the characteristics which separate this genus from the other groups of the family Ancylidae.

REVISION OF THE NEARCTIC SPECIES OF HELOPHILUS AND ALLIED GENERA

C. H. CURRAN, OTTAWA, CANADA,

AND

C. L. FLUKE, University of Wisconsin, Madison, Wis.

The revision of the genus Helophilus Mg. was originally planned by the junior author who succeeded in bringing together most of the described forms from North America. Owing to increased duties it was found impossible to continue the work and consequently he suggested to the senior author that the material gathered together be forwarded and the revision be carried on by him. The outcome was that a most pleasant and successful co-operation was arranged, enabling us to go into fuller details in regard to the various species than would otherwise have been possible. While the preparation of the manuscript has been frequently delayed, this has been found to have been advantageous, as excellent series of some of the less common forms have come to hand during the past fifteen months.

Types of the majority of the species have been examined, viz: all those described by Loew and Williston, in addition to the species described by Graenicher. Access has not been had to types of Wiedemann, Macquart, Walker, or Bigot, but we have secured in many cases examples from the type localities, thus ensuring almost positive identification. Mr. E. E. Wehr, compared a specimen with *Pterallastes perfidiosus* Hunter, but we have not been able to find any trace of the type of *H. pilosus* Hunter. *Pterallastes borealis* Cole quite evidently belongs near *perfidiosus* in the genus Lejops.

The collections upon which this paper is chiefly based are those of C. L. Fluke, C. H. Curran (now incorporated in the Canadian National Collection), the University of Wisconsin Collection, Canadian National Collection and that of the late A. L. Lovett. In addition, many other collections have been examined, including the Museum of Comparative Zoology at Cambridge (Loew and Osten Sacken collections); United States

National Museum; American Museum of Natural History, New York; Boston Society of Natural History; Kansas University, Lawrence; University of Minnesota; Cornell University; Royal Ontario Museum, Toronto; R. C. Shannon; Dr. J. Bequaert; and A. L. Melander. These collections contain thousands of specimens and undoubtedly constitute the majority of specimens in North America. In addition, many collectors in various parts of the United States and Canada have submitted specimens for determination. Wherever material permits, Palaearctic species in the Curran collection have been included in the keys and brief notes given.

Owing to the detailed descriptions, it has been found necessary to eliminate a catalogue of the species. Only references to each of the original descriptions and synonyms are given.

Use is made of the terms: posterior ocellar line (a line drawn between the posterior ocelli) and median ocellar line (a line extending from the anterior ocellus to the middle of the posterior ocellar line); as there is a great deal of variation in the lengths of these lines, the differences are often of specific importance.

Dr. James S. Hine's "Alaskan Species of Diptera of the Genus *Helophilus* with Notes on Others" (Ohio Journal of Science, XXIII, 192, 1923) is the only large paper published on the genus during the past twenty years. Other recent papers containing records have been published, the three most important being: "Syrphidae of Colorado", by C. R. Jones, "Syrphidae of Wisconsin", by C. L. Fluke, and "Syrphidae of Nebraska" by E. E. Wehr. Reference to other papers will be found in the "Syrphidae of Wisconsin".

It has been deemed advisable to recognize the various genera proposed for the different groups belonging to Helophilus. Shannon, in his revision of the subfamilies, etc., recognized at least four groups. We have recognized practically all the genera previously placed in the synonymy and have found it advisable to establish a few others: only one of these, however, occurs in North America. The habitus of the flies in each genus is, for the most part, quite homogeneous and it is felt that the classification is improved by following the course adopted.

It is unfortunate that such well known names as "*conostomus Williston*" and "*similis Macq.*" must be relegated to the synonymy, the latter on account of pre-occupation, but it seems advisable to make the changes at the present time rather than continue the use of invalid names.

MODIFIED TABLE TO GENERA OF HELOPHILINI

A. Diptera with spurious vein between third and fourth longitudinal veins ---------------------- *Syrphidae*

B. Anterior cross vein oblique, terminating at or beyond the middle of the discal cell; third vein with a strong, more or less V-shaped, curve into first posterior cell; each femur at the base antero-ventrally with a small patch of black setulae--------- *Eristalinae*

C. Marginal cell open--------------- *Helophilini* – 1

1. Hind femora at the end with a triangular area before the tip, the base of this with a distinct spur --- *Merodon*

   Hind femora arcuate or plane, not with a triangular projection, if swollen apically the spur is not present---------------------------------- 2
2. Eyes pilose --- 3

   Eyes bare --- 4
3. Thorax with pollinose yellow crossbands; pile moderately abundant; not bumble-bee-like (Europe) ------------------------------------ *Myiatropa*

   Thorax at most slightly pollinose, not with distinct bands; pile very dense, largely obscuring ground color; somewhat bumble-bee-like------- *Mallota*
4. Arista of the male extraordinarily dilated at tip, of female slightly so (Europe)------- *Platynochaetus*

   Arista simple, bare ------------------------------------ 5
5. Large species, the thorax thickly yellow or orange pilose; hind femora swollen and arcuate in both sexes; hind tibia without long apical spur; rather bumble-bee-like flies -- *Mallota*

   Generally smaller, the pile not long and dense; if hind femora arcuate the tibiae with long apical spur and coxae with spur; not bumble-bee-like ------------------------------------- 6
6. Mesonotum densely, evenly yellow pollinose, the ground color nowhere evident; face evenly concave in female; with tubercle, but retreating below in male; abdomen wholly black ----------------------------------- *Pterallastes*

   Mesonotum not entirely yellow pollinose: if almost so the face is more prominent below in male and female, seldom evenly gently concave, the abdomen not wholly black-------------- 7

7. Hind femora of male large, arcuate, abdomen chiefly red; hind femora of female not arcuate, thorax densely pollinose, obscuring ground color; abdomen normally with interrupted greyish yellow pollinose fascia on each segment; face with small tubercle, retreating below; no stigma but stigmal crossvein present; large species, 14 to 17 mm.--*Polydontomyia*
   Not with all these characters; if doubtful the stigma is twice as long as wide or the size is not over 11 mm. *Helophilus* s. lat.

TABLE OF GENERA OF HELOPHILUS S. L.

1. Face wholly pollinose, without a shining median vitta -------------------------------------- 2
   Face with a shining median vitta on at least the lower half -- 5
2. Face produced into a long, acute cone (Subgenus of *Lejops*)--------------*Eurhimyia* Big., page 273
   Face not strongly produced------------------------------------ 3
3. Eyes of male, contiguous or closely approximated; posterior basitarsi with nodulate pubescence below on at least the basal half (Europe, Asia, Africa)-----*Mesembrius* Rond., page 229
   Eyes always broadly separated; hind tarsi with normal hairs ------------------------------------- 4
4. Abdomen short, not twice as long as wide; hind tibiae truncate at apex. (Fig. 25) ------------------------------*Parhelophilus,* page 230
   Abdomen elongate, with parallel sides or tapering, over twice as long as wide; hind tibiae produced at apex below. (Fig. 32)--*Lejops* Rond, page 254
5. Stigma at least twice as long as wide, although often paler apically, not simulating a crossvein; large species, abdomen broad----------------- 6
   Stigma simulating a crossvein (Fig. 22)-------------- 8
6. Scutellum tuberculate at each side apically (N. Zealand) ------------------------*Pilinasica* Mall.
   Scutellum not tuberculate------------------------------ 7
7. Hind femora with a long, sub-basal spur below (New Zealand), Genotype *Syrphus trilineatus* Fabr.)-------------------*Prohelophilus* new genus
   Hind femora without such spur (Palaearctic, Nearctic and Australian Regions)-------- ---------------------------*Helophilus* Meig. page 211
8. Front very broad; posterior ocelli remarkably remote; the ocellar triangle very large or very flat; either the front strongly swollen

below or the face with distinct tubercle; abdomen always broad ---------------------------- 9

Front moderately broad or rather narrow; never unusually large; face, or the front not as described, though often prominent at middle; face rarely tuberculate, in which case the ocellar triangle is small ------------------ 10

9. Front remarkably swollen below; genital claspers remarkably long; ocellar triangle of moderate size; bright colored spp. (S. Am.) ----------------------------*Dolichogyna* (Fig. 28)

Front not remarkably swollen, ocoellar triangle very large; genital claspers normal; dark colored, except sometimes on abdomen, (North America) (Figs. 11, 12) ----------- ------------------------*Asemosyrphus* Big. page 247

10. Face carinate, more or less retreating (Africa, Asia, E. Indies) --------------------------*Mesembrius*

Face tuberculate in both sexes; small dark colored species with broad abdomen and brassy yellow pile (North America) ------------- ----------------------*Lunomyia* new genus, page 252

Key to the Species of Helophilus

1. Face with a median shining black stripe---------------- 4

Face with a median shining yellow or reddish, rarely ferruginous stripe-------------------------- 2

2. Front of male narrow, wholly black pilose above the depression; of the female wholly black pilose ------------------------------*fasciatus* Walk.

Front of male wider, only black pilose on the upper half of the narrowed portion; of the female, broadly yellow haired below--------------- 3

3. European -----------------------------*trivittatus* Fabr.

American ------------------------------*latifrons* Loew

4. Apical fifth of hind femora and basal half of their tibiae reddish yellow; third antennal joint brown ---------------------------------- 8

Hind femora with only the narrow apex or a narrow preapical band reddish and only the basal third of their tibiae yellow------------------ 5

5. Third antennal joint usually largely reddish; abdomen with three or four pairs of transverse oval spots; hind femora often reddish at base; thoracic vittae irregular-----------*obscurus* Lw.

Third antennal joint brown or black; never clearly reddish; abdomen variable, not with oval spots, the hind femora never reddish at base; very dark or chiefly pale flies---------------- 6

6. The spots on the third abdominal segment occupy most of the segment; thoracic vittae never interrupted (Europe, N. A.)--------*hybridus* Lw.
   The pale spots on the third segment are not the predominating color, the segment being at least half black and shining; thoracic vittae often interrupted ---------------------------------- 7
7. The apex of the second segment is black in its entire width or practically so-----*groenlandicus* O. Fabr.
   The apex of the second segment is broadly orange on the sides, so that the whole base of the abdomen to the middle of the third segment is orange laterally---------------*borealis* Staeg.
8. Posterior tibia black on the apical two fifths or more; pollinose section of front of male above depression distinctly longer than wide; ocellar triangle equilateral (Europe)--*pendulus* L.
   Posterior tibia reddish on apical half, yellow on basal half; pollinose section of front above depression wider than long; ocellar triangle decidedly wider than long (Saskatchewan)-*intentus* n. sp.

Helophilus groenlandicus O. Fabricius.

Tabanus groenlandicus Fabr., Fauna Groenl., 208, 1780 (Greenland)
H. arcticus Zett., Ins. Lapp., 595 (1839) (Lappland).
?*H. bilineata* Curtis, Ins. of Ross' Exp., LXXVII, (1831).
?*H. latro* Walker, List III, 607, 1849. (Ont., N. S.)
?*H. androclus* Walk., List III, 612, 1849. (Ont.)

Plate V, figures 4, 5

A deep black species, face with black stripe, thoracic vittae narrow; abdomen with three interrupted pale fasciae, the black apical band and second segment entire; the mesonotum usually largely black, pilose on the disc behind the base of the wings.

Length, 11–12 mm. *Male.* Face black, the sides broadly, yellowish on upper half or more, the middle stripe, oral margin and cheeks shining, elsewhere densely pale yellowish pollinose, the pile rather abundant, whitish; in profile, moderately concave on upper two-fifths, the lower portion with a slight tubercle occupying its upper third, moderately produced below the eyes. Front with pale yellow pollen, broadly shining above; a subtriangular area immediately above the antennae also shining black; pile black, below the groove and slightly above it and at the vertex, yellowish. Occiput greyish pollinose, with yellowish pile. Antennae black, third joint slightly longer than wide, its sides almost parallel, its end obtusely rounded; arista yellowish.

Mesonotum rather dull black, the sides more or less densely greyish pollinose; with a pair of widely separated greyish, narrow, usually entire greyish vittae, one on either side of the middle line. Middle portion of pleura lightly pale pollinose. Pile yellow, brighter laterally; behind the root of the wings, but not reaching any margin, sometimes all black, but often this is reduced to a small black pilose area on either side. Scutellum brownish yellow, the base narrowly black, the pile short, black, longer, yellow on the margins.

Legs black, the narrow apices of the femora, basal fourth or fifth of front and hind tibiae and basal half or less of the middle ones, yellow. Pile black, on the basal half of the middle femora behind and on upper surface of hind ones, inner side of front, postero-ventral surface of hind, base and both anterior and posterior surfaces of the middle tibiae, more or less yellow.

Wings pallidly cinereous, the stigma brownish or brownish yellow, the veins very dark. Squamae yellow, with yellowish fringe. Halteres yellow.

Abdomen opaque black, the apices of the second to fourth segments increasingly widely shining black, the last mentioned half shining, the side margins also shining. First segment lightly greyish pollinose. Second segment with large yellow triangles, not reaching the hind border, their posterior margin a little oblique, the posterior corners usually rounded off slightly, the anterior inner corners usually rather acute, their anterior surface a little concave, the spots reaching the base of the segment broadly at the sides. Third segment with a large basal, sub-rectangular spot occupying two-thirds the length of the segment and extending inwards to occupy one-third the width, the inner ends produced more behind and with a greyish, slightly oblique interior prolongation, the inner ends moderately separated. Fourth segment with a pair of oblique, slightly lunulate, narrowly separated greyish pollinose spots on the front half, their outer ends near the middle of the segment, both ends rounded. Pile short, yellowish, longer laterally, on the posterior half of the second to fifth segments, black, but not reaching the sides. Genitalia almost all pale haired.

Female. Front moderately wide, slightly narrowing above, pale yellowish pollinose but less thickly so on the middle portion, ocellar region bare; pile black except at vertex and a few hairs on the sides below. Legs a little more extensively pale.

Abdomen somewhat more extensively shining, the spots on the second segment narrower, especially the inner arms; only the small corners of the third segment orange, a pair of transverse, very slightly lunulate spots, narrowly separated in the middle, separated from the front margin by less than their width, greyish white pollinose, lying wholly before the middle of the segment. Fourth segment not reddish on basal corners, the pollinose fascia similar to that on preceding segment, less widely separated from base, and not reaching the side margins; fifth segment with similar fascia. The black pile on posterior half of the segments reaches the side margins.

Redescribed from a male, Loew Collection; 2 male, 2 female, Hopedale, Labrador; male, Peaceful Valley, Colo.; female, Lake Opasatika, Que. Over one hundred specimens from Pingree Park, Colorado, 1924.

A very distinct species because the black of the hind margin of the second segment reaches the sides in both sexes. There is considerable variation in the amount of black pile on the posterior part of the thorax and it may be all wanting.

Helophilus borealis Staeger

H. borealis Staeger, Kroyer's Tidskrift, n. ser., I, 359, 1845. (Greenland)
H. glacialis Loew, Stett. Ent. Zeit., 1846, p. 121 (Aldr. Cat. gives 43, 120). (Labrador)
H. dychei Williston, Can. Ent., XXIX, 136, 1897. (Alaska)
H. bruesi Graenicher, Bull. Wis. Soc. VIII, 40, 1910, (Wis.)
?*Eristalis androclus* Walk., List III, 612, 1849.

Allied to *groenlandicus,* but the abdomen is all yellowish pilose except a small apical triangle on each segment, sometimes wanting on second and third.

Length, 12–13. 5 mm. *Male.* A middle stripe, narrow oral margin and cheeks shining black, the face elsewhere yellowish red and densely yellow pollinose, the pile pallidly yellowish. Face in profile moderately concave on upper two-fifths, its lower portion slightly receding and a little convex, two-fifths of the face lying below the lower border of the eye. Front with parallel sides above the depression, moderately wide, but the upper portion decidedly longer than wide; before the suture with whitish yellow pollen, but it becomes yellow or even brownish yellow on the upper portion of this part and is brownish yellow on the upper part, practically bare across the ocelli; a broad shining black arch immediately above the antennae; pile yellow on lower portion, on lower part of upper portion and at vertex, elsewhere black. Occiput greyish yellow pollinose, with yellowish pile which becomes almost whitish below. Antennae black, the third joint velvety brown, irregularly circular, not oval, slightly broader than long, the arista twice as long as antenna, tapering, ferruginous.

Mesonotum rather dull blackish, the sides aeneous or thinly greyish pollinose, with a pair of broadly separated longitudinal almost whitish, slender stripes, widest anteriorly and often scarcely evident on posterior half; in some specimens practically wanting, in others reaching the scutellum and slightly broadened behind.

Pleura thinly greyish yellow pollinose. Scutellum yellow, the narrow base blackish. Thorax wholly greyish yellow pilose, or with some black pile in front of the scutellum, the latter yellow pilose.

Legs black, the apices of the femora, basal third or less, of front and half to two-thirds of the middle tibiae, yellow. Pile on femora black, yellow behind the front four and on dorsal surface of hind ones; on tibiae mostly yellow on front four, only of this color on front side of hind ones, elsewhere black.

Wings almost hyaline, very slightly cinerous. Stigma yellowish brown. Squamae whitish yellow, with yellowish pubescence and white fringe. Halteres yellow.

Abdomen over half shining greenish black, the second segment except the apex, basal half of the third and a small basal spot on the middle of the fourth, more or less opaque, scarcely so in some specimens, the second and third segments with yellow spots, the third and fourth each with a pair of greyish pollinose, transverse spots. The sides of the second segment are wholly rather broadly yellow, expanding to form a large triangle, the two thus formed being broadly separated in the middle, slightly concave in front, slightly convex behind, their posterior inner ends rounded, so that the front end is acute, the posterior margin of the spot oblique; the black on the posterior margin usually extends over half way from the middle line to the side margin, sometimes, two-thirds the distance. Third segment with a small rectangular orange spot on anterior angles, and, on each side of the middle line with a slightly oblique, elongate oval greyish pollinose, spot, the inner ends of the two moderately separated. Fourth segment with a pair of similar spots which are, however, less widely separated, a little more oblique, and slightly narrower. The abdominal pile is all pale, except a small apical black pilose triangle on the apex of the fourth segment, which may be enlarged, in which case the third segment bears a triangle. Genitalia all pale behind.

Female. Agrees closely with the male; the only conspicuous difference is found in the abdominal pile. Second segment with a narrow apical fascia of black pile on the median half, the third with a wider one broadly separated from the lateral margins; fourth segment with the incomplete black haired fascia angularly produced forward in the middle, the fifth with a large apical triangle of black pile almost reaching the base. The extent of the black pile is somewhat variable.

Male. Greenland (von Moschler); from the Loew Collection; specimens were compared with the type. Over 100 specimens from Alaska, Labrador, all Canadian provinces, New England States, N. Y., Wis., Minn., Idaho, Ore., Colorado, and Washington. This species was not recognized by Williston, but he described one of the darker, more shining specimens as *H. daeckei* on material from Alaska, the type of which was examined.

Helophilus latifrons Loew.

H. latifrons Loew, Cent. IV, 73, 1863 (Nebr.).
H. trivittatus Auct. (N. America).

Plate V, figures 7, 8.

Second and third abdominal segments chiefly lemon yellow in male, rather variable in female; face with the middle line always yellow or reddish yellow, never ferruginous or black; front of male only black pilose across ocelli, of female yellow pilose on lower third.

Length, 11 to 15 mm. *Male.* Face yellow, densely whitish pollinose, the middle line on the lower two-thirds or more, broadly shining; narrow oral margin and cheeks shining black; pile white. Face in profile deeply concave on upper two-fifths; the lower three-fifths more prominent above, sometimes sub-tuberculate, retreating. Front black, yellow just above the antennae; before depression whitish yellow pollinose, above it yellow pollinose, shining black across ocelli and vertex, above the antennae with a rather large shining triangle which may be all yellow or largely brownish, its upper portion forming a slender arm not reaching the depression. Pile yellow, black across the ocelli. Occiput greyish pollinose, more yellow above, with the orbits above narrowly shining. Pile yellow. Antennae black, third joint chiefly reddish, but brown above and apically; sometimes chiefly so; scarcely longer than broad; arista yellow.

Mesonotum opaque black, the lateral margin and a moderately wide, broadly separated sub-median vittae yellow or greyish yellow, the latter joined to the former in front. Pleura whitish or greyish pollinose. Scutellum translucent yellow, the corners only black. Pile of thorax all yellow, except on the disc of the scutellum where it is black.

Front four femora on basal half or less, the hind ones except the apex which also bears a black spot, black. Front four tibiae and middle tarsi all yellow; the front tibiae more or less distinctly brownish on apical fifth, the last three joints of the middle tarsi fuscous; front and hind tarsi black; hind tibiae yellow on basal third, elsewhere black. Pile all yellow, the hind femora with short black, bristly hair below and longer bristles on apical half, and in addition several long black or yellowish hairs. Hind tibiae a little produced apically on inner side, arcuate; their femora rather evenly convex below, except basally.

Wings cinerous hyaline or with slight yellowish tinge, the veins yellow basally; stigma yellow. Squamae whitish or pale yellowish, with yellow border and fringe; the lower lobe strongly pubescent above. Halteres pale yellow.

First abdominal segment black, its sides very broadly pale yellow, wholly thinly greyish pollinose. Second segment pale yellow, the base on the middle two-thirds, its hing margin oblique, and rather broadly connected in the middle with a rather narrow subapical band, opaque black; the middle connection usually narrowest anteriorly always widened behind, the posterior fascia widest at middle, slightly but distinctly narrowed to the sides, usually very narrowly separated from the lateral margin; very narrow hind margin reddish, preceded by a narrow shining black fascia. Third segment similar in color, usually with an oval, anteriorly transverse, sometimes with a more elongate, basal spot on the middle fourth, moderately broadly connected with the broad apical fascia, sub-opaque black, often chiefly shining, but the median connection is usually almost all pollinose so the yellow appears to extend entirely across the middle of the segment, the black posterior fascia is biconvex, reaching forward in the middle, and more or less so laterally, but the sides opposite and posterior margin are narrowly reddish. The fourth segment has only the narrow, lateral and apical margins reddish, but there may be a slight broadening of the reddish towards the front; on the anterior half is a rather broad, anteriorly and posteriorly biconcave greyish to yellowish fascia, which is narrowed towards the middle and almost reaches the base at this point in some specimens, spreading more or less along the margin posteriorly. Pile yellow, short, on the apices of the second and third segments, reaching the sides, moderately broadly black; on the fourth segment not reaching the sides, all black behind the fascia.

Female. Abdominal markings usually very different from male except in newly emerged specimens as they very often turn blackish in large part. Face usually slightly less concave; front broadly or narrowly black pilose across the ocelli and a little before them; whitish pollinose on sides below, less thickly so on the broad middle line, the pollen here and above more yellowish, the black shining color as in male.

Abdominal segments shorter, the black more extensive; the anterior curved fascia of the succeeding segment is narrower, the yellow only a little more than half as wide in the middle in most specimens, the posterior fascia slightly wider and less narrowed laterally. Usually the basal black fascia on the third segment extends three fourths across, but, sometimes as in the male, the posterior fascia is wider, occupying almost one-third of the length of the segment: this leaves the yellow as a narrowly interrupted basal, broad fascia, concave on the front border towards the middle, connected at the middle by yellow pollen. Fascia on fourth segment as in male, fifth segment similar but the fascia reaching the base on broad middle portion. Apices of second and following segments broadly black pilose, reaching the sides on only the second, and sometimes the third segment. In almost all the darkened specimens the outlines of the yellow areas are usually quite evident as outlined above, but there is a strong inclination to narrow the spots so that the black predominates, the yellow or orange color forming lunulate, usually complete fasciae on the second and third segments; these lunules very seldom interrupted in the middle.

Described from numerous specimens from all parts of the United States and Canada, April to October.

Helophilus latifrons shares with *H. fasciatus* the distinction of being the most common species in America. Its range extends even into South America where it has been recorded by various European entomologists as *H. trivittatus.* While the two species bear a most remarkable resemblance in almost all respects they are quite distinct. *H. latifrons* is not quite as large as *trivitattus,* the average length being three millimeters less; the face is distinctly less concave below; the antennae are lighter in color, the third segment of trivittatus is black or almost so in all the specimens we have examined; the female is not almost evenly pollinose, but is more shining except on the sides, the fascia on the third segment is scarcely indented by a black triangle, while there is a large triangle in *trivittatus* and the same applies to the following fasciae but the last fascia is interrupted or practically so in that species, always entire in *latifrons* and the last two fasciae are more transverse in the latter. In the male the lumules on the fourth segment are larger and much more oblique, and are narrowly interrupted or sub-interrupted in *trivittatus* and the front femora are over half black. The distinctions between the two species may not appear great from the above, but examination reveals other slight differences and they appear quite distinct when seen together.

There is really no question of synonymy in connection with this species, except that it has been recorded as *trivittatus* from Central and South America.

While we have seen many specimens from Mexico, which are the present species, we have not seen a single *trivittatus* and therefore feel certain that all references to the European species from America are erroneous.

Helophilus trivittatus Fabricius

Eristalis trivittatus Fabricius, Antl., 235, 1805 (Europe).
?*Musca parallelus* Harris, Expos. Engl. Ins., 57, Pl. XV, f. 8 (1776) (Europe).
H. camporum Meigen, Syst. Beschr., III, 372, 1822 (Europe).

Plate V, figure 3.

Extremely like *H. latifrons* Loew. The differences between these two species have been dealt with under *latifrons* and need not be repeated. No specimens have been found in America so far as we know, although the species has been frequently recorded. Its range extends over all Europe and most of Asia. The senior author found it commonly in England and Northern France near suitable breeding places. Verrall includes *H. latifrons* Loew as a synonym but in this he was wrong.

Helophilus fasciatus Walker

H. similis Macquart, Dipt. Exot., II, (2), 64, 1842. (Ga.) nec Curtis.
H. fasciatus Walker. List III, 605, 1849 (Ont.).
Eristalis decissus Walker, List III, 614, 1849. (Ont.)
H. sussurans Jaennicke, Neue Exot. Dipt., 94, 1867. (Ill.)

Plate V, figure 6

Allied to *H. latifrons* but the abdominal bands are narrower; the front is much narrower and the black pile occupies all the front above the depression in the male and all the front in the female. The legs are more extensively black.

Length, 10 to 15 mm. *Male.* Face yellow, thickly yellow pollinose, the middle line broadly shining reddish yellow to ferruginous but never black, the oral margin and cheeks shining black; pile pale yellowish; in profile concave on upper three-fifths, convex below this, the lower two-thirds convex receding, without distinct tubercle although the formation approaches one. Front narrowed above the upper portion nearly twice as long as wide, except on the upper fifth yellow pollinose, the pollen paler on the sides before the depression and often somewhat reddish in the middle and above; immediately above the antennae reddish, the polished triangle chiefly blackish. Occiput yellow to greyish pollinose; with yellow pile. Front black pilose above the suture, yellow below it except sometimes several hairs immediately above the antennae. Antennae reddish, sometimes more or less ferruginous, the third joint brownish above and apically; arista reddish.

Mesonotum opaque (or sub-opaque black, in old specimens), the side margins and broadly separated sub-dorsal stripes opaque yellow or pale greyish, more or less narrowed towards the posterior margin, but sometimes the middle ones a little broadened here, the pale vittae not joined in front. Pleura yellowish grey pollinose. Scutellum translucent yellowish, the very narrow base and the corners black or brown. Pile of thorax all yellow, short, on the disc of the scutellum black.

Femora black, the apical third or less of the front four and the apex of the hind ones reddish yellow; middle tibiae wholly, front ones except the apical third, hind ones on basal third or less and the first two joints of the middle tarsi, yellowish or reddish, the legs elsewhere black. Hind femora moderately broadened, widest at apical third, below with dense black short, coarse hairs and with fine bristles on apical half, and a few long black or yellow hairs, the pile all yellow elsewhere.

Wings cinereous hyaline often quite yellowish anteriorly basad of tip of first vein. Stigma luteous. Squamae whitish, with pale yellow border and yellow fringe, with short pale yellowish pubescence on the lower lobe above. Halteres yellow.

Abdomen opaque black, with large yellow spots on the second and third segments, the fourth segment fasciate with pollen. First segment greyish pollinose except behind the corner of the scutellum the sides broadly yellow. Second segment chiefly yellow the black forming a rather broad basal facia which is almost as long as the width of the thorax, broadly connected on the middle line with the moderately broad posterior margin, the apex shining, the immediate apex narrowly reddish on middle part; the posterior fascia is of almost equal width but is slightly widened at middle and sides but reaches or is very narrowly separated from the lateral margin. Third segment yellow on basal two-thirds with an oval black spot in the middle at the base, connected in almost its full width with the black posterior border, but, in well preserved specimens more or less broadly pollinose on the connection so that the anterior spot appears isolated; the posterior margin is moderately broadly shining, the apex reddish, or sometimes the shining portion is all reddish. The yellow is biconvex behind so the black reaches forwards at the sides, and usually attains the lateral margin. Fourth segment with the narrow lateral margin and rather broad apex reddish or obscurely so, sub-basally with an abbreviated, almost transverse yellow or greyish pollinose, sub-basal fascia, its anterior margin gently concave on either side, narrowed in the middle, so that its posterior margin is somewhat oblique on either side. Pile yellow, short; shorter and stouter on each segment behind the fasciae and reaching the sides on all but the last.

Female. Abdominal fasciae narrower, the front all black pilose. Front narrowed above, yellowish pollinose, the middle line darker and with thin brownish red or yellowish pollen.

Abdominal segments shorter. The black basal fascia on the second segment extends slightly more towards the sides and is quite as wide as the thorax, the yellow spots are sharper inwardly, seldom obtusely rounded as in male. The fascia on the third segment occupies but little over half the width of the segment. The pollinose fascia on the fourth segment is narrower, but slightly narrowed in the middle, its outward posterior portion convex so that each side appears slightly lunulate. The fascia on the fifth segment reaches the base on its middle portion or is narrowly separated laterally, increasingly so towards the margin; it is slightly widened laterally; the segmental margin is yellow as in the preceding. The pollen is always yellow in this sex.

This species is probably more abundant than *latifrons* in most parts of North America, but seems to be a little more northern in distribution even though it extends into Mexico. It is also an earlier appearing insect in most localities and is common on bloom.

Helophilus fasciatus is readily distinguished from its close ally, *H. latifrons,* by its much narrower front in the male and wholly black pilose front in female and also in this sex by the yellow pollinose abdominal fasciae, the male differing less in this respect. The legs are more extensively black. It is a rather variable appearing species, but we are unable to find any differences between the small specimens with grey pollinose fascia and the large ones with yellow, and, notwithstanding the different appearance, a careful analysis shows the distinctions are more apparent than real. *Helophilus pendulus* and *hybridus* have a strong black middle fascial line.

It is with regret that we are forced to change the name of this species, which is so well known as *H. similis* Macq., to that used by Walker, but it is quite evident that Macquart's name cannot be used. As pointed out by Williston, the name *similis* already existed for a British species, which was later however referred to *H. pendulus* L. There is not the slightest excuse for retaining Macquart's name, as might have been done had Curtis' species been placed in another genus, although even this practice appears to be poor policy. The fact remains that we still have a name *similis* for a species in this genus, even though it be a synonym. From the descriptions both *Eristalis decissus* Walker and *H. susurrans* Jaenniche appear to be undoubtedly this species.

Helophilus pendulus Linne

This European species is readily distinguished from *fasciatus*, which it resembles in many respects, by its deep black, shining facial stripe, black basal antennal joints, still more blackish femora, except the hind ones, more reddish posterior tibiae, and always isolated yellow spots and fasciae, as they are all interrupted in the middle. The black facial stripe distinguishes it also from *latifrons*, and the much narrower abdominal yellow spots, and much more extensively reddish hind tibiae separate it from *hybridus*.

Hine, in his recent article, recorded this species from Alaska, but an examination of his specimens, which he so kindly sent us, show them to be *intentus* n. sp.

Helophilus intentus new species

Plate V, figures 9, 10

Allied to *H. pendulus* L. but the hind tibiae are wholly reddish, the frontal projection weaker, front wider, the upper pollinose section being wider than long instead of distinctly longer than wide, etc.

Length, 10 to 11 mm. *Male.* Face yellow, the broad median stripe, oral margin and cheeks black, the cheeks in front and median vitta shining although the latter is thinly greyish pollinose above. Face with yellowish white pollen, which has a slight brassy reflection: in profile the lower two-thirds almost perpendicular (a slight indication of tubercular swelling above), the upper third rather evenly concave. Frontal prominence with a shining full V-shaped area above, the upper fourth subshining black, the balance ochreous pollinose. Upper section of front three-fifths as wide as long, and one-half as wide as one eye measured at the middle; ocellar triangle twice as wide as long, very short. Face with almost white pile; front on lower half, or slightly less, yellow pilose, the upper half with black pile. Occiput yellow pollinose above, greyish pollen on the lower two-thirds and cheeks; pile yellow above, white below; no black occipital cilia. Antennae shining black; the third joint reddish, but broadly reddish brown above, sub-orbicular, a little longer than wide; arista reddish.

Mesonotum opaque black, the broad lateral margins and moderately broad submedian vittae bright yellow, or slightly greyish at ends, the latter pair tapering slightly but again broadened before the scutellum. Pile thick, yellow, becoming white on the lower portion of the pleura; scutellum translucent reddish luteous with narrow black base and much coarser black pile than on the pleura, the immediate margin with pale hairs.

Coaxe black, grey pollinose, whitish pilose, the pile of the front pair very short. Femora black; a little more than the apical fourth of the front and hind pairs and apical third of the middle ones, reddish; tibiae reddish, paler basally; anterior pair broadly brownish at apex, the hind ones with ferruginous tinge on sides of apical third, tarsi black, the middle basitarsus reddish. Pile of legs yellowish; black on the upper surface of the tarsi; the narrow anterior lower edge of the middle femora except basally, and beneath the hind femora, where the hairs are short, rather bristly, and some black, fine spines towards the outer end.

Wings strongly tinged with cinereous or even somewhat luteous on basal half or more in front. Squamae whitish, with yellow border and fringe; halteres pale yellow.

First abdominal segment black, grey pollinose, the lower side pieces pale yellow; second segment opaque black with the narrow apex shining black; on each side with a large pale yellow triangle reaching base and apex broadly, more or less obtusely rounded in the middle and moderately widely separated from each other; they cover more than half the segment; apex of segment narrowly reddish except the sides; yellow triangles covered with yellow pollen. Third segment with a large, basal, reddish or orange spot on either side, reaching four-fifths the distance to the apex and moderately broadly connected with the narrow reddish apex at the sides, their inner end oblique so that their inner posterior end is broadly rounded but is covered by yellow pollen which projects inwards and forwards; posterior margin of the spots a little oblique; spots yellow pollinose; narrow preapical fascia shining black; short basal fascia, median vitta and short facia behind the spots, opaque black. Fourth segment with the narrow lateral margin and broader apex shining reddish yellow, the segment elsewhere shining except for the broad, ochreous pollinose lunules, which are narrowly bordered with opaque black, rounded inwardly and the inner ends somewhat nearer the base than the outer ends. Pile black on the black areas, except: the first segment, base of second, lateral margings of fourth, increasing in width behind, and the lower margins of the second and third segments which are otherwise black pilose behind the middle of the second segment. Pile on pale areas pale yellow; on the genitalia dense, long, yellow.

Female. This is very similar to the femal of *pendulus* but the wholly pale posterior tibiae will separate it.

Holotype. Male, Farewell Creek, S. Saskatchewan, Sept. 1907, No. 2224 in the Canadian National Collection, Ottawa; *allotype*—female, Savonaski, Naknek Lake, Alaska, July, 1919, (J. S. Hine); in Hine Collection.

Paratypes. Male, Farewell Creek, S. Saskatchewan, Sept. 1907, in collection of C. W. Johnson; six males, six females, Savonaski, Naknek Lake, Alaska, July 1919, in collections of J. S. Hine, C. W. Johnson and C. L. Fluke.

This species has very much the habitus of *H. pendulus* L. but the differences pointed out are sufficiently striking to warrant its separation. It might be confused with *H. obscurus* Lw. but that species lacks the sharp points to the spots on the third segment and those on the fourth are only slightly lunulate, much broader and not oblique.

Helophilus hybridus Loew

Plate VI, figure 11

H. hybridus Loew, Stett. Ent. Zeit., 1846, 141—Europe.
H. novaescotiae Macq., Dipt. Exot., Suppl. II, 60, 1847—N. S.
H. latitarsis Hunter, Can. Ent., XXIX, 134, 1897—Minn.

Face with median black stripe; pale markings very extensive on second and third segments of abdomen; in the female much less extensive, those on third segment sharply rounded on inner ends.

Length, 13 to 15 mm. *Male.* Face yellow pollinose, a large triangle on the cheeks, narrow oral margin, broad median stripe, supra-antennal triangle and upper third of front shining black; facial vitta with pollen on upper fourth. Front and back of head bright yellow pollinose. Pile yellowish; on the cheeks and lower orbits white; on upper third or less of the front, (except the vertex) black. Face prominent below, convex on a little more than the lower half, the concavity however occupying more than the upper half. Antennae black; arista red. Ocellar triangle wider than long, moderately large.

Mesonotum opaque black, the wide lateral vittae and moderately wide dorsocentral vittae, yellow pollinose; pleura with greyish yellow pollen. Pile of thorax luteous. Scutellum translucent brownish yellow, darker at base and sides, black pilose except on base and apical margin.

Legs black; broad apices of the anterior four femora, basal third of the front, whole of the middle tibiae, basal fourth of the hind pair and whole of middle basitarsi, reddish yellow; posterior femora with preapical reddish band which is broadly interrupted postero-dorsally. Femora black haired above and below, the bases usually more or less broadly pale haired; the tarsi and under side of hind tibiae also with black hairs; legs elsewhere with yellowish hair.

Wings cinereous hyaline. Squamae whitish with bright yellow border and pubescence and yellow fringe. Halterers yellow.

Abdomen with three pairs of reddish yellow spots or the last pair yellowish grey pollinose. First segment shining black with the sides broadly yellow. Second segment chiefly dull reddish yellow, with the apex reddish on at least the median half and opaque black markings as follows: a broad median vitta which narrows slightly behind where it is connected with a rather narrow subapical fascia which never extends to the lateral margins except rarely as a ferruginous stripe, the median vitta expanded so as to be slightly wider than the black of the mesonotum. Third segment with the apex reddish preceded by a shining black fascia which usually reaches the lateral margins, and an opaque black median vitta which narrows rather sharply to the basal fourth of the segment where it connects with a transverse basal spot which is hardly three times as long as wide and more or less rounded on its outer ends posteriorly; the yellow ground is supplemented by some greyish white pollen so that the pale spots are rather acute inwardly at their middle; pale spots occupying three-fourths or slightly more of the segment at the sides. Fourth segment shining black, with a very narrow, incomplete basal sub-opaque black fascia which is usually narrowly connected with a median opaque black triangle lying between the inner end of the large yellowish grey or greyish yellow pollinose spots which occupy more than the basal half of the segment sub-laterally, are convexly narrowed inwardly and slightly arcuate in front; posterior margin and narrow lateral margin reddish. Genitalia ferruginous. First two segments yellow pilose except the broad posterior margin of the second and the side margins on the posterior half; posterior third of third segment (except the pale spots) and the whole of the lateral margin at base, black pilose; fourth segment with the shining black area and apex black-haired; pile of abdomen elsewhere pale yellowish. Second and third ventral segments usually all yellowish.

Female. Front with a band of yellowish pollen in front of the ocelli interrupting a median black vitta; front black pilose in the middle below and on upper half except the vertex.

Abdominal markings much as in *obscurus* but the spots are larger, being more truncate inwardly on the second segment, more acute on the third and not at all oval on the remaining segments, but transverse, narrow and narrowly separated from each other.

Specimens are before us from Northern Ontario, Manitoba, Saskatchewan, Alberta, British Columbia and the Northwest Territories. Other localities include Nova Scotia, Minnesota and North Dakota.

The male is readily distinguished by the very large pale abdominal markings. The female resembles *obscurus* much more than would be expected and is probably most easily separated by the wholly pale third ventral segment, this being largely shining black in *obscurus,* but the abdominal fasciae are quite different in shape upon close examination. The irregular median vittae of *obscurus* also readily separates the two species. European specimens from England and Denmark do not differ.

Helophilus obscurus Loew

Plate V, figures 1, 2

H. obscurus Loew, Cent. IV, 74, 1863. (Colo.)

Face with median black stripe; abdomen of male with 3 pairs of, of female 4, transverse, more or less oval spots, the first pair large and somewhat triangular, the last pair slightly lunulate in male.

Length 10 to 13.5 mm. *Male.* Face orange yellow, the middle line reaching almost to the antennae, oral margin and cheeks, shining black. Yellow portions of face and front to well above the suture densely yellow pollinose, the pollen on the face usually pale. Face moderately excavated on upper two-thirds, slightly retreating on lower portion. Front narrow above, on the upper half or more of the narrow portion, except the venter, black pilose, elsewhere with yellow pile. Occiput yellow pollinose on about the upper half, the lower half with greyish yellow pollen and white hair. Antennae black, the third joint largely or almost wholly red, the upper and apical margins brown. Arista orange yellow.

Mesonotum deep, black, only sub-shining in some lights, the side margins and a pair of broadly separated, sub-median vittae, yellow or pale yellow, the latter narrowed behind the suture, sometimes interrupted on the suture, usually as before the scutellum, but there are always two wider spots just before the scutellum, and when the vittae are entire they widen behind. Pleura greyish yellow pollinose. Scutellum translucent brownish, its apex reddish; thorax yellow pilose, the scutellum with short, abundant black pile except on its margins.

Legs black. Apices of front four femora, basal third to half of the front tibiae, all the middle tibiae, their apices sometimes slightly darker and the first two joints of the middle tarsi yellow or reddish yellow; hind femora sometimes with their bases, a rather narrow sub-apical band, the basal third of the hind tibiae and sometimes a narrow median band yellow or reddish.

Wings hyaline or tinged with yellow. Stigma brownish. Squamae pale yellow, with yellow fringe. Halteres pale yellow.

Abdomen opaque black, the narrow apex of the second, apex of third and broad apex of fourth segments, shining; with two pair of yellow pollinose spots. Sides of first segment pale yellow;

second segment yellow, except the broad apex, broad median stripe and base, the black on the latter rather rounded laterally and broadly separated from side margins. Base of third segment with a rather broad, sub-oval spot on either side, more widely separated in the middle in front, widely so behind, their posterior margin convex, the spots narrower laterally; at their inner ends posterioly with a small spot of yellow pollen. Fourth segment with a yellow pollinose broad, slightly lunulate spot on either side sub-basally, their outer ends separated from the front and lateral margins, their inner ends separated from each other by about half the distance between the inner ends of the preceding spots. Apices of segments successively more widely, more or less evidently, reddish. Pile black; yellow in front of the hind margin of the yellow markings on each segment and on the sides of the fourth segment. Genitalia usually black; reddish in only one specimen.

Female. Front somewhat narrowed above; black pilose only on the upper half, rarely almost to the antennae, the middle line thinly pollinose, and appearing black; pollen on face and front yellowish white.

Thoracic vittae slightly wider, and rarely interrupted.

Abdomen more shining, the yellow spots narrower, more transverse, those on the third segment only reaching the sides in front. Pollinose fasciae on fourth segment more oval, scarcely concave in front, not lunulate; the basal corners of the fifth segment with transverse, pollinose, triangles, narrowly separated in the middle.

Over 100 specimens from New York, Quebec, Ontario, Manitoba, Alberta, British Columbia, Idaho, Wisconsin and Colorado.

The reddish third antennal joint, and three pairs of interrupted fasciae at once distinguish this species from all others known to us.

Mesembrius Rond

Plate VII, figure 40

The genus Mesembrius does not occur within our range, but is confined to the Old World, being especially abundant in Africa and Asia. It is characterized by the carinate face and the contiguous or narrowly separated eyes in the males and the stigma simulates a cross-vein. Superficially the species included in this genus display the greatest resemblance to Helophilus, but the nature of the stigma forms a ready means of separation.

We are unable to state the number of species which should be included under the genus, as many species described under Helophilus really belong here. Bezzi lists thirteen species from the Ethiopian region, some of which also occur in Asia, and one species is recorded from Europe. It is probable that most of the species of Helophilus listed from Southern Asia and the East Indian Islands belong here.

Another character, which seems to be constant, which may be used to distinguish this genus from all others examined is the presence beneath the hind tarsi of numerous nodulate hairs. Sometimes these hairs are found only at the basal fifth, at other times more than half the tarsal pad is composed of them. In the nine species of Mesembrius which we have examined this character is very well marked and quite easily seen, while we have found no trace of it in any other genera.

Parhelophilus

Girschner, Illustr. Wachenschr., II, 604, 1897

The genus Parhelophilus shows greater affinities to Helophilus than do most of the allied genera previously included under the latter. The abdomen is shorter and more compact, the stigma simulating a cross-vein. The apical production of the hind tibiae is absent, thus readily distinguishing the genus from Lejops. The ocellar triangle, while very broad, is seldom almost equilateral and is always comparatively much smaller than in Asemosyrphus. Genotype, *Helophilus frutetorum* Fabr.

Parhelophilus was not well understood by its founder and could not possibly stand upon the characters used by Girschner. The genus was separated from Helophilus because of slight differences in the squamae, but as these intergrade to a greater or less degree it is evident that the character is of little value. *Lejops lunulatus* was also included in the genus by Girschner, but as that species has the hind tibiae produced, it is quite evident that it cannot belong here. Considered in every way, this is a very compact, homogeneous group and it seems that the isolation of the species into a distinct genus is very desirable.

Table of Species—Males

1. Hind femora with a sub-basal projection below, which may be broader than long and is beset with black setulae ---------------------------------- 2
   Hind femora at most somewhat rounded sub-basally----- 3
2. Femoral process long, bearing an apical fan-like fringe of black hairs (Europe)--------*frutetorum* Fabr.
   Femoral process short, covered with shorter, black setulae ------------------------------*divisus* Loew
3. Abdomen deep black, with three pairs of hoary spots, the ground color reddish only beneath part of the spots on the second segment-----*porcus* Walk.
   Abdomen with yellow ground color on second and third segments, the spots never hoary----------- 4
4. Mesonotum without distinct vittae; hind femora somewhat arcuate ----------------------*obsoletus* Loew
   Mesonotum distinctly vittate; hind femora not arcuate --- 5
5. Large dark species, with 3 pairs of widely separated yellow abdominal spots, unusually narrow front and the basal two-fifths of hind femora yellow -----------------------------*anniae* Brim
   Species of usual size; if with three pairs of broadly separated abdominal spots, the posterior femora are wholly black; front of male wider -- 6
6. Posterior basitarsus with black pile above, the hairs mostly as long or slightly longer than the height of the segment bearing them-------*integer* Lw.
   Posterior basitarsus with appressed short yellow hair above -- 7
7. Apical third or more of anterior tibiae black; posterior basitarsus usually with five or six short, black bristles on apical half of lower anterior surface ------------------------------*rex* n. sp.
   Anterior tibiae wholly yellow or at the most ferruginous on apical fourth; bristles on hind basitarsus, if present, reddish, rarely one or two black------------------------------------ 8
8. Front broadly black pilose immediately above the antennae; the orange color occupies all the sides of the second and third abdominal segments (Europe) -------------------*versicolor* Fabr.
   Front with only a few black hairs above the antennae; posterior black bands of second and third segments entire------------------*laetus* Loew

Females

1. Abdomen black with hoary pollinose spots------*porcus* Walk
   Abdomen not with hoary spots-------------------------2
2. Abdomen opaque black with whitish yellow spots or fasciae------------------------------*rex.* n. sp.
   Abdomen with reddish yellow or orange markings, the pale color predominating------------------ 3
3. Mesonotum without distinct vittae----------*obsoletus* Loew
   Mesonotum with distinct vittae------------------------ 4
4. Face scarcely convex almost straight, slightly produced below -------------------------*divisus* Loew
   Face distinctly concave above, prominent on lower half -------------------------------------- 5
5. Hind femora all yellow below------------------------- 6
   Hind femora largely black below; near their base with long process (Europe)------*frutetorum Fabr.*
6. Hind femora broadly yellow below on only lower surface (Europe)----------------*versicolor* Fabr.
   Hind femora with an anterior and posterior black spot, sometimes joined above (N. America)---- 7
7. Face but little prominent below---------------*laetus* Loew
   Face quite strongly prominent on lower part---*integer* Loew

Parhelophilus porcus Walker

Plate VI, figures 18, 19

Helophilus porcus Walker, Cat. British Dipt. Part III, 551, 1849 (Can.)

Readily recognized by the deep black abdomen with hoary segmental spots.

Length 9 to 11 mm. *Female.* Face yellow, thickly wholly pale yellowish pollinose, narrow oral margin and the cheeks shining brown or blackish. Pile pale, sparse, long. In profile concave above, almost perpendicular below, but still slightly receding, the lower part very slightly convex, strongly produced downwards, rather obtusely conical, the lower portion of the face scarcely less produced than the antennal prominence. Front wide, the sides subparallel, slightly narrowed above the middle, but again slightly widened to the posterior angles of the eyes, which are rounded off. Front shining black in ground color on the lower third, except the reddish supra-antennal W. densely covered with greyish or greyish yellow pollen, which is always darker on its upper margin; pile black abundant, moderately long. Ocellar triangle very broad, the mediam ocellar line scarcely longer than half the posterior ocellar line. Occiput shining black, the orbits broadly greyish pollinose. Pile black on upper half, longest above, short whitish or yellowish on lower half. Antennae ferruginous reddish, third joint sub-orbicular; arista concolorous, long, thickened on basal half.

Mesonotum densely grey pollinose, shining laterally behind the base of the wings; in front on the basal three-fifths with a median, geminate black stripe, slightly divergent posteriorly, a short median stripe just before the scutellum and a sub-lateral stripe not quite reaching either end, opaque black. Pleura black, moderately greyish pollinose, but not entirely obscuring the ground color. Pile on the mesonotum before the suture, less widely so in the middle, and on the pleura except the mesopleura, pale yellowish; elsewhere, black. Scutellum tranluscent reddish, its base and sides black; pile black, on the sides pale yellowish.

Legs black, immediate apices of front four femora, narrow bases of their tibiae and sometimes of the hind ones, and first joint of their tarsi, yellow; all the tibiae with a rather narrow yellow median reddish band; front four tarsi brown, their last joint reddish. Hind femora greatly swollen, somewhat latterally compressed, their tibiae arcuate; front legs slender. Coxae pale haired, the front four with a dense apical ciliation of black hair. Front four femora with black above, with pale pile below; hind femora with shorter, pale pile and black stouter hairs below; tibiae with brownish and brownish yellow short, appressed pile, front tarsi wholly pale, the others chiefly black haired.

Wings cinereous hyaline, stigmal spot brown. Squamae white, with white fringe. Halteres reddish yellow.

Abdomen opaque black, the side margins shining, narrow posterior margin of second to fourth segment, broadened in the middle, on the last two, triangularly, shining black with a greyish sheen, owing to thin grey pollen; the same segments each bearing a roundedly rectangular, transverse spot on either side, these successively nearer the base of the segment, the front ones wider laterally, and more narrowed inwardly, all the spots widely separated, less widely so from the lateral margin. The first segment is all hoary except a roundish lateral opaque black spot; the fifth has a narrow longitudinal basal triangle opaque black, the lateral margins broadly, the apical narrowly shining black, elsewhere greyish. Pile whitish basally, on the hoary spots and side margins opposite and the fifth segment except the middle basally.

Male. Front strongly widened posteriorly, where it is practically twice as wide as at narrowest point; yellowish grey pollinose below the depression; with very scattered greyish pollen in front of the ocelli except at the sides; pile wholly black.

Thorax with a wider black triangle immediately before the middle of the scutellum, the black median vitta only interrupted on its posterior half by the narrow grey line, and narrowly separated from the posterior black triangle. Legs deeper black, the pale markings on the tibiae reduced.

Outer half of the hoary spots on second abdominal segment situated upon reddish ground, the lateral margin shining black, the reddish tinge carried broadly obliquely outward to almost reach the margin broadly behind the basal incissure. Lateral margins shining black opposite the spots on third segment and extending quite to the base; fourth segment more broadly shining laterally. The hoary spots are a little smaller, being less elongate.

Female, Montreal, Que., June, 15, 1906; Female, Banff, Alta., July 4, 1922, (C. B. D. Garrett); Male, Gimli, Man., June 13, 1923, (A. J. Hunter). We have seen specimens from McDiarmid, Ontario, near the type locality; New York, and New England States.

The male was received after the description had been completed in other respects.

Parhelophilus rex new species

Plate VI, figures 15, 16

Belongs to *laetus* group, but much darker, the pale thoracic stripes narrow; opaque black, the abdomen with three pairs of yellow spots.

Length, 10 to 11 mm. *Male.* Face translucent yellowish, densely pale yellowish pollinose, the middle line below and the oral margin broadly shining; narrow oral margin and cheeks, shining black; in profile upper third moderately deeply concave, the lower half slightly receding, scarcely convex, not as prominent as the antennal prominence, only moderately produced below the eyes and therefore obtuse; pile rather long, sparse, yellowish. Front narrowest at lower third, where there is a distinct transverse depression, distinctly widened to the posterior angle of the eyes; lower third yellowish, obscurely blackish above, but wholly yellowish pollinose. Above moderately shining black. Pile yellow before the suture, thick, black above. Ocellar triangle line to outer ocellus greater than the distance between the anterior ocellus and that line. Occiput shining black with a greyish bloom, the orbital margin broadly grey pollinose. Pile yellow, rather long above, the cilia black; on the lower three-fifths short, white, becoming longer and more yellow below and on the cheeks. Antennae reddish; third joint broader than long, obliquely truncate apically, longer below; arista brownish, long, tapering, slightly thickened on basal fourth.

Mesonotum opaque or sub-opaque black, with five greyish vittae, the median one slender, slightly widened posteriorly but fading out at about the posterior third; on either side of the middle line, not quite half way to the lateral strip, is a rather narrow, slightly irregular complete stripe of the same color, which is characteristically broadened inwardly before the scutellum as a long apical triangle, lateral margins broadly of the same color, but subshining, as the pollen is evidently less abundant, the stripe broadening anteriorly and spreading over the humeri to reach the sublateral stripe obscurely. The three median stripes are narrowly bordered by a deeper black. Pleura black with thin pollen of same color as on sides of mesonotum. Pile of thorax tawny or bright reddish yellow; on the pleura less abundant. Scutellum translucent reddish, the base broadly blackish; pile black, on the narrow base and apex yellowish.

Femora black, their apices broadly reddish, on the hind ones with a subapical more or less complete band; hind tibiae with the narrow base yellowish, a reddish band at the middle; front and hind tibiae with narrow base and apex yellow, the sub-basal fourth on outside posteriorly black or blackish, so that apical fourth wholly and the sub-basal fourth on outside posterior black or blackish, so that there appears to be a reddish median band from some views, but the larger portion of the tibiae is reddish. Hind tarsi blackish, the front four reddish with somewhat darker apices. Pile of femora yellowish black on front four posteriorly on apical half or less; similar but all appressed on tibiae and tarsi, but black on exterior surface of the front four tibiae.

Wings cinereous hyaline or faintly yellowish about the middle. Squamae white, with pale yellow border and white fringe. Halteres pale yellow.

Abdomen opaque black; with three pairs of spots and other yellow markings; first segment, the hind margins of the following segments, triangularly expanded in the middle on the third and fourth, and the narrow lateral margins, shining. First segment with an obscure yellow spot in front sublaterally. Second segment with very large lateral sub-triangular spots, occupying the lateral margin on the anterior half, thence cut off by a narrow black triangle, their posterior edge slightly oblique and slightly convex, their inner ends rounded, the anterior inner edge concave, reaching the base of the segment broadly, moderately separated from the posterior margin at sides, and broadly separated in the middle, pale yellow; the inner corners of the spots are situated at the middle of the segment, and some whitish pollen projects slightly onto the black. The spots on the third segment are somewhat similar in shape, but are narrowly separated from or just reach the side margins, are much shorter, occupying about two-thirds the length of the segment, their inner anterior margin not concave, the posterior corners of the spot supplemented by a white pollinose projection which is transversely oval in shape, making the inner ends of the spots appear acute. Posterior margin of the segment yellow on lateral sixth; in the middle with a greyish yellow pollinose triangle. Fourth segment with the posterior margin yellow, the sides and large basal triangles, moderately separated, gray or greyish yellow pollinose, the inner ends of the triangles cut off from the base of the segment by a black triangle; a small yellowish pollinose triangle in the middle apically. Pile black; on the side margins and on the yellow spots, whitish or pale yellow.

Female. Face less sharply concave above, the lower portion more rounded and scarcely receding; pile blackish. Front wide, the sides sub-parallel, slightly widened below; pile all black.

Thorax with black pilose band between the wings, not reaching sides.

Legs more piceous than black, the hind tarsi brownish above, yellowish below.

Abdominal spots more rounded inwardly the first pair convex posteriorly, the spots on the two following segments more transverse, narrower as they occupy only the basal half of the segment and are more rounded inwardly.

The third segment is not yellow posteriorly, but together with the fourth, is narrowly reddish. Fifth segment greyish yellow or yellow pollinose, with a basal, longitudinal median triangle, black or brown.

Described from male, Macdiarmid, Ont., June 29, 1922, (N. K. Bigelow); male, N. W. Bay, Lake George, N. Y., Aug. 20, 1920; female, Algonquin Park, Ont., Aug. 14, 1903, (E. M. Walker); 1 female, Macdiarmid, Aug. 21, 1923 (Bigelow), 2 males and on yellow water lily bloom.

Type in Canadian National Collection. No. 2223.

This species is very much darker than usual in general appearance and has only narrow pale thoracic vittae. It is readily distinguished from the *groenlandicus* group of *Helophilus* by the small stigma.

Parhelophilus anniae Brimley

Helophilus anniae Brimley, Ent. News XXXIV: 278, 1923 (N. Car.)

"Face, antennae, arista, and lower part of front light yellow, the latter with yellow pile, narrower portion of front (between the eyes above) dark brown with dark pile. Thorax with two narrow submedian yellow stripes and a somewhat broader one on each side, scutellum paler than thorax. Legs: front and middle femora dark brown for about basal two-thirds, yellow at apex, front and middle tibiae and tarsi mainly yellow, hind femora yellow on basal third, then abruptly black to apex, hind tibiae and tarsi black. Abdomen: second, third and fourth segments each with a pair of yellow spots, these wider externally, and narrower internally, those of each pair widely separated, those of second and fourth segments broadly reaching the sides of those segments, those of third segment nearly or quite separated from the side of the segment by the ground color, a small yellow spot on the apex of fourth segment. Length about 11 mm.

"A female taken at Aberdeen, North Carolina, May 10, 1922 . . . appears to be the same species, the only differences being that it is slightly larger, the submedian stripes on the thorax are a trifle wider, there is no apical yellow spot on the fourth segment, and the pile on the front above the antennae is largely black, instead of yellow.

"This species looks somewhat like a small *H. similis,* but differs from all species I know or could find descriptions of, in the following combination of characters,—wholly yellow face, antennae, and arista; three pairs of widely separated yellow spots on abdomen, and in the hind femora being yellow at base, and black in middle and apex." Brimley.

This species evidently belongs to the genus Parhelophilus, although we may be mistaken in this. Dr. Aldrich in a letter states that "the hind femora is yellow on the basal two-fifths and provided with a distinct swelling bearing a cluster of black spinules at the point where the tip of the tibia comes in contact with it. In this respect it resembles *frutetorum,* an European species.

Since the above was written, the type has been examined. The species is very distinct from any yet described, being nearest related to *P. rex* from which it differs in the narrower, almost parallel-sided upper part of front, larger size, etc.

Parhelophilus divisus Loew

Plate VII, figure 25

Helophilus divisus Loew, Cent. IV, 78, 1863. (D. C.)

Allied to *laetus* but the face is not at all convex and not prominent below the middle, the abdominal spots transverse and smaller.

Length, 9 to 11 mm. *Male.* Face reddish yellow, yellow pollinose, the narrow oral border and cheeks shining black to light brownish; in profile shortly receding below the antennae, thence slightly produced to the tip of the oral margin, almost straight, only slightly produced below the eyes. Pile rather long, yellowish. Front black or brownish, wholly brownish grey or greyish yellow pollinose, less thickly so at vertex; sides parallel on upper half, somewhat divergent below, the median depression distinct and with a slightly anterior bow. Pile all black or sometimes yellow before the depression. Ocellar triangle very broad, the lateral half of the posterior ocellar line one and one-half as long as the median ocellar line, the lateral ocelli separated from the eyes by little more than their own width. Occuput grey pollinose, yellowish above, the pile yellow on upper half, white and shorter below. Antennae red, third joint large, slightly wider than long, sub-orbicular, the lower corner longer; arista brownish, tapering.

Mesonotum apaque greyish yellow or yellowish grey, more greyish in old specimens, with three opaque black stripes, the median one geminate on anterior two-thirds, narrowed somewhat on posterior third, the dividing line usually very slender, the lateral black stripes about half as wide as the median one, all the stripes not quite reaching the front, but the median reaching the posterior margin, the lateral narrowly separated from it. Pleura grey pollinose. Pile bright yellow. Scutellum reddish yellow, the base and sides black. Pile black, on the margin, longer, yellow; sometimes all yellow.

Femora black, the apical third of the front four and fourth of the hind ones, reddish, the latter black at the apex above, or the hind ones may be all reddish; front four tibiae and tarsi, except a black spot behind, extending to the anterior margin above in the middle, reddish yellow, the apices of the front tibiae and the last two joints of the front four tarsi brownish. Hind tibiae on apical fourth, their tarsi wholly, and an obscure sub-basal band brown or brownish. All the femora may bear an obscure reddish spot below basally. Hind femora somewhat thickened at the base below with a rounded, large tubercular swelling bearing abundant short black setulae.

Wings cinereous hyaline, the stigmal spot small, brown. Squamae whitish with yellow border and fringe. Halteres yellow.

Abdomen opaque black; the fourth segment chiefly grey pollinose; with yellow spots on second and third segments. Second segment with the sides broadly reddish yellow on the anterior two-thirds, expanded inwardly on the middle of the segment as a broad, inwardly rounded projection, its anterior edge concave towards the side, posterior margin slightly convex, the spots medianly separated by the length of one of the arms. Third segment with its outer end produced forward to the anterior angles, and touching the base of the segment broadly; narrow lateral margin of the third and forth segments and the narrow apices of the second to fourth segments yellow. Fourth segment greyish yellow pollinose except a median transverse fascia occupying half the width of the segment, a basal, apically convex fascia occupying one-third the width and a connecting middle stripe. First segment wholly grey pollinose except a roundish black spot on either side; posterior margin of the second segment more broadly in the middle, of the third still more broadly and more angularly in the middle, grey pollinose. Pile yellow, black on the incomplete posterior margins of the second to fourth segments, successively more broadly so. Ventral plates black with yellow apices, the sides of the second broadly yellow.

Female. Front moderately narrowed above, its sides parallel on upper third. Pile less abundant, black. Pile on thorax all shorter.

Front femora with only an incomplete broad brownish basal band behind, their tibiae obscure brownish apically; last two joints of front four tarsi as in male. Middle femora with small, brownish sub-basal patch behind. Hind femora with a broad, incomplete, brownish band about the middle or a little beyond, on postero-dorsal surface produced apicad; sub-basal brownish band on hind tibiae complete.

Abdomen broader, the yellow spots narrower, more elongate, the second pair lunulate, their sides more parallel; fourth segment with narrower black fasciae, the basal one extremely narrow. Fifth segment with a very small black basal triangle, otherwise grey pollinose.

Male, female, Summit, New Jersey, June 8, 1913, (F. M. Schott); two males, female, Westville, N. J. May, (C. W. Johnson); female, Plymouth, Indiana, (M. R. Smith); female, Philadelphia, Pa., July 13, (C. W. Johnson).

H. divisus may be distinguished from all species except *porcus* and *rex* by possessing on the antero-ventral surface of the posterior basitarsus a row of short black bristles. As these bristles are confined to the apical half in *rex,* that species is eliminated, while *porcus* has hoary abdominal markings and wholly black hair on the upper surface of the posterior tarsi.

Parhelophilus frutetorum Fabr.

Plate VI, figure 14

Most nearly allied to *P. divisus* Loew, but the process on the hind femora is nearly twice as long and is strongly fringed with a fan-like row of moderately long, black hairs, the posterior femora are all black or brown except the apex, the usual spot above the apex. Face slightly more convex below; yellow thoracic vittae narrower, more yellow. Front black pilose above.

The female is similar to the male except in abdominal markings and absence of the femoral process. The inner half of the lunule on third segment is formed by a pair of oval, transverse pale yellow pollinose spots, rather narrowly separated.

These characters are sufficient to show the relationship of the two species and also the chief differences between them. In addition the posterior tarsi lack the row of short black bristles on the anteroventral surface of the basitarsi, thus agreeing with all other species in the group (except *divisus, porcus* and *rex*) which lack the bristles on the basal half of the posterior basitarsus.

Specimens—male, Germany; male, female, Denmark.

P. frutetorum is not known from North America.

Parhelophilus laetus Loew

Plate VI, figures 20, 21, 22

Helophilus laetus Loew, Cent. IV, 77, 1863. (N. Y.)
Helophilus aureopilis Townsend, Trans. Am. Ent. Soc., XXII, 51, 1895. (Mich.)

Hind tibiae not produced on inner apex; abdomen chiefly reddish yellow; thoracic vittae usually rather broad, slightly divergent on anterior third, lower portion of face rather prominent and shorter than the concave upper part.

Length, 8.5 to 10 mm. *Male.* Face yellowish, thickly yellow pollinose except the cheeks in front and the broad oral margin to the tip; cheeks black on posterior two-thirds; in profile the face is deeply concave on more than the upper half, the lower portion prominent and gently convex, retreating below. Front yellow before the suture, thickly yellow pollinose; above, blackish, but thickly yellow pollinose, less thickly so across the ocelli. Ocellar triangle much broader than long, the median ocellar line about equal in length to the lateral half of the posterior ocellar line. Occiput blackish, wholly greyish or yellowish pollinose. Pile of head all yellow except a broad black band between the ocelli and depression. Antennae orange colored, the arista black apically.

Mesonotum dull olivaceous black, with the side margins broadly and sub-median, moderately narrow, stripes yellowish or greyish yellow pollinose, all connected along the anterior slope by a transverse band of pollen, which is wider laterally, so that the lateral black fasciae are more widely separated from the front margin than the middle one. The middle yellow stripes are very slightly bowed outwardly and are usually slightly broadened anteriority, and posteriorly and narrowly connected behind to the lateral stripes. Pleura grey or yellowish pollinose. Scutellum yellow or reddish yellow, the base narrowly and the angles, black. Pile of thorax bright yellow, the disk of the scutellum with black pile.

Legs reddish yellow, with black markings. Front four femora with the basal third or fourth black, rarely with the markings almost obsolete; hind femora with a broad median black band, interrupted below, sometimes greatly reduced and leaving only a small spot in front and a large one behind; also with a small spot at apex above. Hind tibiae with sub-basal and apical rather broad black bands, usually the middle half yellow, but this sometimes reduced to one-third; hind tarsi wholly black. Pile all yellowish.

Wings cinereous hyaline or slightly yellowish tinged. Squamae white, with yellow border and yellowish white fringe. Halteres yellow.

First abdominal segment grey pollinose except behind the anterior corners, usually broadly yellow laterally, sometimes but little so. Second segment opaque black, the apex narrowly reddish; the sides broadly, expanded as a large triangle occupying more than half the segment, its inner ends rather truncate or broadly rounded, posterior margin slightly oblique, the anterior oblique and concave on its middle portion; the yellow is rather narrowly separated from the reddish hind margin and the black emits a triangle forward along the margins for a short distance. The black on the third segment is limited to a basal transverse fascia on the middle half, a narrow, almost complete sub-apical fascia, usually moderately broadly jointed to the anterior one in the middle and emitting a small triangle forward laterally. Sometimes the middle connection is obsolete and the basal fascia narrow and not convex posteriorly. Following segment with almost similar markings but the posterior fascia does not reach nearly to the laterally margin and is not or scarcely broadened laterally. The yellow between the fasciae is often wholly due to greyish yellow pollen; in pale specimens the basal fascia and middle connection may be obsolete, in which case the pollen is yellow. Genitalia with yellow or yellowish grey pollen, apices of last two segments and often the narrow lateral margins, reddish. Sternites black, the apices yellow pollinose. Pile of abdomen yellow, black on apices of segments.

Female. Very similar but still more reddish or orange. Front wholly black pilose, more or less yellow in ground color above the antennae, yellow pollinose as in male.

Mesonotal pale vittae slightly wider. Legs showing same variation.

Abdominal segments shorter so that the yellow fasciae are narrower and the black lateral projections of the fasciae usually extend much further forward, sometimes quite to the base of the segment. The black may be obsolete in the same way as in the male. Fifth segment black, the lateral margin and posterior margin, much more broadly in the middle, yellow, the whole covered with yellow or greyish yellow pollen except a median longitudinal basal dash.

This description is drawn from over fifty specimens from the northern States and Canada as far West as Manitoba and Wisconsin. The range extends over practically all the United States and Canada east of the Rockies.

Parhelophilus versicolor Fabr.

Plate VI, figure 17

Perhaps nearest *P. integer* Loew but the posterior femora sub-basally on the antero-ventral surface is somewhat roundedly swollen and bears a tuft of rather conspicuous long yellow pile, the face is scarcely less prominent below, the front is black pilose above and again just above the antennae and the yellow of the second and third abdominal segments reaches broadly to the hind margin.

These differences are well marked and constant in the male. The female has a wider front, as in *laetus,* but the posterior femora are black on the basal half except below, the face is much less prominent, and the black posterior segmental fasciae straighter.

Specimens: male, female, Denmark; male, Europe.

Parhelophilus integer Loew

Plate VI, figure 23

Helophilus integer Loew, Cent. IV, 76, 1863. (N. Y.)

Allied to *laetus* but the front of the male is narrower and wholly yellow pilose; the face is less deeply concave and less prominent in both sexes; the cerci of the hypopygium are short and obtuse.

Length, 9 to 10 mm. *Male.* Face yellow, transluscent, densely yellow pollinose; the cheeks in front and posterior part of oral margin shining; checks black behind a point a little before the suture. Face in profile slightly concave above, gently convex below, but little prominent on lower half. Front yellow, above the suture brownish, densely yellow pollinose even above, though the ground color shows through in the region of the vertex. Middle ocellar line longer than the lateral half of the posterior ocellar line. Occiput greyish or greyish yellow pollinose. Whole head yellow pilose. Antennae orange; arista black on apical half.

Mesonotum densely yellow pollinose, appearing more greyish in old specimens, with broad median and slightly narrower sublateral opaque blackish stripes, the lateral ones narrowly separated from the posterior, widely so from the anterior margin, slightly narrowed at the ends, but still rounded, the median one entire, but thinly pollinose on the anterior slopes. Pleura yellowish pollinose. Pile all bright yellow. Scutellum yellow, dull, the base black; pile black, yellow on margin.

Legs yellow, the basal fourth or less of the anterior four femora, sometimes only faintly so, a broad median band interrupted below, on the hind femora, sometimes all but base and broad apical band; a spot above the apex, the apical third and broad basal band of their tibiae and their tarsi wholly, black or brown. Hind femora only moderately swollen, with black bristles below on apical half. Pile of legs all yellow.

Wings cinereous hyaline. Squamae whitish, yellowish on apical portion, the fringe yellow. Halterers yellow.

Abdomen predominatingly yellow or reddish yellow; opaque black, the first segment grey pollinose except behind the anterior angles, the sides more or less yellow. Second segment reddish yellow, with a large lunulate black basal fascia not reaching the sides, and broadly connected with an entire, narrow, sub-apical opaque black fascia which projects slightly forwards at the sides, behind this a shining black fascia with a triangular median projection forward, the immediate apex narrowly reddish; the apex in the middle with a greyish yellow pollinose spot. The yellow is cut off slightly obliquely at the sides, the inner arms broadly separated, rather truncate, the anterior margin oblique, concave about its middle. Black on third segment limited to a rather narrow, subtriangular basal fascia on middle half or more, connected to a sub-apical opaque fascia situated before a narrow shining band, the apex narrowly reddish and greyish yellow pollinose, the pollen triangularly produced in the middle, the lateral margins black on apical third. Fourth segment very similar, the pale markings composed of greyish yellow or yellow pollen, the spots narrower, very narrowly separated, the posterior black fascia occupies only three-fifths the width of the segment, its arms slightly enlarged, side margins broadly, the apical margin widely greyish yellow pollinose. Genitalia with similar pollen. Sternites black, their sides more or less broadly and apices narrowly, yellow. Pile yellow, rather short, black on apices of segments.

Female. The female is difficult to distinguish from *laetus*, but the face is only slightly concave above and much less projecting below; the front narrower and appearing longer, the hind femora are almost straight on their lower surface, not distinctly convex, and the fifth abdominal segment is nearly half black pilose, not all yellow.

Specimens examined: male, 3 females, Newark, N. J.; 2 males, 1 female, Westville, N. J.; male, female, Long Branch, N. J.; 2 males, female, Martha's Vineyard, Mass.; male, female, Wellfleet, Mass. (C. W. Johnson). Male, female, Arlington, N. J.; female, Caldwell, N. J., (A. Nicolay).

H. integer was originally described from New York, and has never been authentically recorded since, except from the New England States. It is very limited in its range, but probably will be found in all the New England and adjacent states. *H. laetus* has a wide distribution, but apparently does not occur in New England.

Parhelophilus obsoletus Loew

Plate VI, figure 24

Helophilus obsoletus Loew, Cent. IV, 75, 1863 (Hud. B. Terr.).

Allied to *integer* but the thorax is not vittate.

Length 9 to 10 mm. *Male.* Face transluscent yellow, covered, except the very broad oral margin, and cheeks, with pale yellow pollen, cheeks brownish black, the oral margin yellow before the jowls, in profile moderately concave on about the upper half, the lower half moderately prominent. Front yellow before the suture, densely yellowish pollinose; above the suture black, densely yellow pollinose, except just at the vertex, where it is thinly so. Ocellar triangle wider than long, the lateral ocelli narrowly separated from the eyes, the median ocellar line as long as the distance from its base to the orbit. Occiput olivaceous blackish with greyish yellow pollen. Pile of head wholly yellow. Antennae orange yellow, arista concolorous; third joint elliptical.

Mesonotum rather dull olivaceous blackish, broad submedian and broad lateral margins, diffusely slightly more shining or very lightly yellowish. Pleura greyish pollinose. Scutellum impure yellowish, rather dull, only the corner blackish. Pile of thorax yellow, only on the disc of the scutellum black.

Anterior four femora black, on basal half, the hind ones black except the apical third; anterior four tibiae and tarsi wholly yellow; the hind ones black, with the bases and a broad median band yellow. Hind femora with a black dorsal spot just before apex. Pile wholly yellow. Hind femora only moderately enlarged, slightly arcuate.

Wings cinerous hyaline or slightly yellowish. Stigmal spot yellow. Squamae whitish, the border yellow, fringe yellowish white. Halteres yellow.

First abdominal segment sub-opaque black, the sides and anterior angles grey pollinose. Second segment opaque black, the apex shining and narrowly reddish; the sides except the apex broadly yellow, expanded as large obtuse triangles occupying nearly half the length of the segment near their inner end, situated chiefly beyond the middle, their posterior margin slightly oblique, the anterior concave on the middle portion. Base of third segment with an incomplete, medianly broader and an incomplete subapical transverse fascia, these narrowly connected on the middle line, opaque black, elsewhere reddish yellow. Fourth segment with a median stripe, expanded, as basal fascia, and a median incomplete transverse fascia, brownish red, elsewhere reddish, the sub-basal yellow pollinose fascia incomplete and narrowly interrupted. Pile yellowish; broadly black on apices of segments, the black not reaching the sides on the last segment. Sternites black.

Female not before us. Loew's description shows only the following variations: base of scutellum black; thoracic stripes very narrow, yellow; each segment with a triangular spot in middle contiguous to the yellow apex; femora less extensively black, on the front four reduced to two basal spots; the hind ones with a large black spot behind.

Male, Solon Springs, Douglas Co., Wis., July 7–15, 1909.

The male specimen described here was compared with the type and is undoubtedly the same species. The presence of vittae on the thorax of the female is to be expected, but they are extremely faint in the type, as in the male. The nearest ally is *integer* which also has a yellow haired front but differs in having wide thoracic vittae. The median ocellar line is much longer in comparison to the posterior ocellar line than in *laetus*. The two allied European species are more closely related than *laetus* but both have the upper half of front black haired.

Unrecognized Species

Parhelophilus flavifacies Bigot, Annales Ent. Soc. France, pt. 22, 344, 1883.

Hine has suggested that this is the same as *H. divisus* Loew. It seems likely that it is either *divisus* Loew or *anniae* Brimley but it is not possible to decide from the description. The type is in the collection of Mr. J. E. Collin, Newmarket, England.

Asemosyrphus Macq.

Bigot, Bull. Soc. Ent. France, 1882, p. CXXVIII; Annales, 1883, 228.

Giglio-Tos, Ditteri del Messico, II, 18, 1893.

Distinguished from allied genera by the remarkably large, ocellar triangle, more or less tuberculate face, non-pollinose thorax and usually broad, flattish abdomen. The stigma simulates a crossvein, the hind femora are swollen, and slightly compressed. The front in both sexes is wide, the head flattened above and somewhat triangular.

