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TRANSACTIONS

OF THE

WISCONSIN ACADEMY

OF

SCIENCES, ARTS, AND LETTERS

VOL. XVIII, PART II

MADISON, WISCONSIN

1916

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ARTHUR BEATTY,
Secretary.

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CONTENTS

THE WORK OF THE WIND IN WARMING A LAKE

EDW. A. BIRGE

Notes from the Laboratory of the Wisconsin Geological and Natural History Survey. VIII.

1. INTRODUCTION.

It is now generally admitted by limnologists that the warming of a lake is mainly effected by the wind, which distributes the warmed water from the surface to the deeper strata. Certain limitations on this statement due to the penetration of the sun's rays into the water, will be briefly discussed later in this paper. This relation of wind to heating was well stated twenty years ago by Whipple ('95, p. 207). I worked out the same result in the same year but did not publish until 1897 ('97, p. 291). In the same paper I indicated also, I believe for the first time, certain corollaries from this theory of heat distribution, stating that the depth, area, and shape of a lake are important factors in determining its temperature.

Another corollary from the fundamental proposition engaged my attention, viz.: that the distribution of the warmed—and therefore lighter—surface water by the wind involves an amount of work against gravity which is measurable, and whose amount shows one element in the work of the wind on the lake. It affords also a quantitative measure, at least a partial one, of the effect of area and depth on the heat budget. This idea was applied to the explanation of certain temperature phenomena in my discussion of the Finger Lakes of New York in 1914 (Birge and Juday, '14, p. 574). The underlying principle was there stated as follows:

"The work to be done in warming a stratum of water which lies below the direct influence of the sun is done against gravity which resists the descent of the warmer and lighter water. The net work done in warming a stratum of water to a given degree may be measured by the energy which would be needed to transport the mass of water, thus warmed, to the place where it is found, against the resistance of denser water at a temperature of 4°. We may think of such a stratum as pushed down to its place through water at 4°, somewhat as a sheet of cork might be forced down through the water. The weight to be moved is the difference in weight between the warmed water and water at the temperature of maximum density. The distance through which it is carried is the mean distance of the stratum in question from the surface."

The general question was left with this brief statement in that paper because I desired to discuss the matter of the heat budget more fully before taking up that of the distribution of heat. The subject of the heat budget was presented last year (Birge '15), and it is my purpose to state more fully in the present paper the subject of the work of the wind in distributing heat and to give illustrations of methods employed in studying it. I leave most of its applications to a general report on temperatures of Wisconsin lakes.

2. GENERAL EFFECT OF WIND.

The wind blowing over the surface of a lake performs certain mechanical operations on the water. Their results may be grouped under the heads of waves and currents. We are not at present concerned with the work done in making waves, but consider the effect of currents only.

If a lake had no shores, or if its dimensions were indefinitely larger than those of the air movement constituting the wind, there might be produced a simple current in the water moving with the wind, greatest at the surface and rapidly dying out below. But in an inland lake the current induced by wind meets the shore very promptly, and this fact is of great importance to this discussion. The current is stopped and if the wind continues, it must turn back or turn down. Such are the currents whose effect is discussed here.

If the lake is homothermous the current easily turns downward into the deeper water or along the bottom of the lake.

The surface water would be stripped by the wind from the windward side of the lake and transported to the leeward side; it would return along the side or bottom to the windward side. Thus the entire mass of the water of the lake may be brought into a sort of rotatory movement and a complete circulation may be set up.

This programme is interfered with and modified by two factors: (1) the cessation or change of the wind; (2) the warming of the surface water by heat from sun and sky. We have nothing to do at present with the first of these factors, but are concerned with the second.

The effect of the heat received by the surface of the water is to warm the upper stratum and thereby decrease its density. This decrease of density tends to keep the water at the surface as it moves and to prevent the influence of the wind from reaching the deeper strata. This warmer and lighter water pushed along by the wind is stopped as it approaches the leeward shore. It accumulates there, piling up on top of the cooler water whose surface it depresses.

If the wind soon dies out the movement of the water ceases; the cooler water settles back into place and the warm water spreads out above it as a surface stratum. In this process there will be some mixture of the warmer and the cooler water at the junction plane.

If the wind is strong enough and continues long enough and if the surface water is not too much warmed, part of the warmer water will be pushed down into the cooler water and mingled with it. But in general most of it will return to the windward side of the lake in horizontal currents on top of the cooler water. As it flows along the cooler water there will be more or less mixture with consequent warming of the colder and deeper lying strata and cooling of the surface strata.

There arises in this way a continual contest between wind and sun. The wind creates surface currents in the water of the lake which, guided by shores and bottom, would establish and maintain a complete circulation. The sun warms the surface stratum and so tends to confine the wind currents to the surface. From the interaction of these two forces result the phenomena of the actual warming of the lake.

Ideal cases are easily pictured: if the heat were delivered from the sun in small quantity and the wind were steady and violent, the surface current would have enough energy to overcome the thermal resistance to mixture, complete circulation of the water would result, and the heat delivered to the surface would be distributed to the entire mass of the lake. The temperature of the water would be approximately, but not exactly, the same at all depths.

If there were no wind, or only light baffling airs, and the sun shone continually from a clear sky, the surface water would be highly heated and the deeper water would not be warmed at all.

As matters actually go in a lake, the advantage in the contest between sun and wind turns now to one side and now to the other. But on the whole the wind has the worse until in late summer or autumn the sun's energy declines and the water begins to cool.

The work of the wind may be stated in another way. If the wind creates a horizontal current in the water the resistance which the water offers is that due to viscosity and all the work done is done against friction. If the water is homothermous the same statement holds for the vertical component of the movement of the currents as guided by shores and bottom. But if the surface strata of the water are less dense than those below, any downward movement of these upper strata involves the doing of work against gravity; the lighter water must be forced down against the resistance of the denser. So far as the wind accomplishes this task it is the agent for distributing heat through the water of the lake, and the amount of this work done is the measure of the vertical component of the work of the wind.

Obviously, it is impossible to ascertain the full amount of work thus done by the wind. The wind may blow all day, crowding the warm water to one side of the lake and depressing the cooler water. But at night the wind ceases and the water settles back, almost or quite reaching its original position. Work has been done against gravity but little or no record of it has been kept. It is like work done in compressing a spring which returns to its original position as soon as the pressure ceases. But if the water does not settle back to the position held before, if the isotherms at the junction of cooler and warmer water have been pushed down by mixing the several strata there, then work has been done which has left a record and this part of the work can be measured. The warming of this stratum of the deeper water can be expressed in terms of the mechanical work done in pushing the lighter and warmer surface water into the heavier and cooler water.

Here again our knowledge of the process is very small and we can ascertain only the net results, not the exact process itself. The work thus done in mixing any limited stratum is proportional to the temperature gradient of that stratum and this gradient is ordinarily unknown exactly, and certainly varies enormously from stratum to stratum of depth and from place to place of area, and from hour to hour. These processes cannot be followed in detail since we have no continuous record of the temperature changes in the lake. But it is possible to compare the temperature of a lake on different dates; to determine the amount of heat received and distributed during the period; and to compute the amount of work corresponding to this distribution. In general I shall consider in this paper, the amount of work involved in warming a lake from 4° to the summer maximum—the amount necessary for the production of the summer heat-income. This may be stated for the lake as a whole or for its several strata.

3. FORMULA FOR COMPUTING THE WORK OF THE WIND.

In this discussion the following symbols are used:

A = area of lake; A_0, or A with no sign, area at the surface; A_5 etc., area at the depth of 5 m., etc.

V = total volume of the lake: V_{5-10}, volume between 5 m. and 10 m.

RT = reduced thickness, i. e., the thickness of any given stratum if its area is made equal to that of the lake and its sides are vertical. It is computed from the formula $\frac{V_{n-m}}{A_0}$, in which n and m represent any two levels of the lake. The reduced thickness is stated in centimeters.

T = temperature. T_m. mean temperature of the lake as a whole; T_{20-21}, mean temperature of the 20 m.–21 m. stratum.

D = Density of the water; D_n, the density at any given temperature. At 4°, D is equal to; one at any other temperature it is less than one.

Z = distance from the surface of the lake expressed in centimeters.

W = work done in warming the lake as a whole or any given stratum. In general, this is stated in gram-centimeters per square centimeter of area of the lake; thus following the notation employed in stating the heat budget (Cf. Birge '15). Other units may be employed if convenient or desirable for special ends, as is stated later in this paper. Another datum plane may also be selected, but since the direct work of the wind is performed on the surface of the lake, the general reference will be to that surface. This reference will be understood if no other is expressed.

The formula for the work done in warming a stratum, by mixture, from 4° to any given temperature n^0, is, therefore:

$$W = RT \times Z \times (1 - D_n). \quad \text{(Formula I.)}$$

From this formula the value of W will be given in gram-centimeters per square centimeter of the surface of the lake. RT gives the weight in grams of a column of water whose base is one sq. cm. and whose height is the thickness of the stratum when its area is conceived as extended to that of the surface of the lake. The product $RT \times Z$, therefore, states in gram-centimeters the work that would be done in warming the stratum by mixture, if D were reduced to zero, so that $1 - D = 1$. The third factor $(1 - D)$ states the loss of density as a fraction of 1, so that the final product is the measure of the work done, stated in gram-centimeters per square centimeter of the surface of the lake.

In the expression $(1 - D_n)$, 1 is the density of water at 4°, and therefore is equal to D_4. If the lower limit of temperature considered is any other than 4°, its density, say D_m, must be substituted for 1.

4. ILLUSTRATION OF USE OF FORMULA I.

As an illustration of the use of formula I, let the stratum between 20 m. and 21 m., in a given lake, be warmed from 4° to 8°. How much work is involved in this rise of temperature?

In this case let RT = 56 cm. or 56 g. for a column 1 sq. cm. in area.

Z = 2050 cm.

The density of water at 8° is 0.999876. Hence $1 - D_8 =$ 0.000124.

Hence, $W = 56 \times 2050 \times 0.000124 = 14.235$ g. cm.

It thus appears that work amounting to 14.235 gram-centimeters per square centimeter of the surface of the lake is needed to raise the temperature of the stratum in question from 4° to 8°.

To the 20 m.–21 m. stratum there have been delivered 224 g. cal. (56 × [8–4]) per square centimeter of the area of the surface of the lake. It is therefore fair to say that the transport of 224 cal. from the surface to a mean depth of 20.5 m. has cost 14.235 g. cm. of work.

In a similar way the work required to warm each stratum of the lake may be computed. The sum of the several products will equal the work expended in warming the lake.

It must be noted that the work cannot be correctly computed for the lake as a whole by using for RT the mean depth of the lake, and for D the density of water at the mean temperature. This is because the density does not vary directly as the temperature, but decreases more rapidly than the temperature rises. As a result the value of 1 – D in the warm strata has greater weight in determining the mean density than has the value of T in the same strata in determining the mean temperature. The mean value of 1 – D for the several strata of the lake is therefore higher than the value of 1 – D for the mean temperature of the same strata. Compare on this matter plates IV and V.

It is also true that in order to secure great exactness in determining the mean temperature the density of the several strata should be considered. If this were done, however, the results would be but little altered, and any change would be in the direction of increasing the discrepancy just pointed out, since it would lessen the weight of T in the upper and warmer strata. See plates IV and V for an illustration of this matter.

It will be found convenient to compute, once for all, the products of RT and Z for the several strata of any lake which it is desired to study. I have usually computed them by single meters to a depth of 20 m. or 25 m. and by 5 m. or 10 m. intervals at greater depths. The sums of the several factors for single meters of any 5 m. interval may be used in case computation by single meters is not desirable or necessary.

The factor $1-D$ is readily taken from a table showing the values of $1-D$. Such a table is given herewith. (p. 391.) Thus a single multiplication shows the work required for warming any given stratum. In multiplying I have ordinarily used only three significant figures in the factors and have multiplied by the aid of Crelle's Rechentafeln. A certain amount of inaccuracy results from this short method, but there is no use in securing an accuracy of computation far beyond that of the data on which the computation is based.

5. COMPUTATION OF WORK FOR AN ENTIRE LAKE.

An illustration is given herewith of the process and results for Lake Mendota. The results show, substantially, the summer heat-income of the lake for 1910 and the amount of work necessary to distribute it through the lake. The temperatures are the mean of daily observations, August 9-15, 1910.

In practice the results shown in this table would be reached with much less trouble than appears. The numbers in the column $RT \times Z$ would be taken from a table, as would the values of $1-D$. The products only would need to be written down and added.

The number of calories in any stratum, as shown in col. F, is found from the formula: Cal. $= RT\ (T-4)$, in which RT is the reduced thickness of the stratum in centimeters and T is its mean temperature. See Birge and Juday '14, p. 559, and numerous tables in that paper.

TABLE 1.

Work of wind and calories of wind-distributed heat for Lake Mendota. The direct curve of work.

A Depth, m.	B Temp.	C RT×Z	E 1−D	E Product, G. cm.		F Calories	
0–1	24.0	4800	0.002680	12.86		1920	
1–2	23.4	13500	2530	34.15		1750	
2–3	23.0	21000	2440	51.24		1600	
3–4	22.7	27700	2360	65.37		1480	
4–5	22.6	34200	2340	80.03	244.65	1410	8160
5–6	22.4	39600	2300	91.08		1320	
6–7	22.3	44900	2270	101.92		1260	
7–8	21.5	50300	2090	105.13		1170	
8–9	20.0	54400	1770	96.29		1020	
9–10	18.0	58900	1380	81.28	475.70	870	5640
10–11	16.0	60900	1030	62.73		700	
11–12	15.1	62100	889	55.21		600	
12–13	14.6	63800	814	51.93		540	
13–14	14.2	64800	757	49.05		490	
14–15	14.0	63800	720	46.51	265.43	440	2770
15–16	13.7	65100	688	44.79		410	
16–17	13.6	62700	674	42.26		360	
17–18	13.4	56000	647	36.23		300	
18–19	13.2	50000	621	31.00		250	
19–20	13.1	41000	609	24.97	179.25	190	1510
20–21	13.1	27900	609	16.99		124	
21–22	13.1	21900	609	13.34		93	
22–23	13.0	15600	596	9.30		62	
23–24	13.0	7600	0.000596	4.52	44.15	13	290
				1209.18	1209.18		18370

The results of the computation show that the heat gained above 4° by Lake Mendota in 1910 amounted to about 18400 cal. per sq. cm. of surface, and that it required about 1209 g. cm. of work to distribute this heat through the lake. The table also shows the amount of heat given to each one-meter stratum of the lake and the amount of work needed to transport it there. Both these sums are also stated in terms of a square centimeter of surface of the lake.

The results of this table are shown graphically in plate VI.

6. COMPUTATION BY LARGER INTERVALS.

If accurate results are desired the computation should be by single meters either for the full depth of the lake or at least to a depth well below the thermocline. Such a computation is necessary if, for instance, diagrams are to be prepared similar to plate VII. But if general results only are needed the process can be much shortened by using larger intervals of depth; but if this method is followed the result rarely will if ever, be exactly the same as that from the other method. Yet the results may be closely similar as may be seen from the following example, in which the same temperature series from Lake Mendota as that given in table 1 is computed by 5 m. intervals.

TABLE 2

Heat and work in Lake Mendota, computed by five-meter intervals.

Depth, m.	Temp.	RT×Z	1−D	G. cm.	Cal.
0–5	23.2°	101200	0.002483	250.48	8140
5–10	20.6	248100	1895	471.20	5560
10–15	14.8	315400	844	265.86	2750
15–20	13.4	274800	647	177.92	1500
20–24	13.1	73000	609	44.46	290
				1209.92	18240

The results shown by table 2 are substantially identical with those of table 1, but the distribution of work is somewhat different. This will ordinarily be the case when computation is made by larger intervals.

7. CAUSES OF DIFFERENCE IN RESULTS WHEN DIFFERENT THICKNESS OF STRATA ARE EMPLOYED IN COMPUTING.

One fundamental cause for the differences between table 1 and table 2 is the fact that the density of water does not vary directly as the temperature. The density of a stratum at its mean temperature is not the same as the mean density of the several subdivisions of the stratum. A second reason is because both density and volume change in going downward through a stratum and they do not change in a parallel way. Hence, the product of the means will differ from the mean of the several products. A third reason, which is not a necessary one, comes from the way in which mean temperatures of strata are usually computed. The sum of the readings taken at equal intervals in the stratum is ordinarily divided by the number of readings to give the mean temperature, and this process for a stratum of, say, 5 m. is quite accurate enough. But if the temperature is changing rapidly in the stratum this mean will not be quite the same as that derived from the mean temperature assigned to the several meters of the stratum. If readings have been made at each meter of the five, there will be six observations to be added and divided by six, and each will be employed once in determining the mean. If the mean temperature for each meter of the stratum is taken as the mean of the readings at its top and bottom, the mean for the five meters will be the sum of these means divided by five. But in reaching this result four readings of the six have been used twice, all, that is, except the readings at the top and the bottom of the 5 m. stratum. If the temperature falls rapidly in the stratum, the two methods of computations may give results that differ considerably, as the following example shows. This is taken from Beasley lake.

TABLE 3—BEASLEY LAKE.

Depth, m.	Temp.	Depth, m.	Temp.
5	21.5°	5–6	18.5°
6	15.5	6–7	13.35
7	11.2	7–8	10.2
8	9.2	8–9	8.2
9	7.2	9–10	6.85
10	6.5		mean 11.42
	mean 11.85		

The value of $1-D$ for 11.85° is 0.000448 and for 11.42° it is 0.000411, so that the value is increased about 9%, by the different method of computation. This is an extreme case and the difference is usually much less. The following example comes from the thermocline of lake Mendota.

TABLE 4—LAKE MENDOTA.

Depth, m.	Temp.	Depth	Temp.
9	20.3°	9–10	18.8°
10	17.3	10–11	16.3
11	15.3	11–12	14.95
12	14.6	12–13	14.35
13	14.1	13–14	13.9
14	13.7		mean 15.65
	mean 15.9		

In this case computations based on the larger mean give a result about 4.2% larger than that derived from the smaller number.

In most cases, when general results only are desired computation by 5 m. intervals gives sufficient accuracy; especially if single meters are used in the thermocline where the temperature (and therefore the value of $1 - D$) is changing rapidly.

8. MATHEMATICAL STATEMENT OF THE WORK OF THE WIND.

In the preceding discussion I have treated the subject in a way essentially non-mathematical,—a manner suited to my small mathematical knowledge, and, I imagine, to that of most students of lakes. The matter may, however, be stated in mathematical form and has been so stated for me by Dr. C. S. Slichter, professor of applied mathematics, University of Wisconsin. His kind assistance in this matter, as in many others, is gratefully acknowledged. His report is as follows:

It is desirable to change somewhat the notation used in the preceding pages, if the results and formulas are to be stated in strict mathematical form. The symbols "RT" for reduced thickness and "D_n" for density at depth_n are likely to give a misleading impression when used in formal mathematics. The following notation is therefore employed, which is essentially that used by Schmidt ('15) in a paper to be discussed more fully on a later page (see p. 365):

z = depth of any layer of water measured from the surface
z_0 = depth of any layer of water measured from the center of gravity of the lake
$\bar{z}$ = depth of the center of gravity of the lake below the surface
h = total depth of the lake
$\mu(z)$ = the reduced thickness of any layer
d_z = density of the layer of water at depth z
D = the mean density of the lake
A = total area of the surface of the lake
W = work per sq. cm. of lake surface necessary to produce the given vertical distribution of temperature from a uniform density of unity at 4°C.
W_s = Schmidt's measure of stability

Then it follows at once that

$$W = \frac{1}{A}\int_0^h z\ (1 - d_z)\ \mu\ (z)\ dz \tag{1}$$

This is the same result as that reached by more elementary methods in the preceding pages. The simpler methods of computing the result are better, however, than any method of mechanical quadrature.

Schmidt's measure of stability is the work necessary to mix the water at any time to a uniform mass of the then mean density, or

$$W_s = \int_0^h z_o\ (1 - d_z)\ \mu\ (z)\ dz \tag{2}$$

Reducing this result to unit area of surface we obtain

$$W_s\ /\ A = \frac{1}{A}\int_0^h z_o\ (1 - d_z)\ \mu\ (z)\ dz \tag{3}$$

Now since $\bar{z} - z = z_o$, we can write

$$\int_0^h \bar{z}(1 - d_z)\ \mu\ (z)\ dz - \int_0^h z\ (1 - dz)\ \mu\ (z)\ dz$$

$$= \int_0^h z_o\ (1 - d_z)\ \mu\ (z)\ dz \tag{4}$$

Hence substituting (1) and (2) in (3),

$$W_s\ /\ A + W = \frac{1}{A}\int_0^h \bar{z}\ (1 - d_z)\ \mu\ (z)\ dz$$

$$= \frac{1}{A} \times \bar{z} \times h\ (1 - D) \tag{5}$$

We therefore see that Schmidt's measure of stability (divided by the area A) can be found by subtracting Birge's result from the expression $\bar{z}h\ (1 - D)\ /\ A$.

This forms a ready way of computing Schmidt's measure of stability after the measure of work has been found by the methods set forth by Birge in the preceding pages.

9. DETERMINATION OF WORK AND HEAT FROM DIAGRAMS.

A second method of determining the amount of work, and one that is quite as accurate as computation, if general answers are desired, is to plat the results on a diagram and measure the areas. This will be discussed later. There is no saving in time and little, if any, gain in accuracy if one desires to know the quantity of work done for the single strata.

10. THE CURVE OF DISTRIBUTED WORK.

The results thus far reached show the amount of work done in warming a single stratum or an entire lake. They show that 14.235 g. cm., for instance, are needed to warm a given stratum but they do not show where this work is done or how it is distributed. The same is true of the statement for the lake as a whole. The several products combined in the general result of table 1 show the amount of work done *in behalf of* each stratum, but not where this work was done. If this is to be determined a second computation is necessary. In the case of the 20 m.-21 m. stratum the warmer and lighter water was carried from the surface to a mean depth of 20.5 m. Equal work was done in each unit of this distance. If the whole work is divided into 41 parts, two parts, or 4.88% of the whole, were expended in each meter above 20 m. and one part, or 2.44%, in the 20 m.-21 m. stratum. Thus in order to warm the 20 m.-21 m. stratum, 0.695 g. cm. of work was done in each meter above it, and 0.348 g. cm. within it. In a similar way, if the lake is divided into equal strata, the work for each stratum may be distributed; two shares being given to each higher stratum and one to the stratum in question. Of the work necessary to warm the 1 m.-2 m. stratum, for instance, 66.7% belongs to the 0 m.-1 m. stratum and 33.3% to the 1 m.-2 m. stratum; 40% of the work belonging to the 2 m.-3 m. stratum goes to each of the two strata above it.

In this way there may be computed the work done *in* each stratum. This may be platted as a curve which may be called the *curve of distributed work*. The computation of such a table for Lake Mendota is given in table 5, and the method of computing the result is explained under the table. The results of this computation are shown in plate VII.

TABLE 5

Computation of the curve of distributed work for Lake Mendota.

Depth m.	A	B	C	D	E	F	G	Depth	H	I
0–1	00.0	12.86	22.81	180.19	12.86	193.05		0	1208.87	18370
1–2	66.7	34.15	20.48	157.38	11.40	168.78		1	1015.82	16450
2–3	40.0	51.24	18.70	136.90	10.24	147.14		2	847.04	14700
3–4	28.6	65.37	17.76	118.20	9.35	127.55		3	699.90	13100
4–5	22.2	80.03	16.58	100.44	8.88	109.32	745.84	4	772.35	11620
5–6	18.2	91.08	15.71	83.86	8.29	92.15		5	463.03	10250
6–7	15.4	101.92	13.96	68.15	7.85	76.00		6	370.88	8890
7–8	13.3	105.13	11.36	54.19	6.98	61.17		7	294.88	7630
8–9	11.8	96.29	8.54	42.83	6.68	49.51		8	233.71	6460
9–10	10.5	81.28	5.97	34.29	4.27	38.56	317.39	9	184.20	5440
10–11	9.52	62.73	4.80	28.32	2.88	31.20		10	145.64	4570
11–12	8.70	55.21	4.15	23.52	2.40	25.92		11	114.44	3870
12–13	8.00	51.93	3.63	19.37	2.08	21.45		12	88.52	3270
13–14	7.41	49.05	3.21	15.74	1.82	17.56		13	67.07	2730
14–15	6.90	46.51	2.89	12.53	1.60	14.13	110.26	14	49.51	2240
15–16	6.45	44.79	2.56	9.64	1.44	11.08		15	35.38	1800
16–17	6.06	42.26	2.07	7.08	1.28	8.36		16	24.30	1390
17–18	5.71	36.23	1.68	5.01	1.04	6.05		17	15.94	1030
18–19	5.41	31.00	1.28	3.33	.84	4.17		18	9.89	730
19–20	5.13	24.97	.83	2.05	.64	2.69	32.35	19	5.72	480
20–21	4.88	16.99	.62	1.22	.41	1.63		20	3.03	290
21–22	4.65	13.34	.41	.60	.31	.91		21	1.40	166
22–23	4.44	9.30	.19	.19	.20	.39		22	.49	73
23–24	4.26	4.52			.10	.10	3.03	23	.10	13
		1209.18				1208.87	1208.87			

Explanation of Table 5.

A. This column shows, for each stratum of one meter, that percentage of the work performed in warming it which is to be assigned to each one-meter stratum above it.

B. In this column is entered the amount of work for each one-meter stratum. Taken from table 1, col. E.

C. Product of corresponding numbers in A and B; but each product is entered in the line *next above* that which contains the factors.

D. Successive sums of the numbers in C, beginning at the bottom. These numbers show the amount of work done within each stratum in conveying through it the heat for all the strata below it.