Three species are accepted as belonging to this genus but it is possible that *bicolor* is a synonym of *mexicanus*. The material before us does not permit of an opinion on the matter.

Key to species of Asemosyrphus

1. Hind tibiae wholly reddish yellow (Mexico)-----*bicolor* Big.
   Hind tibiae largely black---------------------------- 2
2. Face obtusely short conical; abdomen reddish or with grey lunules; mesonotum olivaceous, with three germinate opaque black vittae-*mexicanus* Macq.
   Face produced as long acute cone; abdomen without grey lunules, all black; mesonotum almost unicolorous (canadensis Curr.)----*willingi* Smith

Asemosyrphus mexicanus Macq.

Plate VI, figure 13

Syn.: *Helophilus mexicanus* Macq., Dipt. Exot., II, 2, 64; Loew, Cent. X, 55, *(Helophilus polygrammus)*; Osten Sacken, West, Dipt., 338; Bigot, Bull. Soc. Ent. Fr., 1882, *(oculiferus, nigroscutatus, flavocaudatus)*; *Bigot,* Ann. Soc. Ent. Fr., 1883, 350, *(oculiferus)*, 351, *(nigroscutatus* and *flavocaudatus)*; Williston, Syn., 186 *(Helophilus)*; Biologia, Dipt., III, 68 *(Helophilus)*; Giglio-Tos, Boll. R. Inst. Torino, VII, No. 123, 1892 *(griseus)*; Ditt. del Messico, II, 20, 1893.

Mesonotum olivaceous, with six slender opaque stripes, the median ones joined to the inner ones of the lateral two; abdomen partly reddish or with grey lunules.

Length, 9 to 10.5 mm. *Male.* Variable, the following description from a single specimen will cover all parts except the abdomen. Face wider than either eye, the middle line, a broad stripe on the cheeks, and narrow oral margin, shining black, elsewhere densely greyish yellow pollinose; in profile, perpendicular, the large, elongate tubercle occupying nearly half the face, above it, moderately concave. Front wide, the sides slightly divergent above, but sub-parallel, slighty convex laterally on upper portion, covered with slightly more greyish pollen than the face; a shining spot immediately above the antennae, the vertex broadly less thickly pollinose, the pile yellow, black just above the depression. Ocellar triangle very large, the posterior ocelli near the posterior angles of the eyes. Occiput densely pale greyish pollinose, yellow pilose. Antennae piceous, the third joint black, sub-circular, a little longer below; arista reddish.

Mesonotum shining olivaceous with a median and sub-lateral, moderately broad, geminate opaque black stripes, the lateral ones abbreviated anteriorly the median one extending to the posterior third; the middle ones connected with the inner lateral stripe by a sub-rectangular spot on apical third, and joined to a narrow median line which runs from the apex of the abbreviated stripe to the scutellum; the outerline of the lateral stripe is triangularly broadened just before and behind the suture and there is a slender, oblique straight line rising at the posterior end of the lateral stripe and running in a line towards the humeri but it does not reach the suture. Pile of thorax yellowish. Pleura bluish black. Scutellum more or less yellowish or reddish, the base blackish, its pile all pale.

Legs black; narrow apices of femora and bases of tibiae yellowish, the pile all yellowish. Hind femora greatly swollen; largest in the middle, more or less laterally compressed, their tibiae rather evenly arcuate.

Wings cinereous hyaline, more cinereous anteriorly. Squamae greyish white with yellow border and fringe. Halteres yellow.

Abdomen variable; in the specimen before us as follows: first segment shining black, with a greyish sheen, an opaque black spot laterally, the sides yellow on posterior half. Second and following segments reddish, with obscure darker areas, the second with a broad basal opaque black fascia, its posterior margin rounded, but produced in the middle as a rounded triangle which does not quite reach the posterior margin and is not as long from its base as its width; sometimes this black projection expands almost to the lateral margin on the apical part. The third segment is much similar but the dark markings are greyish red, leaving basal, more reddish, slightly lunule-forming orange spots on either side, the segment wholly shining; these triangles are overlaid with a slender whitish or yellowish lunule, rising at the anterior angle, extending obliquely towards the middle of the segment and curving somewhat forward at their inner ends which are broadly separated. The base of the fourth segment has a brownish opaque arch on either side of the middle line, and almost completely engaging its posterior border, a narrow, yellowish white lunule, the brown opaque color continued as a more reddish opaque band across the base of the segment, the lunules widely separated; behind the lunules shining ferruginous. Pile short, rather appressed, yellowish, longer on sides basally, the posterior half of the second and third segments, not reaching the sides and excepting the narrow hind margin, and dark basal spots on fourth segment, with short, appressed black pile.

Female. Front wide, slightly narrowed towards the middle, the sides almost parallel on upper portion; usually the black pile is limited to a transverse spot on either side just above the middle.

The abdomen is usually all black, all shining, more or less subopaque on second segment and bases of the two following, with four pairs of grey lunules, the first pair slightly oblique, extending inwards from behind the middle of the grey lateral triangles which reach the base moderately broadly; the lunules on the two following segments similar to male; the fifth segment bears broader, shorter lunules than the fourth, and the side margins are narrowly pollinose. Pile as in male, the fifth segment with all pale pile. The sides of the second segment are often yellowish-red except behind.

Four specimens from California. Numerous specimens have been examined. It is a common species in Mexico and has been reported as far north as British Columbia.

Asemosyrphus mexicanus is very distinct from *A. willingi* which has a sharply conical face and lacks abdominal lunules and thoracic stripes.

Asemosyrphus willingi Smith

Plate VI, figure 12

Helophilus willingi Smith, Proc. Ent. Soc. Wash., XIV, 118 1912; Curran, Can. Ent. LIV, 94, 1922 *(canadensis).*

Face produced downwards and slightly forwards into a long cone; whole fly black, mostly shining; ocelli very widely separated.

Length 9 to 10 mm. *Male.* Face and front shining black, the sides of the face obscured by whitish yellow pollen, leaving a median stripe and the cheeks shining; front broadly covered with similar pollen on the lower half, except an arch above the antennae. Lower half of the face produced as in *Helophilus conostomus* Will., but produced only a little forward, with a long, slender, not prominent tubercle below the middle, above which it is shallowly concave, and below which it is almost straight to the tip of the oral margin; antennal prominence narrowly reddish above the antennae. Antennae shining black, tip of second joint and immediate base of third somewhat reddish; third joint opaque, whitish pubescent, subquadrate, slightly broader than long and slightly shorter than the second joint, but longer than the first; arista bare, long, slender tapering. Posterior orbits yellowish gray pollinose. Pile: on the face limited to the sides, fine and whitish, cheeks bare; front with pale yellow pile, but with a black band across the anterior ocellus; posterior orbits with whitish pile below and yellowish above.

Dorsum of thorax shining blackish green; a moderately wide opaque black, median stripe not quite reaching the scutellum and which usually has a very slender shining stripe in its middle; on each side of this a shining stripe, obsolete before the posterior quarter, wider than the median opaque stripe; on the outer side of this is a broad, opaque black, stripe, which is expanded on the posterior quarter to join the median opaque stripe, is partly interrupted at the suture, and encloses a more or less distinct narrow shining stripe; near the sides is a very narrow opaque stripe on the posterior two-thirds, interrupted at the suture. The shining stripes appear to have a greyish tint in some lights. Pleura and scutellum shining blackish green, with pile of a paler yellowish color than that on the dorsum.

Legs shining greenish black, tips of all the femora and narrow bases of tibiae reddish (in one specimen the bases of the tibiae are more broadly yellowish and there is also a yellowish band just before the middle); hind femora considerably enlarged, the greatest swelling near the middle; hind tibiae arcuate, not ending in a spur; all the tarsi golden pubescent beneath.

Wings a little infuscated; veins reddish, but brownish apically, basal portion of 2-3 longitudinal vein with about seven bristles of a blackish or reddish brown color. Squamae pure whitish with white pile; halteres brown yellow.

Abdomen shining greenish black with a metallic reflection in some lights, the first segment slightly grayish; second segment with a large basal opaque black triangle, broadly separated from the lateral margin and apex; third segment with a small opaque roundish or oval spot before its middle, sometimes obsolete; abdomen elsewhere shining; no lighter markings. Pile of the abdomen pale yellowish, but across the disc on the posterior half of each segment with shorter black pile.

Specimens examined: 4 male, Saskatchewan, July 1907.

This species is very distinct from the only other species in the genus reported from Canada, *A. mexicanus* Macq., and is readily recognized by the absence of light abdominal markings and the conically produced face.

Lunomyia new genus.

Plate VII, figure 27

Allied to Lejops, but the face is distinctly tuberculate in both sexes. Small dark species the abdomen not at all yellow, nor marked with pale, the thorax with a greyish yellow vittae. Third antennal joint broader than long, its apex almost evenly, gently convex. Front moderately wide in male, the sides parallel above, in female slightly narrowed above, the ocellar triangle small. Legs as in Asemosyrphus. Stigma simulating a crossvein. Veination as in Lejops. Genotype: *Helophilus cooleyi*, Seamans.

Lunomyia cooleyi Seamans

Plate VII, figures 26, 27

Helophilus modestus Williston, Synopsis, 192, 1886 (*nec. Wied.*); Seamans, Ent. News, XXVIII, 342, 1917, (*Tropidea cooleyi*).

Resembles an Asemosyrphus, but the ocellar triangle is small. Length, 7 to 8 mm. *Male.* Face black in ground color, except a reddish spot on either side of the slopes below; densely covered with yellow dust which leaves a moderately narrow, dorsally abbreviated median stripe, the oral margin and a broad stripe on the cheeks shining black or browinsh; pile brassy yellow, limited to the sides below, and appearing as a conspicuous tuft; the side margin below and the cheeks with similar but slightly shorter pile. In profile the face is a little prominent below as the concavity of the upper half is deeper than that below the long, rounded tubercle. Front almost one-fourth the width of the head, with a deep depression just below the middle and with a broad, less evident depression extending from it in the middle to the apex of the antennal prominence, before the depression densely yellow pollinose, above it rather dull black, with a little yellowish pollen below on the middle portion and along the whole orbits in some lights. Pile all black except at vertex. Ocellar tubercle swollen, convex, the triangle a little broader than long, not large. Occiput greyish pollinose, with yellow pile. Antennae brownish black, with thin pale pollen, the arista black, thickened and tapering on basal fourth.

Mesonotum dull black, the sides shining aeneous greyish, anteriorly yellowish greyish pollinose, with two widely separated, complete moderately slender vittae of the same color rising at the inner ends of the pollen on the front surface, and widening behind to join the lateral shining portion; these vittae are very thinly pollinose and are, except in fresh specimens very largely shining. In addition there is a slender median line of the same color on the anterior three-fourths. Pleura black, thinly grey pollinose. Scutellum blackish, translucent brownish red apically. Pile of thorax rather conspicuous, all brassy yellow.

Legs black or brown, with brassy yellow pile, apices of the femora, bases of the tibiae, a moderate band on their middle, incomplete on the front ones, yellow. Hind femora wide, somewhat laterally compressed, widest at apical fourth, their tibiae arcuate, with a short, broad, apical lobe.

Wings cinereous, the small, stigmal spot luteous. Squamae white, with pale yellow border and white fringe. Halteres yellowish white.

Abdomen shining greenish black, somewhat piceous on basal angles of second segment. Second segment opaque black except the broad sides, which expand somewhat towards the front, and the narrow hind margin. Third segment with a medianly expanded opaque basal band on middle half. Pile all brassy yellow, longer laterally and on the metallic triangles on the second segment.

Female. Facial turbercle sharper, more acute, the part of the face not prominent below the tubercle, but on a plane with the upper concavity which is rather more angular. Front broader, its sides a little narrowed above, but distinctly diverging behind the ocelli, the depression broad, with a rather large transverse swelling on either side of a broad median foeva just above the antennae, the pollen apparently not so abundant, the swellings bare.

The front and middle tibiae show no indication of a pale median band.

Abdomen as in male but the third segment is only narrowly opaque at the base on the middle third and the metallic color is more extensive on the second segment as it forms a broadly interrupted, broad median fascia the inner ends of the spots rounded and the hind margin of the segment more broadly shining. Fifth segment wholly aenous.

This description is drawn from a pair of paratypes of *Tropidea cooleyi* Seamans, from Bozeman, Montana, June 12 and 20, 1906. Specimens of this were compared with the type of *Helophilus modestus* Williston and are absolutely identical in all respects.

Lejops Rondani

Lejops Rondani, Dipt. Ital. Prodi., II, 33, 1857; Verrall, Brit. Fl., VIII, 524–5 (changes name to *Liops*).
Anasimyia Schiner, Cat. Dept. Eurofae, 108, 1864.

The characters of this genus are: apex of hind tibiae produced as a scoop-like or rather acute spur; stigmal spot simulating a crossvein; ocellar triangle rather small; front of female not as wide as one eye, of male not over half as wide, the ocellar triangle in female rather small, rarely almost equilateral; form rather slender. Genotype, *Mallota vittata* Meig.

The genus which most closely approaches Lejops is Asemosyrphus which, however, never has more than a very slight production of the hind tibiae (*mexicanus*), and has a much broader front in both sexes, very large ocellar triangle, broader abdomen, and more or less distinctly tuberculate face.

When Rondani proposed the name Lejops he included only the one species, *H. vittata* Meig. Subsequent authors have failed to find characters which would separate the genus from Helophilus and consequently several other names have been used which included at least part of the species which we place here. Schiner in 1864 proposed Anisimyia in his catalogue and included two species, the first of which *H. transfugus,* Coquillett* designated as the type species in 1910. Verrall ignored it as it was merely a catalogue name, and while it does not concern us owing to the fact that the type species is included under Rondani's genus Lejops, it would be the next available name for this group, should Lejops ever be disallowed. Then, in 1883, Bigot described his genus Eurhimyia basing it upon *E. rhingioides* n. sp., which was later admitted by him to be the same as *H. lineatus* Fabr. We have retained this as a sub-genus, its affinities to the other species being quite evident, the differences being insufficient to warrant giving Eurhimyia generic rank. Girshner included *H. lunulatus* in his genus Parhelophilus, with frutetorum and *versicolor* but as the former falls within our conception of Lejops, and we have accepted Parhelophilus for the last two species, there need be no further explanation.

Lejops—Table of Species—Males

1. Face produced into a long, acute cone--sub-genus *Eurhimyia*
   Face at most obtusely conical, not greatly produced----- 2
2. Hind trochanters with a moderately long, obtuse projection or with a small sharp tubercle bearing black setulae; tibiae ending in spur---------- 3
   Hind trochanters and tibiae simple, the femora sometimes specialized ---------------------------- 5
3. Process on trochanters long and obtuse; tibial spur of moderate length------------------*relictus* n. sp.
   Process short, tubercular------------------------------- 4
4. Spur on hind tibiae long and acute-------*chrysostomus* Wd.
   Spur on hind tibiae short, not acute, rounded apically -----------------------------*distinctus* Willist.
5. Abdomen without lunules beyond the second segment, although sometimes with the small inner ends apparent-------------------------------- 6
   Abdomen with very distinct lunules beyond second segment ---------------------------------- 8
6. Sides of abdomen usually wholly narrowly reddish beyond second segment; a rounded angle sub-basally on hind femora, the apical two-fifths more swollen; abdomen practically always with sub-median grey pollinose spots -------------------------------*bilinearis Willist.*
   Sides of abdomen usually wholly black, beyond second segment, rarely partly reddish; grey

*Pr. U. S. N. M., XXXVII, 506.

spots wanting; femora with less pronounced basal angle and more evenly swollen ---------------- 7

7. Anterior four femora practically all black haired ----------------------------------- **borealis* Cole

   Anterior four femora all yellow pilose--**perfidiosus* Hunter

8. Lunules strongly curving forward medianly (Europe) --------------------------------- *transfugus* L.

   Lunules scarcely curving forward, except front pair ------------------------------------ *lunulatus* Mg.

Females

1. Second pair of lunules separated from side margins------ 2

   Second pair of lunules reach side margins-------------- 4

2. Front femora black pilose-------------------- *borealis* Cole

   Front femora yellowish pilose------------------------ 3

3. Abdomen not with yellow lateral and apical segmental margins --------------------- *perfidiosus* Hunter

   Abdomen with yellow segmental apices and margins ------------------------------ *bilinearis* Willist.

4. Hind femora red on entire surface above or antero-dorsally ------------------------------------ 5

   Hind femora with black patch covering part of dorsal surface ------------------------------------ 6

5. Abdominal spots but little lunulate---------- *lunulatus* Mg.

   Abdominal spots strongly lunulate (Europe)-- *transfugus* L.

6. Femora all black below-------------------------------- 7

   Femora not all black below with a broad reddish or piceous reddish elongate fascia------ *distinctus* Willist.

7. Tibial spur long and acute------------ ***chrysostomus* Wd.

   Tibial spur not acute---------------------- *relictus* n. sp.

Lejops relictus new species

Helophilus chrysostoma (Wied.), Williston, Synopsis, 190, 1886

Plate VII, figures 31, 32

Hind coaxe of male with long apical projection; female with small tubercle. Abdomen of both sexes long, rather narrow, with nearly parallel sides, usually narrowed at apex of second segment with pale lunules, even though often chiefly reddish in male; the female lunules grey pollinose. In the two allied species the coxae bear no more than tubercles, in one the tibial spur

---

*These species were described in the genus Pterallastes.

**We have not seen the female; the distinctions given may be erroneous but seem probable.

is very long and slender, in the other shorter than in *chrysostomus.*

Length, 8 to 10 mm. *Male.* Face yellow, yellow pollinose, the oral margin to the angles and the cheeks, shining black; in profile rather deeply concave on upper two-fifths, the lower portion very slightly, scarcely convexly receding; pile long, sparse, whitish. Front with a shallow depression just before the middle, in front of this, yellow, densely bright yellow pollinose, above black, with dense ochreous pollen, the ocellar band brownish; pile yellow below, black above. Front narrow above, the sides parallel, the ocellar triangle not very broad, the lateral half of the posterior ocellar line shorter than the median ocellar line, the ocelli separated from the eyes by about the width of one ocellus. Occiput grey pollinose, yellowish above. Pile yellow above, white elsewhere and on cheeks. Antennae ferruginous reddish, third joint slightly longer than broad, sub-circular; arista reddish, its apical half brown.

Mesonotum opaque black, the lateral margins moderately broadly and sub-median, rather narrow stripes, slightly converging posteriorly in most specimens, greyish yellow, yellow or pale yellow pollinose, the stripes broadly connected in front, narrowly so behind; and never as wide as the black stripe. Pleura yellowish grey pollinose. Scutellum brownish, its apex to apical third or even more, reddish. Pile of thorax wholly yellowish, paler on pleura, not long, moderately abundant.

Basal two-thirds of anterior four femora, the hind ones except the base and sub-apical ring similar; front legs reddish, the tibiae with more or less brownish pre-apical bands, the last two tarsal joints fuscous. Hind tibiae and tarsi black, the former with a median band and sub-basal ring, reddish. Hind coxae with an obtuse, rather large prominence, its length as long, usually distinctly longer than its width, densely beset with short, black bristly hairs. Hind femora greatly swollen, the base and apex narrow; beneath on the swollen part, with stout, sub-appressed, apically directed hairs, before the apex in front with five or six stout hairs on lower surface. Spur at apex of hind tibia moderately long, almost equal to length of third tarsal joint, its apex rounded, from ventral view.

Wings hyaline, strongly cinereous, rarely faintly yellowish, squamae whitish, with pale yellow border and fringe. Halteres pale yellow.

Abdomen variable; first segment grey pollinose; second segment opaque black, the apex shining, sometimes broadly reddish, but usually opaque black, rarely opaque brownish in color; the sides apically usually more or less broadly, diffusely reddish; basal three-fifths on either side broadly yellow, gradually widening behind to the middle where there is a short, usually concave in front projection, the hind margin slightly oblique, convex on inner half, the point of the arm usually appearing to distinctly reach forward, but the arm may sometimes be short and more robust, always rather widely separated from each other. Third segment rarely opaque black, usually opaque brownish or dull brick red, the apical margin always shining red, the red opaque color variable in depth and diffuse with the darker, more brownish color. On the basal third on either side, with an overlaying rectangular whitish pollinose spot. A yellow spot, the inner posterior end produced inwards as a rather narrow lunule, the inner ends reaching a little forward and slightly enlarged, the end rounded, moderately separated from each other, the arms sometimes obsolete basally. Fourth segment usually dull reddish, the apex broadly yellowish pollinose, but the region about the lunules may be brownish or blackish. The lunules are not complete, and are only moderately separated from the front margin in the middle, the arm actually reduced to two oval, slightly oblique yellowish pollinose spots, the lateral portion reduced to squarish spot. Genitalia red, sometimes more or less ferruginous. Pile wholly yellow, rather short, not abundant. Ventral segments more or less black or brown.

Female. Quite different, the thoracic stripes wider, the abdominal lunules greyish or reddish yellow. Face slightly prominent at oral margin as it is produced a little on the lower portion, instead of retreating. Front narrowed above, but still moderately wide; brownish yellow pollinose, paler on sides below, shining across ocelli; pile wholly black.

Mesonotum with the greyish or yellowish vittae wider, still not as wide as the black, the middle one usually beginning just back of the front margin, reaching the posterior margin narrowly. Pleura grey pollinose; pile shorter.

Abdomen opaque black, with similar shining areas as in male, and three pairs of yellow lunules, which are apparently always much brighter yellow than in *distinctus.* First segment grey pollinose; second with the lunules often as in male, but the inner areas are a little stouter and less widely separated. Lunules on third segment are much as in male but closer to the base of segment as the lateral portion is very short; concave in front, convex behind, narrowly separated. A rectangular transverse apical spot on middle of third segment, grey pollinose, the shining apex of the fourth segment except usually a slender median line yellowish pollinose; fifth segment wholly greyish yellow pollinose, the middle line often darker on basal third or more. The yellow ground is limited to the sides of the lunules on second segment, the narrow lateral margins and narrow apices of the third to fifth segments.

Holotype—Male, Orillia, Ont., June 28, 1921, (Curran); No. 2222, in the Canadian National Collection, Ottawa.

Allotype—Female, Melrose Highlands, Mass., June 18, 1911, (J. D. Tothill).

Paratypes—Male, Melrose Highlands, Mass., June 18, 1911, (J. D. Tothill); two males, Orillia, Ont., June 28, 1914 and 1921, (Curran) male, Orillia, Aug. 3, 1921; two males, Lawrence, Kans., June 18 and 27, 1922, (Curran); male, Jefferson Junction, Wis., Aug. 12, 1919, (Fluke); three females, Lawrence, Kans., June 17, female June 16, female June 15, (Curran); female, North Fairhaven, N. Y., July 1, 1921; female McLean Bogs, Tompkins Co., N. Y., June 30, 1921; female, Arlington, N. J., May 29, 1918, (A. Nicolay); male, Fort Lee, N. J., June 4, 1905; two males, female, Orillia, Ont., July 20, 23, 1923, (Curran); female, Aylmer, Que., May 23, 1923, (Curran).

The females described above are a homogenous lot. We are not able to definitely distinguish the females of *distinctus* and *relictus* and do not believe that all the specimens included as females of the former belong there. However, the characters used seem to be fairly constant. *H. distinctus* has much greyer pollen, usually greyish, the apices of the segments are never yellow and the median black vitta extends over the front margin of the thorax. These characters are all weak but it seems better to employ them than to leave the female of *distinctus* not recognizable.

Lejops distinctus Williston

Helophilus distinctus Will., Synopsis, 192, 1886.

Plate VII, figures 37, 38

Very similar to *relictus* but evidently distinct. We believe a comparison between the two species will serve better than a full description.

Length, 7.5 to 9.5 mm. *Male.* Facial concavity not quite as deep and slightly longer, the lower portion of the face hardly as long as the upper; ground color rather brownish with a large yellow area on the slopes, but merely appearing dirty owing to the pollen. Front dark in ground color except the W. First two antennal joints brownish.

Thoracic vittae grey, somewhat wider, but not as wide as the black stripes. Hind femora more broadly yellow at base, their under side yellow or obscurely so on their whole length, the black bristles shorter and less abundant. Hind trachanters with a small acute tubercle bearing black hairs.

Abdomen with the same variation in color. The lunules on the second segment do not reach greatly inwards, being only small points and their ground color is wholly yellow except the very small inner point, the yellow reaching more towards the hind margin and being more oblique, while in *relictus* it is reddish on the posterior part. The yellow on the sides of the second segment reaches three-fifths to the apex and the oblique pollinose lunule rises from its posterior end and is strongly curved basally, the inner end ovally enlarged and always more oblique. The sides and apex of the fourth segment are broadly pale yellowish or whitish pollinose, the strong lunulate spots rising about the basal third, their inner ends enlarged and much more oblique, their bases may sometimes be considerably reduced. The lunules are all situated upon reddish or yellowish ground.

Female. Face as in male. Front dark in ground color as in male, pile all black. Thorax greyish, the middle mesonotal line reaching over the front slope. The femora are even paler than in the male, and this seems to be the only distinctive character as they are quite dark in *relictus*. First abdominal lunules a little more widely separated, the ground color of the lunules more extensively pale than in dark specimens of *relictus*.

We have two males, Englewood, N. J., female, Arlington, N. J., two females, Melrose Highlands, Mass., June 17, 18, (J. D. Tothill).

There seems little doubt about the distinctness of the two species ,although it seems possible that there might be intermediate forms. The tibial spur is a little shorter and broader apically in this species than in *relictus*. In an additional male from Melrose Highlands, taken on same date as one of the females, the trochantral tuft is longer but we cannot see that the tubercle is more prominent, and the face is wholly yellow, the ground color of the anterior portion of the front dirty yellowish. The hind femora are similar in color.

Lejops chrysostomus Wiedemann

Eristalis chrysostomus Wiedemann, Auss. Zwiefl., II 174, 1830. (Not Williston, Synopsis).

In the male, the spur on the hind tibia is very long and acute, the trochantral process is small and acute as in *distinctus*, the hind femur is much more swollen than in the allied species.

Length, 10 mm. *Male.* Face and front below the depression yellowish red, the cheeks piceous brownish, the jowls reddish; the reddish parts densely yellow pollinose, only a narrow supra-antennal shining border. In profile the face is deeply concave on the upper half, the lower half gently convex and slightly more prominent than the antennal protuberance, the upper tip of the oral margin is not noticeable and situated on a plane with the lower border of the eyes, the oral angles rather broadly rounded and not produced as far below the eyes as the width of the third antennal joint. Sides of front on almost the upper two-thirds parallel, this part of the front black, more or less densely yellow pollinose, the ocellar region with blackish brown pollen, so that the front is not at all shining; the pile is moderately long, black, on the reddish ground and face, long; yellow. Occiput black, rather densely yellow polinose, with yellow pile, which is shining in some lights. Antennae yellowish red, third joint sub-orbicular, slightly longer than wide, the arista brown.

Mesonotom opaque black, the side margins more broadly than the black vittae, and broadly separated sub-dorsal stripes greyish yellow pollinose, these stripes broadly united in front, narrowly so posteriorly, the sub-dorsal stripes hardly half as wide as the median black one. Pile short, wholly yellow. Pleura brownish or ferruginous, pale yellow pollinose, behind with whitish pollen, the pile pale brassy yellow. Scutellum with a black, posteriorly convex base, the margin broadly yellowish; pile all yellow, long, not abundant.

Basal half of front four femora, the hind ones except the narrow base and apex beyond the swollen part, yellow, the yellow more extensive above on the hind ones, the immediate apex brown. Front four tibiae and tarsi, basal three-fifths of hind tibiae, except a sub-basal, broad, darker band, and the hind tarsi, yellow, all the tarsi darker, more reddish apically, the apical one-fourth of the hind tibiae brown. Hind femora greatly swollen, widest about apical third, below on the apical half, with numerous black, fairly long bristles, at the base with some short, condensed, fine pale yellow pile, the pile elsewhere yellow. The pile on the legs pale yellowish, on the hind tarsi chiefly black. Tibial spur long, acute. Trochantral process short, acute.

Wings cinereous hyaline. Squamae yellow, with yellow border and fringe. Halteres pale yellow, the knob somewhat darker.

Abdomen probably variable, but always less blackish than in allied species. First segment blackish, more brownish laterally, densely grey pollinose. Second segment with a pair of longitudinal pale yellow triangles on the basal two-thirds laterally, widened posteriorly, the anterior inner margin oblique, so that it leaves a large, basal, longitudinal opaque or sub-opaque black triangle, the apical portion of which has the sides parallel; this portion limited anteriorly by a rounded angle, before which the margin of the black triangle is gently concave; the base of the black triangle is broadly separated from the side margins. Behind the yellow triangles the color is shining reddish, but is separated from the yellow by an opaque, rather ferruginous fascia. Third segment dull reddish, the apex broadly shining, on the sides with a long basal yellow longitudinal triangle, the front border broadly, a narrow post median fascia and slender connecting middle line dull ferruginous. Fourth segment all red or with two or three diffuse darker areas, the apical third shining, elsewhere opaque, the sides on the dull portion broadly white pollinose. Usually there is a broad, whitish pollinose lunule occupying most of the yellow triangles on the second segment and the inner arm of a lunule is indicated by an oblique, oval whitish pollinose spot on either side of the middle line of the fourth segment.

Female. (Translation from Wiedemann). Antennae rusty yellow, face and front yellow pollinose; occiput blackish. Thorax deep black, the vittae pale yellow; pleura with shining greyish hair. Scutellum black, the apex somewhat transparent yellow. First abdominal segment whitish grey pollinose; second deep black at the base, on each side with an oblique white band, at the apex rusty yellow, so that the band forms the figure of a goblet; third to fifth segments rusty yellow, on the base of each on either side whitish, the third also with two smaller, the fourth with two larger, whitish transverse spots; the segmental incisures whitish. Wings shorter than the abdomen, yellowish, with small black-brown stigma. Femora black, with rusty brown apex, the hind ones very much swollen; fore tibiae and tarsi rusty yellow; hind tibiae rusty brown, merging into chestnut brown, the apex black; hind tarsi black, their first joint brown.

The description is drawn from male, Washington, D. C., May 17, 1912; and male, Petersburg, Chesterfield Co., Va., June 1, 1917.

It will be seen at once that the female described by Wiedemann is not conspecific with the specimens included by Williston under either *chrysostomus* (Wied.) or *distinctus* Will. as the color of the abdomen is much more reddish than in any specimens we have examined. It is necessary to separate the species on color because Wiedemann did not mention the trochantral prosscess or tibial spur. The color of the legs applies better to the two males which we have than to other males.

Lejops lunulatus Meigen

Helophilus lunulatus Meigen, Syst. Beschr., III, 370, 1822. (Europe).

Helophilus hamatus Loew, Cent. IV, 79, 1863. (Hudson Bay Terr., Canada).

Plate VII, figures 29, 30

Helophilus hamatus Loew is a synonym. Abdomen tapering, with three pairs of fascia; scutellum normally all pale haired;

fourth abdominal segment with opaque fascia beyond lunules in female; face prominent below.

Length, 8 to 11 mm. *Male.* Face yellow, densely white pollinose, cheeks an doral margin to the base of the angles, shining black; pile long, fine, whitish; in profile concave above, the lower half or third more produced, almost or quite as much as the antennal prominence, very slightly more prominent above, scarcely convex, the lower third of the face lying below the eyes, the buccal margin oblique, straight, the face thus forming an obtuse cone. Front yellow below the depression with dense whitish or whitish yellow pollen, depression not deep; above the depression the ground color black, yellow pollinose the sides narrowly opaque black, the upper fourth shining. Pile pale yellowish before the suture, black above. Lateral half of posterior ocellar line about equal to distance from lateral ocellus to eye. Occiput grey pollinose, more yellowish above, with yellow pile, whitish on sides and cheeks. A few black, short hairs above behind the eyes. Antennae reddish, arista slightly darker, its apical half brown, tapering on basal third.

Mesonotum sub-opaque black, usually with a narrow, opaque, middle line; the side margins rather broadly greyish yellow pollinose, the pollen extending broadly inwards along the front margin to form the base of the rather slender dorsal pollinose stripe of the same color, the stripes slightly irregular, somewhat broadened behind, narrowly connected along the posterior margin with the lateral stripes. Pleura rather thickly grey pollinose. Scutellum translucent dull reddish, the base and corners black. Usually the pile is all bright yellowish, but the scutellum is sometimes black pilose on its disc.

Legs reddish; front femora on more than the basal half, except on the broad frontal margin, sometimes less so, middle on nearly its whole length below, more widely at the base, and a broad, elongate sub-basal spot above, sometimes more or less obscurely connected in front with the ventral stripe, a rather small, sub-quadrate spot on front of hind femora, the hind ones behind on almost their whole length, much more narrowly so on apical third, shining black. Hind tibiae with broad subbasal and sub-apical piceous bands; hind tarsi wholly black. Last three joints of front four tarsi brownish, the front ones paler. Hind femora below with short black spinules and several long, pale hairs, legs elsewhere pale pilose. Hind femora moderately swollen, their tibiae curved at base and apical sixth.

Wings cinereous hyaline, sometimes faintly yellowish, rarely markedly so. Squamae whitish with pale yellow border and fringe. Halteres pale yellow.

Abdomen opaque black, the lateral margins, first segment chiefly, the apices of the second to fourth segments broadly, shining. First segment thinly greyish pollinose, except a spot on either side, the lateral margin rarely broadly yellow; second segment with the lateral margin broadly yellow on almost its whole length, gradually increasing in width to about the middle of the segment, thence carried slightly obliquely inward to form an acute point in line with the oblique posterior margin, the anterior margin of this projection often gently concave, the spot chiefly greyish yellow pollinose; the pollen actually forms the points as the yellow ground color has often only a small interior projection. Sides of remainder of abdomen and broad apex of fourth segment at least narrowly yellow or reddish, the apex of the second and third segments yellow in pale specimens. Usually the yellow portion of the lunule on the third segment is in the form of a rectangular, longitudinal spot on the basal half of the segment, the overlying pollen forming the arms, which are slightly concave in front, their inner ends slightly nearer the anterior margin, the lunules moderately separated from each other in the middle; the base of the fourth segment bears two large, narrowly separated greyish or greyish yellow pollinose spots, occupying about half the length of the segment laterally, their posterior border usually convex on inner half; in addition there is a rather narrow, thinly pollinose band of the same color just behind the opaque fascia. Pile usually all pale yellow, short, but often some black pile on apices of third and fourth segments in the middle.

Female. Dissimilar, the thoracic stripes wide, the abdominal lunules different in shape. Face similar. Front black, the W yellow, yellow pollinose, dark across vertex; pile all black; gently convex, with a longitudinal depression above; front wide, narrowed above, the lateral half of the posterior ocellar line much less than ocellar-orbital line.

Mesonotum greyish yellow or yellowish pollinose, the median stripes sometimes greyish on posterior half, somewhat widened posteriorly, not quite as wide on most of their length at the three opaque black stripes, the middle black stripe entire, but narrowed posteriorly, the lateral ones broadly separated from the front, very narrowly from the hind margin, lateral stripes narrowed posteriorly. Rarely the front of the middle vitta is thinly pollinose. Pleura greyish yellow and greyish pollinose. Legs and wings as in male.

Abdomen opaque and shining as in male, the first segment grey pollinose except for sub-lateral apical spots. In typical specimens (*hamatus* Loew), there is very little yellow on the abdomen, only the sides of the second and third segments, narrow lateral margins of fourth and fifth, and their narrow apices reddish. The lunules on the first segment are as large and as complete, the arms a little broader than in the male, their inner ends less widely separated. On the third segment the lunules are much as in male, but less convex behind, slightly oblique, more or less, sometimes scarcely, concave anteriorly, their inner ends closer to front margins than lateral fourth, touching the base and lateral margin rather broadly. The following lunules are closer to the base of the fourth segment, separated sub-laterally by a narrow, apically convex transverse spot which reaches narrowly quite across the base at the middle, the lunules very narrowly separated. All the lunules greyish. There is a sub-oval transverse pollinose spot before the apex of the third segment; the shining portion of the fourth segment, widest at middle; fifth segment entirely with greyish or greyish yellow pollen except a narrow stripe on basal half or more of middle line. In some specimens the lunules are all yellow in ground color, the sides of the abdomen wholly yellow, the apices of the second and following segments, the fifth wholly, reddish; in such cases there is very little shining black color. These examples present a very different appearance, but intergrading forms are found. Pile as in male, the fifth segment wholly pale haired.

Over 50 specimens from Quebec, New York, Ontario, Wisconsin, Manitoba and Alberta.

The male will hardly be confused with *bilinearis.* The female is readily distinguished from *bilinearis* and *perfidiosus* by the second lunules reaching the margins, the wide opaque bands and more extensive pollen behind the lunules, etc.

Lejops lunulatus is common in May in Ontario on Caltha bloom, but occurs also on most bloom near swampy land. Both *bilinearis* and this species occur together, but the former appears to be a little earlier.

The synonymy of this species need not worry us in North America. Loew described *Helophilus hamatus* from the Hudson Bay Region and his specimen does not differ in the least from several specimens before us, all of which have been compared with the type. The face shows slight variation and for a long time we considered both species as valid, but the series before us proves that this is not the case. The brighly marked females, with more yellow thoracic and abdominal pollen appear very distinct by themselves but there is a perfect series of intermediate forms. The specimens from Alberta have considerable black pile on the scutellum, but are quite evidently not distinct, and are really more typical of the European form.

Lejops bilinearis Williston

Helophilus bilinearis Will., Synopsis, 295, 1886

Plate VII, figure 33, 34

Allied to *lunulatus* Meig., distinguished in the male by the absence of abdominal fasciae except on second segment. The female has the abdominal lunules of the third and fourth segments separated from the side margins, and wholly pale haired scutellum. In the mountain species (*Pterallastes perfidiosus* Hunter) the abdomen of the male is wholly black beyond the second segment, never margined with yellow.

Length, 9.5 to 11 mm. *Male.* Face yellow, thickly white pollinose, the narrow oral border and cheeks shining black; in profile the upper three-fifths concave, with a slight tubercle below the concavity, the lower two-fifths slightly retreating, not quite as prominent as the antennal base; pile long, sparse, whitish. Front yellow before the depression, but darker immediately before it, white pollinose; upper portion shining black, before the ocelli moderately thickly yellow pollinose, thinly pollinose above; depression at lower two-fifths, very shallow; sides above slightly diverging behind, considerably diverging in front of depression. Ocellar triangle broad, the centre of the posterior ocellar line but little more than the width of an ocellus from lateral ocellus, the lateral ones much more than their width from the eyes. Pile yellow before the suture, longer, more abundant behind it. Occiput grey pollinose, long yellow pilose above, with shorter, almost white pile on middle, longer whitish pile below and on cheeks. Antennae ferruginous reddish, the third joint eliptical, broader than long; arista brown, thickened on basal third.

Mesonotum dull blackish brown, the side margin rather broadly dull yellowish pollinose, the pollen extending inwards along the front margin over half way to the middle line. Sometimes the pollen is more greyish, the general color blackish, with a slender, complete pollinose vitta sub-medianly, greyish yellow, and a slender middle line on anterior two-thirds, shining black. In one large specimen there is a grey pollinose dash on anterior sixth on either side of the middle line. Pile all moderately short, yellowish.

Color of legs somewhat variable. Front and middle femora black on basal two-thirds or more, in front broadly red for its whole length or with an obscure, brownish sub-basal interruption. Hind femora with a large black spot on basal three-fifths in front, behind all black except the base, apex above narrowly black; the base in front and rest of joint reddish. In one specimen the hind femora are all black except on apical two-fifths behind. Front four tibiae reddish slightly darker sub-apically; hind tibiae with yellowish base, the middle half and under side on whole length, and apex, reddish, sub-apical band blackish, sub-basal band brownish, hind tarsi black; anterior tarsi reddish, their anterior margin above and the last two joints, fuscous; middle tarsi reddish their last two joints brownish. Posterior femora moderately enlarged, laterally compressed, with a small sub-basal swelling below, and bearing short, rather dense setulae below, the anterior black spot with short black pile, legs elsewhere pale yellowish pilose. Hind tibiae curved at base and apical fifth.

Wings cinereous hyaline, stigmal spot short, fuscous. Squamae white, with yellow border and fringe. Halteres pale yellow.

Abdomen shining black, sides of first segment, the second segment, except the broad posterior margin, a longitudinally placed sub-basal rectangular spot on the third segment, concave on its sides, and usually an oval spot in similar position on the fourth segment. Second segment with the lateral margin broadly yellow, slightly widened to the middle of the segment, thence extending slightly anteriorly inwards to a sharp point, the posterior margin oblique and almost straight, the lateral margin on the apical sixth only narrowly reddish yellow: the inner portion of the spots is composed wholly of pollen, which may sometimes be lacking, in which case the yellow forms only a sharp angle interiorly. Beyond the second segment the lateral margin is wholly reddish or orange, the apex of the fourth segment more broadly so, the apex of the third segment more piceous, but often similar in color to the margins. Sometimes there are very faint indications of complete grey pollinose lunules on the third segment rising just inside the yellow margin, extending obliquely back to near the middle of the segment thence curving inwards their last section more distinct, situated just before the middle of the segment, moderately separated by the opaque black spot; as a rule only the inner ends of the lunules are conspicuous and these may be very small. The fourth segment bears a sub-cordate, sub-basal grey pollinose spot in the middle, which almost entirely encloses the oval opaque black spot; sides also broadly grey pollinose. Hypopygium usually almost all blackish, rarely almost all reddish, with thin yellow pollen. Pile all short whitish or pale yellowish, only the apices of the second to fourth segments, successively more widely so, with short black pile.

Female. Quite different in thoracic and abdominal maculation. Face sometimes slightly more prominent below as the tubercle may rarely be almost wanting. Front wide, sides divergent below, the ocellar triangle not larger than in male and therefore the lateral ocelli are separated from the eyes by more than the length of the median ocellar line. There is no trace of a depression and the blackish ground color extends down almost or quite to the red W, not so far on the sides; the lower third is covered with abundant whitish pollen, elsewhere with yellow pollen, the upper third almost bare. On either side of the ocelli is a broad longitudinal depression running to the upper third.

Mesonotum greyish yellow or greyish pollinose, with three back vittae which are not wider than the grey ones, the median one sometimes interrupted by a very slender middle line; lateral ones broadly separated from front margin, narrowly from the hind, the middle one reaching the anterior margin in a less deep or brownish color and distinctly reaching the hind margin.

Legs usually with slightly smaller black markings, the bands on the hind tibiae paler in color. Wings somewhat yellowish tinged.

Abdomen with the sides sub-parallel, only a little tapering on the first four segments. Grey pollinose lunules of first segment shaped moderately as in first male mentioned in description, the inner arms usually slightly wider, the yellow ground color more restricted. Second segment with only slightly lunulate spots which do not reach the side margins narrowly separated from each other in the middle, widely separated from the base; fourth segment with the spots still less lunulate, very narrowly separated in the middle and reaching the side margin narrowly; in the middle there is a narrow longitudinal black line which is bordered behind the lunule by greyish pollinose except a basal median dash and an incomplete basal fascia which is not always visible. First segment wholly grey pollinose. Sides of second and following segments narrowly, and narrow apices of the third, becoming broad on the fifth, segment, yellow or reddish; the sides also thinly grey pollinose.

Specimens examined: male, Flushing, N. Y., female, N. Y.; male, Aweme, Man., May 9, 1915, (N. Criddle); 2 males, Orillia, Ont., April 28, 1921, (Curran); 2 males, Orillia, May 2, 1921; male, Orillia, May 5, 1921, female, Orillia, May 2, 1921; male, Ironside, Que., May 11, 1916; female, Madison, Wis., May 18 1918; female, Ithaca, N. Y., June 2, 1918, (E. G. Anderson); female, Hull, Que., May 16, 1901, (Harrington); female, Ottawa, June 3, 1903, (Harrington); female, Hull, Que., May 30, 1903, (Harrington); female, Madison, Wis., May 6, 1920, (Fluke); female, University Campus, May 25, 1921; female, same data, May 7, 1922.

This species is readily distinguished in the male by the almost entire absence of lunules except on second segment. The female has been confused with *lunulatus* but is readily distinguished by the second lunule not reaching the sides of the segment, and the absence of an opaque crossband behind the third fascia. From *(Pterallastes) perfidiosus* the female is readily distinguished by its usually more reddish legs and by the yellow ground color on sides and apices of terminal segments.

Lejops perfidious Hunter

Pterallastes perfidious Hunter, Can. Ent., XXIX, 139, 1897.

Plate VII, figure 39

Closely allied to *H. bilinearis* Willist., but the mesonotum is even darker and seldom with thin, yellow, incomplete vittae, the abdomen not pollinose beyond the second segment in male; female very similar to *bilinearis,* but there is no yellow or reddish ground color beyond the second segment. A comparison with *H. bilinearis* will serve better than a full description.

Length 10 to 11 mm. *Male.* Front slightly wider, the upper portion actually slightly wider than the length from the suture to posterior angle of eyes, (in *bilinearis* it is exactly square); face generally a little more receding below. Front usually darker in ground color on lower portion.

Mesonotum of a deeper, duller black, the middle line and submedian vittae shining black, sometimes obsolete, the later usually shortly yellowish pollinose anteriorly; no pollen between these vittae in front.

Femora usually more extensively black, rarely as in *bilinearis.*

Abdomen often with the spots on second segment similar, but seldom projecting as far inwards, never as thickly nor extensively pollinose. A small spot on the anterior angles of the third and fourth segment and posterior margin of the fifth, reddish; opaque black markings of last two segments smaller, the posterior one sometimes obsolete or nearly so; posterior margin of the third rarely obscurely reddish; rarely with a slight trace of the inner arms of the grey lunules, on the fourth segment.

Female. Front slightly wider, and more swollen. Legs a little more blackish, the band on the hind femora entire (not always so?).

The chief differences are found in the abdomen. There are absolutely no reddish markings except on basal corners of the second segment. The abdomen wholly lacks greyish or yellowish pollen except on the first segment and on lunules. The wholly shining fifth segment is distinctive.

Four males, Banff, Alta., May 29, 2 males, June 9, male, June 3, female, October 5, 1922, (C. B. D. Garrett); male, Banff, Alta., June 23, 1909, (N. B. Sanson); male, Penticton, B. C., May 1, 1919, (E. R. Buckell). 1 male, B. C. Specimens from Washington State have also been examined.

This species is so very like *bilinearis* that it might well be considered only a variety were the characters not so constant and the female not so markedly distinct. The thorax and abdomen are both darker than in *bilinearis* and the superficial appearance is more distinct than a close examination indicates.

There has been no question about the identity of the species. Hunter evidently had not seen *bilinearis* or he would not have placed the species in Pterallastes. Notwithstanding the rather non-Helophiline appearance, there is no indication of relationship with *Pterallastes,* a genus with a much shorter face, longer third antennal joint and less deeply curved third vein. The species described by Cole as *Pterallastes borealis* is very close to *perfidiosus* but appears to be distinct. The mesonotum of the female bears narrower pale vittae, the femora are largely black pilose, etc.

Mr. E. E. Wehr has kindly compared a specimen with Dr. Hunter's type in the University of Nebraska Collection and pronounces our specimen as absolutely identical in all respects.

Lejops borealis Cole

Pterallastes borealis Cole. Proc. Calif. Acad. Sc., XI, pp. 170–171.

Female: Length 13.5 mm. Very near *P. perfidiosus* Hunter.

Antennae black, arista brown and bare, third joint about as broad as long. Middle of face and triangle in front of cheeks shining black, otherwise yellowish pollinose and pilose, with yellowish ground color under the pollen. Vertex black; frons yellowish pollinose, with erect black pile. Occiput yellowish grey with yellow pile and a few black hairs above eye margin. Proboscis black.

Mesonotum opaque black, with yellowish pollen on lateral margins and two faint yellow longitudinal stripes, widely separated and narrow; pile rather dark yellow. Narrow base of scutellum black, the rest translucent yellow, rather densely yellow pilose. Pleura semishining black, with black pile. Halteres small and yellowish, the stigmata below halteres with short, dense, fur-like, bright yellow pile.

First abdominal segment semishining black, second with broad yellow lateral margin, the yellow portion triangular in shape and reaching one-third distance across abdomen; third segment with small round yellow spot on anterior corners; remainder of abdomen black, the posterior portion of 2 to 5 shining, the basal portion opaque; a pair of linear, oblique, yellow pollinose marks on dorsum of third and fourth segments. Pile of abdomen largely yellow, black on posterior margins of third, fourth and fifth segments. Venter semishining black, with sparse whitish yellow pile. Legs black, extreme tips of femora and bases of tibiae; pile of front femora and most of pile of middle and hind femora; black; some yellowish pile; hind tibiae arcuate; hind femora noticeably thickened and with black bristles below, short and dense on outer third; short pile below on tarsi golden yellow. Wings hyaline; anterior cross-vein slightly beyond middle of cell 1st A.

Male: Length 11.5 mm. Very nearly the female in appearance. Eyes widely separated, frons almost twice as wide as ocellar tubercle; vertex noticeably convex, a depression between it and antennal protuberance. Abdomen lacks oblique yellowish pollinose marks on third and fourth segments. Hypopygium quite large, blackish, with short yellow pile.

Holotype—female, No. 808, and *allotype,* male, No. 809, Mus. Calif. Acad. Sci.; collected by G. Dallas Hanna, August 20, 1920.

Type locality—St. Paul Island, Alaska.

Subgenus Eurhimyia Bigot

This subgenus contains only two species known to us, one North American, the other European. Osten Sacken regarded them as identical, but Williston recognized the American species as distinct. The two species are very close, but seem to present, small, though constant distinctions.

The character distinguishing the group as a subgenus of Lejops, is the production of the face forward and somewhat downward into a long, acute cone. The character is quite evidently of little generic value and we consider the species as forming only a sub-genus.

The two species before us may be separated as follows:

a. Face in both sexes very evidently concave below antennae; front of male never wholly black

pilose; abdominal pale markings a little more extensive, lunules of female markedly enlarged inwardly ---------------------*stipatus* Walk.
Face in both sexes very slightly or not concave below antennae; front of male wholly black pilose; abdominal spots smaller, lunules of female but slightly enlarged inwardly-----*lineatus* Fabr.

Lejops (Eurhimyia) stipatus Walker

Helophilus stipatus Walk., List III, 602, 1849, (N. Y.)
Helophilus anausis Walk., List. III, 603, 1849. (Ont.)
Helophilus lineatus O. S., Cat., 134.
Helophilus conostoma Williston, Syn., 193, 1886. (Conn.)

Plate VII, figures 35, 36

Face produced forward and slightly downward into a long, acute cone; small compact species. There is no closely allied species in North America and the sharply conical face will at once distinguish it.

Length, 8 to 9 mm. *Male.* Face yellow, thickly yellowish pollinose; in profile slightly concave below the antennae, thence obliquely produced forwards, sometimes with one or two slight swellings; oral margin and cheeks broadly shining black, the former in front and the latter behind more or less pollinose; pile long, sparse, whitish. Front dark in ground color except immediately above the antennae, the anterior half paler, and densely yellow pollinose, the upper half largely shining but more or less, thickly below, brownish yellow pollinose; pile sometimes all pale before the depression, at other times practically all black; or intermixed. Ocellar triangle broader than long, the lateral half of the posterior ocellar line shorter than either the middle ocellar line or the ocellar-orbital line. Occiput yellowish pollinose, sub-shining behind vertex, with a less densely pollinose, elongate spot behind the eyes above, but broadly separated from them. Pile yellowish, a few of the orbital ciliae black. Antennae black, the third joint orange, sometimes somewhat fuscous above, broader than long, elliptical; arista brownish or brownish red, tapering on basal third.

Mesonotum opaque black, the lateral margins broadly yellow pollinose, a narrow complete line on either side of the broad middle black stripe, yellow or greyish yellow pollinose, slightly widened and usually greyish posteriorly; in front broadly connected with the side margins. Pleura greyish and greyish yellow pollinose. Scutellum sub-translucent reddish yellow, the base and angles black. Pile wholly yellowish.

Legs reddish, front femora on basal third, sometimes reduced to anterior and posterior spots, middle femora on slightly more than basal third, on over basal half above and below, sometimes reduced to dorsal and ventral broad stripes, apical half or less of front tibiae and their tarsi wholly black; middle tibiae with two darker bands, one sub-apical the other before the middle. Hind femora with a large spot on upper middle half, a spot on anterior surface at the apical constriction, sometimes connected with the dorsal spot, and a spot above the apex, shining black, all sometimes slightly reduced. A sub-basal and preapical blackish, brownish or ferruginous broad band on hind tibiae. Hind tarsi black. Hind femora considerably swollen, with black bristles below on apical three-fifths.

Wings more or less luteous, cinereous apically. Squamae white, with pale yellow border and whitish fringe. Halteres whitish yellow.

Abdomen rather robust, but not or only slightly wider than thorax, slightly narrowed apically, opaque black, with three yellow or yellow pollinose fasciae. Sides of first segment greyish pollinose. Second segment with large median triangles, their posterior ends directed obliquely outwards to join the side margin about the apical sixth, their front margin concave, directed obliquely forward to reach the base of the segment well inside the anterior angles, the inner ends rounded, rather pointed anteriorly; sometimes the lateral margin behind is reddish. Third segment with basal spots occupying three-fourths the length of the segment, their posterior surface scarcely convex, their inner apical half produced inwards, truncate, the black ground color extending lateral in front for almost a distance equal to the distance separating the spots. Fourth segment with the side margins broadly, the rather broad apex and a pair of broad, obtuse, moderately separated, rectangular spots on basal half, narrowly separated from the base, yellow, or greyish yellow pollinose. Sides of last two segments wholly narrowly reddish. Pile all yellowish. Two middle segments of venter without black color. Genitalia thickly pollinose.

Female. Quite different in color of thorax and abdomen. Front wider, slightly narrowed above, wholly black pilose.

Mesonotum with the median lines wider, but still not more than half as wide as the lateral black stripes, except behind, the side margins more greyish yellow, the pleura greyish pollinose.

Abdomen often largely sub-shining, the lunulate spots only yellow in the ground color laterally, the side margin elsewhere black. First segment wholly grey pollinose. Second with the lateral portion of the spots narrower with almost parallel sides and not quite as long, the lunules rather long, moderately concave in front and convex behind, their inner ends somewhat enlarged and rounded, broadly separated; lunules on third segment mostly beyond the middle, but rising before the middle, less widely separated, but very similar in shape to the first pair; fourth segment with the lunules narrower, before the middle of the segment, rising at the anterior angles, less widely separated medianly, narrowly separated from the front margin, the black base convex, but the lunules less curved than on preceding segment. A transverse oval spot on apex of second segment in the middle, the posterior margins of the two following segments more widely medianly and their rather narrow lateral margins and the fifth segment except the base, grey pollinose; or the base of the fifth segment may bear a triangular median basal black spot and no fascia. In immature specimens the pollen is more yellow.

Forty specimens of both sexes from: Quebec, New York, Ontario, Wisconsin, Manitoba, and British Columbia.

There has never been any question about the identity of this species since Williston described it as *H. conostomus.* Osten Sacken considered it the same as the European *H. lineatus* and it was recorded as such by him. Walker's description is short but this is evidently the same species described by him as *H. stipatus* and also *H. anausis.* We have seen specimens from the region of Martin's Falls, the type locality of *anausis,* and there is no other species which agrees at all with Walker's descriptions. The European species is very similar.

Eurhimyia lineatus Fabr.

A pair of this species from Denmark show practically no differences from *stipatus* except those mentioned in the table, but there is little doubt about the two being distinct. Upon examination they appear more distinct than can be demonstrated by description. The differences noted by Williston will not hold in their entirety as several of the characters are more or less subject to variation.

Explanation of Plates.

All drawings were made with the aid of the camera lucida, and are all drawn to the same scale. Enlarged about 10 diameters.

PLATE V.

Figure 1. *Helophilus obscurus,* abdomen of female.
2. *Helophilus obscurus,* abdomen of male.
3. *Helophilus trivittatus,* profile of head, male.
4. *Helophilus groenlandicus,* abdomen of male.
5. *Helophilus groenlandicus,* abdomen of female.
6. *Helophilus fasciatus,* head of male showing narrow front.
7. *Helophilus latifrons,* head of male showing broad front.
8. *Helophilus latifrons,* profile of head, male.
9. *HELOPHILUS INTENTUS,* n. sp., abdomen of male.
10. *Helophilus intentus,* profile of head, male.

PLATE VI.

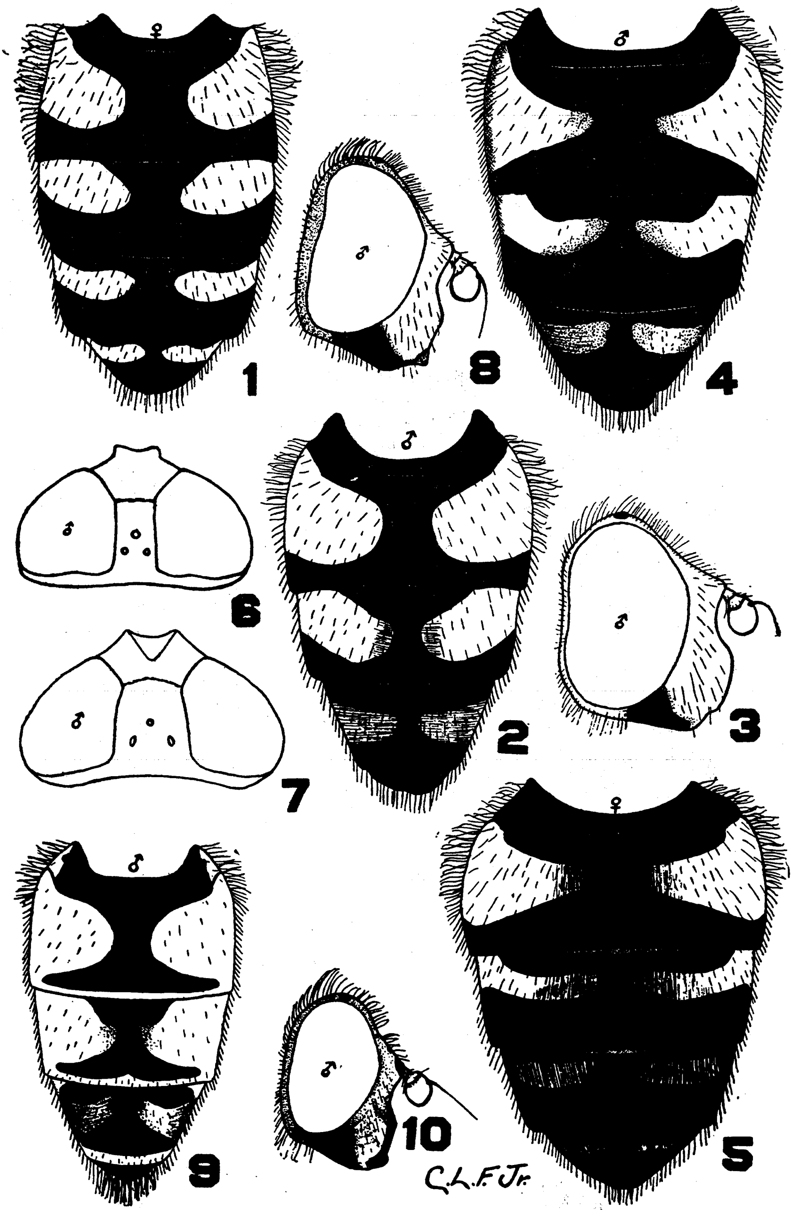
Figure 11. *Helophilus hybridus,* abdomen of male.
12. *Asemosyrphus willingi,* profile of head, male.
13. *Asemosyrphus mexicanus,* profile of head, male.
14. *Parhelophilus frutetorum,* hind femur, male.
15. *PARHELOPHILUS REX,* n. sp., abdomen of male.
16. *Parhelophilus rex,* profile of head, male.
17. *Parhelophilus versicolor,* underside of hind femur, male.
18. *Parhelophilus porcus,* profile of head, female.
19. *Parhelophilus porcus,* abdomen of female.
20. *Parhelophilus laetus,* abdomen of male.
21. *Parhelophilus laetus,* profile of head, female.
22. *Parhelophilus laetus,* wing.
23. *Parhelophilus integer,* profile of head, male.
24. *Parhelophilus obsoletus,* hind femur, male.

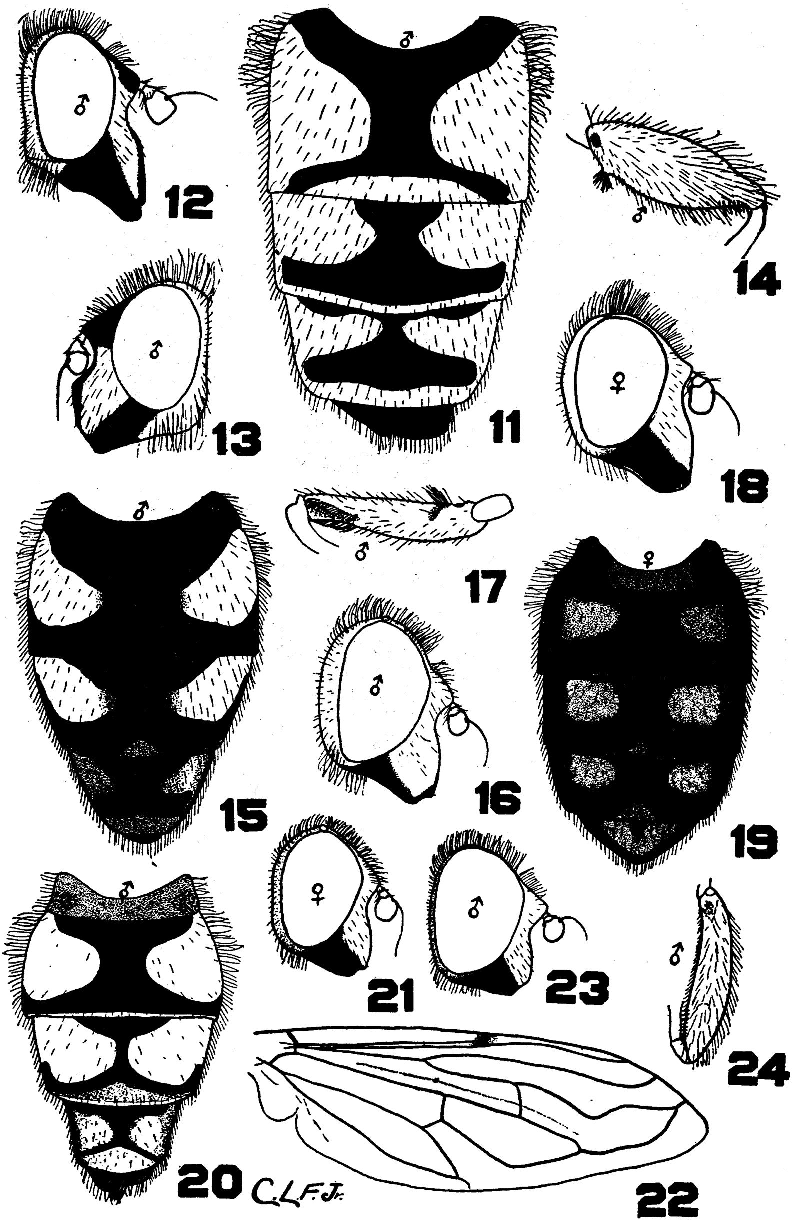
PLATE VII.

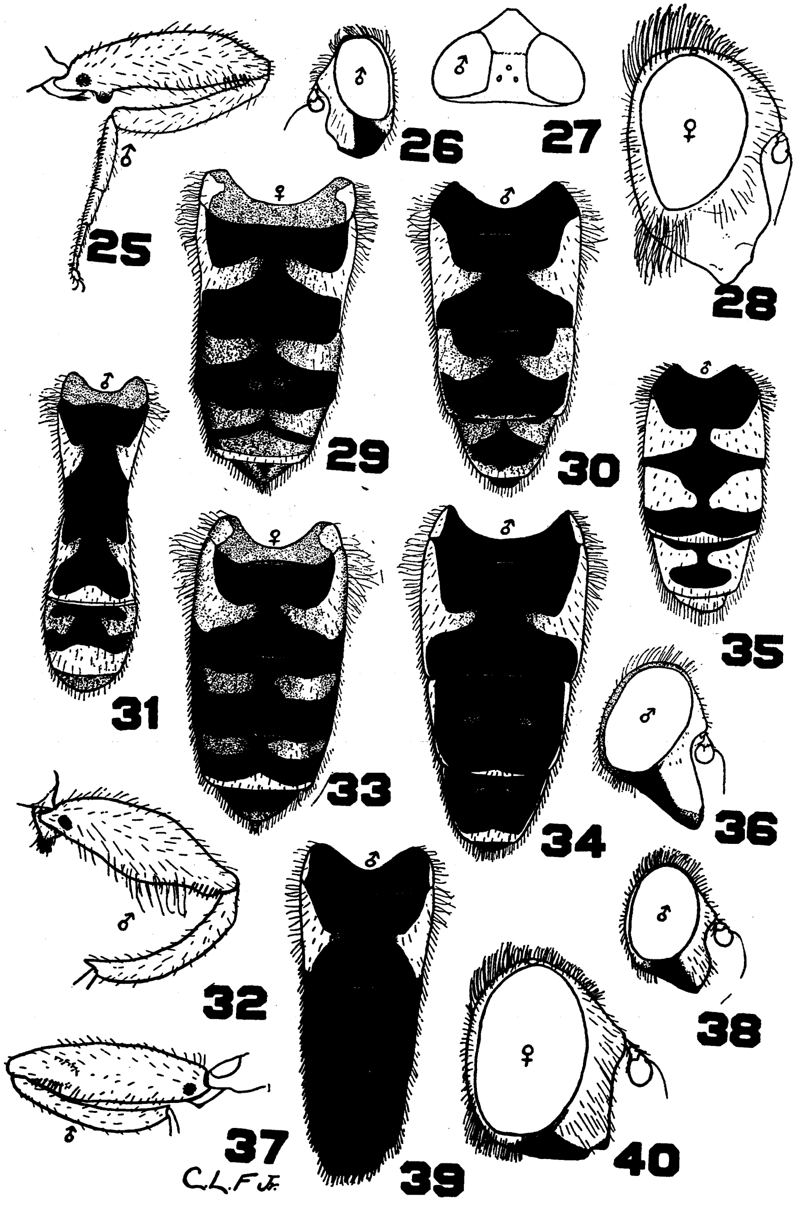
Figure 25. *Parhelophilus divisus,* hind leg of male.
26. *Lunomyia cooleyi,* profile of head, male.
27. *Lunomyia cooleyi,* top view of head, male.
28. *Dolichogyna fasciata,* profile of head, female.

29. *Lejops lunulatus*, abdomen of female.
30. *Lejops lunulatus*, abdomen of male.
31. *LEJOPS RELICTUS*, n. sp., abdomen of male.
32. *Lejops relictus*, n. sp., hind femur and tibia of male.
33. *Lejops bilinearis*, abdomen of female.
34. *Lejops bilinearis*, abdomen of male.
35. *Lejops (Eurhimyia) stipatus*, abdomen of male.
36. *Lejops (Eurhimyia) stipatus*, profile of head, male.
37. *Lejops distinctus*, hind femur and tibia of male.
38. *Lejops distinctus*, profile of head, male.
39. *Lejops perfidiosus*, abdomen of male.
40. *Mesembrius*, profile of head, female.

TRANS. WIS. ACAD., VOL. XXII PLATE V




♂
12
♂
11
♂
14
♂
13
♀
18
♂
♂
17
♀
15
♂
16
19
♀
♂
♂
21
23
24
20 C.L.F.Jr.
22


25
26
27
28
29
30
31
32
33
34
35
36
37
38
39
40
C.L.F.Jr.

THE USE OF PHOTO-ELECTRIC CELLS OF DIFFERENT ALKALI METALS AND COLOR SCREENS IN THE MEASUREMENT OF LIGHT PENETRATION INTO WATER.*

VICTOR E. SHELFORD AND JAKOB KUNZ

I. INTRODUCTION

In 1920 a study of light penetration into sea water in the vicinity of Friday Harbor, Washington, was carried out with photo electric cells by Shelford and Gail (1922). Only potassium cells without screens were used. Numerous difficulties rendered this work perplexing and uncertain. The reading device required too much time, was not sufficiently compact and showed "leaks" in a moist atmosphere. The insulation of the connection between the cell and cable was a constant source of delay and trouble. The cells and especially their apertures were too small and the current too small in proportion to light intensities. Much time has been spent since 1920 in devising and testing equipment designed to eliminate the difficulties encountered.

In addition, a study of available glasses which could be used in combination with cells of the various alkali metals to measure various portions of the spectrum, was conducted. In the paper by Shelford and Gail, calculations of the relative intensities of different colored light at different depths, were presented. These were understood to hold true if the water was not stained and the suspended matter not selective in its transmission of the various wave lengths. The same year Knudsen showed that the sea water about Denmark is stained. He used a special spectrophotometer and the photographic plate.

It is the purpose of this paper to report, on the basis of observations made on Lake Mendota at Madison, Wisconsin, on June 13, 1925, that most of the difficulties encountered earlier can be overcome and that photo-electric cells can be used to show

---

*Contributions from the Zoological Laboratories (No. 274) and the Physical Laboratories of the University of Illinois.

selective absorption of light of different wave lengths. The small number of readings are merely sufficient to demonstrate the feasibility of the method.

Methods and Equipment

The batteries and resistance units were carried in a box which protected them from moisture. Burgess B batteries were connected to telephone jacks mounted in a bakelite panel in such a way that solid plugs could be used to connect battery cells or groups of cells together and give any desired voltage (figs. 1 and 2). The voltage could be read quickly by means of a small Weston volt meter with between forty and fifty thousand ohms in series which reduced the readings to exactly one-fifth and rendered the voltage stable during the readings. The panel was so wired that a photo-electric cell could be connected in the circuit by inserting a two pole plug attached to the cell's cable. The reading instrument was connected into the circuit in the same manner. The two arms of these plugs were connected with telephone jacks. All conductors were carefully insulated except on the contact surface. One purpose of using the jacks and plugs was to make possible the covering of the self-cleaning contact surfaces with vaseline and the complete separation and drying of all parts in case leaks occurred in a moist atmosphere. Two Daven tubular resistance units, one of 250,000 and the other of 500,000 ohms were available in the set; changes could be made by shifting a plug.

The instrument used for the reading was a Rawson single pivot ("Acrid") Micro-ammeter with two ranges of 200 and 20 microamperes respectively. This instrument behaved remarkably well in a small launch 30 ft. in length and 1 ton displacement. Even with a strong wind, it offered no serious difficulties in reading, thus exceeding our expectations.

The cable used was "oko cord," made by the Okonite Company. This consisted of two No. 18 stranded conductors with the usual cloth covered rubber insulation, imbedded in a rubber covering 10 mm. in diameter. This cable gave about one seventh as much leakage under high voltage, as the braid covered cord used in the marine work. The leakage compared with minimum current through the photo-electric cells was almost negligible. The weight of the cells and accessories was carried by the cable.

To make this possible the two wires of the cable were separated and the outer casing was removed for a distance of four feet. The device shown in figure 3 was used to keep water out of the outer casing. This was also constructed so as to permit the use of wire supports to the cell and accessories. The separate wires were further insulated by greasing them with vaseline and pulling tight fitting, pure gum rubber tubing over them.

The form of the cells was changed (fig. 4). The spherical portion was enlarged to 6 cm. in diameter and only the lower half of the surface sensitized. This gave a large surface much more independent of the angle of incidence than was the case of cells used before. The connections with the cable were effected by means of mercury cups (fig. 4). The rubber insulation at the end of the cable wires was removed for about 1/8 inch and the end dipped into solder. The wire was placed in the mercury in the cup (at first through a cork which later was dispensed with) and covered with melted vaseline. The wire was tied in place to prevent injury to the vaseline insulation.

The cells were fitted into section of heavy brass tubing with threaded ring tops to hold glass screens in place and solid brass bottoms (fig. 5). Slots were cut in the brass tube to fit the two arms and filling tube of the cell. A large rubber stopper was roughly hollowed out to fit the cell and a quantity of soft rubber (automobile tire putty) placed in the cavity. The cell was then pressed into place and tied down to the brass bottom with strong cord passed through holes in the bottom plate. This gave the cell a perfect fitting bottom on which to rest. The brass plate was wired to the protecting cage (fig. 5) and the large brass tube set over the cell assembly and fastened to the bottom by means of screws. The cells gave from 120 to 220 microamperes in sunlight with 85 volts and 250,000 ohms in series. This voltage and resistance were usually used; 100 and 120 volts were used only between 10 and 15 meters in one series with the potassium cell. The current-light-intensity curve for these cells was essentially a straight line.

Attempts to make cells in colored globes proved difficult or too expensive to undertake, at least before preliminary use was made of ray filters. Green and ruby tubing presented to us by the Corning Glass Works discolored upon heating and green, red and blue electric light bulbs obscured the interior and rendered the making of the cells very difficult. Many desirable glasses cannot be moulded into such forms or fused with other glass. With the proper moulds, suitable bulbs could be blown from clear glass and some of the colored glasses; hemispherical caps could be made from the nonworkable glasses and cemented over clear cells whenever the expenditure for moulds is justified. This would increase the available aperture of the cells here restricted by the brass cylinders. Ideally the cell should be equally sensitive from all points above a horizontal plane.

The ray filters used were plates of glass, ground, polished, and fitted to the tops of the brass tubes. While a number of glasses were prepared, only the following were used:

1. Blue D, which greatly reduces the long wave lengths leaving blue predominating, was used to reduce the sensitivity of the potassium cells to colors other than blue. See Fig. 6. The curve for the cell with blue glass is the product of the light transmission curve of the glass and the absolute sensitivity curve of the cell.

2. Noviol C (Corning) was used to restrict the rubidium cell to green and yellow light. (Fig. 7).

3. Noviol A (Corning) was used to reduce or eliminate the violet and near ultra violet, but with indifferent results. (Fig. 8).

4. Corning high transmission yellow (G. 30B) was used to restrict the caesium cell to yellow and orange. Corning G 24 (a red pot glass used in railroad signal lights) was used to restrict the caesium cell to orange (fig. 8).

The only difficulties encountered were in connection with the use of the glass ray filters. When the cells were lowered, bubbles of air remained below the glass, making it necessary to tip the baskets to a sharp angle. This forced the mercury against the vaseline and caused leaks in two cases. This difficulty can be remedied by properly grinding places in the edges of the glass so as to allow the air to escape without admitting light.

The leaks were remedied by renewing the vaseline with some melted over an alcohol lamp on the deck of the launch. One cell was removed and replaced by another under the same conditions.

III. Results.

The results are shown in tables 1, 2, and 3 and fig. 9, where percent transmitted by each meter calculated for the sun at zenith, is shown. It was hoped that readings with the pyrlimnometer might be made, but the failure of a cable prevented this.

Table I and figure 9 indicate a sharp difference between the transmission of yellow light (caesium cell and yellow screen) (see figs. 6 and 8) and of blue light (potassium cell and blue screen). This shows that something in the water absorbs the shorter wave lengths. Figure 6 shows that the blue glass cuts off chiefly the longer wave length measured by the potassium cell alone. A comparison of the figures for the clear potassium cell and the same with a blue screen indicates that the absorption of the violet and blue is greater than of the green. Again figure 7 shows that the Noviol C cuts off the blue range of the rubidium cell and should increase the percent transmitted which is shown to be the case in table I. The case of Noviol A over the caesium cell, is not necessarily discordant. No determinations of the transmission of the glass used were made in the violet, because of the weakness of violet light in the equipment available. It appeared to transmit 80–90% of all wave lengths. The curve in figure 8 is from the Bureau of Standards Publication cited. When yellow glass was used the short wave lengths were excluded and the transmission coefficient increased.

In table 2 another series covering two meters is shown. The average transmission coefficient for the combinations of cells and glasses was determined for pure water. The coefficients found were divided by the pure water coefficient .972, .966 and .853, respectively, giving the transmission coefficient of the suspended and dissolved matter. Caesium with a red screen is possibly discordant on the basis of Pietenpol's observations which suggest that orange may be absorbed least, but the current was so small that it may not have been accurately measured. This table again indicates that violet and blue are absorbed by the dissolved or suspended matter.

Table 3 shows the transmission coefficients for the cells given in table 1, divided by the pure water transmission. Here again the increase in absorption toward the blue end is indicated.

The results, however, are essentially qualitative as a determination of the transmission coefficient of the suspended matter is necessary to determine the degree of staining. Pietenpol's results indicate (table 4, p. 577) that the transmission coefficient of the stain in Lake Mendota water is 88.7% for the wave lengths measured by caesium with the yellow screen, in his samples taken several years before. He found the suspended matter to be non-selective. Dividing 74.5% by .887 we get 84.0% for the suspended matter which suggests 57.2% for green and yellow light and 43.3% for blue light due to staining alone.

As a field method it might be possible to measure the transmission of the efflunt when added to pure water, to make possible a rough determination of the effect of stains in the water. This method will have to be developed, however.

A comparison of Lake Mendota with Puget Sound water is shown by reference to the top curve (A) of figure 9 which is for sea water and the bottom curve (G) for Lake Mendota. The potassium cell was used in both cases. From two to three meters of Lake Mendota water absorb as much as ten meters of sea water.

It must be borne in mind that the limited number of readings were intended as a test of the methods and equipment rather than a study of Lake Mendota water. Both equipment and method appear to be adequate for detailed study provided some method of determining the transmission of suspended matter can be developed. It is obvious that selective absorption of light can be determined but suspended and dissolved matter cannot be evaluated with the equipment at hand. While Knudsen found the Danish salt waters stained, he did not differentiate the suspended and dissolved matter.

The most serious defect in the equipment is the small current delivered by the caesium cells under yellow and red glasses. The caesium cells used gave much smaller current in full sunlight than the rubidium and potassium cells, whereas it would be desirable to have caesium cells giving 300 microampheres in full sunlight as the yellow glass reduces it to less than 5%.

The maximum light intensity was found to be only slightly greater in the yellow than in the blue in an unstained water. (Shelford and Gail fig. 12, p. 168). In the Lake Mendota water the light at five meters would be largely restricted to yellow.

Acknowledgments and Bibliography

The expense of the work was borne by the Graduate School, the Department of Zoology, and the Department of Physics of the University of Illinois. The greater part, including the transportation to Madison, was cared for by the Graduate School. The authors are indebted to Dean A. H. Daniels, Prof. H. B. Ward and Prof. A. P. Carman for their unqualified support of the project.

They are further especially indebted to President Birge and Mr. Chancey Juday of the University of Wisconsin and the Wisconsin Geological and Natural History Survey for extensive assistance in connection with the carrying out of the measurements at Madison.

They are also indebted to the Corning Glass Works, especially to Dr. O. A. Gage and to Dr. H. P. Gage for assistance with the glasses used as screens; to Prof. W. F. Schulz and to Mr. A. E. Wuesteman for courtesies in connection with the grinding and polishing of the colored glasses used; to Prof. E. B. Paine of the Department of Electrical Engineering and to Mr. T. O. Henderson, Assistant Superintendent of Buildings, for the loan of equipment; and to Mr. C. E. Hollister of the Department of Chemistry for assistance with the battery box and cable insulator.

Literature Cited

Birge, E. A., 1922. A second report on limnological apparatus. Trans. Wis. Acad. Sci. 20:533–552

Gibson, K. S., Tyndall, E. T. and McNicholas, H. J. 1920. The ultraviolet and visible transmission of various colored glasses. Tech. Papers of the Bur. Stand. 148:1–27

Klugh, A. Brooker, 1925. Ecological photometry and a new instrument for measuring light. Ecology 6:203–237

Knudsen, Martin, 1922. On measurement of the penetration of light into water. Pub. de Circ. (Conseil 1 expl. de la mer.) 76:1–15

Pietenpol, W. B., 1918. Selective absorption in the visible spectrum of Wisconsin lake waters. Trans. Wis. Acad. Sci. 19:562–593

Shelford, V. E. and Gail, F. W., 1922. A study of light penetration into seat water made with the Kunz photoelectric cell with particular reference to the distribution of plants. Pub. Puget Sd. Biol. Sta. 3:141–174

TABLE 1. *Showing the percent of light transmitted by the surface waters of Lake Mendota on the afternoon of June 13, 1925. The first meter is designated as 1; the second, 2, etc. The figures given are calculated to vertical penetration. Duplicate figures are calculated from two meter intervals.*

Meter	Potassium		Rubidium		Caesium		
	Clear	Blue D	Clear	Noviol C	Clear	Noviol A	Yellow
1	47.5	35.4	37.2	47.2	41.2	45.9	63.6
2	33.0	25.5	39.7	44.5	48.3	36.0	65.7
3	43.4	37.8	43.8	47.0	55.3	45.9	68.5
4	43.2	47.7	39.9	54.2	63.3	57.8	70 6
5	43.0	46.1	60.9	56.1	72.2	57.3	70.0
6	47.4	63.4	63.3	62.2	81.5	61.5	----------
7	(60.7)	60.0	77.0	76.9	(79.7)	----------	----------
8	60.7	69.3	83.6	68.3	79.7	----------	----------
9	(65.8)	(56.8)	(75.8)	58.8	(76.5)	----------	----------
10	65.8	56.8	75.8	62.7	76.5	----------	----------

TABLE 2. *Showing percent of light transmitted by the two surface meters of Lake Mendota water near shore on the forenoon of June 13, 1925, with cells with ray filters. The figures .972 etc. are the values of the mean transmission of pure water for the rays measured by the cell and schreen. N for Lake Mendota divided by that of pure water .972 is, for example, 40.0 over .927 or 41.1 of the third column which represents the effect of foreign matter.*

Meter	Potassium		Rubidium		Caesium	
	Blue	N/. 972	Noviol C	N/. 980	Red	N/. 853
1	40.0	41.1	60.2	61.4	50.8	60.7
2	34.4	35.3	68.7	70.1	54.1	63.4

TABLE 3. *Showing the percent of light transmitted per meter after being divided by the transmission coefficient of the cell and glass for pure water.*

Pure Water	.966	.980	.972
Meter	Caesium Yellow	Rubidium Noviol C	Potassium Blue
1	74.5	48.1	36.4
2	77.0	45.4	26.2
3	80.3	47.9	38.8
4	82.7	55.3	49.0
5	82.0	57.2	47.4
6	------------	63.4	65.2
7	------------	78.4	61.9
8	------------	69.7	71.4

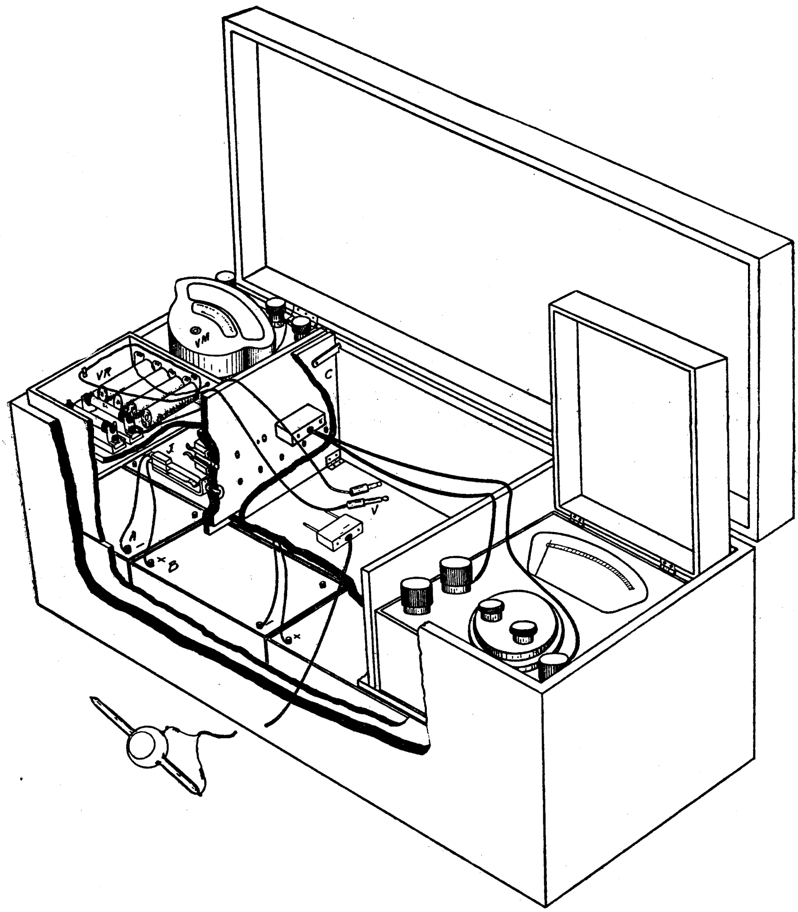


Fig. 1. Battery and switch box used with the photo-electric cells. The B batteries (B) were connected by inserting solid plugs into the telephone jacks (J). The B batteries have a series of cells which may be added in one and one-half volt steps, thus insuring the desired voltage with less than a volt and one-half. The voltage could be read by inserting the volt plug V into connection with the last cell and inserting another solid plug, not shown, to connect the negative pole with the volt meter (see fig. 2). With the voltage resistance in series, the readings were reduced to exactly one-fifth, and stabilized. The micro-ammetr is shown at the right. The cover (C) could not be raised until all plugs were withdrawn, after which the space between the microammeter and the bakelite panel (P) could be used for storage. Large sized B batteries aggregating upwards of 200 volts could be carried. The equipment was designed by V. E. Shelford and C. E. Hollister. See also the wiring diagram shown in fig. 2.

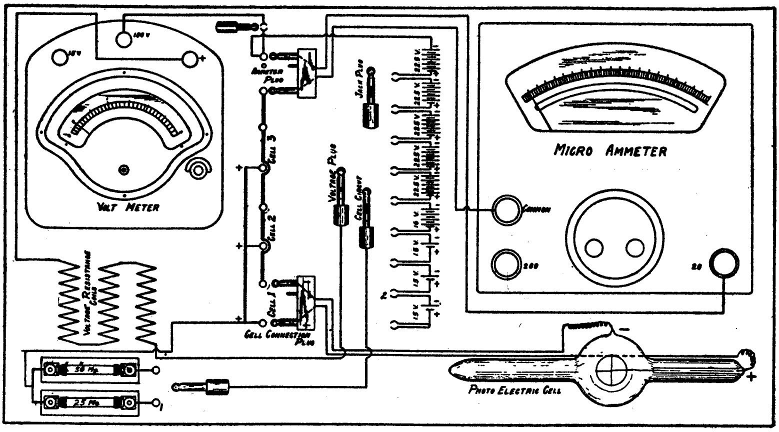


Fig. 2. Wiring diagram of battery and switch box. The cell circuit was completed by inserting one cell circuit plug into opening No. 1 and the other into opening No. 2.

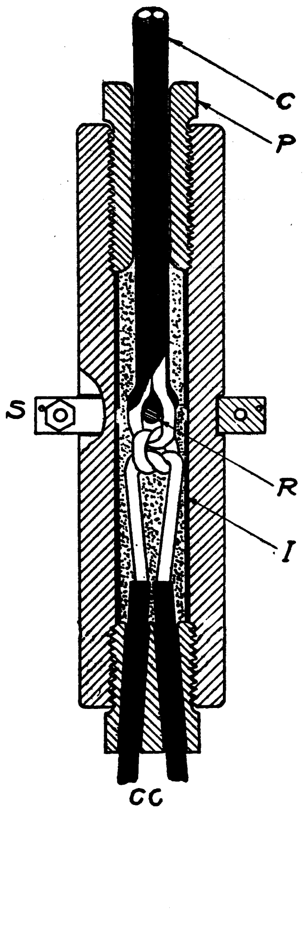


Fig. 3. Insulator to keep water from entering the covering of the outer cable. C, cable; P, plug screwed in after the assembly was completed; S, supports for wires carrying the basket containing the cell; R, short rod for holding the knot in the center of the space; I, iron pipe supports for the rod (R) cc, separated wires covered with gum tubing.

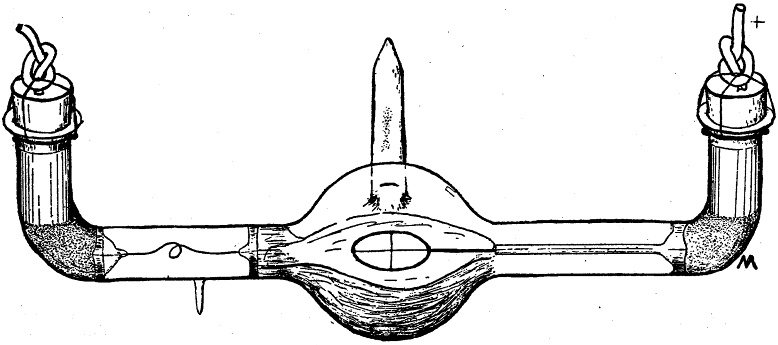


Fig. 4. A photo-electric cell designed for sub-aquatic work. M, space for mercury.

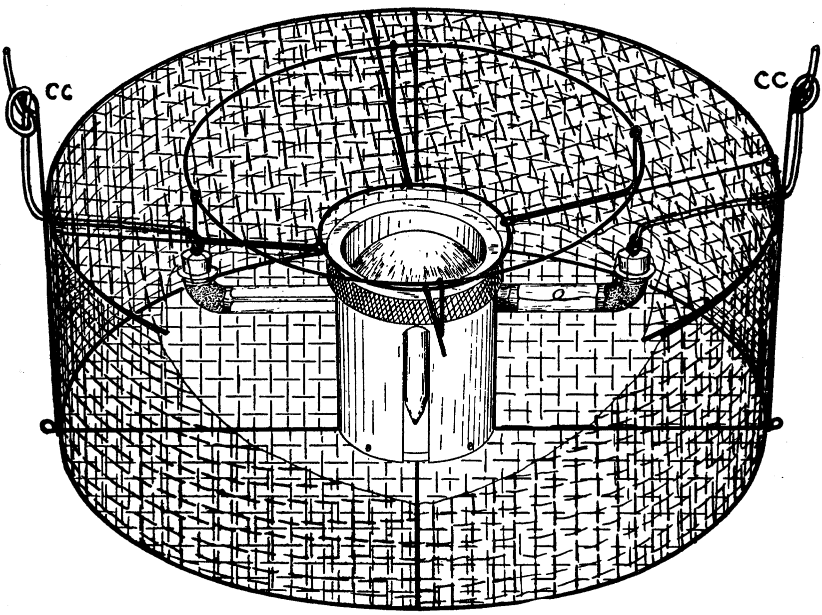


Fig. 5. A cell in position in the protecting basket, with the brass screen holder in position. CC, divided cable strands leading to cc of fig. 3. When necessary a weight could be suspended below the basket from S of fig. 3, by wire or cord passing through the loops on the basket. This was not required in Lake Mendota.

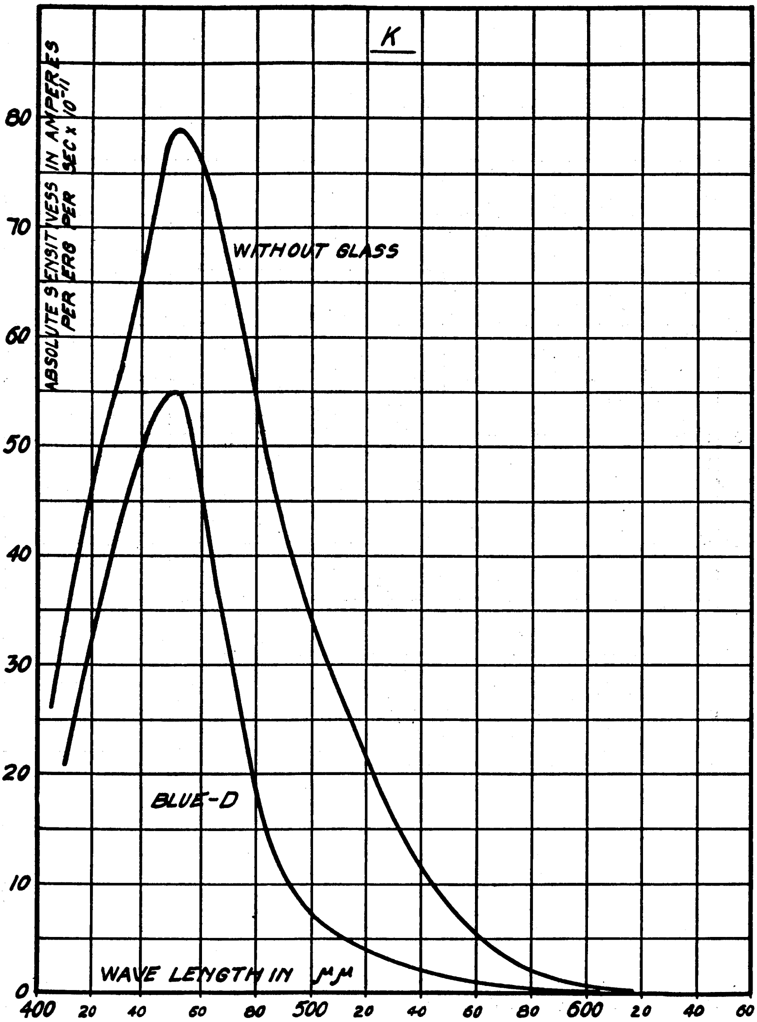


Fig. 6. The sensitivity of the potassium cell with and without blue glass. The sensitivity of the cell with blue glass was used to determine its average transmission for pure water, by taking the transmission of pure water at 420, 3¼ times; at 446, 5½ times; at 480, 1.8 times (actually at more frequent intervals) and securing an average.

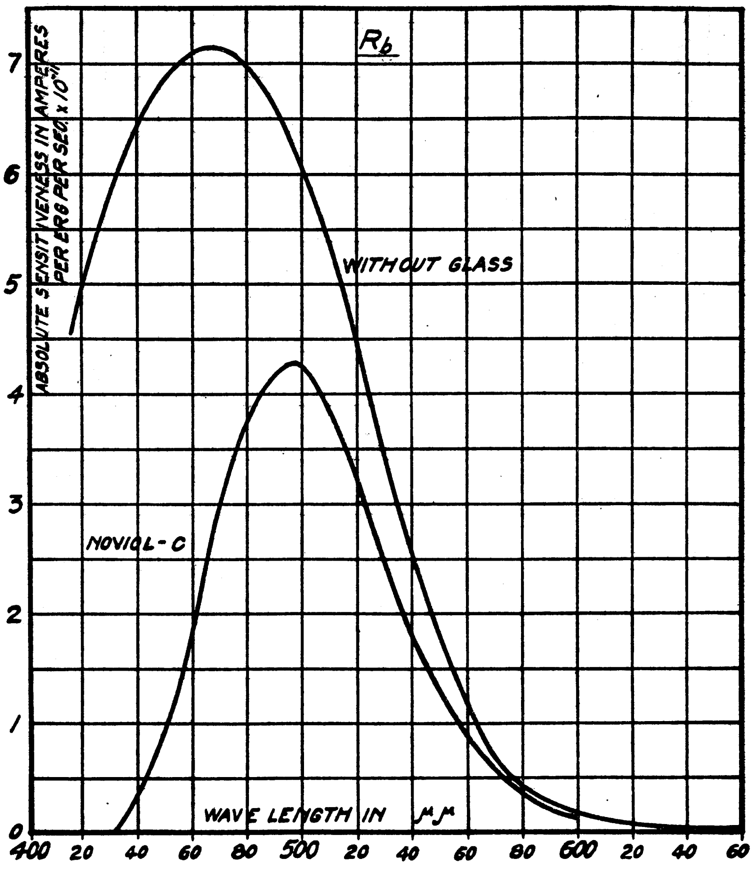


Fig. 7. Sensitivity of the rubidium cell with and without noviol C.

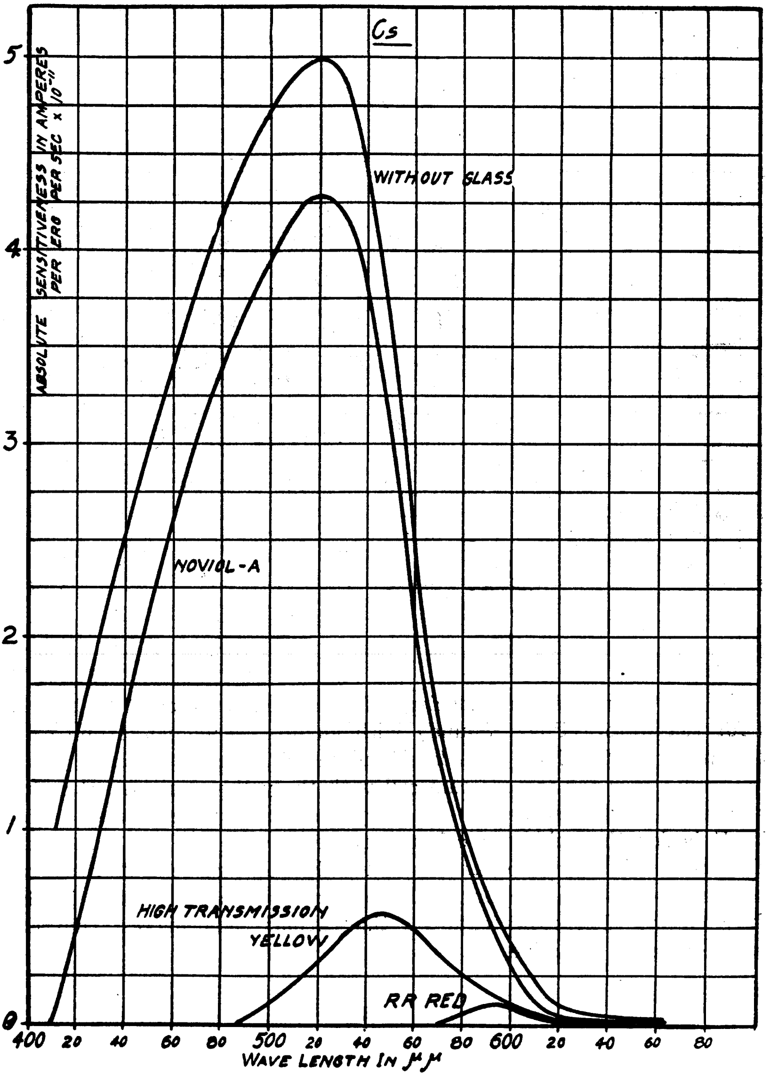


Fig. 8. Sensitivity of the caesium cell with and without, noviol A, yellow glass and red glass.

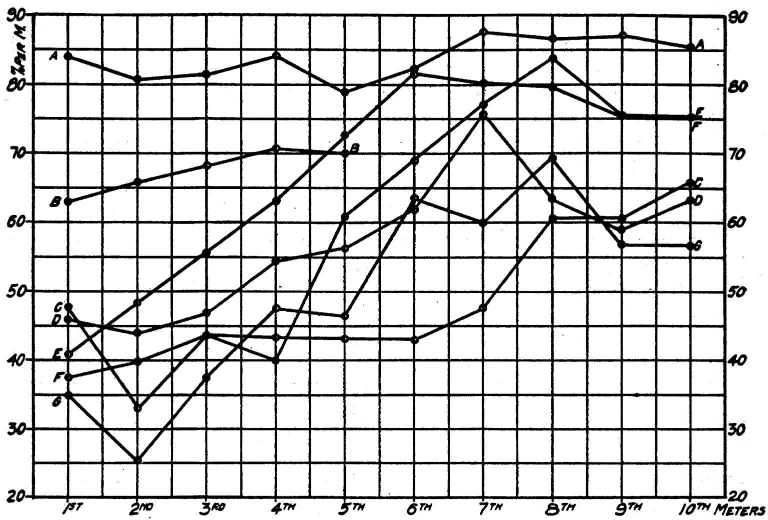


Fig. 9. Transmission coefficients for each meter from 1 to 10. A is for sea water (Puget Sound) with an unscreened potassium cell; compare with G which is Lake Mendota with an unscreened potassium cell. B is for the caesium cell with the yellow screen. E is for the caesium cell unscreened. D is for the rubidium cell with noviol C. F is for the rubidium cell unscreened. C is for the potassium cell alone; G is for the potassium cell with a blue screen. The curves suggest plankton maximum in the second meter and another in the ninth meter. The coefficients for the various cells suggest that the second meter is selective.

A THIRD REPORT ON LIMNOLOGICAL APPARATUS

CHANCEY JUDAY

Notes from the Biological Laboratory of the Wisconsin Geological and Natural History Survey. XXV.

The present paper is a continuation of the two reports that have already been published regarding limnological apparatus, one by Juday in 1916 and the other by Birge in 1922.

THE FOERST ELECTRIC CENTRIFUGE

Quantitative and chemical studies of the net plankton of lakes in the vicinity of Madison, Wisconsin, were begun in 1911 and were continued until 1917. In the early stages of this investigation it was found that a very large portion of the plankton material was lost through the meshes of the net. Various methods of obtaining the lost organisms were tried and a centrifuge proved to be the most efficient instrument for their recovery. A large size De Laval centrifuge was installed in 1915 and was used until 1917 for the investigations relating to the organisms that are lost by the net. A report on this work was published in 1922.

The importance of the results obtained with this large centrifuge made it desirable to extend these studies to lakes in other parts of Wisconsin. The large size and the equipment required to operate it made this De Laval centrifuge impractical for field work in other lake districts. Mr. J. P. Foerst, mechanician of the Physics Department, University of Wisconsin, then undertook the task of constructing a portable centrifuge which could be readily taken into the field and operated wherever electric current is available. The result of his work is the Foerst Electric Centrifuge which is shown in figure 1. This instrument has been used for a period of five years and very interesting and valuable results have been obtained with it during this time.

The motor (M, figure 1) consists of a standard grinding motor manufactured by the Wisconsin Electric Company of Racine, Wisconsin. It has a speed of 20,000 revolutions per minute and operates on either direct or alternating current of 110 volts. Instead of the usual wheels that are attached to the spindle for grinding purposes, a small centrifuge bowl is used.

The motor is mounted on a cast iron base (B) which holds it in a vertical position. Inside the base is a rheostat which gives a range in speed from a few hundred up to 20,000 revolutions per minute. The amount of resistance introduced into the circuit, which determines the speed of the motor, is regulated by turning the wheel marked R in figure 1.

A centrifuge with a still higher speed has been used for the past four years. The motor has a speed of 4,000 revolutions per minute and the spindle is driven by a belt. Seven interchangeable pulleys give a range in speed from 3,600 to 50,000 revolutions per minute; except for a few experiments at the maximum speed this centrifuge has been operated at 32,000. It is a larger and heavier machine than the one shown in figure 1, but it can be readily handled in the field; in fact it has been used for this purpose almost as much as the small machine.

The same bowls are used on both machines. Several hundred duplicate determinations have shown that the small machine removes substantially the same amount of plankton at 20,000 as the large one does at 32,000 revolutions per minute. Likewise several experiments have shown that a speed of 32,000 yields as much material as 50,000. The weight of the small centrifuge is 8 kilograms and of the large one 22 kilograms.

Eight different kinds of bowls have been used in the experimental tests to ascertain which one is most efficient for general use. The two that have given most satisfactory results are shown in cross section in figures 2 and 3. Figure 2 represents the original type. In this bowl the side is vertical; that is, it forms a right angle with the bottom. The corner is rounded off somewhat so that the material can be more readily removed from the angle. At the top of this bowl there is a rim 1.5 millimeters long which projects inward 1 millimeter. The outside diameter of the bowl is 57 millimeters and the height is 29 millimeters. The inside diameter is 50 millimeters at the rim and 52 millimeters below the rim; the depth is 25 millimeters.

The bowl shown in figure 3 has the same outside diameter at the base and the same height as that in figure 2, but the sides slope inward at an angle of 5 degrees; that is, the angle between the side and the bottom of the bowl is 85 instead of 90 degrees.

There is no rim at the top. The inside diameter at the top is 50 millimeters and the depth is 25 millimeters. Experiments have shown that this bowl is just as efficient in removing plankton organisms as the one with the rim; since the catch can be washed out of the bowl with sloping sides a little more conveniently than out of the one with a rim, the former type has been adopted for general use. These bowls are made of brass or steel; the latter has a tendency to rust, which may be prevented by plating it with nickel.

A hub projects upward from the bottom of the bowl for a distance of about 15 millimeters. The upper part of a hole in the middle of this hub is provided with threads by means of which the bowl is screwed onto the spindle of the motor. The point of attachment to the spindle is raised in this manner in order to lower the center of gravity of the bowl and thus prevent undue vibration. In the sloping bowl, the upper part is made thinner in order to keep the center of gravity as low as possible.

A bronze guard (G in figure 1) is fastened to the framework of the motor at the upper end of the spindle; this guard surrounds the greater part of the bowl and is provided with an outlet tube (O) through which the water escapes from the centrifuge. The side wall of this guard is 3 millimeters thick; the inside diameter of the guard is 70 millimeters and the depth is 22 millimeters inside and 27 millimeters outside.

A cover (C in figure 1) made of sheet brass one-half millimeter thick fits snugly inside the guard and completes the housing for the bowl. The cover is 40 millimeters high and possesses a tube (T) in the the center 17 millimeters in diameter, through which the water is fed into the bowl. The feeding tube extends down to within one millimeter of the bottom of the bowl and a diaphragm at the lower end prevents the water from being thrown over the top of the bowl before it is centrifuged. This diaphragm is 49 millimeters in diameter. When the water strikes the bottom of the revolving bowl it is quickly set into rotation and thrown against the side where its speed of rotation is increased as it passes up toward the top of the bowl; it is finally discharged over the top in a fine spray. Most of the organisms are deposited on the side of the bowl within five millimeters of the bottom, thus showing that the water promptly acquires sufficient speed of rotation to cause their deposition. At a speed of 20,000 revolutions per minute, the inner surface of the side of the bowl travels at a rate of 3,200 meters per minute; at a speed of 32,000 the rate is 5,120 meters per minute.

The only water that remains in the bowl at the end of a run is that below the rim in the first type of bowl or that in the angle of the second type; in the bowls described above it amounts to about 4 cubic centimeters.

Bowls with inside depths of 17, 20, 25, and 29 millimeters have been used in the experiments to determine the effectiveness of the different types. It was found that efficiency increases somewhat with increasing depth up to 25 millimeters, but there was no difference between the 25 and 29 millimeter bowls. Two v-shaped grooves 1.5 millimeters wide and 0.5 millimeter deep were cut into the side on the upper half of one of the 29 millimeter bowls, but these grooves did not give this bowl any advantage over the others. In another experimental bowl the top rim projected inward a distance of 3.5 millimeters instead of the usual 1 millimeter, but this made no difference in the size of the centrifuge catch. Two small holes were drilled in the rim so that the quantity of water left in the bowl could be reduced to the usual amount at the end of the run.

Two modifications were made for the purpose of giving the water the same speed of rotation as the bowl. One bowl was provided with four thin brass wings which project inward from the side for a distance of 5 millimeters. The water passes up the side of the bowl between these wings so that it attains substantially the same speed as the bowl before it reaches the top. The amount of material obtained from this bowl, however, did not prove to be any larger than that of a bowl with smooth sides and the same height.

Another bowl was fitted with a special feeding cone which has a rim 6.5 millimeters wide at its lower end; this device is attached to the bottom of the bowl by means of three screws passing through the rim. The water is fed into the top of the cone, passes down to the bottom of the bowl and then out to the side through a series of small grooves on the lower side of the rim. This rim extends out to within 2 millimeters of the side of the bowl, so that the water acquires the same speed of rotation as the bowl before it leaves these grooves. This special bowl did not yield any larger catches of plankton than the duplicates taken with the regular bowls of the same height.

With one exception the first centrifuging removes approximately 98 per cent of the organisms that are usually considered in a plankton catch. Aphanizomenon is the only form noted thus far which is troublesome in this respect; only about half of it is removed in the first centrifuging, but substantially all that remains is taken out by a second centrifuging. With very few exceptions this form is present in such small numbers that a second centrifuging is not necessary.

Plate counts have shown that 40 to 70 per cent of the bacteria are removed from the water by the first centrifuging. This high efficiency is maintained for plankton catches that will weigh as much as 8 milligrams when dry. The water is centrifuged at a rate of one liter in 5 to 8 minutes, 6 to 7 minutes being the usual time. The water is fed into the centrifuge from a one liter aspirator bottle which is placed on a box beside the centrifuge; the rate of flow is regulated by a glass stop-cock in the outlet tube of the aspirator bottle.

With this type of centrifuge, plankton material may be obtained for numerical, gravimetric, and micro-chemical studies. For purposes of enumeration one-half liter samples are used; if some of the organisms are abundant, they are enumerated without concentration and the less abundant forms are then enumerated in the centrifuge catch. Duplicate samples of one liter each are usually used for the gravimetric determinations; when the plankton is scarce a two or three liter sample may be used. The catch is rubbed off the side of the bowl with a glass rod which is tipped with a piece of gum rubber tubing and transferred to a platinum dish with a capacity of 8 cubic centimeters; the bowl is then washed twice with distilled water, about one cubic centimeter being used each time, and this is added to the material in the dish. The catch is placed in an electric oven where the water is evaporated and the material is dried for a period of 24 hours at a temperature of 60° C. After weighing, the catch is ignited in an electric furnace at a temperature of about 600° C. for a period of 30 minutes. A second weighing shows the gross loss on ignition. In order to correct for the loss on ignition sustained by the 4 cubic centimeters of lake water included with the catch, a blank consisting of 10 cubic centimeters of centrifuged water is run along with the plankton sample. The net loss after making this correction is regarded as the organic matter of the plankton. The quantity of organic matter in the plankton of the Wisconsin lakes that have been studied, varies from a minimum of about 700 milligrams to a maximum of 6,000 milligrams per cubic meter of water.

Both numerical and gravimetric results are obtained for the net plankton as well as for the total plankton secured with the centrifuge; the closing net described in the first report is used for these catches. For the gravimetric determinations, the net is hauled through the desired stratum and the catch is transferred from the plankton bucket to a piece of bolting cloth placed in a funnel. After the water has drained off, the net plankton is carefully removed from the bolting cloth with a sharp knife or scalpel and placed in a small platinum dish. The catch is then dried, weighed and ashed as indicated for the centrifuge material.

In addition to the plankton organisms, the centrifuge also removes a certain amount of silt from the lake waters; this is shown by the fact that the ash of the centrifuge catch usually amounts to 50 per cent or more of the dry weight. The percentage of ash in all of the plankton forms, except the diatoms, is much smaller; it is less than 10 per cent in many of these forms.

A certain amount of organic matter is removed by the centrifuge even after all of the plankton organisms, except the bacteria, are gone. With the exception of a small percentage of the bacteria, the plantkon material is all removed from the water by the end of the third centrifuging, yet this water continues to yield small amounts of organic matter up to the eleventh centrifuging; no attempt has been made to carry the experiment further than this. This result suggests that the lake water contains organic matter in a collodial state which is gradually thrown out as the centrifugal process continues.

During the summer of 1925 the centrifuges and the electric furnace were successfully operated in the field by a Kohler Light–Power plant made by the Kohler Company of Kohler, Wisconsin. The plant is especially designed for use on a farm; it furnishes a direct current of 110 volts and has a capacity of 1,500 watts. The plankton material was dried in a copper drying oven which was heated to 60° C. by a kerosene incubator lamp.

Keller Portable Balance

A good portable balance is required for gravimetric studies of the plankton during the summer field work. A Keller portable assay balance, made by the G. P. Keller Manufacturing Company of Salt Lake City, Utah, has given excellent service in such investigations during the past four years. A sketch of it is shown in figure 4. This balance has given good results and has not shown any appreciable effects of ordinary vibrations when used upon tables or temporary benches; it has a capacity of 100 grams and is sensitive to 1/200 milligram.

The balance case is trapezoid in form, 30 centimeters long, 15 centimeters high and 14 centimeters wide at the base. The carrying case is 37 centimeters long, 19 centimeters high and 17 centimeters wide. It requires only a very few minutes to dismantle the balance and place it in the carrying case, or to set it up again upon removal from the case.

Bottom Dredge

The bottom dredge shown in figure 5 is a modification of the one described by Ekman in 1911. It is especially designed for the capture of organisms that live *on* the bottom, such as Mysis and Pontoporeia, and not those that burrow into the mud.

The dredge consists of two parts, namely, a canvas part in front and back of this a straining part made of silk gauze. The dredge has a rectangular opening 16 by 38 centimeters; the canvas part is 40 centimeters long and the gauze part is 55 centimeters long. The dimensions at the point where the canvas and gauze parts join are 19 by 42 centimeters. A canvas apron extends back over about half of the gauze part in order to protect it.

The canvas and gauze are attached to quadrangular frames made of brass. The frame at the mouth of the dredge is made of brass 2 centimeters wide and 3 millimeters thick; the one in the middle of the dredge is 2.5 centimeters wide and 3 millimeters thick. The front part of the middle frame is provided with small holes, about a centimeter apart, through which the canvas is sewed to the frame. In addition to the canvas, the two brass frames are connected at each end by small ropes which pass through holes made to receive them.

The silk gauze is attached to a separate quadrangular frame made of a strip of brass 2.5 centimeters wide and 1 millimeter thick as shown in figure 6. This frame fits snugly over the one in the middle of the dredge to which the canvas is attached and is fastened to the latter by six small screws, two on each side and one at each end. Gauze of different meshes is attached to three or four of these frames, so that one can readily change from one size of mesh to another whenever it is desirable to do so. Small holes in the outer part of these frames provide for the attachment of the canvas band to which the gauze is sewed. A band of light canvas is sewed around the opening in the lower end of the gauze net; a line tied around this canvas closes the bottom of the dredge. During dredging operations a weight is attached to the line about a meter or a meter and a half in front of the mouth of the dredge.

Trap for Plant Dwelling Animals

Many animals dwell upon the larger aquatic plants, such as Potamogeton and Myriophyllum, and the trap shown in figure 7 was designed for the capture of such forms. The sides of the trap are made of light canvas or drilling and the bottom is made of No. 72 extra heavy grit gauze. At the top the canvas bag is sewed to a brass frame which possesses small holes for this purpose. The frame is made of brass 2.5 centimeters wide and 3 millimeters thick; there are two double hinges in the center so that the mouth of the trap can be completely closed. The opening of the trap is 36 by 37 centimeters and the depth is 85 centimeters.

In making a catch the open trap is lowered over the plants to be examined; the plants are then loosened from the bottom and the mouth of the trap is closed. The trap is raised to the surface with the mouth upward and hauled into the boat, the water being allowed to drain out through the gauze before it is taken on board. The plants are transferred to a pail containing some water and taken to the laboratory where the animals are washed off and enumerated. Two individuals are required for the most convenient operation of the trap, one in the water to make the catches and the other in the boat to haul the apparatus on board and remove the material. By using a diving hood the trap has been operated at depths of 5 and 6 meters.

Apparatus for Determining the Coefficient of Nets

The plankton trap described in the first paper on limnological apparatus (Juday 1916) may be used for the determination of the coefficient of nets. Trap catches are made at meter or half meter intervals in the stratum through which the net is hauled and the average result yielded by these catches is a fair index of the efficiency of the net. The trap has been operated successfully at a depth of 60 meters so that the coefficient of a net can be determined in the lower as well as in the upper strata of a lake.

Another instrument was briefly described by Birge in 1898. It consists of a galvanized iron tube 3 meters long and 10 centimeters in diameter which is provided with a closing device at its lower end. A side view of the closing part is shown in figure 8; it consists of a slide and a carrier that bears a small plankton net. The carrier and net can be slipped to one side so that the opening is entirely free when the tube is lowered into the water. The slide is made of a brass plate 26 centimeters long, 15.3 centimeters wide and 3 millimeters thick; two pieces of brass 26 centimeters long and 3 millimeters thick are attached to each side of the brass plate, flush with the edge, by means of four screws. The upper piece of brass is 7 millimeters wide and the lower one is 15 millimeters wide, so that the latter projects inward 8 millimeters beyond the former and forms a track or groove in which the carrier can be moved back and forth.

At one end the brass plate possesses a hole 10 centimeters in diameter around which is soldered a tube 10 centimeters long; this tube is just a little larger than the iron tube so that the latter slips inside and attaches to the brass part by means of two bayonet joints. The other end of the brass plate has a tube 1 centimeter in diameter and 1.5 centimeters long through which the air escapes from the net when the apparatus is submerged; a piece of gauze is tied over the small tube in order to keep plankton organisms out of the net.

The carrier is made of a brass plate 13.8 centimeters square and 3 millimeters thick; it has a hole 10 centimeters in diameter in the middle around which is soldered a tube 5 centimeters long. The net is attached to the lower end of this tube by means of a clamp activated by a screw. The bolting cloth net is 15 centimeters long and the lower end of it is attached to a brass ring that fits one of the standard plankton buckets described in the first report. The weight of the bucket is supported by three pieces of line which are attached to the clamp at the top of the net and to the clamp at the bottom.

A small pulley is soldered to each end of the slide; the lines with which the carrier is moved from one side to the other pass over these pulleys and are tied to a loop soldered to the carrier. These pulleys project below the lower edge of the brass plate and serve as stops to prevent the carrier from being pulled out too far. In actual practice only the closing line is used because the net is moved away from the tube opening before the apparatus is lowered into the water. The slide and carrier are closely fitted together, so that plankton organisms can not escape between the bottom of the tube and the top of the net.

The galvanized iron tube is provided with a heavy wire handle at the upper end to which a rope is attached when the apparatus is being used. The top of the tube also possesses a close fitting, hinged cover. A wire soldered to the cover projects outward 10 centimeters at the point where the hinge is attached; a lead weight at the outer end of this wire keeps the cover open when the tube is being lowered into the water. The cover is closed by means of a line which is attached to a wire loop on the edge of the cover opposite the hinge and which passes through a loop on the side of the iron tube.

In making a catch, the tube is lowered into the water with the net carrier moved to one side of the opening; it is lowered slowly so that no appreciable currents are set up in the water. When the top of the tube is half a meter or a meter below the surface, the cover is closed and the net carrier is drawn across the bottom of the tube, thus imprisoning a column of water 3 meters long and 10 centimeters in diameter. The tube is then slowly raised to the surface and lifted out of the water so that the imprisoned water is filtered through the net. Several catches with the tube as well as with the net, the coefficient of which is to be determined, are taken at the same time through the same stratum of water. A comparison of the number of plankton organisms in the tube catches with that in an equal number of net catches, gives an index of the efficiency of the net.

Literature Cited

Birge, E. A. 1898. Plankton studies on Lake Mendota. II. Trans. Wis. Acad. Sci., Arts and Let. **11**: 278–286.

——— 1922. A second report on limnological apparatus. Ibid. **20**: 533–552.

Birge, E. A. and Juday, C. 1922. Inland lakes of Wisconsin. The plankton. Bul. **64**, Wis. Geol. and Nat. Hist. Survey, 222 pp.

Ekman, S. 1911. Neue Apparate zur qualitativen und quantitativen Erforschung der Bodenfauna der Seen. Internat. Revue **3**: 553–561.

Juday, C. 1916. Limnological apparatus. Trans. Wis. Acad. Sci., Arts and Let. **18**: 566–592.

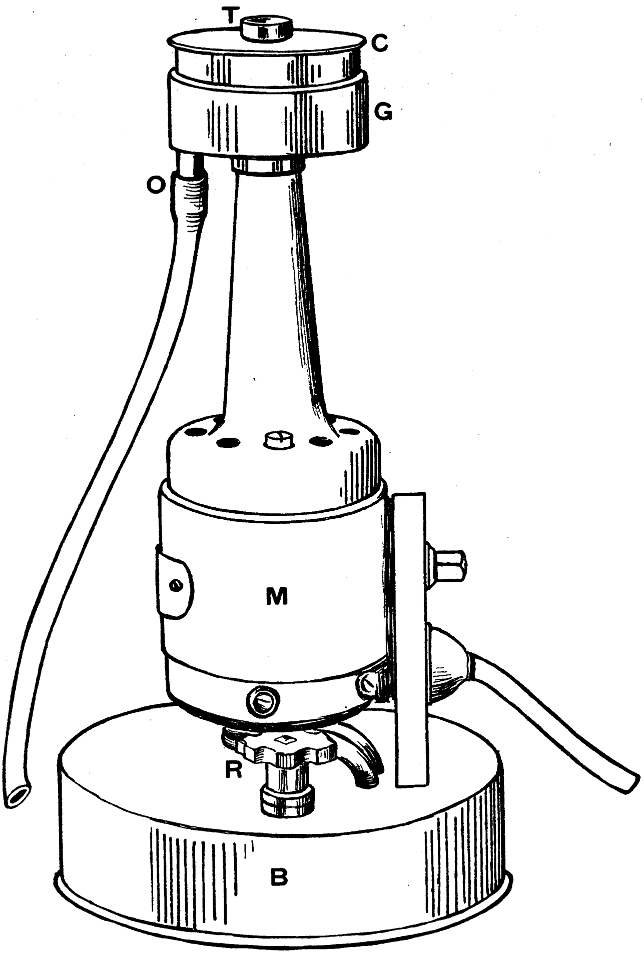


FIG. 1. Sketch of Foerst electric centrifuge. B, base, M, motor, R, rheostat wheel, O, outlet tube, G, guard, C, cover, T, inlet tube.

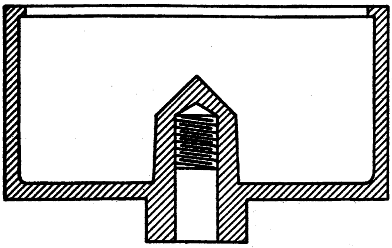


FIG. 2. Cross section of bowl with a rim. Natural size.

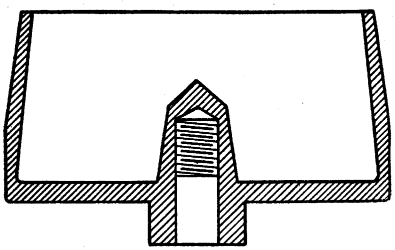


FIG. 3. Cross section of bowl with sloping sides. Natural size.

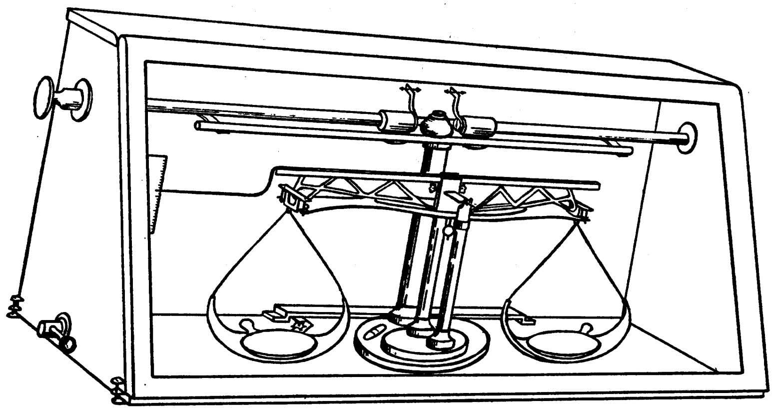


FIG. 4. Keller portable assay balance.

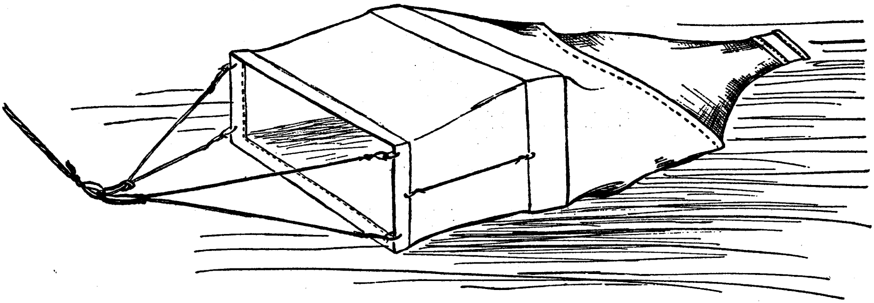


FIG. 5. **Bottom dredge.**

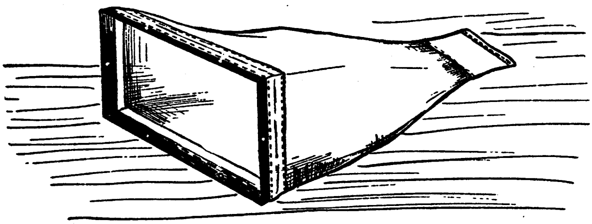


FIG. 6. **Gauze net for bottom dredge.**

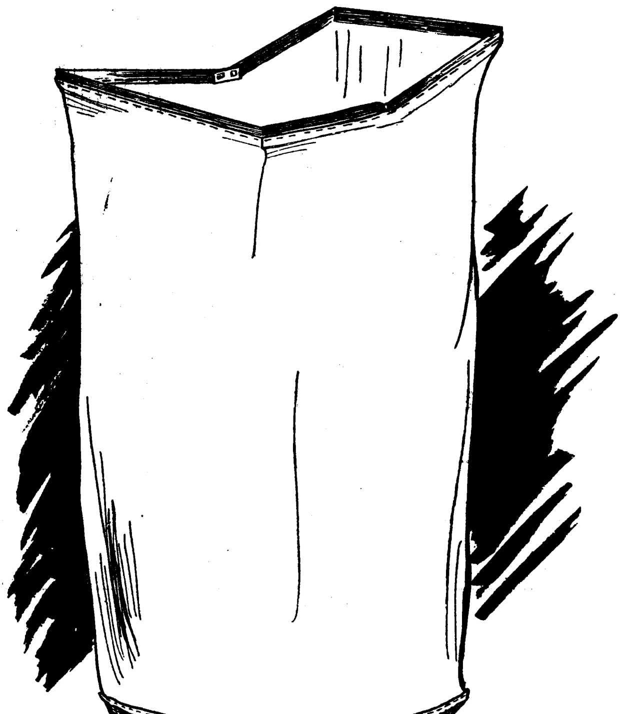


Fig. 7. Trap for capturing plant dwelling animals.

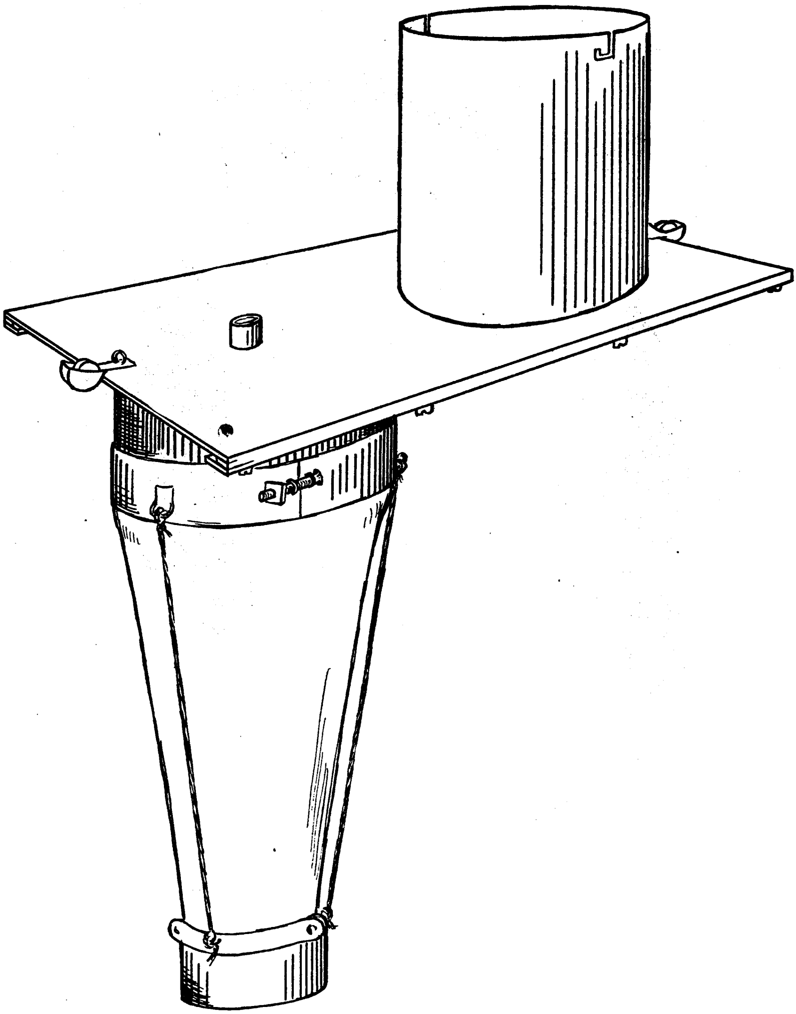


FIG. 8. Closing device attached to lower end of tube used in determining the coefficient of nets.

THE ROTIFER FAUNA OF WISCONSIN.—III.

A Revision of the Genera Lecane and Monostyla

H. K. Harring and F. J. Myers

Notes from the Biological Laboratory of the Wisconsin Geological and Natural History Survey. XXVI.

INTRODUCTION.

Many eminent specialists have declared the "invertebrate" fauna of North America virtually unknown and it is perhaps superfluous to add to this our growing conviction that this is nowhere more readily demonstrable than in the relatively small phylum which we have been studying for some time. When Jennings compiled the records of rotifers found in the United States at the close of the Great Lakes Biological Investigations in 1899, the total number of species was 246, quite a number of these now unidentifiable. In the two papers already published on the rotifers of Wisconsin no less than 136 species are described from personal observations of a part of the family Notommatidae. Of these only 27 species are to be found in Jennings's list, or less than one fifth. As a result of our collections in Wisconsin and a study of the rotifers of Mount Desert Island, undertaken at the suggestion and with the hearty cooperation of Dr. Dahlgren, director of the Mount Desert Island Biological Laboratory, over one hundred undescribed species belonging to the family already dealt with are now on hand. Under the circumstances we may perhaps be granted forgiveness for departing somewhat from our original plans, or rather from their last revision. We had intended to conclude, temporarily at least, the work on the Notommatidae with a revision of the forcipate group or Dicranophorinae, as defined in the second paper. At the time of closing the manuscript we had some 50 identified species belonging to this group. The Mount Desert collections added at least 25 more, or a sufficient number to convince us that we were very far from being able to "see the bottom", in fact, we could not even discover a halting place, where we might at least temporarily feel that we had in hand a fair proportion of the species that were likely to be found in the immediate future. It is very evident that more field work is necessary before a satisfactory revision of the Dicranophorinae can be undertaken with any hope of its being serviceable for even a few years; we are therefore compelled to postpone this for the moment, hoping that it may shortly appear to be a more promising undertaking.

A large amount of material for a revision of the genera Lecane and Monostyla has been accumulating for some years as a sort of by-product and this seems now to offer some possibility for reasonable permanency when worked up. Undescribed species belonging to these two genera are slowly and steadily decreasing in numbers; this is especially true of Monostyla, where a new species is now rarely found.

Lecane and Monostyla are very closely related and individual species do not as a rule exhibit striking differences. We have therefore limited the descriptions strictly to what is necessary for the determination of the species; no attempt has been made to deal with the anatomy, which seems to be quite uniform throughout the two genera. The outline of the lorica, its surface markings and the form and length of the toes are very constant; for this reason special emphasis has been placed upon these features and no effort has been spared to represent them as accurately as possible in the figures. The descriptions must be considered largly supplementary; it seems impossible to state in words with sufficient clearness the slight, but important, differences of form and ornamentation of these animals.

A few words on the classification of the rotifers may not be out of place. The one employed by Hudson and Gosse, a modification of Dujardin's, is now generally considered unsatisfactory. Some radical changes were suggested by Wesenberg-Lund in 1899, and De Beauchamp provided ten years later the rational basis needed for a revision, but did not carry it out in detail. In his latest paper Wesenberg-Lund offers some modifications to his earlier outline, bringing it into fair agreement with De Beauchamp's ideas, with the notable exception of the relationship of the families with malleo-ramate mastax. With this material available we have by degrees arrived at the tentative classification given below; as will be noted, it is mainly De Beauchamp's, with some modifications suggested by personal observations, and includes only the Ploima, around which the principal differences of opinion are centered. The number of families has been reduced somewhat, and this will probably not be considered objectionable. There is no obvious advantage in having a separate family for each genus; any system of classification put forward must be a means of expressing the author's ideas on the mutual relationship of the component parts; placing each in a separate box is a confession of failure.

We have divided the Ploima into six major groups, which may be termed suborders, tribes, superfamilies or anything else that individual fancy may suggest. This regrouping seems, on the evidence available, to give a better perspective of the order. No detailed evidence for the placement of the individual genera will be offered at this time; on the whole we do not anticipate any violent dissent, but welcome constructive criticism. The reasons that appear to favor this arrangement will be given in future papers on the rotifer fauna of Wisconsin; in the absence of a thorough revision it is hardly possible to do more. However, in spite of, or perhaps on account of, this serious shortcoming, a useful purpose may be served in calling attention once more to some of the as yet unsettled problems of rotatorian taxonomy.

Order PLOIMA.

NOTOMMATOIDEA.

Family NOTOMMATIDAE.

Subfamily PROALINAE.

Genus *Proales.*

Proalinopsis.

? Squatinella.

Subfamily NOTOMMATINAE.

Genus *Notommata.*

Taphrocampa.

Drilophaga.

Pleurotrocha.

Cephalodella.

Dorystoma.

Rousseletia.

Tylotrocha.

Resticula.

Eosphora.

Eothinia.

Sphyrias.

Scaridium.

Monommata.

Subfamily TETRASIPHONINAE.

Genus *Tetrasiphon.*
Subfamily LINDIINAE.
Genus *Lindia.*
Subfamily BIRGEINAE.
Genus *Birgea.*
Subfamily DICRANOPHORINAE.
Genus *Dicranophorus.*
Encentrum.
Erignatha.
Albertia.
Family SYNCHAETIDAE.
Genus *Synchaeta.*
Parasynchaeta.
Ploesoma.
Polyarthra.
Anarthra.
? Microcodon.
Family GASTROPODIDAE.
Genus *Gastropus.*
Ascomorpha.
Chromogaster.
Family TRICHOCERCIDAE.
Genus *Trichocerca.*
Diurella.
Elosa.

ASPLANCHNOIDEA.
Familiy ASPLANCHNIDAE.
Genus *Asplanchna.*
Asplanchnopus.
Harringia.

BRACHIONOIDEA.
Family BRACHIONIDAE.
Genus *Brachionus.*
Schizocerca.
Platyias.
Keratella.
Notholca.
Anuraeopsis.
Family EPIPHANIDAE.
Genus *Epiphanes.*
Rhinoglena.
Cyrtonia.
Proalides.
Mikrocodides.
Family EUCHLANIDAE.
Genus *Euchlanis.*
Dipleuchlanis.
Lecane.

Monostyla.
Lepadella.
Colurella.
Mytilina.
Trichotria.
Lophocharis.
Wolga.
Macrochaetus.

FILINIOIDEA.
Family FILINIIDAE.
Genus *Filinia.*
Tetramastix.
Pedalia.

TESTUDINELLOIDEA.
Family TESTUDINELLIDAE.
Genus *Testudinella.*
Pompholyx.

TROCHOSPHAEROIDEA.
Family TROCHOSPHAERIDAE.
Genus *Trochosphaera.*

Genus LECANE Nitzsch.

Euchlanid rotifers with illoricate, retractile head and loricate body, strongly compressed dorso-ventrally and oval or ovate in outline; dorsal and ventral plates connected by a flexible membrane, forming lateral and posterior sulci; foot with two extremely short, rudimentary joints, of which only the posterior is movable; toes two; corona of family type; mastax modified malleate, with a piston attached to its ventral wall; eyespot single and at the posterior end of ganglion; retrocerebral sac usually present, but no subcerebral glands.

Type of the genus.—Lecane luna (Müller)=*Cercaria luna* Müller.

This genus includes *Cathypna* Gosse and *Distyla* Eckstein; as pointed out by Murray there are no real differences between the species referred to them that would warrant their maintainance. In his Infusionsthierchen Ehrenberg pointed out that if *Euchlanis luna* were to be separated from *Euchlanis*, it would have to take the generic name *Lecane* Nitzsch, an injunction ignored by Gosse.

Quite a number of species have been described which we have not seen. Some of these are of doubtful validity, and others appear to be good species; a list is given below.

Cathypna affinis LEVANDER.

Cathypna affinis LEVANDER, Acta Soc. Fauna et Flora Fennica, vol. 12, No. 3, 1895, p. 50, pl. 3, fig. 31.—MURRAY, Journ. Royal Micr. Soc., 1913, p. 346.

Distyla affinis IROSO, Mon. Zool. Italiano, vol. 21, 1910, p. 302; Atti R. Ist. Incorr. Napoli, vol. 64 (for 1912), 1913, p. 466, fig. 13.—LUCKS, Rotatorienfauna Westpreussens, 1912, p. 110.—SACHSE, Süsswasserfauna Deutschlands, pt. 14, 1912, p. 176.

Cathypna amban STEWART, Rec. Indian Mus., vol. 2, 1908, p. 320, text fig.

Cathypna diomis GOSSE, Journ. Royal Micr. Soc., 1887, p. 362, pl. 8, fig. 2; HUDSON and GOSSE, Rotifera, Suppl., 1889, p. 41, pl. 31, fig. 38.

Cathypna gossei LORD, Science Gossip, vol. 26, 1890, p. 202, text fig.

Cathypna gracilis SACHSE, Arch. Hydrobiol., vol. 10, 1914, p. 70, fig. 10.

Cathypna hudsoni LORD, Science Gossip, vol. 26, 1890, p. 202, text fig.

Cathypna latifrons GOSSE, Journ. Royal Micr. Soc., 1887, p. 362, pl. 8, fig. 3.—HUDSON and GOSSE, Rotifera, Suppl., 1889, p. 42, pl. 31, fig. 37.

Cathypna magna STENROOS, Acta Soc. Fauna et Flora Fennica, vol. 17, No. 1, 1898, p. 161, pl. 2, fig. 21.

Cathypna magna tenuior STENROOS, Acta Soc. Fauna et Flora Fennica, vol. 17, No. 1, 1898, p. 161, pl. 2, fig. 22.

Cathypna rotundata OLOFSSON, Zool. Bidr. Uppsala, vol. 6, 1918, p. 593, fig. 53.—IDELSON, Trudy Plovuch. Morsk. Nauchn. Inst., pt. 12, 1925, p. 90.

Cathypna rusticola GOSSE, in Hudson and Gosse, Rotifera, 1886, vol. 2, p. 95, pl. 24, fig. 6. —SACHSE, Süsswasserfauna Deutschlands, pt. 14, 1912, p. 173, fig. 341.

Cathypna spenceri SHEPHARD, Victorian Nat., vol. 9, 1892, p. 15.

Cathypna sulcata GOSSE, in Hudson and Gosse, Rotifera, 1886, vol. 2, p. 96, pl. 24, fig. 5.—SACHSE, Süsswasserfauna Deutschlands, pt. 14, 1912, p. 173, fig. 340.—? MURRAY, Journ. Royal Micr. Soc., 1913, p. 557, pl. 22, fig. 5.

Cathypna weberi MOLA, Zool. Anz., vol. 42, 1913, p. 115, figs. 5, 6; Ann. Biol. Lac., vol. 6, 1913, p. 261.

Distyla acinaces MOLA, Zool. Anz., vol. 42, 1913, p. 119, figs. 11, 12; Ann. Biol. Lac., vol. 6, 1913, p. 260.

Distyla aculeata JAKUBSKI, Zool. Anz., vol. 39, 1912, p. 542, figs. 3, 4.

Distyla branchicola PIOVANELLI, Mon. Zool. Italiano, vol. 14, 1903, p. 348.

Distyla gissensis ECKSTEIN, Zeitschr. Wiss. Zool., vol. 39, 1883, pl. 383, pl. 27, fig. 51.—HUDSON and GOSSE, Rotifera, 1886, vol. 2, p. 96, pl. 24, fig. 8.—WEBER, Rev. Suisse Zool., vol. 5, 1898, p. 597, pl. 22, figs.

6, 7.—SACHSE, Süsswasserfauna Deutschlands, pt. 14, 1912, p. 175, figs. 343, 344.—MOLA, Ann. Biol. Lac., vol. 6, 1913, p. 261.—WEBER and MONTET, Cat. Invert. Suisse, pt. 11, 1918, p. 186.

Distyla korschelti MOLA, Zool. Anz., vol. 42, 1913, p. 117, figs. 7, 8.

Distyla minnesotensis HERRICK, Bull. Denison Univ., vol. 1, 1885, p. 5, pl. 2, fig. 17.

Distyla striata GOSSE, Journ. Royal Micr. Soc., 1887, p. 5, pl. 2, fig. 17.—HUDSON and GOSSE, Rotifera, Suppl., 1889, p. 43, pl. 31, fig 40.

Distyla terracianoi MOLA, Zool. Anz., vol. 42, 1913, p. 118, figs. 9, 10; Ann. Biol. Lac., vol. 6, 1913, p. 260.

Lecane carinata (JAKUBSKI).

Distyla carinata JAKUBSKI, Zool. Anz., vol 39, 1912, p. 542, figs. 1, 2.

Lecane carinata HARRING, Bull. 81 U. S. Nat. Mus., 1913, p. 60.

Lecane muscicola (BRYCE).

Distyla musicola BRYCE, Science Gossip vol. 27, 1891, p. 206, text fig.

Distyla muscicola BRYCE, Science Gossip, vol. 27, 1891, p. 236.

? *Cathypna muscicola* MURRAY, Journ. Royal Micr. Soc., 1913, p. 555, pl. 23, fig. 19.

Lecane musicola HARRING, Bull. 81 U. S. Nat. Mus., 1913, p. 61.—HAUER, Mitt. Geogr. Ges. u. Naturhist. Mus. Lübeck, ser. 2, No. 30, 1925, p. 168.

LECANE CURVICORNIS (Murray).

Plate VIII, figures 1, 2.

Cathypna curvicornis MURRAY, Journ. Royal Micr. Soc., 1913, p. 346, pl. 14, fig. 22.

Cathypna nitida MURRAY, Journ. Royal Micr. Soc., 1913, p. 347, pl. 14, fig. 24.

Cathypna lofuana MURRAY, Journ. Royal Micr. Soc., 1913, p. 551, pl. 22, fig. 1.

Lecane curvicornis HARRING, Proc. U. S. Nat. Mus., vol. 17, 1914, p. 535, pl. 17, fig. 3.

The lorica is broadly pyriform in outline; the anterior margins are somewhat variable according to the stage of contraction, but normally coincident, with a broad, V-shaped sinus; at the external angles are two fairly large spines. The dorsal plate is oval, truncate posteriorly and considerably narrower than the ventral plate. Specimens from certain localities show a very faint dorsal facetting, but the boundaries of the individual facets are so indistinct that we have not attempted to figure them. The lateral sulci are deep, but do not quite reach the anterior margin. The ventral plate is more distinctly pyriform than the dorsal and much wider; the transverse fold is very strongly marked. The posterior segment is small and rounded posteriorly; the coxal plates are moderately large and obtusely pointed. The first foot joint is large and parallel-sided but somewhat indistinct; the second fairly large and subsquare. The toes are very long, slender and parallel-sided, ending in a small claw with basal spicule; their length is about one-third of the total length.

Total length 280μ; length of dorsal plate 120μ, of ventral plate 132μ; width of dorsal plate 95μ, of ventral plate 113μ; anterior points 63μ; toes wihout claw 69μ; claw 10μ.

Lecane curvicornis is very abundant in certain localities; Murray found it in Brazil, it was collected by the Panama Biological Survey in the Panama Canal Zone, by Myers at Los Angeles, California, by Dr. E. A. Birge and Mr. C. Juday in Texas and Arkansas, by Dr. Birge during the Great Lakes Investigations in 1899 at various points around Lake Erie and by Mr. Juday in Guatemala. Murray's *C. lofuana* was collected in a tributary to Lake Tanganyika in Africa. From this it will be seen to be widely, but erratically distributed; where it is found, it is usually abundant.

As noted by Harring, the three species described by Murray are one and the same species; through the kindness of the late Mr. Rousselet we had an opportunity to examine the original specimens from which Murray described them and after comparison with material from other sources we have no doubt of their identity.

LECANE ACRONYCHA Harring and Myers, new species.

Plate VIII, figures 3, 4.

The outline of the lorica is a moderately elongate oval; the anterior dorsal margin is almost straight, projecting slightly in front of the ventral margin, which is somewhat concave; at the external angles are two large, triangular cusps. The dorsal plate is oval and without markings or facetting; it is considerably narrower than the ventral plate and its edges do not reach the anterior margin. The ventral plate is of the same general outline as the dorsal; it is marked by a fairly distinct transverse ridge in front of the foot joint. The lateral sulci are fairly deep. The posterior segment is rather small and somewhat indistinct; the coxal plates are small and obtusely pointed. The first foot joint is indistinct, the second moderately large and trapezoidal in form. The toes are long and fairly robust, very slightly enlarged above the relatively short claw; this has a small basal spicule. The length of the toes is more than one third of the total.

Total length 290μ; length of dorsal plate 162μ, of ventral plate 182μ; width of dorsal plate 136μ, of ventral plate 146μ; anterior points 80μ; length of toes without claw 90μ; claw 12μ.

Lecane acronycha appears to be confined to regions with soft, acid water; we have found it abundant in Vilas and Oneida counties, Wisconsin, around Atlantic City, New Jersey and on Mt. Desert Island, Maine. It is related to *L. ungulata* and is its equal in length, but not in bulk; it is readily distinguished by its regular oval form, narrow anterior margin, small, rounded posterior segment and the short claws.

LECANE UNGULATA (Gosse).

Plate IX, figures 3, 4.

Cathypna ungulata GOSSE, Journ. Royal Micr. Soc., 1887, p. 361, pl. 8, fig. 1.—HUDSON and GOSSE, Rotifera, Suppl., 1889, p. 42, pl. 31, fig. 36.—WIERZEJSKI, Rozpr. Akad. Umiej., Wydz. Mat.-Przyr., Krakow, ser. 2, vol. 6, 1893, p. 242.—BILFINGER, Jahresh. Naturk. Württemberg, vol. 50, 1894, p. 58.—JENNINGS, Bull. U. S. Fish Comm., vol. 19 (for 1899), 1900, p. 91, pl. 19, figs. 26, 27.—DADAY, Zoologica, pt. 44, 1905, p. 111; pt. 59, 1910, p. 84.—ROUSSELET, Journ. Royal Micr. Soc., 1906, p. 406, pl. 15, fig. 1.—MEISSNER, Izv. Turkestansk. Otd. Imp. Russk. Geogr. Obshch., vol. 4, pt. 8, 1908, p. 20, pl. 1, fig. 4.—DE BEAUCHAMP, Arch. Zool. Expér., ser. 4, vol. 10, 1909, p. 160, pl. 3, fig. 22.—SACHSE, Süsswasserfauna Deutschlands, pt. 14, 1912, p. 173, fig. 335.—JAKUBSKI, Rozpr. Wiad. Muz. Dzieduszyckich, vol. 1, 1914, p. 31.—WEBER and MONTET, Cat. Invert. Suisse, pt. 11, 1918, p. 190.—OPARINA-KHARITONOVA, Izv. Biol. Nauchno-Issl. Inst. Permsk. Univ., vol. 3, 1925, p. 44.

Cathypna glandulosa STOKES, Ann. Mag. Nat. Hist., ser. 6, vol. 19, 1897, p. 632, pl. 14, fig. 8–10.

Cathypna magna LUCKS, Rotatorienfauna Westpreussens, 1912, p. 109, fig. 32; not *Cathypna magna* STENROOS.

Cathypna ungulata magna SACHSE, Süsswasserfauna Deutschlands, pt. 14, 1912, p. 173.—IDELSON, Trudy Plovuch. Morsk. Nauchn. Inst. pt. 12, 1925, p. 89; not *Cathypna magna* STENROOS.

Cathypna minnesotensis MURRAY, Journ Royal Micr. Soc., 1913, p. 345, pl. 13, fig. 18.—SACHSE, Arch. Hydrobiol., vol. 10, 1914, p. 69, fig. 9; not *Cathypna minnesotensis* HERRICK.

Lecane ungulata HARRING, Bull. 81 U. S. Nat. Mus., 1913, p. 62; Proc. U. S. Nat. Mus., vol. 47, p. 535; Rep. Canadian Arctic Exp.

1913—18, vol. 8 pt. E, p. 9.—KOZAR, Zool. Anz., vol. 44, 1914, p. 420.—JAKUBSKI, Kosmos (Lwów), 1918–1919, p. 28.

The lorica is broadly oval in outline; the anterior dorsal margin is virtually straight, the ventral very slightly concave; at the external angles are two large, triangular cusps. The dorsal plate is oval and without markings of any kind; it is considerably narrower than the ventral and the margins become indistinguishable before reaching the anterior edge. The ventral plate is of the same general outline as the dorsal, but somewhat narrower at the beginning of the posterior segment; its markings are limited to an indistinct, broken, transverse fold some distance in front of the foot joint. The lateral sulci are deep. The posterior segment is very broad and slightly truncate; it projects slightly beyond the foot; the coxal plates are large and obtusely pointed. The first foot joint is very indistinct, the second short and fairly broad. The toes are straight and nearly parallel-sided, very slightly enlarged posteriorly and end in a long, stout claw with a fairly prominent basal spicule; their length is more than one third of the total length.

Total length 285μ; length of dorsal plate 220μ, of ventral plate 255μ; width of dorsal plate 180μ, of ventral plate 195μ; anterior points 135μ; length of toes without claw 75μ; claw 45μ.

Lecane ungulata is very common and widely distributed in the United States; it seems to be less common in Europe; according to Rousselet it is rare in England. It is the largest known species of the genus and is readily recognized by its robust form, the broad posterior segment and long claws.

LECANE SIBINA Harring.

Plate IX, figures 1, 2.

Lecane sibina HARRING, Proc. U. S. Nat. Mus., vol. 47, 1914, p. 535, pl. 23, figs. 5–7.

The lorica is broadly pyriform; the anterior margins of the dorsal and ventral plates are nearly coincident and slightly concave with distinct lateral cusps. The dorsal plate is subcircular and without facetting; a low, median, anterior hump is formed by the retraction of the head. The ventral plate is oval, slightly narrower than the dorsal, and its only surface markings are some faint transverse ridges on the posterior third; the anterior margin has a very small, median, lunate sinus.

The lateral sulci are moderately deep and do not reach the anterior margin. The posterior segment is prominent and projects some distance over the base of the toes; the large and obtusely triangular coxal plates do not extend beyond the second foot joint. The first foot joint is very indistinct, the second short and broadly triangular. The toes are very nearly parallel-sided, about one third of the total length and end in a long, stout claw with a basal spicule; a short distance in front of the claw are one or two indistinct annular constrictions.

Total length 200μ; length of dorsal plate 130μ, of ventral plate 135μ; width of dorsal plate 125μ, of ventral plate 116μ, width of anterior margin 78μ; length of toes without claw 42μ; claw 20μ.

Lecane sibina is related to *L. ungulata;* it is much smaller and the lorica is relatively broader. It was described from material collected in the Panama Canal Zone and has since been found by Mr. C. Juday at Puerto Barrios, Guatemala.

LECANE GRANDIS (Murray).

Plate X, figures 1, 2.

Cathypna grandis MURRAY, Journ. Royal Micr. Soc., 1913, p. 344, pl. 13, fig. 20.

Lecane grandis FADEEV, Trudy Kharkovsk. Obshch. Isp. Prir., vol. 50, 1925, p. 8, pl. 1, fig. 6.

The outline of the lorica is broadly ovate and truncate posteriorly. The anterior margins of both dorsal and ventral plates are nearly straight; the dorsal plate projects slightly beyond the anterior ventral margin and the lorica consequently remains partly open when the head is completely retracted. The dorsal and ventral plates are of the same width and differ very slightly in outline; no surface markings are present. The lateral sulci are not very deep. The posterior segment is short and very broad, projecting but little beyond the dorsal plate. The coxal plates are large and sharply pointed. The foot joints are unusually broad and rather short. The toes are long, very slightly blade-shaped and straight on the inner edges, ending in a conical claw with a small basal spicule.

Total length 240μ; length of dorsal plate 165μ, of ventral plate 175μ; width of lorica 140μ; anterior margin, dorsal, 100μ, ventral 118μ; toe without claw 60μ; claw 12μ.

Lecane grandis is common in brackish or salt tide pools; it was first found by Murray at Rio de Janeiro; we have collected it around Atlantic City, New Jersey, and it has recently been reported by Fadeev from salt lagoons at Novorossiisk, on the Black Sea.

LECANE LEONTINA (Turner).

Plate X, figures 3–5.

Cathypna leontina TURNER, Bull. Denison Univ., vol. 6, 1892, p. 61, pl. 1, fig. 12.—KELLICOTT, Trans. Amer. Micr. Soc., vol. 19, 1897, p. 53.—JENNINGS, Bull. Michigan Fish Comm., No. 3, 1894, p. 24; Bull. U. S. Fish Comm., vol. 19 (for 1899), 1900, p. 91, pl. 19, fig. 25.—HEMPEL, Bull. Illinois State Lab. Nat. Hist., vol. 5, 1898, p. 374.—DADAY, Zoologica, pt. 44, 1905, p. 109, pl. 6, fig. 12; pt. 59, 1910, p. 83.—ROUSSELET, Journ. Royal Micr. Soc., 1906, p. 405, pl. 14, fig. 6.—KOFOID, Bull. Illnois State Lab. Nat. Hist., vol. 6, No. 1, 1908, p. 197.—MURRAY, Journ. Royal Micr. Soc., 1913, p. 345, pl. 13, fig. 21.

Cathypna scutaria STOKES, Ann. Mag. Nat. Hist., ser. 6, vol. 19, 1897, p. 631, pl. 14, fig. 7.

Cathypna macrodactyla DADAY, Math. Termész. Ertes., vol. 16, 1898, p. 92; Termész. Füzetek, vol. 21, Suppl., 1898, p. 15, fig. 3.

Cathypna leontina bisinuata DADAY, Zoologica, pt. 44, 1905, p. 109, pl. 6, fig. 18.

Cathypna biloba DADAY, Math. Termész. Ertes., vol. 23, 1905, p. 330; zoologica, pt. 44, 1905, p. 111, pl. 6, fig. 17.

Cathypna incisa DADAY, Math. Termész. Ertes., vol. 23, 1905, p. 330; Zoologica, pt. 44, 1905, p. 111, pl. 6, fig. 14.

? *Cathypna appendiculata* DADAY, Zoologica, pt. 44, 1905, p. 110, pl. 6, fig. 13.

Lecane leontina HARRING, Bull. 81 U. S. Nat. Mus., 1913, p. 61; Proc. U. S. Nat. Mus., vol. 47, 1914, p. 536.