E. Work done in each stratum in warming the stratum itself. The number in the 0 m.–1 m. stratum is the entire result given for that stratum in col. B; each of the remaining numbers is one-half of the corresponding number in col. C, placed in the line belonging to the stratum, not in that above it.

F. Sums of numbers in cols. D and E. Total work in each stratum stated in g. cm. per sq. cm. of surface of the lake.

G. Numbers in col. F added by 5 m. intervals.

H. Total amount of work with quantity remaining at each one-meter level.

I. Figures for calories similar to those given for work in col. H.

The computation of table 5 involves a good deal of work but I see no way of escaping the work if the result is desired. Table 1 can be constructed graphically and the results obtained by measurement, although little time will thus be saved. But no such procedure is possible for table 5 and the information derived from this table is quite as valuable as that from table 1. From table 1, for instance, we learn that nearly 102 g. cm. (col. E) were needed to warm the 6 m.-7 m. stratum from 4° to 22.3° and that heat amounting to 1260 cal. (col. F) was transported from the surface into that stratum. We learn that 223 g. cm. were needed to warm all the water below 15 m. and that 1800 cal. were transported into that part of the lake.

Table 5 shows, for example, that of the 102 g. cm. used in warming the 6 m.-7 m. stratum, 7.85 g. cm. were used (col. E) within the stratum itself and the remainder between 0 m. and 6 m. It shows that over 68 g. cm. were used in that stratum (col. D) to carry through it the 7630 cal. which went to the water below 7 m. Col. H shows that of the 223 g. cm. used to warm the water below 15 m. only about 35 g. cm. were used within the lower water itself, leaving 188 g. cm. as the amount used in bringing the 1800 cal. down to the 15 m. level.

11. THE CURVE OF DISTRIBUTED WORK COMPUTED BY FIVE-METER INTERVALS.

The curve of distributed work can also be computed by 5 m. intervals, as is shown in the accompanying table. As in the case of the direct curve, the total result is closely similar to that reached by using 1 m. intervals but the distribution differs. In those strata where the volume of the single meters declines rapidly, the 5 m. interval gives results differing considerably from the 1 m. This is seen especially on comparing the strata for 0 m.-5 m. and 20 m.-24 m. in table 6 with the corresponding strata of table 5.

TABLE 6.

Computation of the curve of distributed work for Lake Mendota by five-meter intervals.

Depth	A	B	C	D	E	F	Depth	G	H
0–5	00.0	250.48	314.16	481.29	250.48	731.77	0	1210.22	182.40
5–10	66.7	471.20	106.34	167.13	157.08	324.21	5	478.45	101.00
10–15	40.0	265.86	50.91	60.79	53.17	113.96	10	154.24	45.40
15–20	28.6	177.92	9.88	9.88	25.46	35.34	15	40.28	17.90
20–24	29.2	44.46			4.94	4.94	20	4.94	2.90
							24	00	0.00
		1209.92				1210.22			

The explanation for this table is the same as for table 5.

12. COMPARISON OF SIMILAR STRATA IN DIFFERENT LAKES

It is often desirable to compare cases of similar strata in different lakes. An illustration may be taken from lake Geneva and Green lake. The following table shows the close resemblance of the two lakes:

TABLE 7.

	Geneva	Green
Length, km.	12.1	11.9
Breadth, km.	3.2	3.2
Area, sq. km.	22.1	29.7
Depth, max., m.	49.3	72.2
Depth, mean, m.	19.7	33.1

The depth is the only feature in which the lakes are not substantially identical. The resemblance is even closer than the table indicates, as may be seen by reference to the hydrographic maps. (Juday '14, pl. XVII, XXV). It extends to orientation, form, shape of basin, position of deep water; and even to the presence, position and size of a bay on the north side of each lake.

The essential facts of heat and work for August, 1913, are shown in the following table:

TABLE 8.

Comparison of Lake Geneva and Green Lake, 1913.

	Geneva	Green
Summer heat-income, cal.	26695.	27316.
Mean temperature, C°	17.50	12.25
Total work, g. cm.	2336.6	2022.6
Calories 0 m.-20 m.	23005.	21886.
Mean temperature, 0 m.-20 m.	20.15	18.85
Calories below 20 m.	3690.	5450.
Work, 20 m. and below, g. cm.	500.6	476.5
RT. 0 m.-20 m., meters	14.3	14.7
RT. 20 m. to bottom, m.	5.5	18.4

By summer heat-income is meant the quantity of heat gained by the lake above 4°. See Birge '15, p. 2. The quantity of heat and of work is stated in this table, as well as elsewhere, in units per sq. cm. of the surface of the lake.

The heat income in each lake is about the same; Green lake having an amount somewhat greater and accumulated with the expenditure of decidedly less work. This is the customary relation of the lakes. The amount of work done in warming the water of the two lakes at depths below 20 m. is closely alike. This might be expected, since lakes of the same size and form ought to be able to furnish about the same amount of work to distribute heat at such a depth. The amount of heat distributed by the work is, however, very different, lake Geneva securing from 500 g. cm. of work only about two-thirds as much heat as Green lake gets from 476 g. cm. This is because the shallower lake involves a higher temperature, and the rise of temperature involves an increase of thermal resistance which exceeds the increase of work due to the greater depth of Green lake.

This, however, does not tell the whole story; for in this statement the units of work and heat are referred to a unit of area at the surface of the lake. If they are referred to a unit of area at the 20 m. level the disadvantage of the shallower lake becomes more apparent. The area of lake Geneva at 20 m. is 50.7% of that at the surface, and that of Green lake is 61.0%. If the figures for work and heat are divided by these numbers the result is:

TABLE 9.

	Geneva	Green
Heat per sq. cm. of area at 20 m., cal.	7280	8930
Work at 20 m., g. cm.	990	780

This comparison shows the state of the facts more clearly than the other. The deep water of lake Geneva has over 80% as much heat as Green lake has, and this difference is a measure of the disadvantage in gaining heat which the shallower lake finds, so far as one observation can indicate this. The work needed to distribute this smaller quantity through the water below 20 m., is more than 25% greater than that needed by Green lake.

By comparisons of this sort it is not difficult to ascertain whether the limitations of the heat budget of a given lake are due to area or to depth, and to state, roughly, the amount of such limitations.

13. OTHER METHODS OF EXPRESSING THE WORK OF THE WIND.

In the preceding pages both heat and work have been stated in units referred to a unit of area of the surface of the lake. This is in general the most convenient way of stating the facts; but other units may be employed if desirable. If the total quantity of work done on a lake is desired, this may easily be derived from the results already reached. These are given in gram-centimeters per square centimeter of the surface of a lake having a certain area and mean depth. If this amount is divided by 10 the result will show the number of kilogram-meters per square meter of the surface. This result again multiplied by the area of the lake in square meters will give the total work done in kilogram-meters. In the example from lake Mendota we have:

$W = 1208.9$ g. cm. per sq. cm. of surface.

Dividing by 10 we have $W = 120.89$ kg. m. per sq. m. of surface.

But the area of lake $= 39.4 \times 10^6$ sq. m.

Hence, $W = 120.89 \times (39.4 \times 10^6)$ kg. m. $= 4759 \times 10^6$ kg. m. This is the total amount of work represented by the warming of the lake from 4° to 19.11° in 1910.

The volume of the lake is 478.4×10^9 kg. and this number multiplied by 15.11 cal. gives a summer heat-income of 7229×10^9 large calories. It will be noted that the ratio between quantity of work and of distributed heat is the same by this computation as by the first method. It is also obvious that if work is stated as a total amount for the entire lake, it is possible to compare the work done in the same lake in different years; but it is not possible to compare work done on different lakes.

Work for single strata may be stated in similar fashion with the same advantages and limitations.

Other reference planes may be used than the surface of the lake and this is necessary in certain cases, as illustrated on a preceding page.

Work may be stated in ergs instead of g. cm. The result in g. cm. multiplied by 981 gives work in ergs.

14. EFFECT OF THE PENETRATION OF THE SUN'S RAYS INTO THE WATER.

In this discussion I have not observed the limitations indicated in the quotation with which I opened the paper. I have not confined the discussion of the work of the wind to a consideration of the work found in that region of the lake which "lies below the direct influence of the sun." On the contrary all computations and discussions have proceeded on the assumption that all distribution of heat from the surface down is due to the wind. This method has been followed for two reasons. First, we have as yet little knowledge of the quantitative relations of the forces which distribute heat and clearness of thought on the subject may be furthered by selecting one agent at a time and analysing its possible powers, rather than by attempting a simultaneous analysis of numerous interrelated forces. The second reason is that the possible help of the sun in distributing heat is so much more complex than the wind and is so little known that we find it difficult to make even a possible quantitative statement about it.

We know indeed that a large share of the heat found in the upper meters of the water must be delivered there by the sun, and therefore, that a considerable part of the work assigned to wind in these strata really belongs to sun. The larger part of the area MA1 in pl. VII, for instance, belongs to the sun; a smaller share of the corresponding area for the 1 m.-2 m. stratum belongs to the sun; and so on in a ratio that rapidly declines and becomes zero before the thermocline is reached. We know also that the wind-currents which convey heat to the deeper water do not take all of it from the surface but pick up some of it at a greater or smaller distance below the surface. Thus the distance is reduced through which this part of the heat must be carried, and the work is correspondingly reduced.

In certain directions we have some quantitative knowledge of the effect of insolation. The amount of heat delivered at the surface of the lake and that received at a distance below the surface can be measured. In lake Mendota the average quantities thus received have been found to be as follows: At 0.5 m. the sun's rays have about 24% of the intensity which they have in the air; at 1 m., 13%; 2 m., 6.5%; 3 m., 2%; 4 m., 1%. These are average results in the middle of the day in summer, and are subject to variation according as the lake contains more or less plankton. The corresponding figures for other lakes may be higher or lower. In Marl lake as much as 20% of the energy present in the air may be found at a depth of one meter. In Turtle lake, which has very highly colored water, less than 2.5% is found at the same depth. These numbers are plainly too high if applied to the whole day and to the entire time of warming. Smaller percentages would be found in the early and later parts of the day, and also in cloudy weather, when a larger percentage of incident energy is reflected.

If we assume that the percentages of penetration indicated above are constant, it will be possible to compute roughly the amount of aid that the sun renders. For this computation we need to know the distribution of heat, computed as shown in table 5, col. H, and also the amount of heat delivered by the sun during the period under consideration. In this way the quantity of heat delivered directly at various depths may be computed and compared with the number of calories that passed through the corresponding levels. These results can be platted as work on the curve of distributed work (pl. VII) and the area thus deducted from the work-curve will represent the aid given by the sun.

If this method is applied to the mean temperature curve of lake Mendota, the result will show that about 16% of the work involved in the distribution of the heat may be contributed directly by the sun. The amount thus contributed will vary greatly in different parts of the warming season, being least in April, when the heat is being carried rapidly to considerable depths, and greatest in June, when the epilimnion is warming rapidly and but little heat goes to deeper water.

The number given above represents the maximum amount attributable to the sun. It assumes that the lake retains all the heat delivered by the sun to depths below the surface, and that all losses of heat by the lake come from that at or close to the surface. This assumption is evidently too favorable to the share of the sun, especially when we recall that three-fourths of the incident heat find no place in the heat budget of the lake. The percentage of the sun's contribution should, therefore, be reduced from the figure given above. As an estimate, it might be placed at 10-12% rather than 16%; but from the nature of the case this is merely an estimate.

This result can not be carried directly over to other lakes, each of which offers its own problem. The sun gives a larger percentage of aid in a shallow lake; less in a deep one. It does more for a small lake; less for a large one. The transparency or opacity of the lake seems to make little, or no, difference in the heat budget; at least within the limits found in Wisconsin, where all the water has considerable color. The temperature curves and the thickness of the epilimnion seem to have no relation to the color of the water, such as they plainly have with area and depth. This fact alone shows the dominance of the wind as the distributing agent for heat, and the very secondary part which the sun plays in most lakes.

For the present the subject may be left with these general statements, and with an additional remark on the uses to which the work-budget will naturally be put. The work budget is derived, not from direct observations, but by inference from the heat budget. It is, therefore, a secondary matter and of use chiefly in aiding to interpret the heat budget. The total work budget does not add greatly to the knowledge obtainable through the heat budget, on which it depends. Lakes will naturally be compared on the basis of their heat budgets, which come from direct observations of temperature, rather than on that of the work budgets derived from the heat budgets. The value of the work budget lies chiefly in its application to the deeper strata, first to the hypolimnion as a whole, and then to its several strata.

It will help to bring, if not a solution, at least a partial understanding of the difficult questions of the effect of the depth and volume of the lower water on its temperature, and so on the heat budget of the lakes.

15. THERMAL RESISTANCE.

In 1910 (Birge '10, pp. 989-1004) I discussed the matter of thermal resistance. The paper gave a formula for determining the work done in mixing a column of water with unit base and height, and a uniform temperature gradient. This is

$$W \text{ (ergs)} = \frac{AC^2}{12}(D_2 - D_1) \qquad \text{(Formula II.)}$$

In this A is the area and C the height of the column. D_1 is the density of the water at the upper surface of the column and D_2 that at the lower surface.

If A and C are assumed as constants—for instance, 1 sq. cm. and 100 cm.—then the thermal resistance will vary according to the value of $D_2 - D_1$, or (to state it in terms of $(1-D)$, according to the value of $(1-D_1)-(1-D_2)$.

For the purposes of limnology it is convenient to assume the values of A as 1 sq. cm. and of C as 100 cm., to take as the standard temperature gradient 1° per meter, and as the standard unit, the amount of work required to mix such a column of water whose temperature is 5° at the top and 4° at the bottom. In this case W = 0.0067 ergs and this value can be taken as the unit of work done in mixing. But since comparative values rather than absolute quantities are needed, it is just as well to avoid this computation and take as the unit of thermal resistance $D_4 - D_5$, which equals .000008.

Then in any column of water 1 sq. cm. in area and 100 cm. high with a uniform temperature gradient, the number of units of thermal resistance is equal to $\frac{D_m - D_n}{8}$; m and n being the temperatures of the water at the ends of the column. These relative values for differences of 1° are given in the paper referred to (p. 991 column IV) and are also shown graphically in pl. LXV (p. 1005).

If this method is applied to the temperature series from lake Mendota discussed in this paper we have the following result. Operations are performed with $1-D$, instead of D.

TABLE 10

Thermal resistance of Lake Mendota for temperature condition used in preceding tables.

Depth	T	1–D	Depth	D²–D¹ / 8
0	24.2°	0.002727	0–1	15.4
1	23.7	2604	1–2	15.0
2	23.2	2483	2–3	12.1
3	22.8	2388	3–4	5.9
4	22.6	2341	4–5	3.0
5	22.5	2318	5–6	3.0
6	22.4	2295	6–7	3.0
7	22.3	2272	7–8	44.4
8	20.7	1917	8–9	36.7
9	19.3	1628	9–10	62.2
10	16.6	1130	10–11	24.4
11	15.4	935	11–12	11.4
12	14.8	844	12–13	7.4
13	14.4	785	13–14	5.2
14	14.1	743	14–15	5.2
15	13.8	701	15–16	3.1
16	13.6	674	16–17	1.6
17	13.5	661	17–18	5.0
18	13.2	621	18–19	1.5
19	13.1	609	19–20	0.6
20	13.1	609	20–21	0.4
21	13.1	609	21–22	0.3
22	13.0	596	22–23	0.2
23	13.0	596	23–24	0.1
24	13.0	596		

The numbers in the last column show the thermal resistance in each meter in terms of the unit stated on the preceding page. The results are also shown in fig. 10. In this figure the values of the thermal resistance are platted in the middle of the space assigned to each meter. The diagram shows, even more clearly than the table, the strata of the lake where thermal resistance is greatest. These are the upper three meters, where there is a super-heated layer which will make it hard to get heat from the surface to the strata below. On the other hand, while the difference in density is considerable, the decline of temperature is not great. (pl. II). The loss of relatively few calories would permit the easy transfer of heat through the epilimnion from surface to thermocline.

The situation at the thermocline is very different. Here is a sudden and great rise of resistance, so great that only very strong winds can force warmed water into the cooler strata, even those at the top of the thermocline. When therefore such a fully developed thermocline has appeared it offers a very effective resistance to the direct influence of the wind.

Thus the temperature gradient in the thermocline is so steep that very little mixture takes place there except when the wind is exceptionally violent; and when the wind is strong, so that most of the epilimnion is pushed to one side of the lake, this process compresses the thermocline and greatly increases the temperature gradient at the very place where the currents set up by the wind are most vigorous. The same statement may be made of oscillations, like the temperature seiche. These are robbed of much of their possible effect in warming the lake by the fact that each of their movements which tends to mix the water at the junction of epilimnion and thermocline increases also the thermal resistance to mixture in that stratum.

Thus much of the energy of the wind is lost so far as concerns its effect in distributing heat. The temperature gradient in the thermocline acts somewhat like a spring resisting the action of the wind. It is compressed when the wind pushes harder; it releases when the wind dies down; but in either case its resistance is proportioned to the vigor of the pressure on it, and it is almost equally effective at all times in preventing mixture. Hence there are found only small results, or even none that are measurable, from violent winds in summer, unless these are accompanied by a decided fall of temperature.

The distribution of heat below the thermocline depends on currents indirectly occasioned by the wind, and therefore relatively feeble under ordinary conditions. They operate, however, on water which has a decreasing thermal gradient and therefore are in position to effect some mixture. The discussion of this matter, however, does not belong in this paper.

16. THE "STABILITY" OF A LAKE.

In 1915 Professor Wilhelm Schmidt of Vienna published a very thoughtful and suggestive paper entitled "Uber den Energiegehalt der Seen" (Schmidt '15). In this he discussed a subject nearly related to that of the present paper, under the head of the *stability* of a lake. The meaning of this may be stated as follows: A lake in a homothermous condition is in a condition of indifferent equilibrium; if its upper strata are warmed the equilibrium becomes proportionally stable. The amount of this stability may be measured by the amount of work needed to complete the distribution of heat through the lake and so to bring the lake again to a condition of uniform temperature and indifferent equilibrium. The amount of this work may be expressed in kilogram-meters for the total volume of the lake or in the amount of the displacement of the center of gravity of the lake, which this amount of work would effect. Problems relating to the temperature seiche, and others as well, may be discussed in the light thrown on them by the stability thus ascertained.

Schmidt's point of view is very different from mine. He starts with a certain condition of heat (and therefore of density) and desires to follow out the further effects of this condition. I ask how much work was required to bring about that condition of temperature. He determines the stability and sees in this an important factor in advancing our knowledge of movements of the water such as the temperature seiche. I attempt to determine the work done in distributing heat; and I hope, by solving this problem, to get more light on the relation of the area, depth, and form of lakes to their heat budget.

Schmidt's problem begins where the problem ends which is discussed in the present paper. He considers not the amount of work needed to produce the stability (and this is another way of stating my problem) but the amount necessary to continue the distribution of heat until an indifferent equilibrium again results.

It is not necessary here to discuss Schmidt's methods in detail. Their mathematical theory is very skilfully worked out and rests on the calculus. Practically the problems are solved graphically and the methods of constructing the diagrams are given. These are also excellent, and I will apply them to the case of lake Mendota which has already been discussed, in order to show more clearly the relation of the methods and of the results obtained.

Since the result is to be stated in terms of the effect on the center of gravity, the position of the level is determined in which this lies, and the moment of each stratum above this plane and below it is computed. The horizontal lines of fig. 9 show the result for lake Mendota, computed by 1 m. intervals. The center of gravity (CG) lies at 8.35 m. The vertical distance between the several meter lines of the diagram is proportional to the moment of each one-meter stratum of the lake. On this diagram are platted the several values of $1-D$ for the temperature condition found. The area to the left of the curve A A is proportional to the amount of work needed to overthrow the stability. That part which lies above C G, the center of gravity, is to be taken as positive and that below as negative. The areas may be measured by a planimeter and the quantity of energy thus determined. This quantity will be expressed in kilogram-meters and if the result is divided by the volume of the lake expressed in liters the quotient will equal the displacement of the center of gravity in meters. In this case the amount of work done above the center of gravity is 2867.9×10^6 kg. m. and that below the center of gravity is 837.1×10^6 kg. m. Subtracting the second result from the first, we have 2030.8×10^6 kg. m. as the amount of work necessary to restore the lake to a condition of indifferent equilibrium.

The volume of the lake is 478000×10^6 liters. The measure of the stability is therefore $S = \frac{2030.8 \times 10^6}{478000 \times 10^6} = 0.425$ cm.; that is to say, the work of restoring the lake to a condition of indifferent equilibrium at the higher temperature is equal to that of raising the weight of the lake through a distance of 0.425 cm.

17. COMPARISON OF SCHMIDT'S RESULTS WITH THOSE REACHED THE PRECEDING PAPER.

The above result can be stated in terms similar to those which I have employed in this paper, in gram-centimeters per square centimeter of the area of the lake, and by so doing the relation of Schmidt's method and mine will be made apparent. The mean depth of the lake is 12.1 m. and a column of water with this height and a base of 1 sq. cm. weighs 1210 g. The work necessary to restore indifferent equilibrium would raise all of these columns through a distance of 0.425 cm., involving work to the amount of 514.25 g. cm. on each column (1210×0.425).

This result may be called the complement of that reached by me, as the following considerations will show. A formula may be given from which may be computed the amount of work necessary to cause a lake to pass from a condition of indifferent equilibrium at 4° (D = 1) to a similar condition at a higher temperature and a smaller density.

This formula* is

W = (CG) × (RT) × (1 − Dm). (Formula III.)

In this formula, CG equals the distance from the surface of the lake to the plane in which is found the center of gravity of the lake.

RT is in this case the mean depth of the lake.

1 − Dm is the mean value of 1 − D for the lake at the higher temperature conditions that have been developed.

This formula means that the work involved in the process described is that necessary to move a weight equal to (1 − D) multiplied by the mean depth of the lake, through a distance equal to that of the center of gravity from the surface of the lake.

The value of 1 − Dm for lake Mendota in the temperature conditions used in former examples is 0.001705.

The value of CG is 835 cm.; of RT 1210 cm., which for a column 1 cm. square is equal in weight to the same number of grams.

Therefore W = 835 × 1210 × 0.001705 = 1722.65 g. cm. per sq. cm. of the surface of the lake.

But it has been already shown (p. 349) that the work necessary to produce the temperature condition here discussed is 1209.18 g. cm. The work necessary to complete the distribution of the heat, according to Schmidt's method, is 514.25 g. cm. (p. 367). The sum of these is 1723.41 g. cm., a result which checks quite accurately with that given above.

If therefore one desires to know the stability of a lake for which he has computed the work necessary to bring its temperature into a certain condition, the result may be derived as above.

It should be noted that the value of (CG) × (RT) is approximately equal to the sum of the factors given in table 1, col. C for RT × Z. Conversely, the position of CG may be derived from the formula

$$CG = \Sigma(RT \times Z)\frac{A}{V}$$

*This formula has been given to me by Professor C. S. Slichter, who also pointed out the relation here stated between my results and those of Schmidt.

In this formula $\Sigma(RT \times Z)$ is the sum of the products in table 1, column C. A is the area of the lake and V its volume.

The result thus obtained will be only approximately correct and will need adjustment if accurate computations are to be made by Schmidt's method.

The value for the stability thus obtained may readily be converted into other units, such as the displacement of the center of gravity, or the total amount of work in kg. m.

Attention is again directed to the point, that in formula III the value of $1-D$ for the mean temperature of the lake can not be used instead of the mean value of $1-D$ (cf. p. 347).

It is also apparent that the value of the total work, as computed in this paper, may be called the complement of the results obtained by Schmidt, and may be derived from his results in the same way that his results may be derived from mine. The choice of methods is, however, by no means a matter of indifference. So far as total results go they reach the same conclusions and involve about equally tedious computations. They lend themselves equally well to graphical methods. But the case is different when one desires to examine the results for single strata of the lake or to compare strata in different lakes. In my method the datum plane, from which all computations start, is the surface of the lake; in Schmidt's method the datum plane is that of the center of gravity. I use the surface to which the energy of the wind is directly applied and that from which the distribution of heat starts in fact. It is also the surface which is a chief factor in any discussion that involves other surfaces and volumes of the lake. We must start from this surface for instance, in order to determine the position of the center of gravity. My method therefore seems to be the more simple and direct one. The results which Schmidt reaches can readily be obtained by it, and others as well which may be used in the discussion of a wider range of problems.

DIAGRAMS.

The following diagrams show in graphic form the chief results of this paper. Each figure has a somewhat full explanation and this need not be repeated in the text. In general it may be said that graphic methods, when they are applicable, are quite as accurate as computation by such methods as those which I have employed. Undoubtedly the curve of $1-D$ in pl. VI can be drawn so that measurement will give more accurate results than computation by 1 m. intervals. If total results only are wanted the graphic method is also about as rapid as computation. But the gain in accuracy is slight at best, and the computation is in all cases more accurate than the observations on which it is based, and far more accurate than the assumptions which accompany the observations.

If the work done for or in the single strata is desired the results can be obtained much more quickly by computation than from diagrams. The measurement of numerous small areas consumes much time with little or no corresponding gain in accuracy.

It will be noted that the longest computation—that by which the curve of distributed work is derived from the direct curve, can not be mechanically performed.