The lorica is broadly pyriform in outline; the anterior dorsal margin is slightly concave; the ventral margin has a broad, V-shaped sinus, rounded at the posterior angle; at the external angles are two small, triangular spines. The dorsal plate is nearly as wide as the ventral and of the same general form; it is rounded posteriorly and without markings. The ventral plate has an indistinct transverse fold in front of the foot. The lateral sulci are deep. The posterior segment is continued over the base of the foot as a tail-like projection, widest posteriorly, rarely with two long, divergent spines, as in fig. 3. The coxal plates are large and obtusely pointed. The first foot joint is parallel-sided and somewhat indistinct; the second foot joint is subsquare. The toes are extremely long, slender, straight and parallel-sided, ending in a fairly long claw with basal spicule; they are nearly as long as the entire body.

Total length 330μ; length of dorsal plate 170μ, of ventral plate 210μ; width of dorsal plate 140μ, of ventral plate 145μ; anterior points 90μ; toes without claw 135μ; claw 15μ. The form with posterior spines shown in figure 3 measures: total length 370μ; length of dorsal plate 165μ, of ventral plate 240μ; width of dorsal plate 147μ; of ventral plate 152μ; anterior points 90μ; toes without claw 140μ; claw 15μ.

Lecane leontina is common in weedy ponds all over the United States; records from other countries are not numerous. The variety with posterior spines is rare; the specimen figured was collected at the Fish Hatchery at Delafield, Wisconsin.

LECANE DEPRESSA (Bryce).

Plate XVI, figures 1, 2.

?*Cathypna latifrons* GOSSE, Journ. Royal Micr. Soc., 1887, p. 362, pl. 8, fig. 3.—HUDSON and GOSSE, Rotifera, suppl., 1889, p. 42, pl. 31, fig. 37.

? *Proales prehensor* GOSSE, Journ. Royal Micr. Soc., 1887, p. 366, pl. 8, fig. 12.—HUDSON and GOSSE, Rotifera, Suppl., 1889, p. 24, pl. 31, fig. 12.

Distyla depressa BRYCE, Science Gossip, vol. 27, 1891, p. 205, text fig.

Cathypna depressa MURRAY, Journ. Royal Micr. Soc., 1913, p. 555, pl. 23, fig. 17.

Lecane depressa HARRING, Bull. 81 U. S. Nat. Mus., 1913, p. 61; Rep. Canadian Arctic Exp. 1913–18, vol. 8, pt. E, 1921, p. 9.

? *Cathypna levistyla* OLOFSSON, Zool. Bidr. Uppsala, vol. 5, 1917, p. 280, fig. 10.

The outline of the lorica is broadly ovate; its width is about three fourths of the length. The anterior dorsal margin is nearly straight; the ventral margin has a shallow, V-shaped sinus. At the external angles are two small, stout anterior spines. The dorsal plate is broadly ovate and rounded posteriorly; the ventral plate is oval and somewhat narrower than the dorsal; both are entirely without facetting or surface markings. The lateral sulci are fairly deep. The posterior segment is fairly large and projects considerably beyond the dorsal plate; at the level of the base of the toes are two small, but very distinct marginal indentations. The coxal plates are rather small and rounded posteriorly. The first foot joint is narrow and overlaps the second joint with a small, rounded, median lobe only; the second joint is subsquare and some distance in front of the posterior margin. The toes are fairly long, about one fourth of the total length, parallel-sided for half their length and taper to acute points; the inner edges are straight.

Total length 130μ; length of dorsal plate 90μ, of ventral plate 95μ; width of dorsal plate 75μ, of ventral plate 65μ; width of anterior margin 54μ; length of toes 30μ.

Lecane depressa is widely distributed and seems to be a typical wet sphagnum species. It is closely related to *L. mitis, L. scobis* and *L. tudicola;* the form of the lorica and the dimensions show sufficient differences to preclude any confusion.

LECANE TUDICOLA, Harring and Myers, new species

Plate XI, figures 1, 2.

The outline of the lorica is very broadly ovate; its width is more than three fourths of the length. The anterior dorsal margin is straight; the ventral margin has a very shallow, V-shaped sinus. At the external angles are two small, stout anterior spines. The dorsal plate is very broadly ovate and broadly truncate posteriorly; it is as wide as the ventral plate at its widest point, but narrower both anteriorly and posteriorly. The ventral plate is very broadly ovate and slightly larger than the dorsal; both are without surface markings or facetting. The lateral sulci are shallow. The posterior segment is broadly rounded and projects somewhat beyond the dorsal plate; at the level of the coxal plates there are two small, but distinct marginal indentations. The coxal plates are small and rounded posteriorly. The first foot joint is fairly large and narrow, with a small, rounded median lobe overlapping the second joint, which is large and somewhat reniform and slightly in advance of the posterior margin. The toes are fairly long, about one fourth of the total length, parallel-sided for a little less than half their length and gradually tapering to acute points; the inner edges are straight.

Total length 145μ; length of dorsal plate 105μ, of ventral plate 110μ; width of lorica 85μ; width of anterior margin 60μ; length of toes 37μ.

Lecane tudicola was collected by Dr. G. H. Parker, of Harvard University, among algae in the "Ice House Pond" on St. Paul, Prybilof Islands, Alaska. It is related to *L. depressa,* but readily distinguished by the smaller dorsal plate, as well as its larger size and relatively greater width.

LECANE MITIS Harring and Myers, new species

Plate XI, figures 3, 4.

The outline of the lorica is broadly ovate; its width is about three fourths of the length. The anterior dorsal margin is straight medially, with a blunt angle at the external edges; the ventral margin is slightly lunate. At the external angles are two small, slightly incurved spines. The dorsal plate is broadly reversed-ovate and broadly truncate posteriorly; the ventral plate is elongate oval and considerably narrower than the dorsal; both are quite smooth, without surface markings. The lateral sulci are moderately deep. The posterior segment is large and rounded and projects far beyond the dorsal plate. The coxal plates are small and obtusely pointed; they do not project beyond the foot. The first foot joint is small and broadly ovate and its small, but very distinct median lobe almost reaches to the base of the toes; the second joint is subsquare, very broad and some distance from the posterior margin. The toes are fairly long, a little more than one fourth of the entire length, parallel-sided for fully half their length and taper to acute points; the inner edges are straight.

Total length 165μ; length of dorsal plate 110μ, of ventral plate 130μ; width of dorsal plate 100μ, of ventral plate 80μ; width of anterior margin 60μ; length of toes 45μ.

Lecane mitis was collected among floating and partly submerged sphagnum at Gravelly Run, near Atlantic City, New Jersey. It is closely related to *L. depressa,* but differs in the form of the anterior dorsal and ventral margin, the posterior segment, the foot and the truncate dorsal plate, as well as in being consistently larger.

LECANE SCOBIS Harring and Myers, new species

Plate XI, figures 5, 6.

The outline of the lorica is very broadly ovate; its width is five sixths of the length. The anterior dorsal margin is straight and the ventral margin slightly concave; at the external angles are two short, stout and slightly incurved spines. The dorsal plate is very broadly ovate, its width but little less than its length, and rounded posteriorly; the ventral plate is broadly oval and considerably narrower than the dorsal; both are without surface markings. The lateral sulci are moderately deep. The posterior segment is rounded and very broad; its projects somewhat beyond the dorsal plate. The coxal plates are large and rounded posteriorly. The first foot joint is large and pyriform, with a small median lobe overlapping the second joint which is rounded anteriorly and angulate posteriorly; it is slightly in advance of the posterior margin. The toes are fairly long, a little more than one fourth of the total length, parallel-sided for a little less than half their length and gradually tapering to acute points; the inner edges are straight.

Total length 160μ; length of dorsal plate 114μ of ventral plate 122μ; width of dorsal plate 102μ, of ventral plate 88μ; width of anterior margin 66μ; length of toes 43μ.

Lecane scobis was collected by Dr. Frits Johansen while serving as biologist on the Southern party of the Canadian Arctic Expedition, among algae growing on stones in the river bed at Bernard Harbour, North West Territories. It is related to *L. depressa,* but readily distinguished by its greater size, relatively greater width and the form of the foot.

LECANE MUCRONATA Harring and Myers, new species.

Plate XXIX, figures 3–5.

The lorica is broadly ovate; its width is about two thirds of the length. The anterior dorsal and ventral margins are coincident and straight. At the external angles are two pairs of anterior spines; one pair, on the dorsal plate, are very small. The second pair, attached to the membrane of the lateral sulci, are very long and stout, broad at the base and acutely pointed; when the animal is swimming, these spines point straight upwards, but in the extensive deformations taking place incident to the contraction and closure of the lorica they are bent outwards, as shown in the figure. The dorsal plate is very broadly oval and rounded posteriorly; its width is about four fifths of the length. The ventral plate is elongate pyriform and considerably narrower than the dorsal plate. The surface markings of the lorica are a strong, V-shaped anterior fold on the dorsal plate, formed by the contraction of the lorica, and a transverse fold on the ventral plate, some distance in front of the foot. The lateral sulci are fairly deep. The posterior segment is semicircular and rather small; it projects far beyond the dorsal plate. The coxal plates are rather small and rounded posteriorly. The first foot joint is indistinct anteriorly and projects with a small median lobe over the large, subsquare second foot joint, which reaches almost to the posterior margin. The toes are long and slender, nearly one third of the total length, parallel-sided and approximately straight, with undulating edges. The claw is short and stout; at the base is a small spicule.

Total length 175μ; length of lorica, including frontal spines, 140μ; length of dorsal plate, without spines, 115μ, of ventral plate 126μ; width of dorsal plate 105μ, of ventral plate 84μ; length of anterior spines, from base to tip, 28μ; length of toes without claw 48μ; claw 6μ.

Lecane mucronata has been collected in Oneida and Vilas Counties, Wisconsin, on Mount Desert Island, Maine, and in New Jersey around Atlantic City and at Batsto; it is usually rare, but at Batsto it was common in the gelatinous algal covering of a dwarf species of sphagnum growing in shallow water. The form of the swimming animal has but little resemblance to the contracted specimens; the body is very slender, the length of the lorica alone being equal to the entire length of the contracted animal, and the frontal spines are pressed towards the head and the anterior edge of the lorica, so that they are not seen unless carefully searched for.

LECANE PYRRHA Harring and Myers, new species.

Plate XII, figures 3–6.

The outline of the lorica is a very elongate oval, the greatest width being only two thirds of the length, and the body is somewhat compressed dorso-ventrally. The anterior dorsal and ventral margins are coincident and concave; at the external angles are two stout, triangular cusps. The dorsal plate is elongate oval and slightly truncate posteriorly; the ventral plate is very nearly parallel-sided and both are without facetting. The lateral sulci are fairly deep. The posterior segment is somewhat irregular in outline and projects but little beyond the dorsal plate. The coxal plates are unusually small and obtusely pointed posteriorly. The first foot joint is narrow and wedge-shaped, the second subsquare and robust. The toes are long and slender, about one fourth of the total length, straight and parallel-sided, and end in acute points without claws.

Total length 280μ; length of dorsal plate 193μ, of ventral plate 210μ; width of dorsal plate 135μ, of ventral plate 125μ; width of anterior points 80μ; length of toes 75μ.

Lecane pyrrha is common in weedy ponds with soft, acid water, but is never found in hard water regions. The entire body is, with rare exceptions, colored a deep reddish brown. An aberrant variety from Eagle River, Vilas County, Wisconsin, is shown in figures 5 and 6; the principal difference is in the greater width of the lorica. The typical form is abundant at Atlantic City, New Jersey, in Oneida and Vilas Counties, Wisconsin, and on Mount Desert Island, Maine.

LECANE PLOENENSIS (Voigt).

Plate XIII, figures 5, 6.

Distyla ploenensis Voigt, Zool. Anz., vol. 25, 1902, p. 679; Forschungsber. Biol. Stat. Plön, vol. 11, 1904, p. 71, pl. 4, fig. 39.—Sachse, Süsswasserfauna Deutschlands, pt. 14, 1912, p. 177, fig. 350.—Rousselet, Proc. Royal Irish Acad., vol. 31, pt. 51, 1911, p. 10.

Cathypna ploenensis Murray, Journ. Royal Micr. Soc., 1913, p. 552, pl. 22, fig. 4.

Lecane ploenensis Harring, Bull. 81 U. S. Nat. Mus., 1913, p. 62; Proc. U. S. Nat. Mus., vol. 47, 1914, p. 536.

The outline of the lorica is elongate oval. The anterior margins are coincident and straight; at the external angles are two small, cusplike spines. The ovate dorsal plate is slightly truncate posteriorly and very firm; the surface markings are very prominent and constant. The pattern is rather complicated; the median portion is regularly facetted, but towards the margins the ridges become more complex, as shown in figure 5. The ventral plate follows the general outline of the dorsal, but is somewhat narrower, especially in front; the markings are less intricate than on the dorsal plate. The lateral sulci are moderately deep. The posterior segment is rather small and rounded, projecting but little beyond the dorsal plate; the coxal plates are large and rounded posteriorly. The first foot joint is narrow and indistinct, the second large and pyriform or subtriangular. The toes are very long and slender, about one third of the total length, parallel-sided, straight on the inner edges and ending in acute points without claws.

Total length 260μ; length of dorsal plate 170μ, of ventral plate 185μ; width of dorsal plate 112μ, of ventral plate 105μ; width of anterior points 84μ; length of toes 86μ.

Lecane ploenensis is abundant in weedy ponds everywhere in the United States. According to Rousselet, who collected it on Clare Island, it is a rare species, and European records are not numerous. It is quite likely that this may be Levander's *Cathypna affinis*, but his description is lacking in detail, and it is not now possible to decide among the large number of species which one was really meant. The only course open seems to be to drop it as unidentifiable.

LECANE SIGNIFERA (Jennings).

Plate XIII, figures 3, 4.

Distyla signifera JENNINGS, Bull. Michigan Fish Comm., No. 6, 1896, p. 92, figs. 1, 2.

Cathypna signifera MURRAY, Journ. Royal Micr. Soc., 1913, p. 552, pl. 23, fig. 13.

Lecane signifera HARRING, Bull. 81 U. S. Nat. Mus., 1913, p. 62.

The outline of the lorica is elongate oval, and the anterior margins coincident and straight; at the external angles are two small, cusplike spines. The dorsal plate is slightly ovate and rounded posteriorly. The ventral plate is narrower than the dorsal, but of the same general outline. The surface markings of the lorica are of an unusual type; upon a pattern of elevated ridges, rounded at the top and of the design found in *L. ploenensis,* is superposed rows of small, closely spaced, hemispherical, beadlike elevations. These beads are on the slopes of the ridges, midway between the rounded tops and bottoms of the facets. The lateral sulci are moderately deep. The posterior segment is rounded and projects but slightly beyond the dorsal plate. The coxal plates are moderately large and rounded posteriorly. The first foot joint is long and narrow, the second short, broad and subsquare. The toes are long and slender, about one third of the total length, parallel-sided, straight on the inner edges and ending in acute points without claws.

Total length 200μ; length of dorsal plate 135μ, of ventral plate

148μ; width of dorsal plate 90μ, of ventral plate 82μ; width of anterior points 68μ; length of toes 60μ.

Lecane signifera usually occurs in small numbers, but it is widely distributed in the United States. We have collected it in Wisconsin, Mount Desert Island, Maine, New Jersey, Maryland, the District of Columbia and Florida, and it also occurred in collections made by Dr. Jennings at Ann Arbor, Michigan.

LECANE AQUILA Harring and Myers, new species.

Plate XIII, figures 1, 2.

The outline of the lorica is reversed-ovate and fairly broad. The anterior margins are coincident and very nearly straight; at the external angles are two small cusplike spines. The ovate dorsal plate is slightly truncate posteriorly and rather flexible; the surface markings are very faint and differ from other species of the genus, as will be seen from figure 2. The ventral plate is oval and its anterior edges somewhat flexible and indistinct. The lateral sulci are moderately deep. The posterior segment is rounded and projects but very slightly beyond the dorsal plate; the coxal plates are moderately large and rounded posteriorly. The first foot joint is narrow and indistinct, the second large and subsquare. The toes are very long and slender, one third of the total length, parallel-sided and ending in acute points without claws.

Total length 300μ; length of dorsal plate 190μ, of ventral plate 202μ; width of dorsal plate 148μ, of ventral plate 125μ; width of anterior points 95μ; length of toes 100μ.

Lecane aquila was first collected in a shallow, weedy pond at Eagle River, Vilas County, Wisconsin; it is common on Mount Desert Island, Maine. It is closely related to *L. ploenensis* and *L. signifera,* but is much larger and more robust than these two species; the toes are also relatively longer.

LECANE LUNA (Müller)

Plate XIV, figures 5, 6.

Cercaria luna MÜLLER, Zool. Danicae Prodr., 1776, p. 280; Animalcula Infusoria, 1786, p. 139, pl. 20, figs. 8, 9.

Furcocerca luna LAMARCK, Hist. Nat. Anim. sans Vert., vol. 1, 1815, p. 448.

Trichocerca luna BORY DE ST. VINCENT, Class. Anim. Micr., 1826, p. 42.

Lecane luna NITZSCH, Encycl. Wiss. u. Künste sect. 1, vol. 16, 1827, p. 68.—HARRING, Bull. 81 U. S. Nat. Mus., 1913, p. 61; Proc. U. S. Nat. Mus., vol. 47, 1914, p. 534; Rep. Canadian Arctic Exp. 1913–18, vol. 8, pt. E, 1921, p. 9.—KOZAR, Zool. Anz., vol. 44, 1914, p. 420.—REZVOI, Trudy Borodinsk. Biol. Stants. Imp. Petrogradsk. Obshch. Estestvoisp., vol. 4, 1916, p. 180.—JAKUBSKI, Kosmos (Lwów), 1918–1919, p. 28.

? *Furcularia jobloti* BORY DE ST. VINCENT, Encycl. Méth., Zooph. (pt. 2), 1827, p. 425.

Brachionus luna BLAINVILLE, Dict. Sci. Nat., vol. 60, 1830, p. 148.

Euchlanis luna EHRENBERG, Abh. Akad. Wiss. Berlin (for 1831), 1832, p. 131; Infusionsthierchen, 1838, p. 462, pl. 57, fig. 10.—DUJARDIN, Hist. Nat. Zooph. Inf., 1841, p. 634.—PERTY, Zur Kenntn. kleinst. Lebensf., 1852, p. 41.—BARTSCH, Jahresh. Naturk. Württemberg, vol. 26, 1870, p. 357; Rotat. Hungariae, 1877, p. 45.—Eyferth, Mikr. Süsswasserbew., 1877, p. 54, fig. 92; Einf. Lebensformen, 1878, p. 89, pl. 5, fig. 37; ed. 2, 1885, p. 114, pl. 7, fig. 37.—PLATE, Jenaische Zeitschr. Naturw., vol. 19, 1885, p. 59.—DADAY, Termész. Füzetek, vol. 9, 1885, p. 127.

Cathypna luna GOSSE, in Hudson and Gosse, Rotifera, 1886, vol. 2, p. 94, pl. 24, fig. 4.—DADAY, Termész. Füzetek, vol. 15, 1892, p. 28; Math. Termész. Ertes., vol. 12, 1893, p. 31.—PETR, Sitzungsber. Böhm. Ges. Wiss. (for 1890), 1892, p. 233.—TERNETZ, Rotat. Umg. Basels, 1892, p. 17.—WIERZEJSKI, Rozpr. Akad. Umiej., Wydz. Mat. Przyr., Krakow, ser. 2, vol. 6, 1893, p. 242.—KERTESZ, Budapest Rotat. Faun., 1894, p. 39.—LEVANDER, Acta Soc. Fauna et Flora Fennica, vol. 12, No. 3, 1895, p. 49, pl. 3, fig. 29.—SKORIKOV, Trav. Soc. Nat. Kharkow, vol. 30, 1896, p. 319.—HEMPEL, Bull. Illinois State Lab. Nat. Hist., vol. 5, 1898, p. 374.—WEBER, Rev. Suisse Zool., vol. 5, 1898, p. 593, pl. 22, figs. 4, 5.—JENNINGS, Bull. U. S. Fish Comm, vol. 19 (for 1899), 1900, p. 91, pl. 19, figs. 28, 29.—Voronkov, Trudy Gidr. Stants. Glubokom Oz., vol. 2, 1907, pp. 109, 204, 283.—SCHLENKER, Mitt. Geol. Abt. Württemberg. Stat. Landesamt, No. 5, 1908, p. 249.—KOFOID, Bull. Illinois State Lab. Nat. Hist., vol. 8, No. 1, 1908, p. 198.—MEISSNER, Izv. Turkestansk. Otd. Imp. Russk. Geogr. Obshch., vol. 4, pt. 8, 1908, p. 20.—DE BEAUCHAMP, Arch. Zool. Expér., ser. 4, vol. 10, 1909, p. 210, fig. XXVI.—VON HOFSTEN, Arkiv Zool., Stockholm, vol. 6, No. 1, 1909, p. 56; Wiss. Unters. Sarekgeb., vol. 4, pt. 8, 1923, p. 860.—LIE PETTERSEN, Bergens Mus. Aarbog (for 1909), 1910, p. 63.—DADAY, Zoologica, pt. 59, 1910, p. 85.—LUCKS, Rotatorienfauna Westpreussens, 1912, p. 107.—SACHSE, Süsswasserfauna Deutschlands, pt. 14, 1912, p. 171, figs. 336–338.—MOLA, Ann. Biol. Lac., vol. 6, 1913, p. 259.—MURRAY, Journ. Royal Micr. Soc., 1913, p. 345, pl. 13, fig. 19.—JAKUBSKI, Rozpr. Wiad. Muz. Dzieduszyckich, vol. 1, 1914, p. 30.—MONTET, Rev. Suisse Zool., vol. 23, 1915, p. 335.—WEBER and MONTET, Cat. Invert. Suisse, pt. 11, 1918, p. 188.—BEHNING, Izv. Kaluzhsk.

Obshch. Izuch. Prir. Mestn. Kraia. vol. 3, 1918, p. 92.—MONARD, Rev. d'Hydrol., vol. 2, 1922, p. 13.—BRYCE, Journ. Quekett Micr. Club, ser. 2, vol. 15, 1924, p. 97.

The lorica is broadly pyriform or subcircular; its greatest width is nearly equal to the length. The dorsal and ventral plates have a deep, lunate anterior sinus. The dorsal plate is almost circular in outline and without any surface markings; the angles of the sinus are very blunt and without spines. A broad, median hump is formed by the excessive contraction of the anterior margin. The ventral plate is very little narrower than the dorsal and slightly more ovate in outline; the only surface marking present is a straight transverse fold immediately in front of the foot. The lunate anterior sinus is cuspidate at its external angles. The lateral sulci are unusually deep. The posterior segment of the body is very small and rounded, projecting very little beyond the dorsal plate; the coxal plates are bluntly pointed at their posterior, free ends. The first foot joint is small and indistinct, the second very large and subsquare. The toes are parallel-sided, about one third of the total length, and end in a distinct claw with a minute basal spicule.

Total length 180μ; length of dorsal plate 125μ, of ventral plate 135μ; width of dorsal plate 125μ, of ventral plate 115μ; width of dorsal sinus 40μ, of ventral sinus 65μ; length of toe without claw 55μ; claw 9μ.

Lecane luna occurs in abundance in weedy ponds all over the world and is without doubt one of the commonest of all rotifers. It is readily recognized by its large size, nearly circular outline and deep anterior sinus.

LECANE PAPUANA (Murray)

Plate XIV, figures 3, 4.

Cathypna papuana MURRAY, Journ. Royal Micr. Soc., 1913, p. 551, pl. 22, fig. 2.

Lecane papuana HARRING, Proc. U. S. Nat. Mus., vol. 47, 1914, p. 534.

The outline of the lorica is subcircular; its width is very nearly equal to the length. The anterior dorsal margin is nearly straight. The ventral margin has a broad, shallow, V-shaped anterior sinus between two rounded lobes projecting considerably beyond the dorsal plate; the sinus is rounded posteriorly and its sides undulate. The dorsal plate is subcircular and rounded posteriorly. The ventral plate is slightly narrower than the dorsal and of the same outline; it has a transverse fold in front of the foot. The lateral sulci are moderately deep. The posterior segment is small and rounded; it projects slightly beyond the dorsal plate. The coxal plates are small and obtusely pointed. The first foot joint is pyriform and rounded posteriorly, the second joint robust and very broadly ovate. The toes are long and fairly slender, more than one fourth of the total length, nearly parallel-sided, straight on the inner margins and very slightly broadened externally in front of the stout, acutely pointed claw, which has two basal spicules.

Total length 160μ; length of dorsal plate 102μ, of ventral plate 115μ; width of dorsal plate 102μ, of ventral plate 98μ; width of anterior dorsal margin 52μ, of ventral margin 62μ; length of toes without claw 38μ; claw 9μ.

Lecane papuana was described by Murray from a single specimen from New Guinea. It is common in the Panama Canal Zone and in material collected by Mr. Juday at Puerto Barrios, Guatemala; in the United States we have found it only in Polk County, Florida.

LECANE BRACHYDACTYLA (Stenroos).

Plate XV, figures 5, 6.

Cathypna brachydactyla STENROOS, Acta Soc. Fauna et Flora Fennica, vol. 17, No. 1, 1898, p. 160, pl. 2, fig. 20.—ROUSSELET, Journ. Quekett Micr. Club, ser. 2, vol. 11, 1912, p. 372, pl. 13, fig. 3.—LUCKS, Rotatorienfauna Westpreussens, 1912, p. 108.—MURRAY, Journ. Royal Micr. Soc., 1913, p. 554, pl. 23, fig. 15.—SACHSE, Arch. Hydrobiol., vol. 9, 1914, p. 68, fig. 8.—OPARINA-KHARITONOVA, Izv. Biol. Nauchno-Issl. Inst. Permsk. Univ., vol. 3, 1925, p. 439.

Cathypna luna brachydactyla SACHSE, Süsswasserfauna Deutschlands, pt. 14, 1912, p. 172.—JAKUBSKI, Rozpr. Wiad. Muz. Dzieduszyckich, vol. 1, 1914, p. 31.

Distyla truncata LEISSLING, Arch. Hydrobiol., vol. 9, 1914, p. 255, fig. 2.

Lecane brachydactyla HARRING, Bull. 81 U. S. Nat. Mus., 1913, p. 60; Rep. Canadian Arctic Exp. 1913–18, vol. 8, pt. E, 1921, p. 9, pl. 3, figs. 5, 6.

The outline of the lorica is ovate, truncate posteriorly and the anterior margin cuspidate. The dorsal plate is broadly oval, truncate posteriorly and somewhat narrower than the ventral plate. The anterior margin of the dorsal plate is approximately straight and slightly wavy with prominent lateral cusps; the ventral margin has a median concavity. The lorica is strongly compressed dorso-ventrally and without surface markings; the lateral sulci are fairly deep. The posterior segment is very prominent and trapezoidal in outline, slightly rounded at the angles. The coxal plates are circular and fairly large. The first foot joint is somewhat elongate, widest posteriorly, and the second joint subsquare. The toes are short, straight on the inner edges, cylindrical at the base and end in long, conical points.

Total length 150μ; length of dorsal plate 100μ, of ventral plate 128μ; width of dorsal plate 92μ, of ventral plate 100μ; anterior points 72μ; length of toes 28μ.

Lecane brachydactyla is fairly common among sphagnum in soft, acid water ponds; we have collected it in Vilas and Oneida Counties, Wisconsin, around Atlantic City, New Jersey, and on Mount Desert Island, Maine.

LECANE JESSUPI Harring

Plate XV, figures 3, 4.

Lecane jessupi HARRING, Rep. Canadian Arctic Exp. 1913–18, vol 8, pt. E, 1921, p. 8, pl. 3, figs. 3, 4.

The outline of the lorica is slightly ovate, truncate posteriorly and the anterior margin cuspidate. The dorsal plate is ovate, rounded posteriorly and slightly narrower than the ventral plate, which is somewhat elliptic. The anterior margin of the dorsal plate is slightly convex for the greater portion of its width and excavate at the lateral cusps; the anterior margin of the ventral plate is lunate. There are no markings on either dorsal or ventral plate; the lateral sulci are deep. The lorica is strongly compressed dorso-ventrally. The posterior segment is roughly trapezoidal in outline and cuspidate at the external angles; the margin is convex in the median portion and has a slight concavity at the angles. There is a well marked constriction at the junction of the ventral plate and the posterior segment. The coaxal plates are semi-ovate. The first foot joint is well marked and widest posteriorly; the second joint is subsquare. The toes are short, cylindric for one half their length and end in acute, conical points, straight on their inner edges.

Total length 126μ; length of dorsal plate 93μ, of ventral plate 108μ; width of dorsal plate 93μ, of ventral plate 96μ; anterior points 58μ; length of toes 27μ.

Lecane jessupi was collected by Mr. J. M. Jessup in lakes on Old Crow River flats, north of New Rampart House, Alaska, during the Alaskan Boundary Survey. It was not abundant and has not been found elsewhere.

LECANE LIGONA (Dunlop)

Plate XVI, figures 3–6.

Cathypna ligona DUNLOP, Journ. Quekett Micr. Club, ser. 2, vol. 8, 1901, p. 29, pl. 2, figs. 4–6.—VOIGT, Forschungsber. Biol. Stat. Plön, vol. 11, 1904, p. 70, pl. 4, fig. 38.—Lie-Pettersen, Bergens Mus. Aarbog (for 1909), 1910, No. 15, p. 64, pl. 2, fig. 14.—LUCKS, Rotatorienfauna Westpreussens, 1912, p. 109.—SACHSE, Süsswasserfauna Deutschlands, pt. 14, 1912, p. 174, fig. 342.—MURRAY, Journ. Royal Micr. Soc., 1913, p. 554, pl. 23, fig. 16.
Lecane ligona HARRING, Bull. 81 U. S. Nat. Mus., 1913, p. 61; Rep. Canadian Arctic Exp. 1913–18, vol. 8, pt. E, 1921, p. 8.

The outline of the lorica is a broad oval, squarely truncate posteriorly and convex anteriorly. The dorsal plate is slightly ovate, truncate posteriorly and narrower than the ventral plate. The anterior margin of the dorsal plate is distinctly convex with small lateral spines; the ventral margin is concave. The lorica is strongly compressed dorso-ventrally and without surface markings; the lateral sulci are deep. The posterior segment is short and very broad, produced laterally as two triangular cusps; its posterior margin is usually somewhat wavy. The coxal plates are semi-ovate and rather indistinct. The first foot joint is bluntly pointed; the second joint is rectangular. The toes are short, straight on their inner margins, cylindrical at the base and end in conical points.

Total length 92μ; length of dorsal plate 66μ, of ventral plate 80μ; width of dorsal plate 60μ, of ventral plate 70μ; anterior points 42μ; length of toes 18μ.

Lecane ligona is not rare among sphagnum growing in soft, acid water ponds; strangely enough it occurs also in brackish ditches in the tide marshes around Atlantic City, New Jersey European records of its occurrence are not numerous, but this may possibly be accounted for by the fact that collections are generally from hard water regions. We have found it especially abundant in Starvation Lake, Vilas County, Wisconsin, and common in ponds and lakes in the northern part of the state, as well as in New Jersey and on Mount Dessert Island, Maine. A variety with rounded posterior angles, shown in figures 5 and 6, is found in Bubble Pond and Long Pond, Mount Desert Island.

LECANE PYCINA Harring and Myers, new species

Plate XVII, figures 5, 6.

The outline of the lorica is broadly ovate; its width is about three-fourths of the length. The anterior dorsal margin is slightly convex and the ventral margin has a shallow sinus, rounded posteriorly; at the external angles are two acute spines. The dorsal plate is ovate and rounded posteriorly. The ventral plate is oval and slightly narrower than the dorsal. The lorica is strongly compressed dorso-ventrally and without surface markings; the lateral sulci are deep. The posterior segment is rather short and very broad with a short, relatively broad projection, slightly sinuate posteriorly and with small lateral, triangular cusps. The coxal plates are fairly large and rounded posteriorly. The first foot joint is hardly traceable, the second joint is small and subsquare. The toes are short, about one fifth of the total length, straight on their inner margins and convex externally, ending in acute points.

Total length 150μ; length of dorsal plate 120μ, of ventral plate 135μ; width of dorsal plate 100μ, of ventral plate 95μ; width of anterior points 70μ; length of toes 30μ.

Lecane pycina was collected in Long Lake and Bubble Pond, Mount Desert Island, Maine. It is related to L. *ligona, L. brachydactyla* and *L. jessupi,* but differs from these species in having the dorsal plate wider than the ventral, as well as in the form of the posterior projection.

LECANE PERTICA Harring and Myers, new species

Plate XII, figures 1, 2.

The outline of the lorica is a very elongate oval, the greatest width being only two thirds of the length; the body is compressed dorso-ventrally. The anterior margins are very nearly coincident, the dorsal almost straight and the ventral slightly concave; at the external angles are two small, pointed spines. The dorsal plate is oval and squarely truncate posteriorly; the facetting is very distinct and consists of the usual four rows, the first somewhat broken and irregular. The ventral plate is oval and somewhat narrower than the dorsal; the surface markings are prominent. The lateral sulci are deep. The posterior segment is nearly semicircular and projects considerably beyond the dorsal plate. The coxal plates are large and obtusely pointed posteriorly. The first foot joint is long and narrow, the second robust and subsquare, projecting the greater part of its length beyond the posterior segment. The toes are extremely long and very slender, about one third of the total length, parallel-sided and straight, and end in acute points without claws.

Total length 260μ; length of dorsal plate 140μ, of ventral plate 160μ; width of dorsal plate 100μ, of ventral plate 88μ; width of anterior points 64μ; length of toes 85μ.

Lecane pertica is very common in weedy ponds with soft, acid water, but is never found in hard water. We have collected it in Oneida and Vilas Counties, Wisconsin, Polk County, Florida, Mount Desert Island, Maine, and at Atlantic City, New Jersey.

LECANE EUTARSA Harring and Myers, new species.

Plate XVIII, figures 1, 2.

The outline of the lorica is ovate and the body is compressed dorso-ventrally. The anterior margins are coincident and very slightly concave; at the external angles are two small spines. The dorsal plate is ovate, truncate posteriorly and narrow at the anterior margin. The surface markings consist of four transverse rows of not very prominent facets. The ventral plate is ovate and very slightly narrower than the dorsal; the markings consist of a number of rather indistinct longitudinal ridges as shown in figure 2. The posterior segment is narrow and rounded; it projects somewhat beyond the dorsal plate. The coxal plates are indistinct, closely appressed to the foot, and pointed posteriorly. The lateral sulci are fairly deep. The first foot joint is long and narrow, the second joint unusually large and somewhat angular. The toes are long and very slender, more than one fourth of the total length, straight and parallel-sided with a very long, spine-like claw with a small basal spicule.

Total length 45μ; length of dorsal plate 95μ, of ventral plate 102μ; width of dorsal plate 64μ, of ventral plate 60μ; width of anterior points 44μ; length of toe without claw 30μ, claw 12μ.

Lecane eutarsa was found in small numbers in material collected by Mr. Juday in ditches along the railroad, near Puerto Barrios, Guatemala. It has not been found elsewhere.

LECANE PELATIS Harring and Myers, new species

Plate XVIII, figures 3, 4.

The outline of the body is broadly oval or very slightly ovate. The anterior margins are coincident and somewhat concave; at the external angles are two distinct cusps. The ovate dorsal plate is truncate posteriorly; the surface markings are fairly prominent and consist of four rows of facets. The ventral plate is oval and considerably narrower than the dorsal; the markings are distinct and less simple than is usually the case. The posterior segment is rounded and fairly prominent; the coxal plates are large and pointed posteriorly. The lateral sulci are deep. The first foot joint is elongate oval and pointed posteriorly, the second joint large and robust, squarely truncate posteriorly, and rounded at the naterior end. The toes are long and slender, about one fourth of the total length, parallel-sided and terminate in acute claws.

Total length 160μ; length of dorsal plate 110μ, of ventral plate 122μ; width of dorsal plate 92μ, of ventral plate 70μ; width of anterior points 53μ; length of toe without claw 35μ; claw 9μ.

Lecane pelatis is common in weedy ponds around Minocqua, Wisconsin, at Atlantic City, New Jersey, and on Mount Desert Island, Maine.

LECANE MIRA (Murray)

Plate XVIII, figures 5, 6.

Cathypna mira MURRAY, Journ. Royal Micr. Soc., 1913, p. 553, pl. 22, fig. 3.

The outline of the lorica is oval and the body is quite deep. The anterior dorsal margin is nearly straight and the ventral slightly concave; at the external angles are two stout, triangular cusps. The dorsal plate is broadly oval or subcircular and slightly truncate posteriorly; the surface markings are not very prominent and differ somewhat from the usual pattern, as the anterior row of facets is incomplete. The ventral plate is broadly ovate and considerably narrower than the dorsal; it is not facetted. The lateral sulci are deep. The posterior segment is small and truncate, projecting considerably beyond the dorsal plate. The coxal plates are fairly large and obtusely pointed posteriorly. The first foot joint is long and narrow, the second large and pyriform. The toes are long and slender, about one fourth of the total length, parallel-sided and straight, terminating in a stout claw with a minute basal spicule.

Total length 200μ; length of dorsal plate 132μ, of ventral plate 145μ; width of dorsal plate 130μ, of ventral plate 100μ; width of anterior points 60μ; length of toes without claw 40μ; claw 9μ.

Lecane mira is fairly common in weedy ponds with neutral or acid water. We have collected it in Oneida and Vilas Counties, Wisconsin, on Mount Desert Island, Maine, in New Jersey, District of Columbia and Florida; it occurs also in material collected by Dr. Birge and Mr. Juday in Arkansas, Louisiana and Texas. Murray's original description was based on material from Washington.

LECANE METHORIA Harring and Myers

Plate XIX, figures 1, 2.

The outline of the lorica is broadly ovate, the width about two thirds of the length. The anterior dorsal and ventral margins are coincident and very faintly convex; at the external angles are two stout, triangular spines. The dorsal plate is broadly ovate and very slightly truncate posteriorly; the facetting is of an unusual pattern and the separate facets are bounded by double lines, as in *L. haliclysta*. The ventral plate is considerably narrower than the dorsal; its margins are flexible and the outline consequently somewhat indefinite, but approximating an obtusely pointed triangle. The ventral markings are quite intricate and some of the lines are doubled, as on the dorsal plate. The lateral sulci are very indistinct. The posterior segment is very small and rounded and projects slightly beyond the dorsal plate. The coxal plates are fairly large and somewhat pointed at their posterior ends. The first foot joint is very narrow and elongate, its outlines merging gradually and without distinct separation with the markings of the ventral plate; its posterior, obtusely pointed termination projects over the robust, subsquare second foot joint. The toes are long and moderately slender, about one fourth of the total length, parallel-sided and very slightly incurved; the inner margins are excavate at the ends, but a true claw is not present.

Total length 102μ; length of dorsal plate 70μ, of ventral plate 75μ; width of dorsal plate 54μ, of ventral plate 45μ; width of anterior points 50μ; length of toes 24μ.

Lecane methoria was collected in small numbers in weedy bays of Town Line Lake, at Three Lakes, Oneida County, Wisconsin. It has not been found elsewhere.

LECANE STICHAEA Harring

Plate XIX, figures 3, 4.

Lecane stichaea HARRING, Proc. U. S. Nat. Mus., vol. 46, 1913, p. 397, pl. 35, figs. 4–6. — REZVOI, Trudy Borodinsk. Biol. Stants. Imp. Petrogradsk. Obshch. Estestvoisp., vol. 4, 1916, p. 180, pl. 1, figs. 11, 12.—FADEEV, Russk. Gidr. Zhurn., vol. 3, No. 3–5, 1924, p. 4.

The outline of the lorica is broadly ovate and the body is somewhat compressed dorso-ventrally. The anterior margins are coincident and slightly convex; at the external angles are two stout spines. The dorsal plate is ovate and truncate posteriorly. As shown in figure 3, the surface markings are of a rather aberrant pattern. The normal number of transverse rows of facets are present, but the first row is irregular and shows a tendency to subdivide; in the second to fourth row the facets are more numerous than in other species of the genus. The ventral plate is very nearly parallel-sided anteriorly and rounded posteriorly; the markings are fairly prominent and rather intricate. The coxal plates are large and somewhat indistinct, closely appressed to the foot and pointed posteriorly. The lateral sulci are moderately deep. The first foot joint is long and narrow, the second large and subsquare. The toes are long and slender, more than one fourth of the total length, straight and parallel-sided; the claw is fairly large, acutely pointed and without basal spicule.

Total length 145μ; length of dorsal plate 92μ, of ventral plate 105μ; width of dorsal plate 76μ, of ventral plate 58μ; width of anterior points 64μ; length of toes without claw 32μ; claw 7μ.

Lecane stichaea is common in wet sphagnum; we have collected it in Wisconsin, Mount Desert Island, Maine, New Jersey, Maryland, Virginia and Florida.

LECANE SAGINATA Harring and Myers, new species

Plate XIX, figures 5, 6.

The outline of the lorica is broadly ovate; the greatest width is about three fourths of the length. The anterior margins of the dorsal and ventral plates are coincident and straight, but slightly wavy; at the external angles are two short, stout spines. The dorsal plate is broadly ovate and rounded posteriorly. The facetting is well marked and differs, as may be seen from the figure, only in details from the usual pattern. The ventral plate is narrower than the dorsal, ovate in outline and the edges ill-defined and wavy. The surface markings are fairly prominent and more complex than the prevailing design. The posterior segment is small and rounded, with a very slight median concavity, and projects but little beyond the dorsal plate. The coxal plates are fairly large and obtusely pointed. The first foot joint is moderately large, pyriform and somewhat indistinct; the second joint is large and pyriform and projects very slightly beyond the posterior segment. The toes are long and slender, more than one fourth of the total length, parallel-sided and very slightly incurved; the tip is excavate on the inner margin, forming a pseudo-claw.

Total length 140μ; length of dorsal plate 75μ, of ventral plate 81μ; width of dorsal plate 66μ, of ventral plate 54μ; width of anterior points 50μ; length of toes without claw 33μ; claw 7μ.

Lecane saginata occurs in soft, acid water ponds in Oneida and and Vilas Counties, Wisconsin, on Mount Desert Island, Maine, and around Atlantic City, New Jersey; it is nowhere common. Its nearest relative is *L. intrasinuata;* this species is consistently larger, the lorica is relatively broader and oval in outline, without facetting, while the lorica of *L. saginata* is distinctly pyriform and the dorsal facetting prominent.

LECANE ELASMA Harring and Myers, new species

Plate XX, figures 1, 2.

The lorica is membranous and very flexible, but its form is quite constant; the outline is broadly ovate and rounded posteriorly. The anterior margins are coincident and straight; at the external angles are two small, but stout spines. The dorsal plate is broadly oval and rounded posteriorly; it is without facetting or folds of any kind. The ventral plate is oval and slightly narrower than the dorsal plate; the surface markings are faint, but constant. The lateral sulci are moderately deep. The posterior segment is fairly large and rounded; it projects considerably beyond the dorsal plate. The coxal plates are small and pointed posteriorly. The first foot joint is pyriform and somewhat indistinct, lobate posteriorly, the second joint large and rounded anteriorly, abruptly reduced above the base of the toes and projecting half its length beyond the lorica. The toes are very long and slender, about one third of the total length, parallel-sided for half their length and somewhat abruptly reduced to long, excessively slender and acute points.

Total length 130μ; length of dorsal plate 75μ, of ventral plate 85μ; width or dorsal plate 65μ, of ventral plate 56μ; width of anterior points 46μ; length of toes 40μ.

Lecane elasma is not rare in wet sphagnum; we have collected it around Washington, District of Columbia, at Tuckerton, New Jersey, and in Northern and Central Wisconsin.

LECANE RHYTIDA Harring and Meyers, new species

Plate XX, figures 3, 4.

The outline of the lorica is broadly ovate; the width is about two thirds of the length. The anterior dorsal and ventral margins are coincident and very slightly concave, produced at the external angles into two stout, triangular cusps. The dorsal plate is oval and very slightly truncate posteriorly. The facetting is prominent and does not depart very much from the usual pattern. The ventral plate is elongate ovate and considerably narrower than the dorsal; the surface markings are few in number, but prominent. The lateral margins of the ventral plate are somewhat wavy and indistinct and the lateral sulci ill-defined. The posterior segment is small and semicircular; it projects somewhat beyond the dorsal plate; the coxal plates are small and obtusely pointed posteriorly. The first foot joint is indistinct and elongate pyriform; the second joint is roughly hexagonal and quite robust, projecting fully half its length beyond the lorica. The toes are long and slender, about one fourth of the total length, parallel-sided for half their length and tapering to extremely long, acute points.

Total length 126μ; length of dorsal plate 80μ, of ventral plate

87μ; width of dorsal plate 69μ, of ventral plate 65μ; width of anterior points 42μ; length of toes 39μ.

Lecane rhytida is not rare among floating sphagnum in soft, acid water ponds. We have collected it in a large pond at Gravelly Run, near Atlantic City, New Jersey, and in Upper Mill Meadow pond on Mount Desert Island, Maine.

LECANE LAUTERBORNI Hauer

Plate XX, figures 5, 6.

Lecane lauterborni HAUER, **Zool. Anz., vol. 61, 1924, p. 145, figs. 1–3.**

The lorica is firm and its outline broadly reversed-ovate; its width is more than three fourths of the length. The anterior margins are coincident and slightly convex. At the external angles are two stout frontal spines. The dorsal plate is broadly ovate and indistinctly facetted. The ventral plate is nearly parallel-sided for half its length, obtusely triangular posteriorly and much narrower than the dorsal plate; its surface markings are of a very simple pattern. The lateral sulci are deep. The posterior segment is obtusely triangular and projects far beyond the dorsal plate. The coxal plates are indistinct, small and oval. The first foot joint is short, broad and somewhat ill-defined, the second joint long and narrow. The toes are long and slender, more than one fourth of the total length, straight, parallel-sided for about one third of their length, and taper to very acute points.

Total length 150μ; length of dorsal plate 92μ, of ventral plate 110μ; width of dorsal plate 82μ, of ventral plate 70μ; width of anterior spines 65μ; length of toes 42μ.

Lecane lauterborni was described by Hauer from sphagnum bogs in the Schwarzwald, where it is common. We have collected this species in shallow, weedy areas of Witch Hole, Mount Desert Island, Maine. Material forwarded to us by Hauer shows the German form to be consistently smaller, about two-thirds the size of the Mount Desert specimens.

LECANE COMPTA Harring

Plate XXI, figures 1, 2.

Cathypna flexilis MURRAY, **Journ. Royal Micr. Soc., 1913, p. 351, pl. 14, fig. 27; not *Distyla flexilis* GOSSE.**

Lecane compta HARRING, **Proc. U. S. Nat. Mus., vol. 47, 1914, p. 540, pl. 20, figs. 1–3.**

The outline of the lorica is a slightly elongate oval; the width of the body is three fourths of the total length. The anterior margins of the dorsal and ventral plates are coincident and straight; at the external angles are two short, robust spines. The dorsal plate is ovate and narrowly truncate posteriorly; the surface markings are fairly prominent and consist of the usual four rows of facets, the first row somewhat irregular. The ventral plate is narrower than the dorsal, parallel-sided anteriorly and rounded posteriorly; its surface markings are prominent and of an irregular pattern, as shown in figure 2. The lateral sulci are indistinct and the entire lorica very flexible. The posterior segment is large and bluntly pointed; it projects considerably beyond the dorsal plate. The coxal plates are small and rounded posteriorly. The first foot joint is oval and somewhat indistinct, the second joint large and subcircular. The toes are long and slender, more than one fourth of the entire length, straight and parallel-sided, with conical points ending in an acute spicule.

Total length 115μ; length of dorsal plate 70μ, of ventral plate 80μ; width of dorsal plate 60μ, of ventral plate 56μ; width of anterior points 45μ; length of toes 30μ.

Lecane compta was originally described from material collected in the Panama Canal Zone; we have since found it in small numbers in Southern Wisconsin. It seems to be confined to moderately hard waters.

LECANE HALICLYSTA Harring and Myers, new species

Plate XXI, figures 5, 6.

The outline of the lorica is broadly ovate and the width of the body is nearly three fourths of the length. The anterior dorsal and ventral margins are coincident and straight; at the external angles are two very small spines. The dorsal plate is broadly ovate and slightly truncate posteriorly; the facetting is of an unusual pattern, the separate facets being bounded by double lines. The ventral plate is very slightly narrower than the dorsal and of the same general outline; the surface markings are irregular and the lines doubled; as on the dorsal plate. The lateral sulci are indistinct. The posterior segment is small and rounded and projects but little beyond the dorsal plate. The coxal plates are small and obtusely pointed posteriorly.

The first foot joint is elongate ovate, reaching down over the pyriform second joint with a lobate extension. The toes are long and slender, more than one fourth of the total length, straight and parallel-sided, and end in an indistinct, acute claw.

Total length 145μ; length of dorsal plate 105μ, of ventral plate 92μ; width of dorsal plate 78μ, of ventral plate 74μ; width of anterior points 60μ; length of toes with claw 42μ.

Lecane haliclysta occurs in small numbers in weedy ponds with soft water; we have collected it in Oneida and Vilas counties, Wisconsin, around Atlantic City, New Jersey, on Mount Desert Island, Maine, and we have found it also in collections made by Dr. Birge in Hatchery Bay, South Bass Island, Lake Erie, during the Great Lakes Investigation by the United States Fish Commission in 1899.

LECANE ASPASIA Myers

Lecane aspasia **Myers, Proc. U. S. Nat. Mus., vol. 52, 1917, p. 476, pl. 40, figs. 6–8.**

The lorica is very broad, nearly parallel-sided anteriorly and rounded posteriorly; the dorso-ventral depth of the body is somewhat greater than usual. The anterior margins of the dorsal and ventral plates are coincident and very slightly convex; at the external angles are two small spines. The dorsal plate is very broadly ovate and slightly truncate posteriorly; its surface markings are fairly prominent and consist of the usual four transverse rows of facets, in this instance somewhat larger than usual. The ventral plate is very broadly ovate and of the same width as the dorsal plate. The lateral sulci are moderately deep. The posterior segment is broadly rounded and projects considerably beyond the dorsal plate. The coxal plates are roughly triangular. The first foot joint is parallel-sided and rather small, the second joint short, broad and subrhomboid. The toes are long and slender, more than one fourth of the total length, straight and slightly tapering; the claw is long, slender and acutely pointed.

Total length 132μ; length of dorsal plate 82μ, of ventral plate 94μ; width of lorica 75μ; width of anterior points 63μ; length of toes without claw 30μ; claw 8μ.

Lecane aspasia was described from material collected near Los Angeles, California; it has not been found elsewhere.

LECANE LUDWIGII (Eckstein)

Plate XXII, figures 5, 6.

Distyla ludwigii ECKSTEIN, Zeitschr. Wiss. Zool., vol. 39, 1883, p. 383, pl. 26, fig. 37.—BLOCHMANN, Mikr. Thierw. Süssw., 1886, p. 107.—HUDSON and GOSSE, Rotifera, Suppl., 1889, p. 43, pl. 33. fig. 36.—TERNETZ, Rotat. Umg. Basels, 1892, p. 18.—WIERZEJSKI, Rozpr. Akad. Umiej., Wydz. Mat.-Przyr., Krakow, ser. 2, vol. 6, 1893, p. 242.—SKORIKOV, Trav. Soc. Nat. Kharkow, vol. 30, 1896, p. 320.—WEBER, Rev. Suisse Zool., vol. 5, 1898, p. 602, pl. 22, figs. 9–11.—JENNINGS, Bull. U. S. Fish Comm., vol. 19 (for 1899), 1900, p. 92, pl. 20, fig. 32.—VOIGT, Forschungsber. Biol. Stat. Plön, vol. 11, 1904, p. 71.—DADAY, Zoologica, pt. 44, 1905, p. 108, pl. 6, fig. 11; pt. 59, 1910, p. 82.—VORONKOV, Trudy Gidr. Stants. Glubokom Oz., vol. 2, 1907, p. 204.—MEISSNER, Izv. Turkestansk. Otd. Imp. Russk. Geogr. Obshch., vol. 4, pt. 8, 1908, p. 21, pl. 1, fig. 2.—DE BEAUCHAMP, Arch. Zool. Expér., ser. 4, vol. 10, 1909, p. 161.—LIE-PETTERSEN, Bergens Mus. Aarbog (for 1909), 1910, No. 15, p. 65.—SACHSE, Süsswasserfauna Deutschlands, pt. 14, 1912, p. 176, figs. 348.—JAKUBSKI, Rozpr. Muz. Dzieduszyckich, vol. 1, 1914, p. 32.

Distyla ornata DADAY, Math. Termész. Ertes., vol. 15, 1897, p. 135, fig. 4; Termész. Füzetek, vol. 24, 1901, p. 18, fig. 2.

Distyla oxycauda STENROOS, Acta Soc. Pauna et Flora Fennica, vol. 17, No. 1, 1898, p. 162, pl. 2, figs. 23–25.

Cathypna ludwigii MURRAY, Journ. Royal Micr. Soc., 1913, p. 352, pl. 14, fig. 23.—WEBER and MONTET, Cat. Invert. Suisse, pt. 11, 1918, p. 187.

Lecane ludwigii HARRING, Bull. 81 U. S. Nat. Mus., 1913, p. 61; Proc. U. S. Nat. Mus., vol. 47, 1914, p. 537.—KOZAR, Zool Anz., vol. 44, 1914, p. 420.—REZVOI, Trudy Borodinsk. Biol. Stants. Imp. Petrogradsk. Obshch. Estestvoisp., vol. 4, 1916, p. 180.—JAKUBSKI, Kosmos (Lwów), 1918–1919, p. 28.

The outline of the lorica is oval and moderately broad. The anterior margins are coincident and slightly concave; at the external angles are two fairly long, stout spines. The dorsal plate is oval and truncate posteriorly; it is very firm and marked with four transverse rows of prominent, coarse tesselations. The ventral plate is slightly pyriform in outline and narrower than the dorsal; the surface markings consist of a few longitudinal ridges, as shown in the figure. The lateral sulci are very deep. The posterior segment is roughly semicircular and is produced as a long, triangular, pointed spine. The coxal plates are large and rounded posteriorly. The first foot joint is narrow and overlaps the trapezoidal second joint as a lobate projection. The toes are long and slender, one fourth of the total length, parallel-sided and ending in acute conical points without claws.

Total length 165μ; length of dorsal plate 120μ, of ventral plate 162μ; width of dorsal plate 77μ, of ventral plate 68μ; width of anterior points 45μ; length of toes 45μ.

Lecane ludwigii is very widely distributed, but seems not to occur in large numbers; we have collected it in weedy ponds in Wisconsin, New Jersey, Maine, District of Columbia, Virginia and Florida and have found it in material from many other localities in the United States.

Lecane ludwigii, L. ohioensis, L. marshi, L. stokesii and *L. ichthyoura* form a very closely related group. The form of the prolongation of the posterior segment is quite different in these species and the obvious character upon which they were established. Some other minor differences deserve notice. The form of the second foot joint is slightly different in all the species; likewise the outline of the coxal plates. The form and relative length of the toes also show small, but constant differences. The outline of the body, the dorsal plate, the very rigid lorica and the surface markings of both dorsal and ventral plates are virtually alike in all the species, and the same is true of the frontal spines, with the single exception of *L. marshi.* We have tried to reproduce all the similarities and all the differences as faithfully as possible in the figures; many of these are so slight that no word picture would describe them adequately and the figure must therefore be used as the final criterion.

LECANE MARSHI Harring

Plate XXII, figures 1, 2.

Lecane marshi HARRING, Proc. U. S. Nat. Mus., vol. 47, 1914, p. 537, pl. 18, figs. 1–3.

Lecane ercodes HARRING, Proc. U. S. Nat. Mus., vol. 47, 1914, p. 537, pl. 18, figs. 4–6.

The outline of the lorica is broadly oval or very slightly pyriform. The anterior margins are coincident and somewhat concave; at the external angles are two fairly long, slender spines, usually with the point recurved as a conspicuous hook, semicircular in lateral view. The dorsal plate is oval and truncate posteriorly; it is very firm and marked with four transverse rows of prominent, coarse tesselations. The ventral plate is more elongate and somewhat narrower than the dorsal; the markings consist of a few longitudinal ridges, as shown in the figure. The lateral sulci are fairly deep. The posterior segment is rather large and somewhat angulate, ending in an obtusely pointed, triangular lobe. The coxal plates are moderately large and rounded posteriorly. The first foot joint is indistinct and projects slightly over the subcircular second joint. The toes are about one fourth of the total length, straight, slender, parallel-sided and end in acute conical points without claws.

Total length 173μ; length of dorsal plate 114μ, of ventral plate 138μ; width of dorsal plate 84μ, of ventral plate 76μ; width of anterior points 54μ; height of hook 9μ; length of toes 45μ.

Lecane marshi was originally described from material collected in the Panama Canal Zone, the "hookless" form as a distinct species. Subsequent study of the collections demonstrated that they occur together and it is probable that they are only varieties of a single species. We have also found the hookless form in collections made by Dr. N. Gist Gee at Soochow, China; they agree in every way with the Panama specimens.

LECANE ICHTHYORA (Anderson and Shephard)

Plate XXII, figures 3, 4.

Distyla ichthyoura ANDERSON and SHEPHARD, Proc. Royal Soc. Victoria, new ser., vol. 4, 1892, p. 78, pl. 12, fig. 5.

Cathypna appendiculata LEVANDER, Acta Soc. Fauna et Flora Fennica, vol. 12, No. 3, 1895, p. 50, pl. 3, fig. 30.—? DADAY, Zoologica, pt. 44, 1905, p. 110 pl. 6, fig. 17.

Lecane ichthyoura HARRING, Bull. 81 U. S. Nat. Mus., 1913, p. 61.—HAUER, Mitt. Geogr. Ges. u. Naturhist. Mus. Lübeck, ser. 2, No. 30, 1925, p. 166, fig. 7.

The outline of the lorica is oval and moderately broad. The anterior dorsal margin is slightly concave, the ventral somewhat more so; at the external angles are two stout, triangular spines. The dorsal plate is oval and truncate posteriorly; it is very firm and marked with four rows of prominent tesselations. The ventral plate is more elongate and narrower than the dorsal; it is marked with a few longitudinal ridges. The lateral sulci are very deep. The posterior segment is produced as a peculiar lobe, rounded behind and with two lateral, triangular points. The coxal plates are small and rounded posteriorly. The first foot joint is somewhat indistinct and overlaps the subsquare second joint with a small, rounded projection. The toes are long and slender, more than one fourth of the total length, parallel-sided and end in acute, conical points without claws.

Total length 140μ; length of dorsal plate 96μ, of ventral plate 120μ; width of dorsal plate 80μ, of ventral plate 72μ; width of anterior points 48μ; length of toes 40μ.

Lecane ichthyoura is rare; we have found it in Polk County, Florida, in small numbers. It is a question whether the form figured by Hauer should not be considered a variety of *L. ohioensis*.

LECANE STOKESII (Pell)

Plate XXIII, figures 1–3.

Cathypna stokesii PELL, The Microscope, vol. 10, 1890, p. 144, text fig.—MURRAY, Journ. Royal Micr. Soc., 1913, p. 553, pl. 23, fig. 12.
Distyla stokesii JENNINGS, Bull. Michigan Fish Comm., No. 3, 1894, p. 24; Bull. U. S. Fish Comm., vol. 29 (for 1899), 1900, p. 92, pl. 20, fig. 35.—HEMPEL, Bull. Illinois State Lab. Nat. Hist., vol. 5, 1898, p. 375.
Lecane stokesii HARRING, Bull. 81 U. S. Nat. Mus., 1913, p. 62.

The outline of the lorica is oval and somewhat narrower than usual. The anterior dorsal and ventral margins are very nearly coincident and slightly concave; at the external angles are two stout, triangular spines. The dorsal plate is ovate and truncate posteriorly; it is very firm and marked with four rows of prominent tesselations. The ventral plate is more elongate and narrower than the dorsal; its markings consist of a few longitudinal ridges, constant in position, but not very conspicuous. The lateral sulci are deep. The posterior segment is semicircular and ends in two long spines, separated by a wide interspace, rounded anteriorly; the coxal plates are small and obtusely pointed. The first foot joint is fairly narrow and not very strongly marked, the second truncate pyriform. The toes are long, straight, slender and acutely pointed without any claw; their length is about one fifth of the total length.

Total length 155μ; length of dorsal plate 98μ, of ventral plate 130μ; width of dorsal plate 83μ, of ventral plate 77μ; width of anterior points 50μ; length of toes 48μ.

Lecane stokesii occurs in weedy ponds and is widely distributed in the United States, but is seldom found in large numbers. The variety shown in figure 3 was figured by Murray as the "English form"; we have collected it among sphagnum at Hyattsville, near Washington, District of Columbia. It differs from the typical form mainly in the form of the posterior spines, which are stouter and much shorter; it is somewhat more robust and the lorica less oval. It is uncertain whether this should be considered a variety or an independent species; no transition forms between the two are known and the typical form does not appear to be variable. However, until more is known about the actual relationship between the members of this group within the genus, it is probably better to leave it provisionally as a "variety", even though this term as applied to rotifers is somewhat ambiguous.

LECANE OHIOENSIS (Herrick)

Plate XXIII, figures 4, 5.

Distyla ohioensis HERRICK, Bull. Denison Univ., vol. 1, 1885, p. 54, fig. 1 (on page preceding index).—HEMPEL, Bull. Illinois State Lab. Nat. Hist., vol. 5, 1898, p. 375.—JENNINGS, Bull. U. S. Fish Comm., vol 19 (for 1899), 1900, p. 91, 20, fig. 30.—IROSO, Mon. Zool. Ital., vol. 21, 1910, p. 302; Atti R. Ist. Incorr. Napoli, vol. 64 (for 1912), 1913, p. 467, figs. 9–12.—JAKUBSKI, Rozpr. Wiad. Muz. Dzieduszyckich, vol. 1, 1914, p. 32, pl. 1, fig. 8.

Cathypna ohioensis TURNER, Bull. Denison Univ., vol. 6, 1892, p. 61.—MURRAY, Journ. Royal Micr. Soc., 1913, p. 552, pl. 23, fig. 14.

Lecane ohioensis HARRING, Bull. 81 U. S. Nat. Mus., 1913, p. 62.—JAKUBSKI, Kosmos (Lwów), 1918–1919, p. 28.—FADEEV, Russk. Gidr. Zhurn., vol. 3, No. 3–5., 1924, p. 4.

The outline of the lorica is a moderately broad oval; the anterior margins are slightly concave and very nearly coincident, the ventral a trifle shorter. At the external angles are two fairly prominent, stout spines. The dorsal plate is broadly oval and truncate posteriorly; it is very firm and marked with four transverse rows of prominent, coarse tesselations. The ventral plate is somewhat ovate and narrower than the dorsal plate; the markings consist of a few folds or ridges, shown in the figure. The lateral sulci are deep. The posterior segment is approximately semicircular with a short, median, squarely truncate projection. The coxal plates are large and obtusely pointed posteriorly. The first foot joint is indistinct and overlaps the subsquare second joint as a lobate projection. The toes are long and slender, a little less than one fourth of the total length, parallel-sided and end in acute conical points without claws.

Total length 156μ; length of dorsal plate 97μ, of ventral plate

116μ; width of doral plate 78μ, of ventral plate 70μ; width of anterior points 48μ; length of toes 40μ.

Lecane ohioensis is common everywhere in weedy ponds and frequently occurs in large numbers.

LECANE ARCULA Harring

Plate XXIV, figures 1, 2.

Cathypna aculeata MURRAY, Journ. Royal Micr. Soc., 1913, p. 350, pl. 14, fig. 28; not *Distyla aculeata* JAKUBSKI.
Lecane arcula HARRING, Proc. U. S. Nat. Mus., vol. 47, 1914, p. 539, pl. 19, figs. 4–6.

The outline of the lorica is broadly ovate and it is but little longer than wide. The dorsal and ventral anterior margins are straight and parallel and nearly coincident; at the external angles are two moderately large spines, directed slightly upwards and outwards. The dorsal plate is ovate and rounded posteriorly. The dorsal markings are of the usual pattern and rather faint. The ventral plate is ovate and as wide as the dorsal; the surface markings are indicated in figure 2. The lateral sulci are moderately deep. The posterior segment is broad and rounded; it projects but slightly beyond the dorsal plate. The coxal plates are indistinct and rounded posteriorly. The first foot joint is large and elongate pyriform, the second joint also large and of irregular form. The toes are fairly long and slender, about one fourth of the total length, straight and parallel-sided; the claw is slender, acutely pointed and recurved.

Total length 96μ; length of dorsal plate 63μ, of ventral plate 68μ, width of dorsal plate 55μ, of ventral plate 55μ; width of anterior spines 47μ, length of toe without claw 18μ; claw 5μ.

Lecane arcula was first described from the Panama Canal Zone, and collected by Murray in South America and Australia. It is common in weedy ponds everywhere in the United States. *Distyla aculeata* Jakubski is, according to the description and figure, more elongate, strongly compressed dorso-ventrally and has much longer anterior spines.

LECANE FLEXILIS (Gosse)

Plate XXIV, figures 3, 4.

Distyla flexilis GOSSE, in Hudson and Gosse, Rotifera, 1886, vol. 2, p. 97, pl. 24, fig. 7.—GLASSCOTT, Proc. Royal Dublin Soc., new ser., vol. 8, 1893, p. 72.—WEBER, Rev. Suisse Zool., vol. 5, 1898, p. 599, pl. 22, fig. 8.—VORONKOV, Trudy Gidr. Stants. Glubokom Oz., vol. 2, 1907, p. 111.—VON HOFSTEN, Arkiv Zool., Stockholm, vol. 6, No. 1, 1909, p. 58, fig. 12.—LUCKS, Rotatorienfauna Westpreussens, 1912, p. 110.—SACHSE, Süsswasserfauna Deutschlands, pt. 14, 1912, p. 176, figs. 346, 347.—MONTET, Rev. Suisse Zool., vol. 23, 1915, p. 336.—JAKUBSKI, Rozpr. Wiad. Muz. Dzieduszyckich, vol. 1, 1914, p. 32.—OPARINA-KHARITONOVA, Izv. Biol. Nauchno-Issl. Inst. Permsk. Univ., vol. 3, 1925, p. 440.

Cathypna flexilis STENROOS, Acta Soc. Fauna et Flora Pennica, vol. 17, No. 1, 1898, p. 159, pl. 2, fig. 19.—MURRAY, Journ. Royal Micr. Soc., 1913, p. 351, pl. 14, fig. 27.—WEBER and MONTET, Cat. Invert. Suisse, pt. 11, 1918, p. 185.—VON HOFSTEN, Naturw. Unters. Sarekgeb., vol. 4, 1923, p. 861.

Cathypna brevis MURRAY, Journ. Royal Micr. Soc., 1913, p. 555, pl. 22, fig. 8.—OLOFSSON, Zool. Bidr. Uppsala, vol. 6, 1918, p. 592, fig. 52.

Lecane flexilis HARRING, Bull. 81 U. S. Nat. Mus., 1913, p. 61; Proc. U. S. Nat. Mus., vol. 47, 1914, p. 538, pl. 19, figs. 1–3; Rep. Canadian Arctic Exp. 1913–18, vol. 8, pt. E, 1921, p. 9.—JAKUBSKI, Kosmos (Lwów), 1918–1919, p. 28.

The outline of the lorica is subcircular and the body is strongly gibbous. The anterior dorsal and ventral margins are coincident and distinctly convex; at the external angles are two short, very stout, slightly incurved spines. The dorsal plate is subcircular and rounded posteriorly; the surface markings consist of the usual four transverse rows of facets, but the first row is somewhat irregular and the others have rather more than the usual number of facets. The lorica is quite firm and the facets prominent. The ventral plate is considerably narrower than the dorsal and its edges ill-defined; the markings are less distinct than on the dorsal plate. The lateral sulci are very indistinct. The posterior segment is small and rounded and projects but little beyond the dorsal plate; the coxal plates are semicircular. The foot does not project beyond the end of the lorica; the first joint is elongate oval, the second large and subrhomboid. The toes are fairly long and slender, about one fourth of the total length, straight and parallel-sided for the greater part of their length, thence tapering slightly to the small, acute, recurved claw, which has dorsally a small basal spicule.

Total length 96μ; length of dorsal plate 72μ, of ventral plate 76μ; width of dorsal plate 66μ, of ventral plate 50μ; width of anterior points 55μ; length of toes without claw 19μ; claw 4μ.

Lecane flexilis is common in weedy ponds everywhere in the United States; Mr. David Bryce and the late Mr. C. F. Rousselet have sent us specimens from England. Our identification of this species with Gosse's animal is based on the form of the animal when swimming; its length is then nearly twice as great, the body is slender and flattened dorso-ventrally and the dorsal markings much more prominent.

LECANE INTRASINUATA (Olofsson)

Plate XXIV, figures 5, 6.

Cathypna intrasinuata OLOFSSON, Zool. Bidr. Uppsala, vol. 5, 1917, p. 281, fig. 11.—IDELSON, Trudy Plovuch. Morsk. Nauchn. Inst., Moskva, pt. 12, 1925, p. 90.

Lecane ephestra HARRING, Rep. Canadian Arctic Exp. 1913–18, vol, 8, pt. E, 1921, p. 7, pl. 3, figs. 1, 2.—HAUER, Zool. Anz., vol. 61, 1924, p. 149.

The outline of the lorica is broadly oval, the greatest width about three fifths of the length. The anterior margins of the dorsal and ventral plates are coincident and very slightly convex; at the external angles are two small, robust spines. The dorsal plate is subcircular, rounded posteriorly and without surface markings. The ventral plate is considerably narrower than the dorsal, nearly parallel-sided and rounded posteriorly; the margins are ill-defined and no lateral sulci are present. The surface markings are not prominent, but quite constant. The posterior segment is rounded and projects but little beyond the dorsal plate. The coxal plates are small and obtusely triangular. The first foot joint is long, wide anteriorly and sharply constricted immediately in front of the second joint; this is large and pyriform, projecting about half its length beyond the posterior segment. The toes are long and slender, about one fourth of the total length, parallel-sided and very faintly incurved; the tip is excavate on the inner margin, forming a pseudo-claw.

Total length 150μ; length of dorsal plate 90μ, of ventral plate 95μ; width of dorsal plate 78μ, of ventral plate 62μ; width of anterior points 54μ; length of toes without claw 34μ, claw 6μ.

Lecane intrasinuata was described by Olofsson from a few specimens collected in a pond near Alexandrovsk, on the Murman Coast, Russian Lapland. We believe this to be identical with *L. ephestra,* although the illustration accompanying the original description is lacking in detail. *L. intrasinuata* is common in soft, acid water ponds in Oneida and Vilas Counties, Wisconsin, on Mount Desert Island, Maine, and around Atlantic City, New Jersey. It has recently been found by Hauer in the Schwarzwald, where it is not rare, and by Idelson on Novaja Zemlja.

LECANE CLIMACOIS Harring and Myers, new species

Plate XXV, figures 1, 2.

The outline of the lorica is broadly ovate; the width is about two thirds of the length. The anterior dorsal margin is straight and the ventral margin slightly concave; at the external angles are two small, acute spines. The dorsal plate is broadly ovate and slightly truncate posteriorly; the facetting is very regular and of the usual pattern, but very faint and distinctly visible only by turning the animal partly on its side. The ventral plate is somewhat elongate oval; the surface markings are fairly simple and not very distinct. The lateral sulci are deep. The posterior segment is fairly large and nearly semicircular. The coxal plates are small, broad at the base and acuminate posteriorly. The first foot joint is long, parallel-sided and pointed posteriorly; the second joint is robust and somewhat pyriform with two small, lateral knobs; it projects about two thirds of its length beyond the lorica. The toes are fairly long and robust, a little less than one fourth of the total length, parallel-sided and straight; the long, conical claw is sharply indented at its base.

Total length 95μ; length of dorsal plate 64μ, of ventral plate 70μ; width of dorsal plate 51μ, of ventral plate 45μ; width of anterior points 34μ; length of toes without claw 15μ; claw 7μ.

Lecane climacoïs occurs in wet sphagnum or sphagnum bogs; we have collected it at Glenburnie, near Baltimore, Maryland; in Polk County, Florida, and in "Annecta Pool", a very acid, roadside ditch not far from Atlantic City, New Jersey. Only at the last named location has it been found in large numbers.

LECANE VERECUNDA Harring and Myers, new species

Plate XXV, figures 3, 4.

The outline of the lorica is broadly ovate and somewhat pointed posteriorly. The anterior margin of the ventral plate is nearly straight; the dorsal margin is very slightly convex and projects a little beyond the ventral plate. At the external angles are two small, slightly incurved frontal spines. The dorsal plate is ovate, somewhat pointed posteriorly and squarely truncate at the extreme end. The dorsal facetting is not very prominent and follows the prevailing pattern. The ventral plate is nearly parallel-sided anteriorly and rounded posteriorly; the margins are wavy and ill-defined, as are the lateral sulci; the surface markings are very simple. The posterior segment is small and rounded and projects but very little beyond the dorsal plate. The coxal plates are small and very obtusely pointed posteriorly. The first foot joint is ovate and the second joint large and rhomboid in outline, projecting slightly beyond the posterior segment. The toes are fairly long and slender, about one fourth of the total length, straight and very slightly tapering; the claw is moderately long, very slender, acutely pointed and spine-like.

Total length 105μ; length of dorsal plate 72μ, of ventral plate 76μ; width of dorsal plate 60μ, of ventral plate 50μ; width of anterior points 45μ; length of toe without claw 22μ; claw 6μ.

Lecane verecunda was collected in small numbers in weedy ponds at the State Fish Hatchery, near Madison, Wisconsin, and in Witch Hole, Mount Desert Island, Maine. Its nearest relative is probably *L. arcula,* from which it differs in the more ovate outline of the dorsal plate, slightly truncate posteriorly, the smaller posterior segment and the relatively narrower ventral plate.

LECANE MYLACRIS Harring and Myers, new species

Plate XXV, figures 5, 6.

The lorica is very firm and very broadly ovate; its width is three fourths of the length. The anterior margins are nearly coincident, the ventral almost straight and the dorsal slightly convex; at the external angles are two minute frontal spines. The dorsal plate is very broadly ovate and projects beyond the ventral plate both laterally and posteriorly. The ventral plate is nearly parallel-sided for about two thirds of its length and rounded posteriorly; surface markings are found only on the ventral plate and are limited to a few fairly distinct folds. The lateral sulci are deep. The coxal plates are very small and pointed posteriorly. The first foot joint is oval, somewhat indistinct and lobate posteriorly; the second joint is very large, robust and subsquare, projecting about one third of its length beyond the lorica. The toes are moderately long and slender, about one fourth of the total length, straight on their inner edges and very faintly sigmoid externally, terminating in a small, pointed claw; they are inserted near mid-length of the second foot joint instead of on the posterior edge.

Total length 175μ; length of dorsal plate 145μ, of ventral plate 130μ; width of dorsal plate 108μ, of ventral plate 82μ; width of anterior spines 70μ; length of toes without claw 32μ; claw 7μ.

Lecane mylacris was collected in small numbers in Upper Mill Pond, Mount Desert Island, Maine, and is common in weedy areas of Lake Hartridge, Polk County, Florida.

LECANE GLYPTA Harring and Myers, new species

Plate XXVI, figures 1, 2.

The outline of the lorica is somewhat elongate ovate, nearly parallel-sided anteriorly and rounded posteriorly. The anterior margins are not coincident; the dorsal margin is convex and the ventral slightly concave. At the external angles are two very small frontal spines. The entire lorica is quite flexible. The dorsal plate is elongate ovate and slightly truncate posteriorly; the facetting is of an aberrant pattern, not found in any other species. The ventral plate is elongate ovate, rounded posteriorly and as wide as the dorsal plate; the surface markings are, as shown, unusually intricate. The lateral sulci are indistinct. The posterior segment is relatively small, nearly semicircular and projects slightly beyond the dorsal plate. The coxal plates are small and rounded posteriorly. The first foot joint is long and narrow, the second joint broadly pyriform and does not quite reach the posterior end of the lorica. The toes are fairly long and slender, about one fourth of the total length, nearly parallel-sided and with a very slight, sigmoid curvature; the claw is small, acute and slightly outcurved, with a distinct basal spicule.

Total length 110μ; length of dorsal plate 80μ, of ventral plate 86μ; width of lorica 50μ; width of anterior points 42μ; length of toes without claw 22μ; claw 5μ.

Lecane glypta was collected in weedy ponds on the Pine Valley golf course, near Clementon, New Jersey. This is on the border line between the acid and alkaline waters of the state.

LECANE TABIDA Harring and Myers, new species

Plate XXVI, figures 3, 4.

The lorica is broadly ovate and nearly parallel-sided anteriorly; its width is about two thirds of the length. The anterior margins of the dorsal and ventral plates are coincident, very slightly convex and on account of the flexibility of the entire lorica, somewhat wavy. The dorsal plate is broadly ovate and its edges ill-defined; it is rounded posteriorly. The facetting is rather faint and the number of facets considerably greater than in the usual pattern. The ventral plate is nearly parallel-sided for the greater part of its length and rounded posteriorly; its markings are faint and depart somewhat from the usual design. The lateral sulci are rather shallow and ill-defined. The posterior segment is large and nearly semicircular; the coxal plates are rather small and very obtusely pointed. The first foot joint is narrow and elongate, lobate posteriorly, the second joint subsquare, somewhat narrower anteriorly, and projecting nearly half its length beyond the lorica. The toes are rather short and robust, less than one fourth of the total length, straight on their inner edges, parallel-sided for nearly three fourths of their length and terminate in gradually acuminating points.

Total length 130μ; length of dorsal plate 94μ, of ventral plate 98μ; width of dorsal plate 65μ, of ventral plate 60μ; width of anterior points 55μ; length of toes 30μ.

Lecane tabida was collected in small numbers among Fontinalis in quiet pools along Trout Brook, on Mount Desert Island, Maine. It has not been found elsewhere.

LECANE INFULA Harring and Myers, new species

Plate XXVI, figures 5, 6.

The outline of the lorica is broadly oval; its width is about two thirds of the length. The anterior margins are nearly coincident and slightly concave; at the external angles are two very stout, slightly incurved spines. The dorsal plate is broadly oval and rounded posteriorly. The facetting is of a remarkably intricate and very irregular pattern; each facet is outlined by a double row of minute, raised dots or beads. On the posterior half of the dorsal plate there is near the margins a pair of incipient "dorsal sulci". The ventral plate is considerably narrower than the dorsal, nearly parallel-sided and its margins somewhat wavy; the surface markings are of a fairly simple pattern. The lateral sulci are moderately deep. The posterior segment is large and very obtusely pointed; it projects somewhat beyond the dorsal plate. The coxal plates are obtusely triangular and their points some distance from the posterior end of the lorica. The first foot joint is rather indistinct and pointed posteriorly, the second joint large and pyriform and does not quite reach the margin of the posterior segment. The toes are long and slender, nearly one third of the total length, straight and parallel-sided; the claw is short and very slightly incurved.

Total length 160μ; length of dorsal plate 105μ, of ventral plate 120μ; width of dorsal plate 80μ, of ventral plate 65μ; width of anterior spines 45μ, length of toes without claw 40μ; claw 6μ.

Lecane infula was collected in Lower Breakneck Pond, on Mount Desert Island, Maine, in small numbers; it is not known from any other localities.

LECANE SATYRUS Harring and Myers, new species

Plate XXVII, figures 3, 4.

The outline of the lorica is broadly ovate; its width is about three fourths of the length. The median portion of the anterior dorsal margin forms a sort of guard for the opening of the lorica; it occupies about half the width of the dorsal plate and is limited externally by two small, incurved spines; outside of these spines there is on each side a distinct, small sinus. As a result of the general deformation of the dorsal plate taking place when the head is retracted, this lobe bends down over the anterior edge of the ventral plate, thus affording additional protection for the delicate corona. At the external angles of the lorica are two very large, antler-like frontal spines; these are normally at right angles to the ventral plate and, when thus turned up, serve to protect the corona when the animal is swimming; in retraction they turn outwards so that they are substantially in the plane of the ventral plate. Although very irregular in outline and slightly variable in details of the denticulation, they may be described as rather slender, acutely pointed spines with a sigmoid curvature, directed forward and outwards; on the external edge there is near the base a single large tooth, and on the internal edge four or five teeth, varying slightly in size and location in different individuals, but limited to the basal half of the spine; the terminal portion is always slender, acutely pointed and slightly incurved. The anterior margin of the ventral plate is slightly convex. The dorsal plate is broadly ovate and slightly truncate posteriorly. The surface ornamentation of both dorsal and ventral plate is unique and very intricate and must be studied from the figures; it consists of a system of elevated ridges, rounded at the top and with very closely spaced, hemispherical beads on the sloping sides. Similar "secondary markings" are found in *L. signifera,* but the general pattern is quite different. The ventral plate is broadly ovate and somewhat angular posteriorly, slightly truncate at the extreme end. The posterior segment is fairly large and projects considerably beyond the dorsal plate. The coxal plates are small and narrowly oval. The first foot joint is narrow, elongate and pointed posteriorly, second joint large and pyriform, projecting about half its length beyond the lorica. The toes are long and slender, about one fourth of the total length, straight and parallel-sided, terminating in acutely pointed claws with a small basal spicule.

Total length 175μ; length of dorsal plate without anterior spines 95μ, of ventral plate 105μ; width of dorsal plate 78μ, of ventral plate 72μ; width of anterior margin at base of spines 65μ; width over spines 75μ; length of spines 25μ; length of toe without claw 34μ; claw 7μ.

Lecane satyrus is usually, if not exclusively, found in wet sphagnum. We have collected it at Glenburnie, near Baltimore, Maryland; on Mount Desert Island, Maine; in Polk County, Florida; around Atlantic City, New Jersey, and in Vilas County, Wisconsin, where it was abundant in a small pool near Bent's resort on Mamie Lake; it is usually found only in small numbers. It is perhaps the most remarkable species of the genus; the rotatable, protective anterior spines are found in *Lecane mucronata,* but in a much simpler form, and the surface markings are far more elaborate than in any other species.

LECANE HASTATA (Murray)

Plate XXVIII, figures 5, 6.

Cathypna hastata Murray, Journ. Royal Micr. Soc., 1913, p. 348, pl. 14, fig. 25.

The lorica is very broadly ovate and somewhat flexible. The anterior dorsal margin is very slightly convex and the ventral margin straight; at the external angles are two small anterior spines. The dorsal plate is broadly ovate and slightly truncate posteriorly; it is much smaller than the ventral plate. The ventral plate is very broadly ovate; its surface markings consist of a transverse fold and two faint, longitudinal ridges. Lateral sulci are not present; the section of the lorica connecting the dorsal and ventral plates is very slightly concave. The posterior segment is relatively small and rounded; the coxal plates are apparently absent. The first foot joint is large and indistinct, the second subsquare, projecting beyond the posterior end of the lorica. The toes are long and slender, more than one fourth of the total length, straight, parallel-sided with a bulbous enlargement near the posterior end, and terminating in a long, slender, acutely pointed claw.

Total length 150μ; length of dorsal plate 95μ, of ventral plate 110μ; width of dorsal plate 75μ, of ventral plate 90μ; width of anterior points 70μ; length of toe without claw 25μ; claw 15μ.

Lecane hastata was described by Murray from a brackish pond at Rio de Janeiro, Brazil. We have found this species in abundance in brackish ditches at Port Republic, New Jersey, in perfectly fresh water at Barrows, Virginia, near Washington, and in collections from Baton Rouge, Louisiana. In the Port Republic material the dorsal plate is smooth; the specimens from Barrows show a very faint tesselation towards the anterior edge of the dorsal plate. *L. hastata* is probably related to *L. crepida;* they agree in the peculiar structure of the lorica and the posterior segment and foot joints.

LECANE CREPIDA Harring

Plate XXVIII, figures 1, 2.

Distyla gissensis JENNINGS, Bull. U. S. Fish Comm., vol. 19 (for 1899), 1900, p. 91, pl. 20, figs. 33, 34; not *Distyla gissensis* ECKSTEIN.

Lecane crepida HARRING, Proc. U. S. Nat. Mus., vol. 47, 1914, p. 533, pl. 22, figs. 4–7.

The lorica is very flexible, parallel-sided for one half of its length and tapers rapidly to the foot; it is strongly gibbous posteriorly. The anterior dorsal margin is slightly convex and the ventral a trifle concave; at the external angles are two very stout, curved anterior spines. The dorsal plate is strongly convex and much smaller than the ventral; the edges are rather indistinct and the surface markings limited to three pairs of divergent, wavy ridges, beginning near the anterior margin.

The ventral plate is moderately convex and has two interrupted series of ridges extending the greater part of its length; there is a well marked transverse fold immediately in front of the foot. Lateral sulci are not present; the section of the lorica connecting the dorsal and ventral plates is very slightly concave. The posterior segment merges without definite anterior limit with the body; ventrally it has a large, circular opening for the foot. The coxal plates are very indistinct. The first foot joint is large and bulbous, the second joint is subsquare and projects with more than half its length beyond the lorica. The toes are very long and slender, more than one fourth of the total length, straight and slightly tapering, terminating in a long, slender, acutely pointed claw, sharply constricted at the base.

Total length 135μ; length of dorsal plate 75μ, of ventral plate 90μ; width of dorsal plate 45μ, of ventral plate 60μ; width of anterior spines 52μ; length of toe without claw 30μ; claw 9μ.

Lecane crepida was described from material collected in the Panama Canal Zone, where it is common; we have since found it at Oconomowoc, Wisconsin, and on Mount Desert Island, Maine. Jennings records it from South Bass Island, Lake Erie. We are unable to see any resemblance between this species and Eckstein's *Distyla gissensis;* this is said to have two anterior spines on one side and one on the other and, apart from this evident error, bears little resemblance to *L. crepida.* It was evidently one of the smaller Lecanes, but the original description is so lacking in detail, and so many species have later been listed under this name that it is now apparently hopeless to attempt to identify it.

LECANE SAGULA Harring and Myers, new species

Plate XXVIII, figures 3, 4.

The outline of the lorica is very broadly ovate; the width is nearly equal to the length. The anterior margins are coincident and form a somewhat wavy, straight line; frontal spines are not present. The entire lorica is semi-flexible and its margins somewhat indefinite; the dorso-ventral depth of the body is unusually great. The dorsal plate is very broadly ovate and rounded posteriorly; the facetting is rather faint and of an unusual pattern. The ventral plate is nearly parallel-sided anteriorly and very obtusely triangular posteriorly; it is a little narrower than the dorsal plate. The ventral surface markings are very intricate and must be studied from the figure. The lateral sulci are indistinct. The posterior segment is rather small and broadly rounded; its entire length projects beyond the dorsal plate. The coxal plates are large and rounded posteriorly. The first foot joint is short and pyriform with a bluntly pointed posterior lobe; the second joint is huge, nearly circular and projects about half its length beyond the lorica. The toes are rather short and straight, a little less than one fourth of the total length, parallel-sided for the greater part of their length and slightly reduced at the base of the small, acute claw.

Total length 95μ; length of dorsal plate 48μ, of ventral plate 60μ; width of dorsal plate 48μ, of ventral plate 45μ; width of anterior margin 38μ; length of toes without claw 19μ; claw 4μ.

Lecane sagula was collected in small numbers in a weedy pond at Minocqua, Wisconsin, and in Witch Hole, Mount Desert Island, Maine.

LECANE FORMOSA Harring and Myers, new species

Plate XXIX, figures 1, 2.

The lorica is very broadly ovate, almost parallel-sided anteriorly and rounded posteriorly; it is moderately flexible. The anterior margins of the dorsal and ventral plates are coincident and straight; no anterior spines are present. The dorsal plate is very broadly ovate and slightly truncate posteriorly; the anterior margin is considerably narrower than the ventral plate and surface markings are entirely absent. The ventral plate is nearly parallel-sided anteriorly, somewhat triangular posteriorly and broadly rounded at the extreme end; it is as wide as the dorsal plate and its surface markings are limited to a transverse fold in front of the foot and two longitudinal lines diverging towards the anterior margin. The lateral sulci are fairly deep. The posterior segment is broadly rounded and projects slightly beyond the dorsal plate; the coxal plates are very indistinct and pointed posteriorly. The first foot joint is widest anteriorly and lobate posteriorly; the second joint robust and broadly pyriform. The toes are long and slender; about one third of the total length, straight and slightly tapering; the claw is long, very slender and acutely pointed.

Total length 110μ; length of dorsal plate 74μ, of ventral plate 80μ width of lorica 68μ; width of anterior margin 60μ; length of toes without claw 25μ; claw 7μ.

Lecane formosa has been found only in Lac Vieux Desert, Vilas County, Wisconsin, in shallow, weedy indentations near the outlet.

LECANE AEGAENA Harring

Plate XXVII, figures 1, 2.

Lecane aeganea HARRING, Proc. U. S. Nat. Mus., vol. 47, 1914, p. 542, pl. 21, figs. 1–3. —FADEEV, Russk. Gidr. Zhur., vol. 3, No. 3–5, 1924, p. 5, fig. 1.

The outline of the lorica is broadly ovate and the dorso-ventral depth less than usual. The anterior dorsal margin is slightly convex and the ventral margin straight; they do not meet when the head is retracted, but leave the lorica partly open; no anterior spines are present. The dorsal plate is oval and rounded posteriorly; the facetting is fairly regular and not very conspicuous. The ventral plate is longer and wider than the dorsal; its markings are prominent, especially on the posterior half. The lateral sulci are not very deep and the entire lorica is quite flexible. The posterior segment is small and rounded; it projects somewhat beyond the dorsal plate. The coxal plates are very small and rounded posteriorly. The first foot joint is very long, but almost obliterated near the middle; the second joint is large and subrhomboid. The toes are long and slender, about one third of the total length, straight and very slightly conical, terminating in a long, slender, acute claw with a small basal spicule.

Total length 110μ; length of dorsal plate 70μ, of ventral plate 76μ; width of dorsal plate 56μ, of ventral plate 60μ; width of anterior margin 50μ; length of toes without claw 24μ; claw 10μ.

Lecane aeganea was described from material collected in the Panama Canal Zone; we have since found it around Atlantic City, New Jersey, but never in large numbers. Fadeev reports it from the gouvernments Kharkov and Tamboy, European Russia.

LECANE VENUSTA Harring and Myers, new species

Plate XXVII, figures 5, 6.

The outline of the lorica is very broadly ovate; its width is about seven eighths of the length. The anterior dorsal margin is very slightly convex and the ventral nearly straight; no anterior spines are present. The dorsal plate is broadly ovate and rounded posteriorly; the facetting follows in general the usual pattern and is not especially prominent. The ventral plate is almost parallel-sided anteriorly and broadly rounded posteriorly; the surface markings are fairly complex. The lateral sulci are not very deep. The posterior segment is broadly rounded and projects only slightly beyond the dorsal plate, but it is unusually distinct. The coxal plates are almost as large as the posterior segment and of the same general form. The first foot joint is pyriform and lobate posteriorly, the second joint large and subsquare. The toes are long and slender, nearly one-third of the total length, very slightly incurved, parallel-sided and terminating in moderately acute points, but not forming a claw.

Total length 130μ; length of dorsal plate 86μ, of ventral plate 84μ; width of dorsal plate 75μ, of ventral plate 70μ; width of anterior margin 62μ; length of toes 42μ.

Lecane venusta has been found only in small numbers in Ottman Lake, near Waupaca, Wisconsin.

LECANE CANDIDA Harring and Myers, new species

Plate XIV, figures 1, 2.

The outline of the lorica is broadly ovate; its width is about two thirds of the length. The anterior margins are coincident and very slightly convex; no anterior spines are present. The dorsal plate is broadly ovate and very obtusely pointed posteriorly; it is without markings of any kind. The ventral plate is nearly parallel-sided anteriorly and rounded posteriorly; its markings are confined to a few folds on the posterior half. The lateral sulci are fairly deep. The posterior segment is large and rounded; it projects somewhat beyond the dorsal plate. The first foot joint is somewhat indistinct and lobate posteriorly, the second joint nearly circular. The toes are long, about one third of the total length, straight and slender, terminating in an acutely pointed claw, very slightly outcurved at the tip, and with distinct basal spicule.

Total length 100μ; length of dorsal plate 65μ. of ventral plate 72μ; width of dorsal plate 56μ, of ventral plate 48μ; width of anterior margin 48μ; length of toes without claw 22μ, claw 7μ.

Lecane candida was collected in small numbers among sphagnum growing on the margins of Loon Lake, near Eagle River, Vilas County, Wisconsin. It has not been found elsewhere.

LECANE PUSILLA Harring

Plate XXX, figures 1, 2.

Lecane pusilla HARRING, Proc. U. S. Nat. Mus., vol. 47, 1914, p. 541, pl. 20, figs. 4–6.—FADEEV, Russk. Gidr. Zhurn., vol. 3, No. 3–5, 1924, p. 6.

The lorica is very broadly ovate and the dorso-ventral depth of the body is greater than usual. The anterior margins are straight and the dorsal plate projects somewhat beyond the ventral, so that the lorica is not closed when the head is completely retracted. No anterior spines are present. The dorsal plate is subcircular and slightly truncate posteriorly. The facetting is fairly distinct and does not differ widely from the usual pattern. The ventral plate is parallel-sided in its anterior half and very obtusely triangular posteriorly; the surface markings are conspicuous only on the median portion of the pattern. The lateral sulci are deep. The rounded posterior segment projects considerably beyond the dorsal plate; the coxal plates are rather small and rounded posteriorly. The first foot joint is indistinct, the second large and nearly circular. The toes are long and slender, more than one fourth of the entire length, straight and slightly tapering, terminating in a long, recurved, very slender and acute claw.

Total length 75μ; length of dorsal plate 54μ, of ventral plate 60μ; width of dorsal plate 52μ, of ventral plate 45μ; width of anterior margin 50μ; length of toes without claw 15μ; claw 5μ.

Lecane pusilla was described from material collected in the Panama Canal Zone, where it is locally common; Fadeev reports finding it at Kharkov, Russia.

LECANE ASTHENA Harring and Myers, new species

Plate XXX, figures 3, 4.

The outline of the lorica is very broadly ovate and the dorsoventral depth of the body is somewhat greater than usual. The anterior margins of the dorsal and ventral plates are coincident and slightly convex; no anterior spines are present. The dorsal plate is approximately circular and very slightly truncate posteriorly; the facetting follows in general the usual pattern. The ventral plate is very slightly narrower than the dorsal, almost parallel-sided anteriorly and semicircular posteriorly; the surface markings are somewhat more intricate than is usually the case. The lateral sulci are fairly deep. The posterior segment is short and very broadly rounded; it projects somewhat beyond the dorsal plate. The coxal plates are obtusely truncate at their posterior, free ends. The first foot joint is narrow and nearly parallel-sided, the second joint is nearly hemispherical, very short and very broad. The toes are long and slender, more than one fourth of the entire length, straight and slightly tapering, terminating in a long, slender, acute claw of such form that its external edge is a continuation of the external edge of the toe and a slight excavation formed on the inner edge.

Total length 80μ; length of dorsal plate 54μ, of ventral plate 60μ; width of dorsal plate 54μ, of ventral plate 50μ; width of anterior margin 48μ; length of toes without claw 17μ; claw 6μ.

Lecane asthena was collected in a shallow, dead bay of Lake Kawaguesauga at Minocqua, Wisconsin; only a few specimens were present, and it has not been found elsewhere.

LECANE SUBTILIS Harring and Myers, new species

Plate XXX, figures 5, 6.

The anterior portion of the lorica is roughly parallel-sided and the posterior portion sub-triangular and rounded at the apex. The anterior dorsal and ventral margins are coincident and very slightly convex; no anterior spines are present. The dorsal plate is parallel-sided anteriorly and obtusely rounded posteriorly; its surface markings are of a very intricate and unusual pattern. The ventral plate is as wide as the dorsal, parallel-sided anteriorly and obtusely triangular posteriorly; its surface markings are even more unusual than the dorsal and have no counterpart in the genus. The lateral sulci are evanescent and the entire lorica is quite flexible. The posterior segment is small and nearly semicircular. The coxal plates are rudimentary. The first foot joint is very indistinct and its outlines confluent with the central portion of the ventral markings; the second joint is subsquare and projects slightly beyond the lorica. The toes are very long and slender, about one third of the total length, straight, very slightly conical and terminate in a long, slender, acutely pointed claw, sharply constricted at the base.

Total length 110μ; length of dorsal plate 70μ, of ventral plate 75μ; width of lorica 60μ; width of anterior margin 56μ; length of toe without claw 24μ; claw 8μ.

Lecane subtilis was collected in a very shallow bay of Arbor Vitae Lake, near Minocqua, Wisconsin; it has not been found elsewhere.

LECANE ELEGANS Harring

Plate XV, figures 1, 2.

Lecane elegans HARRING, Proc. U. S. Nat. Mus., vol. 47, 1914, p. 544, pl. 23, figs. 1, 2.

The body is elongate, slender and parallel-sided. The dorsal plate is very flexible, the ventral much less so. The anterior margin of the ventral plate is nearly straight and of fairly constant form; the dorsal margin is irregularly puckered by the inversion of the head. The dorsal plate is strongly convex, nearly semicircular in cross section. The lateral sulci are barely indicated on the posterior third of the body, the ventral plate may be said to be joined directly to the dorsal; it has prominent longitudinal ridges. The posterior segment of the body is very large and unusually prominent; it may be considered as beginning near the middle of the ventral plate and its outline is ovate, broadest posteriorly. Coxal plates are not present. The first foot joint is extremely long, tapering posteriorly to half its anterior width; the second joint is large and subsquare and projects with its entire length beyond the lorica. The toes are very long and slender, about one third of the total length, and slightly recurved in the posterior third; the claw is nearly half as long as the toe, outcurved and slightly recurved, with a conspicuous, laterally directed basal spine.

Total length 170μ, length of lorica 108μ, width 45μ; toe without claw 36μ; claw 15μ.

Lecane elegans was described from material collected in the Panama Canal Zone; only a few specimens were collected and it has not been found elsewhere.

LECANE ELONGATA Harring and Myers, new species

Plate XXXI, figures 1, 2.

The outline of the lorica is elongate reversed-ovate; its width is only three fifths of the length. The anterior margin of the dorsal and ventral plates is slightly convex and the lorica is widely open in front when the head is fully retracted; no anterior spines are present. The dorsal plate is elongate oval and squarely truncate posteriorly; the pattern of the dorsal and ventral surface markings is unlike that of any other species of the genus and must be studied from the figures. The ventral plate is elongate reversed-ovate and as wide as the dorsal plate. The lateral sulci are fully developed only on the posterior half, disappearing gradually towards the anterior margin. The posterior segment is very large, obtusely pointed and projects far beyond the dorsal plate. The coxal plates are somewhat obscure and bluntly pointed posteriorly. The first foot joint is very long and has a circular enlargement near its anterior end; the second joint is subsquare and projects nearly its length beyond the lorica. The toes are very long and very slender, nearly one third of the total length, straight, slightly tapering and rounded at the ends; the claw is extremely long, slender and acutely pointed.

Total length 220μ; length of dorsal plate 120μ, of ventral plate 145μ; width of lorica 84μ; width of anterior margin 60μ; toes without claw 38μ; claw 20μ.

Lecane elongata was collected among the leaves of a species of sphagnum growing on the bottom in shallow bays of Doughty Mill pond, near Atlantic City, New Jersey. It has not been found elsewhere.

LECANE TENUISETA

Plate XXXI, figures 3, 4.

Lecane tenuiseta HARRING, Proc. U. S. Nat. Mus., vol. 47, 1914, p. 543, pl. 22, figs. 1–3.—FADEEV, Russk. Gidr. Zhurn., vol. 3, No. 3–5, 1924, p. 5; Raboti Sev.-Kavkazhsk. Gidrobiol. Stants., vol. 1, 1925, p. 23, pl. 5, fig. 2—HAUER, Zool. Anz., vol. 61, 1924, p. 149.

The lorica is membranous and very flexible; its outline is elongate oval and the body is fairly thick. The anterior dorsal and ventral margins are parallel and usually slightly convex in the median half of their width; they do not quite meet and the lorica is left partly open in retraction. The dorsal plate is oval, rounded posteriorly and without facetting; it is strongly gibbous and bends down considerably even in front. The ventral plate is as wide as the dorsal and more elongate oval; its markings consist of a few slightly elevated ridges, as shown in figure 4. The lateral sulci are very shallow. The posterior segment of the body is broad and rounded and projects considerably beyond the dorsal plate. The coxal plates are large and semicircular. The first foot joint is narrow and parallel-sided and overlaps the second joint as a rounded lobe with a small median projection; the second joint is short and broad, rounded anteriorly and constricted immediately in front of the toes; it does not project beyond the posterior segment. The toes are long and slender, about one third of the total length, slightly conical and terminate in an extremely long, spinelike claw, very slender and very acute, its inner edge a continuation of the toe and a distinct shoulder on the outer edge at the junction of toe and claw.

Total length 106μ; length of dorsal plate 64μ, of ventral plate 73μ; width of lorica 56μ; width of anterior margin 45μ; length of toe without claw 20μ; claw 13μ.

Lecane tenuiseta is common in wet sphagnum and in weedy, soft water ponds, apparently all over the United States. Fadeev reports it from Kharkov and Lake Madatapin in the Kaukasus, and Hauer from bogs in the Schwarzwald.

LECANE DORYSSA Harring

Plate XXXI, figures 5, 6.

Lecane doryssa HARRING, Proc. U. S. Nat. Mus., vol. 47, 1914, p. 542, pl. 21, figs. 4–6.

The lorica is very broadly pyriform and its consistency leathery, so that the boundaries of the plates are not very distinct, but the general outline is nevertheless quite constant. The dorso-ventral depth of the body is unusually great. The anterior margin of the dorsal plate is slightly convex and sinuate, as the ridges of the plate are continued up to the edge; the ventral margin is almost straight and frontal spines are not present. The dorsal plate is subcircular and slightly truncate posteriorly; the facetting is very prominent and deviates somewhat from the regular pattern, especially towards the margins. The ventral plate is slightly narrower than the dorsal, approximately parallel-sided anteriorly and narrows somewhat abruptly to the posterior segment; the surface markings are prominent and their pattern quite complex, as shown in figure 6. The lateral sulci are shallow and much wrinkled. The posterior segment is large and projects considerably beyond the dorsal plate; the coxal plates are large and rounded. The first foot joint is large and prominent, strongly constricted near the middle and overlaps the large, subsquare second joint as a broad, bluntly pointed lobe; the second joint projects beyond the lorica for more than half its length. The toes are very long and slender, about one third of the total length, straight and very slightly tapering for a little more than half their length; at this point they are abruptly reduced to a clawlike terminal spine, straight, very slender and very acutely pointed.

Total length 106μ; length of dorsal plate 58μ, of ventral plate 58μ; width of dorsal plate 60μ, of ventral plate 58μ; width of anterior margin 52μ; length of toe without terminal spine 17μ, of spine 13μ.

Lecane doryssa was described from material collected in the Panama Canal Zone; it also occurred in collections made by Mr. Juday in ditches along the Ferrocarril Central de Guatemala at Puerto Barrios, Guatemala. It was not numerous at either location. The nearest relative of this species is probably *L. hornemanni*, which rivals it in thickness of the body and also resembles it in general appearance. The lorica of *L. hornemanni* has surface markings of quite a different pattern; the toes are without any claw and the peculiar coxal plates, ending in points close to the foot, also distinguish it from *L. doryssa.*

LECANE INOPINATA Harring and Myers, new species

Plate XXXII, figures 5, 6.

The lorica is broadly ovate; its width is about two thirds of the length. The anterior dorsal and ventral margins are coincident and very slightly convex; no anterior spines are present. The dorsal plate is broadly oval and slightly truncate posteriorly; it is not facetted. The ventral plate is broadly ovate and very slightly narrower than the dorsal; its surface markings consist of two transverse and several longitudinal ridges. The lateral sulci are fairly deep. The posterior segment is small and rounded and projects somewhat beyond the dorsal plate. The coxal plates are small and rounded posteriorly. The first foot joint is fairly large and pyriform, lobate posteriorly, the second joint subsquare and robust. The toes are long and slender, about one fourth of the entire length, straight and parallel-sided, terminating in a fairly large, acute claw; they are fused for one third of their length and consequently immovable.

Total length 110μ; length of dorsal plate 75μ, of ventral plate 80μ; width of dorsal plate 62μ, of ventral plate 58μ; width of anterior margin 52μ; length of toes without claw 26μ; claw 5μ.

Lecane inopinata was found in small numbers in weedy ponds near Minocqua, Wisconsin. It may with seemingly equal justification be called a Lecane with fused toes or a Monostyla with a divided toe; as Monostylas are unquestionably Lecanes with fused toes, it seems advisable to give preference to *Lecane* where the fusion is incomplete.

LECANE NANA (Murray)

Plate XXXIV, figures 1, 2.

Cathypna nana, MURRAY, Journ. Royal Micr. Soc., 1913, p. 353, pl. 14, fig. 29.

Lecane nana HARRING, Proc. U. S. Nat. Mus., vol. 47, 1914, p. 536. —HAUER, Zool. Anz., vol. 61, 1924, p. 149; Mitt. Geogr. Ges u. Naturhist. Mus. Lübeck, ser. 2, No. 30, 1925, p. 168, fig. 8.

The outline of the lorica is roughly subcircular. The anterior margins of the dorsal and ventral plates are coincident and slightly convex; no anterior spines are present. The dorsal plate is subcircular and very slightly pointed posteriorly; it is without surface markings. The ventral plate is considerably narrower than the dorsal, nearly parallel-sided anteriorly and obtusely pointed posteriorly. The surface markings consist of a few broken lines, as shown in figure 2. The lateral sulci are deep. The posterior segment is small and obtusely pointed and projects somewhat beyond the dorsal plate. The coxal plates are small and rounded posteriorly. The first foot joint is obtusely conical and widest in front, the second joint irregularly subsquare and does not project beyond the posterior segment. The toes are long and fairly slender, about one fourth of the total length, acuminate and straight on their inner edges.

Total length 85μ, length of dorsal plate 56μ, of ventral plate 64μ; width of dorsal plate 54μ, of ventral plate 48μ; width of anterior margin 45μ; length of toes 21μ.

Lecane nana was described by Murray from Lake Titicaca, Bolivia. It occurs also in the Panama Canal Zone, and we have collected it in wet sphagnum from many localities in the United States: Central and Northern Wisconsin; Mount Desert Island, Maine; around Atlantic City, New Jersey; Maryland and the District of Columbia and in Polk County, Florida. It has a superficial resemblance to *L. tryphema,* but the outline of the lorica and the relative proportions of the dorsal and ventral plates are quite different.

LECANE TRYPHEMA Harring and Myers, new species

Plate XXXIV, figures 5, 6.

The outline of the lorica is very broadly oval. The anterior margin of the dorsal plate is approximately straight, but on account of the flexibility of the entire lorica it is somewhat wavy and irregular; the ventral margin is slightly concave and no anterior spines are present. The dorsal plate is subcircular and truncate posteriorly; it is without permanent markings. The ventral plate is very broadly ovate and rounded posteriorly; its markings are limited to a transverse fold in front of the foot. The lateral sulci are deep. The posterior segment is small, rounded and its anterior limits obscure; it projects considerably beyond the dorsal plate and slightly beyond the second foot joint. The coxal plates are small and rounded posteriorly. The first foot joint overlaps the second with nearly half its length and is lobate posteriorly; the second foot joint is very robust and roughly subsquare. The toes are slender and fairly long, about one fourth of the total length, straight on their inner edges and tapering at the extreme ends to conical points without claws.

Total length 104μ; length of dorsal plate 70μ, of ventral plate 78μ; width of dorsal plate 70μ, of ventral plate 66μ; width of anterior margin 53μ; length of toes 27μ.

Lecane tryphema was first collected in a cranberry bog at Mather, Wisconsin. It is fairly common in bog pools and ponds among algae and mosses around Atlantic City, New Jersey, and also on Mount Desert Island, Maine.

LECANE HORNEMANNI (Ehrenberg)

Plate XXXIV, figures 3, 4.

Euchlanis hornemanni EHRENBERG, Abh. Akad. Wiss. Berlin (for 1833) 1834, pp. 206, 220; Infusionsthierchen, 1838, p. 462, pl. 57, fig. 9.

Distyla hornemanni HUDSON and GOSSE, Rotifera, Suppl., 1889, p. 42, pl. 33, fig. 37.—BILFINGER, Jahresh. Naturk. Württemberg, vol. 50, 1894, p. 58.—SACHSE, Süsswasserfauna Deutschlands, pt. 14, 1912, p. 175, fig. 345.

Cathypna hornemanni MURRAY, Journ. Royal Micr. Soc., 1913, p. 349, pl. 14, fig. 26.

Lecane hornemanni HARRING, Proc. U. S. Nat. Mus., vol. 47, 1914, p. 543; Rep. Canadian Arctic Exp. 1913–18, vol. 8, pt. E, 1921, p. 8.

The lorica is very broadly ovate; its width is greater than the length and the dorso-ventral depth when fully contracted is unusually great. The anterior dorsal margins are coincident and decidedly convex; no anterior spines are present. The dorsal plate is very broadly oval and rounded posteriorly; its width is considerably greater than the length. The surface markings consist of hemispherical bosses, apparently corresponding in number and position to the usual facets, and separated by wide depressions of approximately semicircular cross section; there are no sharp lines of demarcation anywhere, the bosses merging gradually with the dividing grooves and it is extremely difficult to determine their respective locations with any accuracy and for this reason they have been omitted from the figure. The ventral plate is very broadly pyriform, considerably narrower than the dorsal plate, and its edges wavy and somewhat ill-defined; the surface markings consist of a few longtiudinal and transverse folds. The lateral sulci are deep. The posterior segment is short, broad and semicircular; it projects somewhat beyond the dorsal plate. The coxal plates are obtusely pointed. The first foot joint is fairly large and roughly parallel-sided; the second joint is very large, somewhat elongate, rounded anteriorly and projects considerably beyond the lorica. The toes are long and fairly stout, one fourth of the total length, very slightly tapering for about two thirds of their length, terminating in long, conical, acute points, very slightly outcurved and without any claw.

Total length 120μ, length of dorsal plate 72μ, of ventral plate

84μ; width of dorsal plate 87μ, of ventral plate 72μ; width of anterior margin 63μ; length of toes 30μ.

Lecane hornemanni is fairly common in weedy ponds; we have collected it at Washington, District of Columbia; around Atlantic City, New Jersey; in northern and central Wisconsin and on Mount Desert Island, Maine; it occurred also in collections made by Dr. H. S. Jennings at Ann Arbor, Michigan.

LECANE CLARA (Bryce)

Plate XVII, figures 3, 4.

? *Diaschiza cupha* GOSSE, Journ. Royal Micr. Soc., 1887, p. 3, pl. 1, fig. 6.—HUDSON and GOSSE, Rotifera, Suppl., 1889, p. 38, pl. 31. fig. 31.

Distyla clara BRYCE, Science Gossip, vol. 28, 1892, p. 271, text fig.

Cathypna clara MURRAY, Journ. Royal Micr. Soc., 1913, p. 556, pl. 22, fig. 6.

Cathypna sulcata MURRAY, Journ. Royal Micr. Soc., 1913, p. 557, pl. 22, fig. 5; not *Cathypna sulcata* GOSSE.

Lecane clara HARRING, Bull. 81 U. S. Nat. Mus., 1913, p. 60; Rep. Canadian Arctic Exp. 1913–18, vol. 8, pt. E, 1921, p. 9.

Diglena beauchampi VON HOFSTEN, Naturw. Unters. Sarekgeb., vol. 4, 1923, p. 851, fig. 5.

The lorica is membranous, very flexible and its outline variable in the living animal; it is difficult to obtain fully contracted specimens, even with strong preservatives, and they are in the nature of accidents. The following description is based on such contracted specimens, in order to make comparison possible with other species of the genus.

The outline of the contracted lorica is broadly oval and rounded posteriorly. The anterior margins are not coincident and complete closure of the lorica appears to be impossible; the dorsal margin is slightly convex and the ventral slightly concave. Anterior spines are not present. The dorsal plate is oval and rounded posteriorly; no permanent folds or other markings are present. The ventral plate is oval, rounded posteriorly and somewhat narrower than the dorsal plate. The lateral sulci are evanescent. The rounded posterior segment has no definite anterior limit; the coxal plates are fairly large and obtusely pointed posteriorly. The first foot joint is elongate pyriform and somewhat indistinct, the second joint very broadly pyriform. The toes are long and robust, about one third of the total length, broadly lancet-shaped and terminate in a bristle-like spicule.

Total length of contracted specimen 120μ; length of dorsal plate 80μ, of ventral plate 82μ, width of dorsal plate 62μ, of ventral plate 55μ; width of anterior margin 55μ; length of toes, 38μ.

Lecane clara was found by Bryce in sphagnum; we have found it in weedy ponds at Kenilworth and Hyattsville, near Washington, District of Columbia, and at Oceanville, near Atlantic City, New Jersey.

LECANE RHACOIS Harring and Myers, new species

Plate XVII, figures 1, 2.

The integument is so flexible that there is no justification for calling it a lorica. As in the case of *L. clara* fully contracted specimens are seldom obtained and even then they are virtually shapeless balls. The characteristic features are the posterior segment, foot and toes. The posterior segment is limited anteriorly by a distinct fold, representing the termination of the dorsal plate; it is rounded posteriorly and projects slightly beyond the dorsal plate. The coxal plates are small and very obtusely pointed posteriorly. The first foot joint is pyriform and somewhat indistinct, the second joint short, broad and squarish, projecting about half its length beyond the posterior segment. The toes are long, stout, straight and nearly parallel-sided; the edges are not true straight lines, but very slightly wavy and irregular, varying individually, the points are blunt and have a minute terminal spicule.

Total length, extended 140μ, contracted 100μ; length of toes 40μ.

Lecane rhacois is common in wet sphagnum growing in an old gravel pit at Hyattsville, near Washington, District of Columbia, and under similar conditions in Oneida and Vilas Counties, Wisconsin.

LECANE INERMIS (Bryce)

Plate XXXIII, figures 1, 2.

Distyla inermis BRYCE, Science Gossip, vol. 28, 1892, p. 274, text fig.—JAKUBSKI, Rozpr. Wiad. Muz. Dzieduszyckich, vol. 1, 1914, p. 32.—MONTET, Rev. Suisse Zool., vol. 23, 1915, p. 336.

Cathypna inermis MURRAY, Journ. Royal Micr. Soc., 1913, p. 556, pl. 22, fig. 7.—WEBER and MONTET, Cat. Invert. Suisse, pt. 11, 1918, p. 187.

Lecane inermis HARRING, Bull. 81 U. S. Nat. Mus., 1913, p. 61.—BRYCE, Journ. Quekett Micr. Club, ser. 2, vol. 15, 1924, p. 97.

Lecane amorpha HARRING, Proc. U. S. Nat. Mus., vol. 47, 1914, p. 544, pl. 23, figs. 1, 2.—HAUER, Zool. Anz., vol. 61, 1924, p. 148.

The lorica is membranous and very flexible and the outlines of the dorsal and ventral plates somewhat variable, but nevertheless fairly constant. The outline of the fully contracted lorica is broadly pyriform and rounded posteriorly. The anterior margins are coincident and usually straight, dependent somewhat on the degree of contraction; the lorica is widely open in front, even when fully contracted. The dorsal plate is approximately parallel-sided anteriorly and rounded posteriorly. The ventral plate is broadly ovate and considerably wider than the dorsal plate; both are without permanent surface markings. The lateral sulci are represented by the very flexible and slightly concave membrane connecting the dorsal and ventral plates. The posterior segment is small and rounded, projecting nearly its entire length beyond the dorsal plate. The coxal plates are small and obtusely pointed. The first foot joint is somewhat wedge-shaped and pointed posteriorly, the second joint large and subsquare, projecting slightly beyond the lorica. The toes are relatively short, straight and slightly tapering, rounded at the ends and terminate in a very slender, acutely pointed, slightly recurved claw, nearly as long as the toe itself.

Total length 115μ; length of dorsal plate 80μ, of ventral plate 86μ; width of dorsal plate 42μ, of ventral plate 48μ; width of anterior margin 40μ; length of toes without claw 16μ; claw 12μ.

Lecane inermis is common everywhere in wet sphagnum. It is the best known representative of a peculiar group within the genus of virtually illoricate species, composed of *L. inermis, L. clara, L. rhacois, L. agilis, L. palinacis* and *L. calcaria.* Their similarity may, however, be a result of simple convergence rather than an indication of any actual relationship.

LECANE PALINACIS Harring and Myers, new species

Plate XXXII, figures 3, 4.

The integument is very flexible and shows no trace of a true lorica. The animal contracts very readily and the body assumes an almost spherical form without indictions of either a dorsal or ventral plate. The posterior segment is, however, distinctly separated from the body, short and very broad; at its external angles are two prominent, curved, acute spines, probably representing rudimentary coxal plates. The first foot joint is elongate and somewhat pyriform, lobate posteriorly; the second joint is very large, broadly elliptic anteriorly and sharply indented immediately in front of the toes, projecting beyond the posterior segment nearly two thirds of its length. The toes are fairly long and stout, about one fourth of the total length, straight and very slightly tapering; they terminate in a small, acute, slightly outcurved claw.

Total length, extended 120μ, contracted 75μ; length of body, contracted 60μ; width 47μ; coxal spines 4μ; length of toes without claw 14μ; claw 4μ.

Lecane palinacis is fairly common in wet sphagnum in various localities around Washington, District of Columbia, and also in moss forwarded from Massachusetts by Mrs. A. C. Clarke, of the Quekett Microscopical Club.

LECANE CALCARIA Harring and Myers, new species

Plate XXXIII, figures 3, 4.

The integument is very flexible and shows but slight traces of a lorica, but the form is fairly constant; the outline is very broadly reversed-ovate. The anterior margin is approximately straight; no anterior spines are present and the lorica is widely open in front when fully contracted. The posterior segment is limited anteriorly by a distinct fold indicating the posterior end of a dorsal plate; the segment is nearly semicircular and projects far beyond the dorsal fold. No lateral sulci are present. The coxal plates are very firm, extremely large, curved and pointed posteriorly and project considerably beyond the posterior segment. The first foot joint is elongate, rather narrow and somewhat indistinct, the second joint very large and broadly ovate, projecting about one third of its length belond the body. The toes are fairly long and very stout, about one fourth of the total length, strongly outcurved, broad at the base and taper rapidly to very acute points.

Total length 65μ; length of body 50μ, width 41μ; width of anterior margin 42μ; toes 15μ.

Lecane calcaria was collected in large numbers in a swamp at Oceanville, near Atlantic City, New Jersey, some four years ago; it has not occurred elsewhere.

LECANE NIOTHIS Harring and Myers, new species

Plate XXXIII, figures 5, 6.

The outline of the lorica is broadly ovate and somewhat irregular. The integument is quite flexible and the anterior margins variable, but usually strongly convex and coincident. The dorsal plate is subcircular and rounded posteriorly; the facetting is rather faint, but the pattern is quite constant and somewhat unusual. The ventral plate is of the same width and length as the dorsal; its surface markings also differ slightly from the normal pattern. The lateral sulci are indistinct. The posterior segment is short, broad and rounded; it projects slightly beyond the dorsal plate. The coxal plates are very small, rounded and indistinct. The first foot joint is indistinct and ovate, the second large and broadly pyriform. The toes are fairly long and stout, slightly less than one third of the total length, parallel-sided at the base and taper gradually to acute points without any claw.

Total length 70μ; length of lorica 50μ, width 48μ; length of toes 20μ.

Lecane niothis was collected among the leaves of a species of sphagnum growing on the bottom of some shallow, artificial ponds at Manset, on Mount Desert Island, Maine; it has not been found elsewhere. It is one of the very small, soft-bodied Lecanes, but readily recognized by the well marked lorica.

LECANE AGILIS (Bryce)

Plate XXXII, figures 1, 2.

Distyla agilis BRYCE, Science Gossip, vol. 28, 1892, p. 273, text figures.

Lecane agilis HARRING, Bull. 81 U. S. Nat. Mus., 1913, p. 60.

The lorica is very soft and flexible and therefore somewhat indefinite in outline; the more usual form is a moderately elongate oval, squarly truncate anteriorly. The lateral edges of the dorsal plate are ill-defined and wavy, the anterior margin straight. The ventral plate is slightly wider than the dorsal and its straight anterior margin projects somewhat beyond the anterior margin of the dorsal plate. Both plates are marked with very faint, irregular ridges in a definite pattern. The posterior segment projects slightly beyond the dorsal plate; the indistinct coxal plates are rounded at the posterior angles. The first foot joint is very obscure, the second small and pyriform. The toes are very short and blade-shaped with acute, outcurved points; they appear to be fused anteriorly for nearly half of their length.

Total length 55μ; length of dorsal plate 38μ, of ventral plate 45μ; width of dorsal plate 25μ, of ventral plate 30μ; width of anterior dorsal margin 14μ, ventral margin 20μ; toes 12μ.

Lecane agilis seems to be found only in wet sphagnum; it appears to be rare, but this may be on account of its minute size and excessive transparency. It moves about among the debris with a peculiar jerky motion, but never swims.

Genus MONOSTYLA Ehrenberg

Euchlanid rotifers with illoricate, retractile head and loricate body, strongly compressed dorso-ventrally and oval or ovate in outline; dorsal and ventral plates connected by a flexible membrane, forming lateral and posterior sulci; foot with two extremely short, rudimentary joints, of which only the posterior is movable; toe single; corona of family type; mastax modified malleate, with a piston attached to its ventral wall; eyespot single and at the posterior end of ganglion; retrocerebral sac usually present, but no subcerebral glands.

Type of the genus.—Monostyla cornuta (Müller)=*Trichoda cornuta* Müller.

The following species have not been studied. We may say that the specimen from which Murray described his *Monostyla cochlearis* was sent to us by the late Mr. Rousselet; it was in such poor condition that we consider it a very doubtful species.

Monostyla amazonica MURRAY, Journ. Royal Micr. Soc., 1913, p. 354, pl. 15, fig. 34.

Monostyla asymmetrica MURRAY, Journ. Royal Micr. Soc., 1913, p. 361, pl. 15, fig. 44.

Monostyla cochlearis, MURRAY, Journ. Royal Micr. Soc., 1913, p. 361, pl. 15, fig. 45.

Monostyla cornuta anglica BRYCE, Journ. Quekett Micr. Club, ser. 2, vol. 15, 1924, p. 98.

Monostyla dentiserratus MOLA, Zool. Anz., vol. 42, 1913, p. 122, figs. 16, 17; Ann. Biol. Lac., vol. 6, 1913, p. 265.

Monostyla falcata MURRAY, Journ. Royal Micr. Soc., 1913, p. 558, pl. 22, fig. 9.

Monostyla lordii GOSSE, in Hudson and Gosse, Rotifera, 1886, vol. 2, p. 99, pl. 25, fig. 5.

Monostyla lunaris aperta STEINECKE, Schriften Phys.-ökon. Ges. Königsberg i. P., vol. 57, 1916, p. 96, figs. 2c, 2e; vol. 64, 1924, p. 41.
Monostyla macrognatha SCHMARDA, Neue wirbellose Thiere, 1859, vol. 1, p. 59, pl. 14, fig. 134.
Monostyla öophthalma SCHMARDA, Neue wirbellose Thiere, 1859, vol. 1, p. 59, pl. 14, fig. 126.
Monostyla ovalis JAKUBSKI, Rozpr. Wiad. Muz. Dzieduszyckich, vol. 1, 1914, p. 34, pl. 1, fig. 11.
Monostyla ovata FORBES, Bull. U. S. Fish Comm., vol. 11 (for 1891), 1893, p. 256.
Monostyla paradoxa STEINECKE.
Monostyla lunaris paradoxa STEINECKE, Schriften Phys.-ökon. Ges Königsberg i. P., vol. 57, 1916, p. 97, fig. 3.
Monostyla paradoxa STEINECKE, Schriften Phys.-ökon. Ges Königsberg i. P., vol. 64, 1924, p. 41.
Monostyla tentaculata COSMOVICI, Naturaliste (Paris), vol. 14, 1892, p. 70; Anal. Acad. Romana, ser. 2, vol. 28, 1906, p. 44, fig. 29; not a *Monostyla.*
Monostyla testudinea MOLA, Zool. Anz., vol. 42, 1913, p. 120, fig. 13; Ann. Biol. Lac., vol 6, 1913, p. 263.
Monostyla unguitata FADEEV, Trudy Kharkovsk. Obshch. Isp. Prir., vol. 50, pt. 1, 1925, p. 9, pl. 1, fig. 7.
Monostyla ungulata MOLA, Zool. Anz., vol. 42, 1913, p. 122, figs. 14, 15; Ann. Biol. Lac., vol. 6, 1913, p. 264.

MONOSTYLA LUNARIS (Ehrenberg)

Plate XXXV, figures 1–6.

Lepadella lunaris EHRENBERG, Abh. Akad. Wiss. Berlin (for 1831), 1832, p. 127.

Monostyla lunaris EHRENBERG, Infusionsthierchen, 1838, p. 460, pl. 57, fig. 6.—DUJARDIN, Hist. Nat. Zooph., Inf., 1841, p. 635.—DADAY, Termész. Füzetek, vol. 9, 1885, p. 127; vol. 19, 1892, p. 28; Math. Termész. Ertes., vol. 12, 1893, p. 19; Zoologica, pt. 44, 1905, p. 113; pt. 59, 1910, p. 85.—HUDSON and GOSSE, Rotifera, 1886, vol. 2, p. 98, pl. 25, fig. 2.—LEVANDER, Acta Soc. Fauna et Flora Fennica, vol. 12, No. 3, 1895, p. 50, pl. 3, fig. 32.—SKORIKOV, Trav. Soc. Nat. Kharkow, vol. 30, 1896, p. 321.—JENNINGS, Bull. Michigan Fish Comm., No. 3, 1896, p. 93; Bull. U. S. Fish Comm., vol. 19 (for 1899), 1900, p. 92, pl. 21, fig. 41.—HEMPEL, Bull. Illinois State Lab. Nat. Hist., vol. 5, 1898, p. 375—VOIGT, Forschungsber. Biol. Stat. Plön, vol. 11, 1904, p. 72.—VORONKOV, Trudy Gidr. Stants. Glubokom Oz., vol. 2, 1907, pp. 110, 205, 284.—KOFOID, Bull. Illinois State Lab. Nat. Hist., vol. 8, No. 1, 1908, p. 201.—MEISSNER, Izv. Turkestansk. Otd. Imp. Russk. Geogr. Obshch., vol. 4, pt. 8, 1908, p. 22.—SCHLENKER, Mitt. Gool. Abt. Württemberg. Stat. Landesamt, No. 5, 1908, p. 249.—RUNNSTROM, Zool. Anz., vol. 34, 1909, p. 271.—VON HOFSTEN, Arkiv Zool., Stockholm, vol. 6, No. 1, 1909, p. 59; Naturw. Unters. Sarekgeb., vol. 4, 1923, p. 861.—LIE-PETTERSEN, Bergens Mus. Aarbog (for 1909), 1910, No. 15, p. 66.—LUCKS, Rotatorienfauna Westpreussens, 1912, p. 112.—SACHSE, Süsswasserfauna Deutschlands, pt. 14, 1912, p. 179, fig. 355.—MOLA, Ann. Biol. Lac., vol. 6, 1913, p. 263.—MURRAY, Journ. Royal Micr. Soc., 1913, p. 353, pl. 15, fig. 31.—KOZAR, Zool. Anz., vol. 44, 1914, p. 420.—MONTET, Rev. Suisse Zool., vol. 23, 1915, p. 335.—JAKUBSKI, Rozpr. Wiad. Muz. Dzieduszyckich, vol. 1, 1914, p. 34, pl. 1, fig. 12; Kosmos (Lwów), 1918–1919, p. 28.—REZVOI, Trudy Borodinsk. Biol. Stants. Imp. Petrogradsk. Obshch. Estestvoisp., vol. 4, 1916, p. 181.—STEINECKE, Schriften Phys.-ökon. Ges. Königsberg i. P., vol. 57, 1916, p. 89, fig. 2; vol. 64, 1924, p. 41.—WEBER and MONTET, Cat. Invert. Suisse, pt. 11, 1918, p. 193.—OLOFSSON, Zool. Bidr. Uppsala, vol. 6, 1918, p. 594, fig. 54.—HARRING, Rep. Canadian Arctic Exp. 1913–18, vol. 8, pt. E, 1921, p. 10.—BRYCE, Journ. Quekett Micr. Club, ser. 2, vol. 14, 1922, p. 313.—IDELSON, Trudy Plovuch. Morsk. Nauchn. Inst., Moskva, pt. 12, 1925, p. 90.

Monostyla quennerstedti BERGENDAL, Acta Univ. Lundensis, vol. 28, 1892, sect. 2, No. 4, p. 118, pl. 6, fig. 39.

Monostyla constricta MURRAY, Journ. Royal Micr. Soc. 1913, p. 557, pl. 22, fig. 10.

Monostyla virga HARRING, Proc. U. S. Nat. Mus., vol. 47, 1914, p. 546, pl. 24, figs. 1–3.—FADEEV, Russk. Gidr. Zhurn., vol. 3, No. 3–5, 1924, p. 6, fig. 1.—OPARINA-KHARITONOVA, Izv, Biol. Nauchno-Issl. Inst. Permsk. Univ., vol. 3, 1925, p. 440.

The outline of the lorica is broadly ovate; its width is about two thirds of the length. The anterior margin of the dorsal plate is narrow and has a V-shaped sinus, broadly rounded at the posterior angle; the ventral margin is wide and the sinus deep, occasionally with minute, lateral cusps opposite the anterior points of the dorsal plate. The dorsal plate is very broadly ovate and rounded posteriorly. The ventral plate is somewhat narrower than the dorsal and broadly oval. The surface markings consist of a transverse dorsal fold at the base of the anterior sinus and a transverse ventral fold a short distance in front of the foot. The lateral sulci are fairly deep. The posterior segment is large and rounded; it projects considerably beyond the dorsal plate. The coxal plates are rather small and obtusely pointed posteriorly. The first foot joint is short, parallel-sided and somewhat indistinct, the second joint subsquare and robust. The toe is very long and slender, more than one third of the total length, straight and parallel-sided; it has two faint annular constructions, dividing it into three nearly equal sections. The claw is long, slender and acutely pointed; at the base are two minute spicules.

Total length 165μ; length of dorsal plate 100μ, of ventral plate 118μ; width of dorsal plate 86μ, of ventral plate 80μ; width of anterior dorsal margin 30μ, ventral margin 43μ; toe without claw 58μ; claw 8μ.

Monostyla lunaris is abundant in weedy ponds all over the world. The outline of the anterior margin varies considerably according to the degree of contraction; the form of figures 1 and 2 is what may be expected in collections preserved in alcoholic mixtures and should be considered fully contracted. Figures 3 and 4 represent the normal form, with a shallower anterior sinus and broader anterior margin. At English Creek and in a cranberry bog near Egg Harbor, New Jersey, occurs a peculiar variety, shown in figures 5 and 6; the lorica is much broader than in the normal form and the posterior segment is angular and squarely truncate; the claw has a distinct median line, but is not actually double.

Monostyla virga Harring, described from the Isthmus of Panama, appears to be a form of *M. lunaris,* the differences noted being probably due to the preservative used.

MONOSTYLA CRENATA Harring

Plate XXXVI, figures 5, 6.

Monostyla crenata HARRING, Proc U. S. Nat. Mus., vol. 46, 1913, p. 399, pl. 36, figs. 4–6.

The outline of the lorica is broadly ovate; its width is about two thirds of the length. The anterior dorsal margin is very slightly concave; the ventral plate has a deep anterior sinus, rounded at the bottom and with curved, convex sides. The dorsal plate is broadly ovate and slightly truncate posteriorly. The ventral plate is broadly oval and somewhat narrower than the dorsal plate. The surface markings are limited to a transverse ventral fold a short distance in front of the foot. The lateral sulci are deep. The posterior segment is small and rounded; it projects slightly beyond the dorsal plate. The coxal plates are rather small and obtusely pointed; they do not reach beyond the first foot joint. This is oval; the second joint is robust and somewhat elongate reniform. The toe is extremely long and slender, a little less than half the total length, straight and parallel-sided, terminating in a short claw with two minute basal spicules.

Total length 200μ; length of dorsal plate 108μ, of ventral plate

116μ; width of dorsal plate 92μ, of ventral plate 82μ; width of anterior dorsal margin 38μ, of ventral margin 42μ; toe without claw 84μ; claw 8μ.

Monostyla crenata is widely distributed in weedy ponds; we have collected it around Washington, District of Columbia; Polk County, Florida; at Atlantic City, New Jersey; in Oneida and Vilas Counties, Wisconsin, and on Mount Desert Island, Maine; it was common in collections made by Dr. Birge during the Great Lakes Biological Investigations in 1899, and by Dr. Birge and Mr. Juday in Texas, Arkansas, Mississippi and Louisiana in 1903. James Murray found it at Sydney, Australia, and in New Zealand.

MONOSTYLA ACUS Harring

Plate XXXVI, figures 3, 4.

Monostyla acus HARRING, Proc. U. S. Nat. Mus., vol. 46, 1913, p. 398, pl. 36, figs. 1–3.—HAUER, Zool. Anz., vol. 61, 1924, p. 147.

? *Monostyla lunaris obserata* STEINECKE, Schriften Phys.-ökon. Ges. Königsberg i. P., vol. 57, 1916, p. 97, fig. 2, e, f; vol. 64, 1924, p. 41.

The outline of the lorica is broadly ovate; its width is more than four fifths of the length. The anterior margins of the dorsal and ventral plates are identical in outline, with a shallow, broadly V-shaped sinus; the ventral margin projects very slightly beyond the dorsal. No anterior spines are present. The dorsal plate is broadly oval and truncate posteriorly. The ventral plate is somewhat narrower than the dorsal and oval in outline; there is a transverse ventral fold in front of the foot. The lateral sulci are deep. The posterior segment is truncate and very large, projecting its entire length beyond the dorsal plate. The coxal plates are small and rounded. The first foot joint is parallel-sided and rounded anteriorly; the second joint is large and slightly angular. The toe is extremely long and slender, nearly half the entire length, parallel-sided and straight, with three internal annular constructions, equally spaced from the foot; the claw is long and slender and has two minute, basal spicules

Total length 180μ; length of dorsal plate 85μ, of ventral plate 100μ; width of dorsal plate 82μ, of ventral plate 72μ; width of anterior dorsal margin 40μ, of ventral margin 44μ; length of toe without claw 70μ; claw 10μ.

Monostyla acus is common in wet sphagnum in the United States wherever we have made collections. Hauer reports it as common in the Schwarzwald.

MONOSTYLA BULLA Gosse

Plate XXXVII, figures 1, 2.

Monostyla bulla GOSSE, Ann. Mag. Nat. Hist., ser. 2, vol. 8, 1851, p. 200.—HUDSON and GOSSE, Rotifera, 1886, vol. 2, p. 99, pl. 25, fig. 4.—TERNETZ, Rotat. Umg. Basels, 1892, p. 17.—WIERZEJSKI, Rozpr. Akad. Umiej., Wydz. Mat.-Przyr., Krakow, ser. 2, vol. 6, 1893, p. 243.—SKORIKOV, Trav. Soc. Nat. Kharkow, vol. 30, 1896, p. 321.—HEMPEL, Bull. Illinois State Lab. Nat. Hist., vol. 5, 1898, p. 375.—STENROOS, Acta Soc. Fauna et Flora Fennica, vol. 17, No. 1, 1898, p. 163, pl. 3, fig. 9.—JENNINGS, Bull. U. S. Fish Comm., vol. 19 (for 1899), 1900, p. 93, pl. 21, figs. 37–39.—DADAY, Zoologica, pt. 44, 1905, p. 112; pt. 59, 1910, p. 84.—VORONKOV, Trudy Gidr. Stants. Glubokom Oz., vol. 2, 1907, pp. 110, 205, 284.—KOFOID, Bull. Illinois State Lab. Nat. Hist., vol. 8, No. 1, 1908, p. 201.—MEISSNER, Izv. Turkestansk. Otd. Imp. Russk. Geogr. Obshch. vol. 4, No. 8, 1908, p. 22.—SCHLENKER, Mitt. Geol. Abt. Württemberg. Stat. Landesamt, No. 5, 1908, p. 249.—DE BEAUCHAMP, Arch Zool. Expér., ser. 4, vol. 10, 1909, p. 161.—RUNNSTROM, Zool. Anz., vol. 34, 1909, p. 271.—VON HOFSTEN, Arkiv. Zool., Stockholm, vol. 6, No. 1, 1909, p. 61; Naturw. Unters. Sarekgeb., vol. 4, 1923, p. 861.—LIE-PETTERSEN, Bergens Mus. Aarbog (for 1909), 1910, No. 15, p. 67.—LUCKS, Rotatorienfauna Westpreussens, 1912, p. 112.—SACHSE, Süsswasserfauna Deutschlands, pt. 14, 1912, p. 179, fig. 356.—MURRAY, Journ. Royal Micr. Soc., 1913, p. 353, pl. 15, fig. 33.—MOLA, Ann. Biol. Lac., vol. 6, 1913, p. 262.—KOZAR, Zool. Anz., vol. 44, 1914, p. 420.—HARRING, Proc. U. S. Nat. Mus., vol. 47, 1914, p. 547; Rep. Canadian Arctic Exp. 1913–18, vol. 8, pt. E, 1921, p. 10.—JAKUBSKI, Rozpr. Wiad. Muz. Dzieduszyckich, vol. 1, 1914, p. 32; Kosmos (Lwów), 1918–1919, p. 28.—REZVOI, Trudy Borodinsk. Biol. Stants. Imp. Petrogradsk. Obshch. Estestvoisp., vol. 4, 1916, p. 181.—WEBER and MONTET, Cat. Invert. Suisse, pt. 11, 1918, p. 194.—BRYCE, Journ. Quekett Micr. Club, ser. 2, vol. 15, 1924, p. 98.

Monostyla lunaris PERTY, Zur Kenntn. kleinst. Lebensf., 1852, p. 41, pl. 1, fig. 4.—ECKSTEIN, Zeitschr. Wiss. Zool., vol. 39, 1883, p. 381, pl. 27, figs. 47–49.—BLOCHMANN, Mikr. Tierw. Süssw., 1886, p. 107, pl. 7, fig. 241.—WEBER, Rev. Suisse Zool., vol. 5, 1898, p. 608, pl. 22, figs. 12, 13. Not *Monostyla lunaris* EHRENBERG.

Monostyla bipes STOKES, Ann. Mag. Nat. Hist., ser. 6, vol. 18, 1896, p. 23, pl. 8, figs. 11–13.

Monostyla incisa DADAY, Math. Termész. Ertes., vol. 15, 1897, p. 137, fig. 5; Termész. Füzetek, vol. 24, 1901, p. 22, fig. 5.

The outline of the very firm lorica is somewhat elongate ovate; its width is about three fifths of the length. The anterior dorsal margin has a shallow, V-shaped anterior sinus with a large, median notch for the protrusion of the dorsal antenna. The ventral margin has a very deep anterior sinus, rounded at the posterior end and with a very slight cusp near the front. The dorsal plate is slightly elongate ovate and rounded posteriously; the ventral plate is virtually identical in outline and of the same width. Surface markings are limited to a transverse, ventral fold in front of the foot. The lateral sulci are deep. The posterior segment is small and rounded; it projects slightly beyond the dorsal plate. The coxal plates are very small and rounded posteriorly. The first foot joint is short, broad and somewhat indistinct, the second joint large and somewhat triangular, narrowed posteriorly. The toe is very long and slender, about one third of the total length, slightly enlarged in the middle, and ends in a long, slender, acute claw with distinct basal spicules. The claw has a distinct median line, but is not divided.

Total length 170μ; length of dorsal plate 112μ, of ventral plate 118μ; width of lorica 76μ; width of anterior margin 36μ; length of toe without claw 46μ; claw 12μ.

Monostyla bulla is abundant everywhere in weedy ponds all over the world. The form of the anterior margin is somewhat dependent on the degree of contraction of the lorica.

MONOSTYLA STYRAX Harring and Myers, new species

Plate XXXVII, figures 3, 4.

The lorica is very firm and its outline broadly ovate; its width is about three fourths of the length. The anterior margin is narrow and has a wide, median, elliptic notch for the protrusion of the dorsal antenna. The ventral margin has a deep, straight-sided anterior sinus, rounded postriorly. The dorsal plate is broadly ovate and rounded posteriorly; the ventral plate is nearly identical in outline and of the same width. No surface markings are present except a ventral, transverse fold in front of the foot. The lateral sulci are very deep. The posterior segment is very short and rounded; it projects very slightly beyond the dorsal plate. The coxal plates are very small and obtusely pointed posteriorly. The first foot joint is very short, broad and somewhat indistinct, the second joint large and slightly hexagonal. The toe is very long and slender, more than one third of the total length, and is narrowed at one third of its length; from this point it increases slightly in width and finally tapers to a blunt, obscurely wrinkled point. The claw is extremely long, slender and acutely pointed.

Total length 200μ; length of dorsal plate 124μ, of ventral plate 128μ; width of lorica 90μ; width of anterior margin 32μ; length of toe without claw 52μ; claw 24μ.

Monostyla styrax is not rare in soft water ponds; we have collected it in Oneida and Vilas counties, Wisconsin, on Mount Desert Island, Maine, and at Atlantic City, New Jersey. It is related to *M. bulla,* but differs considerably in the form of the anterior margin, the foot and the toe; the long, needle-like claw is without a parallel in the genus.

MONOSTYLA GONIATA Harring and Myers, new species.

Plate XXXVII, figures 5, 6.

The outline of the lorica is very broadly ovate and somewhat angular; its width is about four fifths of the length. The anterior dorsal margin has a very shallow, V-shaped sinus with a broad, nearly semicircular excision for the dorsal antenna; the ventral sinus is very deep, narrow and rounded posteriorly with a minute cusp near the front. The dorsal plate is very broadly ovate-angular and sharply pointed posteriorly. The ventral plate is of approximately the same width and outline as the dorsal plate, but distinctly narrowed in front of the foot. No surface markings are present. The lateral sulci are fairly deep, but not visible in either the dorsal or ventral view. The posterior segment is rather small, somewhat angular and slightly concave terminally. The coxal plates are small and obtusely rounded. The first foot joint is short, very broad and somewhat indistinct, the second joint large and roughly trapezoidal, projecting slightly beyond the lorica. The toe is very long, about one third of the total length, stout and spindle-shaped; it is distinctly enlarged near mid-length and terminates in a very acute, conical point resembling a claw and having a median line, which does not indicate a division, but possibly the opening of the mucus duct.

Total length 200μ; length of lorica 145μ; width of lorica 115μ; width of anterior margin 40μ; length of toe 65μ.

Monostyla goniata has been collected in large numbers in a shallow pond at Eagle River, Vilas County, Wisconsin, and in a cranberry bog at English Creek, near Atlantic City, New Jersey. It is closely related to *M. bulla,* but differs in so many details that it seems advisable to list it as a distinct species.

MONOSTYLA QUADRIDENTATA Ehrenberg

Plate XXXVIII, figures 3–5.

Monostyla quadridentata **EHRENBERG, Abh. Akad. Wiss. Berlin (for 1831), 1832, p. 130; Infusionsthierchen, 1838, p. 459, pl. 57, fig. 5.—DUJARDIN, Hist. Nat. Zooph., Inf., 1841, p. 635.—BARTSCH, Jahresh. Naturk. Württemberg, vol. 26, 1870, p. 358; Rotat. Hungariae, 1877, p. 47.—EYFERTH, Einf. Lebensformen, 1878, p. 88; ed. 2, 1885, p. 113.—HUDSON and GOSSE, Rotifera, 1886, vol. 2, p. 100, pl. 25, fig. 3.—ANDERSON, Journ. Asiatic Soc. Bengal, vol. 58, pt. 2, 1889, p. 355.—TERNETZ, Rotat. Umg. Basels, 1892, p. 18.—WIERZEJSKI, Rozpr. Akad. Umiej., Wydz. Mat.-Pryzyr., Krakow, ser. 2, vol. 6, 1893, p. 243.—GLASSCOTT, Proc. Royal Dublin Soc., new ser., vol. 8, 1893, p. 73.—KERTESZ, Budapest Rotat. Faun., 1894, p. 40.—SKORIKOV, Trav. Soc. Nat. Kharkow, vol. 30, 1896, p. 322.—HEMPEL, Bull. Illinois State Lab. Nat. Hist., vol. 5, 1898, p. 376.—JENNINGS, Bull. U. S. Fish Comm., vol. 19 (for 1899), 1900, p. 92, pl. 21, fig. 40.—DADAY, Zoologica, pt. 44, 1905, p. 113; pt. 59, 1910, p. 85.—VORONKOV, Trudy Gidr. Stants. Glubokom Oz., vol. 2, 1907, p. 110.—KOFOID, Bull. Illinois State Lab. Nat. Hist., vol. 8, No. 1, 1908, p. 201.—MEISSNER, Izv. Turkestansk. Otd. Imp. Russk. Geogr. Obshch., vol. 4, pt. 8, 1908, p. 21.—LUCKS, Rotatorienfauna Westpreussens, 1912, p. 111.—SACHSE, Süsswasserfauna Deutschlands, pt. 14, 1912, p. 181, fig. 358.—MOLA, Ann. Biol. Lac., vol. 6, 1913, p. 264.—MURRAY, Journ. Royal Micr. Soc., 1913, p. 354, pl. 15, fig. 34.—HARRING, Proc. U. S. Nat. Mus., vol. 47, 1914, p. 547.—JAKUBSKI, Rozpr. Wiad. Muz. Dzieduszyckich, vol. 1, 1914, p. 35; Kosmos (Lwów), 1918–1919, p. 28.—REZVOI, Trudy Borodinsk. Biol. Stants. Imp. Petrogradsk. Obshch. Estestvoisp., vol. 4, 1916, p. 181.—WEBER and MONTET, Cat. Invert. Suisse, pt. 11, 1918, p. 195.—BRYCE, Journ. Quekett Micr. Club, ser. 2, vol. 15, 1924, p. 99.**

Lepadella cornuta **SCHMARDA, Neue wirbellose Thiere, 1859, vol. 1, p. 58, pl. 14, fig. 122; not *Lepadella cornuta* (MULLER) of Bory de St. Vincent, 1826.**

Metopidia cornuta **HUDSON and GOSSE, Rotifera, Suppl., 1889, p. 47, pl. 34, fig. 3.**

Monostyla bicornis **DADAY, Math. Termész. Ertes., vol. 15, 1897, p. 139, text fig ; Termész. Füzetek, vol. 24, 1901, p. 23, fig. 6.**

The outline of the lorica is very broadly ovate; its width is about three fourths of the total length. The anterior margin is relatively narrow; the dorsal plate has a very deep and narrow, pyriform median sinus for the protrusion of the dorsal antenna; the sinus is flanked by two stout, outcurved and decurved spines. The ventral plate has a deep, sharply pointed V-shaped sinus, its sides very slightly convex near the front; two minute frontal spines are present. The dorsal plate is very broadly ovate, slightly truncate posteriorly; the anterior margin is but one-half of the greatest width. The ventral plate is of approximately the same outline as the dorsal and somewhat narrower. Surface markings are limited to two divergent dorsal folds or ribs, originating on the anterior spines, and a ventral transverse fold in front of the foot. The posterior segment is small and rounded; it is not covered by the dorsal plate. The lateral sulci are deep. The coxal plates are small and obtusely rounded posteriorly. The first foot joint is elongate oval and rather narrow, the second joint elongate, narrow and subcylindric. The toe is very long, about one third of the total length, slender, parallel-sided and has a faint annular constriction near the posterior end; the claw has two small basal spicules and is very long, slender and acutely pointed.

Total length 225μ; length of dorsal plate 130μ, of ventral plate 142μ; width of dorsal plate 96μ, of ventral plate 110μ; width of anterior dorsal margin 30μ, of ventral margin 50μ; length of toe without claw 52μ; claw 16μ.

Monostyla quadridentata is one of the commonest rotifers in weedy ponds in the United States and is apparently widely distributed on other continents; according to Bryce it is, strangely enough, rare in Great Britain.

The male is shown in figure 5; we believe this is the only male *Monostyla* known or identified. Unfortunately there is very little to add to the figure; the lorica is fairly rigid and so deeply colored with the characteristic yellowish-brown tint so conspicuous in the female that it is impossible to make out the internal anatomy. Its length is 100μ; toe 23μ.

MONOSTYLA LAMELLATA Daday

Plate XXXIX, figures 5, 6.

Monostyla lamellata DADAY, Math. Termész. Ertes., vol. 12, 1893, p. 40, pl. 2, figs. 1, 2; Math. Naturw. Ber. Ungarn, vol. 11, 1894, p. 319, pl. 24, figs. 1, 2.—ROUSSELET, Zool. Anz., vol. 21, 1898, p. 595.—ZERNOV, Izv. Turkestansk. Otd. Imp. Russk. Geogr. Obshch., vol. 4, pt. 3, 1903, p. 9, pl. 1, fig. 34.—MURRAY, Journ. Royal Micr. Soc., 1913, p. 458, pl. 19, fig. 1.—BRYCE, Journ. Quekett Micr.

Club, ser. 2, vol. 15, 1924, p. 98.—FADEEV, Raboti Sev.-Kavkazhsk. Gidrobiol. Stants., vol. 1, pt. 1, 1925, p. 23, pl. 5, fig. 3.
Monostyla appendiculata SKORIKOV, Zool. Anz., vol. 21, 1898, p. 556, text fig.

The outline of the lorica is broadly ovate; its width is about three fourths of the length. The anterior dorsal margin has a moderately deep sinus with sinuate sides and rounded posteriorly; the ventral sinus is lunate and slightly deeper than the dorsal sinus. At the external angles are two very large, acutely triangular spines or cusps. The dorsal plate is broadly ovate and rounded posteriorly. The ventral plate is very slightly narrower than the dorsal and the outline nearly identical; it is marked with a distinct transverse ventral fold in front of the foot. The lateral sulci are fairly deep and terminate at a considerable distance from the anterior spines, nearly at the level of the anterior sinus. The posterior segment is short, rounded posteriorly and produced laterally as two acute, triangular cusps; it projects in its entire length beyond the dorsal plate. The coxal plates are large and obtusely pointed posteriorly. The first foot joint is small and parallel-sided, the second joint small and rounded. The toe is long and stout, more than one fourth of the entire length, slightly enlarged beyond mid-length; it terminates in a large, acute claw with basal spicules and a median mucus groove.

Total length 260μ; length of dorsal plate 168μ, of ventral plate 190μ; width of dorsal plate 128μ, of ventral plate 120μ; width of anterior spines 72μ; width of posterior segment 70μ; length of toe without claw 58μ; claw 17μ.

Monostyla lamellata was described by Daday from a slightly alkaline lake in the Hungarian Alföld at Halas, in the county Pest-Pilis-Solt-Kiskun between the Danube and the Theiss, Skorikov found it in "salt" lakes near Kharkov, Russia. Bryce records this species from Devils Lake, North Dakota, and we have found it in collections made by Mr. Juday in alkaline waters at San Cristóbal, near Mexico City. As far as now known, it is confined to alkaline waters and has never been found in strictly fresh water.

MONOSTYLA THALERA Harring and Myers, new species

Plate XXXIX, figures 3, 4.

The outline of the lorica is broadly oval; its width is about three fourths of the length. The anterior dorsal margin is concave and sinuate; the ventral margin has a moderately deep, V-shaped sinus, slightly rounded at the apex. At the external angles are two small anterior spines. The dorsal plate is subrhomboid and rounded posteriorly; the ventral plate is of approximately the same outline and a little narrower than the dorsal plate; it is marked with a transverse fold in front of the foot. The lateral sulci are fairly deep and do not quite reach the anterior margin. The posterior segment is large and somewhat angular, truncate posteriorly, and projects considerably beyond the dorsal plate. The coxal plates are large and obtusely pointed posteriorly. The first foot joint is elongate ovate, the second joint very large and somewhat prismatic. The toe is long and stout, a little less than one third of the total length, spindle-shaped and enlarged near the middle; the claw is long, stout and acutely pointed and has small, basal spicules and a median mucus groove.

Total length 240μ; length of dorsal plate 150μ, of ventral plate 160μ; width of dorsal plate 128μ, of ventral plate 115μ; width of anterior dorsal margin 60μ, of ventral margin 75μ; length of toe without claw 58μ; claw 18μ.

Monostyla thalera was first found in material collected by Mr. Juday in alkaline ditches draining into the large, very shallow Lago de San Cristóbal, near Mexico City. It was abundant in collections made by Dr. W. E. Allen in sloughs of the San Joaquin River, at Stockton, California; here the water is probably slightly brackish, rather than alkaline, as there is a tide of 3 feet and the gradient of the river is very slight between Stockton and the Bay of San Francisco. This is probably the species listed by Bryce as *Monostyla lamellata var.* from Devils Lake, South Dakota. Although there is, perhaps, a certain superficial similiarity between these two forms, they differ so much in detail that there can be no doubt of their being specifically distinct, even though they are the two largest species of the genus and sometimes occur together.

MONOSTYLA STENROOSI Meissner

Plate XXXIX, figures 1, 2.

Monostyla bicornis Stenroos, Acta Soc. Fauna et Flora Fennica, vol. 17, No. 1, 1898, p. 164, pl. 2, fig. 26; not *Monostyla bicornis* Daday, 1897.—? Voronkov, Trudy Gidr. Stants. Glubokom Oz., vol. 2, 1907, p. 285, pl. 6, figs. 6–8.—Murray, Journn. Royal Micr.

Soc., 1913, p. 355, pl. 15, fig. 35.—SACHSE, Arch. Hydr., vol. 10, 1914, p. 71, fig. 11.

Monostyla stenroosi MEISSNER, Izv. Turkestansk. Otd. Imp. Russk. Geogr. Obshch., vol. 4, pt. 8, 1908, p. 22, pl. 1, fig. 8.—MYERS, Proc. U. S. Nat. Mus., vol. 52, 1917, p. 476.

The outline of the lorica is very broadly oval; its width is about five sixths of the length. The anterior dorsal margin is straight and narrow, the lateral sulci reducing its width somewhat. The ventral margin has a shallow, rounded sinus with strongly convex sides and externally two short, stout, incurved, hooklike frontal spines. The dorsal plate is oval and narrowed anteriorly. The ventral plate is very broadly oval and in its posterior half projects beyond the dorsal plate, both laterally and posteriorly. The surface markings consist of a transverse ventral fold in front of the foot and two pairs of short ridges directed outwards and backwards. The lateral sulci are deep, especially so in the anterior half, where they produce the peculiar indentation shown on the ventral plate and terminating rather abruptly, to reappear on the dorsal side; this accounts for the distinct angle at the edges of both plates. The posterior segment is very broad and rounded, its limits ill-defined. The coxal plates are large and semielliptic. The first foot joint is oval and somewhat indistinct, the second joint robust and rhomboid. The toe is long and stout, about one third of the total length, slightly tapering and very slightly enlarged near the middle; the claw is short, stout, acutely pointed and has two distinct basal spicules.