Plate I. Diagram for determining RT for the several one-meter strata of lake Mendota (after Schmidt '15, fig. 1.). The volume of the lake below any level whose volume has been computed, is platted on the proper line and the points thus determined are joined by a curve. In this case the points are at 0, 3, 5, 10, 15 and 20 m. Horizontal lines are then drawn for each meter of depth. From the intersection of these lines with the curve perpendiculars are drawn to the scale at the bottom. Then the distances on the scale, 0-1, etc. are proportional to the reduced thickness of the several one-meter strata. Their numerical value may be ascertained by measuring these distances, and computing their value as percentages of the mean depth of the lake $\left(\frac{V}{A}\right)$. In this case the entire length of the scale corresponds to a mean depth of 12.1 m. Since, however, the volumes of the several strata are likely to be needed for other purposes, it is quite as easy to determine these from the diagram and ascertain RT directly by using the formula

$$RT = \frac{V_{0-1}}{A_0}, \text{etc.}$$

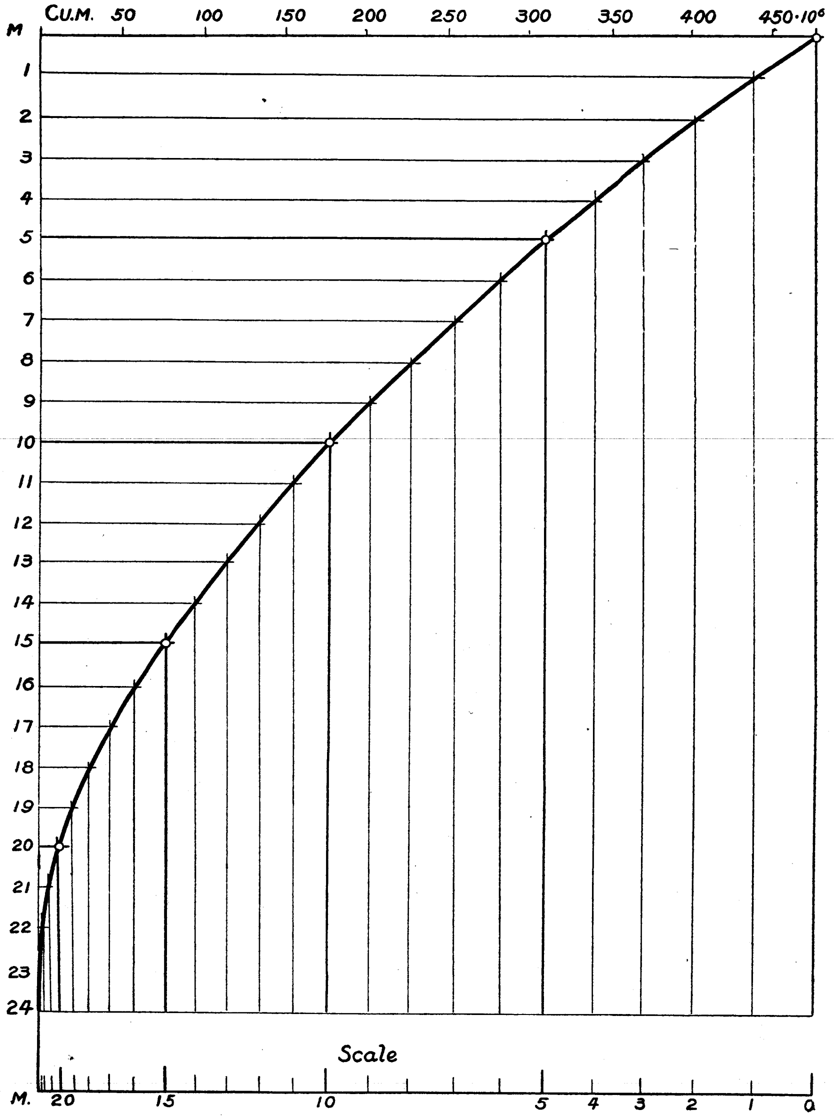

CU.M.
50
100
150
200
250
300
350
400
450·10⁶
M
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
Scale
M.
20
15
10
5
4
3
2
1
0

Plate I

Plate II. Temperature curve and density curve of lake Mendota. This is the mean of the daily observations Aug. 9-15, 1910. Ordinates represent depth and abscissas temperature or the value of $1-D$. The scale for $1-D$ is 100 times as great as for temperature and its zero starts at 4°. For purposes of comparison 4° should also be the starting point of temperature and loss of density should be compared with increase of heat as measured from that point. It is more convenient to treat $1-D$ as a whole number, except in multiplying and to think of it as representing loss of weight—milligrams per liter, for instance. In this case a gain of 20° above 4° involves a loss of 2677 points in density, while a similar gain of 10° or half as much heat, reduces the density less than one-third as much, 729 points.

It is this fact which makes it worth while to make a study of the work involved in distributing heat. If the density varied directly as the heat, the results of a change of density would not differ from those of a change of heat.

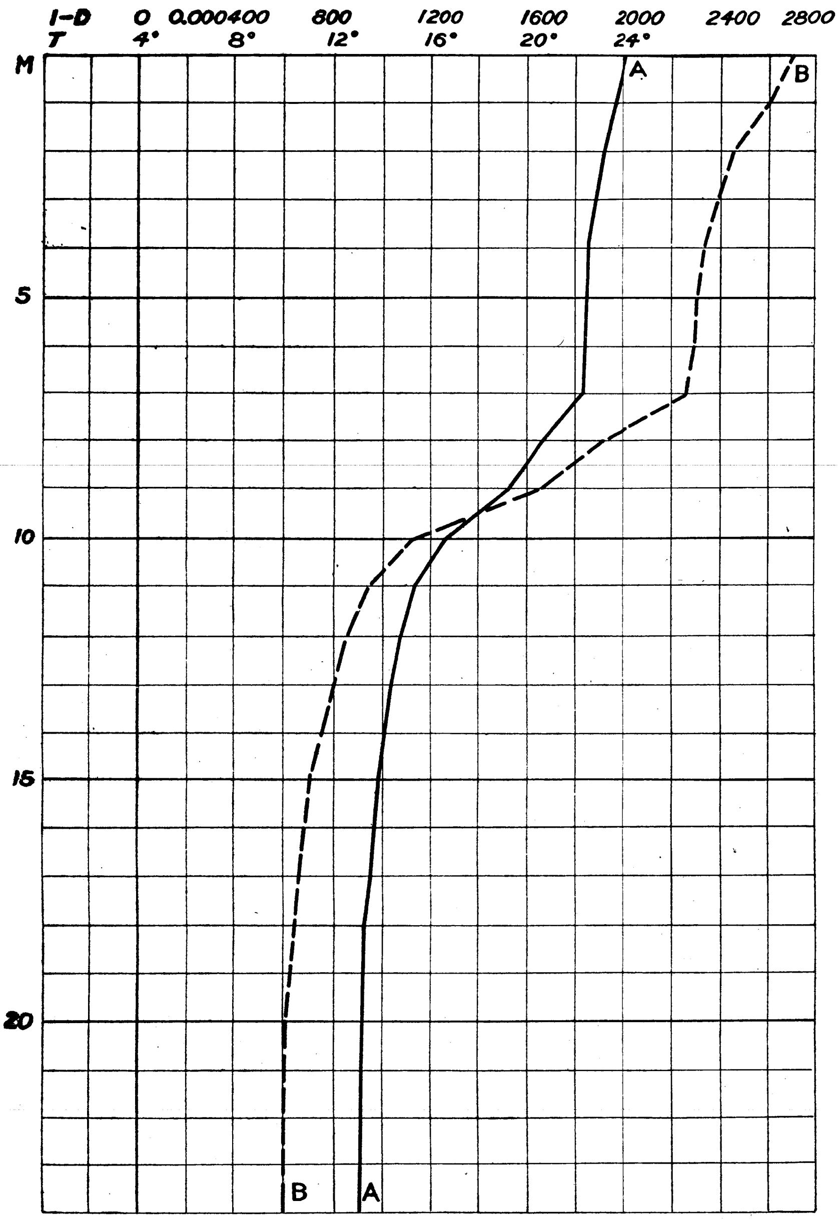

I-D 0 0.000400 800 1200 1600 2000 2400 2800
T 4° 8° 12° 16° 20° 24°
M
5
10
15
20
A
B
B
A

Plate II

Plate III

Plate III. Temperature and 1 — D, Beasley Lake, Aug. 31, 1900. An extreme case of rapid decline from a high temperature, with corresponding difference between the temperature curve and the density curve. See explanation of Plate II

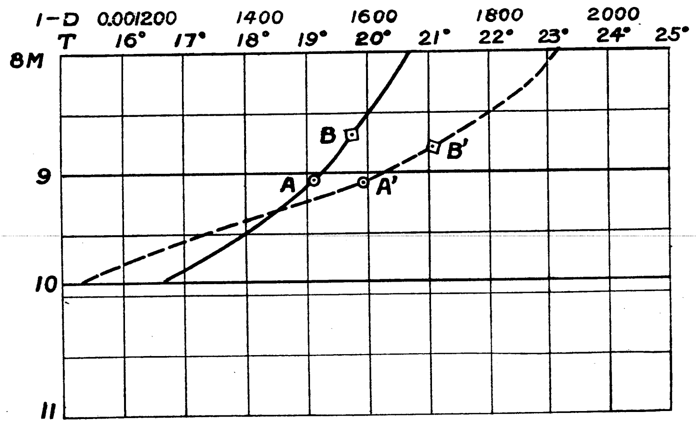


Plate IV

Plate IV. Part of Plate V on a larger scale. (See p. 347.)
A = mean temperature, 19.11°; A′ = value 1 − D for mean temperature, 0.001590; B′ = mean value 1 − D, 0.001705; B = temperature corresponding to 0.001705, 19.68°.

Plate V. Quantitative curves of heat and density, Mendota. The scale of abscissas is the same as in fig. 2. The vertical divisions correspond to the RT scale shown in fig. 1. One horizontal space equals two calories or 200 density points. One vertical space on the scale equals 100. The horizontal lines for this scale are not drawn for fear of confusion with the meter lines, which are necessary for platting and measuring. In practice the diagram would be drawn on coordinate paper. The area between the line for 4° and the curve of temperature or density respectively may be measured with a planimeter. The total gain of heat and loss of density can be thus determined, and from these results the mean temperature and the mean density.

The area bounded by any two meter-lines, the 4° line, and the curve, will give the amount of heat or loss of density in any given meter.

The points are marked on the curves which correspond to mean temperature and mean density.

So far as the temperature curve is concerned, pl. V. corresponds to figs. 2 and 3, in my paper on heat budgets. (Birge '15, p. 22, 23.)

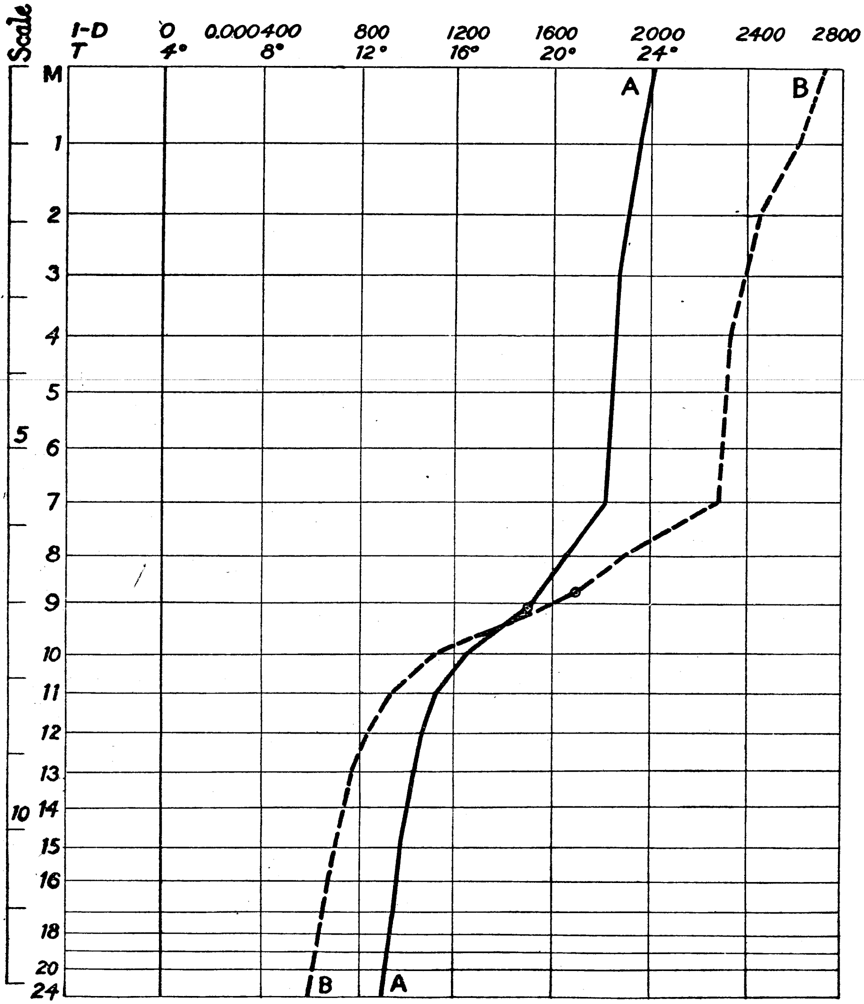

Scale
1-D
T
0
4°
0.000400
8°
800
12°
1200
16°
1600
20°
2000
24°
2400
2800
M
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
18
20
24
5
10
A
B
A
B

Plate V

Plate VI. Diagram of work, lake Mendota, Aug. 1910. This diagram corresponds to the calories and loss of density shown in pl. V and table 1. In this diagram the horizontal lines represent the meters, and the distances between them represent the values of $RT \times Z$. The scale is placed beside the diagram and lines for it are not drawn, so as to avoid confusion. In a working diagram coordinate paper would be used. One space on the vertical scale equals 50,000 g. cm. One space on the horizontal scale equals 0.0004. The values of $1-D$ are platted on the meter-lines. The area enclosed by the density curve may be measured with a planimeter, and the value of W ascertained. The result will be given in g. cm. per sq. cm. of the surface of the lake. By similar measurement the value of W for any single meter may be ascertained. The broken line representing $1-D$ may be replaced by a smooth curve if this is thought advisable.

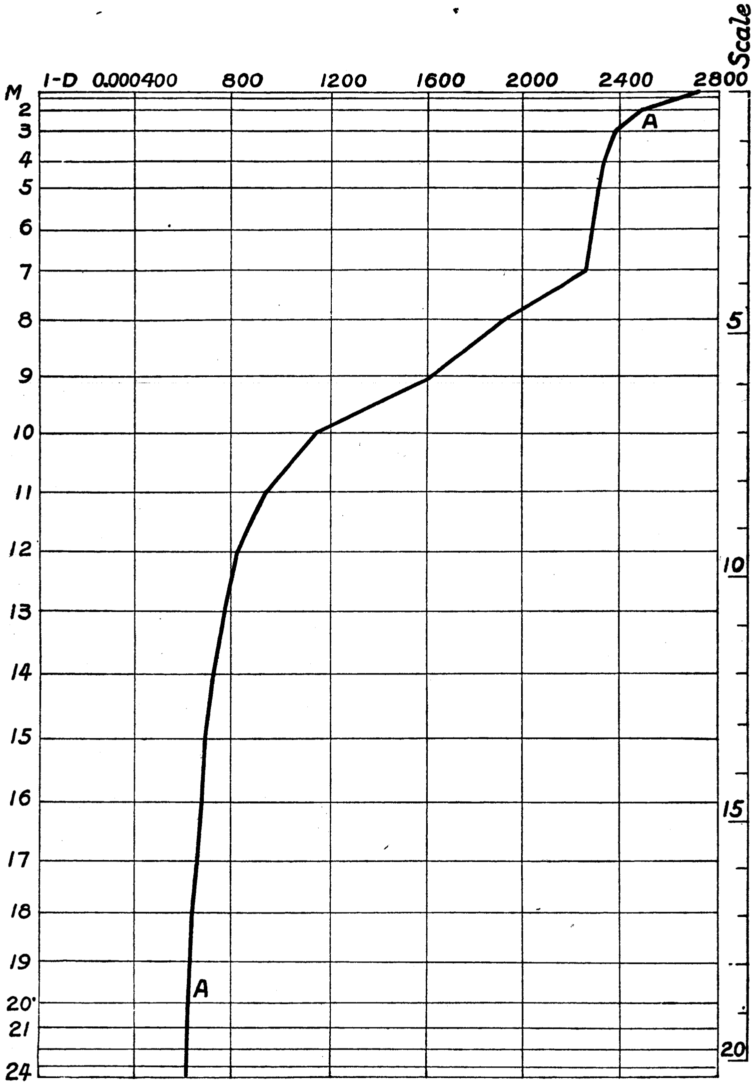

Scale
I-D 0.000400 800 1200 1600 2000 2400 2800
M 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 24
A
A
5
10
15
20

Plate VI

Plate VII. Direct curve of work and curve of distributed work. The full line, A B D D, is the direct curve. To obtain this the value of W for each meter is taken from table 1 and is platted in the middle of the space assigned to the meter. These points are then connected by a curve. Each horizontal space equals 10 g. cm. and each vertical space equals 1. Then the area MA 1 gives the value of W for the stratum 0 m.-1 m.; 1 AB 2 gives the value of W for the 1m.-2 m. stratum, etc. The area enclosed by the entire curve will give the total value of W. This curve shows the work done *in behalf* of each stratum.

The broken line, RR, gives the curve of distributed work, showing the work done *in* each stratum. It shows graphically the results given in table 5 col. F. The total area enclosed by the curve is the same as that of the direct curve. The dotted area in the 1 m.-2 m. stratum shows the amount of work done in that stratum in warming it (table 5 col. E). The remainder of the area 1 CD 2 shows the amount of work done in it in order to carry heat to deeper strata (col. D).

The numbers from which the curves are platted are given in g. cm. per sq. cm. of the surface of the lake. They can be converted into g. cm. per sq. cm. of the area at any depth and the results would be similar to those shown in pl. 8.

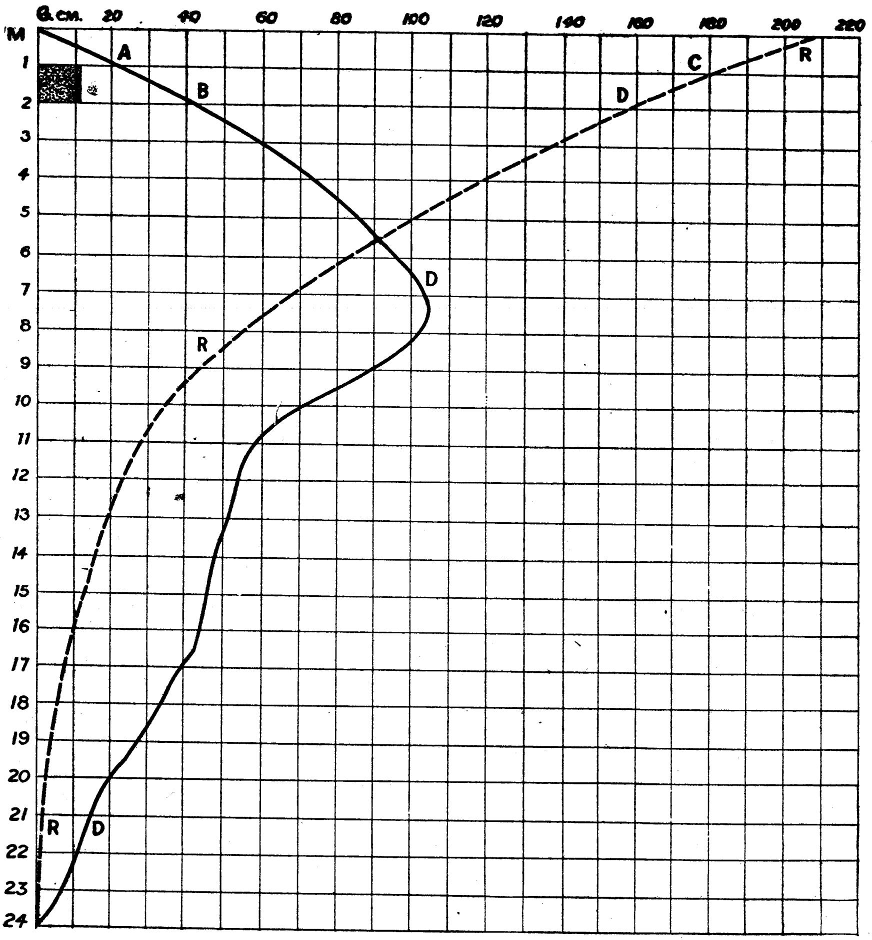

G. cm. 20 40 60 80 100 120 140 160 180 200 220
M
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
A
B
C
D
R
D
R
R D

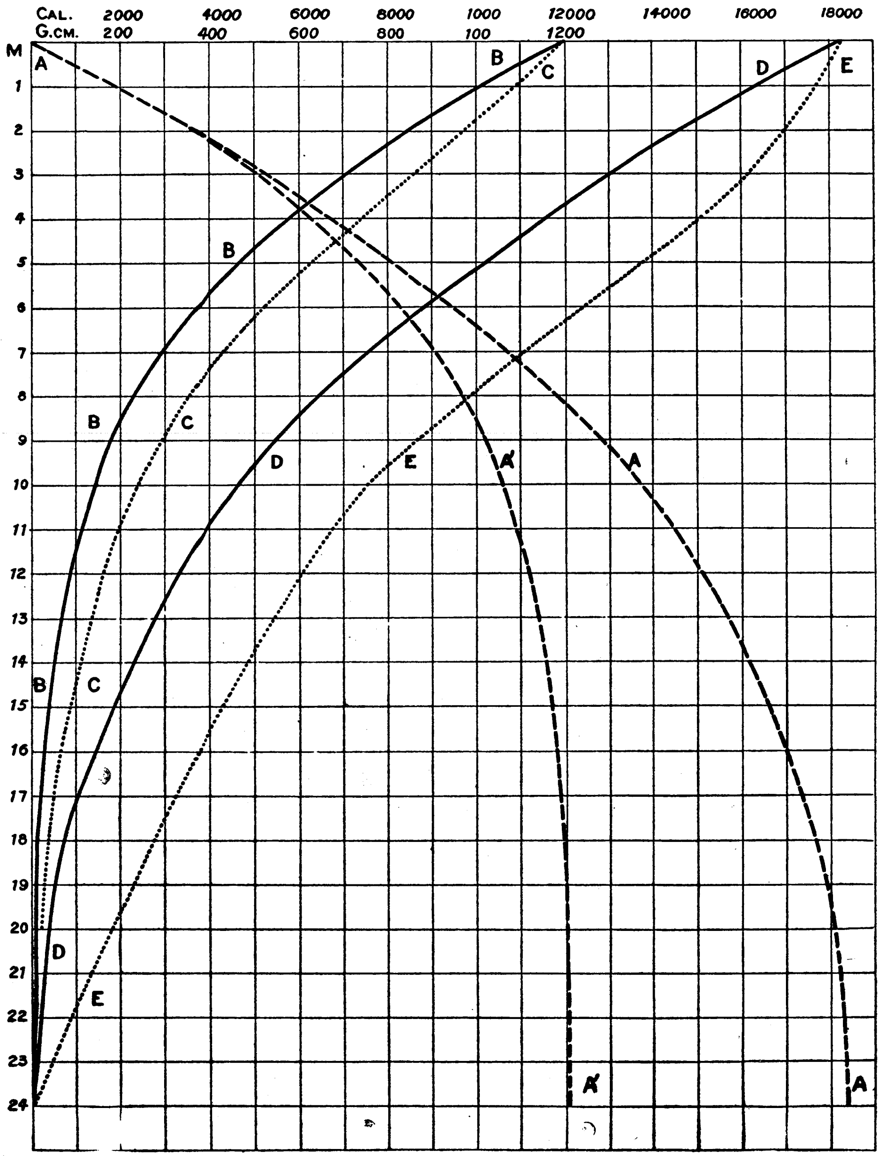
Plate VII

Plate VIII. Summation and subtraction curves of calories and work; summer heat-income of lake Mendota. Horizontal scale for calories ten times that for work. Summation curves in broken lines; subtraction curves in full lines. The summation curve for calories is AA: that for work is AA′. The value at the intersection of any meter-line with the work-curve shows the amount of energy expended in distributing through the water above the meter-line, the amount of heat indicated at the intersection of the same meter-line with the heat-curve. For instance, a depth of 5 m. about 745 g. cm. of work has been done to distribute in the water above that depth about 8150 cal. In both cases the numbers refer to sq. cm. of the surface of the lake. At 10 m. the amount of work expended is increased to nearly 1065 g. cm. and 13800 cal. have been left behind. Thus 5650 cal. have been brought from the surface into the 5 m.-10 m. stratum and distributed through it by an expenditure of 325 g. cm.

It is noticeable that in the upper meters heat and work increase together and at about the same rate; but as depth increases the curves diverge and in the lower and cooler water the number of calories increases much more rapidly than the number of gram-centimeters of work needed to distribute it. This means that the decline of thermal resistance decreases work more rapidly than the increase of depth adds to it. The deep lake therefore calls for less work in proportion to gains of heat, than does the shallower lake.

The subtraction curve for work is BB; that for calories is DD. These curves show at the surface, for example, that about 1210 g. cm. of work per sq. cm. of the lake's surface were required to distribute 18370 cal. per sq. cm. into the water of the lake; that at the depth of 5 m. about 465 g. cm. were left to distribute about 10300 cal. through the water below 5 m.

The dotted lines CC and EE show the amount of work and heat at any given depth as referred, not to the area of the lake's surface, but to the area at that depth. Thus the main curves BB, DD, show that at the depth of 10 m. there are left about 145 g. cm. and 4600 cal. per sq. cm. of the lake's surface. But since the area of the lake at 10 m. is 61% of that at the surface, these results are divided by 0.61. The quotients show that there were brought to a depth of 10 m. nearly 7600 cal. for each sq. cm. of the area of the lake at that depth and there were similarly about 240 g. cm. of work available for its distribution. Similar computations are made for various points along the curves; the results are platted and connected by the dotted lines. This change in the datum plane is necessary if similar strata in different lakes are to be compared. See p. 357.