Total length 175μ; length of dorsal plate 105μ, of ventral plate 118μ; width of lorica 96μ; width of anterior dorsal margin, less exposed part of lateral sulci, 44μ, of ventral margin over spines 38μ; length of toe without claw 40μ; claw 11μ.

Monostyla stenroosi is not common; Stenroos found it in Finland, Voronkov in collections made on the Shat-el-Arab, Murray at Rio de Janeiro, Sachse at Trachenberg in Schlesien and Meissner on the shores of the Amu-Darja. We have collected it at Los Angeles, California, in small numbers; it was fairly common in material forwarded by Dr. N. Gist Gee from Soochow, in Kiang-su, China.

MONOSTYLA CORNUTA (Müller).

Plate XL, figures 5, 6.

Trichoda cornuta MULLER, Animalcula Infusoria, 1786, p. 208, pl. 30, figs. 1–3.

Lepadella cornuta BORY DE ST. VINCENT, Dict. Class. Hist. Nat., vol. 9, 1826, p. 285.—EHRENBERG, Isis (Oken), vol. 26, 1833, col. 246.

Lepadella glumiformis BORY DE ST. VINCENT, Encycl. Méth., Zooph. (pt. 2), 1827, p. 484 = *Trichoda cornuta* renamed.

Notommata cornuta EHRENBERG, Isis (Oken), vol. 23, 1830, col. 767.

Monostyla cornuta EHRENBERG, Abh. Akad. Wiss. Berlin, 1830, p. 46; ibid., 1831, p. 130; Infusionsthierchen, 1838, p. 459, pl. 57, fig. 4.—PERTY, Zur Kenntn. kleinst. Lebensf., 1852, p. 41.—BARTSCH, Jahresh. Naturk. Würtemberg, vol. 26, 1870, p. 358.—EYFERTH, Mikr. Süsswasserbew., 1877, p. 54; Einf. Lebensformen, 1878, p. 88, pl. 5, fig. 29; ibid., 1885, p. 113, pl. 7, fig. 29.—ECKSTEIN, Zeitschr. Wiss. Zool., vol. 39, 1883, p. 382, pl. 27, fig. 50.—BLOCHMANN, Mikr. Thierw. Süssw., 1886, p. 107.—HUDSON and GOSSE, Rotifera, 1886, vol. 2, p. 98, pl. 25, fig. 1.—BERGENDAL, Acta Univ. Lundensis, vol. 28, 1892, sect. 2, No. 4, p. 119.—TERNETZ, Rotat. Umg. Bassels, 1892, p. 17.—LEVANDER, Acta Soc. Fauna et Flora Fennica, vol. 12, No. 3, 1895, p. 51, pl. 3, fig. 32a.—HEMPEL, Bull. Illinois State Lab. Nat. Hist., vol. 5, 1898, p. 375.—JENNINGS, Bull. U. S. Fish Comm., vol. 19 (for 1899), 1900, p. 92, pl. 20, figs. 35, 36.—VORONKOV, Trudy Gidr. Stants. Glubokom Oz., vol. 2, 1907, pp. 110, 284.—SCHLENKER, Mitt. Geol. Abt. Württemberg. Stat. Landesamt, No. 5, 1908, p. 249.—VON HOFSTEN, Arkiv Zool., Stockholm, vol. 6, No. 1, 1909, p. 60.—RUNNSTRÖM, Zool. Anz., vol. 34, 1909, p. 271.—SACHSE, Süsswasserfauna Deutschlands, pt. 14, 1912, p. 178, figs. 352–354.—MOLA, Ann. Biol. Lac., vol. 6, 1913, p. 265.—KOZAR, Zool. Anz., vol. 44, 1914, p. 420.—JAKUBSKI, Rozpr. Wiad. Muz. Dzieduszyckich, vol. 1, 1914, p. 33; Kosmos (Lwów), 1918–1919, p. 28.—MONTET, Rev. Suisse Zool., vol. 23, 1915, p. 336.—REZVOI, Trudy Borodinsk, Biol. Stants. Imp. Petrogradsk. Obshch. Estestvoisp., vol. 4, 1916, p. 181.—WEBER and MONTET, Cat. Invert. Suisse, pt. 11, 1918, p. 191.—OLOFSSON, Zool. Bidr. Uppsala, vol. 6, 1918, p. 594, fig. 55.—HARRING, Rep. Canadian Arctic Exp. 1913–18, vol. 8, pt. E, 1921, p. 10.—BRYCE, Journ. Quekett Micr. Club, ser. 2, vol. 14, 1922, pp. 313, 314.

Trichocerca cornuta GRAVENHORST, Nova Acta Acad. Caes. Leop.-Carol. Nat. Cur., Bonn, vol. 16, 1832, p. 870.

Dicerratella cornuta DESHAYES and MILNE EDWARDS, in Lamarck, Hist. Nat. Anim. sans Vert., ed. 2, vol. 1, 1835, p. 431; not *Diceratella triangularis* BORY DE ST. VINCENT 1826 (= *Leucophra cornuta* MÜLLER renamed).

Monostyla truncata TURNER, Bull. Denison Univ., vol. 6, 1892, p. 62, pl. 1, fig. 11.

Monostyla robusta STOKES, Ann. Mag. Nat. Hist., ser. 6, vol. 18, 1896, p. 22, pl. 7, figs. 6–8.—MURRAY, Journ. Royal Micr. Soc., 1913, p. 557 pl. 23, fig. 21.

Monostyla rotundata JAKUBSKI, Rozpr. Wiad. Muz. Dzieduszyckich, vol. 1, 1914, p. 34, pl. 1, fig. 6.

The lorica is almost circular or very slightly elliptic. The dorsal and ventral plates have a fairly deep, lunate anterior sinus. The dorsal plate is circular in outline and without any surface markings; the angles of the anterior sinus are somewhat obtuse and without spines; a curved fold, starting at the bottom of the dorsal sinus and joining the external edges some distance from the anterior points, is formed when the head is completely retracted. The ventral plate is as wide as the dorsal plate and nearly identical in outline, very slightly narrower in the posterior half. The lateral sulci are very deep. The posterior segment of the body is short, very broad and somewhat indistinct, projecting very little beyond the dorsal plate; the coxal plates are broad, bluntly pointed and not very prominent. The first foot joint is moderately large and rather obscure, the second reniform and well marked; in front of the foot is a well marked transverse fold, indicating the limits of the body proper and the foot. The toe is parallel-sided, about one fourth of the total length, and ends in a large claw with a median groove and two distinct basal spicules; in some specimens the claw appears to be double.

Total length 190μ; length of dorsal plate 134μ, of ventral plate 138μ; width of lorica 132μ; width of anterior sinus 65μ, depth 13μ; length of toe without claw 45μ; claw 12μ.

Monostyla cornuta is abundant in weedy ponds everywhere in the United States; there is very little reliable information on its occurrence elsewhere, as existing descriptions are unsatisfactory and somewhat contradictory. We have followed Jennings in accepting this form as the animal identified by Ehrenberg with Müller's description; it also agrees fairly well with the description and figures of Hudson and Gosse.

A diminutive form of this species is found in collections from the Isthmus of Panama, which measures: total length 120μ; length of lorica 85μ; length of toe without claw 23μ, claw 9μ. With the exception of its small size and the relatively much longer claw it agrees in other respects with the normal form, which is abundant on the Isthmus.

MONOSTYLA SYLVATICA Harring

Plate XL, figures 3, 4.

Monostyla sylvatica **HARRING, Proc. U. S. Nat. Mus., vol. 46, 1913, p. 399, pl. 35, figs. 1–3.**

The lorica is subcircular in outline; its width is equal to the length. The anterior margin of the dorsal plate is very narrow and concave; the ventral margin is much wider and has a shallow, V-shaped sinus with flaring sides; no anterior spines are present. The dorsal plate is subcircular and truncate posteriorly. The ventral plate is broadly oval and only four fifths of the width of the dorsal plate. A well marked transverse fold on the ventral plate, a short distance in front of the foot, is the only surface marking present. There are no lateral sulci in the contracted animals; the dorsal and ventral plates are joined by a virtually flat, unbroken membrane. The posterior segment is small and rounded; it projects but little beyond the posterior plate. The coxal plates are rather small and obtusely pointed. The first foot joint is somewhat indistinct, the second short, broad and reniform. The toe is very long and slender, about one third of the total length, parallel-sided and slightly decurved. The claw is short and acute; it has a distinct median line, but does not appear to be actually divided.

Total length 150μ; length of dorsal plate 96μ, of ventral plate 100μ; width of dorsal plate 100μ, of ventral plate 82μ; width of anterior dorsal margin 32μ, ventral margin 53μ; length of toe without claw 44μ; claw 8μ.

Monostyla sylvatica was quite common among mosses and hepatics growing on rocks in the bed of a gently flowing stream in the woods north of the Bureau of Standards, in Washington, District of Columbia; the little stream is now polluted and uninhabitable for rotifers. No other localities are known for this species.

MONOSTYLA COPEIS Harring and Myers, new species.

Plate XLI, figures 1, 2.

The outline of the lorica is very broadly ovate; its width is more than four fifths of the length. The anterior margins are coincident and very slightly concave. The dorsal plate is subcircular and rounded posteriorly. The ventral plate is nearly parallel-sided anteriorly and rounded posteriorly; it is considerably narrower than the dorsal plate and its margins ill-defined and wavy. Surface markings consist of a transverse ventral fold in front of the foot and some short, curved folds on each side of the foot. The lateral sulci are indistinct and shallow. The posterior segment is fairly large and rounded; it projects slightly beyond the dorsal plate. The coxal plates are small and rounded posteriorly. The first foot joint is parallel-sided and squarely truncate posteriorly, the second joint heart-shaped. The toe is spindle-shaped and much enlarged in the middle, ending in a stout, acute claw; its length is slightly less than one fourth of the total length.

Total length 130μ; length of dorsal plate 88μ, of ventral plate 94μ; width of dorsal plate 80μ, of ventral plate 65μ; width of anterior dorsal margin 50μ, of ventral margin 58μ; length of toe without claw 33μ; claw 5μ.

Monostyla copeïs was collected by Dr. H. L. Shantz in Prospect Lake, on the slopes of Pikes Peak, Colorado, at an altitude of 1830 meters, and by Dr. Paul Galtsoff in Lake Pepin, Wisconsin. The specimens from Colorado are slightly smaller and the claw relatively longer; the toe is also somewhat broader, but there is no doubt of their specific identity.

MONOSTYLA RHOPALURA Harring and Myers, new species.

Plate XLI, figures 3, 4.

Monostyla closterocerca JENNINGS, Bull. Michigan Fish Comm. No. 3, 1894, p. 25, fig. 9.—HEMPEL, Bull. Illinois State Lab. Nat. Hist. vol. 5, 1898, p. 376; not *Monostyla closterocerca* SCHMARDA.

The outline of the lorica is broadly oval; its width is four fifths of the length. The anterior dorsal margin is very narrow and has a rather shallow, V-shaped sinus, rounded posteriorly; the ventral margin is crescentic; the external angles are moderately acute, both dorsally and ventrally. The dorsal plate is broadly oval and rounded posteriorly. The ventral plate is oval and slightly narrower than the dorsal; it has a transverse fold in front of the foot. The lateral sulci are fairly deep. The posterior segment is large and rounded and protrudes nearly full length beyond the dorsal plate. The coxal plates are large and obtusely pointed. The first foot joint is semi-elliptic; the second joint is large and pyriform. The toe is long and stout, nearly one third of the total length, fusiform and much enlarged in the middle; the claw is long, slender and acutely pointed, with a median line or indistinct groove.

Total length 180μ; length of dorsal plate 115μ, of ventral plate 130μ; width of dorsal plate 98μ, of ventral plate 90μ; width of anterior dorsal margin 36μ, of ventral margin 50μ; length of toe without claw 46μ; claw 8μ.

Monostyla rhopalura is locally common; we have collected it around Atlantic City, New Jersey; at Eagle River, Vilas County, Wisconsin, and on Mount Desert Island, Maine. Jennings collected it in ponds on the shores of Lake Erie and in inland lakes in Michigan.

MONOSTYLA PIDEIS Harring and Myers, new species.

Plate XLI, figures 5, 6.

The outline of the lorica is nearly circular; its width is equal to the length. The dorsal plate is subcircular, with very slight, lateral indentations near the posterior end. The ventral plate is somewhat narrower than the dorsal and obtusely pointed posteriorly. The anterior dorsal margin is very narrow and cuspidate, with a deep, V-shaped sinus, which has, for the protrusion of the dorsal antenna, a large, median notch, squarely truncate posteriorly. The ventral sinus is deeply lunate. Surface markings are limited to the usual transverse fold in front of the foot and two dorsal transverse lines, one at the bottom of the anterior sinus and another near the end of the dorsal plate. The lateral sulci are deep. The posterior segment is short and does not project beyond the dorsal plate. The coxal plates are minute and scale-like; they are smaller than in any other species of this group and do not extend beyond the first foot joint. The foot is unusually robust and both joints very broad and short. The toe is long, about one third of the total length, extremely broad and parallel-sided, narrowed at the base and rounded posteriorly; it is compressed dorso-ventrally and oval in cross section. The claw is short and triangular.

Total length 160μ; length of dorsal plate 122μ, of ventral plate 122μ; width of dorsal plate 108μ, of ventral plate 100μ; width of anterior margin 32μ; length of toe without claw 45μ; claw 6μ.

Monostyla pideis was collected among submerged mosses in Bubble Pond, Mount Desert Island, Maine. Its nearest relatives are probably *M. cornuta and M. rhopalura.*

MONOSTYLA SCUTATA Harring and Myers, new species

Plate XL, figures 1, 2.

The outline of the lorica is subcircular; its width is nearly equal to the length. The anterior margins are coincident and very slightly concave, the dorsal margin slightly narrower than the ventral; anterior spines are not present. The dorsal plate is subcircular and rounded posteriorly; the ventral plate is parallel-sided anteriorly and rounded posteriorly. Surface markings are limited to a transverse fold on the ventral plate, in front of the foot. The lateral sulci are rather shallow and indistinct. The posterior segment is broad and rounded and projects somewhat beyond the dorsal plate. The coxal plates are fairly large and obtusely rounded posteriorly. The first foot joint is pyriform and rounded posteriorly, the second joint short and very broadly elliptic. The toe is long and fairly stout, about one third of the total length, parallel-sided for about three fourths of its length and tapering to the long, slender and acute claw.

Total length 100μ; length of dorsal plate 62μ, of ventral plate 70μ; width of dorsal plate 65μ, of ventral plate 50μ; width of anterior dorsal margin 44μ, ventral margin 48μ; length of toe without claw 28μ; claw 5μ.

Monostyla scutata was collected in small numbers in Ottman Lake, near Waupaca, Wisconsin. No other localities are known for this species.

MONOSTYLA PYGMAEA Daday

Plate XLII, figures 1, 2.

Monostyla pygmaea DADAY, Math. Termész. Ertes., vol. 15, 1897, p. 139, fig. 7; Termész. Füzetek, vol. 24, 1901, p. 21, fig. 4.—HARRING and MYERS, Trans. Wisconsin Acad. Sci., vol. 20, 1922, p. 557.—HAUER, Zool. Anz., vol. 61, 1924, p. 149.

Monostyla turbo MURRAY, Journ. Royal Micr. Soc., 1913, p. 558, pl. 22, fig. 11.

The outline of the lorica is broadly ovate; its width is about three fourths of the length. The anterior dorsal margin is straight, the ventral margin convex with a small, shallow, rounded median sinus; this species shares with *M. obtusa* the peculiarity of having the anterior dorsal margin wider than the ventral. The dorsal plate is broadly ovate and rounded posteriorly. The ventral plate is ovate and somewhat narrower than the dorsal plate, especially in front. There is a fairly prominent transverse ventral fold above the foot. The lateral sulci are fairly deep. The posterior segment is large and rounded; it projects somewhat beyond the dorsal plate. The coxal plates are small and obtusely pointed posteriorly. The first foot joint is somewhat indistinct and widest anteriorly, the second joint roughly hexagonal and slightly inside the posterior edge of the lorica. The toe is long and straight, about one fourth of the total length, and ends in a small, acute claw with median dividing line and without basal spicules.

Total length 125μ; length of dorsal plate 80μ, of ventral plate 88μ; width of dorsal plate 72μ, of ventral plate 65μ; width of anterior dorsal margin 58μ, of ventral margin 48μ; length of toe without claw 37μ; claw 5μ.

Monostyla pygmaea is common in wet sphagnum; we have collected it around Washington, District of Columbia; at Atlantic City, New Jersey; in Polk County, Florida; in Oneida and Vilas Counties, Wisconsin and on Mount Desert Island, Maine. Hauer reports it from the Schwarzwald. Murray found it among Rousselet's collections from Clare Island, Ireland.

MONOSTYLA ORNATA Harring and Myers, new species

Plate XXXVI, figures 1, 2.

The lorica is broadly ovate; its width is about three fourths of the length. The anterior dorsal margin is slightly convex; the ventral has a small median sinus, broadly rounded at the bottom and with convex sides. The dorsal plate is broadly oval and rounded posteriorly. The ventral plate is nearly parallel-sided for half its length and very bluntly triangular posteriorly. The surface markings are unique and must be studied from the figures; they consist of a system of raised ridges with lateral buttresses or branches at close intervals, but the usual pattern of facets is not traceable. The lateral sulci are shallow and the margins of the ventral plate somewhat undulate. The posterior segment is narrow and rounded posteriorly; it projects slightly beyond the dorsal plate. The coxal plates are very small and obtusely pointed. The first foot joint is large and conical, the second subcircular, slightly reduced in front of the toe and well within the posterior segment. The toe is long and slender, about one third of the total length, straight and parallel-sided with a distinct annular constriction near the posterior end; the claw is long, fairly stout and acutely pointed.

Total length 130μ; length of dorsal plate 82μ, of ventral plate 87μ; width of dorsal plate 68μ, of ventral plate 60μ; width of anterior margin 55μ; length of toe without claw 38μ; claw 7μ.

Monostyla ornata was collected in large numbers in a swamp at Oceanville, near Atlantic City, New Jersey. No other localities are known for this very interesting species.

MONOSTYLA OBTUSA Murray

Plate XLII, figures 5, 6.

Monostyla obtusa MURRAY, Journ. Royal Micr. Soc., 1913, p. 357, pl. 15, fig. 37.—HARRING, Proc. U. S. Nat. Mus., vol. 47, 1914, p. 548.—HAUER, Zool. Anz., vol. 61, 1924, p. 147.

? *Monostyla lunaris aperta* STEINECKE, Schriften Phys.-ökon. Ges. Königsberg i. Pr., vol. 57, 1916, p. 89, fig. 2, c, d; vol. 64, 1924, p. 41.

The outline of the lorica is broadly oval; its width is three fourths of the length. The anterior margins of the dorsal and ventral plates are coincident and straight; at the external angles are two minute frontal spines. The dorsal plate is broadly oval and rounded posteriorly. The ventral plate is considerably narrower than the dorsal plate and broadly oval; it is somewhat flexible and its margins rather indefinite. The lorica is without any surface markings. The lateral sulci are shallow and ill-defined. The posterior segment is small and rounded, projecting very little beyond the dorsal plate. The coxal plates are moderately large and obtusely rounded posteriorly. The first foot joint is parallel-sided and indistinct, the second joint fairly large and subsquare, projecting slightly beyond the lorica. The toe is fairly long and straight, about one fourth of the total length, spindle-shaped, narrow at the base and slightly enlarged towards the posterior end; the claw is fairly long, acutely pointed and has a median dividing line without being double; two basal spicules are present.

Total length 115μ; length of dorsal plate 76μ, of ventral plate 80μ; width of dorsal plate 70μ, of ventral plate 58μ; width of anterior dorsal margin 58μ, of ventral margin 48μ; length of toe without claw 32μ; claw 7μ.

Monostyla obtusa was collected by Murray at Rio de Janeiro. It seems to be rare; we have found it common in collections from the Panama Canal Zone, and a few specimens in material from Audubon Park, in New Orleans, Louisiana, collected by Dr. Birge and Mr. Juday in 1903 and also in Sphagnum forwarded from Hubbardstown, Massachusetts, by Mrs. A. C. Clarke. Hauer reports it common in sphagnum bogs in the Schwarzwald and apparently this is the animal found by Steinecke in the Zehlaubruch near Königsberg.

MONOSTYLA VASTITA Harring and Myers, new species
Plate XLII, figures 3, 4.

The outline of the lorica is very broadly reversed-ovate; its width is but little less than the length. The anterior margins are nearly coincident; the dorsal is very slightly concave and the ventral straight. The dorsal plate is very broadly oval and rounded posteriorly; the ventral plate is much narrower and oval in outline; it has a transverse and two longitudinal folds. The lateral sulci are shallow and ill-defined. The posterior segment is large and rounded; it projects with its entire length beyond the dorsal plate. The coxal plates are large and obtusely pointed. The first foot joint is very long, constricted near the posterior, lobate end; the second joint is robust, very broad and roughly pentagonal in outline. The toe is long and slender, about one third of the total length, parallel-sided and obtuse posteriorly; the claw is long, slender and acutely pointed with a median mucus groove.

Total length 130μ; length of dorsal plate 78μ, of ventral plate 90μ; width of dorsal plate 78μ, of ventral plate 62μ; width of anterior dorsal margin 65μ, of ventral margin 50μ; length of toe without claw 35μ; claw 7μ.

Monostyla vastita was collected in Round Pond, on Mount Desert Island, Maine; this is the only location known for this species. It resembles *M. obtusa* in having the dorsal anterior margin wider than the ventral, but differs in nearly every other respect, and there can be no confusion between these two species.

MONOSTYLA TETHIS Harring and Myers, new species

Plate XXXVIII, figures 1, 2.

The outline of the lorica is very broadly oval; its width is but little less than the length. The anterior margins of the dorsal and ventral plates are coincident and straight. The dorsal plate is very broadly ovate and narrowly truncate posteriorly. The ventral plate is as wide as the dorsal and very broadly oval. The dorsal facetting is of an unusual pattern and very regular; each facet is bounded by double longitudinal lines. The surface markings of the ventral plate are also somewhat aberrant, as shown in figure 2. The lateral sulci are moderately deep. The posterior segment is very short and broadly rounded; it projects very slightly beyond the dorsal plate. The coxal plates are large and nearly semicircular. The first foot joint is rudimentary and indistinct, the second joint large and subcircular. The toe is long, nearly one third of the total length, straight and very slightly tapering; the claw is fairly long, slender and acutely pointed.

Total length 100μ; length of dorsal plate 70μ, of ventral plate 74μ; width of lorica 62μ; width of anterior dorsal margin 42μ, of ventral margin 53μ; length of toe without claw 24μ; claw 6μ.

Monostyla tethis was collected in small numbers among sphagnum from Aunt Bettys Pond, Mount Desert Island, Maine. No other localities for this species are known.

MONOSTYLA RUGOSA Harring

Plate XLIII, figures 3, 4.

Monostyla rugosa HARRING, Proc. U. S. Nat. Mus., vol. 47, 1914, p. 548, pl. 24, figs. 4–6.—FADEEV, Russk. Gidr. Zhurn., vol. 3, No. 3–5, 1924, p. 6.

The outline of the lorica is very broadly ovate; its width is slightly greater than the length. The anterior margins are nearly coincident, the dorsal slightly convex and the ventral straight. The dorsal plate is very broadly ovate and narrowly truncate posteriorly; the facetting resembles closely the usual pattern except in the anterior row, which is irregular. The ventral plate is flexible and its margins somewhat indefinite, but it is roughly subsquare and rounded posteriorly; the pattern of the surface markings is fairly complex. The lateral sulci are indistinct and shallow. The posterior segment is very short and broad; it is almost completely covered by the dorsal plate. The coxal plates are fairly large and semicircular. The toe is long, about one third of the total length, robust and parallel-sided; the long claw is distinctly double, but the two parts are rarely separated.

Total length 84μ; length of dorsal plate 54μ, of ventral plate 57μ; width of dorsal plate 62μ, of ventral plate 56μ; width of anterior dorsal margin 34μ, of ventral margin 45μ; length of toe without claw 21μ; claw 6μ.

Monostyla rugosa is common in the Panama Canal Zone; we have not found it in the United States. Fadeev records it from Kharkov, Russia.

MONOSTYLA ELACHIS Harring and Myers, new species

Plate XLIII, figures 1, 2.

The outline of the lorica is subcircular; its width is nearly equal to the length. The anterior dorsal margin is slightly convex; the ventral margin has a shallow median concavity and is convex towards the external angles; no frontal spines are present. The dorsal plate is subcircular and rounded posteriorly. The ventral plate is nearly parallel-sided anteriorly and rounded posteriorly; it is narrower than the dorsal plate. The anterior row of facets on the dorsal plate is very regular; the rest of the facetting is of the usual pattern; the ventral plate has a fairly prominent transverse fold in front of the foot. The lateral sulci are deep. The posterior segment is moderately large and rounded; it projects somewhat beyond the dorsal plate. The coxal plates are small and obtusely rounded posteriorly. The first foot joint is short and rather indistinct, the second joint is large and heartshaped. The toe is fairly long, more than one fourth of the total length, straight and parallel-sided, terminating in a short, acutely pointed claw.

Total length 90μ; length of dorsal plate 62μ, of ventral plate 68μ; width of dorsal plate 62μ, of ventral plate 54μ; width of anterior dorsal margin 40μ, of ventral margin 50μ; toe without claw 20μ; claw 4μ.

Monostyla elachis is common in weedy ponds in the United States; whether it occurs elsewhere is as yet unknown. It has considerable resemblance to other small species of the genus, but is one of the few with dorsal facetting, which, if not very prominent, is at least very constant.

MONOSTYLA FURCATA Murray

Plate XLIII, figures 5, 6.

Monostyla furcata MURRAY, Journn. Royal Micr. Soc., 1913, p. 358, pl. 15, fig. 40.—HARRING, Proc. U. S. Nat. Mus., vol. 47, 1914, p 548.—JAKUBSKI, Rozpr. Wiad. Muz. Dzieduszyckich, vol. 1, 1914, p. 35.—FADEEV, Russk. Gidr. Zhurn., vol. 3, No. 3–5, 1924, p. 6.

The outline of the lorica is broadly ovate or subcircular; its width is but little less than the length, and the integument is semi-flexible. The anterior margins of the dorsal and ventral plates are wide, straight and coincident. The dorsal plate is subcircular and without posterior truncation. The ventral plate is roughly parallel-sided anteriorly and rounded posteriorly. Surface markings are limited to a transverse fold on the ventral plate in front of the foot. The lateral sulci are fairly deep, the posterior segment is rounded and almost completely covered by the dorsal plate. The coxal plates are small and rounded posteriorly. The first foot joint is parallel-sided and somewhat indistinct, the second joint nearly spherical. The toe is short and stout, about one fourth of the total length, straight and parallel-sided, terminating in two very distinct claws, immobile and separated by a V-shaped notch.

Total length 100μ; length of dorsal plate 75μ, of ventral plate 78μ; width of dorsal plate 70μ, of ventral plate 60μ; width of anterior dorsal margin 43μ, of ventral margin 58μ; length of toe without claws 22μ; claws 5μ.

Monostyla furcata is probably widely distributed, but has no doubt often been confused with other small species of the genus. Murray found it at Rio de Janeiro; it was common in the collections of the Panama Biological Survey and we have found it at Washington, District of Columbia; around Atlantic City, New Jersey; in Oneida and Vilas Counties, Wisconsin, and on Mount Desert Island, Maine, as well as in collections made by Mr. Juday at Puerto Barrios, Guatemala.

MONOSTYLA PUNCTATA Murray

Plate XLIV, figures 3, 4.

Monostyla punctata MURRAY, Journ. Royal Micr. Soc., 1913, p. 355, pl. 15, fig. 36.

The outline of the lorica is very broadly ovate; its width is nearly equal to the length. The anterior dorsal margin is very slightly convex and very much narrower than the ventral margin, so that a part of the integument belonging to the lateral sulcus is prominently in view from the dorsal side and equalizes the difference in width between the two plates; the ventral margin is slightly concave opposite the dorsal plate and from this point recedes at an obtuse angle to the external edge. The dorsal plate is very broadly ovate and rounded posteriorly. The ventral plate is considerably narrower than the dorsal, widest anteriorly and tapers gradually towards the rounded posterior end; it is quite flexible and the edges somewhat ill-defined. The lateral sulci are shallow except at the front, where they make up for the difference in width between the dorsal and ventral plates. The posterior segment is small and rounded; it projects but little beyond the dorsal plate. The coxal plates are small and obtusely pointed. The first foot joint is very large, but somewhat indistinct; the second joint is large and rounded. The toe is long and slender, more than one fourth of the total length, very slightly enlarged near mid-length and blunted posteriorly; the claw is fairly long, slender and acutely pointed, with a median mucus groove.

Total length 110μ; length of dorsal plate 76μ, of ventral plate 80μ; width of dorsal plate 70μ, of ventral plate 55μ; width of anterior dorsal margin 36μ, of ventral margin 58μ; length of toe without claw 24μ; claw 6μ.

Monostyla punctata was described by Murray from material collected in a brackish lagoon at Rio de Janeiro. We find it abundant in salt ponds and tide pools around Atlantic City, New Jersey. The structure as described by Murray seems very complex; this is evidently due to poor and incompletely retracted material; there is nothing especially remarkable about *M. punctata* except the great difference between the dorsal and ventral anterior margins.

MONOSTYLA CLOSTEROCERCA Schmarda

Plate XLIV, figures 5, 6.

Monostyla closterocerca SCHMARDA, Neue wirbellose Thiere, 1859, vol. 1, p. 59, pl. 14, fig. 125.—MURRAY, Journ Royal Micr. Soc., 1913, p. 357, pl. 15, fig. 39.—HARRING, Proc. U. S. Nat. Mus., vol. 47, 1914, p. 548; Rep. Canadian Arctic Exp. 1913–1918, vol. 8, pt. E, 1921, p. 10.—JAKUBSKI, Rozpr. Wiad. Muz. Dzieduszyckich, vol. 1, 1914, p. 32, pl. 1, fig. 4; Kosmos (Lwów), 1918–1919, p. 26.

? *Monostyla truncata* TURNER, Bull. Denison Univ., vol. 6. 1892, p. 62, pl. 1, fig. 11.

? ***Monostyla cornuta*** **Olofsson, Zool. Bidr. Uppsala, vol. 6, 1918, p. 594, fig. 55.—Hauer, Mitt. Geogr. Ges. u. Naturhist. Mus. Lübeck, ser. 2, No. 30, 1925, p. 170, fig. 9.**

The outline of the lorica is subcircular; its width is virtually equal to the length. The anterior dorsal and ventral margins are coincident and form a shallow, broadly V-shaped sinus with widely flaring, convex sides. The dorsal plate is nearly circular, rounded posteriorly and its anterior edges curving inwards without actually reaching the anterior margin. The ventral plate is very broadly oval and considerably narrower than the dorsal plate. The surface markings are a faint dorsal fold, originating near the apex of the anterior sinus, and a transverse ventral fold in front of the foot. The lateral sulci are shallow. The posterior segment is very broad and semicircular, and projects slightly beyond the dorsal plate. The coxal plates are large and rounded posteriorly, terminating slightly beyond the first foot joint; this is indistinct, rather narrow and parallel-sided, the second joint large and varying from subcircular to subsquare. The toe is long, a little less than one third of the total length, parallel-sided for half its length and tapering to a slender, acute point.

Total length, 110μ; length of dorsal plate 72μ, of ventral plate 78μ; width of dorsal plate 75μ, of ventral plate 5μ; width of anterior margin 44μ; length of toe 33μ.

Monostyla closterocerca is abundant everywhere in weedy ponds. Murray's figure shows the toe reduced at the base; this is an error; it is always parallel-sided.

MONOSTYLA PYRIFORMIS Daday.

Plate XLV, figures 1, 2.

Monostyla pyriformis **Daday, Math. Termész. Ertes., vol. 23, 1905, p. 330; Zoologica, pt. 44, 1905, p. 112, pl. 7, fig. 16.—Harring, Proc. U. S. Nat. Mus., vol. 47, 1914, p. 547.**

Monostyla truncata **Murray, Journ. Royal Micr. Soc., 1913, p. 358, pl. 15, fig. 38; not *Monostyla truncata* Turner.**

The outline of the lorica is very broadly ovate; its width is four fifths of the length. The anterior margins are coincident, straight for the greater part of their length and strongly rounded towards the edges of the lorica. The dorsal plate is very broadly ovate and rounded posteriorly. The ventral plate is ovate and considerably narrower than the dorsal. The lateral sulci are rudimentary. The posterior segment is small and rounded; it projects somewhat beyond the dorsal plate. The coxal plates are small and obtusely pointed. The first foot joint is semi-elliptic; the second joint is robust and subsquare. The toe is very long, about one third of the total length, parallel-sided for one half its length and tapering gradually to a slender, bristle-like point.

Total length 80μ; length of dorsal plate 55μ, of ventral plate 58μ; width of dorsal plate 48μ, of ventral plate 40μ; length of toe 24μ.

Monostyla pyriformis is not rare in wet sphagnum. We have used Daday's name for this species, as partly contracted specimens agree perfectly with his figure. Turner's *M. truncata* is figured with a straight, acute angled anterior margin, which this species never has; his animal may have been any one of the smaller Monostylas; the details given are insufficient to decide which one and his figure does not inspire much confidence in its accuracy.

MONOSTYLA SUBULATA Harring and Myers, new species.

Plate XLV, figures 3, 4.

The outline of the lorica is very broadly ovate; its width is virtually equal to the length. The anterior margins of the dorsal and ventral plates are coincident and straight; two minute indentations are usually present near the external angles. The dorsal plate is very broadly ovate and rounded posteriorly. The ventral plate is reduced considerably in width anteriorly and the posterior portion is consequently nearly circular in outline; it is much narrower than the dorsal plate. No surface markings are present on either dorsal or ventral plates. The lateral sulci are somewhat indistinct. The posterior segment is very small and rounded; it projects considerably beyond the dorsal plate. The coxal plates are rather small and obtusely pointed. The first foot joint is semi-elliptic; the second joint is heart-shaped and projects about two thirds of its length beyond the posterior segment. The toe is long and stout, about one fourth of the total length, tapering and has a median line or indistinct groove.

Total length 100μ; length of dorsal plate 64μ, of ventral plate 68μ; width of dorsal plate 65μ, of ventral plate 52μ; width of anterior margin 50μ; length of toe without claw 16μ; claw 10μ.

Monostyla subulata is fairly common in wet sphagnum and is not infrequently found in weedy ponds in the United States; we have found it in sphagnum from Epping Forest, sent to us by Mr. David Bryce.

MONOSTYLA OPIAS Harring and Myers, new species.

Plate XLV, figures 5, 6.

The outline of the lorica is very broadly ovate; its width is five sixths of the length. The anterior margins are coincident and straight; at the external angles are two very small, acute frontal spines. The dorsal plate is very broadly ovate and rounded posteriorly. The ventral plate is broadly ovate and slightly narrower than the dorsal plate; in front of the foot is a fairly conspicuous transverse fold. The lateral sulci are moderately deep. The posterior segment is fairly large and rounded; it projects somewhat beyond the dorsal plate. The coxal plates are small and obtusely pointed. The first foot joint is small and indistinct; the second is large and rounded. The toe is long, more than one fourth of the total length, and tapers gradually to a slender, bristle-like point.

Total length 100μ; length of dorsal plate 66μ, of ventral plate 72μ; width of dorsal plate 60μ, of ventral plate 55μ; width of anterior spines 45μ; length of toe 28μ.

Monostyla opias is rare; we have found it in wet sphagnum from Hyattsville, near Washington, District of Columbia, and from Squirrel Lake, about 15 miles west of Minocqua, Oneida County, Wisconsin; only a few specimens were collected at each station.

MONOSTYLA MONOSTYLA (Daday).

Plate XLVI, figures 1, 2.

Diarthra monostyla DADAY, Math. Termész. Ertes., vol. 15, 1897, p. 143, fig. 10; Termész. Füzetek, vol. 24, 1901, p. 26, fig. 9; Zoologica, pt. 44, 1905, p. 127, pl. 7, fig. 17.

Monostyla monostyla HARRING, Proc. U. S. Nat. Mus., vol. 46, 1913, p. 390.—HARRING and MYERS, Trans. Wisconsin Acad. Sci., vol. 20, 1922, p. 537.—IDELSON, Trudy Kosinsk. Biol. Stants., pt. 2, 1925, p. 72, fig. 1.

Monostyla spinifera IDELSON, Russk. Gidr. Zhurn., vol. 3, 1924, p. 224, text fig.

The lorica is oval in outline; the anterior margins of dorsal and ventral plates are straight and coincident; at the external angles are two very small spines. The dorsal plate is very slightly narrower than the ventral and rounded posteriorly; it is very flexible and without facetting. The ventral plate is evenly rounded posteriorly and without evident markings; the coxal plates are small and rounded posteriorly. The lateral sulci are fairly deep; hinged to the margin of the dorsal plate is a curved spine, which may be swung outward and folded back into the lateral sulcus. The process of withdrawing the spine from the position shown in the figure is accomplished by a rotation downwards and inwards through an angle of 180 degrees; when the animal is swimming, there is no sign of the spine, concealed in the lateral sulcus with its "posterior" edge turned outwards and conforming to the outer edge of the dorsal plate. The first foot joint is large, the second small and inverted pyriform. The toe is about one fourth the total length, parallel-sided for one half its length and ending in a conical point without claw.

Total length 90μ; length of dorsal plate 58μ, of ventral plate 65μ; width of dorsal plate 47μ, of ventral plate 50μ; anterior points 38μ; toe 25μ.

Monostyla monostyla was first found by Daday in material from New Guinea and later in South American collections. We have found this species in numerous localities in the United States: at Washington; around Atlantic City, New Jersey; in Polk county, Florida; numerous places in Wisconsin and on Mt. Desert Island, Maine. It seems confined to wet sphagnum.

MONOSTYLA ARCUATA Bryce.

Plate XLVII, figures 3, 4.

Monostyla arcuata BRYCE, Science Gossip, vol. 27, 1891, p. 206, text fig.—MURRAY, Journ. Royal Micr. Soc., 1913, p. 360, pl. 15, fig. 42.—HAUER, Zool. Anz., vol. 61, 1924, p. 148.

The outline of the lorica is broadly oval; its width is about four fifths of the length. The anterior dorsal margin is slightly concave; the ventral margin has a shallow median sinus flanked by two straight sections. The dorsal plate is broadly oval and rounded posteriorly. The ventral plate is elongate oval and considerably narrower than the dorsal plate; it has a transverse ventral fold in front of the foot and two longitudinal folds. The lateral sulci are fairly deep, especially near the anterior margin, where they compensate the difference in width between the dorsal and ventral plate. The posterior segment is large and rounded; it projects slightly beyond the dorsal plate. The coxal plates are small and obtusely pointed posteriorly. The first foot joint is small and nearly parallel-sided; the second joint is large and rounded. The toe is long and fairly stout, more than one fourth of the total length, nearly parallel-sided for half its length and tapering gradually to a moderately acute point. In some specimens the toe is very slightly broader in the middle than at the base.

Total length 90μ; length of dorsal plate 60μ, of ventral plate 68μ; width of dorsal plate 54μ, of ventral plate 44μ; width of anterior dorsal margin 24μ, of ventral margin 36μ; length of toe 24μ.

Monostyla arcuata is fairly common in wet sphagnum. It has a certain resemblance to *M. closterocerca*, but differs considerably in details, as well as in general proportions.

MONOSTYLA DECIPIENS Murray

Plate XLVII, figures 5, 6.

Monostyla decipiens MURRAY, Journ. Royal Micr. Soc., 1913, p. 360, pl. 15, fig. 43.—HARRING, Proc. U. S. Nat. Mus., vol. 47, 1914, p. 548.

The outline of the lorica is broadly ovate; its width is about four fifths of the length. The anterior margins are coincident and the sinus very deep and V-shaped, rounded posteriorly and with a slight cusp opposite the incurved edges of the dorsal plate; no frontal spines are present, but two triangular, acute cusps are formed between the anterior sinus and the edges of the lorica. The dorsal plate is broadly ovate and rounded posteriorly. The ventral plate is ovate and slightly narrower than the dorsal plate; the lorica is without surface markings. The lateral sulci are deep, especially at the anterior margin; the dorsal plate terminates opposite the cusps on the sides of the sinus and a large, triangular area belonging to the sulcus completes it anteriorly. The posterior segment is rather small and very obtusely pointed; it projects considerably beyond the dorsal plate. The first foot joint is narrowly semi-elliptic and somewhat indistinct; the second joint is broadly ovate and widest posteriorly. The toe is long and slender, nearly one third of the total length, parallel-sided for half its length and tapering gradually to an acute point; in some specimens the toe is very slightly wider at mid-length than it is at the base.

Total length 175μ; length of dorsal plate 116μ, of ventral plate 128μ; width of dorsal plate 98μ, of ventral plate 78μ; width of anterior cusps 44μ; length of toe 48μ.

Monostyla decipiens was collected by Murray at Rio de Janeiro; our specimens are from the Panama Canal Zone and uniformly larger than Murray's material. This species has a superficial resemblance to *M. hamata,* but differs in nearly every detail and, as it is quite rare, there is little danger of confusing the two species.

MONOSTYLA HAMATA Stokes.

Plate XLVII, figures 1, 2.

Monostyla hamata STOKES, Ann. Mag. Nat. Hist., ser. 6, vol. 18, 1896, p. 21, pl. 7, figs. 6–8.—JENNINGS, Bull. U. S. Fish Comm., vol. 19 (for 1899), 1900, p. 94, pl. 22, figs. 42–44.—VORONKOV, Trudy Gidr. Stants. Glubokom Oz., vol. 2, 1907, pp. 110, 284, pl. 6, figs. 2–5.—RUNNSTRÖM, Zool. Anz., vol. 34, 1909, p. 271, fig. 3.—DADAY, Zoologica, pt. 59, 1910, p. 84.—SACHSE, Süsswasser-fauna Deutschlands, pt. 14, 1912, p. 180, figs. 351, 357.—MURRAY, Journ. Royal Micr. Soc., 1913, pp. 359, 458, pl. 15, fig. 41.—KOZAR, Zool. Anz., vol. 44, 1914, p. 421.—HARRING, Proc. U. S. Nat. Mus., vol. 47, 1914, p. 548; Rep. Canadian Arctic Exp. 1913–18, vol. 8, pt. E, 1921, p. 10.—JAKUBSKI, Rospr. Wiad. Muz. Dzieduszyckich, vol. 1, 1914, p. 33; Kosmos (Lwów), 1918–1919, p. 10.—MONTET, Rev. Suisse Zool., vol. 23, 1915, p. 336.—REZVOI, Trudy Borodinsk. Biol. Stants. Imp. Petrogradsk. Obshch. Estestvoisp., vol. 4, 1916, p. 181, pl. 1, figs. 13, 14.—WEBER and MONTET, Cat. Invert. Suisse, pt. 11, 1918, p. 192.—CHUGUNOV, Raboti Volzhskoi Biol. Stants., vol. 6, 1921, p. 116.

The outline of the lorica is elongate oval; its width is about two thirds of the length. The anterior margins are not coincident; the dorsal margin is very narrow and deeply lunate; the ventral margin has a very deep, V-shaped sinus, rounded posteriorly and with two prominent cusps near the middle of the sides. No frontal spines are present, but two acute-angled cusps are formed between the external edges of the ventral plate and anterior sinus. The dorsal plate is oval and rounded posteriorly; the dorsal facetting is well marked and very regular. The ventral plate is elongate oval and slightly narrower than the dorsal; its surface markings consist of a transverse fold in front of the foot and a few longitudinal folds. The lateral sulci are fairly deep, especially so at the front, where the difference in the widths of the anterior margins is compensated by the exposure of a large, triangular area of the sulcus. The posterior segment is large and very obtusely pointed; it projects somewhat beyond the dorsal plate. The coxal plates are small and obtusely pointed posteriorly. The first foot joint is small, oval and distinct, the second joint large and subsquare. The foot is long and slender, more than one fourth of the total length, parallel-sided for half its length and tapers gradually to an acute point without claw.

Total length 120μ; length of dorsal plate 78μ, of ventral plate 92μ; width of dorsal plate 58μ, of ventral plate 53μ; width of anterior dorsal margin 18μ, of ventral margin 30μ; length of toe 33μ.

Monostyla hamata is common in weedy ponds everywhere.

MONOSTYLA BATILLIFER Murray.

Plate XLVI, figures 3, 4.

Monostyla batillifer MURRAY, Journ Royal Micr. Soc., 1913, p. 458, pl. 19, fig. 2.

The outline of the lorica is elongate ovate; its width is about two thirds of the length. The anterior margins of the dorsal and ventral plates are not coincident; the margin of the dorsal plate is deeply lunate and very narrow; the ventral margin has a very deep, obtusely V-shaped sinus with two very large, lateral, almost spine-like cusps. The dorsal plate is ovate and rounded posteriorly. The ventral plate is oval, constricted anteriorly and somewhat narrower than the dorsal plate; its surface markings consist of a transverse fold in front of the foot and two longitudinal folds. The lateral sulci are fairly deep; the difference in the width of the anterior margins is made up by exposure of a triangular portion of the sulcus. The posterior segment is small, narrow, slightly undulate posteriorly and has two laterally projecting, acutely triangular cusps; the segment is only partly covered by the dorsal plate. The coxal plates are small and rounded posteriorly. The first foot joint is small and slightly conical, the second joint large, transversely oval and some distance from the posterior margin. The toe is fairly long, about one fourth of the total length, parallel-sided for nearly three fourths of its length, conical posteriorly and ends in a bristle-like point.

Total length 120μ; length of dorsal plate 85μ, of ventral plate 95μ; width of dorsal plate 62μ, of ventral plate 55μ; width of anterior dorsal margin 17μ, of ventral margin 26μ; length of toe 30μ.

Monostyla batillifer was collected by Murray in a pond at Sydney, Australia; our description is taken from his material. No other localities are known for this interesting species. Murray's figures are slightly incorrect in some details, especially the anterior margin and the form of the toe.

MONOSTYLA BIFURCA Bryce

Plate XLIV, figures 1, 2.

Monostyla bifurca BRYCE, Science Gossip, vol. 28, 1892, p. 274, text fig.

Notommata monostylaeformis STENROOS, Acta Soc. Fauna et Flora Fennica, vol. 17, No. 1, 1898, p. 126, pl. 1, fig. 25.—VON HOFSTEN, Arkiv Zool., Stockholm, vol. 6, No. 1, 1909, p. 34.

Monostyla monostylaeformis IROSO, Mon. Zool. Italiano, vol. 21, 1910, p. 303; Atti R. Ist. d'Incorr. di Napoli, vol. 64 (for 1912), 1913, p. 471, figs. 3, 4.—FADEEV, Raboti Sev.-Kavkazhsk. Gidrobiol. Stants., vol. 1, pt. 1, 1925, p. 23, pl. 4, fig. 8.

Although the integument of this species is very flexible and can not by any stretch of the imagination be called a lorica, it is nevertheless sufficiently firm to assume a fairly definite form when completely contracted. The outline of the body is very broadly oval; its width is nearly equal to the length. The anterior margin is straight and the dorsal and ventral edges fail to meet in complete retraction. No lateral sulci are present and the limits of the dorsal plate are distinguishable posteriorly where it leaves the small posterior segment protruding slightly. This bears at the sides of the foot two small, slightly curved spines, which are probably to be interpreted as rudimentary coxal plates, as in *Lecane palinacis.* The foot joints are very large; the first joint is ovate and has a small, median, posterior lobe; the second joint is heart-shaped. The toe is fairly long, more than one fourth of the entire length, widest at the base and tapering gradually towards the posterior end; the claw is double, its two parts spread wide apart and immovable.

Total length of contracted animal 75μ; length of dorsal plate 54μ, of ventral plate 58μ; width of anterior margin 35μ; length of toe without claws 15μ; claws; 4μ.

Monostyla bifurca is not rare in wet sphagnum; the paucity of records is probably due to its small size rather than to any actual rarity.

EXPLANATION OF PLATES.

All figures are highly magnified. For actual measurements see text.

PLATE VIII.

Fig. 1. *Lecane curvicornis*, dorsal view, p. 321.
Fig. 2. *Lecane curvicornis*, ventral view.
Fig. 3. *Lecane acronycha*, dorsal view, p. 322.
Fig. 4. *Lecane acronycha*, ventral view.

PLATE IX.

Fig. 1. *Lecane sibina*, dorsal view, p. 324.
Fig. 2. *Lecane sibina*, ventral view.
Fig. 3. *Lecane ungulata*, dorsal view, p. 323.
Fig. 4. *Lecane ungulata*, ventral view.

PLATE X.

Fig. 1. *Lecane grandis*, dorsal view, p. 325.
Fig. 2. *Lecane grandis*, ventral view.
Fig. 3. *Lecane leontina*, dorsal view, p. 326.
Fig. 4. *Lecane leontina*, ventral view.
Fig. 5. *Lecane leontina*, dorsal view.

PLATE XI.

Fig. 1. *Lecane tudicola*, dorsal view, p. 328.
Fig. 2. *Lecane tudicola*, ventral view.
Fig. 3. *Lecane mitis*, dorsal view, p. 329.
Fig. 4. *Lecane mitis*, ventral view.
Fig. 5. *Lecane scobis*, dorsal view, p. 329.
Fig. 6. *Lecane scobis*, ventral view.

PLATE XII.

Fig. 1. *Lecane pertica*, dorsal view, p. 340.
Fig. 2. *Lecane pertica*, ventral view.
Fig. 3. *Lecane pyrrha*, dorsal view, p. 331.
Fig. 4. *Lecane pyrrha*, ventral view.
Fig. 5. *Lecane pyrrha*, dorsal view.
Fig. 6. *Lecane pyrrha*, dorsal view.

PLATE XIII.

Fig. 1. *Lecane aquila*, dorsal view, p. 334.
Fig. 2. *Lecane aquila*, ventral view.
Fig. 3. *Lecane signifera*, dorsal view, p. 333.
Fig. 4. *Lecane signifera*, ventral view.
Fig. 5. *Lecane ploenensis*, dorsal view, p. 332.
Fig. 6. *Lecane ploenensis*, ventral view.

PLATE XIV.

Fig. 1. *Lecane candida*, dorsal view, p. 368.
Fig. 2. *Lecane candida*, ventral view.
Fig. 3. *Lecane papuana*, dorsal view, p. 336.
Fig. 4. *Lecane papuana*, ventral view.
Fig. 5. *Lecane luna*, dorsal view, p. 334.
Fig. 6. *Lecane luna*, ventral view.

PLATE XV.

Fig. 1. *Lecane elegans*, dorsal view, p. 371.
Fig. 2. *Lecane elegans*, ventral view.
Fig. 3. *Lecane jessupi*, dorsal view, p. 338.
Fig. 4. *Lecane jessupi*, ventral view.
Fig. 5. *Lecane brachydactyla*, dorsal view, p. 337.
Fig. 6. *Lecane brachydactyla*, ventral view.

PLATE XVI.

Fig. 1. *Lecane depressa*, dorsal view, p. 327.
Fig. 2. *Lecane depressa*, ventral view.
Fig. 3. *Lecane ligona*, dorsal view, p. 339.
Fig. 4. *Lecane ligona*, ventral view.
Fig. 5. *Lecane ligona*, dorsal view.
Fig. 6. *Lecane ligona*, ventral view.

PLATE XVII.

Fig. 1. *Lecane rhacois*, dorsal view, p. 379.
Fig. 2. *Lecane rhacois*, ventral view.
Fig. 3. *Lecane clara*, dorsal view, p. 378.
Fig. 4. *Lecane clara*, ventral view.
Fig. 5. *Lecane pycina*, dorsal view, p. 340.
Fig. 6. *Lecane pycina*, ventral view.

PLATE XVIII.

Fig. 1. *Lecane eutarsa*, dorsal view, p. 341.
Fig. 2. *Lecane eutarsa*, ventral view.
Fig. 3. *Lecane pelatis*, dorsal view, p. 342.
Fig. 4. *Lecane pelatis*, ventral view.
Fig. 5. *Lecane mira*, dorsal view, p. 342.
Fig. 6. *Lecane mira*, ventral view.

PLATE XIX.

Fig. 1. *Lecane methoria*, dorsal view, p. 343.
Fig. 2. *Lecane methoria*, ventral view.
Fig. 3. *Lecane stichaea*, dorsal view, p. 344.
Fig. 4. *Lecane stichaea*, ventral view.
Fig. 5. *Lecane saginata*, dorsal view, p. 345.
Fig. 6. *Lecane saginata*, ventral view.

PLATE XX.

Fig. 1. *Lecane elasma*, dorsal view, p. 345.
Fig. 2. *Lecane elasma*, ventral view.
Fig. 3. *Lecane rhytida*, dorsal view, p. 346.
Fig. 4. *Lecane rhytida*, ventral view.
Fig. 5. *Lecane lauterborni*, dorsal view, p. 347.
Fig. 6. *Lecane lauterborni*, ventral view.

PLATE XXI.

Fig. 1. *Lecane compta*, dorsal view, p. 347.
Fig. 2. *Lecane compta*, ventral view.
Fig. 3. *Lecane haliclysta*, dorsal view, p. 348.
Fig. 4. *Lecane haliclysta*, ventral view.
Fig. 5. *Lecane aspasia*, dorsal view, p. 349.
Fig. 6. *Lecane aspasia*, ventral view.

PLATE XXII.

Fig. 1. *Lecane marshi*, dorsal view, p. 351.
Fig. 2. *Lecane marshi*, ventral view.
Fig. 3. *Lecane ichthyoura*, dorsal view, p. 352.
Fig. 4. *Lecane ichthyoura*, ventral view.
Fig. 5. *Lecane ludwigii*, dorsal view, p. 350.
Fig. 6. *Lecane ludwigii*, ventral view.

PLATE XXIII

Fig. 1. *Lecane stokesii*, dorsal view, p. 353.
Fig. 2. *Lecane stokesii*, ventral view.
Fig. 3. *Lecane stokesii*, dorsal view.
Fig. 4. *Lecane ohioensis*, dorsal view, p. 354.
Fig. 5. *Lecane ohioensis*, ventral view.

PLATE XXIV.

Fig. 1. *Lecane arcula*, dorsal view, p. 355.
Fig. 2. *Lecane arcula*, ventral view.
Fig. 3. *Lecane flexilis*, dorsal view, p. 355.
Fig. 4. *Lecane flexilis*, ventral view.
Fig. 5. *Lecane intrasinuata*, dorsal view, p. 357.
Fig. 6. *Lecane intrasinuata*, ventral view.

PLATE XXV.

Fig. 1. *Lecane climacois*, dorsal view, p. 358.
Fig. 2. *Lecane climacois*, ventral view.
Fig. 3. *Lecane verecunda*, dorsal view, p. 358.
Fig. 4. *Lecane verecunda*, ventral view.
Fig. 5. *Lecane mylacris*, dorsal view, p. 359.
Fig. 6. *Lecane mylacris*, ventral view.

PLATE XXVI.

Fig. 1. *Lecane glypta*, dorsal view, p. 360.
Fig. 2. *Lecane glypta*, ventral view.
Fig. 3. *Lecane tabida*, dorsal view, p. 361.
Fig. 4. *Lecane tabida*, ventral view.
Fig. 5. *Lecane infula*, dorsal view, p. 361.
Fig. 6. *Lecane infula*, ventral view.

PLATE XXVII.

Fig. 1. *Lecane aeganea*, dorsal view, p. 367.
Fig. 2. *Lecane aeganea*, ventral view.
Fig. 3. *Lecane satyrus*, dorsal view, p. 362.
Fig. 4. *Lecane satyrus*, ventral view.
Fig. 5. *Lecane venusta*, dorsal view, p. 368.
Fig. 6. *Lecane venusta*, ventral view.

PLATE XXVIII.

Fig. 1. *Lecane crepida*, dorsal view, p. 364.
Fig. 2. *Lecane crepida*, ventral view.
Fig. 3. *Lecane sagula*, dorsal view, p. 365.
Fig. 4. *Lecane sagula*, ventral view.
Fig. 5. *Lecane hastata*, dorsal view, p. 363.
Fig. 6. *Lecane hastata*, ventral view.

PLATE XXIX.

Fig. 1. *Lecane formosa*, dorsal view, p. 366.
Fig. 2. *Lecane formosa*, ventral view.
Fig. 3. *Lecane mucronata*, dorsal view, p. 330.
Fig. 4. *Lecane mucronata*, ventral view.
Fig. 5. *Lecane mucronata*, lateral view.

PLATE XXX.

Fig. 1. *Lecane pusilla*, dorsal view, p. 369.
Fig. 2. *Lecane pusilla*, ventral view.
Fig. 3. *Lecane asthena*, dorsal view, p. 369.
Fig. 4. *Lecane asthena*, ventral view.
Fig. 5. *Lecane subtilis*, dorsal view, p. 370.
Fig. 6. *Lecane subtilis*, ventral view.

PLATE XXXI.

Fig. 1. *Lecane elongata*, dorsal view, p. 372.
Fig. 2. *Lecane elongata*, ventral view.
Fig. 3. *Lecane tenuiseta*, dorsal view, p. 372.
Fig. 4. *Lecane tenuiseta*, ventral view.
Fig. 5. *Lecane doryssa*, dorsal view, p. 373.
Fig. 6. *Lecane doryssa*, ventral view.

PLATE XXXII.

Fig. 1. *Lecane agilis*, dorsal view, p. 382.
Fig. 2. *Lecane agilis*, ventral view.
Fig. 3. *Lecane palinacis*, dorsal view, p. 380.
Fig. 4. *Lecane palinacis*, ventral view.
Fig. 5. *Lecane inopinata*, dorsal view, p. 374.
Fig. 6. *Lecane inopinata*, ventral view.

PLATE XXXIII.

Fig. 1. *Lecane inermis*, dorsal view, p. 379.
Fig. 2. *Lecane inermis*, ventral view.
Fig. 3. *Lecane calcaria*, dorsal view, p. 381.
Fig. 4. *Lecane calcaria*, ventral view.
Fig. 5. *Lecane niothis*, dorsal view, p. 382.
Fig. 6. *Lecane niothis*, ventral view.

PLATE XXXIV.

Fig. 1. *Lecane nana*, dorsal view, p. 375.
Fig. 2. *Lecane nana*, ventral view.
Fig. 3. *Lecane hornemanni*, dorsal view, p. 377.
Fig. 4. *Lecane hornemanni*, ventral view.
Fig. 5. *Lecane tryphema*, dorsal view, p. 376.
Fig. 6. *Lecane tryphema*, ventral view.

PLATE XXXV.

Fig. 1. *Monostyla lunaris*, dorsal view, p. 384.
Fig. 2. *Monostyla lunaris*, ventral view.
Fig. 3. *Monostyla lunaris*, dorsal view.
Fig. 4. *Monostyla lunaris*, ventral view.
Fig. 5. *Monostyla lunaris*, dorsal view.
Fig. 6. *Monostyla lunaris*, ventral view.

PLATE XXXVI.

Fig. 1. *Monostyla ornata*, dorsal view, p. 402.
Fig. 2. *Monostyla ornata*, ventral view.
Fig. 3. *Monostyla acus*, dorsal view, p. 387.
Fig. 4. *Monostyla acus*, ventral view.
Fig. 5. *Monostyla crenata*, dorsal view, p. 386.
Fig. 6. *Monostyla crenata*, ventral view.

PLATE XXXVII.

Fig. 1. *Monostyla bulla*, dorsal view, p. 388.
Fig. 2. *Monostyla bulla*, ventral view.
Fig. 3. *Monostyla styrax*, dorsal view, p. 389.
Fig. 4. *Monostyla styrax*, ventral view.
Fig. 5. *Monostyla goniata*, dorsal view, p. 390.
Fig. 6. *Monostyla goniata*, ventral view.

PLATE XXXVIII.

Fig. 1. *Monostyla tethis*, dorsal view, p. 405.
Fig. 2. *Monostyla tethis*, ventral view.
Fig. 3. *Monostyla quadridentata*, dorsal view, p. 391.
Fig. 4. *Monostyla quadridentata*, ventral view.
Fig. 5. *Monostyla quadridentata*, male, dorsal view.

PLATE XXXIX.

Fig. 1. *Monostyla stenroosi*, dorsal view, p. 394.
Fig. 2. *Monostyla stenroosi*, ventral view.
Fig. 3. *Monostyla thalera*, dorsal view, p. 393.
Fig. 4. *Monostyla thalera*, ventral view.
Fig. 5. *Monostyla lamellata*, dorsal view, p. 392.
Fig. 6. *Monostyla lamellata*, ventral view.

PLATE XL.

Fig. 1. *Monostyla scutata*, dorsal view, p. 401.
Fig. 2. *Monostyla scutata*, ventral view.
Fig. 3. *Monostyla sylvatica*, dorsal view, p. 398.
Fig. 4. *Monostyla sylvatica*, ventral view.
Fig. 5. *Monostyla cornuta*, dorsal view, p. 396.
Fig. 6. *Monostyla cornuta*, ventral view.

PLATE XLI.

Fig. 1. *Monostyla copeis*, dorsal view, p. 398.
Fig. 2. *Monostyla copeis*, ventral view.
Fig. 3. *Monostyla rhopalura*, dorsal view, p. 399.
Fig. 4. *Monostyla rhopalura*, ventral view.
Fig. 5. *Monostyla pideis*, dorsal view, p. 400.
Fig. 6. *Monostyla pideis*, ventral view.

PLATE XLII.

Fig. 1. *Monostyla pygmaea*, dorsal view, p. 401.
Fig. 2. *Monostyla pygmaea*, ventral view.
Fig. 3. *Monostyla vastita*, dorsal view, p. 404.
Fig. 4. *Monostyla vastita*, ventral view.
Fig. 5. *Monostyla obtusa*, dorsal view, p. 403.
Fig. 6. *Monostyla obtusa*, ventral view.

PLATE XLIII.

Fig. 1. *Monostyla elachis*, dorsal view, p. 406.
Fig. 2. *Monostyla elachis*, ventral view.
Fig. 3. *Monostyla rugosa*, dorsal view, p. 405.
Fig. 4. *Monostyla rugosa*, ventral view.
Fig. 5. *Monostyla furcata*, dorsal view, p. 407.
Fig. 6. *Monostyla furcata*, ventral view.

PLATE XLIV.

Fig. 1. *Monostyla bifurca,* dorsal view, p. 416.
Fig. 2. *Monostyla bifurca,* ventral view.
Fig. 3. *Monostyla punctata,* dorsal view, p. 407.
Fig. 4. *Monostyla punctata,* ventral view.
Fig. 5. *Monostyla closterocerca,* dorsal view, p. 408.
Fig. 6. *Monostyla closterocerca,* ventral view.

PLATE XLV.

Fig. 1. *Monostyla pyriformis,* dorsal view, p. 409.
Fig. 2. *Monostyla pyriformis,* ventral view.
Fig. 3. *Monostyla subulata,* dorsal view, p. 410.
Fig. 4. *Monostyla subulata,* ventral view.
Fig. 5. *Monostyla opias,* dorsal view, p. 411.
Fig. 6. *Monostyla opias,* ventral view.

PLATE XLVI.

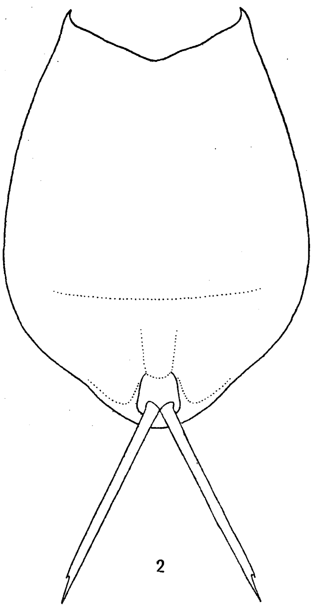
Fig. 1. *Monostyla monostyla,* dorsal view, p. 411.
Fig. 2. *Monostyla monostyla,* ventral view.
Fig. 3. *Monostyla batillifer,* dorsal view, p. 415.
Fig. 4. *Monostyla batillifer,* ventral view.

PLATE XLVII.

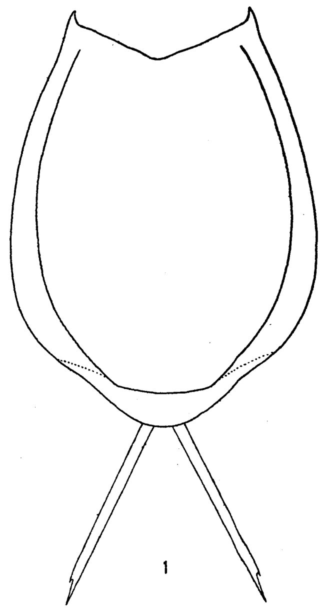
Fig. 1. *Monostyla hamata,* dorsal view, p. 414.
Fig. 2. *Monostyla hamata,* ventral view.
Fig. 3. *Monostyla arcuata,* dorsal view, p. 412.
Fig. 4. *Monostyla arcuata,* ventral view.
Fig. 5. *Monostyla decipiens,* dorsal view, p. 413.
Fig. 6. *Monostyla decipiens,* ventral view.

CORRECTIONS TO PART II, VOLUME XXI.

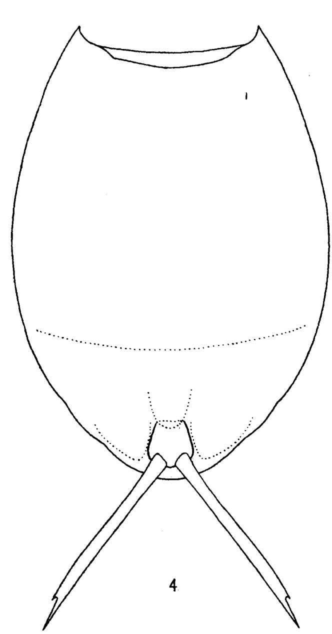
Pp. 488 and 546: for *Cephalodella piulca* read *C. hiulca.* P. 501: *Cephalodella collactea* has a cervical eyespot. P. 505: *Cephalodella cuneata* also has a cervical eyespot.



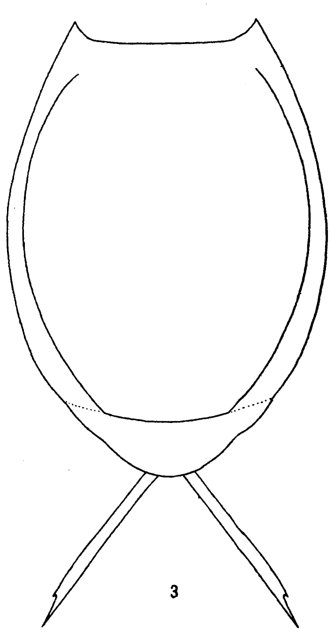
2



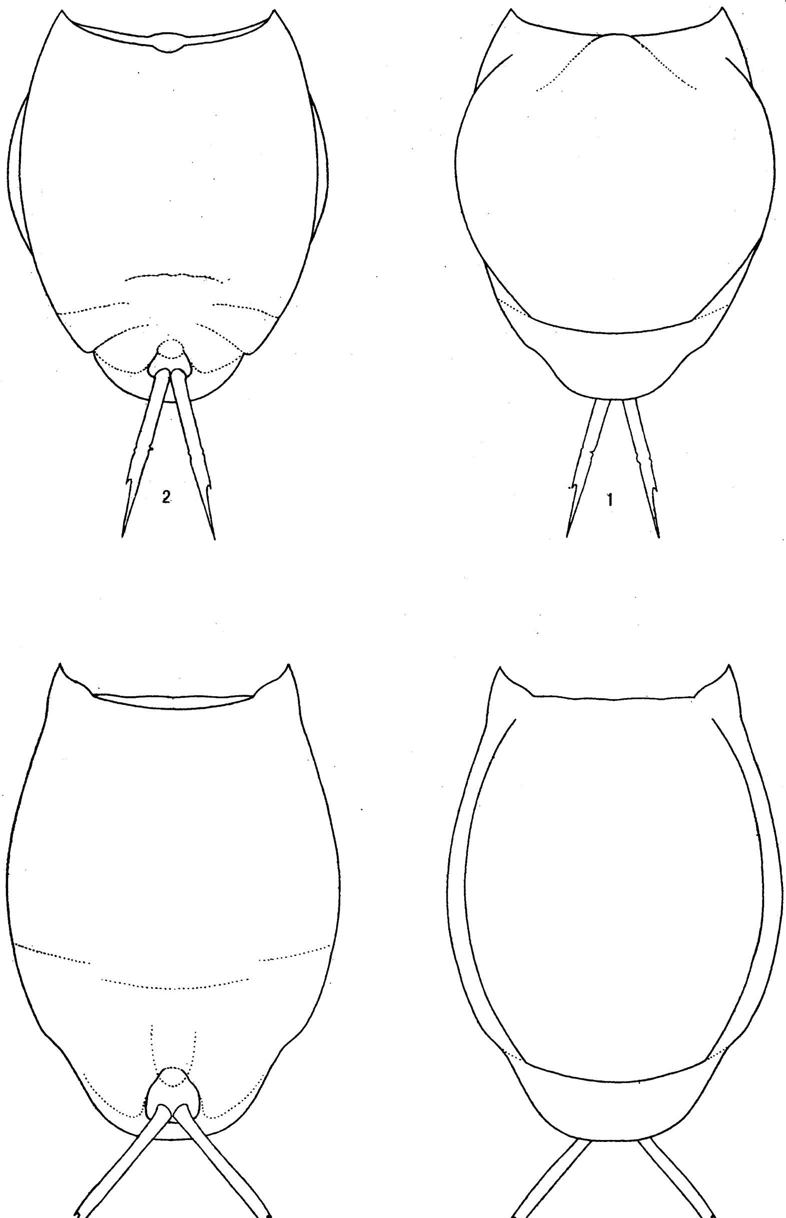
1



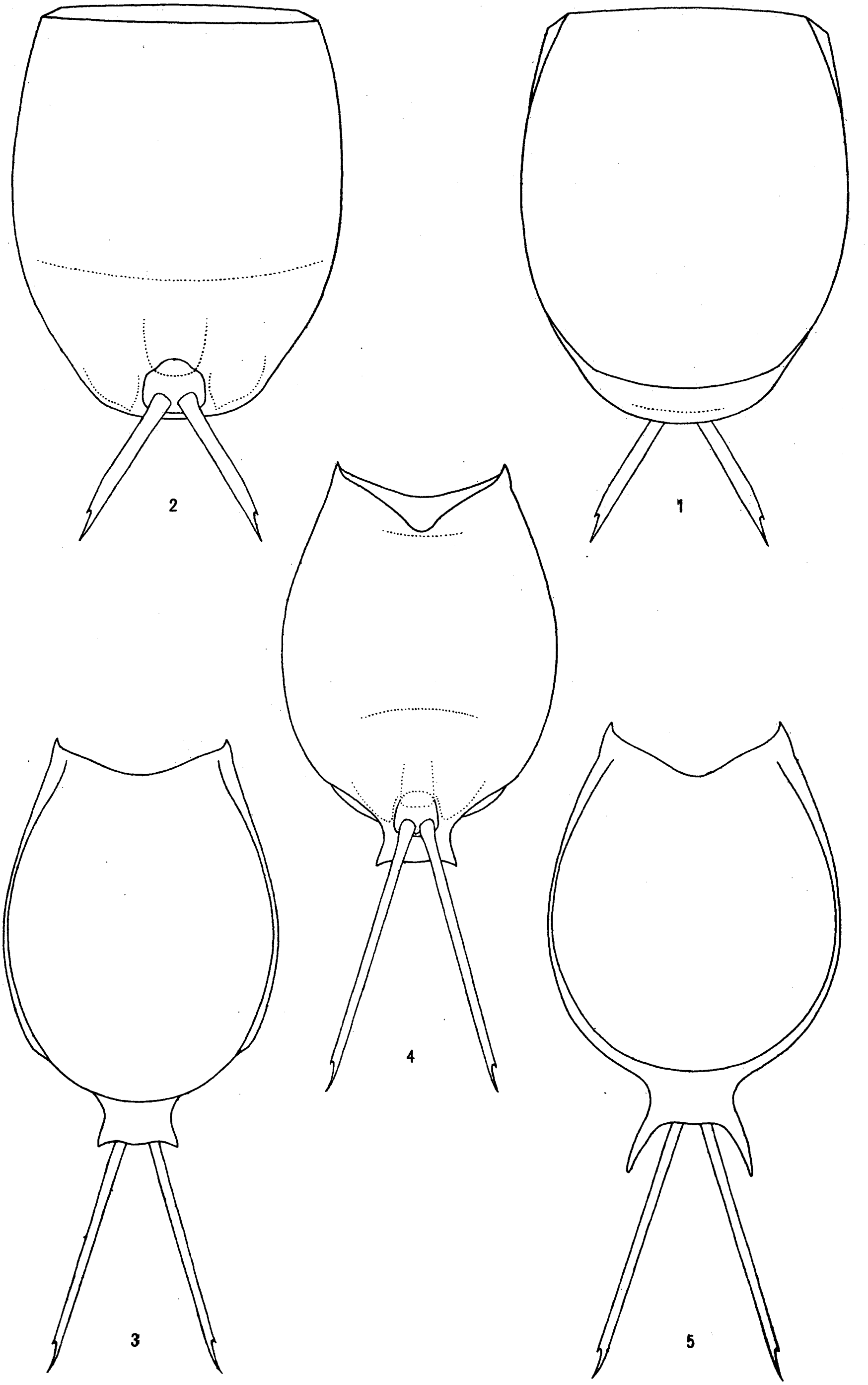
4

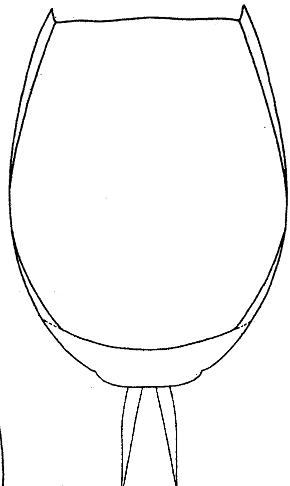


3

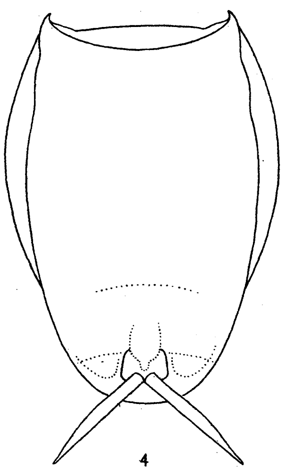


HARRING AND MYERS - LECANE

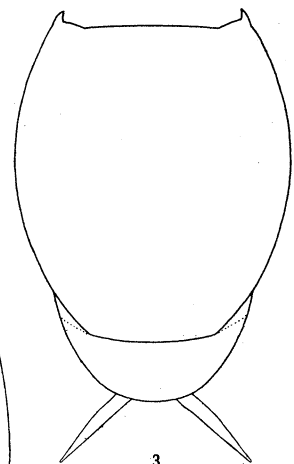

2
1
4
3
5



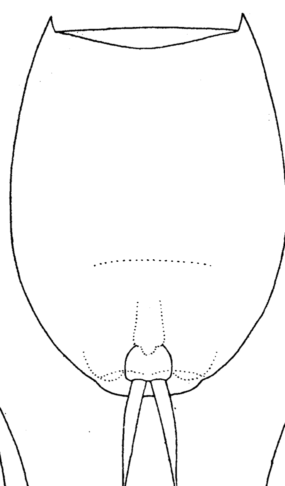
1



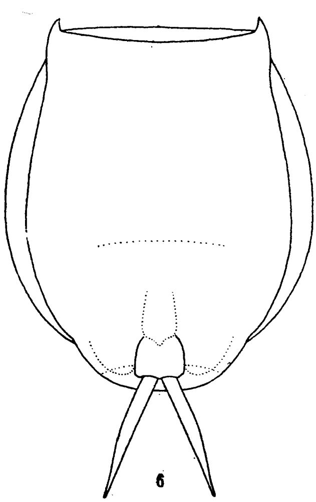
4



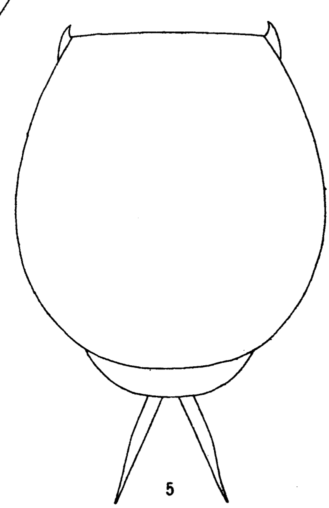
3



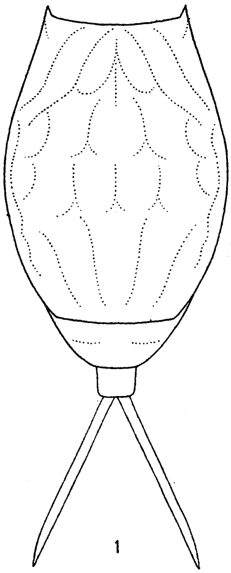
2



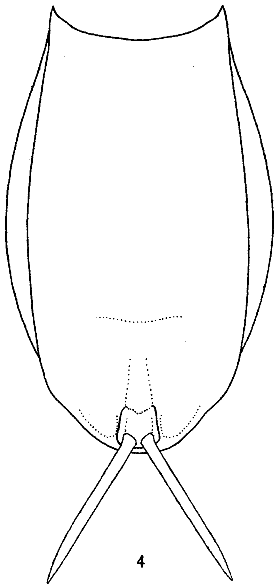
6



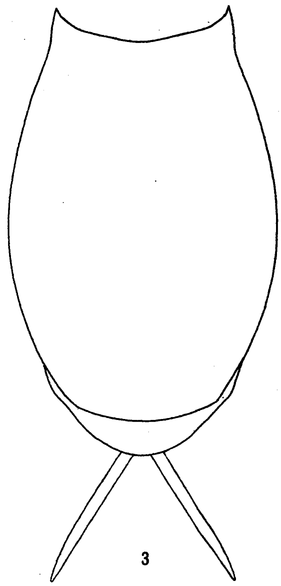
5



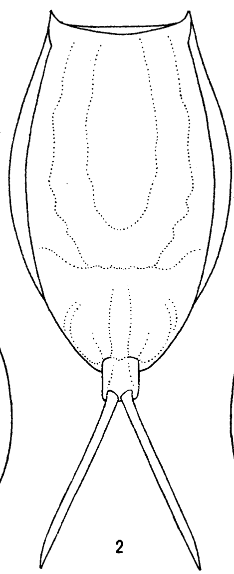
1



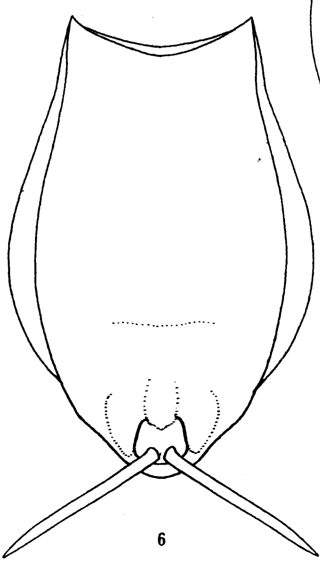
4



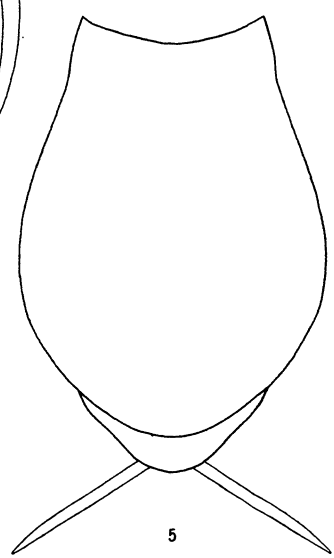
3



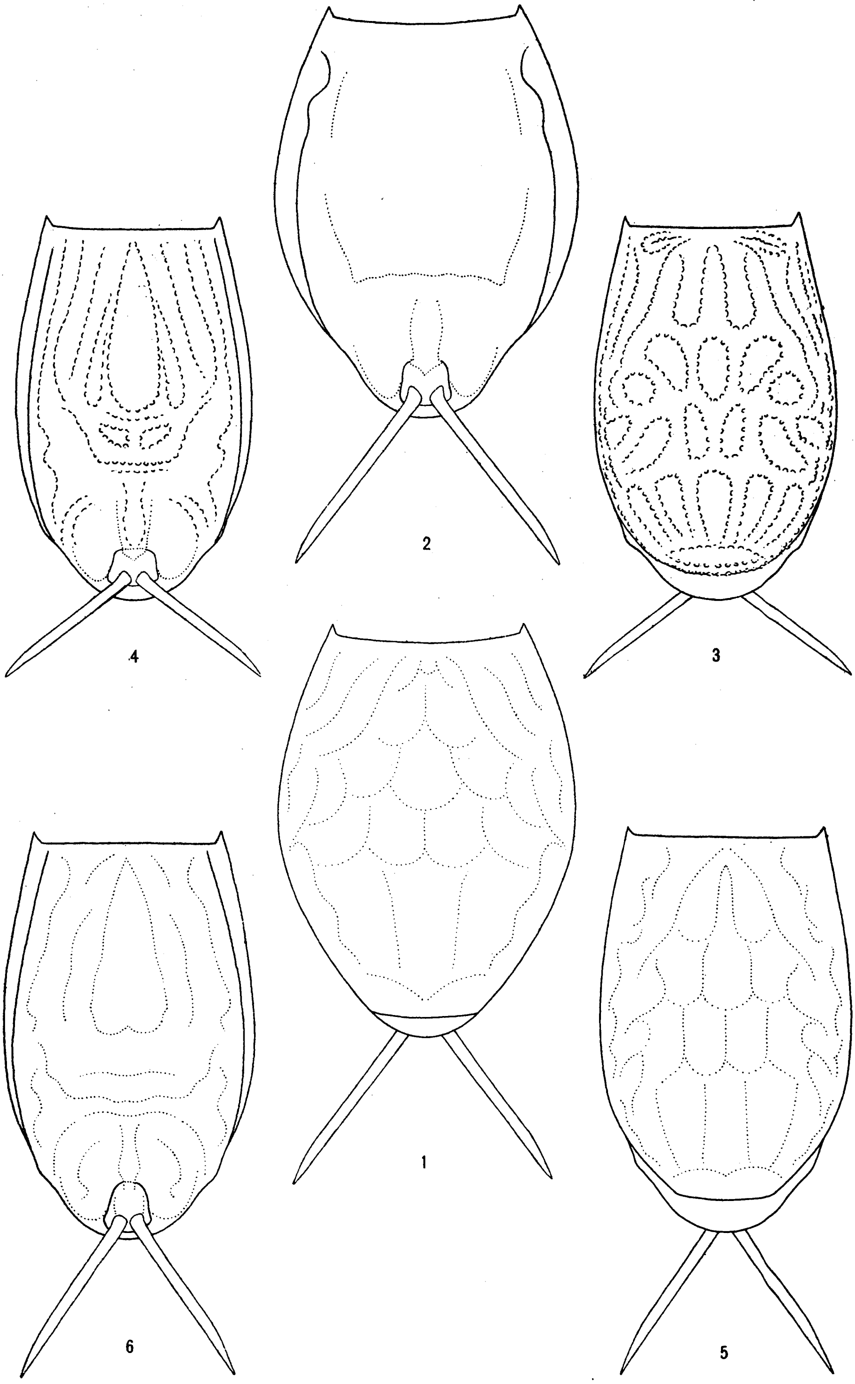
2

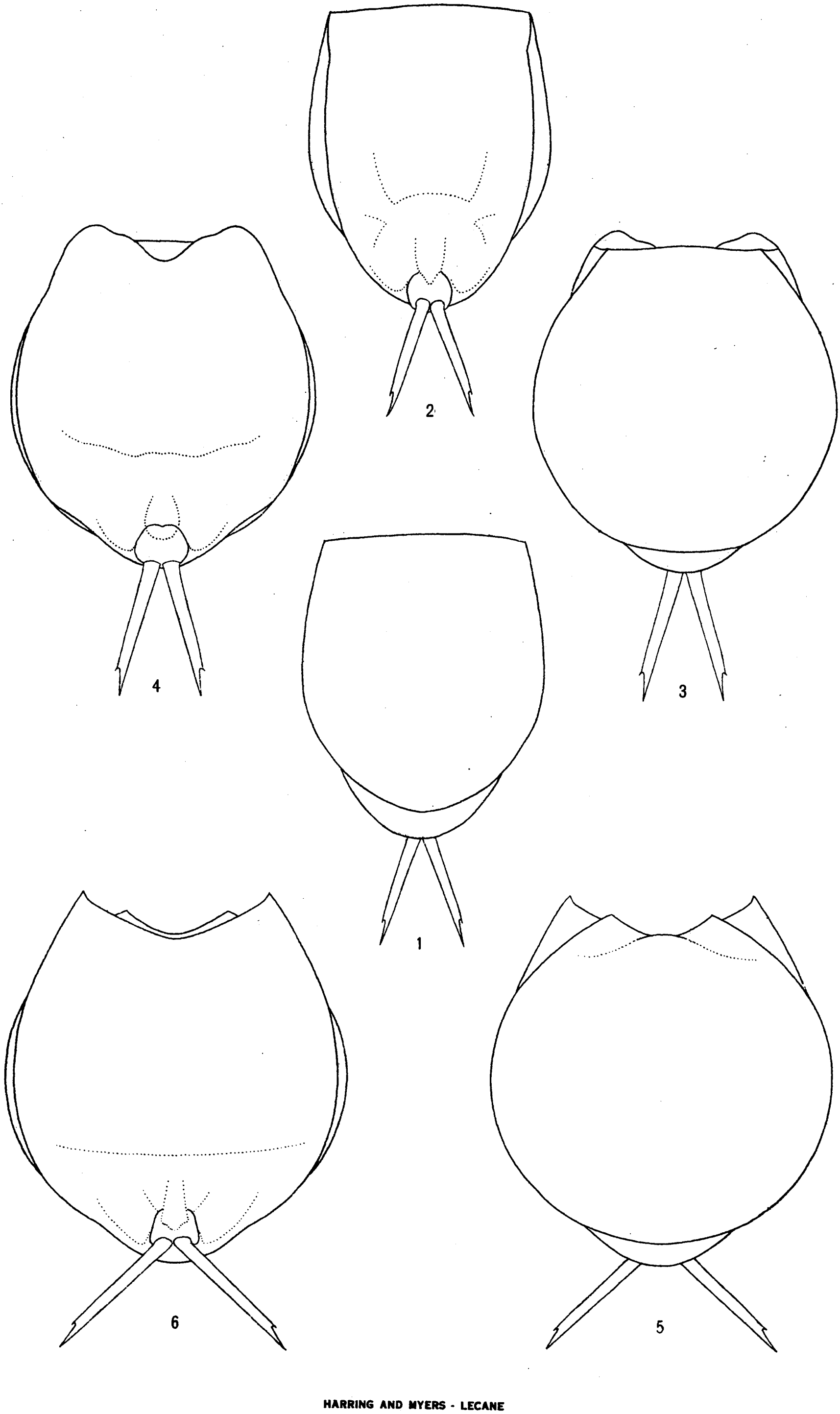


6

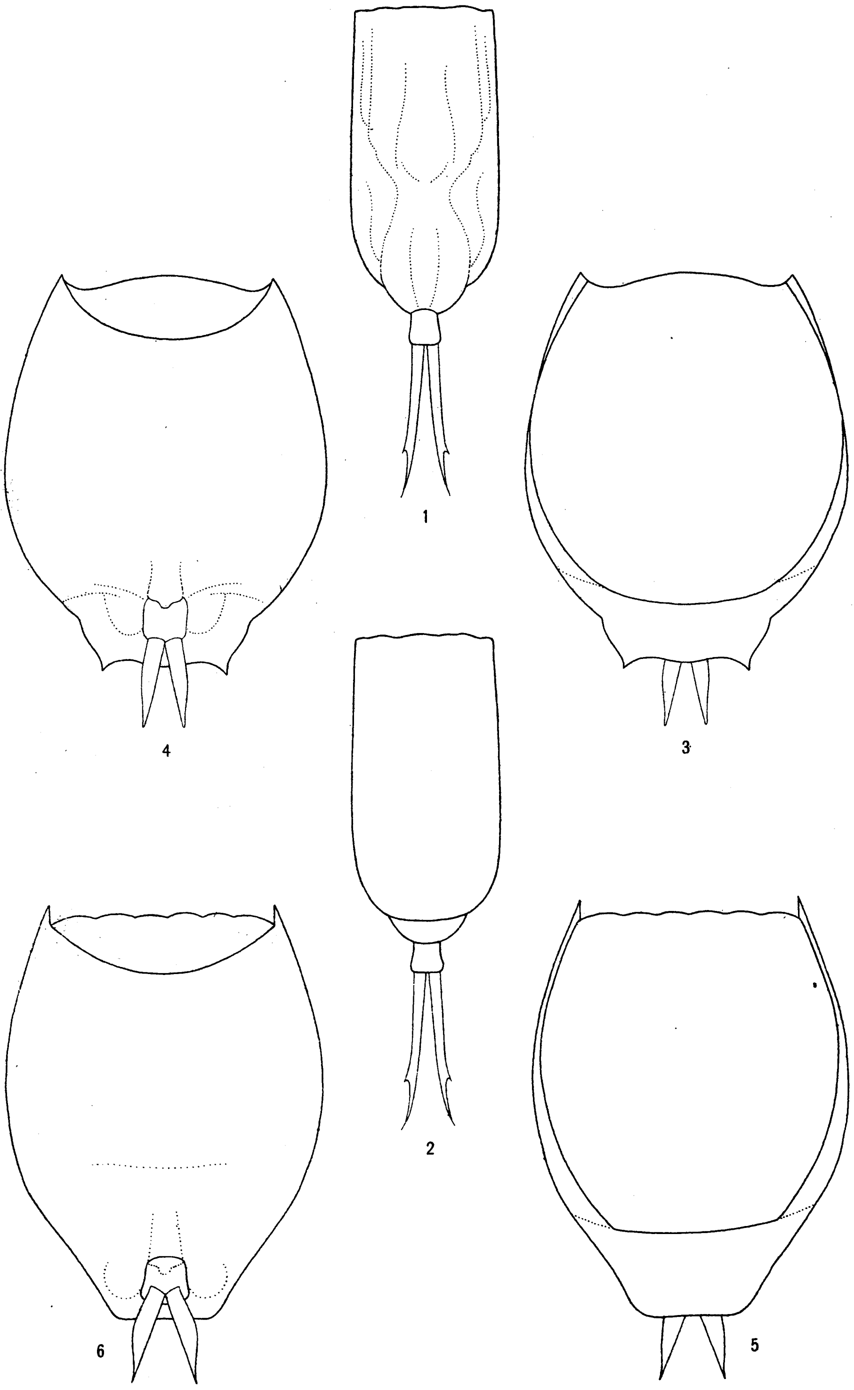


5

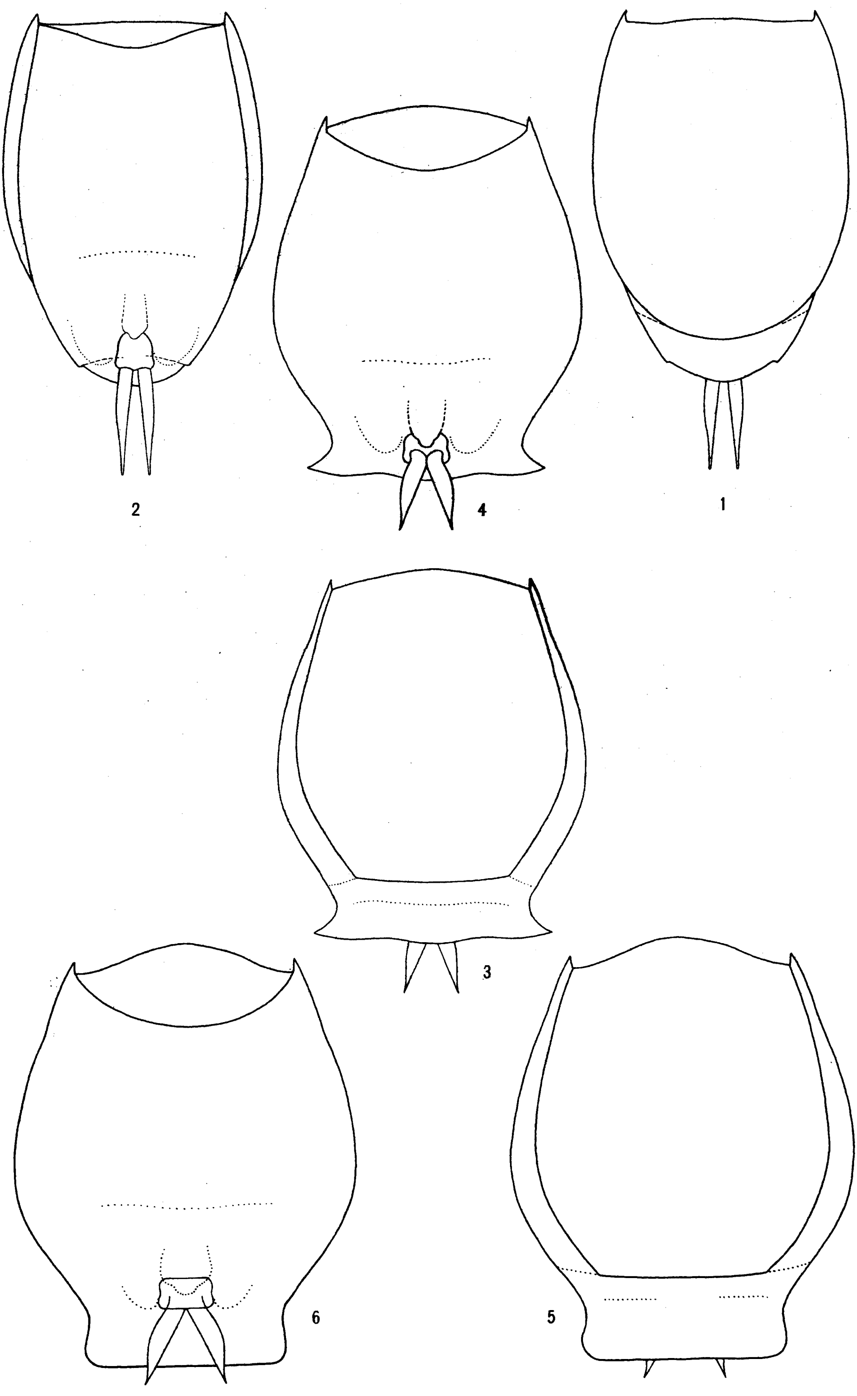

2
4
3
1
6
5

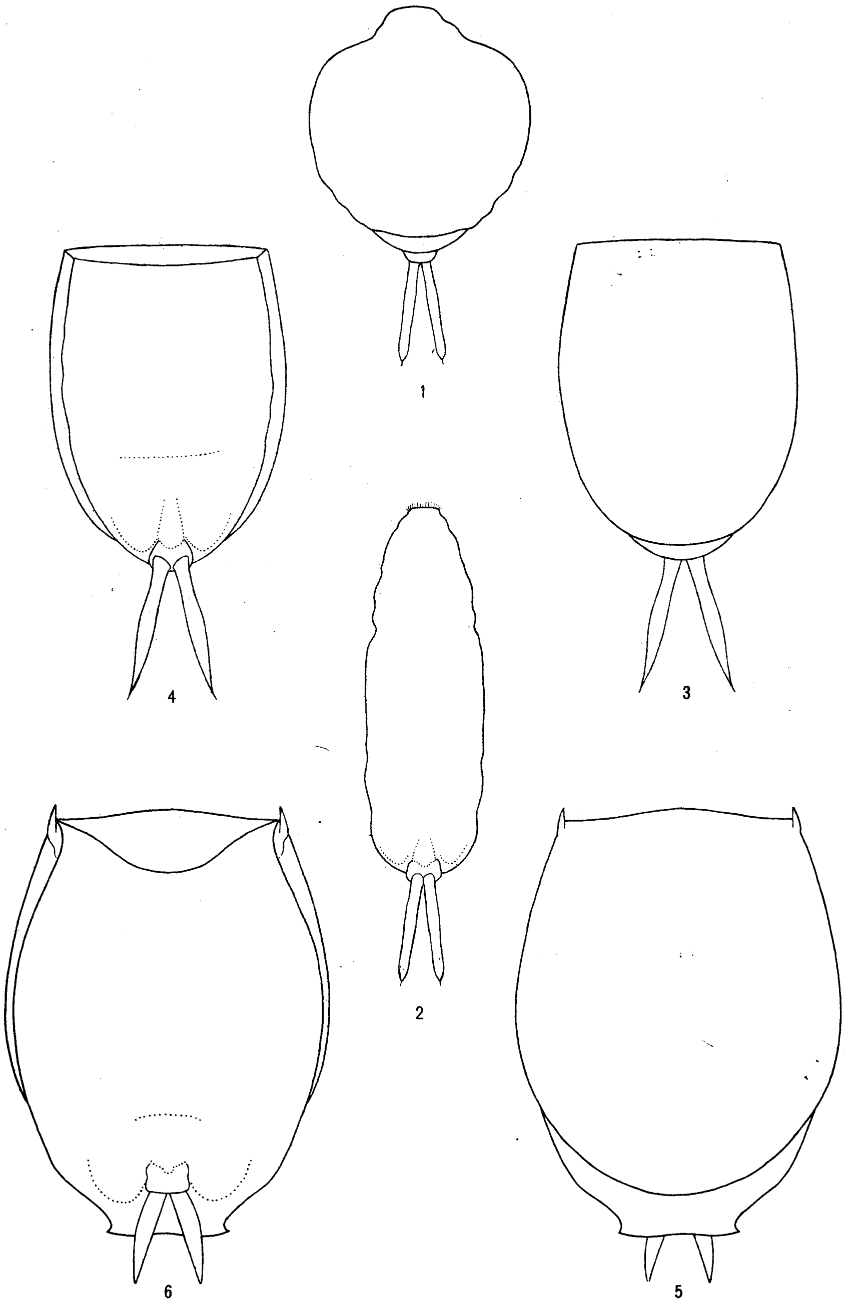


HARRING AND MYERS - LECANE

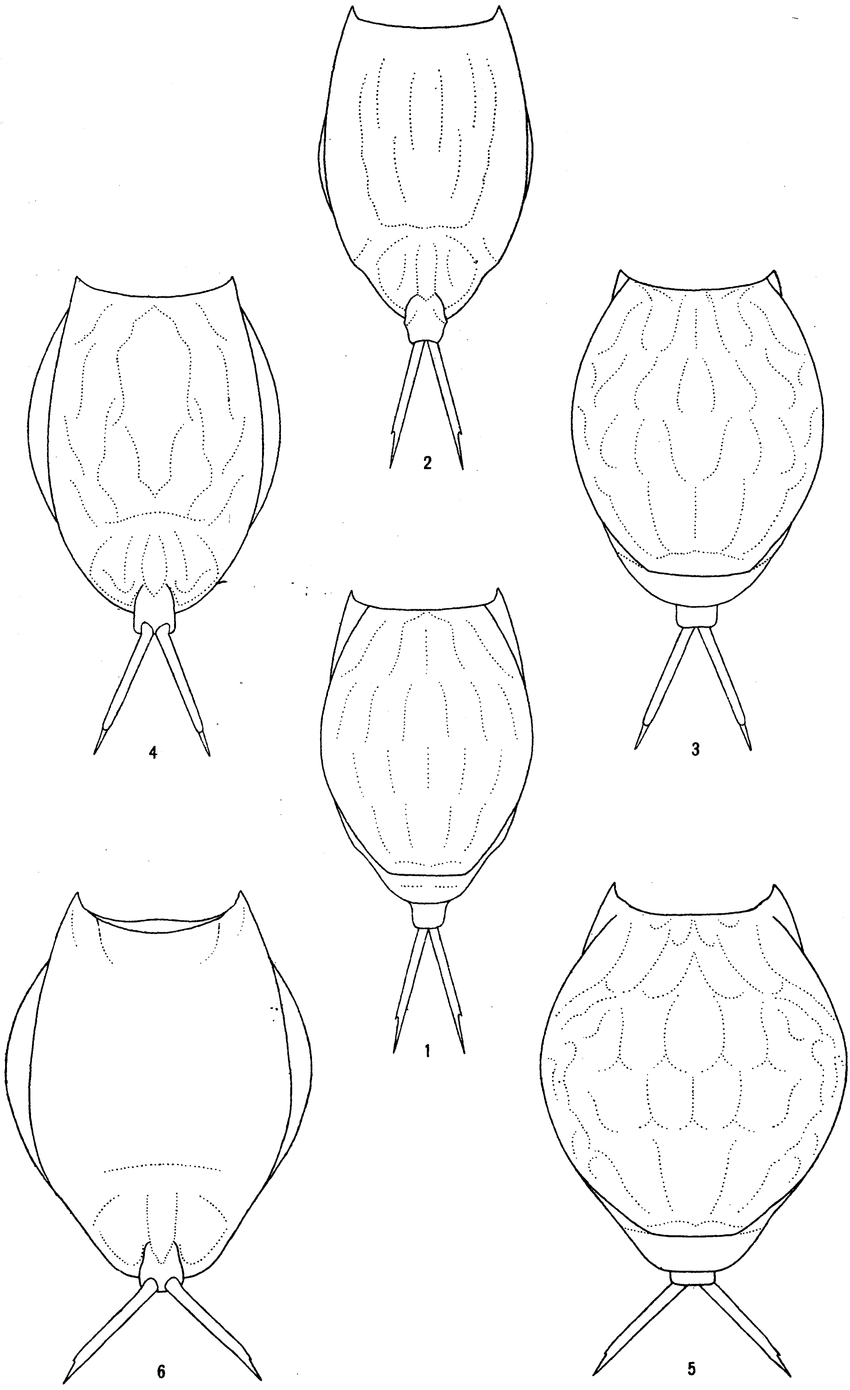


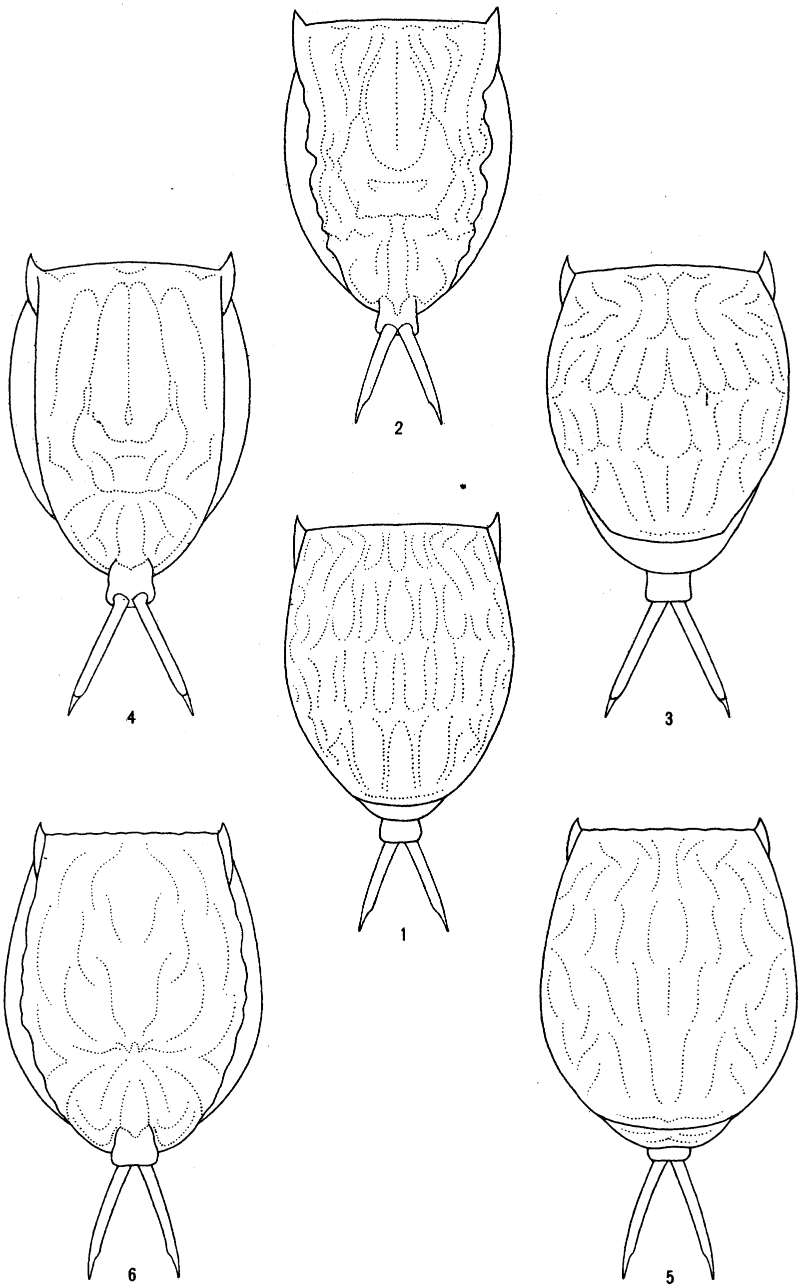
HARRING AND MYERS - LECANE


2
4
1
3
6
5

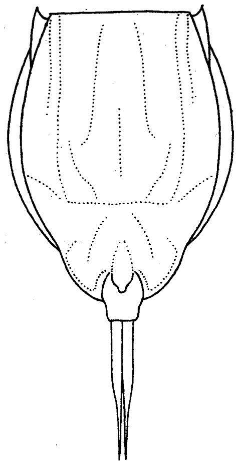


HARRING AND MYERS - LECANE

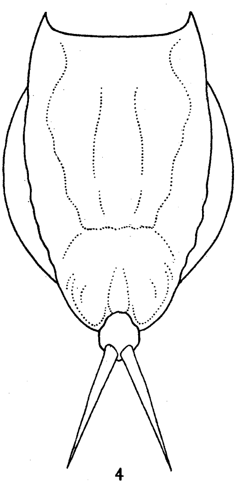

2
4
3
1
6
5



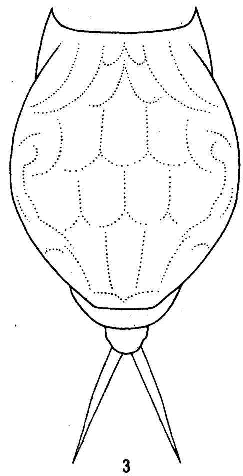
HARRING AND MYERS - LECANE



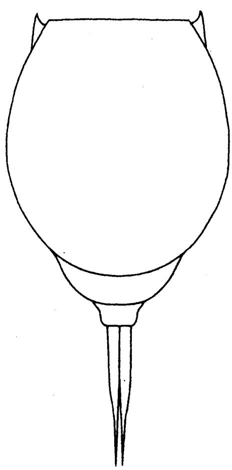
2



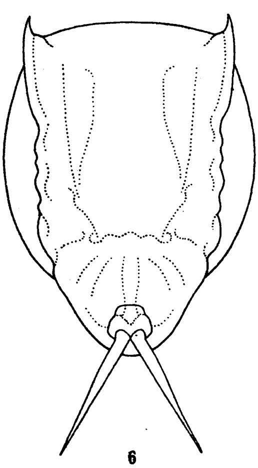
4



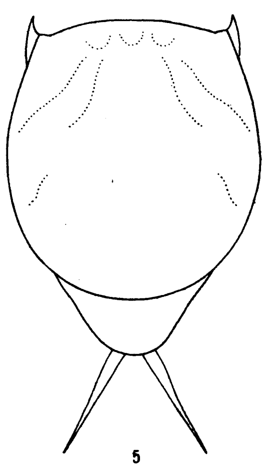
3



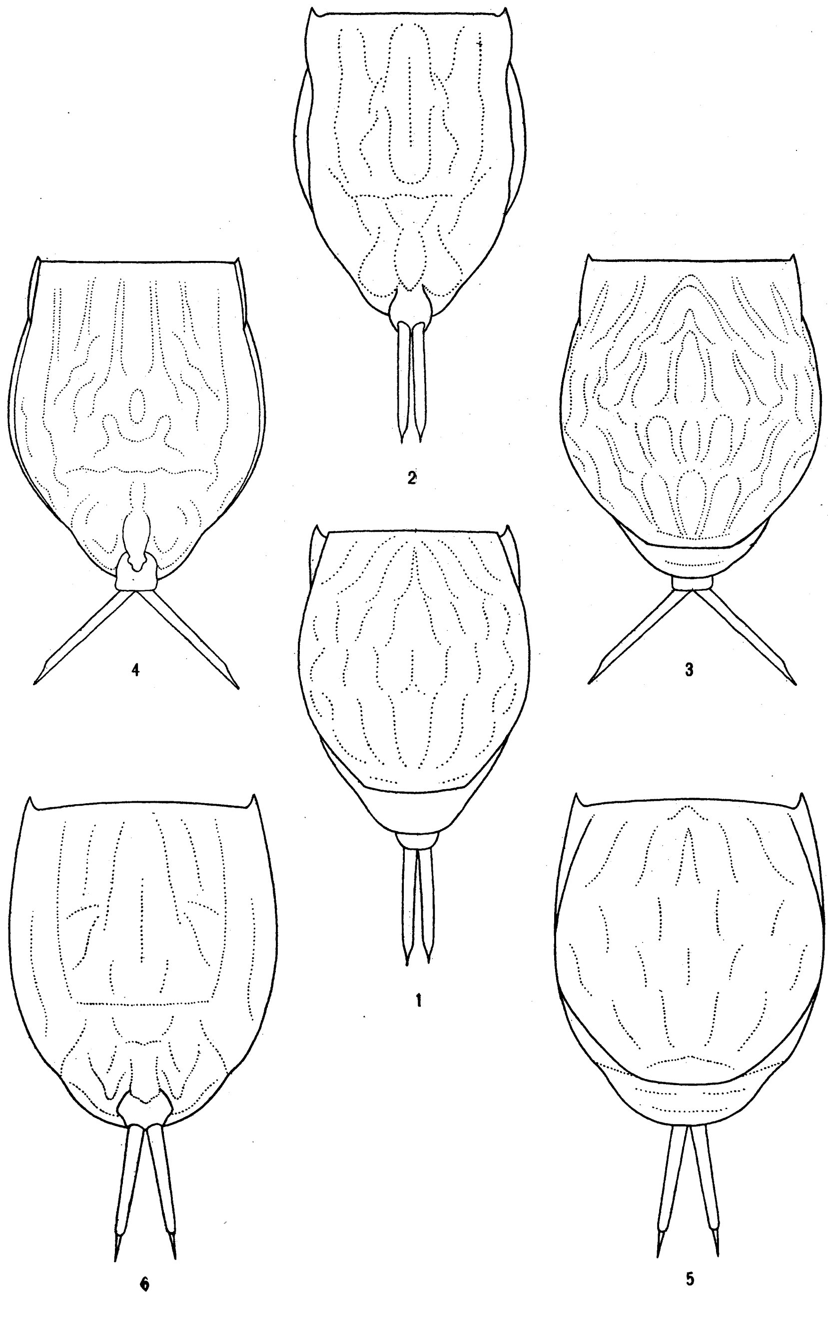
1

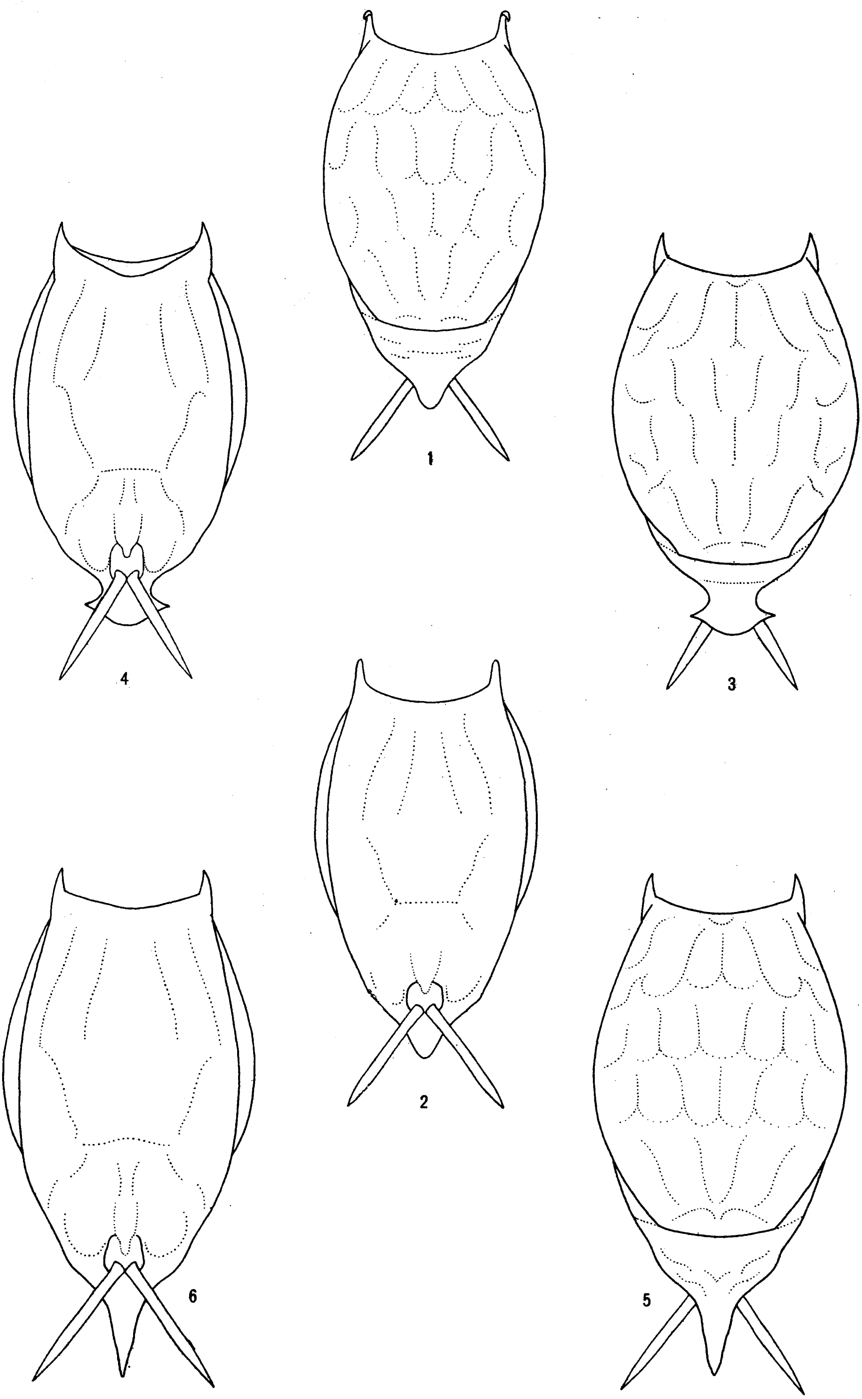


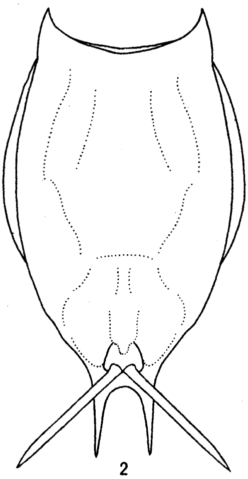
6



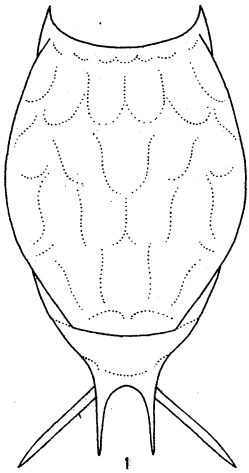
5


2
4
3
1
6
5

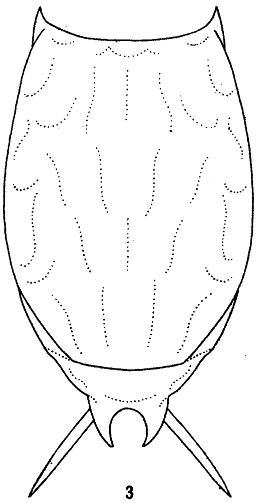

1
4
3
2
6
5



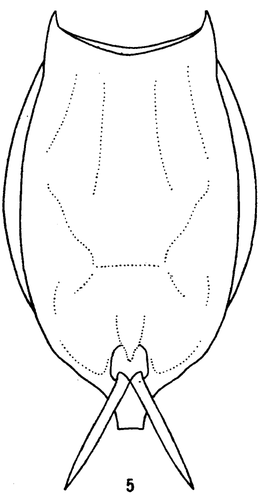
2



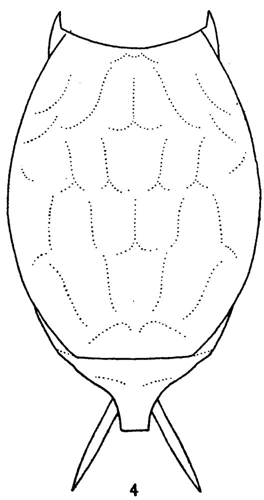
1



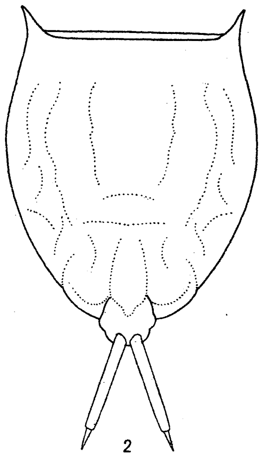
3



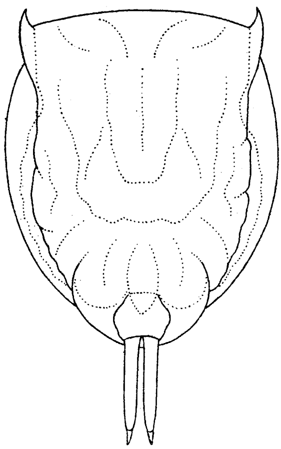
5



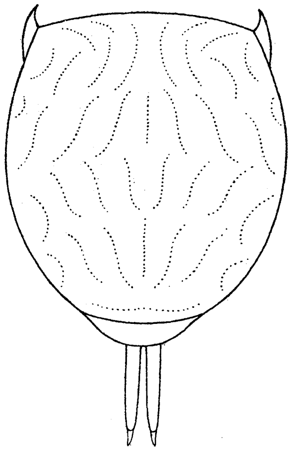
4



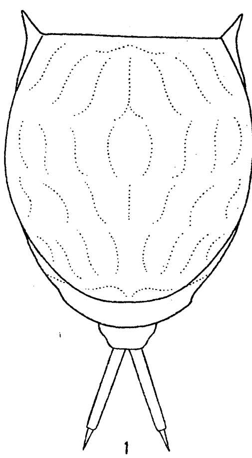
2



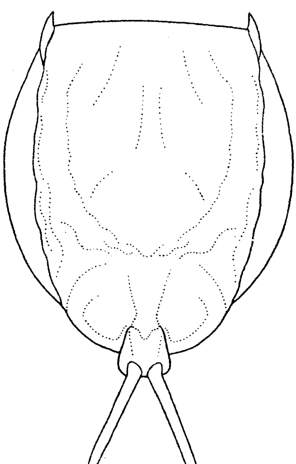
4



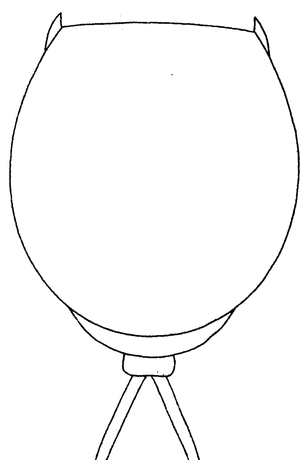
3



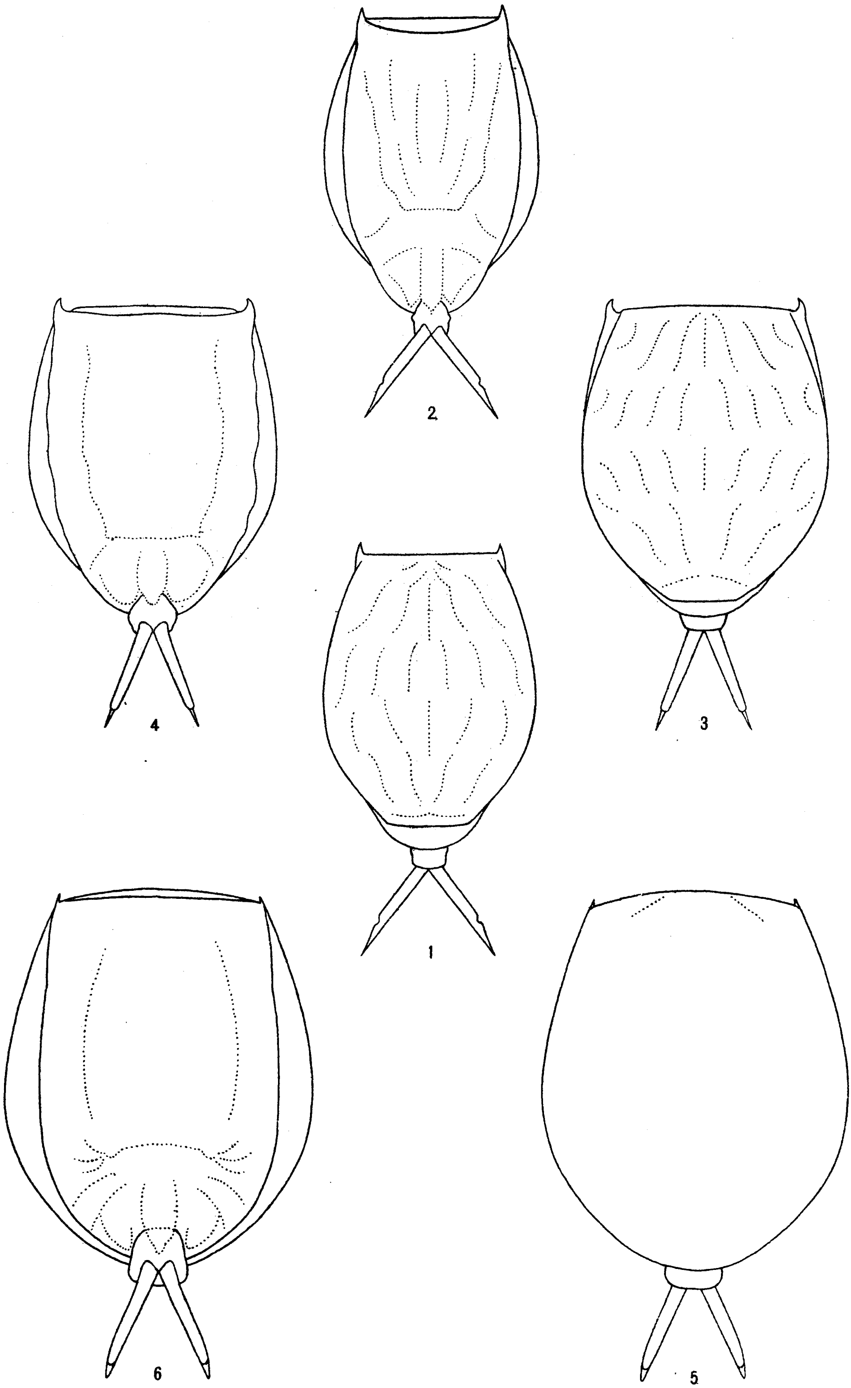
1



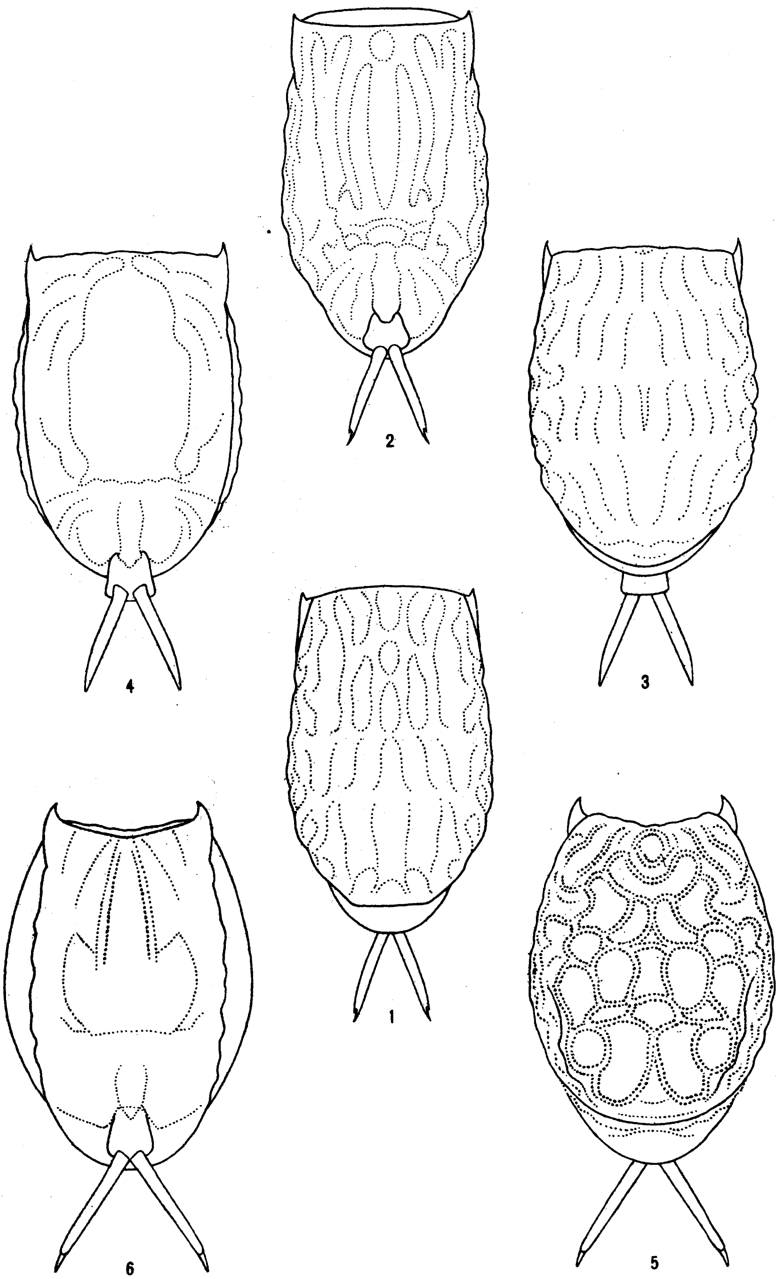
6

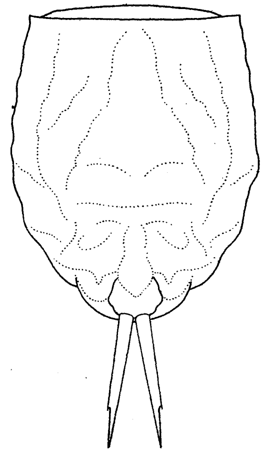


5

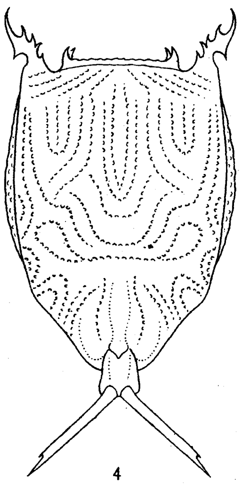


HARRING AND MYERS - LECANE

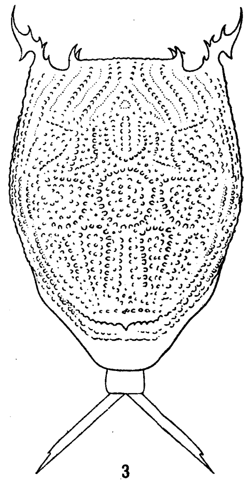

2
4
3
1
6
5



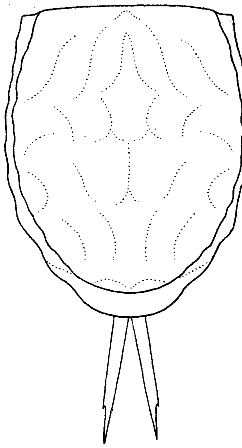
2



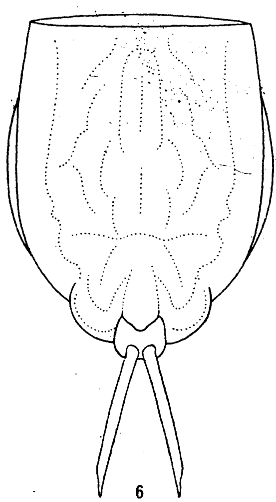
4



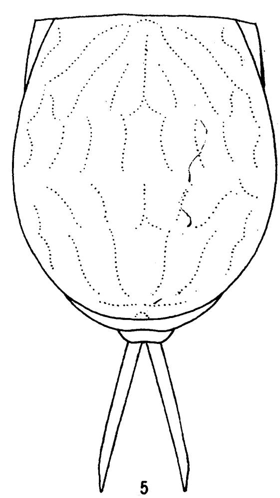
3



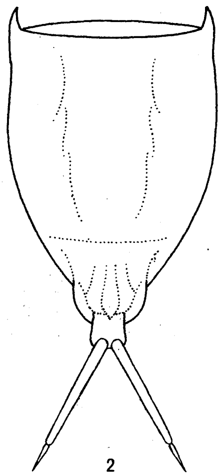
1



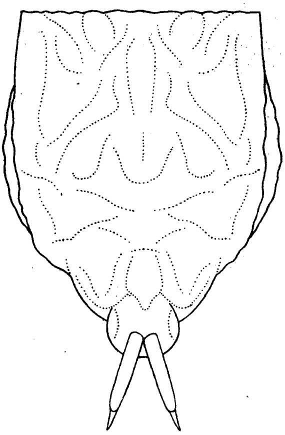
6



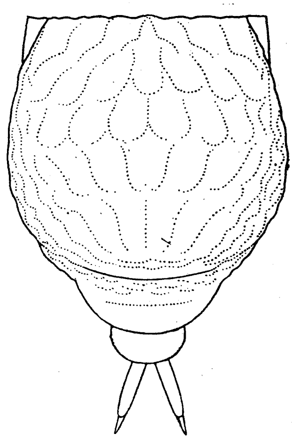
5



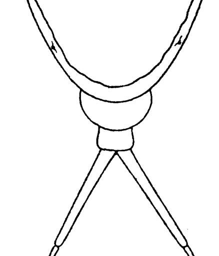
2



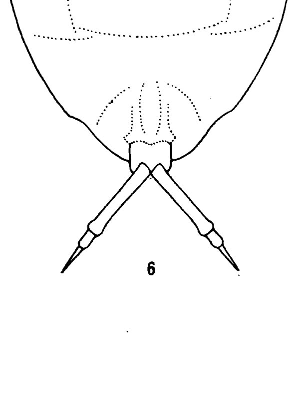
4



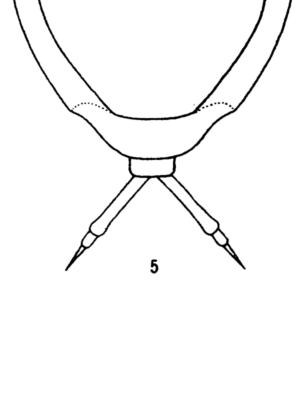
3



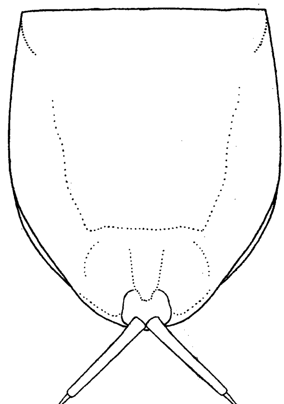
1



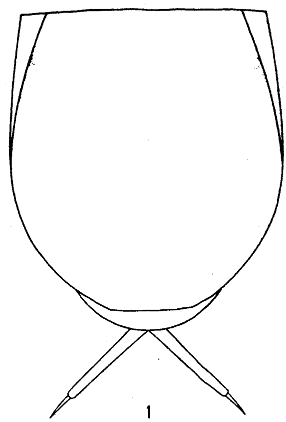
6



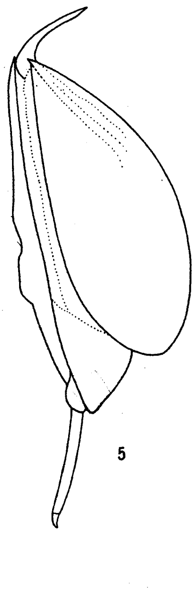
5



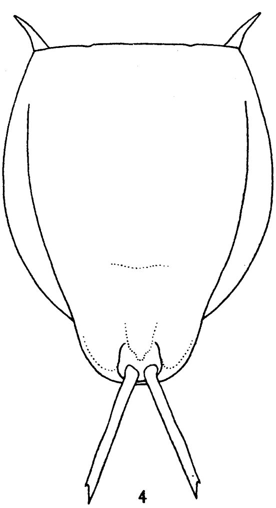
2



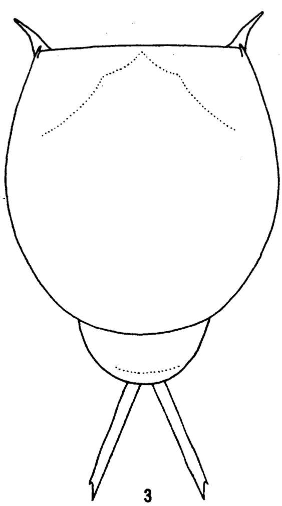
1



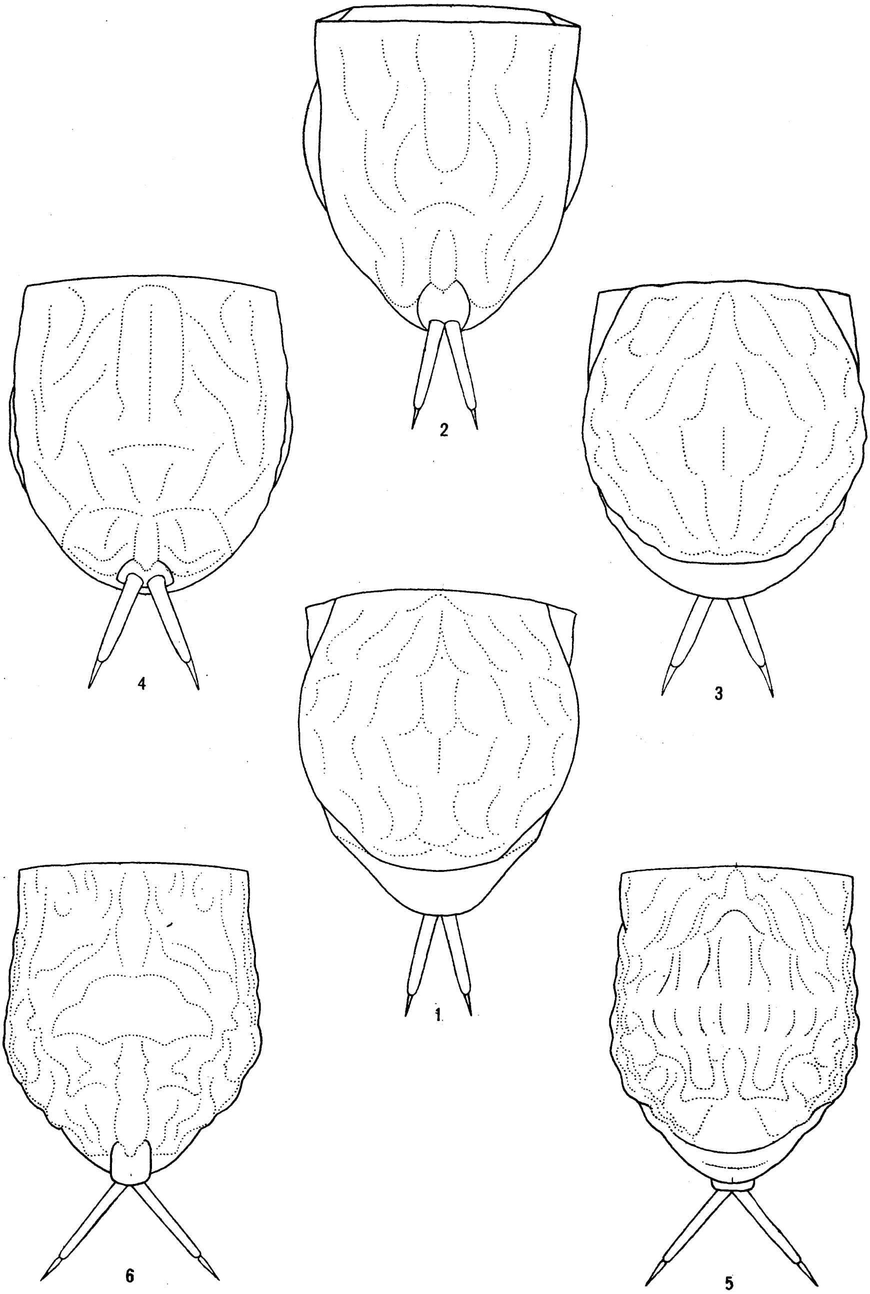
5

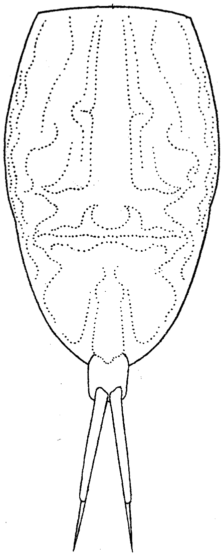


4

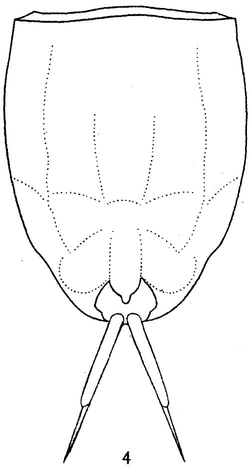


3

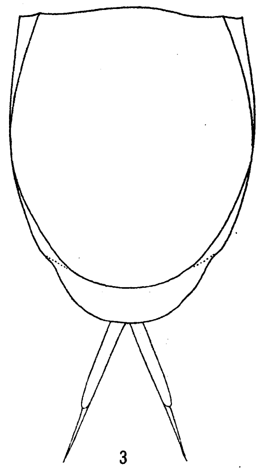

2
4
3
1
6
5



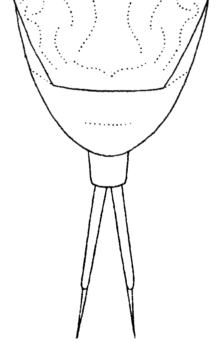
2



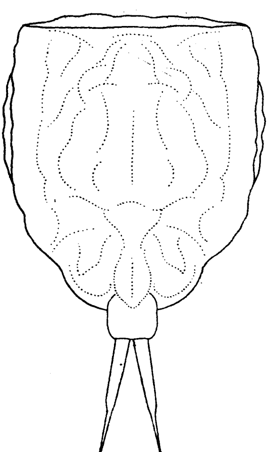
4



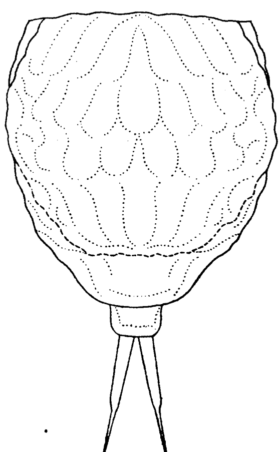
3



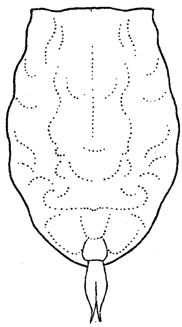
1



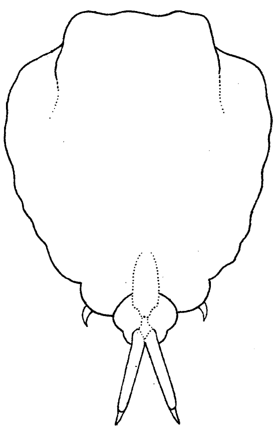
6



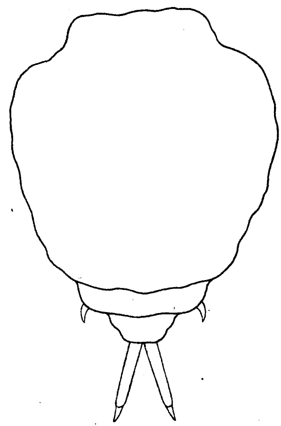
5



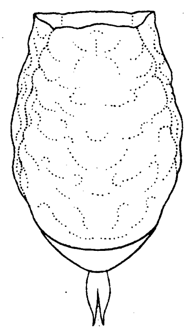
2



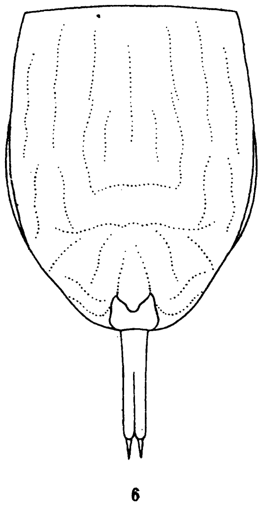
4



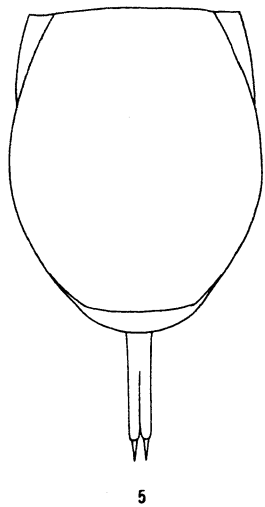
3



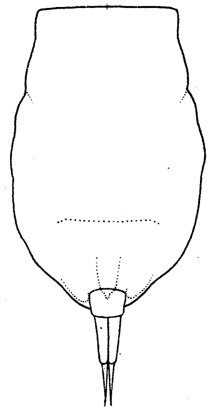
1



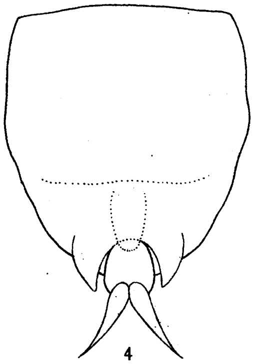
6



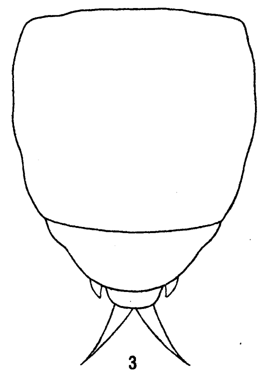
5



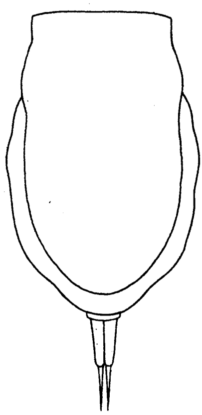
2



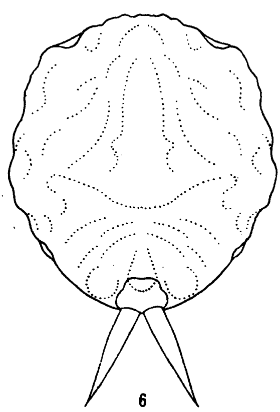
4



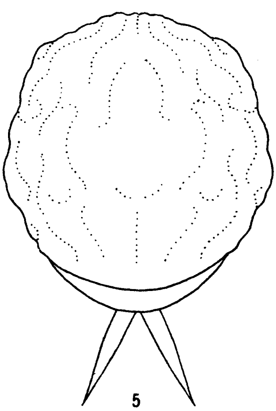
3



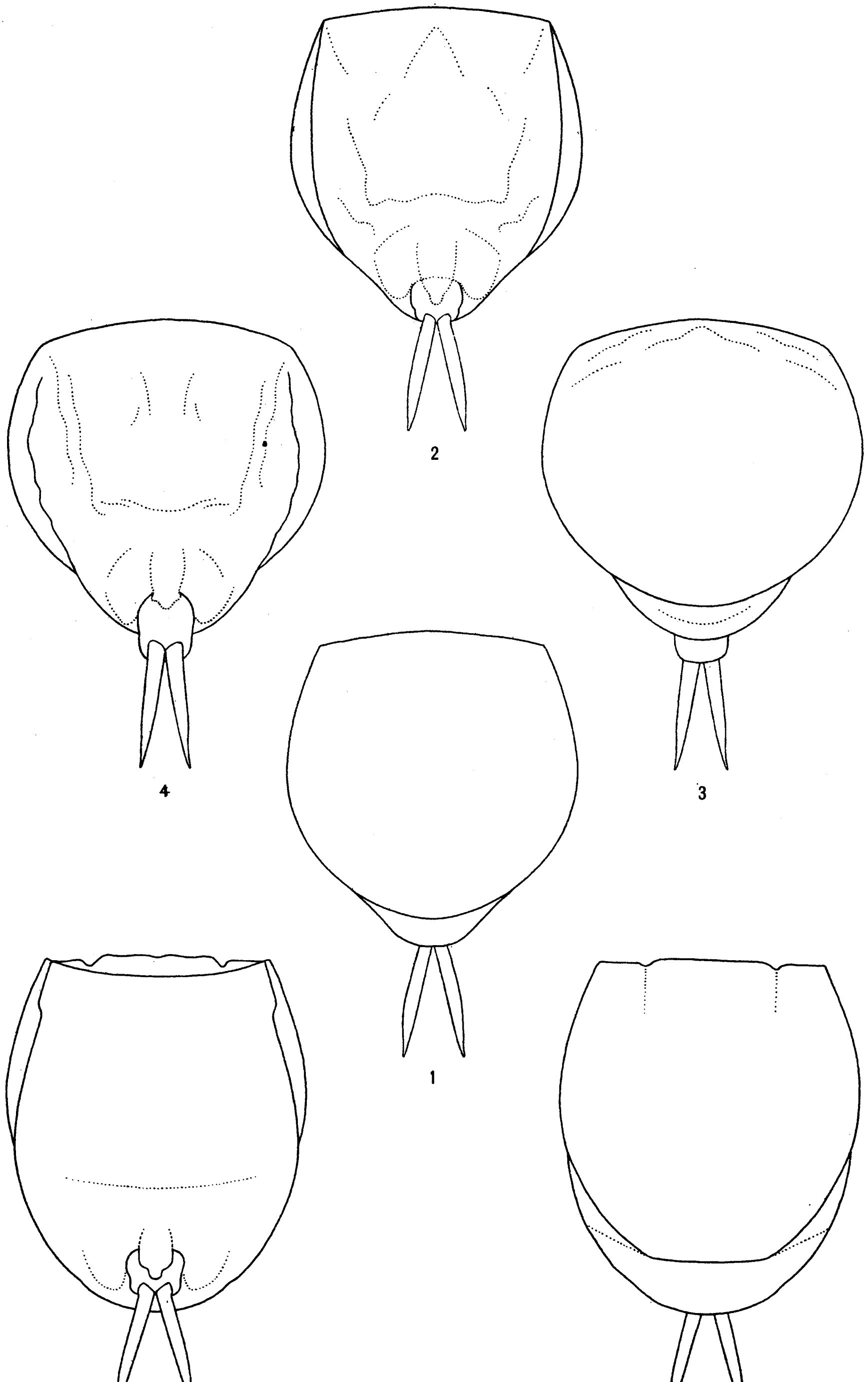
1



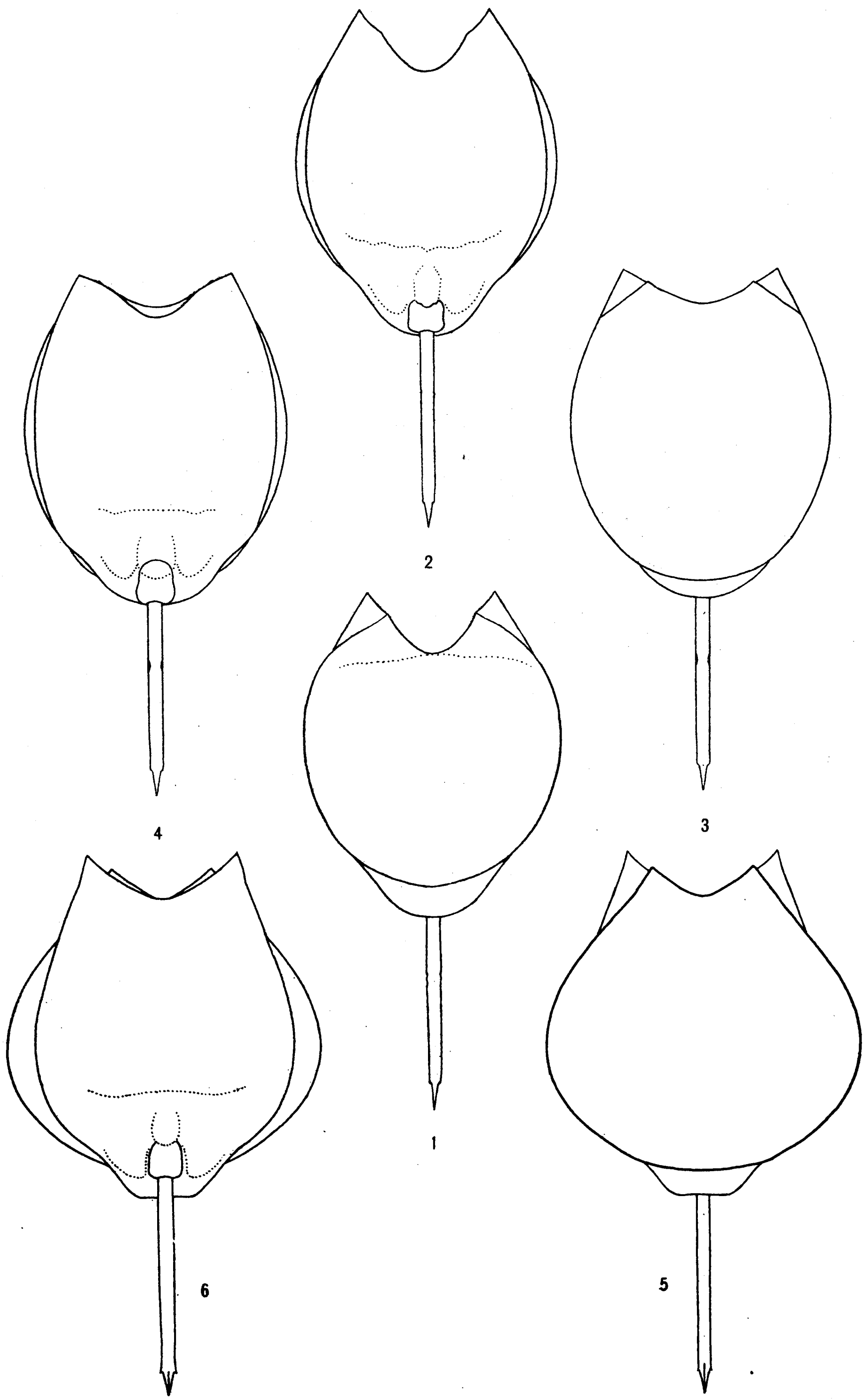
6

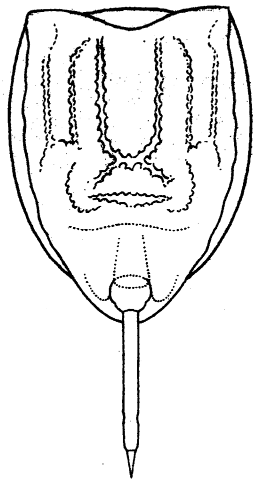


5

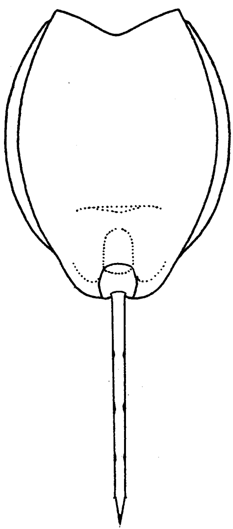


HARRING AND MYERS - LECANE

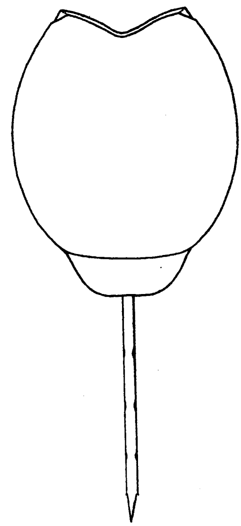

2
4
3
1
6
5



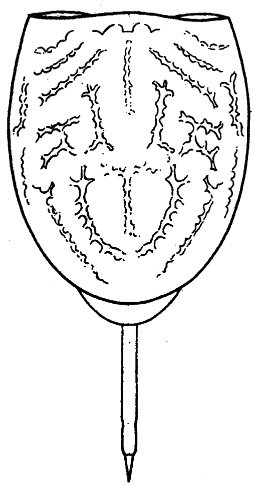
2



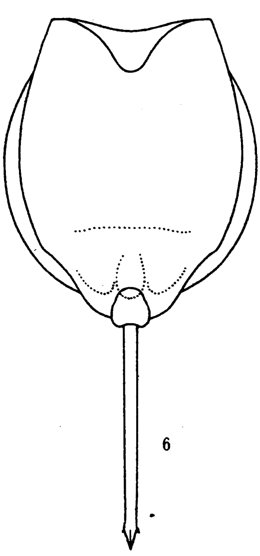
4



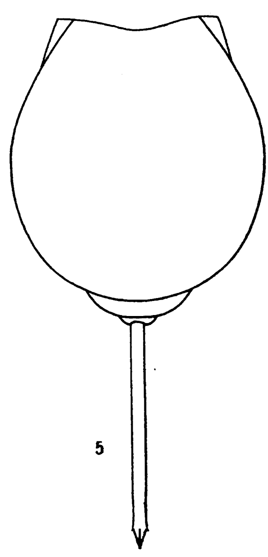
3



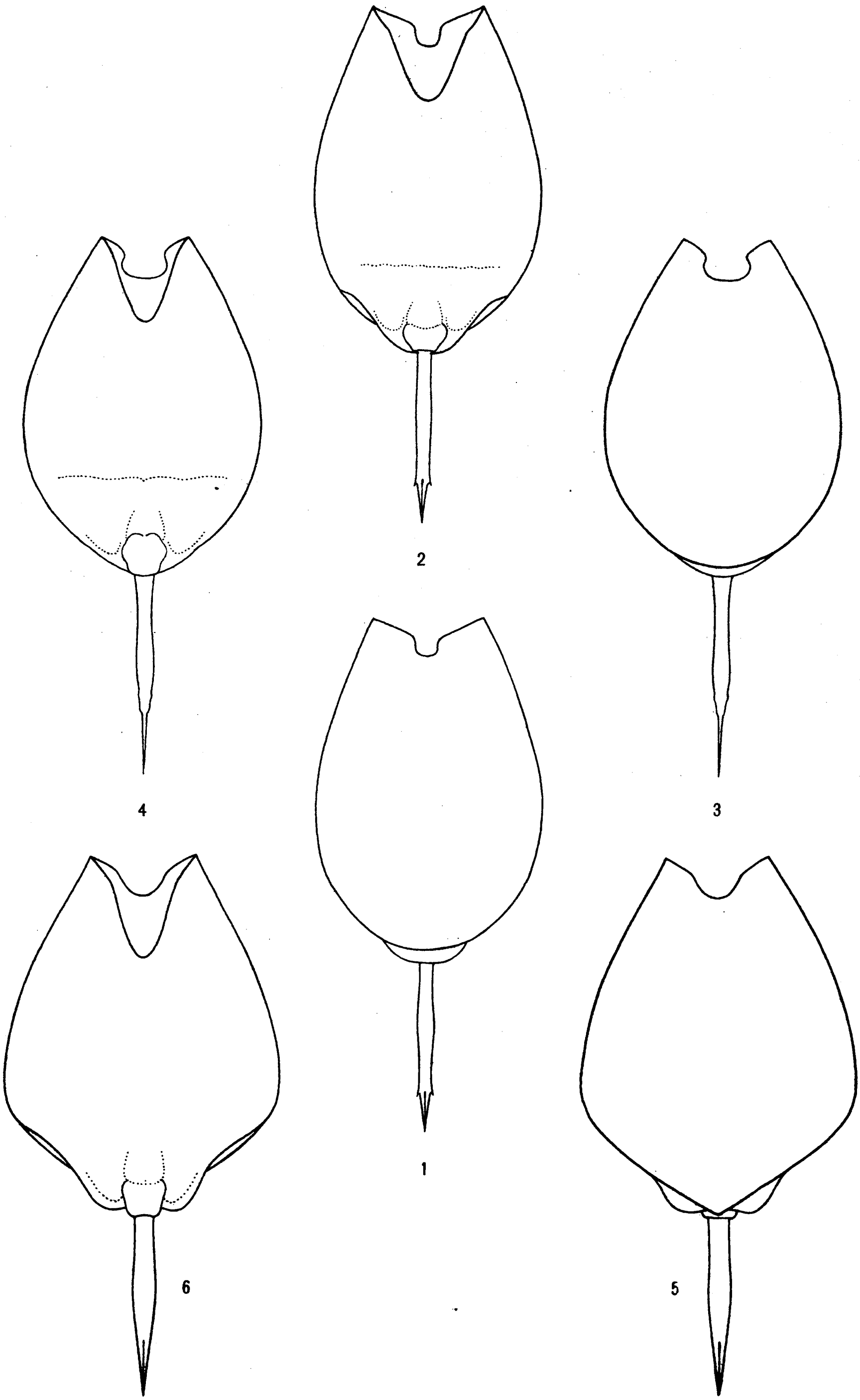
1

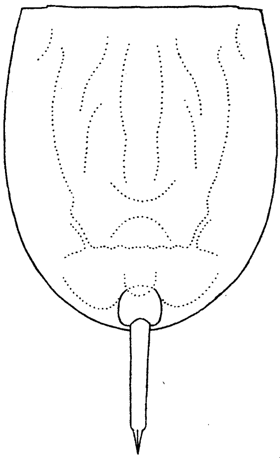


6

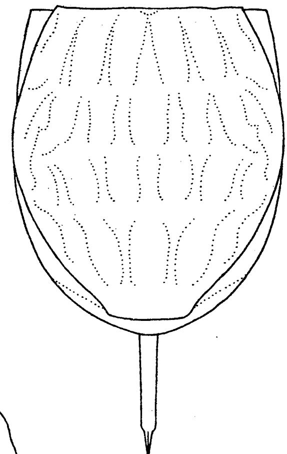


5

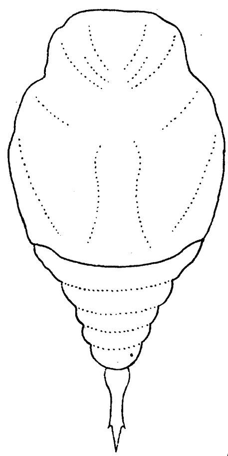

2
4
3
1
6
5



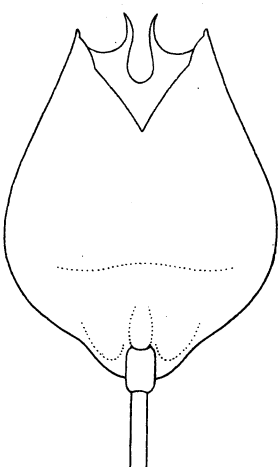
2



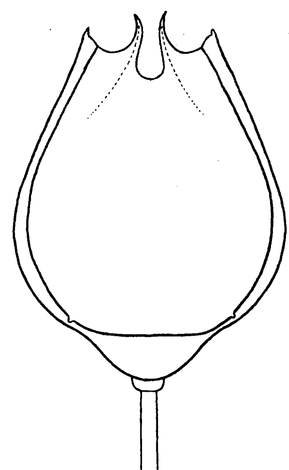
1



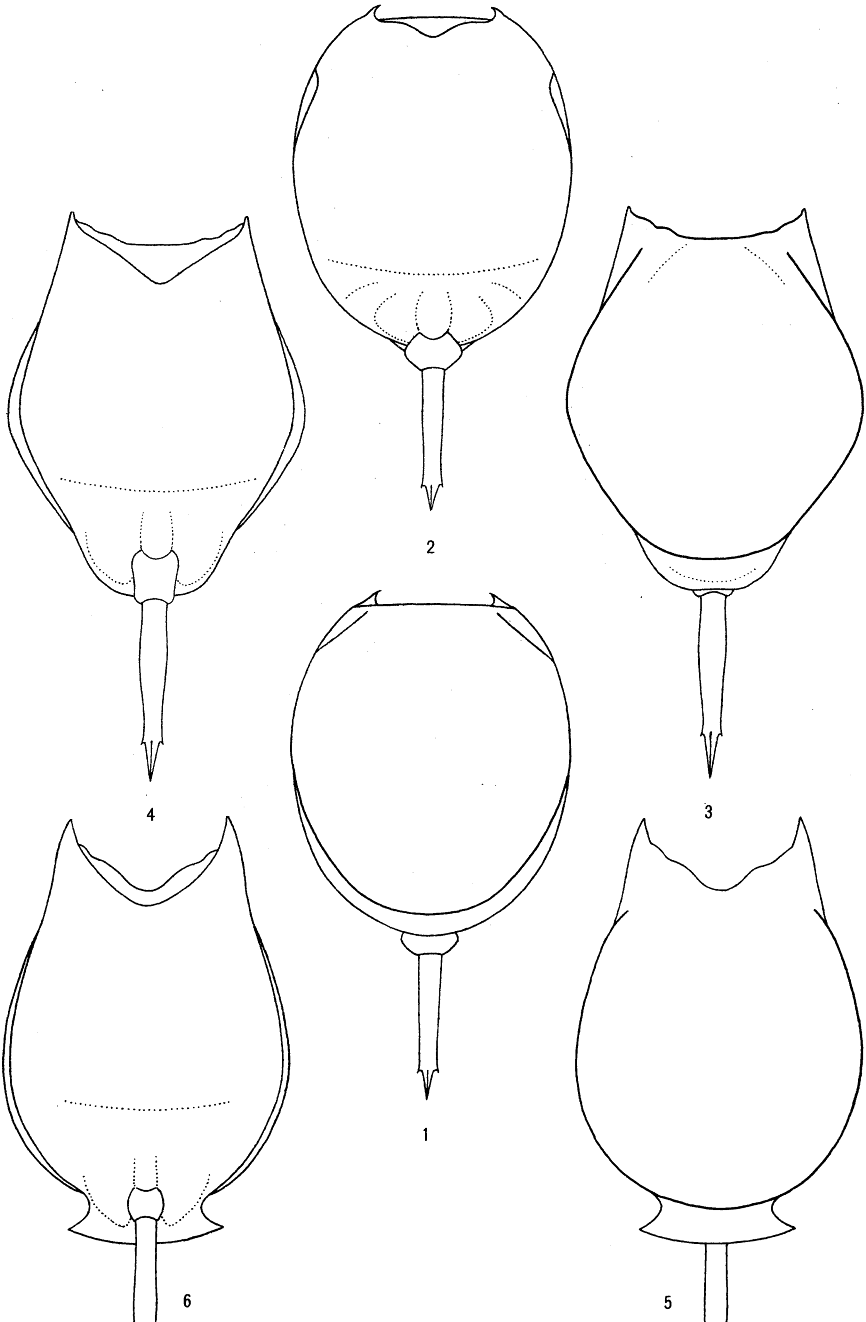
5

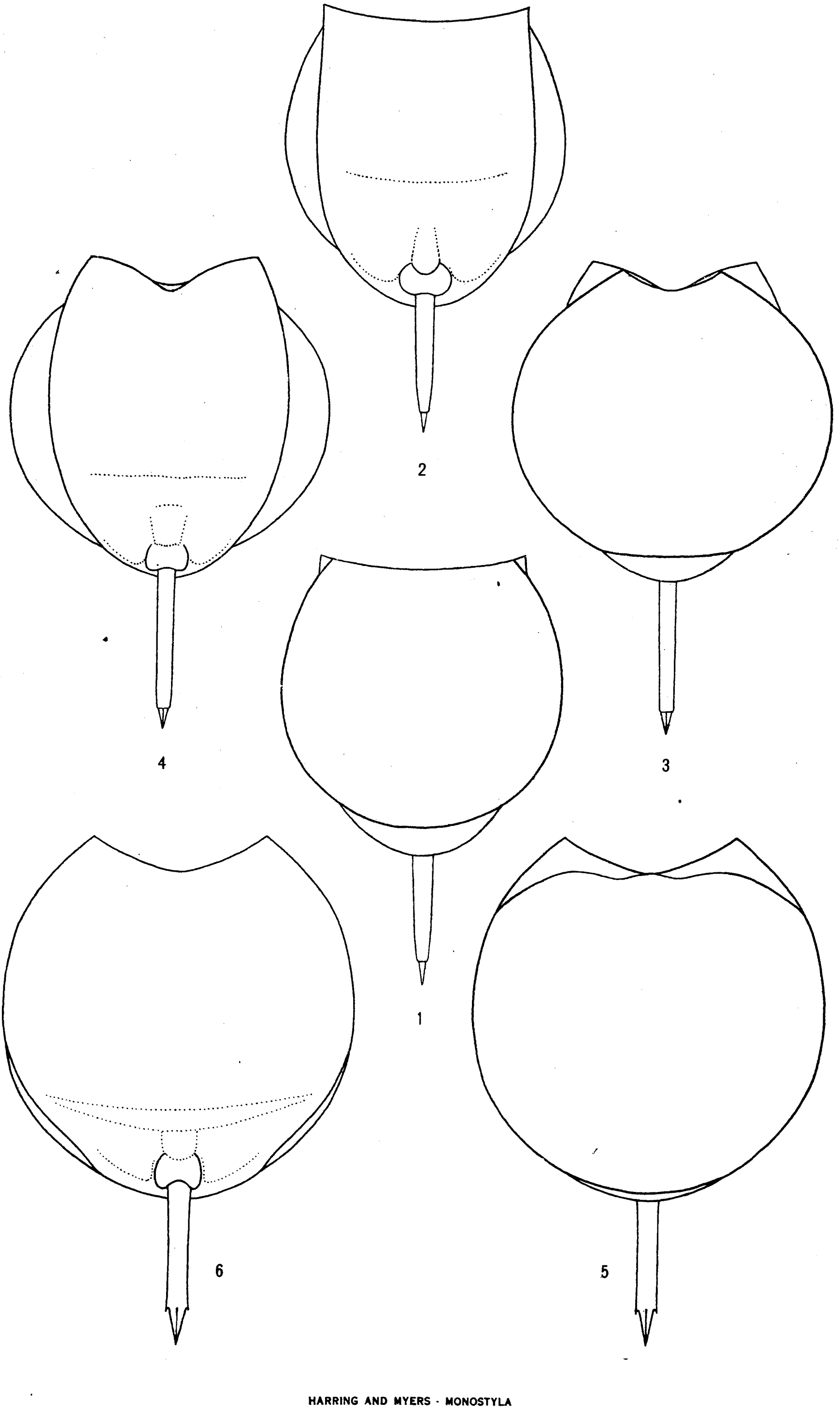


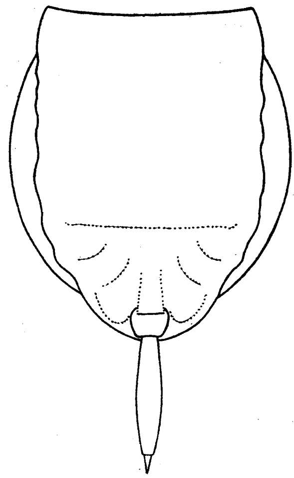
4



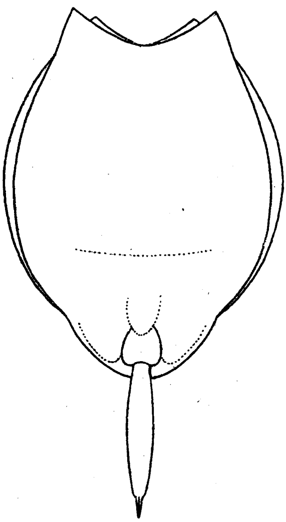
3


2
4
3
1
6
5

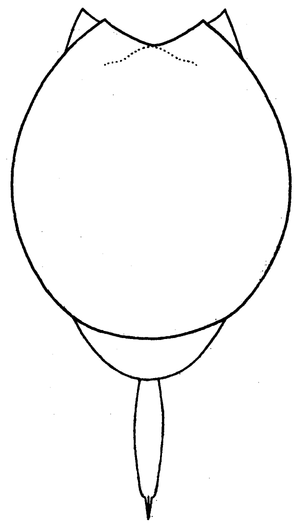

2
4
3
1
6
5



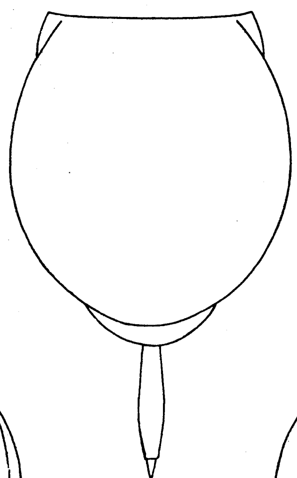
2



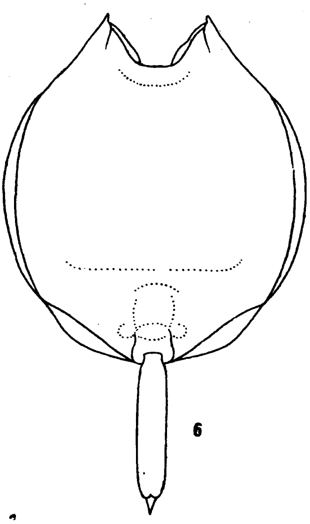
4



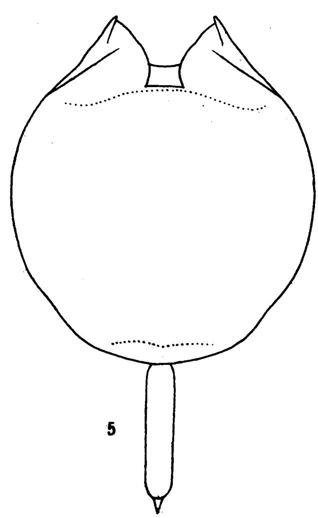
3



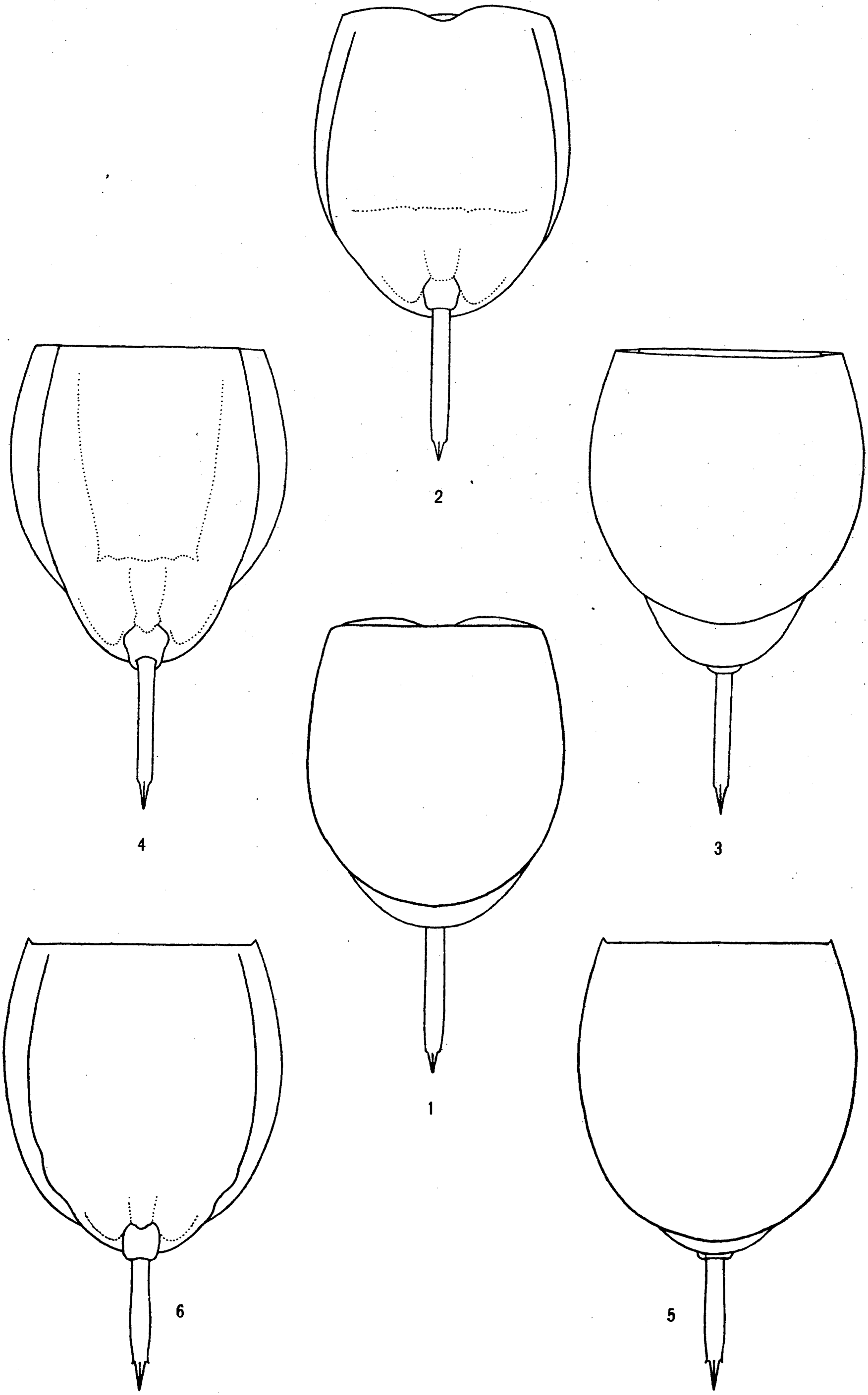
1

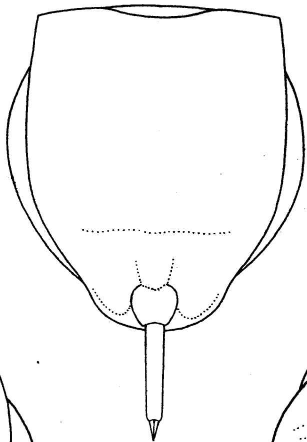


6

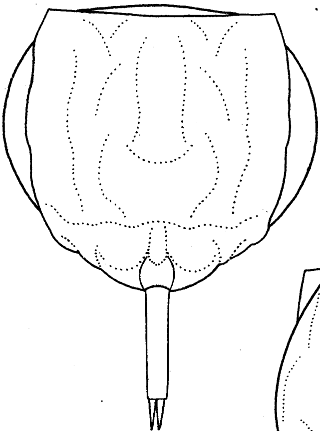


5

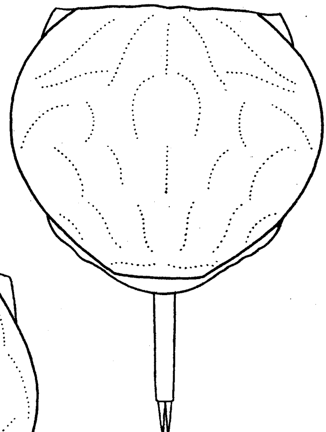

2
4
3
1
6
5



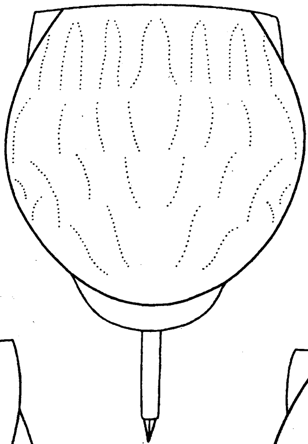
2



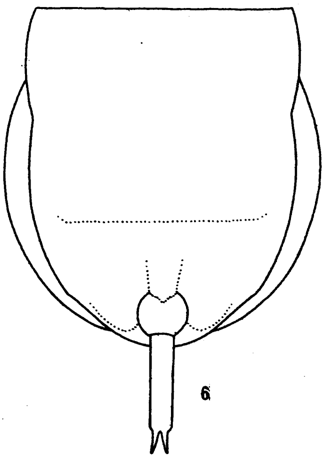
4



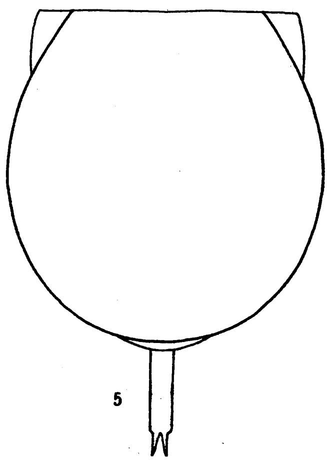
3



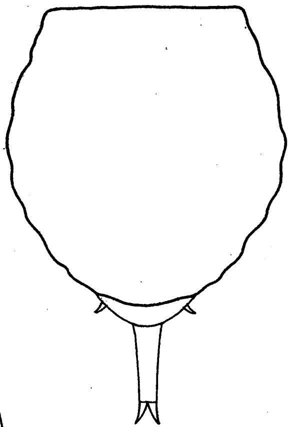
1



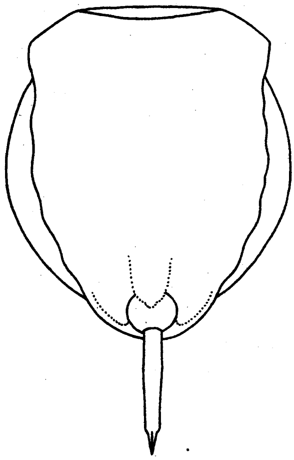
6



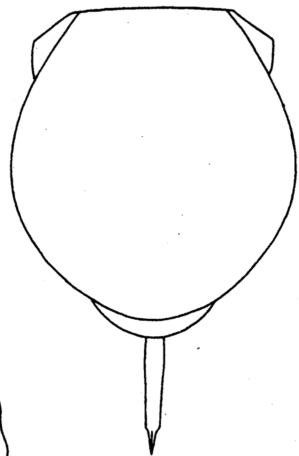
5



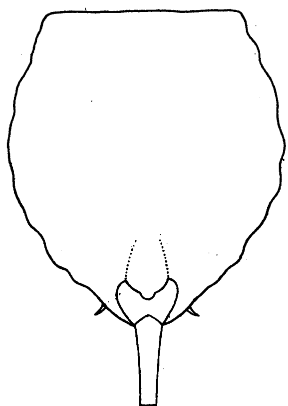
1



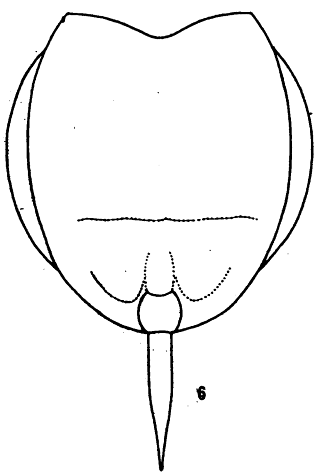
4



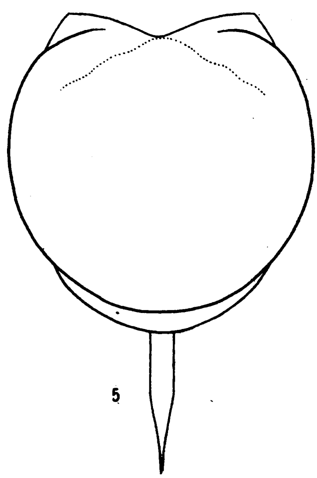
3



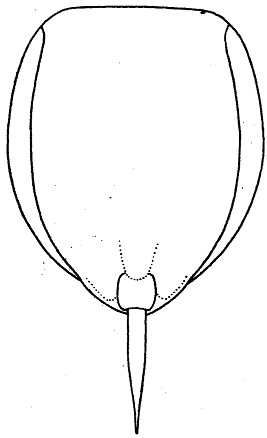
2



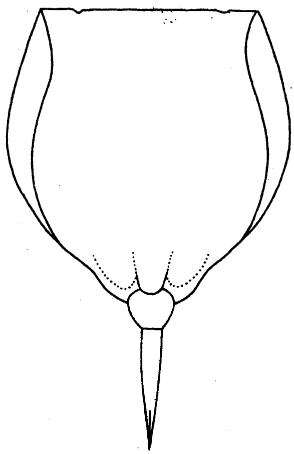
6



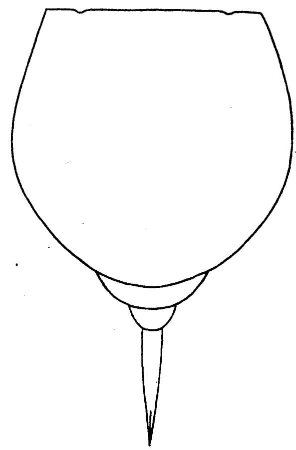
5



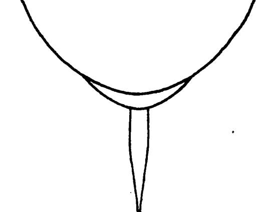
2



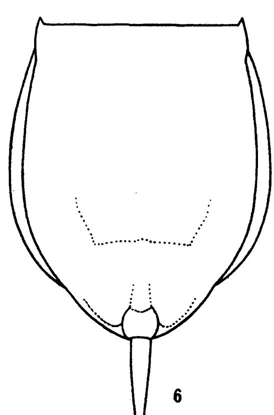
4



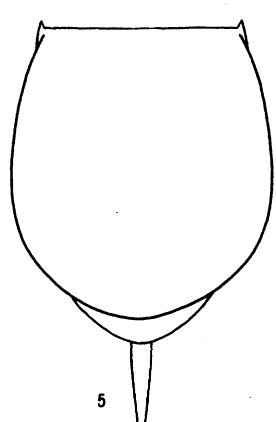
3



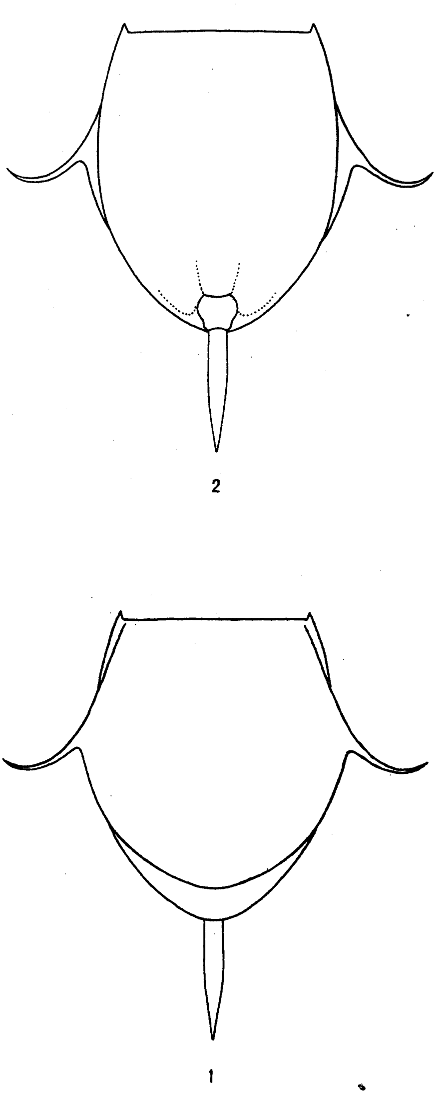
1

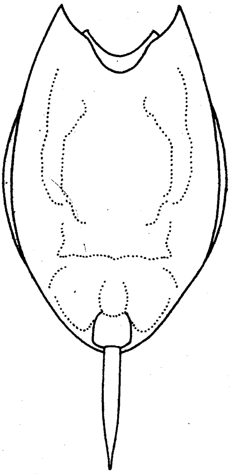


6

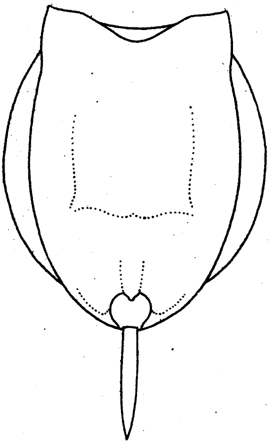


5

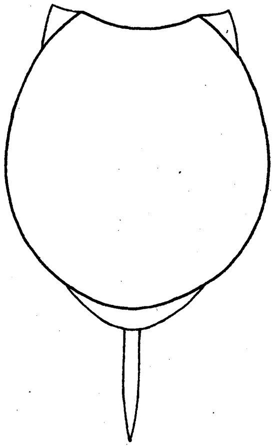

4
2
3
1



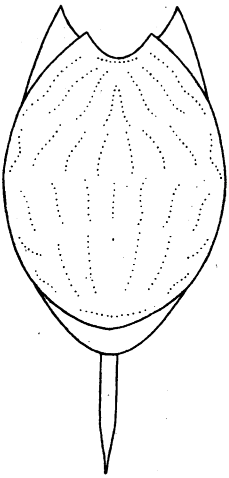
2



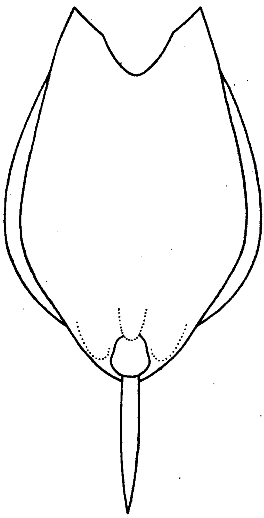
4



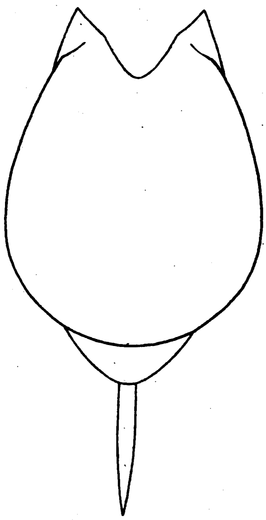
3



1



6



5

HARRING AND MYERS - MONOSTYLA

PROCEEDINGS OF THE ACADEMY
1924 AND 1925

FIFTY-FOURTH ANNUAL MEETING, 1924

The fifty-fourth annual meeting of the Wisconsin Academy of Sciences, Arts, and Letters, in joint session with the Wisconsin Archeological Society, was held at Madison, in the Biology Building of the University of Wisconsin, on Friday and Saturday, April 11 and 12, 1924.

Under the direction of the president the following programme was presented:

First Session, Friday, April 11, 10:00 A.M.

General Business.

Presentation of Papers.

1. Notes on some Wisconsin Saprolegniaceae. I. E. M. GILBERT. Illustrated.
2. Notes on some Wisconsin Saprolegniaceae. II. J. A. LOUNSBURY. Illustrated.
3. Some relations of chlorides in plant nutrition. W. E. TOTTINGHAM.
4. The nutrition of *Venturia inaequalis* (Cooke) Went. C. N. FREY. By title.
5. A method of anesthetizing Mimosa. C. N. FREY and E. H. TOOLE. By title.
6. Some water mites from Alaska. RUTH MARSHALL. By title.
7. Two Diptera suitable for experimental work in genetics. C. L. TURNER.
8. Factors influencing distribution of fresh-water ciliates. L. E. NOLAND.
9. Anti-body formation from injured tissues. M. F. GUYER.
10. Some geographic influences in the development of the Wisconsin dairy industry. G. T. TREWARTHA.
11. The constitution of liquids. FARRINGTON DANIELS. Illustrated.

Second Session, Friday, April 11, 2:00 P.M.

Presentation of Papers.

12. Duluth and the Discovery of the Northwest. LOUISE P. KELLOGG.

13. The name Chicago: Its Indian original, etc. E. P. WHEELER.
14. The teaching of Wisconsin history. W. C. ENGLISH.
15. Constellations of a Pawnee sky map. R. A. BUCKSTAFF. Fifteen minutes. Illustrated.
16. The antiquity of the tubular drill. GEO. B. PHILLIPS.
17. The Archangel campaign. JOHN G. GREGORY.
18. Some interesting customs of the people of India. NAND SINGH. Illustrated.
19. Napoleonic soldiers buried in Wisconsin. ALBERT O. BARTON.
20. A Wisconsin copper axe and gouge. CHARLES E. BROWN.

Third Session, Saturday, April 12, 9:30 A.M.

General Business.

Presentation of Papers.

21. Magnetic rotation in cobalt films. L. R. INGERSOLL. Illustrated.
22. The chance of rain. E. R. MILLER.
23. The dust fall of February 13, 1923. A. N. WINCHELL and E. R. MILLER.
24. The fauna of the Galena limestone near Appleton. JOHN W. OCKERMAN. (Introduced by R. M. Bagg)
25. Glacial history of Lake Mendota. W. O. HOTCHKISS.
26 Magnetic work in geology. H. R. ALDRICH. Illustrated.
27. The new geological groups at the Milwaukee Public Museum. IRA EDWARDS. Illustrated.
28. Road materials investigations. E. F. BEAN.

The annual dinner was held on Friday evening, April 11, at 6:30 p. m. Thirty-two members and guests were present. Following the dinner Professor Max Mason delivered an address on "Some Gordian Knots in Physical Theory".

At the business session the Secretary presented the following applications for membership. On motion he was unanimously instructed to cast the ballot in their favor.

Bernhard P. Domogalla, Madison
Percival T. Gates, Chicago
F. Gregory Hall, Milton
Edward S. Hathaway, Madison
James A. Lounsbury, Madison
Harland W. Mossman, Madison
Harvey M. Smith, Madison
Rubert B. Streets, Madison

Report of Secretary, April 1, 1923, to March 31, 1924

Honorary Members	7
Life Members	17

Corresponding Members	31	
Active Members	306	
		361
Resigned	2	
Deaths	5	
Dropped for non-payment of dues	15	
		32

Five members have been lost by death during the past year: Bishop Samuel Fallows, Professor R. D. Salisbury, Professor M. S. Slaughter, President Sidney T. Smythe, Mr. Edgar E. Teller.

CHANCEY JUDAY,
Secretary.

Report of Treasurer, April 1, 1923, to March 31, 1924

Receipts

Balance in Treasury April 1, 1923	$1,547.26
Received for dues and initiations	273.00
Interest on bonds in 1923	150.25
Received from sales of Transactions	30.44
Bonds maturing in 1924	1,000.00
Interest on bonds in 1924	156.25
Annual appropriation July 1, 1923	1,500.00
	$4,657.20

Disbursements

Bonds purchased	$1,200.00
Certificate of deposit	72.75
Safe deposit rent, 1923 and 1924	5.00
Expenses of speakers at Beloit meeting	27.00
Postage	2.51
Printing and stationery	130.66
	$1,437.92
Balance in Treasury March 31, 1924	3,219.28

Securities held by Academy, March 31, 1924

U. S. Government bond	$100.00
City of Madison bonds	2,800.00
Certificates of deposit	72.75
	$2,972.75

Audited and found correct.

CHANCEY JUDAY,
Treasurer.

C. L. TURNER,
A. S. PEARSE,
Auditors.

FIFTY-FIFTH ANNUAL MEETING, 1925

The fifty-fifth annual meeting of the Wisconsin Academy of Sciences, Arts and Letters was held at the State Normal School, Oshkosh, on Friday and Saturday, April 10 and 11, 1925, in joint session with the Wisconsin Archeological Society, the Wisconsin Museums Conference, and the Winnebago County Archeological and Historical Society.

The following programme was presented at the various sessions.

First Session, Friday, April 10, 9:30 A.M.

General Business.

Presentation of Papers.

1. The method by which parental characters in a liverwort are distributed among the offspring. C. E. ALLEN. Illustrated.
2. Temperature relations to seed germination. J. F. GROVES. Illustrated.
3. The orchids of Wisconsin. ALBERT E. FULLER. Illustrated.
4. Notes on parasitic fungi in Wisconsin. XIII. J. J. DAVIS. By title.
5. The reaction pathway, with demonstration. R. C. MULLENIX.
6. Some recent discoveries in the Wisconsin Cambrian. IRA EDWARDS.
7. Artesian conditions of the Appleton region. J. W. OCKERMAN.
8. Progress in bird banding. W. I. LYON. Illustrated.

Second Session, Friday, April 10, 2:00 P.M.

General Business.

Presentation of Papers.

9. An unusual agricultural museum. L. J. COLE. Illustrated.
10. Practical benefits of the Wisconsin Museums Conference. S. A. BABBETT.

11. Administrative methods for small museums. W. D. BABCOCK, JR.
12. Round table discussion of museum topics. The discussion will be led by Mrs. ARTHUR C. NEVILLE and Miss DEBORAH B. MARTIN.

Third Session, Saturday, April 11, 9:00 A.M.

General Business.

Presentation of Papers.

13. The flowers of Shakespeare's garden. HURON H. SMITH. Illustrated.
14. Extracts from the original letter book of Judge James Duane Doty dated 1821. GENE STURTEVANT.
15. The Wisconsin military road. H. E. COLE.
16. Development of a typical Wisconsin rural community. E. A. CLEMENS.
17. Indian remains of Winnebago County. GEORGE OVERTON.
18. Wisconsin archeological researches, 1912–1925. CHARLES E. BROWN.

The annual dinner was held at the Athearn Hotel on Friday evening at 6:30 p. m. Forty-three members and guests were present.

Following the dinner Mr. Alonzo W. Pond delivered an address on "Delving Back of History", illustrated with lantern slides. Dr. S. A. Barrett then gave an address on "Filming Moose on Isle Royale", illustrated with moving pictures. These addresses were held in the Assembly Room of the City High School of Oshkosh.

At the business session the Secretary presented the following applications for membership. On motion he was unanimously instructed to cast the ballot in their favor.

E. F. Bean, Madison
Nile J. Behncke, Oshkosh
Tranquilino G. Fajardo, Madison
Albert M. Fuller, Milwaukee
A. A. Granovsky, Madison
John W. Ockerman, Appleton
C. M. Tompkins, Madison
E. J. Wimmer, Milwaukee.
R. T. Zoch, Madison

Report of Secretary, April 1, 1924, to March 31, 1925

Honorary Members	7
Life Members	15
Corresponding Members	28
Active Members	288
	338
Resigned	2
Dropped for non-payment of dues	4
Deaths	4
	10

Information regarding the death of four members has been received during the past year:

Professor Joseph Paxon Iddings, Mr. Thomas Evans Brittingham, President Samuel Plantz, Dr. Norman Bridge.

A vote of thanks was extended to the Winnebago County Archeological and Historical Society, the State Normal School, and the City High School for their interest in the meetings and for the use of rooms for the sessions.

CHANCEY JUDAY,
Secretary.

Report of Treasurer, April 1, 1924, to March 31, 1925

Receipts

Balance in Treasury, April 1, 1924	$3,204.28
Sale of Transactions	9.57
Received for reprints	175.00
Received from Wisconsin Survey for printing	500.00
Interest on bonds	7.93
Annual dues of members	296.00
Annual appropriation July 1, 1924	1,500.00
	$5,692.78

Disbursements

Printing announcements and programmes	$16.12
Printing Volume XXI of Transactions	2,202.67
Allowance of Secretary for 1924	200.00
Miscellaneous expenses and postage	9.18
	$2,427.97

Balance in Treasury March 31, 1925	3,264.81

Cash and securities held by Academy, March 31, 1925

U. S. Government bond	$100.00
City of Madison bonds	2,900.00
Certificates of deposit	73.66
Cash	42.82
	$3,116.48

Audited and found correct.

CHANCEY JUDAY,
Treasurer.

R. N. BUCKSTAFF,
GEORGE WAGNER,
Auditors.

LIST OF OFFICERS AND MEMBERS

CORRECTED TO NOVEMBER 1, 1925.

OFFICERS

President, L. J. COLE, Madison.
Vice-President, Sciences, SAMUEL A. BARRETT, Milwaukee.
Vice-President, Arts, GRANT SHOWERMAN, Madison.
Vice-President, Letters, ARTHUR BEATTY, Madison.
Secretary, CHANCEY JUDAY, Madison.
Treasurer, CHANCEY JUDAY, Madison.
Curator, C. E. BROWN, Madison.
Librarian, WALTER M. SMITH, Madison.

COMMITTEE ON PUBLICATION

The President, ex officio,
The Secretary, ex officio,
W. E. TOTTINGHAM, Madison.

COUNCIL

The President, Vice-Presidents, Secretary, Treasurer, Librarian and Past Presidents retaining their residence in Wisconsin.

Committee on Library.

The Librarian, ex officio,
W. H. Barber, Madison,
A. E. Culver, Stevens Point,
George Wagner, Madison.

Committee on Membership.

The Secretary, ex officio,
A. S. Pearse, Madison,
P. W. Boutwell, Beloit,
R. N. Buckstaff, Oshkosh,
Huron H. Smith, Milwaukee.

Past Presidents.

Honorable John W. Hoyt,[1] 1870–1875.
Doctor P. R. Hoy,[1] 1876–1878.
President A. L. Chapin,[1] 1879–1881.
Proffessor Ronald D. Irving,[1] 1882–1884.
Professor Thomas C. Chamberlin, 1885–1887.
Professor William F. Allen,[1] 1888–1889.
Professor Edward A. Birge, 1889–1890.
Librarian George W. Peckham,[1] 1891–1893.
President Charles R. Van Hise,[1] 1894–1896.
Professor C. Dwight Marsh, 1897–1899.
Professor Charles S. Slichter, 1900–1902.
Doctor John J. Davis, 1903–1905.
Professor Louis Kahlenberg, 1906–1909.
President Samuel Plantz,[1] 1910–1912.
Professor Dana C. Munro, 1913–1915.
Director Henry L. Ward, 1916–1918.
President Edward A. Birge, 1919–1921.
President Melvin A. Brannon, 1922–1924.

HONORARY MEMBERS

Chamberlin, Thomas Chrowder, University of Chicago, Chicago, Ill.

Garland, Hamlin, New York, N. Y.

---

[1] Deceased.

Jordan, David Starr, Stanford University, Cal.
Merrick, George B., 350 W. Washington Ave., Madison.
Trelease, William, University of Illinois, Urbana, Ill.
Wheeler, William Morton, Forest Hills, Boston, Mass.

LIFE MEMBERS

Beatty, Arthur, 1824 Vilas Street, Madison
*Birge, Edward A., 2011 Van Hise Ave., Madison
*Davis, John Jefferson, 419 Sterling Place, Madison
Hixon, Frank P., La Crosse
Hobbs, William H., University of Michigan, Ann Arbor, Michigan
Horlick, A. J., Racine
*Leith, Charles K., Moraine, Old Sauk Road, Madison
Logan, Frank A., Chicago, Illinois
*Marsh, C. Dwight, 1882 Monroe Street, Washington, D. C.
Norris, Mrs. Fanny, 1906 Grand Ave., Milwaukee
Peckham, Mrs. Elizabeth G., 46 Marshall Street, Milwaukee
Sharp, Frank C., University of Wisconsin, Madison
*Skinner, Ernest Brown, 210 Lathrop Street, Madison
*Slichter, Charles Sumner, 636 North Frances Street, Madison

CORRESPONDING MEMBERS

Coulter, John Merle, University of Chicago, Chicago, Illinois
Crooker, Joseph Henry, 24 East Concord Ave., Orlando, Florida
Eckels, William Alexander, La Fayette College, Easton, Pa.
Hendrickson, George Lincoln, Yale University, New Haven, Conn.
Hoskins, Leander Miller, Palo Alto, California
Kinley, David, University of Illinois, Urbana, Illinois
Leverett, Frank, University of Michigan, Ann Arbor, Michigan
Libby, Orin Grant, Grand Forks, North Dakota
Marx, Charles David, Palo Alto, California
McClumpha, Charles Flint, 56 Church Street, Amsterdam, New York

*Member of American Association for the Advancement of Science.

Munro, Dana Carlton, Princeton University, Princeton, New Jersey

Olive, Edgar W., Brooklyn Botanic Garden, Brooklyn, New York

Power, Frederick Belding, Bureau of Chemistry, Washington, D. C.

Stone, Ormond, Clifton Station, Virginia

Tolman, Albert Harris, University of Chicago, Chicago, Illinois

Townley, Sidney Dean, Stanford University, California

Turner, Frederick Jackson, 2214 Van Hise Ave., Madison

Verrill, Addison Emery, Yale University, New Haven, Connecticut

ACTIVE MEMBERS

*Addleman, Irving M., 511 Third Street, Wausau

*Addoms, Ruth M., 419 Sterling Place, Madison

Aitken, Robert T., Bishop Museum, Honolulu, Hawaii

Alderman, William E., 718 Church Street, Beloit

*Allen, Charles E., 2014 Chamberlain Avenue, Madison

*Arzberger, Emil G., Bureau of Plant Industry, Washington, D. C.

*Bagg, Rufus M. Jr., 7 Brokaw Place, Appleton

*Baird, Edgar A., University of North Dakota, Grand Forks, N. D.

Barber, Wm. Harley, 303 Princeton Avenue, Madison.

*Bardeen, Charles Russell, 23 Mendota Court, Madison

*Barnes, Kenneth B., 718 Church Street, Beloit

Barrett, Samuel A., Public Museum, Milwaukee

*Barrett, Storrs Barrows, Yerkes Observatory, Williams Bay

Barth, George Peter, 3006 Chestnut Street, Milwaukee

Bascom, Lelia, 419 Sterling Place, Madison

*Bean, Elizabeth Smith, Dalhousie University, Halifax, N. S.

*Bean, E. F., College Hills, Madison

Behncke, Nile J., 785 Algoma Blvd., Oshkosh

*Bennett, Edward, 1919 Jefferson Street, Madison

Bleyer, Willard G., 423 North Carroll Street, Madison

*Boutwell, Paul Winslow, Beloit College, Beloit

*Boyle, C., University College, Cork, Ireland

*Brannon, Melvin Amos, State Capitol, Helena, Montana

Braun, Adolph R., 832 38th Street, Milwaukee
*Brink, R. Alex., University of Wisconsin, Madison
Brown, Charles E., 136 Lathrop Street, Madison
Brown, Charles Newton, 41 Roby Road, Madison
*Browne, Frederick Lincoln, 223 Clifford Court, Madison
*Browning, Harold William, State College, Kingston, R. I.
*Bryan, George Smith, 803 State Street, Madison
Buckstaff, Ralph N., 1501 South Main Street, Oshkosh
Buehler, Henry Andrew, Rolla, Missouri
*Bunting, Charles Henry, 2020 Chadbourne Avenue, Madison
Busssewitz, M. A., 435 Kenwood Boulevard, Milwaukee
Butterfield, Mrs. Ellen F., 713 Milwaukee Avenue, South Milwaukee
Cahn, A. R., 606 East Stoughton Street, Champaign, Illinois
Cairns, William B., 2010 Madison Street, Madison
Carter, Sylvester J., 437 Kenwood Boulevard, Milwaukee
Chandler, Elwyn Francis, University of North Dakota, Grand Forks, N. D.
Chase, Wayland J., 141 Summit Avenue, Madison
*Churchill, B. P., 569 Mitchell Street, Milwaukee
*Clark, Paul F., 2136 Van Hise Ave., Madison
Clark, William A., State Normal School, Stevens Point
Clas, Alfred Charles, 445 Milwaukee Street, Milwaukee
Clawson, Arthur Brooks, 1884 Monroe Street, N. W. Washington, D. C.
Clowes, Herbert, Public Museum, Milwaukee
Cole, Harry E., 908 Ash Street, Baraboo
*Cole, Leon J., 1915 Keyes Ave., Madison
*Collie, George Lucius, 48 Sherwood Drive, Beloit
Commons, John R., University of Wisconsin, Madison
*Comstock, George C., 635 College Street, Beloit
Conklin, George Hall, 1924 John Ave., Superior
*Conwell, H. H., 921 Park Ave., Beloit
*Cooper, George Olds, 431 Hawthorne Court, Madison
*Culver, Garry Eugene, State Normal School, Stevens Point
*Daniels, Farrington, Nakoma, Madison
*Davis, Carl Henry, 141 Wisconsin Street, Milwaukee
*Dawson, Percy M., University of Wisconsin, Madison
Dean, Aletta F., 87 West Street, Mansfield, Mass.
*Delwiche, Edmond Joseph, R. F. D. 3, Green Bay
*Densmore, H. D., 718 Clary Street, Beloit

*Denniston, Rollin Henry, 1414 Washington Ave., Madison
Dodge, B. O., Bureau of Plant Industry, Washington, D. C.
Dodge, R. E. N., 115 N. Allen Street, Madison
*Domogalla, Bernhard P., 803 State Street, Madison
*Dowling, Linnaeus Wayland, 2 Roby Road, Madison
Downes, Robert Hugh, 574 Algoma Street, Oshkosh
*Drechsler, Charles, Department of Agriculture, Washington, D. C.
*Dresden, Arnold, 2114 Vilas Street, Madison
DuMez, Andrew Grover, 25th and E. Street, N. W., Washington, D. C.
*Edwards, Ira, Public Museum, Milwaukee
Ely, Richard T., Northwestern University, Evanston, Ill.
*Evans, Clarence T., 3415 Sycamore Street, Milwaukee
*Evans, Edward, 121 South 13th Street, La Crosse
*Fajardo, Tranquilino G., 147 Lathrop St., Madison
*Farley, John Herbert, 474 Alton Street, Appleton
*Fiebiger, George J., Waterloo
Finch, V. C., College Hills, Madison
Finkler, Adolph, 612 Commerce Street, Milwaukee
*Fischer, Richard, 119 E. Johnson, Madison
Fish, Carl Russell, 511 N. Carroll, Madison
*Fish, Emma Luella, University of Wisconsin, Madison
Fluke, Charles L., Jr., 512 Wingra, Madison
*Foster, Arthur C., Box 549, Sandford, Florida
*Fracker, Stanley B., 1632 Adams Street, Madison
*Fred, Edwin B., 610 N. Frances Street, Madison
Frey, Charles N., 103 West 183rd Street, New York, N. Y.
*Frost, William D., 1010 Grant Street, Madison
Fuller, Albert M., Public Museum, Milwaukee
*Gates, Percival T., University of Chicago, Chicago, Ill.
Gay, Lucy M., 216 N. Pinckney Street, Madison
*Gerry, Eloise, 419 Sterling Place, Madison
*Gilbert, Edward M., 2120 Chamberlain Ave., Madison
Glicksman, Harry, 2024 Chamberlain Ave., Madison
Gloyer, Walter O., 106 Lyceum Street, Geneva, N. Y.
Granovsky, Alexander A., 803 State Street, Madison
Greene, Howard, 559 Marshall Street, Milwaukee
Gregory, John G., 729 Jenifer Street, Madison
*Groves, James F., Ripon College, Ripon
Gutsch, Milton R., University of Texas, Austin, Texas

*Guyer, Michael F., 138 Prospect Ave., Madison
Haase, Ewald, 182 Wisconsin Street, Milwaukee
Haessler, Louise, 100 Morningside Drive, New York, N. Y.
Hall, F. Gregory, Milton College, Milton
*Hall, Sidney S., 159 Malcolm Ave., S. E., Minneapolis, Minn.
Hargrave, Josephine R., Ripon College, Ripon
Harper, Robert A., Columbia University, New York, N. Y.
Harper, Mrs. Robert A., Columbia University, New York, N. Y.
*Hastings, E. G., 2111 Van Hise Ave., Madison
*Hathaway, Edward S., Tulane University, New Orleans, La.
*Hawkins, Pliny H., Absarokee, Mont.
*Heddle, John R., 1215 Carlisle Ave., Racine
*Heineman, Paul G., 1508 Jonquil Terrace, Chicago, Ill.
*Henmon, V. A. C., College Hills, Madison
*Hodgson, A. J., Box 166, Waukesha
Hohlfeld, A. R., 124 Breese Terrace, Madison
Holmes, Samuel J., University of California, Berkeley, Cal.
*Hotchkiss, W. O., State School of Mines, Houghton, Mich.