CAL. 2000 4000 6000 8000 1000 12000 14000 16000 18000
G.CM. 200 400 600 800 100 1200
M
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
A
B
C
D
E
A'

Plate VIII

Plate IX. Diagram showing stability curve of Lake Mendota. After Schmidt '15, p. 21. fig. 3. The vertical distance between the meter lines indicates the moment of the one-meter strata with reference to the plane of the center of gravity (CG). One horizontal space indicates 0.0004 in the value of $1-D$. One space on the vertical scale equals 125000×10^6 kg.m. The lines corresponding to this scale have not been drawn across the diagram. The values of $1-D$ are platted on the meter lines and the points thus ascertained joined by a curve AA. The area above CG and that below it are measured with a planimeter, and from the areas is determined the number of kg. m. represented by each. The difference between these sums shows the amount of work necessary to restore indifferent equilibrium at a density equal to the mean density of the lake in the condition shown by the diagram. See p. 366.

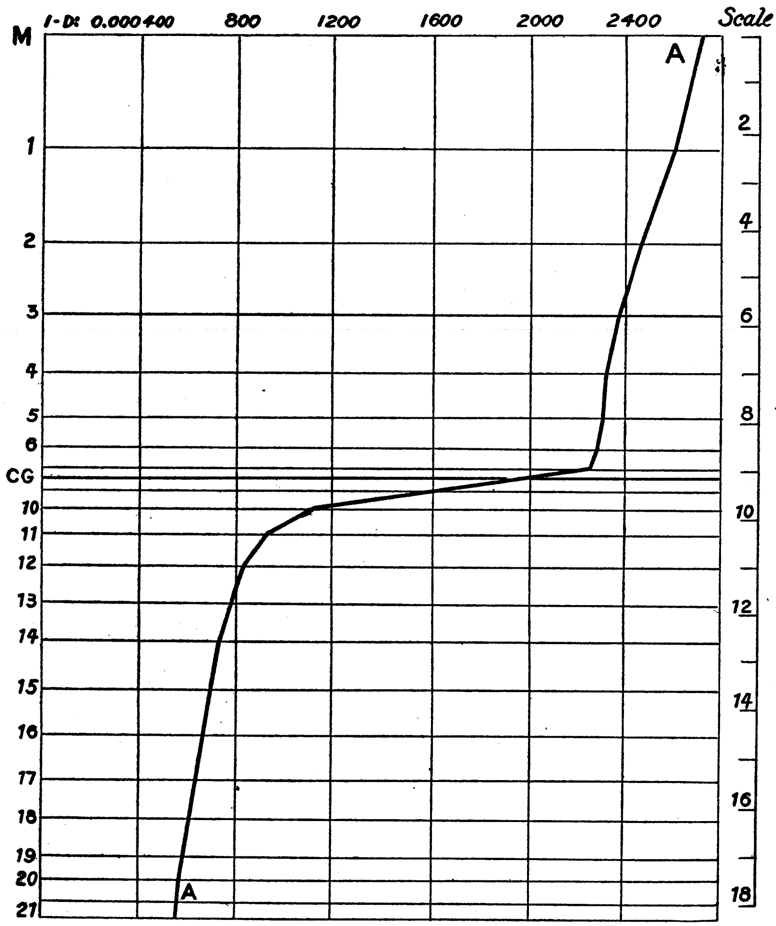

1-D: 0.000400
800
1200
1600
2000
2400
Scale
M
A
1
2
3
4
5
6
CG
10
11
12
13
14
15
16
17
18
19
20
21
A
2
4
6
8
10
12
14
16
18

Plate IX

Plate X. Thermal resistance. Lake Mendota, Aug. 1915. The diagram shows the thermal resistance to mixture presented by lake Mendota under the temperature conditions discussed in other diagrams and tables. The vertical spaces represent depth: each horizontal space represents five units of thermal resistance as defined on p. 363. The length of the heavy black line shows the number of such units that are found in the one-meter stratum within which it lies.

Note the concentration of resistance in the thermocline, and to a less degree at the surface. Note also that the currents directly caused by wind have to meet an increasing resistance at the thermocline with currents that are declining in energy. Below the thermocline the indirectly caused currents are operating on water whose resistance is decreasing as the depth increases.

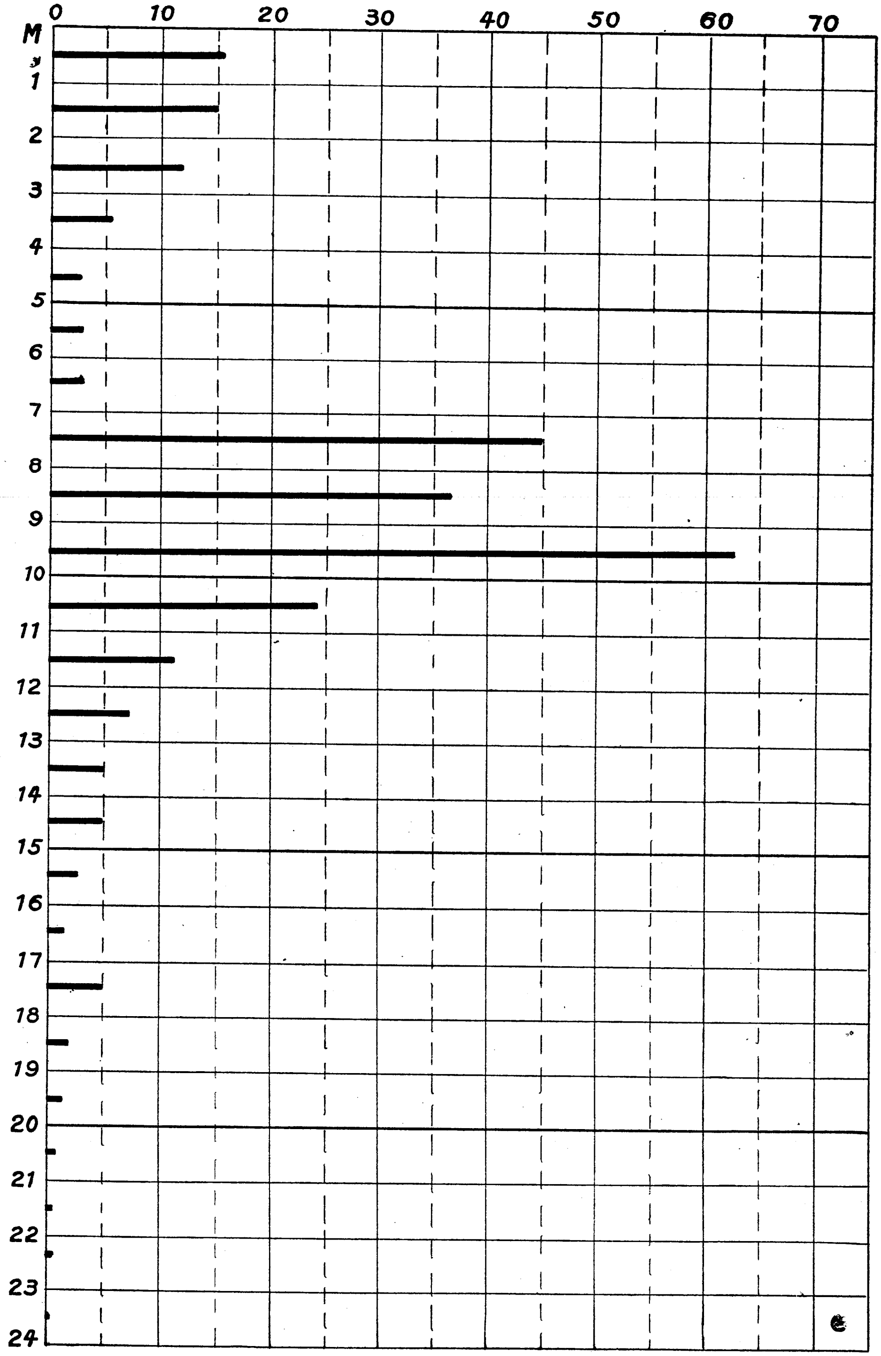

0
10
20
30
40
50
60
70
M
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24

Plate X

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APPENDIX.

TABLE 11.

Value of 1.000,000—D, 0° to 27° C.
(From Landolt and Börnstein.)

T	.0	.1	.2	.3	.4	.5	.6	.7	.8	.9
0	0.000132	126	119	113	107	101	95	89	84	79
1	73	69	64	59	55	51	47	43	39	35
2	32	29	26	23	20	18	16	13	11	9
3	8	6	5	4	3	2	1	1	0	0
4°	0.000000	0	0	1	1	2	3	4	5	7
5	8	10	12	14	16	18	21	23	26	29
6	32	35	38	42	46	49	53	57	62	66
7	71	75	80	85	90	96	101	107	112	118
8	124	130	136	143	149	156	163	170	177	184
9	192	199	207	215	222	231	239	247	256	264
10	273	282	291	300	309	319	328	338	348	358
11	368	378	388	399	409	420	431	442	453	464
12	475	487	498	510	522	534	546	558	571	583
13	596	609	621	634	647	661	674	688	701	715
14	729	743	757	771	785	800	814	829	844	859
15	874	889	904	919	935	950	966	982	998	1015
16	1030	1047	1063	1080	1096	1113	1130	1147	1164	1181
17	1199	1216	1234	1251	1269	1287	1305	1323	1341	1360
18	1378	1397	1415	1434	1453	1472	1491	1510	1529	1549
19	1568	1588	1608	1628	1648	1668	1688	1708	1729	1749
20	1770	1790	1811	1832	1853	1874	1895	1917	1938	1960
21	1981	2003	2025	2047	2069	2091	2113	2136	2158	2181
22	2203	2226	2249	2272	2295	2318	2341	2365	2388	2412
23	2435	2459	2483	2507	2531	2555	2579	2604	2628	2653
24	2677	2702	2727	2752	2777	2802	2827	2853	2878	2904
25	2929	2955	2981	3006	3032	3059	3085	3111	3137	3164
26	0.003190	3217	3244	3270	3297	3324	3352	3379	3406	3433

ADDITIONAL SPECIES OF PHOLIOTA, STROPHARIA AND HYPHOLOMA IN THE REGION OF THE GREAT LAKES

EDWARD T. HARPER

Since publishing the species of Pholiota, Stropharia and Hypholoma in Vol. XVII of these Transactions I have secured photographs of a number of additional forms which are shown in the plates accompanying this article. They belong to the Pholiota dura-praecox, aegerita and curvipes groups, the Stropharia stercoraria-semiglobata group and the Hypholoma sublateritium, velutinum and appendiculatum-candolleanum groups. I also give a photograph of Hypholoma hydrophilum which belongs to the Psilocybe spadicea group.

These are good examples of the groups in the Agaricaceae and I take the opportunity to describe them more in detail and to explain the method of grouping I have followed and the names chosen for the groups.

The agarics in this region fall naturally into groups. The forms in a group resemble each other closely but the groups are quite distinct. Most groups contain one or more common and wide spread species as well as rare and local forms. If we mention only those forms which have been named as species there are in the Pholiota dura-praecox group the common species Pholiota dura and Pholiota praecox and the rare Pholiota howeana, vermiflua, temnophylla, duroides, etc. In the Stropharia stercoraria-semiglobata group are the rare forms Stropharia umbonatescens, siccipes, siccipes var. radicata, etc. In the Hypholoma velutinum group are Hypholoma rugocephalum and Hypholoma boughtoni. In the Hypholoma appendiculatum-candolleanum group a wealth of forms have been named, among them Hypholoma incertum, cutifractum, madiodiscum, hymenocephalum, flocculentum, longipes, Stropharia irregularis, longistriata, etc.

The situation in Europe is the same as here. In each of the groups I have mentioned the ,well known species are the same. Pholiota dura, praecox, aegerita and curvipes, Stropharia stercoraria and semiglobata and Hypholoma appendiculatum, candolleanum, sublateritium and velutinum are all reported as common species in the floras of the British Isles, France, Germany, Bavaria, etc. There are also numerous more local forms in the same groups in each flora. For example in the floras of the British Isles Hypholoma lanaripes, appendiculatum, var. lanatum, leucotephrum, egenulum and piluliforme are given in the appendiculatum-candolleanum group. It is difficult to determine the relationship of many of these forms to those listed in the same group from France or described by Britzelmayr from Bavaria and still more difficult to determine their connection with the minor forms in the group in this country. Similar difficulties arise in the study of each group. What is the relation of Pholiota sphaleromorpha to Pholiota howeana or duroides?. Of Stropharia longistriata to Stropharia spintrigera? etc. Specific descriptions in the traditional form do not enable us to answer these questions and yet these questions are of the highest significance if the variations and geographical relations of the plants are to be understood. What is the use of continuing to write descriptions until these questions are answered? It only makes the problem more complex.

A concrete example of the need of grouping the agarics is before me as I write. I have just collected a species of Lepiota about one inch broad and two inches high. The pileus is floccose, smooth and lemon yellow on the umbo and striate plicate on the margin. The gills are broadly free. The stem is white and somewhat bulbous with a median annulus. It evidently belongs among the smaller forms of the Lepiota cepaestipes group. A look through the literature shows that a large number of similar forms have been described by European mycologists and in this country Peck has described several, Morgan two and Clements two. The species in this country are said to be known only from the single collections. That they all belong to one group is shown by the spores which measure about $3—4 \times 5—7 \mu$ in each species. My plants do not exactly agree with any of these descriptions. The authors of the species do not help for the descriptions are written independently and agreements and differences are not noted.

As a step in the right direction I have endeavored to place the forms in their natural groups regardless of the characters used to distinguish genera or make artificial keys, to name the groups after their most common and wide spread representatives and to compare the groups with corresponding groups in Europe and other regions.

1. Emphasis must be laid on plylogenetic rather than fluctuating differences in recognizing the natural groups. Spore characters are generally considered among the most diagnostic features and in all the groups here considered the spores in the different forms are alike and characteristic. This does not, however, result in uniting forms unlike in general appearance. It will be long before phylogenetic relationship can be proved in all cases among the agarics but it is probable that natural groups which agree in the fruiting bodies, the character of the hyphae or tissue and the general structure are in most cases phylogenetic. The differences in shape, size, color and surface can often be seen to be due to accidental causes. The sudden changes or mutations which plants undergo the causes of which are as yet little understood make the grouping of forms still more essential. In some cases the supposed boundaries of a species are overstepped in a single generation. The groups should be broad enough to include the mutants.

The recent careful study of the structure and development of the agarics by Fayod, Atkinson, Lavine, Zeller and others will undoubtedly lead to a better understanding of the natural groups. In several of the groups here illustrated I have given a description of the structure as far as it is shown in the photographs.

2. Naming the groups after their most common representative helps in the determination of the forms and in understanding the relation between them. It is also the logical carrying out of the natural system of classification. It substitutes a plant for a verbal description and aims at a comparison of varieties. The so-called identity of species is

always approximate for no two plants are alike in all particulars.

The best known names have historical significance also. They usually represent the European form of the group which was first studied. They are also general and inclusive and well fitted to represent groups. New species are usually made by dividing groups previously considered wholes. It does not appear that a single species of group value has been discovered in this region in the genera Pholiota, Stropharia or Hypholoma. The same is true in the genus Clitocybe and probably in most other genera of Agarics. Some species included even more than one group as the forms are recognized today. Dr. Murrill in Mycologia for May, 1915, calls attention to the fact that Hypholoma lacrimabundum and Hypholoma velutinum are historically one species.

It is better to name the groups after these well known and inclusive species than to give them special generic names. Generic names would be unnecessarily multiplied. Generic names also fail to secure the advantages mentioned. Furthermore if the groups are considered generic unrelated forms the groups of which have not yet been determined must be included in some of them at least. It is better to preserve the old large genera based on a few characters which the groups possess in common. These genera must always be more or less artificial and plants belonging in different genera will sometimes be found in the same group. The only entirely natural division is the phylogenetic group.

3. The comparison of the groups with those of different regions or habitats is the most fruitful means of understanding a local flora. The group is the proper unit of comparison. It is significant that the species chosen as names for the groups in our region are reported in most of the floras of Europe and are the common species there. This does not prove that the species do not vary in the different regions however. Descriptions in their present form are not sufficient to settle that question. In order to do so they should be written from the comparative standpoint and show the relation of the forms described to their nearest relatives in other countries. Even in the few groups here studied significant facts appear as soon as the comparative method is followed. Our common "brick top" is Hypholoma sub-

lateritium while the form on the Pacific coast is Hypholoma fasciculare. Hypholoma perplexum is the most usual variety here while Hypholoma epixanthum is found in Europe. The luxuriant annulate form of Hypholoma appendiculatum occurs also on the Pacific coast and its corresponding European form is apparently Stropharia spintrigera growing on rotton logs, etc. The value of the study of a local flora is seen in this connection. Work like that of Dr. Peck in New York State and Britzelmayr following Schaeffer in Bavaria is the necessary basis for comparative study. The suggestions given by Peck and Britzelmayr as to the relationships of the new forms they describe are the most valuable part of their work. The comparative point of view should be kept constantly in mind in studying a local flora.

THE PHOLIOTA PRAECOX-DURA GROUP

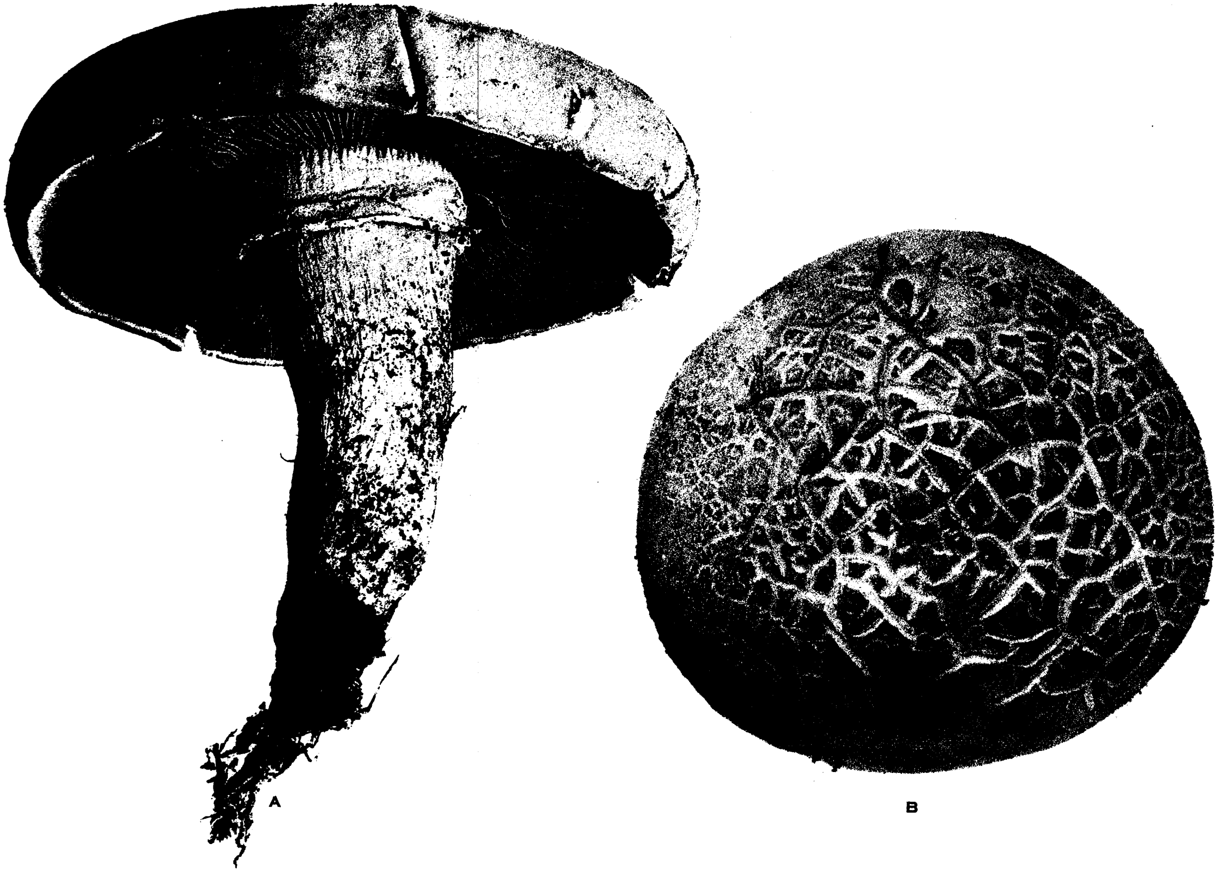
1. **Pholiota dura** (Bolt.) Typical form. Pls. XI-XIII AB.

Typical forms of Pholiota dura were abundant in a garden at Geneseo, Ills., in June, 1915. The photographs in pls. XI-XIII AB were taken from these specimens. The characteristic features of the form are: the habitat in fields and gardens, the regularly convex pileus with incurved margin and areolately cracked surface, the thick white flesh, the short thick stem enlarged upward and furnished with abundant myceloid rootlets at the base, the thick horizontal veil which tears irregularly and leaves a lacerate annulus close to the apex of the stem, the large rusty brown spores 6—8 x 11—14 μ.

These characters are emphasized in the European descriptions of the species so that this appears to be the typical form though the spores are given in the Sylloge as 5—6 $\times$ 8—9 μ. Britzelmayr gives 4—7 $\times$ 8—10 μ. Photographs of plants collected near Chicago by Dr. Moffatt agree with these in all respects.

2. Form with the veil appendiculate. Pl. XIII CD.

The photograph shows a form of Pholiota dura with the veil wholly appendiculate as in the genus Hypholoma. The plants grew in a hop field at Sumner, Wash. The habitat, general appearance, solid flesh, cracked pileus, colors and large spores, 5—7 $\times$ 11—13 μ, shaped exactly like those of

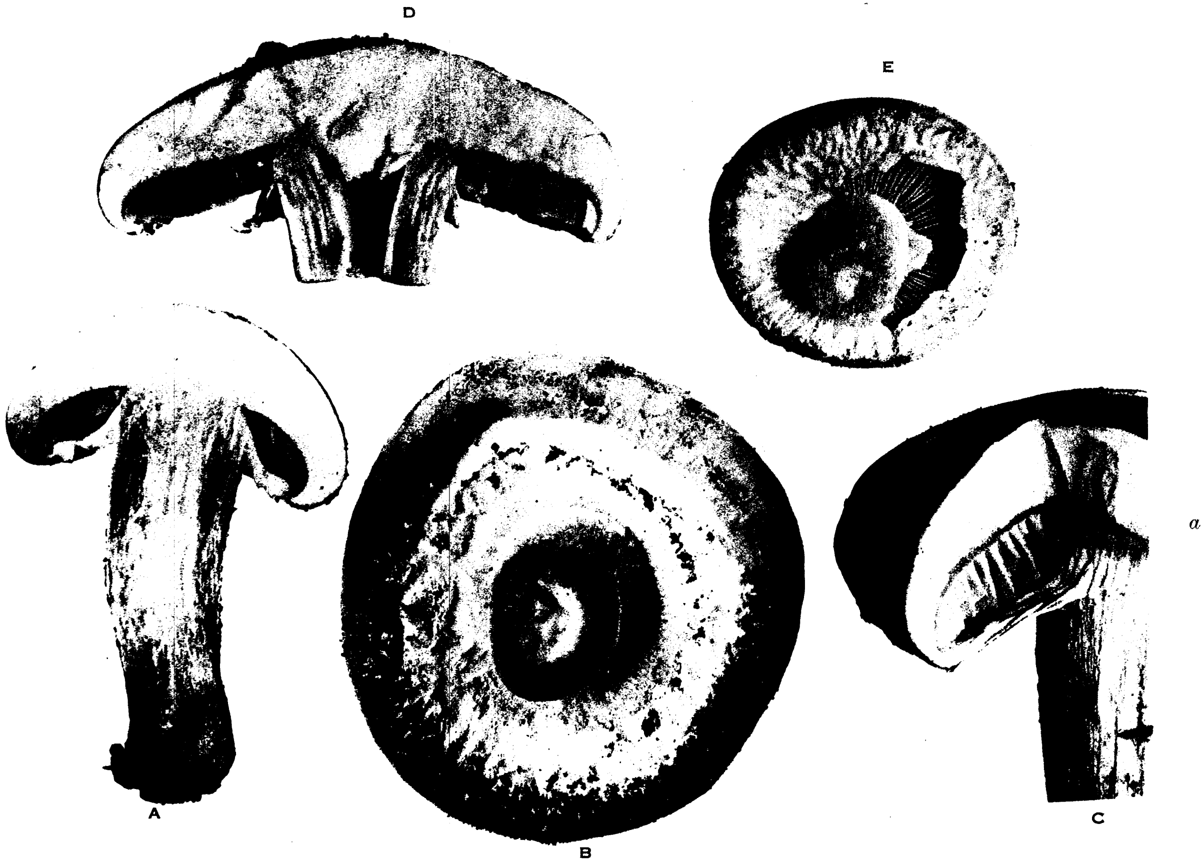


A

B

PHOLIOTA DURA (BOLT.)

COCKAYNE, BOSTON



PHOLIOTA DURA (BOLT.)

COCKAYNE, BOSTON

B A

C D

PHOLIOTA DURA (BOLT.)

A B SECTIONS

C D FORM WITH APPENDICULATE VEIL

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A B C D

A B PHOLIOTA SPHALEROMORPHA BULL.
C D PHOLIOTA PRAECOX PERS.

COCKAYNE, BOSTON

typical Pholiota dura, show that they belong to this group. They differ from the usual forms in the long equal stems sometimes curved at the base and the wholly appendiculate veil the remnants of which hang in broad triangular patches from the margin of the pileus. The pileus is smooth, convex, whitish or dirty cream color and areolately cracked as in the typical forms.