Hubbard, Frank G., 141 W. Gilman Street, Madison
*Hubert, Ernest E., Forest Products Laboratory, Madison
*Humphrey, Clarence J., 1714 Adams Street, Madison
*Ingersoll, Leonard R., 1933 West Lawn Ave., Madison
Jackson, Hartley H. T., U. S. Biological Survey, Washington, D. C.
*Jana, Ashutosh, Tamluk, Bengal, India
*Jansky, Cyril M., 2117 Jefferson Street, Madison
*Jasper, Thomas McLean, A. O. Smith Corporation, Milwaukee
*Jastrow, Joseph, 237 Langdon Street, Madison
*Johnson, Aaron G., Department of Agriculture, Washington, D. C.
*Johnson, James, 2005 Madison Street, Madison
*Jones, Fred R., 1713 Chadbourne Ave., Madison
*Jones, Mrs. F. R., 1713 Chadbourne Ave., Madison
*Jones, Leon K., University of Wisconsin, Madison
*Jones, Lewis R., 146 Prospect Ave., Madison
*Jones, Sarah V. H., Rochester, Mich.
*Juday, Chancey, 35 Lathrop Street, Madison
*Kahlenberg, Louis, 234 Lathrop Street, Madison
*Keitt, George W., 803 State Street, Madison
*Kemmerer, George I., 916 Van Buren Street, Madison

Kenyon, W. A., Hamline University, St. Paul, Minn.
Kiekhofer, W. H., 1919 Arlington Place, Madison
*Koehler, Arthur, 1819 Adams Street, Madison
*Kowalke, O. L., 2012 Jefferson Street, Madison
*Kraus, Ezra J., 803 State Street, Madison
*Kremers, Edward, University of Wisconsin, Madison
Lannerd, Willard H., 103 Parkwood Blvd., Mansfield, O.
*Lee, Oliver J., Yerkes Observatory, Williams Bay
*Lenher, Victor, 1718 Summit, Madison
*Leonard, Clifford S., Yale University, New Haven, Conn.
Lewis, F. F., 115 Jackson Street, Janesville
*Lobeck, Armin K., 1635 Madison Street, Madison
Loft, Genivera E., 2121 Kendall Ave., Madison
Lounsbury, James A., Marquette University, Milwaukee
*Lowe, John N., State Normal School, Marquette, Mich.
*McAllister, Fred, University of Texas, Austin, Texas
McKenna, Maurice, 114 3rd Street, Fond du Lac
McLeod, Andrew F., 5986 Ridge Ave., Chicago, Ill.
*McMinn, Amelia, State Normal School, Milwaukee
Main, Mrs. Angie K., Fort Atkinson
Majerowski, Stephen J., 932 10th Ave., Milwaukee
*March, Herman W., 1825 Summit Ave., Madison
*Marlatt, Abby L., 612 Howard Place, Madison
*Marquette, William G., Pleasantville, N. Y.
*Marschall, A. J., 14 Proudfit Street, Madison
Marshall, Ruth, Rockford College, Rockford, Ill.
*Marshall, William S., 139 E. Gilman, Madison
*Martin, Ella May, Illinois Wesleyan University, Bloomington, Ill.
*Mason, Max, University of Chicago, Chicago, Ill.
*Mathews, J. Howard, 128 Lathrop Street, Madison
*Maurer, Edward R., 167 Prospect Ave., Madison
*Mavor, James W., Union College, Schnectady, N. Y.
*Meachem, John G., 745 College Ave., Racine
*Mead, Daniel W., 120 W. Gorham Street, Madison
*Mead, Warren J., 2113 Adams Street, Madison
*Mendenhall, Charles E., 510 N. Carroll Street, Madison
Meyer, Balthaser H., 3825 Wisconsin Ave., Washington, D. C.
*Miller, Eric R., 2125 Van Hise Ave., Madison
*Miller, William S., 2001 Jefferson Street, Madison
*Moe, Carl, Box 75, International Falls, Minn.

Monroe, C. E., 728 Racine Street, Milwaukee
*Morris, Harold H., 2040 Pine Street, Philadelphia, Penn.
*Mossman, Harland W., 1707 Jefferson Street, Madison
*Mullenix, Rollin C., Lawrence College, Appleton
*Murphy, Ray B., Illinois Wesleyan University, Bloomington, Ill.
*Musbach, Fred L., 407 S. Cherry Street, Marshfield
Muttkowski, Richard A., Detroit University, Detroit, Mich.
*Nagler, Mrs. Ellen T., 1913 Kendall Ave., Madison
*Nardin, F. Louise, Lathrop Hall, Madison
Naylor, Wilson S., Lawrence College, Appleton
*Noland, Lowell E., 1723 Summit Ave., Madison
Oberholser, Harry C., 2805 18th Street, N. W., Washington, D. C.
Ockerman, J. W., 416 South Elwood Street, Tulsa, Oklahoma
*Ogden, Henry V., 141 Wisconsin Street, Milwaukee
*O'Shea, M. Vincent, 529 N. Pinckney Street, Madison
Otto, Max C., 1155 Edgewood Ave., Madison
*Overton, James B., 512 Wisconsin Ave., Madison
Pammel, L. H., Iowa State College, Ames, Iowa
Parker, Fletcher A., 14 W. Gilman Street, Madison
Patzer, C. E., State Normal School, Milwaukee
Paxson, Frederick L., 2122 Van Hise Ave., Madison
*Pearse, A. S., 2240 Rowley Ave., Madison
Peltier, George L., College of Agriculture, Lincoln, Neb.
Peter, George, Public Museum, Milwaukee
*Peterson, William H., University of Wisconsin, Madison
*Phillips, James D., University of Wisconsin, Madison
Pitman, Annie M., 414 N. Henry Street, Madison
Pope, Thomas E. B., Public Museum, Milwaukee
Porteus, Charles R., Public Museum, Milwaukee
*Potter, George F., New Hampshire College, Durham, N. H.
Powell, John W., 471 Van Buren Street, Milwaukee
*Public Museum, Milwaukee
*Reed, George M., Brooklyn Botanic Garden, Brooklyn, N. Y.
*Reid, Mary E., Boyce Thompson Institute, Yonkers, N. Y.
*Richards, C. Audrey, 415 Sterling Place, Madison
*Rickett, Harold W., University of Missouri, Columbia, Mo.
*Riker, Mrs. A. J., 105 N. Spooner Street, Madison
*Roark, Raymond J., 1707 Madison Street, Madison
*Roebuck, John R., 2210 Hollister Ave., Madison

Roedder, E. C. L. C., 38 Breese Terrace, Madison
Rogers, Thomas A., State Normal School, Stevens Point
*Rose, Jessie P., 1101 7th Street, S. E., Minneapolis, Minn.
*Sammis, John L., 234 Breese Terrace, Madison
Schinner, Augustine F., Right Reverend, 238 E. 13th Ave., Spokane, Wash.
*Schlundt, Herman, University of Missouri, Columbia, Mo.
*Schmidt, Albert H., Palatine, Cook County, Ill.
Schorger, A. W., 2021 Kendall Ave., Madison
Schubring, E. J. B., 415 N. Park Street, Madison
Schubring, Mrs. E. J. B., 415 N. Park Street, Madison
*Schuette, Henry A., Maple Bluff, Madison
*Schultz, Alfred R., 800 Vine Street, Hudson
Seaman, Gilbert E., 312 Goldsmith Building, Milwaukee
Showalter, Amos M., Department of Botany, Stanford University, Calif.
Showerman, Grant, 410 N. Butler Street, Madison
Sieker, William C., 7th and Prairie Streets, Milwaukee
*Simon, Arthur, Cutler-Hammer Mfg. Co., Milwaukee
Smith, Elmer A., 1281 Pat. Pl'k. Road, Secaucus, N. J.
*Smith, Gilbert B. L., 401 Dryden Road, Ithaca, N. Y.
*Smith, Gilbert M., Stanford University, Cal.
*Smith, Harvey M., University of Wyoming, Laramie, Wyo.
*Smith, Huron H., Public Museum, Milwaukee
Smith, Walter M., 127 Langdon Street, Madison
*Snell, Walter H., 19 Nisbet Street, Providence, R. I.
*Snow, Benjamin, W., University of Wisconsin, Madison
*Steenbock, Harry, 2117 West Lawn Ave., Madison
*Steidtmann, Edward, 13 White Street, Lexington, Va.
*Steil, William N., Marquette University, Milwaukee
*Steiner, Gotthold, Bureau of Plant Industry, Washington, D. C.
*Stickney, Gardner P., 864 Summit Ave., Milwaukee
Stickney, M. E., Denison University, Granville, Ohio
*Stock, Kurt, Fish Creek
*Stout, Arlow B., New York Botanical Garden, New York, N. Y.
*Streets, Rubert B., University of Arizona, Tucson, Ariz.
Talbert, George A., Medical School, University of Nebraska, Omaha, Neb.
Taylor, Warner, 619 North Frances Street, Madison

*Thompson, Noel F., 1809 Keyes Ave., Madison
*Tisdale, William B., Quincy, Fla.
Titus, W. A., 54 Oak Ave., Fond du Lac
*Tomlinson, Charles W., 1610 Bixby Ave., Ardmore, Okla.
*Tompkins, C. M., 803 State Street, Madison
*Toole, Eben H., Bureau of Plant Industry, Washington, D. C.
*Tottingham, W. E., 2206 West Lawn, Madison
*Trautman, William J., 1 Gordon Court, Beloit
*Truog, Emil, 803 State Street, Madison
Turneaure, Frederick E., 166 Prospect Ave., Madison
Turner, Clarence L., Beloit College, Beloit
*Twenhofel, William H., Lake Forest, Madison
Tyrrell, Edward R., Public Museum, Milwaukee
*Uehling, Edward A., 3226 McKinley Blvd., Milwaukee
*Ullrich, Fred T., State Normal School, Platteville
Van Ostrand, Mrs. E. H., 214 W. Gilman Street, Madison
*Van Vleck, Edward B., 519 N. Pinckney Street, Madison
Vaughan, R. E., Nakoma, Madison
Voss, E. K. J. H., 175 Virginia Terrace, Madison
Wadmond, Samuel C., 305 Washington Street, Delavan
*Wagner, George, 1901 Jefferson Street, Madison
*Wakeman, Nellie A., 1814 Keyes Ave., Madison
*Walker, J. Charles, 221 Lathrop Street, Madison
*Warfield, Louis M., 1746 Washtenaw Ave., Ann Arbor, Mich.
*Weber, George F., Experiment Station, Gainesville, Fla.
*Wenstrand, David E. W., 210 Wisconsin Street, Milwaukee
*Werner, Fred W., 991 16th Street, Milwaukee
West, George A., 2828 Highland Blvd., Milwaukee
*Whealdon, Albert D., State Normal School, Superior
Whitbeck, R. H., 200 Prospect Ave., Madison
Whitson, Andrew R., University of Wisconsin, Madison
*Wilson, H. F., 1815 Jefferson Street, Madison
Wimmer, Edward J., University of Wisconsin, Madison
*Winchell, Alexander N., 200 Prospect Ave., Madison
*Windesheim, Gustave, 453 Durkee Ave., Kenosha
Woodmansee, Wilson R., Ripon College, Ripon
*Wright, William H., 1905 West Lawn Ave., Madison
Young, Karl, Yale University, New Haven, Conn.
Zdanowicz, Casimir, 803 State Street, Madison
Zimmerman, 324 S. Ashland Ave., La Grange, Ill.
*Zoch, Richmond T., Weather Bureau, Broken Arrow, Oklahoma

CHARTER OF THE ACADEMY

AN ACT to incorporate the Wisconsin Academy of Sciences, Arts and Letters.

The people of the state of Wisconsin, represented in senate and assembly, do enact as follows:

SECTION 1. Lucius Fairchild, Nelson Dewey, John W. Hoyt, Increase A. Lapham, Alexander Mitchell, Wm. Pitt Lynde, Joseph Hobbins, E. B. Wolcott, Solon Marks, R. Z. Mason, G. M. Steele, T. C. Chamberlin, James H. Eaton, A. L. Chapin, Samuel Fallows, Charles Preusser, Wm. E. Smith, J. C. Foye, Wm. Dudley, P. Engelmann, A. S. McDill, John Murrish, Geo. P. Delaplaine, J. G. Knapp, S. V. Shipman, Edward D. Holton, P. R. Hoy, Thaddeus C. Pound, Charles E. Bross, Lyman C. Draper, John A. Byrne, O. B. Smith, J. M. Bingham, Henry Bætz, Ll. Breese, Thos. S. Allen, S. S. Barlow, Chas. R. Gill, C. L. Harris, J. C. Squires, George Reed, J. G. Thorp, William Wilson, Samuel D. Hastings, and D. A. Baldwin, at present being members and officers of an association known as "The Wisconsin Academy of Sciences, Arts and Letters," located at the city of Madison, together with their future associates and successors forever, are hereby created a body corporate by the name and style of the "Wisconsin Academy of Sciences, Arts, and Letters," and by that name shall have perpetual succession; shall be capable in law of contracting and being contracted with, of suing and being sued, of pleading and being impleaded in all courts of competent jurisdiction; and may do and perform such acts as are usually performed by like corporate bodies.

SECTION 2. The general objects of the Academy shall be to encourage investigation and disseminate correct views in the various departments of science, literature, and the Arts. Among the specific objects of the Academy shall be embraced the following:

1. Researches and investigations in the various departments of the material, metaphysical, ethical, ethnological, and social sciences.
2. A progressive and thorough scientific survey of the state with a view of determining its mineral, agricultural, and other resources.
3. The advancement of the usual arts, through the applications of science, and by the encouragement of original invention.
4. The encouragement of the fine arts, by means of honors and prizes awarded to artists for original works of superior merit.
5. The formation of scientific, economic, and art museums.
6. The encouragement of philological and historical research, the

collection and preservation of historic records, and the formation of a general library.

7. The diffusion of knowledge by the publication of original contribution to science, literature, and the arts.

SECTION 3. Said Academy may have a common seal and alter the same at pleasure; may ordain and enforce such constitution, regulations, and by-laws as may be necessary, and alter the same at pleasure; may receive and hold real and personal property, and may use and dispose of the same at pleasure; provided, that it shall not divert any donation or bequest from the uses and objects proposed by the donor, and that none of the property acquired by it shall, in any manner, be alienated other than in the way of exchange of duplicate specimens, books, and other effects, with similar institutions and in the manner specified in the next section of this act, without the consent of the legislature.

SECTION 4. It shall be the duty of the said Academy, so far as the same may be done without detriment to its own collections, to furnish, at the discretion of its officers, duplicate typical specimens of objects in natural history to the University of Wisconsin, and to the other schools and colleges of the state.

SECTION 5. It shall be the duty of said Academy to keep a careful record of all its financial and other transactions, and, at the close of each fiscal year, the President thereof shall report the same to the Governor of the State, to be by him laid before the Legislature.

SECTION 6. The constitution and by-laws of said Academy now in force shall govern the corporation hereby created, until regularly altered or repealed; and the present officers of said Academy shall be officers of the corporation hereby created, until their respective terms of office shall regularly expire, or until their places shall be otherwise vacated.

SECTION 7. Any existing society or institutions having like objects embraced by said Academy, may be constituted a department thereof, or be otherwise connected therewith, on terms mutually satisfactory to the governing bodies of the said Academy and such other society or institution.

SECTION 8. For the proper preservation of such specimens, books and other collections as said Academy may make, the Governor shall prepare such apartment or apartments in the Capitol as may be so occupied without inconvenience to the State.

SECTION 9. This act shall take effect and be in force from and after its passage.

Approved March 16, 1870.

STATUTES OF 1898.

TRANSACTIONS OF THE ACADEMY.

SECTION 341. There shall be printed by the state printer biennially in pamphlet form two thousand copies of the transactions of the Wisconsin Academy of Sciences, Arts, and Letters, uniform in style with the volumes heretofore printed for said society.

NOTE.—Under a ruling of the printing commissioners of the state of Wisconsin, made in response to a presentation by a committee of the Academy appointed December 29, 1897, each volume of the Transactions might be issued in two consecutive parts; so that a publication might thus be issued each year covering the papers accepted after the previous annual meeting. The Academy allows each author one hundred separate reprints of his paper from the Transactions without expense, except a small charge for printed covers when desired. Additional copies are charged for at the actual cost of printing and binding.

OF THE DISTRIBUTION OF PUBLIC DOCUMENTS.

SECTION 365. The transactions of the Wisconsin Academy of Sciences, Arts, and Letters shall be distributed as follows: One copy to each member of the legislature, one copy to the librarian of each state institution; one hundred copies to the State Agricultural Society; one hundred copies to the State Historical Society; one hundred copies to the State University, and the remainder to said Academy.

SECTION 366. In the distribution of books or other packages, if such packages are too large or would cost too much to be sent by mail, they shall be sent by express or freight, and the accounts for such express or freight charges, properly certified to, shall be paid out of the state treasury.

STATUTES OF 1901.

CHAPTER 447.

BINDING OF EXCHANGES.

SECTION 1. Section 341 of the revised statute of 1898 is hereby amended by adding thereto the following: The secretary of state may authorize the state printer to bind in suitable binding all periodicals and other exchanges which the Society shall hereafter receive, at a cost not exceeding one hundred and fifty dollars per annum. The secretary of state shall audit the accounts for such binding.

STATUTES OF 1921.

SECTION 35.32. That part of section 35.32 of the statutes relating to printing for the Wisconsin Academy of Sciences, Arts, and Letters is amended to read: "of each number as issued, of the transactions of the Wisconsin Academy of Sciences, Arts, and Letters, not more than two thousand copies * * * together with suitable binding at a cost not exceeding one hundred and fifty dollars per annum of all periodicals and other exchanges which said academy shall hereafter receive."

CONSTITUTION

OF THE WISCONSIN ACADEMY OF SCIENCES, ARTS, AND LETTERS.

[As amended at various regular meetings.]

ARTICLE I.—*Name and Location.*

This association shall be known as the Wisconsin Academy of Sciences, Arts, and Letters, and shall be located at the city of Madison.

ARTICLE II.—*Object.*

The object of the Academy shall be the promotion of sciences, arts, and letters in the state of Wisconsin. Among the special objects shall be the publication of the results of investigation and the formation of a library.

ARTICLE III.—*Membership.*

The Academy shall include four classes of members, viz.: life members, honorary members, corresponding members, and active members, to be elected by ballot.

1. Life members shall be elected on account of special services rendered the Academy. Life membership in the Academy may also be obtained by the payment of one hundred dollars and election by the Academy. Life members shall be allowed to vote and to hold office.
2. Honorary members shall be elected by the Academy and shall be men who have rendered conspicuous services to sciences, arts, or letters.
3. Corresponding members shall be elected from those who have been active members of the Academy, but have removed from the state. By special vote of the Academy men of attainments in science or letters may be elected corresponding members. They shall have no vote in the meetings of the Academy.
4. Active members shall be elected by the Academy or the council and shall enter upon membership on the payment of an initiation fee of two dollars which shall include the first annual assessment of one dollar. The annual assessment shall be omitted for the president, secretary, treasurer, and librarian during their term of office.

ARTICLE IV.—*Officers.*

The officers of the Academy shall be a president, a vice-president for each of the three departments, sciences, arts and letters, a secretary, a librarian, a treasurer, and a custodian. These officers shall be chosen by ballot, on recommendation of the committee on nomination of officers, by the Academy at an annual meeting and shall hold office for three years. Their duties shall be those usually performed by officers thus named in scientific societies. It shall be one of the duties of the president to prepare an address which shall be delivered before the Academy at the annual meeting at which his term of office expires.

ARTICLE V.—*Council.*

The council of the Academy shall be entrusted with the management of its affairs during the intervals between regular meetings, and shall consist of the president, the three vice-presidents, the secretary, the treasurer, the librarian, and the past presidents who retain their residence in Wisconsin. Three members of the council shall constitute a quorum for the transaction of business, provided the secretary and one of the presiding officers be included in the number.

ARTICLE VI.—*Committees.*

The standing committees of the Academy shall be a committee on publication, a library committee, and a committee on the nomination of members. These committees shall be elected at the annual meeting of the Academy in the same manner as the other officers of the Academy, and shall hold office for the same term.

1. The committee on publication shall consist of the president and secretary and a third member elected by the Academy. They shall determine the matter which shall be printed in the publications of the Academy. They may at their discretion refer papers of a doubtful character to specialists for their opinion as to scientific value and relevancy.

2. The library committee shall consist of five members, of which the librarian shall be *ex officio* chairman, and of which a majority shall not be from the same city.

3. The committee on nomination of members shall consist of five members, one of whom shall be the secretary of the Academy.

ARTICLE VII.—*Meetings.*

The annual meeting of the Academy shall be held at such time and place as the council may designate; but all regular meetings for the election of the board of officers shall be held at Madison. Summer field meetings shall be held at such times and places as the Academy or the council may decide. Special meetings may be called by the council.

ARTICLE VIII.—*Publications.*

The regular publication of the Academy shall be known as its Transactions, and shall include suitable papers, a record of its proceedings, and any other matter pertaining to the Academy. This shall be printed by the state as provided in the statutes of Wisconsin. All members of the Academy shall receive gratis the current issues of its Transactions.

ARTICLE IX.—*Amendments.*

Amendments to this constitution may be made at any annual meeting by a vote of three-fourths of all the members present; *provided*, that the amendment has been proposed by five members, and that notice has been sent to all the members at least one month before the meeting.

RESOLUTIONS.

REGULATIVE OF THE PROCEEDINGS OF THE ACADEMY.

THE TRANSACTIONS OF THE ACADEMY.

[*By the Academy, December* 28, 1882.]

2. The secretary of the Academy shall be charged with the special duty of overseeing and editing the publication of future volumes of the Transactions.

3. The Transactions of the Academy hereafter published shall contain: (a) a list of officers and members of the Academy; (b) the charter, by-laws and constitution of the Academy as amended to date; (c) the proceedings of the meetings; and (d) such papers as are duly certified in writing to the secretary as accepted for publication in accordance with the following regulations and no other.

6. In deciding as to the papers to be selected for publication, the committee shall have special regard to their value as genuine, original contributions to the knowledge of the subject discussed.

9. The sub-committee on publication shall be charged with insisting upon the correction of errors in grammar, phraseology, etc., on the part of authors, and shall call the attention of authors to any other points in their papers which in their judgment appear to need revision.

[*By the Academy, June* 2, 1892.]

The secretary was given authority to allow as much as ten dollars for the illustration of a paper when the contribution was of sufficient value to warrant it. A larger amount than this might be allowed by the committee on publication.

[*By the Academy, December* 29, 1896.]

The secretary was directed to add to the date of publication as printed on the outside of author's separates the words, "Issued in advance of general publication."

Fees of Life Members.

[*By the Academy, July* 19, 1870.]

Resolved, That the fees from members for life be set apart as a permanent endowment fund to be invested in Wisconsin state bonds, or other equally safe securities, and that the proceeds of said fund, only, be used for the general purposes of the Academy.

Annual Dues.

[*By the Academy, December* 29, 1892.]

Resolved, That the secretary and treasurer be instructed to strike from the list of active members of the Academy the names of all who are in arrears in the payment of annual dues, except in those cases where, in their judgment, it is desirable to retain such members for a longer time.

Arrears of Annual Dues.

[*By the Council, December* 29, 1897.]

Resolved, That the treasurer be requested to send out the notices of annual dues as soon as possible after each annual meeting and to extend the notice to the second or third time within a period of four months where required.

Secretary's Allowance.

[*By the Academy, December* 27, 1902.]

Resolved, That the Academy hereby appropriates the sum of seventy-five dollars per annum as an allowance for secretary's expenses, for which a single voucher shall be required.

Secretary's Allowance.

[*By the Council, April* 5, 1912.]

Resolved, That the Academy appropriates the sum of two hundred dollars per annum for the secretary-treasurer's allowance.

Election of Mrs. Lucius Fairchild as Honorary Member.

[*By the Council, April* 12, 1918.]

Resolved, That because of the honorable and leading part that was played by the late General Fairchild in the founding of this Academy, his widow, Mrs. Lucius Fairchild, of Madison, be voted an honorary member of the Wisconsin Academy of Sciences, Arts and Letters.