3. **Pholiota praecox** (Pers.). Typical form. Pl. XIV CD.

The plants shown here are more typical Pholiota praecox than those illustrated in Vol. XVII., pl. XXVII. The absence of an annulus in those plants is a character of Pholiota praecox var. minor though the plants are large for that form. The plants photographed here differ from typical Pholiota dura in the habitat in grassy places, the lighter colors, the smooth not areolately cracked pileus, the long slender nearly equal stems and the more scanty annulus. The spores measure $6—8 \times 10—13 \mu$. Sylloge gives $6—7 \times 8—13$. They are nearly the same size and shape as those of Pholiota dura.

4. Form resembling Pholiota sphaleromorpha Bull. Pl. XIV AB.

The plants shown in this plate were collected and photographed by Mr. Burtt Leeper at Salem, Ohio, in June. They grew on the ground in woods. The spores, shape, general appearance, colors, solid white flesh and smooth areolately cracked pileus show that they belong to the Pholiota praecox-dura group. The spores are a little smaller than those of the plants considered typical Pholiota praecox and Pholiota dura above. They measure $4—6 \times 8—10 \mu$. The stems are enlarged below and the annulus is more distant and broadly membranous. The shape of the stem and the annulus agree with the description of Pholiota sphaleromorpha Bull. which is considered a variety of Pholiota praecox by French writers. The photograph of Leeper's plants agrees well with Bulliard's figure t. 540. The plants differ from the description of Pholiota sphaleromorpha in the sinuate decurrent instead of "arcuate decurrent" gills and in the whitish gray instead of "yellowish" pileus. The following is a description of Leeper's plants:

Pileus convex when young becoming expanded and depressed in the center, fleshy, margin incurved, somewhat wavy, areolately cracking in the center, grayish. FLESH firm, white. Lamellae sinuate with a decurrent tooth, not crowded, color of burnt umber. STEM somewhat flexuous, swollen at the base, tapering upwards, whitish pruinose, solid becoming hollow, striate at the apex. ANNULUS distant, membranous, persistent. SPORES ferruginous brown, 4—6 ×8 —10 μ.

In woods. On ground rich in rotten wood. June.

Notes 1. The plants described and illustrated in Vol. XVII p. 477 and pl. XXVI which I doubtfully referred to Pholiota howeana Pk. have the more distant membranous annulus and stem enlarged below of Pholiota sphaleromorpha. The darker yellowish tint of the pileus agrees better with Pholiota sphaleromorpha than the gray of Leeper's plants. My field notes suggested that the plants were related to Pholiota praecox. There is little difference between Peck's description of Pholiota howeana and the description of Pholiota sphaleromorpha. Dr. Peck himself allowed considerable variation in this species. I have plants sent to me by Simon Davis which were indentified by Peck as Pholiota howeana but which were smaller, tougher and with larger spores than his description of Pholiota howeana calls for, 5—6 ×10 —12 μ instead of 5—6 ×8—10 μ. The spores of my plants were 4—5 ×8—9 μ and of Leeper's 4—6 ×8—10 μ. There is no doubt that all of them are close together in the Pholiota praecox-dura group.

2. The plants described and illustrated in Vol. XVII p. 480 and pl. XXIX are not as typical Pholiota dura as those shown here in pl. XI. As was remarked the plants there described had the pileus thinner and more expanded with the surface very little cracked. The stem also was more slender and the annulus more perfect and entire. The spores were smaller 4—6 ×7—9 μ. These peculiarities are those of Pholiota duroides Pk. which is decribed in N. Y. State, Mus. Bull. 122, pp. 148-149 from plants collected by G. E. Morris in Mass. Peck's description reads:

"PILEUS thin, convex becoming nearly plane. glabrous or slightly rimose squamose in the center, varying in color from creamy white to ochraceous buff either wholly or in the center only. FLESH white. TASTE mild. LAMELLAE thin, close, narrow, adnexed sometimes broadly sinuate and having a decurrent tooth, whitish becoming brown or rusty brown. STEM equal or nearly so, stuffed or hollow, glabrous, whitish, the annulus thick and cottony, often lacerated and evanescent, white. SPORES broadly elliptic 4—5 ×6—7 μ.

Pileus 1—2 inches broad. Stem 1—2 inches long, 2—4 lines thick.

Rocky ground. August and September.

It is similar to Pholiota dura (Bolt.) Fr. but may be separated from it by its different colors, softer substance and especially by its smaller spores. These are more brown than the spores of Pholiota praecox Pers. and make it doubtful whether the species would not better be placed in the genus Stropharia."

SYNOPSIS OF THE FORMS ILLUSTRATED

1. Typical Pholiota dura.................................Pls. XI-XIIIAB
   2. Plants with thinner, more expanded and less cracked pileus and smaller spores. Similar to Pholiota duroides Pk...............................Vol. XVII, Pl. XXIX.
   3. Plants with long nearly equal stems and appendiculate veil...Pl. XIIICD.
4. Typical Pholiota praecox.................................Pl. XIVCD.
   5. Plants with appendiculate veil. Similar to Pholiota praecox, var minor. Also a form with the pileus umbonate..............................Vol. XVII, Pl. XXVII.
   6. Plants with stems enlarged below and distant annulus. Similar to Pholiota sphaleromorpha Bull. and Pholiota howeana Pk...
      ....Pl. XIVAB and Vol. XVII, pl. XXVI.
   7. Autumn plants like Pholiota praecox but with the pileus cracking. Pholiota vermiflua Pk.
      Vol. XVII, pl. XXVIII, C—F.
   8. Plants with the lamellae obliquely truncate next the stem. Pholiota temnophylla Pk.
      Vol. XVII, pl. XXXIIIA.

Other forms reported from the United States are mentioned in Vol. XVII, pp. 477–481. Further study emphasizes the remark on page 481 regarding the variability of plants in this group.

Whether the variation in the group is the same in Europe as in the United States or not we have not the data to decide fully. The two species Pholiota praecox and Pholiota dura are reported in most European floras. Var. minor is reported from the British Isles and Bavaria. Pholiota sphaleromorpha is reported from France, Germany and Bavaria. Pholiota gibberosa Fr. is a small fragile form with free gills reported from Germany but so far as I am aware has not been found in this country.

STRUCTURE OF THE PLANTS IN THE GROUP

The photographs of Pholiota dura in pls. XI-XIII AB show the structure of the plants in the Pholiota praecox-dura group. I will point out several of the characteristic features.

a. The white floccose universal veil or primordial cuticle as Fayod calls it which covered the young carpophore disappears early from the pileus and stem leaving only a few small patches around the margin of the pileus and scattered over the stem, Pl. XI A.

b. The part of this covering usually called the partial veil which lies between the stem and the gills and covers the gill chambers in the young plant is well developed and more persistent. The expansion of the pileus strips it upward from the surface of the stem and its under surface appears as in Pl. XII B. At this stage it is attached to the apex of the stem and the margin of the pileus but its upper surface has torn from the edges of the gills and sagged down leaving an annular gill cavity as seen in pl. XII A. As the pileus continues to expand the veil is ruptured. The break usually takes place near the margin of the pileus leaving an annulus on the stem, pl. XI A, XIV A, etc. Sometimes the veil is torn from the stem leaving the fragments hanging from the margin of the pileus, pl. XIII C. The tear is often irregular leaving the stem annulate and the margin of the pileus more or less appendiculate.

c. The partial veil in Pholiota dura is stripped off to the apex of the stem and there is very little superannular elongation of the stem so that the gills remain horizontal and the annulus is close to the apex of the stem as seen in pl. XII D. Other forms in the group show more superannular elongation of the stem, as shown in pl. XIV, but the veil is not often ruptured above the annulus and the ridges on the upper surface of the annulus are continuous from the annulus to the base of the gills as in pl. XII C, XIV C, etc.

d. The edges of the gills are at first attached to the upper surface of the partial veil and leave grooves in the veil when they are torn away. These grooves and the ridges between them are shown in pl. XI A, XII C, etc. In cases of retarded expansion of the pileus the spores ripen and fall on these ridges before the rupturing of the veil as shown in pl. XII C.

Such ridges stained with spores can be observed in many species of Agarics. The most noted case is that of Stropharia coronilla. These ridges lie between the gills, pl. XI A, and must be distinguished from the decurrent teeth of the gills which connect with the grooves. The ridges can be seen in cross section in pl. XIII AB. The section is horizontal and made at the point where the ends of the primary gills connect with the stem, pl. XII Ca. The dead tissue of the veil shows white in contrast with the dark hymenial and subhymenial layers of the stem, pileus and gills beneath the gill chambers. The primary gills connect with the subhymenial layer of the stem between the ridges. Owing to their horizontal position the gill chambers widen outward very rapidly and secondary gills appear as folds in the bottom of the gill chambers very close to the stem. Some of them so close to the stem that they touch the ridges, pl. XIII A. The ridges extend but a very short distance into the gill chambers in Pholiota dura since there is little elongation of the stem to lengthen the decurrent teeth of the gills and a section above the extreme basal point of the primary gills does not show them. The hymenium covers the base and sides of the gill chambers. The chambers become forked by the appearance of the secondary gills. The forking ridges which cover them are well shown on the annulus of Pholiota fulvo-squamosa, vol. XVII, pl. LX.

e. The pileus in this group is covered by a well developed cortex which forms under the universal veil and is left naked when the veil disappears. It is smooth, leathery and more or less deeply colored. It often cracks areolately as the pileus expands, pl. XI B.

The thick solid flesh, the well developed partial veil, the firm cortex, the horizontal gill chambers and the subannular stem are the chief characteristics of the plants of this group. They all have the rusty ochraceous spores of the genus Pholiota. The spores are the same shape and character in all the forms in the group varying a little in size from $4—6 \times 7—9 \mu$ to $6—8 \times 11—14 \mu$.

THE PHOLIOTA AEGERITA GROUP

There are in this region two closely related plants belonging to this group. Their structure is very nearly like that in the Pholiota praecox-dura group the characters of which are:

the thick solid flesh, the convex often areolately cracked pileus, the horizontal gills, the apical annulus and the subannular stem. They differ in the habitat on stumps and rotten logs, the colors which are varying shades of reddish yellow, becoming black in Pholiota luxurians, the often finely squamulose as well as areolate rimose pileus and the irregular stems, which vary in size and shape according to the position on the logs or stumps. The spores vary from 4—6 μ broad and 7—10 μ long. They are the same shape and character in both species but apparently a little larger in Pholiota luxurians than in Pholiota aegerita.

Both Pholiota aegerita and Pholiota luxurians are reported from the British Isles, France and Germany. Bresadola gives a good illustration of Pholiota aegerita from the Tyrol but neither species appear to have been collected by Britzelmayr in Bavaria.

Pholiota aegerita has been reported by Hard from Ohio, Dodge from Wisconsin, etc., but I have seen no report of Pholiota luxurians from this region.

1. **Pholiota aegerita Brigant.** Pl. XV.

The plants were collected and photographed by Mr. Burtt Leeper at Salem, Ohio. They represent the species better than the photographs I published in vol. XVII, pl. XLIX, though there is no doubt as to the identity of the plants. The dried specimens are very characteristic. The pilei are very hard inrolled and cracked as well as finely squamose. The gills are bright ferruginous and the stems smooth and hard. Mr. Leeper sent some of the plants to Prof. Atkinson, who confirmed the identification.

The character of the species are: the habitat on logs and stumps, the thick convex pileus areolately cracked in the center and wrinkled on the incurved margin, the tawny colors nearly white on the margin of the pileus, the apical annulus and the thick smooth irregular stem which often becomes cracked and shreddy on the surface. The stems may be long, nearly equal and curved, short and thickened at the base or short and tapering downward. Cooke's illustration 453 shows long curved stems. Bresadola, Fung. Mang. t. 50, illustrates plants more nearly like Mr. Leeper's. I have given the technical description of the species in vol. XVII, p. 493.

A

B

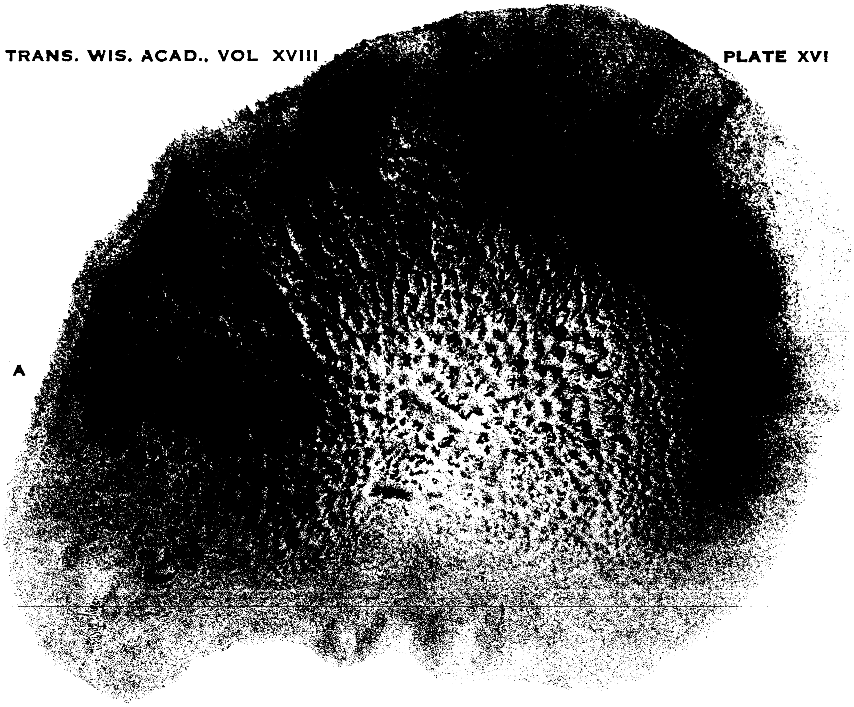
C

PHOLIOTA AEGERITA BRIGANT.

HARPER—PHOLIOTA

COCKAYNE, BOSTON

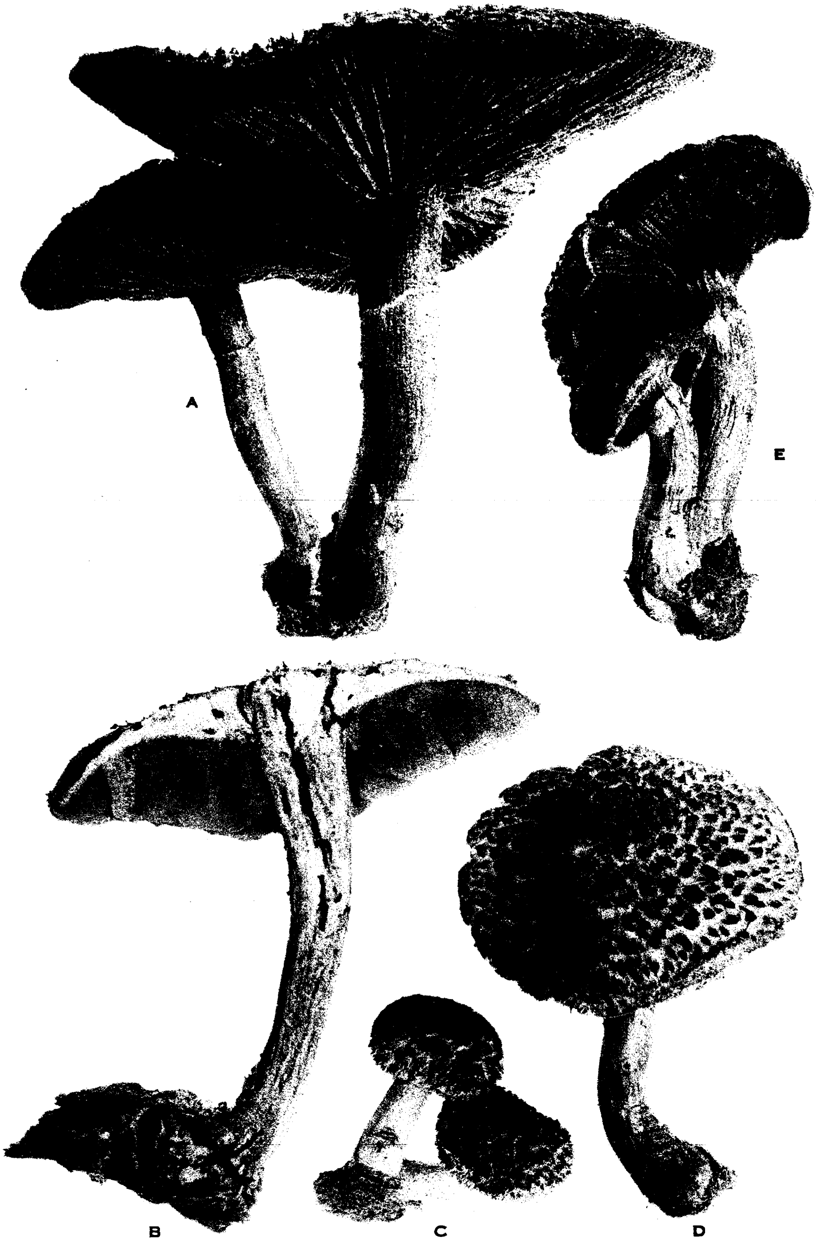
A



B

HARPER—PHOLIOTA PHOLIOTA LUXURIANS FR.

COCKAYNE, BOSTON



PHOLIOTA CURVIPES FR.

HARPER—PHOLIOTA

COCKAYNE, BOSTON

2. **Pholiota luxurians** Fr. Pl. XVI.

Pholiota luxurians has the same structure and shape as Pholiota aegerita but the colors are darker with more red and yellow. Old plants turn black. The pileus is both squamulose and cracked. The spores are alike in color and shape but average slightly larger, 4—6×7—10μ instead of 4—5×7—9μ. The plants are larger and coarser in every way.

Fine specimens of this species grew on maple stumps at Geneseo, Ills., in October. Some of the pilei were eight inches in diameter. The shape of the stems varies as in Pholiota aegerita, long or short, equal or enlarged at the base or tapering downward. Many of the plants were caespitose. The photograph was made from plants collected at Sumner, Wash. They grew on top of a maple log and had short stems, tapering downward. The areolae on the pileus are seen to be covered with fine scales as in Leeper's photographs of Pholiota aegerita.

Pileus variable in size, sometimes very large, irregular, convex and gibbous to expanded, even on the margin, smooth and silky or somewhat squamulose, rimose cracked, reddish yellow becoming darker and the whole plant blackening with age. Flesh thick whitish to yellowish and finally black. Lamellae broad, rounded adnexed or decurrent according to the position of the pileus, becoming ochraceous-ferruginous with spores, reddening and blackening with age. Stem variously shaped, thick, smooth, with a thick evanescent annulus, colored like the rest of the plant. Spores ferruginous 4—6×7—10μ.

Plants single or caespitose. Stems sometimes grown together at the base. On logs and about stumps in autumn.

THE PHOLIOTA CURVIPES GROUP

1. **Pholiota curvipes** Fr. Pl. XVII.

The plants photographed were found on rotten logs at Geneseo, Ills., in autumn. I have followed Peck in referring them to Pholiota curvipes Fr. They agree with Peck's description in N. Y. State Mus. Bull. 122, p. 154, except that they average a little larger. The size of the spores 5—6×8—10μ is exactly the same as Peck's measurements. Peck calls attention to the fact that the spores are larger than the measurements given in the European descriptions. The Sylloge gives 3—4 × 6—7 μ. Otherwise the agreement of the plants with the European descriptions is close. They agree also with the illustrations in Fries Icon. 104 and Cooke's Illust. 370.

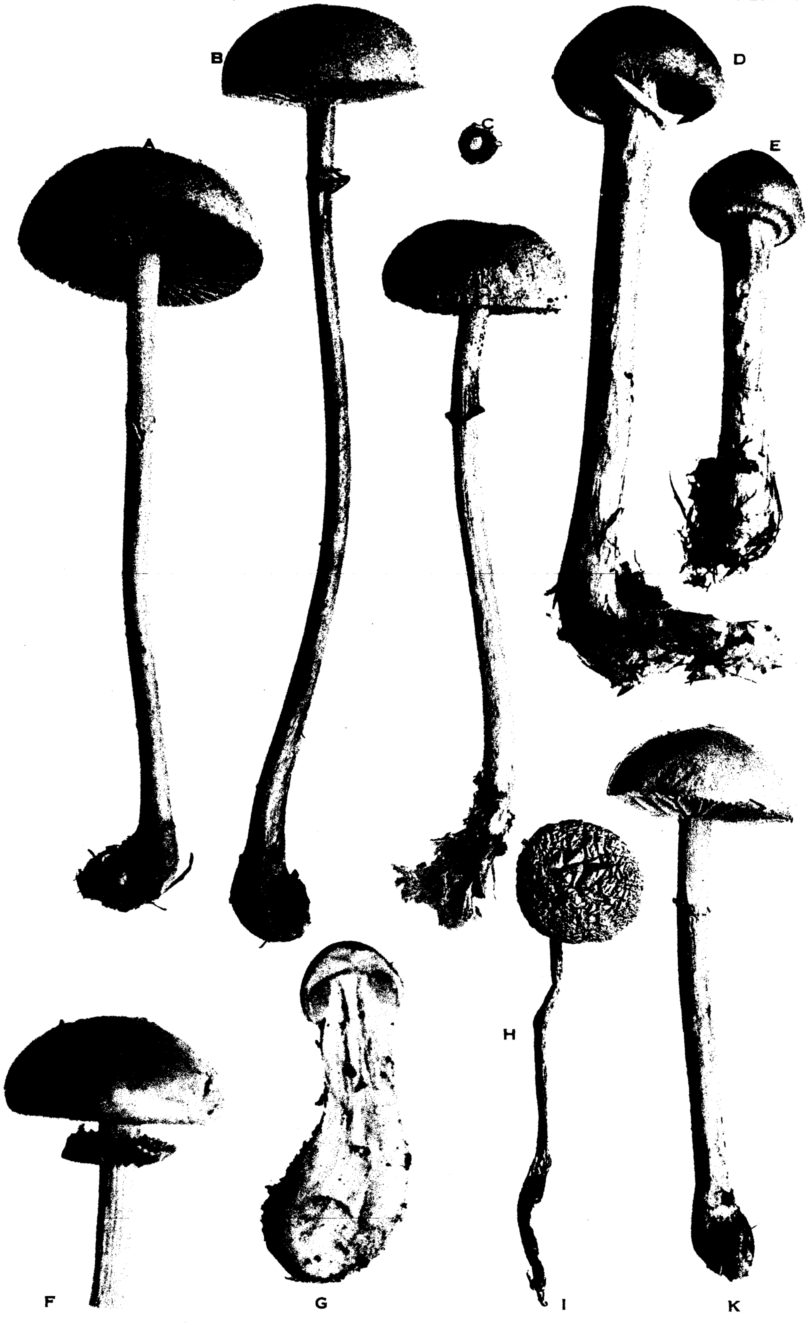
The chief characteristic of the plants is the very scaly pileus contrasted with the smooth innate fibrous stem. A form with a scaly stem is however given in Constantin and Dufour's key. The annulus is very scanty. The gills are very broad, crenate and white floccose on the margin. The stems are nearly equal with very slight bulbous enlargement at the base.

PILEUS somewhat fleshy, 1—2½ inches broad, convex to plane, margin incurved and extending beyond the gills, covered with a thick floccose coat which tears into concentric scales composed of bundles of fibers, often squarrose, scales tawny on a lighter yellowish background. FLESH solid, light yellow. TASTE mild. LAMELLAE adnate with a decurrent tooth, very broad, light yellow becoming tawny, more or less crenate and white floccose on the edge. STEM 1–2 inches long, 1–3 lines thick, fibrous but not scaly, solid or fistulose, curved, light yellow above becoming dark tawny below, equal or tapering downward, equal or very slightly bulbous at the base, mealy above the slight annulus. SPORES, inequilateral, ellipsoid, 4—6 × 8—10 μ.

On rotten logs in woods. October.

Note. The affinities of these plants are not very clear. Farlow in the index considers Pholiota curvipes as identical with Pholiota tuberculosa. The only striking difference between the two species as illustrated by Fries in Icon. 104, 2 and 3, is that Pholiota tuberculosa has a beautiful round bulb at the base of the stem while the stem of Pholiota curvipes is not bulbous at the base. This is a marked difference between the plants illustrated in vol. XVII, pl. XLI and these plants. These agree better with Schaeffer t. 79 but that is considered a poor illustration of Pholiota tuberculosa. The bulbous stem might be a fluctuating variation but the size of the spores in my plants differs widely and is the reverse of the difference between the spore measurements of the two species as given in the Sylloge. The spores of Pholiota tuberculosa are said to measure 4—5 × 8—10 μ while those of Pholiota curvipes measure 3—4 × 6—7 μ. Plants with such widely differing spore measurements should scarcely be placed in the same group.

Both Pholiota tuberculosa and Pholiota curvipes are reported by Stevenson, Constantin and Dufour, Winter and Britzelmayr.



A - H STROPHARIA SEMIGLOBATA BATSCH.
K STERILE FORM
I STROPHARIA SICCIPES VAR. RADICATA PK.

HARPER—STROPHARIA

COCKAYNE, BOSTON

The chief distinction is always that of the bulbous and non-bulbous stem. In Constantin and Dufour forms of both species with scaly stems are reported.

THE STROPHARIA STERCORARIA-SEMIGLOBATA GROUP

1. **Stropharia semiglobata. Batsch.** Typical form, Pl. XVIII.

Plants of this species are common on dung in pastures at Geneseo, Ills. It is more frequently met with than any other form in the group. It was described but not illustrated in the article on Species of Stropharia in the Region of the Great Lakes, vol. XVII of these Transactions, p. 1022.

The characteristic marks of the species are the smooth, viscid, cream colored, hemispherical pileus, the broad, squarely adnate gills, the long, smooth, hollow stem and the scanty annulus in the mature plants. Its ally Stropharia stercoraria may be distinguished by the more flattened pileus, more floccose stuffed stem, narrower gills and more persistent annulus.

2. **Stropharia semiglobata.** Sterile form. Pl. XVIII K.

Sterile plants of this species were found several times during the summer of 1915 on dung heaps in a pasture at Geneseo, Ills. They agreed with the normal plants in all respects except that the gills remained white and bore no spores. There were numerous fertile plants in the neighborhood. A number of sterile forms of different species have been reported. Clitocybe sadleri B. and Br. is supposed to be a sterile form of Hypholoma fasciculare.

3. **Stropharia siccipes Karst.** Var. radicata Pk. Pl. XVIII I.

Specimens of the rooting form of Stropharia siccipes were sent to me by Dr. Mary Whetstone in June, 1915. They grew in rich ground and had conspicuous roots some of them nearly horizontal. A photograph of a dried specimen of these plants is shown in pl. XVIII I. Peck suggested that the plants grew from manure buried in the ground. It is possible that the root is a sclerotium and survives the winter. The illustration shows the appearance of the pileus of dried plants in this group. The cortex is smooth and shining and becomes areolately wrinkled.

SYNOPSIS OF THE FORMS ILLUSTRATED

Stem as well as the pileus viscid. Yellowish. Pileus convex or hemispherical, obtuse.

Stem stuffed........S. stercoraria, vol. XVII, pl. LXVII.
Stem hollow......................... S. semiglobata, pl. XVIII.
Sterile form of S. semiglobata................ Pl. XVIII K.
Pileus umbonate...
....................S. umbonatescens, vol. XVII, pl. LXV B.

Stem dry. Plants argillaceous.

Without a root..........................
.......................S. siccipes, vol. XVII, pl. LXVI DEF.
With a root...............................
.............................S. siccipes v. radicata, pl. XVIII I.

Stropharia semiglobata and Stropharia stercoraria are both included in the important European lists and the characters ascribed to them are the same there as here. Semiglobata has been illustrated twenty times and Stercoraria seven times, so that semiglobata appears to be the best known species in Europe as well as in America. Stropharia umbonatescens corresponds to Stropharia mammillata Kalch. and Stropharia siccipes is a European species so that the variation in the group in Europe corresponds closely to that in the United States.

STRUCTURE OF THE PLANTS IN THE GROUP

The photographs in pl. XVIII show the structure of the plants in the group.

a. The white floccose universal veil which covered the young plants can be seen on the stems in D and E. It disappears earlier from the pileus than from the stem and both pileus and stem are covered with a smooth viscid coat when mature.

b. The young lamellae are nearly orbicular, G. The partial veil fills the triangular space between the gills and the stem and extends up to the base of the gills at the junction of the pileus and the stem. It appears white in G in contrast with the gills and the growing tissue of the stem. The expansion of the pileus and elongation of the stem tears the under surface of the partial veil from the stem below and the upper surface from the edges of the gills above forming an annular gill cavity. The free part of the veil is stretched into a thin semitransparent membrane extending from the margin of the pileus to the stem as in E. Continued expansion tears it from the margin of the pileus, D, and it remains as a thin papery annulus about the stem, F. It soon collapses and only a few fragments stained with spores remain on the mature plant, A and B. The upper portion of the partial veil which was not stripped from the stem by the expansion of the pileus becomes very thin as the superannular elongation of the stem continues and the ridges on its upper surface which closed the gill chambers are obliterated from the central portion remaining near the annulus and at the apex of the stem, H. Also vol. XVII, pl. LXVII. The superannular portion of the stem is at first somewhat floccose or furfuraceous from the remains of the partial veil just as the stem below the annulus is floccose from the remains of the universal veil. The superannular portion is, however, more finely furfuraceousand later becomes smooth and viscid like the subannular portion of the stem. As in Pholiota dura the ridges on the upper surface of the annulus are often dusted with spores and the remains of the annulus seen on the stem are usually blackened with spores, otherwise they are mostly inconspicuous. The edges of the gills remain white and floccose where they were torn from the veil.

c. The gills are adnate to the stem and as the epinasty is wholly in the pilear area the bases of the gills are drawn down, the stem in decurrent teeth. The ridges of the partial veil extend up between the teeth for a short distance as in Pholiota dura. In G the growing layer of the stem appears dark and connects with the subhymenial layer under the base of the gill chambers. The central portion of the stem is composed of white medullary tissue. The dying tissue widens at the apex of the stem, and connects with the medullary portion of the pileus. This is seen in a greater degree in species of Hypholoma. See pl. XXIII D. The stem becomes hollow in Stropharia semiglobata, C, but remains stuffed in Stropharia stercoraria. The group is remarkable for the great elongation of the stem which takes place in both the subannular and superannular areas. The annulus is often nearly medial. Such long slender stems are characteristic of Agarics which grow on dung.

THE HYPHOLOMA SUBLATERITIUM GROUP

The "brick tops" form a characteristic group of agarics composed of a number of closely related forms. The relation of the forms to each other and the geographical distribution was discussed in vol. XVII, pp. 1146–1147 and illustrations of four forms were given.

Beautiful specimens of the squamose variety of Hypholoma sublateritium were found by an oak stump in woods at Geneseo, Ills., in September, 1915. They are shown in pl. XIX. The pilei were conspicuously spotted with dark oppressed scales arranged in concentric rows giving the plants a striking appearance quite unlike that of the ordinary form of the species. The scales were due to the persistence of the universal veil on the pileus. The variety has been illustrated by Cooke, Illus. 558.

SYNOPSIS OF THE FORMS ILLUSTRATED

Hypholoma sublateritium. Typical form..............
Vol. XVII, pl. LXXII.
  Pileus squamose. Var. squamulosum.................Pl. XIX.
  Stems long and slender, etc., H. perplexum......
Vol. XVII, pl. LXXIII.
Hypholoma capnoides. Typical form.....................
Vol. XVII, pl. LXXIV.
Hypholoma fasciculare. (Form from the Pacific Coast.)
  Stems short, thick at the base. Var. robustior......
Vol. XVII, pl. LXXV.

All these forms are reported in Europe except Hypholoma perplexum. Of the other European forms in the group Hypholoma elaeodes is a variety of Hypholoma fasculare and should be found with that species on the Pacific coast. The two varieties of Hypholoma sublateritium, var. subsolitarium which is less caespitose, the pileus uniformly colored and the stipes thickened at the base, and var. Schaefferi with a yellow rugose pileus, hollow stem and narrow decurrent lamellae, should be looked for in this region. The occurrence of Hypholoma epixanthum in this country is doubtful as noted in the article in Vol. XVII, p. 1147.

A

B

HYPHOLOMA SUBLATERITIUM VAR. SQUAMOSUM CKE.

COCKAYNE, BOSTON

Hypholoma dispersum is reported in Farlow's Index. It is a small non-caespitose species apparently belonging to this group.

STRUCTURE OF THE PLANTS IN THE GROUP

a. The universal veil is composed of long fibers of hyphae. It is seen on the pileus in the squamose forms and in the partial veil which is stretched into cobwebby fibrils by the expansion of the pileus like a cortina and does not form a membrane. Where exposed on the pileus and stem the universal veil becomes colored but remains white in the partial veil. In most cases the universal veil disappears early and the pileus and stem are covered with a smooth colored cortex.

b. The fibers of the partial veil break near the stem, pl. XIXa, and vol. XVII, pl. LXXII B, leaving no visible trace of an annulus on the stem. The remains of the veil on the margin of the pileus are also loosely fibrous so that they disappear early. The resemblance of the veil to a cortina is seen in pl. XIX B. The veil does not strip off from the stem in a membrane as in the Hypholoma appendiculatum group, pl. XXIII E, but the hyphal threads pull away separately up and down the stem as in species of Cortinarius. The ridges which are usually to be seen on the upper surface of membranous annuli are not apparent.

c. The pilei are shaped like those in the Pholiota praecox-dura group. They are convex with thick solid flesh and incurved margins. The lamellae are nearly horizontal and secondary lamellae are numerous. The epinasty is in the pilear area so that as the plant elongates the gills become more and more adnate with long decurrent teeth. When young they are rounded at the stem and nearly free. Compare the young gills in pl. XIX B with those in the expanded pilei in Vol. XVII, pl. LXXII. Intermediate degrees of elongation of the bases of the gills can be seen in vol. XVII, pl. LXXIV.

THE HYPHOLOMA VELUTINUM GROUP

The group is separated from the closely related Hypholoma lacrimabundum group by the opaque tuberculate and apiculate spores 6—7×8—12μ, with an apical pore covered by a hyaline papilla. There are four principal forms in the group, Hypholoma velutinum, rugocephalum, boughtoni and pyrotrichum. Photographs of Hypholoma velutinum were published in vol. XVII, pl. LXXIX. Since then we have collected Hypholoma rugocephalum and Hypholoma boughtoni. They grow on the ground in open woods at Geneseo, Ills. All four species have the spores exactly alike in size and character, see vol. XVII, pp. 1153–1154. The chief difference in the plants is in the surface of the pileus. It is matted fibrous in Hypholoma velutinum, innate fibrous and concentrically cracking in Hypholoma boughtoni, somewhat viscid and rugose wrinkled in Hypholoma rugocephalum and matted fibrous and bright fiery tawny in Hypholoma pyrotrichum. All these species appear to be closely related and the differences due chiefly to age and weather conditions.

1. **Hypholoma rugocephalum** Atk. Pl. XX.

The plants were found at Geneseo, Ills., in open woods. The plants are larger than either Hypholoma velutinum or Hypholoma boughtoni. The pilei were innate fibrous when young becoming glabrous, slightly viscid and rugose wrinkled. They were at times somewhat cracked near the margin showing close affinity with Hypholoma boughtoni. The other characters were exactly those of the group. Atkinson's description is as follows. Mushrooms, p. 30, fig. 29.

PILEUS convex to expanded and revolute, marked with radiating rugose, wrinkles, broadly umbonate, fleshy at the center, thinner toward the margin, slightly viscid, smooth, not hairy or scaly, the thin margin, extending beyond the gills, fulvous-tawny. FLESH tinged with yellow. LAMELLAE adnate, slightly sinuate, 5—7 mm broad, easily breaking from the stem and then rounded at the base, spotted with black spores, lighter on the edge. SPORES black in mass with a slight purple tinge, oval to broadly elliptical, inequilateral, pointed at each end, echinulate or minutely tuberculate 8—11×6—8μ. BASIDIA short, cylindrical, CYSTIDIA cylindrical, somewhat enlarged at the free end, delicate, thin walled, in groups of 2—6 or more. . STEM cylindrical, even, somewhat bulbous, colored like the pileus, lighter above the annulus, irregular, smooth, fleshy, hollow, continuous with

HYPHOLOMA RUGOCEPHALUM ATK.

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COCKAYNE, BOSTON

A B C HYPHOLOMA BOUGHTONI PK.
D HYPHOLOMA DELINEATUM PK.

COCKAYNE, BOSTON

the substance of the pileus. ANNULUS a few threads stained black with spores.

Damp places in woods, single or caespitose. Plants 8—12 cm high. Cap 6—10 cm broad. Stem 6—10 mm in thickness.

2. **Hypholoma boughtoni** Pk. Pl. XXI, ABC.

The plants agree with Peck's illustration, N. Y. State Mus. Bull. 139, pl. II. They have the tawny brown, innate fibrous, areolately or concentrically cracked pileus. Otherwise the characters are those of the group, dark brown opaque tuberculate apiculate spores, gills white floccose on the edges and distilling drops of water, universal veil covering the stem and pileus, concrete with the cortex and forming a scanty annulate appendiculate veil. Peck's description reads:

"PILEUS fleshy, thin except in the center, broadly convex or subhemispheric, rarely with a slight umbo, glabrous or slightly fibrillose, often concentrically or areolately cracking, pale reddish brown or grayish brown. FLESH whitish. TASTE disagreeable. LAMELLAE unequal, moderately close, adnate, purplish brown, seal brown or blackish, obscurely spotted, whitish on the edge. STEM equal, floccosely fibrillose, striate at the top, hollow, white or whitish. SPORES black on white paper, broadly elliptic, apiculate, 7—8 $\times$ 10—12 μ.

"Pileus 2.5—7 cm broad; stem 2.5—6 cm long, 4—10 mm thick. Ground in woods and open places. August.

"This species is closely allied to Hypholoma velutinum (Pers.) from which it may be separated by its dry, not hygrophanous, pileus, its whitish flesh and stem, the absence of cystidia and the larger spores."

The differences between the Hypholoma velutinum group and the closely related Hypholoma lacrimabundum group have been discussed in Vol. XVII, pp. 1152–1155, where two forms of the latter and one of the former were illustrated. The essential difference between the two groups is in the spores. The following synopsis shows the forms illustrated in each group:

Spores smooth, 3—5 $\times$ 7—9 μ. Plants whitish to tawny.
Plants smaller, lighter colored, squamose............
H. lacrimabundum, vol. XVII, pl. LXXVII C.
Plants larger, darker colored, squarrose...........
H. echiniceps, vol. XVII, pl. LXXVII B–LXXVIII.

Spores echinulate apiculate 6—8×10—12μ. Plants brown, tawny.

Matted fibrous....H. velutinum, vol. XVII, pl. LXXIX.
Innate fibrous, cracking....H. boughtoni. Pl. XXI, ABC.
Rugose and viscid............H. rugocephalum. Pl. XX.

Hypholoma pyrotrichum is a fiery tawny plant belonging to the second group and Hypholoma regidipes is a small form with scaly pileus related by its spores to the second group.

Note. Prof. R. Maire in the Bull. Soc. Myc. de France, Tome XXVII, fas. 4, discusses the relation between Hypholoma lacrimabundum and Hypholoma velutinum in Europe. The two species have been much confused. According to Maire Hypholoma velutinum is the most common species. It was described by Persoon. Bulliard t. 194 and 525 figured it under the name Agaricus lacrimabundus. True Hypholoma lacrimabundum is illustrated by Fries. Icon. 134 which he wrongly connected with one of Bulliard's figures. The species has been described several times under different names. Hypholoma storea var. caespitosum Cke. Hypholoma hypoxanthum Phill. and Plow. Geophila cotonea Quel. belong to this species. The two species are distinguished as follows. Hypholoma lacrimabundum grows usually in tufts by stumps or roots, the pileus is scaly on a whitish background, the lamellae are not clouded and more rarely weeping and the spores are smooth 3—5×6—9μ without an apical pore. Hypholoma velutinum grows singly or in groups on humus, the pileus is fibrous, ochraceous or tawny, the lamellae are clouded and often weeping, the spores are 6—7×10—12μ strongly verrucose and with an apical pore covered with a hyaline papilla.

The difference is practically the same as that between the two groups in this region. The essential distinction is in the spores. The spores of my specimens of Hypholoma lacrimabundum agree with those of Hypholoma storea var. caespitosum in Jaap's exsiccati, 143, except that they average slightly larger 3—5×7—9μ instead of 4—4.5×7.5—8μ. Not as large however as the spores of Hypholoma hypoxanthum 4—5×9—11μ.

The European confusion of the two species has extended to this country and forms of Hypholoma velutinum have no doubt been referred to Hypholoma lacrimabundum. Maire rightly questions Hard's figs. 263 and 264 which have the appearance of Hypholoma velutinum. Atkinson's fig. 28 is more like Hypholoma lacrimabundum though the large spores 7—8×9—11 make it doubtful. The spores of the plant illustrated in Vol. XVII pl. LXXVII C were smooth and 4—5×7—8μ. On p. 1153 I gave the spores of Hypholoma lacrimabundum 5—6×8—10μ following Sylloge, Peck, Quelet etc. Maire says the spores of

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A B C D E F

A B C HYPHOLOMA APPENDICULATUM BULL.

D E F FORM WITH RUGOSE PILEUS AND NARROW GILLS

HARPER—HYPHOLOMA

COCKAYNE, BOSTON

true Hypholoma lacrimabundum in Europe are not more than 4—5×7—9μ. Murrill in Mycologia, May, 1915 p. 116 pl. CLVIII 2, gives a good figure of Hypholoma velutinum but calls it Hypholoma lacrimabundum (Bull) Quel. He appears to be of the opinion that Fries' plant was an old scaly form of the one illustrated by Bulliard.

Note 2. Hypholoma delineatum Pk., N. Y. State Mus. Bull. 150 p. 83 is placed in the Hypholoma velutinum group by the author. Dr. Peck said it could be easily mistaken for Hypholoma rugocephalum from which it was to be separated by its more narrow obtuse and smooth spores. Dr. Dodge sent me a dried plant which he considered Hypholoma delineatum after examination of Peck's specimens. A photograph of it is shown in pl. XXI D. Both Peck's description and Dodge's specimen differ from the plants in the Hypholoma velutinum group in the smooth stem and broad membranous annulus as well as in the smooth, not opaque and not apiculate, spores. Nor have the gills in the dried specimen turned black. In all these characters the plants agree with members of the Pholiota erebia group as described in the note, Vol. XVII p. 1163 and pl. LXXXIV. Peck also calls attention to the rugose pileus with radiating ridges on the margin and to the habitat on both rotten logs and the ground both features of forms in the Pholiota erebia group. Furthermore the spores in the dried specimen are larger than those described by Peck, 5—6×12—14μ instead of 4—6×8—10μ, both of which measurements are found in forms I have included in the Pholiota erebia group. It is probable therefore that Hypholoma delineatum Pk. belongs to the Pholiota erebia group.

THE HYPHOLOMA APPENDICULATUM–CANDOLLEANUM GROUP

In vol. XVII, pls. LXXX–LXXXIII of these Transactions I published illustrations of five forms belonging to this group. Hypholoma candolleanum, leucotephrum, cutifractum, longipes and incertum. I here add illustrations of typical Hypholoma appendiculatum, a form similar to leucotephrum and the annulate form described as Stropharia irregularis Pk. or Stropharia longistriata Murr. The spores in all the forms are of the same size and character 4—6×7—12μ.

1. **Hypholoma appendiculatum** Bull. Pl. XXII ABC.

Hypholoma appendiculatum was very abundant at Geneseo., Ills., during the summer of 1915. The plants grew in lawns and pastures, preferring the vicinity of stumps and buried roots. They varied much but the most typical form appeared to be that shown in the illustration. The plants were large, ovate when young, becoming convex and expanded. The colors are hygrophanous yellow or brown at first becoming lighter to cream color or whitish as the water is lost. The pileus is regular, even and smooth, covered with the white floccose remains of the universal veil when young, but soon naked. The flocci remain on the pileus under favorable weather conditions and then the plants represent the variety flocculosarum. The change in color of the gills from white to flesh color and then brown and the floccose apex of the pileus were evident in some plants but not universally marked. These are the characters supposed to separate the species from its ally Hypholoma candolleanum. The apex of the stem is usually more or less striate and the gills never become a bright pink as in Agaricus campestris. The change is usually from whitish to a dull violaceous then turning purple brown with the ripe spores. The gills are broad and rounded at the stem narrowing toward the margin of the pileus, pl. XXII C. The veil is scanty and seen only in young plants. The further description of the species was given in vol. XVII, pp. 1157–1158.

2. Form with narrow gills and irregular rugose pileus. Pl. XXII DEF.

The illustrations show a marked form which was common about logs and stumps in open woods and pastures at Geneseo., Ills. The gills were narrow, remaining whitish for a long time and showing very little of the incarnate tints. The pilei were irregular and rugose wrinkled. The color was dark hygrophanous at first becoming light cream color. The form approaches Hypholoma leucotephrum but the stems were not long and slender nor markedly grooved at the apex as in that species.

3. Annulate form. **Stropharia irregularis Pk.** Pl. XXIII.

In June, 1915, there was a patch of very luxuriant plants of this group two or three yards in extent over a buried stump on a lawn in Geneseo, Ills. The partial veil was very thick and remained as a persistent annulus on the stem, often becoming moveable. Otherwise they did not differ from Hypholoma appendiculatum which was abundant in the neighborhood. The veil was of the same character as that in

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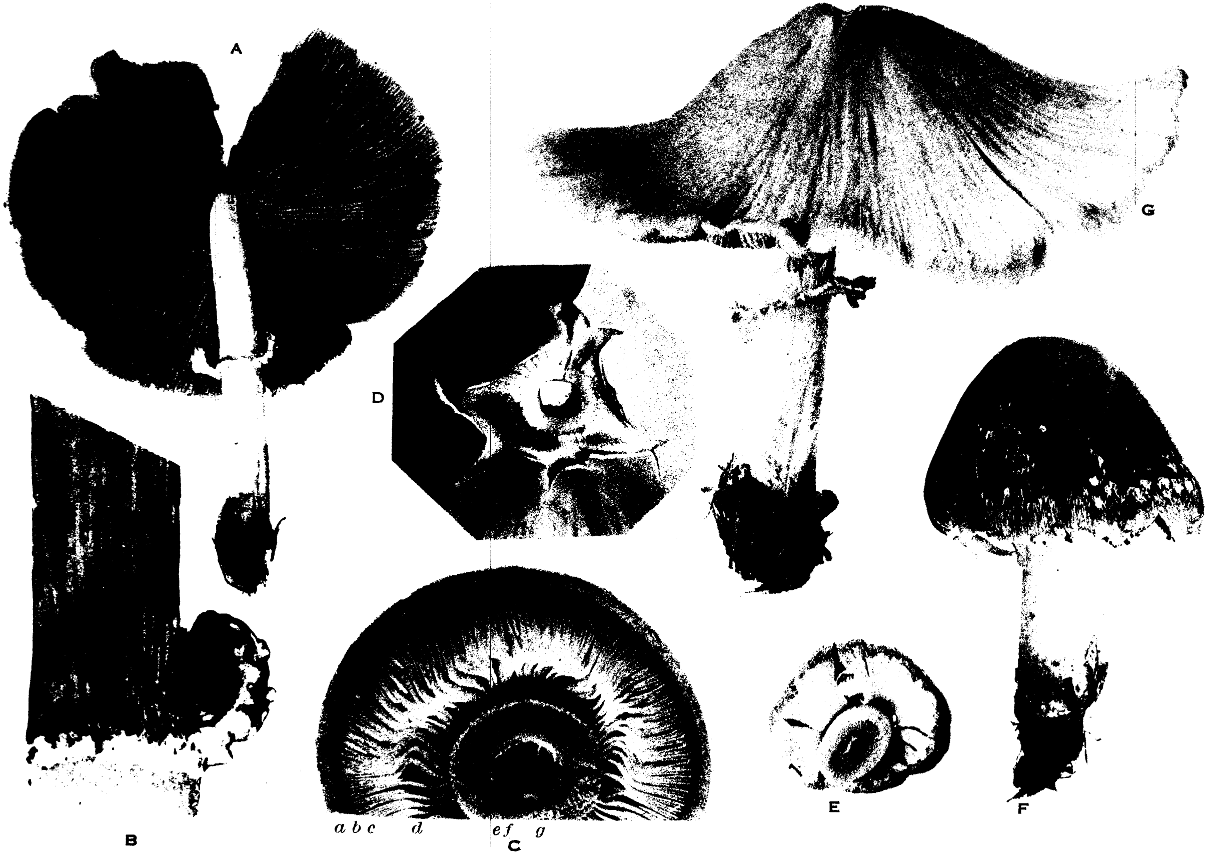
PLATE XXIII



HYPHOLOMA APPENDICULATUM BULL.
FORM WITH AN ANNULUS

HARPER—HYPHOLOMA

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typical Hypholoma appendulatum which usually splits into segments and remains as patches on the margin of the pileus, see pl. XXIII E.

Peck's description of a similar form which was found at Linden, Virginia, and which he named Stropharia irregularis, is given in Torr. Bull. Jan., 1900, pp. 16–17. It agrees with our plants even to the cracked umbo and split margin of the pileus. According to Earle, Peck was of the opinion later that the species was a form of Hypholoma incertum. The more persistent annulus and the long striae on the margin of the pileus agree still better with Stropharia longistriata Murr., Mycologia, Nov., 1912, which is described from specimens found on the Pacific coast.

If we judge by the illustrations of the European Stropharia spintrigera in Cooke's Illus. 542, and Fries' Icon. 132, and the descriptions given of that species we must conclude that this is the corresponding American form to that species. Note especially the "distant fugacious annulus" the slight "incarnate" tint of the pileus often seen in this form and in Hypholoma appendiculatum, and the gills "joined behind" as in pl. XXIII A. The spores of Stropharia spintrigera also are reported as oblong-ellipsoid 4—6 $\times$9—12μ. The species is said to be rare in Europe and to grow caespitose on trunks.

STRUCTURE OF THE PLANTS IN THIS GROUP

These large annulate forms offer good material in which to study the structure of the plants in the Hypholoma appendiculatum-candolleanum group.

a. The universal veil which covered the young plants remains as white floccose fragments on the pileus, pl. XXIII F, especially is it evident around the margin of the pileus and at the base of the stem in young plants, pl. XXII A. It soon disappears entirely except in the floccose varieties.

b. The partial veil is made of similar tissue and lies between the gills and the stem in the young plants covering the mouths of the gill chambers. There is much superannular elongation of the stem preceding the expansion of the pileus which ruptures the veil around the stem. The torn upper margin of the veil around the stem can be seen in pl. XXIII AB and G. The ridges on the upper surface are still to be seen on the annulus and on the remains of the veil at the apex of

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the stem. In most cases the expansion of the pileus which follows splits the veil and the fragments remain hanging to the margin of the pileus. Compare pl. XXIII E. with vol. XVII, pl. LXXX D and LXXXII E. In these annulate plants the veil is torn from the margin of the pileus without breaking up, and remains as a free annulus on the stem, pl. XXIII A and G. At the apex of the stem the veil remains attached to the edges of the gills and tears away from the stem leaving the gills joined together at their bases, pl. XXIII A. The part of the veil above the annulus is often broken into fragments by the elongation of the stem, leaving the stem furfuraceous or floccose above the annulus as in pl. XXII B. By this process the ridges on the veil are more or less obliterated. This breaking up of the partial veil above the annulus is analogous to that which takes place when the universal veil is torn into scales by the elongation of the stem in the volvar area in plants which have a volvar stem.

c. A well developed cortex is formed on the pileus beneath the universal veil. The coating on the stem is less developed. The stem is hollow and the cavity is coated by a medullary sheath, pl. XXIII C. The context of the pileus becomes pithy in the center and is divided into a cortical and a subhymenial layer. It is the cortical layer which cracks and peels off in the forms like Hypholoma cutifractum, vol. XVII, pl. LXXXII. There is a tendency to crack in this manner in the pilei of all the forms in the group which I have observed. The split often begins at the apex of the pileus as in pl. XXIII G. The hollow of the stem extends into the pileus and the cortical layer becomes very thin at the apex of the pileus. It is often perforated as was noted in the descriptions of Hypholoma candolleanum and Hypholoma longpipes. Plate XXIII D shows the apex of the pileus of the annulate form. The cortical layer has split off and the end of the hollow stem covered with the medullary sheath is seen in the center. Around it appears the dark subhymenial layer which connects with the growing tissue of the stem. The latter appears dark in the cross section of the stem, C, between the light tissue of the partial veil and the medullary sheath. In D the subhymenial layer appears radiating outward under the gill chambers. The rays are divided by the lighter colored tissue of the trama of the gills. Plate XXIII C shows a cross section

HYPHOLOMA HYDROPHILUM BULL.

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through the pileus of a plant at about the stage of development of E. There is shown (a) the dark colored cortical layer, (b) the central portion of the pileus with lighter colored tissue, (c) the dark subhymenial layer, (d) the gill chambers covered on their bottom and sides with the hymenium. The spores have not formed. Later the gills are blackened with the spores except on their edges which remain white and floccose where they were torn from the tissue of the partial veil, (e) the partial veil appearing as a light colored layer about the stem. It is fluted by the grooves made by the edges of the gills, (f) the context of the stem, (g) the light colored medullary sheath.

THE PSILOCYBE SPADICEA GROUP

1. **Hypholoma hydrophilum** Bull. Pl. XXIV.

The plants I have referred to this species were collected by Dr. Mary Whetstone on a lawn in Minneapolis, Minn. They are closely related to Psilocybe spadicea and appear to belong to the same group. The spores of the two species are alike in shape, size and color, $3—5 \times 7—9\,\mu$, but Hypholoma hydrophilum is furnished with very numerous dart shaped colored cystidia about $15—20 \times 55—70\,\mu$. These cystidia are the most distinctive mark of the species. The plants differ from Psilocybe spadicea also in the appendiculate veil which hangs in patches from the margin of the pileus in young plants, but soon disappears, in the more solid substance, the more irregular, rugose wrinkled and repand pileus, the fibrillose stem striate at the apex and the absence of incarnate hues on the lamellae. All these features are characters of Hypholoma hydrophilum.

PILEUS $\frac{1}{2}$—3 inches broad, ovate to convex and expanded, somewhat firm and fleshy, repand, striate or rugose wrinkled especially near the incurved margin, disk smoother and even, hygrophanous, tawny or yellowish brown becoming pale avellaneous. Sometimes with scattered white squamules when young. LAMELLAE adnexed, rounded behind, narrow, not crowded, whitish becoming dark brown. STEM 2—3 inches long, 3 lines thick, hollow, equal or slightly tapering upward, somewhat striate above, white or pale cream colored. SPORES dark rusty brown, $3—5 \times 7—9\,\mu$, basidia

4—5×20—25 μ, Cystidia numerous, colored, dart shaped 15—25×55—70 μ.

On the ground in yards, about logs, etc. Caespitose.

The plants agree well with Cooke's Illus. 605 and Bulliard t. 511. The species has been reported from Michigan by Kauffmann.

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A MONOGRAPH OF THE ALGAL GENUS *SCENEDESMUS* BASED UPON PURE CULTURE STUDIES

GILBERT MORGAN SMITH

The species that have been described in the genus *Scenedesmus* are based almost wholly on field material. The specific differences are founded on the shape of the cells, presence of horns, teeth, lateral ridges, and cell measurements. The question of the amount of variation within the limits of a single species, however, has always been one of considerable dispute, since there has been no way of determining whether or not any particular character is permanent or persists for a single generation only. The application of the pure culture method to the study of algae by Beyerinck in 1891 has given an exact method for the study of variation within the limits of a single species. Methods for the isolation of algae have been described by Beyerinck, Chodat, Grintzesco, and myself, so that an extended account of the process is superfluous.

In this article an attempt is made to cover the entire literature relating to *Scenedesmus* for the purpose of determining the geographical range of the various species. For the sake of brevity in citation, articles are referred to by date only, and the letters A, B, C, etc. used to distinguish between the publications of one man for the same year. Exsiccatae have not been included since there were not a sufficient number available to warrant doing so. Geographical distribution has been cited according to political rather than physiographical boundaries. In spite of the fact that these units of area are artificial and of unequal size this method is the most serviceable since geographical interest is generally confined to certain specific countries.

Individual species are treated by citing the literature, the description (with the use of the original description as far as possible), a discussion of its variation as observed in pure culture, the geographic range.

The first species of the genus were figured by Turpin in 1820 as species of *Achnanthes*. These were illustrations only, but in 1828 Turpin gave a better series of illustrations and also described the different species. In 1829, Meyen, who was not aware of the work of Turpin, established the genus *Scenedesmus* and described several species. This existence of two sets of names has produced considerable confusion. The parallelism between the species of Turpin and Meyen was pointed out by Guillemin in 1830, in his review of Meyen's article, but no attempt was made to reduce the two to synonymy.

The first combination of Turpin's species with Meyen's genus is by Kützing in 1833, who thought that the species of the two were distinct and so gave the description of both series. At this time *Scenedesmus* was placed with the Desmidiaceae which were thought to be a family of the Diatomaceae. The spelling of the name *Scenedesmus* is also confused; since Meyen spells it *Scenedesmus* in the text of the original description while on the accompanying plate it is spelled *Scaenaedesmus*. Later on he added a further variation by spelling it *Scaenedesmus* (1830). On account of this vacillation in spelling and also for entymological reasons Ehrenberg changed the spelling to *Scenodesmus*. Ehrenberg later established the genus *Arthrodesmus* and transferred the species of *Scenedesmus* to this new genus.

Between the years 1840 and 1860 various collections of the species of *Scenedesmus* are found. In these early descriptions the number and arrangement of the cells in the colony constituted the chief method by which the various species were distinguished, but today these characters are of minor importance for differentiating species. For this reason practically all of the older species should be regarded as synonyms or placed among the questionable species. The most complete collections of species made at this time are those of Meneghini and of Kützing.

The modern work on *Scenedesmus* really began with Lagerheim's collection of the data on the known species

(1883). He was also the first to describe species based on the external sculpturing of the cell wall, a method which has been used almost entirely ever since for establishing new species. The work of de Toni (1889B) is by far the most complete that we have for the distribution of the various species and is a critical compilation of the species that were known at that time but is quite inadequate at present. In 1893 de Wildemann also published a monograph of the genus, but his material was drawn to a large extent from de Toni's data. The chief point in the work of de Wildemann is the uniting of *S. quadricauda* and *S. bijuga* into one species called *S. variabilis* but even this possesses no originality since Franzé had previously united these two species under the emended name *S. obtusus* (Meyen) Franzé.

At the time this work was started there was no modern collection of the species of the genus but during its preparation two notable publications have appeared. In 1913 Brunnthaler presented a key to the species of *Scenedesmus* with figures of the species he recognized. This has been of great service in checking up data that I have secured. In the same year Chodat published an extensive monograph based on pure culture studies, the greater portion of the work being carried out on the genus *Scenedesmus*. It is a matter of regret that I must take so critical an attitude towards his work, but it is practically impossible to determine the different species he describes. Few cell measurements are given and the only differences between many of the species are physiological. Chodat himself admits the impossibility of the worker in the field identifying many of his species.

The cultural work that I have carried on shows that the shape of the cell, the presence of four terminal horns, the presence of horns in addition to those at the four corners of the coenobe, lateral ridges, and teeth are characters that are constant in any one culture isolated by pure culture methods. The relative arrangement of the cells is a character that is constant in certain species and variable in others. In the present work the presence of any one of these characters which persists in a pure culture is taken as the character that distinguishes a single species. The combination of two of these characters in a single coenobe is one that is generally regarded as also constituting specific rank and this practice has been followed in the treatment of the different species. The cultures also show that different forms may possess the same character (as spines at the four corners) but have dimensions which differ greatly within certain fixed limits. I have therefore considered as varieties strains showing the same external morphological characters but varying in the size of the component cells. An attempt had been made throughout the work to make the descriptions suitable to the needs of the investigator who collects his material in the field, and only those characters have been included which are discernable through the microscope.

The dimensions of the cells err on the side of exaggeration if at all. The work of Senn, Chodat, and myself has shown that external conditions influence the size of the cell to some extent, so control cultures have been carried out in sterile lake water to avoid the abnormalities produced by a too high strength of the nutrient solution. Unless otherwise noted the cultures have been made in 0.1% Knop's solution since I find that I cannot distinguish between the cultures grown in this medium and in natural waters.

KEY TO THE SPECIES OF *Scenedesmus*.

I. Colony enclosed in a gelatinous sheath.

1. *S. oahensis* (Lemm.) nov. comb.

II. Colony not enclosed in a gelatinous sheath.

1. Cell membrane smooth, without terminal spines, teeth, granulations, or lateral ridges.

A. Cells acicular to spindle shaped.

a. Cells without polar bulbs or thickenings.

X. Cells in a flat plane.

*. All cells in the coenobe erect.

2. *S. obliquus* (Turp.) Ktz.

**. Median cells erect, outer cells curved.

3. *S. dimorphus* (Turp.) Ktz.

XX. Cells not in one plane.

*. Cells alternately arranged, terminal cells usually not in same plane as others in coenobe.

4. *S. Bernardii* nov. spec.

**. Cells forming a curved surface.

5. *S. acuminatus* (Lag.) Chod.

b. Cells with polar bulbs or thickenings.

X. Cells acicular with small polar bulbs, apices of cells pointing away from center of coenobe.

6. *S. antennatus* de Bréb.

XX. Cells blunts spindle shaped, with polar nodules. Wall of cell convex on side away from center of coenobe, concave towards center.

7. *S. incrassatulus* Bohl.

B. Cells ovoid.

a. Outline of cell perfect oval.

X. Cells in a linear or alternating series, never in a double series.

8. *S. bijuga* (Turp.) Lag.

XX. Cells arranged in two series.

*. Cells alternately arranged, large interstices between cells, coenòbe curved.

9. *S. curvatus* Bohl.

**. Cells in two series, interstices between cells small, coenobe curved or flat.

10. *S. arcuatus* Lemm.

b. Cells with capitate ends.

11. *S. producto-capitatus* Schmula.

2. Cell membrane with teeth at poles, without spines, ridges or external ornamentation in the middle of the cell.

A. 2-3 teeth at each pole.

12. *S. denticulatus* Lag.

B. Several teeth at poles of cells.

13. *S. acueolatus* Reinsch.

3. Cell membrane with longitudinal ridges, with or without spines or teeth.

A. Cells with longitudinal ridges only.

a. Middle cells with a ridge on each side, and cells with four ridges.

14. *S. acutiformis.* Schröder.

b. Cells with four to six longitudinal ridges on all cells.

15. *S. costatus* Schmidle.

B. Cells with longitudinal ridges and teeth on poles.

16. *S. brasiliensis.* Bohlin.

C. Cells with longitudinal ridges and spines at poles of terminal cells.
  a. Cells with spines on end cells.
    17. *S. armatus* (Chod) nov. comb.
  b. Cells with spines on end cells and teeth on poles of all cells.
    18. *S. carinatus* (Lemm.) Chodat.

4. Short spines or granulations in the middle portion of cell wall as well as on the ends.
  A. Spines or granulations completely covering the cell wall.
    X. Cells without long horns at poles of terminal cells.
      19. *S. hystrix* Lag.
    X. Cells with long horns on poles of terminal cells, interstices between cells.
      20. *S. ornatus* (Lemm.) nov. comb.
    XXX. Spines on ends of all cells.
      21. *S. insignis* (West and West) Chod.
  B. Spines or granulations in rows on sides of cells.
    a. 3-4 rows of granulations from pole to pole on each cell.
      22. *S. granulatus* West and West.
    b. Two rows of spines from pole to pole on median cells, one row on terminal cells. Teeth on poles.
      23. *S. serratus* (Corda) Bohl.

5. Cells without external ornamentation aside from long horns.
  A. Spines on both median and terminal cells.
    a. Spines on middle part of cell wall as well as on poles.
      24. *S. abundans* (Kirch.) Chod.
    b. Spines only on poles of all cells.
      25. *S. longus* Meyen.
  B. Spines on ends of terminal cells only.
    a. Colonies without linear interstices between cells.
      X. Ends of cells rounded, cells in lateral contact entire length.

26. *S. quadricauda* (Turp.) de Bréb.

XX. Cells naviculate, in lateral contact in middle third only.

27. *S. opoliensis* Richt.

b. Colonies with linear interstices between cells.

28. *S. perforatus* Lemm.

1. **S. oahuensis** (Lemm.) nov. comb. (Pl. XXV: Fig. 1).

S. quadricauda var. *oahuensis.* Lemmermann, 1905A, p. 630; Pl. VIII, Figs. 4-5. Lemmermann, 1900C, p. 335. (as *S. quadricauda* var. *insignis* West and West.)

"Coenobium 2–16 cellulares, tegumento hyalino, mucosa circumvelatum. Cellulae 2 costis lateralis instructae, apivibus et lateralibus 1–4 aculeis fragilibus, granulosis armatae. Costae subtiliter granulatae. Membrana cellularum poris minutis densissime instructae."

Description of a gelantinous sheath in the genus *Scenedesmus* is confined to this single species described by Lemmermann. The number of supplementary spines in addition to those on the four corners of the coenobe is variable.

2. **S. obliquus** (Turp.) Ktz. (Pl. XXV: Fig. 7. Pl. XXIX: Figs. 63–68).

Kützing, 1833, p. 609. de Brébisson, 1839, p. 271. Meneghini 1840, p. 208. Ralfs, 1848, p. 192; Pl. XXXI, Figs. 15A-15C. Bailey, 1851, p. 29. Bailey, 1855, p. 12. Griffith and Henfrey, 1856, p. 565; Pl. X, Fig. 51. Archer, 1857, p. 40. Spencer, 1882, p. 296. Griffith and Henfrey, 1883, p. 679; Pl. XIV, Fig. 51. Lagerheim, 1883, pp. 64, 66. Wille, 1884, pp. 10, 45. Griffith and Henfrey, 1885, p. 686; Pl. X, Fig. 51. Hansgirg, 1886, p. 116. Nordstedt, 1888, p. 19. Hansgirg, 1889, p. 132. de Toni, 1889B, p. 566. Hansgirg, 1890A, p. 112. Hansgirg, 1891, p. 317. Lemmermann, 1891, p. 148. Hansgirg, 1892B, p. 120. Lemmermann, 1893, p. 524. Schmidle, 1893A, p. 13. de Wildemann, 1893A. de Wildemann, 1893B, p. 91. Lemmermann, 1895A, p. 41. Lemmermann, 1895B, p. 296. West and West, 1895, p. 83. de Wildemann, 1895, p. 26. Borge, 1896, p. 7. Schröder, 1896, p. 46. West and West, 1896, p. 381. Farlow in Trelease, 1897, p. 196. Lemmermann, 1897, p. 108. Schröder, 1897C, p. 45. Strohmeyer, 1897, p. 6. West and West, 1897B, p. 500. de Wildemann, 1897A, p. 61. de Wildemann, 1897C, p. 78. Lemmermann, 1898C, p. 249. Mez, 1898, p. 149; Pl. IV, Fig. 166. Schorler, 1898, p. 38. Schröder, 1898, p. 24. Tilden, 1898, p. 26. Zacharias, 1898, p. 94. Boergesen, 1899A, p. 135. Boergesen, 1899B, p. 333. Borge, 1899, p. 7. Forti, 1899, p. 89. Garbini, 1899A, p. 15. Lemmermann, 1899, p. 133. Levander, 1899, pp. 63, 70, 80. Marsson, 1899, pp. 171, 254. de Toni et Forti, 1899B, p. 792. G. S. West, 1899, p. 221. de Wildemann, 1899, p. 11. Zacharias, 1899, p. 83. Balsamo, 1900, p. 266. Chodat, 1900, p. 2. Lagerheim, 1900, p. 10. Lemmermann, 1900C, p. 339. Schmidle, 1900B, p. 126. Schorler, 1900, p. 5. Boergesen, 1901A, p. 240. Borge, 1901A, p. 101. Borge, 1901B, p. 13. Dalla Torre und von Sarnthein, 1901, p. 35. Fanning, 1901, p. 617. Lemmermann, 1901, p. 92. Marsson, 1901A, pp. 96, 101, 115. Treboux, 1901, p. 478. West and West, 1901A, p. 196. West and West, 1901B, p. 119. Wille, 1901, p. 11. Chodat, 1902, p. 210. Forti, 1902, p. 60. Riddle, 1902, p. 317. Schmidle, 1902B, p. 125. West and West, 1902B, p. 64. Fournier, 1903, p. 28. Gutwinski, 1903, p. 204. Lemmermann, 1903C, p. 119. Pascher, 1903, p. 175. Schmidle, 1903, p. 80. Snow, 1903, p. 391. Volk, 1903, p. 104. Wille, 1903, p. 92. Zacharias, 1903A, p. 203. Cozette, 1904, p. 273. Lemmermann, 1904A, pp. 27, 71. Lemmermann, 1904B, p. 305. Lemmermann, 1904C, p. 159. Marsson, 1904, pp. 139, 146. Schmidle, 1904B, p. 7. G. S. West, 1904A, p. 287. G. S. West, 1904B, p. 220; Figs. 92A-92B. West and West, 1904, p. 531. Fink, 1905, p. 25. Hansgirg, 1905, p. 458. Huber, 1905, p. 57. Krause, 1905, p. 110. Lauterborn, 1905, p. 645. Lemmermann, 1905B, pp. 158, 162. Lemmermann, 1905C, pp. 166, 168. Stadler, 1905, p. 236. Suhr, 1905, p. 252. Trotter, 1905, p. 45; Fig. 8 Volk, 1905, p. 65. West and West, 1905, p. 30. Hardy, 1906, p. 38. Pascher, 1906, p. 168. Petkoff, 1906B, p. 158. Ruttner, 1906, p. 10. Schinz, 1906, p. 392. Schorler, Thallwitz und Schiller, 1906, p. 247. Borge, 1907A, p. 58. Borge, 1907B, p. 4. Brunnthaler, 1907, p. 206. Buchanan, 1907, p. 81. Krause, 1907, pp. 220, 221. Larsen, 1907A, p. 358. Lemmermann, 1907B, p. 409. Migula, 1907, p. 658; Pl. XXXV (K), Fig. 9. Ostenfeld, 1907, p. 384. Le Roux, 1907, p. 244. Schorler, 1907, p. 356. Selk, 1907, pp. 57, 64, 73, 79, 85, 91, 94, 99, 112, 115. Teodoresco, 1907, p. 130. G. S. West, 1907, p. 139. West and West, 1907, p. 229. Adams, 1908, p. 35. Forti et Trotter, 1908, pp. 32, 86. Huber, 1908, p. 313. Kaiser, 1908, p. 163. Kolkowitz und Marsson, 1908, p. 514. Lemmermann, 1908A, p. 167. Marsson, 1908A, pp. 30, 32, 40. Marsson, 1908B, pp. 93, 97, 107, 114, 116, 120. West and West, 1908, p. 102. Adams, 1909, p. 186. Borge, 1909, p. 16. Collins, 1909, p. 168. Eyferth, 1909, p. 116; Pl. III, Fig. 22. Marsson, 1909, pp. 547, 557, 561. Schodduyn, 1909, p. 166. G. S. West, 1909A, p. 29. G. S. West, 1909C, p. 245. G. S. West, 1909D, p. 69. West and West, 1909B, p. 184. Gugliemetti, 1910, p. 32. Hayden, 1910, p. 44. Kofoid, 1910, p. 31. Kolkowitz, 1910, p. 60. Bachmann, 1911, p. 191. Bethge, 1911, p. 500. Comère, 1911, p. 51. Klugh, 1911, p. 97. Lauterborn, 1911, p. 250. Marsson, 1911, pp. 261, 263, 266, 275, 276, 283. Conrad et

Kufferath, 1912, p. 321. Griffith, 1912, p. 11. Borge, 1913, p. 60. Brunnthaler, 1913, pp. 165, 170; Fig. 1. Chodat, 1913, p. 26; Figs. 1-11, 22. Fritsch and Rich, 1913, p. 43. Hardy, 1913, p. 93. Krmpotic, 1913, p. 27. Migula, (no date) p. 37; Pl. IV, Fig. 7.

Achnanthes obliqua. Turpin, 1820, Fig. 9. Turpin, 1828, p. 312; Pl. XIII, Fig. 9.

S. acutus. Meyen, 1829, p. 775; Pl. XLIII, Fig. 32. Kützing, 1833, p. 609. de Brébisson, 1839, p. 271. Meneghini, 1840, p. 207. Kützing, 1843, p. 164. Hassall, 1845, p. 393; Pl. XCII, Fig. 14. Ralfs, 1845, p. 403; Pl. XII, Fig. 6. Ralfs, 1846, p. 160; Pl. XV, Fig. 6. Ralfs, 1848, p. 191; Pl. XXXI, Figs. 14, 16. Bailey, 1851, p. 29. Zanardini, 1857, p. 250. Archer, 1858, p. 258. Grunow, 1858, p. 499. Reinsch, 1867, p. 82. Rabenhorst, 1868, p. 64; Figs. 34A-34C. Wood, 1869, p. 135. Hohenbühel-Heufler, 1871, p. 318. Wittrock, 1872, p. 31. Archer, 1874, p. 329. Wood, 1874, p. 90. Reinsch, 1876. Kirchner, 1878, p. 98. Wille, 1879, p. 30. Cienowsky, 1881, p. 304. Wolle, 1881, p. 213. Cooke, 1882, p. 33. Nordstedt, 1882, p. 46. Hansgirg, 1883, p. 288. Hansgirg, 1884B, p. 365. Artari, 1884, p. 132. Cooke, 1885. Pâque, 1885, p. 52. de Wildemann, 1885, p. 123. Bennett, 1886, p. 3. Campbell, 1886, p. 93. Parfitt, 1886, p. 392. de Toni et Levi, 1886, p. 67. Beck, 1887, p. 274. Bennett, 1887, p. 9. de Toni et Levi, 1887, p. 1585. Wolle, 1887, p. 173; Pl. CLVI, Figs. 25-26. Alexenko, 1888, p. 158. Balsamo, 1888, p. 40. W. West, 1888, p. 748. Heiden, 1889, p. 5. MacKenzie, 1889, p. 271. Riabinine, 1889A, p. 302. Riabinine, 1889B, p. 47. W. West, 1889A, p. 290. W. West, 1889B, p. 206. W. West, 1889C, p. 88. Bennett, 1890, p. 2. Chmielweski, 1890, p. 92. Roy, 1890, p. 338. W. West, 1890, p. 298. de Wildemann, 1890A, p. 137. de Wildemann, 1890B, p. 155. Alexenko, 1891, p. 61. Beyerinck, 1891, p. 279. Ianouchkievitch, 1891, p. 290. W. West, 1891A, p. 248. Bennett, 1892, p. 5. Franzé, 1892, p. 154; Pl. III, Figs. 1-3. Turner, 1892, p. 161. Weiss, 1892, p. 37. W. West, 1892A, p. 194. W. West, 1892B, p. 738. Beyerinck, 1893, p. 368. Chodat et Malinesco, 1893, p. 184. Franzé, 1893, p. 286. Stokes, 1893, p. 52. Alexenko, 1894, p. 72. Borge, 1894, p. 9. Alexenko, 1895, p. 92. Borge, 1895, p. 6. Bohlin, 1897, p. 24. Chodat, 1897, p. 291. Chodat, 1898, pp. 166, 179. Nitardy, 1898, p. 104. Zacharias, 1898, p. 93. Iwanoff, 1899, p. 380. Senn, 1899, p. 70. Balsamo, 1900, p. 266. Chodat et Grintzesco, 1900, p. 387. Lindau, 1901, p. 136. Bohlin, 1902, p. 44. Fritsch, 1902, p. 582. Larder, 1902, p. 59. Voigt, 1902, p. 76. Fritsch, 1903, pp. 640, 643, 646. Snow, 1903, p. 391. W. West, 1903, p. 100. Zacharias, 1903B, pp. 254, 263. Comère, 1904, p. 62. Heering und Homfeld, 1904, p. 83. Marquand, 1904, p. 269. Moreto, 1904, p. 440. Nitardy, 1904, p. 318. Andersson, 1890, p. 5. Suhr, 1905, p. 252. Fritsch, 1906, p. 205. Tanner-Fullmann, 1907, p. 232. Adams, 1908, p. 35. Bachmann, 1908, p. 44. Quelle, 1908, p. 43. Viret, 1908, p. 977. Andrews, 1909, p. 379. Chodat, 1909,

p. 91; Pl. VIII. Honigmann, 1909, p. 54. Schmula, 1910, p. 86. Comère, 1911, p. 49. Petersen, 1911, p. 160; Fig. 5. Andressen, 1913, Smith, 1914A, p. 283; Pl. XVI, Figs. 1-23. Smith, 1914B, p. 1185; Pl. LXXXVII and LXXXVIII.

S. pectinatus. Meyen, 1829, p. 775; Pl. XLIII, Figs. 33-35. Kützing, 1833, p. 608. de Brébisson, 1839, p. 271. Meneghini, 1840, p. 208. Balsamo, 1900, p. 266.

Scenodesmus acutus. Ehrenberg, 1834, p. 310. Kützing, 1845, p. 139. Kützing, 1849, p. 186. Nägeli, 1849, p. 92; Pl. V, Figs. 5A-5C. Rabenhorst, 1850, p. 157. de Brébisson, 1856, p. 160. Archer, 1861, p. 753. Kirchner, 1891, p. 18. Brunnthaler, 1900, p. 310. Conn and Webster, 1908, p. 35; Pl. VI, Fig. 37.

Arthrodesmus acutus var. *obtusior*. Ehrenberg, 1836.

S. fusiformis. Meneghini, 1837, p. 18. Meneghini, 1840, p. 208.

S. triseriatus. Meneghini, 1837, p. 18. Meneghini, 1840, p. 208. de Brébisson, 1839, p. 271. Ralfs, 1845, p. 403; Pl. XII, Fig. 7. Ralfs, 1846, p. 151; Pl. XV, Fig. 7. Balsamo, 1900, p. 267.

Arthrodesmus acutus. Ehrenberg, 1838, p. 151; Pl. X, Fig. 19. Ehrenberg, 1843, p. 338. Pritchard, 1841, p. 190.

Arthrodesmus pectinatus. Ehrenberg, 1838, p. 151; Pl. X, Fig. 17. Pritchard, 1841, p. 190. Pokorny, 1854, p. 58.

S. acutus var. *fusiformis*. de Brébisson, 1839, p. 271.

Scenodesmus pectinatus. Kützing, 1843, p. 164. Kützing, 1845 p. 140. de Brébisson, 1856, p. 159.

Scenodesmus acutus var. *biseriatus*. Kützing, 1849, p. 186.

Scenodesmus dimorphus var. *pectinatus*. Kützing, 1849, p. 186.

Scenodesmus acutus var. *fusiformis*. Kützing, 1849, p. 186.

Scenodesmus acutus var. *obliquus*. Kützing, 1849, p. 186.

Arthrodesmus pectinatus var. *acutus*. Pokorny, 1854, p. 58.

Scenodesmus obliquus. de Brébisson, 1856, p. 156.

S. acutus var. *obliquus*. Rabenhorst, 1868, p. 64. W. West, 1883, p. 105. Cooke, 1882, p. 33. Cooke, 1885, de Wildemann, 1885, p. 123. Parfitt, 1886, P. 392. W. West, 1889A, p. 290. W. West, 1889B, p. 206. W. West, 1890, p. 298. W. West, 1891B, p. 421. W. West, 1892A, p. 194. W. West, 1892B, p. 738. Borge, 1894, p. 9. Fritsch, 1902, p. 582. Fritsch, 1903, p. 646. W. West, 1903, p. 100. Fritsch, 1905, p. 164. Fritsch, 1906, p. 205.

S. obliquus forma *alternans*. Huber, 1908, p. 313.

S. obliquus forma *parvus*. Bernard, 1908, p. 181; Pl. XIV, Figs. 407-416, 414′, 415′, 416′, Bernard, 1909, p. 76; Pl. VI; Figs. 160-161.

"Coenobiis 4–8 cellularibus; cellulis fusifoideis, utroque polo acute plerumque in seriem simplicem dispositis. Dimens. cell. 5–27 x 3–9 μ."

S. obliquus has been isolated several times from various localities in this vicinty. The species has been studied in pure culture by Beyerinck, Grintzesco, Chodat, Tischutkin, Andreesen, and myself, so that the variations occurring within the limits of a pure culture are well known. Interest in the species has increased considerably since Chodat and Grintzesco described the remarkable series of transformations in which the cells are all isolated at one time, and at others form branching systems which resemble *Dactylococcus infusionem* Nägeli. I (1914) have recently discussed the question of this *Dactylococcus* stage and find that it never occurs in pure cultures of *S. obliquus.* On the other hand I have isolated an alga with cells shaped like *S. obliquus* but they were always arranged in branching chains as in *D. infusionem* and therefore concluded that the two should be regarded as separate species and not different growth-forms of the same alga. In this connection it is interesting to note that the investigator who first stated that *S. obliquus* and *D. infusionem* are the same alga (Chodat), brings forth no additional data in his recent work (1909, 1913) to show that the two are related, but relies on earlier work as evidence.

It is generally agreed, however, that cultural conditions may produce a change in the shape of the individual cells, causing them to become less acicular with the increase in concentration of the nutrient medium.

In the different strains of this alga so far isolated, I am unable to differentiate between any of them on the basis of cell size, whereas in certain other species it is possible to distinguish the different strains by cell measurements. The arrangement of the cells may be either in a linear series (Figs. 63, 64; Pl. XXIX) or in an alternating series (Figs. 67, 68), a fact which I have shown to be due to the manner of formation of the young colony by the mother cell.

GEOGRAPHICAL DISTRIBUTION

EUROPE. *Austria-Hungary* (Alexenko, 1888, 1894, 1895; Beck, 1887; Brunnthaler, 1900, 1907; Franzé, 1892, 1893; Grunow, 1858; Ianouchkievitch, 1891; Hansgirg, 1883, 1884B, 1886, 1889, 1890A, 1891, 1892B, 1905; Pascher, 1903, 1906; Pokorny, 1854; Riabinine, 1889A, 1889B; Ruttner, 1906; Stadler, 1905). *Belgium* (Conrad et Kufferath, 1912; Pâque, 1885; de Wildemann, 1885, 1890A, 1890B, 1893B, 1895, 1897B). *Bulgaria* (Petkoff, 1906B). *Denmark* (Chodat, 1900; W. West, 1891B). *England* (Bennett, 1886, 1887, 1890, 1892; Cooke, 1882, 1885; Fritsch, 1902, 1903, 1905, 1906; Fritsch and Rich, 1913; Griffith, 1912; Griffith and Henfrey, 1856, 1883, 1885; Hassall, 1845; Larder, 1902; Marquand, 1904; Parfitt, 1886; Pritchard, 1841; Ralfs, 1845, 1846, 1848; Roy, 1890; G. S. West, 1899, 1904B, 1909D; W. West, 1883, 1889A, 1889C, 1890, 1891A, 1892B; West and West, 1897B, 1901B, 1908). *Germany* (Andreesen, 1913; Bethge, 1911; Ehrenberg, 1834, 1838; Eyferth, 1909; Heering und Homfeld, 1904; Heiden, 1889; Honigmann, 1909; Kaiser, 1908; Kirchner, 1878, 1891; Kolkowitz, 1910; Kolkowitz und Marsson, 1908; Krause, 1905, 1907; Kützing, 1845, 1849; Lauterborn, 1911; Lemmermann, 1891, 1893, 1895A, 1895B, 1897, 1898A, 1898C, 1899, 1901, 1901B, 1903C, 1904B, 1905B, 1905C, 1907B; Lindau, 1901; Marsson, 1899, 1901A, 1904, 1908A, 1908B, 1909, 1911; Meyen, 1829; Migula, 1907; Nitardy, 1898, 1904; Quelle, 1908; Schmidle, 1893A; Schmula, 1910; Schorler, 1898, 1900, 1907; Schorler, Thallwitz und Schiller, 1906; Schröder, 1896, 1897C, 1898; Selk, 1907; Senn, 1899; Strohmeyer, 1897; Voigt, 1902; Volk, 1903, 1905; Weiss, 1892; Zacharias, 1898, 1899, 1903A, 1903B). *France* (de Brébisson, 1856; Chodat, 1898; Comère, 1904, 1911; Cozette, 1904; Fournier, 1903; Reinsch, 1867; Le Roux, 1907; Schodduyn, 1909; Turpin, 1820, 1828). *Holland* (Beyerinck, 1891, 1893). *Ireland* (Adams, 1908, 1909; Archer, 1857, 1858; W. West, 1892A; West and West, 1902B). *Italy* (Balsamo, 1888; Chodat, 1898; Forti, 1899, 1902; Forti et Trotter, 1908; Garbini, 1899A; Gugliemetti, 1910; Hohenbühel-Heufler, 1871; Meneghini, 1840; Moreto, 1904; Rabenhorst, 1850; de Toni et Forti, 1899B; de Toni et Levi, 1886, 1887; Trotter, 1905; Zanardini, 1857). *Montenegro* (Schmidle, 1900B, 1902B). *Roumania* (Teodoresco, 1907). *Russia* (Alexenko, 1891; Artari, 1884; Borge, 1894; Chmielweski, 1890; Cienowsky, 1881; Iwanoff, 1899; Krmpotic, 1913; Levander, 1899; Treboux, 1901; Wille, 1879). *Scotland* (W. West, 1903; West and West, 1904, 1905, 1909B). *Sicily* (Lemmermann, 1908A). *Sweden* (Andersson, 1890; Borge, 1895, 1907A, 1913; Lagerheim, 1883; Lemmermann, 1904A; Petersen, 1911). *Switzerland* (Bachmann, 1908; Borge, 1901A; Chodat, 1897, 1902, 1909, 1913; Chodat et Grinzesco, 1900; Chodat et Malinesco, 1893; Dalla Torre und von Sarnthein, 1901; Huber, 1905, 1908; Tanner-Fullmann, 1907; Viret, 1908; de Wildemann, 1897A).

AFRICA. *Lake Albert Nyanza* (G. S. West, 1909C). *Azores* (Archer, 1874; Bohlin, 1902; Farlow in Trelease, 1897). *Central Africa* (West and West, 1896). *Madagascar* (West and West, 1895). *Lake Nyassa* (Schmidle, 1903; G. S. West, 1907). *Lake Tanganyika* (G. S. West, 1907). *Zambesi* (Schinz, 1906; Wille, 1903).

ASIA AND OCEANIA. *Australia* (Borge, 1896; Hardy, 1906, 1913; G. S. West, 1909A). *Burma* (West and West, 1907). *Ceylon* (West and West, 1901A). *China* (Gutwinski, 1903; Ostenfeld, 1907). *India* (Turner, 1892). *Java* (Bernard, 1908; Lemmermann, 1904C; de Wildemann, 1897C, 1899). *Johore* (Bernard, 1909). *New Zealand* (Lemmermann, 1900C; Nordstedt, 1888, Spencer 1882).

AMERICAS. *Argentina* (Borge, 1899, 1907B; Nordstedt, 1882; Wille, 1884). *Barbados* (G. S. West, 1904). *Brazil* (Bohlin, 1897; Wille, 1884). *Canada* (Borge, 1909; Klugh, 1911; MacKenzie, 1899). *Pategonia* (Borge, 1901B; Nordstedt, 1882). *Paraguay* (Bohlin, 1897). *United States* (Andrews, 1909; Bailey, 1851; 1855; Borge, 1909; Buchanan, 1907; Campbell, 1886; Collins, 1909; Conn and Webster, 1908; Ehrenberg, 1843; Fanning, 1901; Fink, 1905; Hayden, 1910; Kofoid, 1910; Riddle, 1902; Snow, 1903; Stokes, 1893; Tilden, 1898; W. West, 1889B; Wood, 1869; 1874; Wolle, 1881, 1887).

POLAR AND SUB-POLAR REGIONS. Boergesen, 1899A. *Faeroes* (Boergesen, 1899B, 1901A). *Greenland,* (Larsen, 1907A; Lauterborn, 1905). *Kerguel's Land* (Reinsch, 1876).

3. **S. dimorphus** (Turp.) Ktz. (Pl. XXV: Fig. 8. Pl. XXXII: Figs. 185–189. Pl. XXXIII: Figs. 190–195.)

Kützing, 1833, p. 608. de Brébisson, 1839, p. 271. Meneghini, 1840, p. 208. Hassall, 1845, p. 393; Pl. XCII, Fig. 13. Ralfs, 1845, p. 403; Pl. XII, Fig. 5. Ralfs, 1846, p. 160; Pl. XV, Fig. 5. Ralfs, 1848, p. 191; Pl. XXXI, Figs. 13A-13B. Grunow, 1858, p. 499. Zanardini, 1857, p. 250. Kirchner, 1878, p. 98. Artari, 1884, p. 133. Martel, 1887B, p. 11. Wolle, 1887, p. 173; Pl. CLVI, Figs. 18-21. Alexenko, 1888, p. 159. Heiden, 1889, p. 5. Riabinine, 1889B, p. 47. Webber, 1889, p. 1012. Chmielweski, 1890, p. 92. Alexenko, 1891, p. 62. Lemmermann, 1891, p. 148. Harvey, 1892, p. 119.. Weiss, 1892, p. 37. Franzé, 1893, p. 286. Jeliffe, 1893A, p. 243. Jeliffe, 1893B, p. 605; Pl. III, Fig. 35. Schröder, 1893, p. 72. Stokes, 1893, p. 51. Alexenko, 1894, p. 72. Jeliffe, 1894, p. 594. Alexenko, 1895, p. 92. Zacharias, 1898, p. 93. Iwanoff, 1899, p. 379. Jeliffe, 1899, p. 5. Balsamo, 1900, p. 266. Forti, 1902, p. 60. Snow, 1903, p. 391. Zacharias, 1903A, p. 213. Comère, 1904, p. 62. Moreto, 1904, p. 440. Skorikow, 1905, p. 105. Quelle, 1908, p. 43. Andrews, 1909, p. 379. Comère, 1911, p. 50.

Achnanthes dimorpha. Turpin, 1820, Fig. 2. Turpin, 1828, p. 313; Pl. XIII, Fig. 12.

Scenodesmus dimorphus. Kützing, 1849, p. 186. de Brébisson, 1856, p. 159. Conn and Webster, 1908, p. 35; Pl. IV. Fig. 42.

S. acutus var. *dimorphus.* Rabenhorst, 1868, p. 64; Fig. 34i. Cooke, 1882, p. 34; Pl. XIII, Fig. 6. de Wildemann, 1885, p. 123. Parfitt, 1886, p. 392. Beck, 1887, p. 274. Andersson, 1890, p. 5. W. West, 1891A, p. 248. W. West, 1892A, p. 194. W. West, 1892B, p. 738. Borge, 1894, p. 9. Fritsch, 1902, p. 582. Fritsch, 1903, p. 646. Fritsch, 1906, p. 205.

S. obliquus var. *dimorphus.* Hansgirg, 1886, p. 116. de Toni, 1889B, p. 567. Hansgirg, 1890A, p. 112. Lemmermann, 1893, p.

524. West and West, 1895, p. 83. Schröder, 1896, p. 46. Schröder, 1897A, p. 372. Schröder, 1897B, p. 487. Schröder, 1897C, p. 45. West and West, 1897B, p. 500. Schröder, 1898, p.24. Garbini, 1899A, p. 15. Levander, 1899, p. 70. Schröder, 1899, p. 22. Lagerheim, 1900, p. 10. Schorler, 1900, p. 5. West and West, 1901B, p. 119. Zykoff, 1902, p. 61. Volk, 1903, p. 104. Fink, 1905, p. 25. Hansgirg, 1905, p. 459. Huber, 1905, p. 57. Borge, 1907A, p. 58. Buchanan, 1907, p. 81. Migula, 1907, p. 658. Huber, 1908, p. 313. Collins, 1909, p. 169. Hayden, 1910, p. 44.

"Coenobiis 4–8–cellularibus; cellulis fusiformibus, utroque polo acutatis, ad 35 μ longis, circ. 8 μ latis, in seriem simplicem (?) arctissime conjunctis, medianis rectis, extimis vel lateralibus extrorsum lunulatis."

This species is frequently considered by some a variety of *S. obliquus*, while others consider the curving of the outer cells a normal variation of *S. obliquus* and consequently unworthy of naming. Since both the curving of the terminal cells and the acicular shape of all cells shows a greater resemblance to *S. acuminatus* (Lag.) Chod. than to *S. obliquus* the form might more properly be placed as a variety of *S. acuminatus*, but since the cultural work shows that this lunate shape of the outer cells is quite characteristic, I prefer to consider it a distinct species.

There is a great deal of variation in the strain of this species that I have isolated. The outer cells of the very young four-celled colonies rarely show the characteristic curving (Figs. 190, 195) but the erectness of the two median cells and the lunate character of the terminal cells is very pronounced in the mature colonies. (Figs. 185, 193, 194.) Certain of the largest colonies in the culture, however, do not show this curving as well but resemble *S. obliquus* (Figs. 186, 187). The arrangement of the cells in the four-celled colonies is always linear or sub-alternate.

The eight-celled colonies occur as frequently as do the four-celled ones. The cells in the eight-celled colonies are always arranged in a markedly alternate series, and never linear. This is in direct opposition to the general view expressed in previous descriptions, namely that the cells of the eight-celled colonies may be either in a linear or alternating arrangement. Although the terminal cells are lunate in these colonies as in the four-celled ones they do not appear so at first glance, due to the optical illusion caused by the alternate arrangement of the cells. (Figs. 189, 192.)

GEOGRAPHICAL DISTRIBUTION

EUROPE. *Austria-Hungary* (Alexenko, 1888, 1894, 1895; Beck, 1887; Grunow, 1858; Hansgirg, 1886, 1890A, 1905; Riabinine, 1889A, 1889B). *Belgium* (de Wildemann, 1885). *England* (Cooke, 1882; Fritsch, 1902, 1903, 1906; Hassall, 1845; Parfitt, 1886; Ralfs, 1845, 1846, 1848; W. West, 1891A, 1892B; West and West, 1897B, 1901B). *France* (de Brébisson, 1856; Comère, 1904, 1911; Turpin, 1820, 1828). *Germany* (Heiden, 1889; Kirchner, 1878; Lemmermann, 1891, 1893; Quelle, 1908; Schorler, 1900; Schröder, 1893, 1896, 1897A, 1897B, 1897C, 1898, 1899; Volk, 1903; Weiss, 1892; Zacharias, 1898, 1903A). *Ireland* (W. West, 1892A). *Italy* (Forti, 1902; Garbini, 1899A; Martel, 1887B; Moreto, 1904; Zanardini, 1857). *Russia* (Alexenko, 1891; Artari, 1884; Borge, 1894; Chmielweski, 1890; Iwanoff, 1899; Levander, 1899; Skorikow, 1905; Zykoff, 1902). *Sweden* (Andersson, 1890; Borge, 1907A). *Switzerland* (Huber, 1905, 1908).

AFRICA. *Madagascar.* (West and West, 1895).

ASIA AND OCEANIA. *Java* (Bernard, 1908).

AMERICA. *United States* (Andrews, 1909; Buchanan, 1907; Collins, 1909; Conn and Webster, 1908; Fink, 1905; Harvey, 1892; Hayden, 1910; Jeliffe, 1893A, 1893B, 1894, 1899; Stokes, 1893; Snow, 1903; Webber, 1889; Wolle, 1887).

4. **S. Bernardii** nov. spec. (Pl. XXV: Fig. 6. Pl. XXXII: Figs. 196–208).

S. obliquus forma *magnus* Bernard, 1908, p. 182, Fig. 420 (not Fig. 421).

Coenobia 2–8–cellularum. Cellulis fusiformibus saepe sigmoideis. Cellulis leniter alternis dispositis, polis cellularum solis lateraliter conjunctis. Long. cell. 17–8 μ. Lat. cell. 6–3 μ.

This alga was isolated in pure culture from the plankton of Lake Monona (Wisconsin). The loose alternate arrangement of the cells is quite similar to that of *S. obliquus* form *magnus* Bernard but the cells are much smaller. Since a *S. magnus* has been described the specific name *Bernardii* is given to the species.

In my cultures eight-celled colonies are fully as abundant as are four-celled. The terminal cells in these eight-celled colonies are lunate and frequently lie at an angle to the plane of the other cells, which are more often sigmoid than lunate. The terminal cells of the four-celled colonies show at times the same relationship to the colony as do the terminal cells of the eight-celled colonies (Figs. 203, 208) but at other times all the cells are in the same plane (Figs. 206, 209). The two median cells in these colonies come in contact with each other only in the middle portion but join the terminal cells by their apices.

The objection to recognizing this material as a distinct species might be raised on the grounds that the extreme polymorphism of *S. obliquus* has created a *Dactylococcus* stage and not a distinct species. The question of the *Dactylococcus* stage of *S. obliquus* has already been discussed. The fact that the cells in the cultures of *S. Bernardii* are always grouped definitely in twos, fours, or eights shows that we are dealing with a definitely organized coenobe and not an irregular branching system. There is also the further evidence that *S. obliquus* and *S. Bernardii* both retain their identity when grown under the same conditions of light, temperature, and chemical environment.

5. **S. acuminatus** (Lag.) Chodat (Pl. XXV: Figs. 3–5).

Chodat, 1902, p. 211. Lemmermann, 1904A, p. 40. Lemmermann, 1904C, p. 159. Hansgirg, 1905, p. 459. Lemmermann, 1905B, p. 158. Reinhardt, 1905, p. 26. Volk, 1905, p. 64. Lemmermann, 1907B, p. 411. Brunnthaler, 1907, p. 207. Schorler, 1907, p. 356. Selk, 1907, pp. 5, 57, 61, 64, 68, 73, 78, 79, 85, 91, 94, 98, 99, 103, 108, 112, 115. Tanner-Fullmann, 1907, pp. 122, 125, 132. Bachmann, 1908, p. 44. Bernard, 1908, p. 183; Pl. XIV, Fig. 422. Kolkowitz und Marsson, 1908, p. 93, 120. Marsson, 1909, pp. 547, 557, 559, 561. Marsson, 1911, p. 261, 263, 266, 275, 282, 285. Petersen, 1911, p. 160; Fig. 5. Conrad et Kufferath, 1912, p. 321. Brunnthaler, 1913, p. 165, 170; Fig. 2. Chodat, 1913, p. 22.

Selenastrum acuminatum Lagerheim, 1883, p. 71; Pl. III, Figs. 27-30. de Toni, 1889B, p. 596. Turner, 1892, p. 162; Pl. XX, Fig. 30. Marsson, 1901B, p. 96. Marsson, 1904, p. 146. Marsson, 1908B, p. 107, 111. Marsson, 1908A, p. 32, 40. *S. obliquus* var. *acuminatus* Playfair, 1912, p. 518, Pl. LVI, Fig. 8. *S. falcatus* Chodat, 1894, p. 625. de Wildemann, 1897A, p. 60. Chodat, 1900, p. 3. Chodat, 1901, p. 1309. Tanner-Fullmann, 1906, p. 158. Tanner-Fullmann, 1907, pp. 124, 125. *S. acuminatus* var. *biseriatus* Reinhardt, 1905, p. 26.

"*S.* familiis e cellulis quaternis constitutis, cellulis arcuatis vel falcatis, apicibus acuminatis; apicibus cellularum adultarum 30–40 μ inter se distantibus; crassitudo cellularum 6–7 μ."

The typical form was not isolated but one with smaller cells was.

GEOGRAPHICAL DISTRIBUTION

EUROPE. *Austria-Hungary* (Brunnthaler, 1907; Hansgirg, 1905; Reinhardt, 1905). *Belgium* (Conrad et Kufferath, 1912). *Denmark* (Chodat, 1900). *Germany* (Kolkowitz und Marsson, 1908; Lemmermann, 1905B, 1907B, 1908D; Marsson, 1901B, 1904, 1908A, 1908B, 1909, 1911; Schorler, 1907; Selk, 1907; Volk, 1905). *Sweden* (Lemmermann, 1904A; Petersen, 1911). *Switzerland* (Bachmann, 1908; Chodat, 1894, 1901, 1902; Tanner-Fullmann, 1906, 1907; de Wildemann, 1897A).

ASIA AND OCEANIA. *Australia* (Playfair, 1912). *India* (Turner, 1892). *Java* (Bernard, 1908). *Singapore* (Lemmermann, 1904C).

Var. **minor** nov. var. (Pl. XXIX: Figs. 70–74).

Cellulis brevioribus; apicibus cellularum 18, 20, 24, 25, 28 μ inter se distantibus. Lat. cell. 3.4, 4.5, 6 μ.

The arrangement of the cells of the colony in the variety *minor* is similar to that of the typical form described by Lagerheim. The cells are never in a plane but always form a curved surface which at times is semicircular. The alga was isolated from material which had originally been collected from the shore of a bay in Lake Monona (Wisconsin) but which had been standing in the laboratory for some time. The station was revisited several times but the alga was not found in nature. Several strains were isolated from this collection all showing the same general characteristics. The number of cells in the colony is always four, as described by Lagerheim for *S. acuminatus*, but the cells are more irregular in shape, being typically lunate (Figs. 70, 71) but occasionally sigmoid (Fig. 72). In this feature they show a striking similarity to the cells of *Ankistrodesmus*. The cells of the young colonies are very narrow but upon maturing increase in thickness without a corresponding increase in length. (Figs. 70 and 74.)

Var. **tetradesmoides** nov. var. (Pl. XXIX: Figs. 75–80.)

Dimens. cell. 11 x 2.5, 12.5 x 3, 15 x 3.5, 15 x 4 μ.

The organism was isolated from a collection of algae gathered from the east shore of Devil's Lake, Wisconsin. The cells are not as markedly lunate nor as long as those described by Lagerheim. The curve of the coenobe may be very slight (Fig. 75) or it may be so great that the cells form two parallel series (Fig. 76). All gradations between these two conditions can be found in my pure cultures.

Stages similar to that shown in Figure 76 appear to be identical with *Tetradesmus wisconsinensis* Smith; the cells of both are about the same size, but the cultural evidence of both Smith and Chodat shows that the cells of *T. wisconsinensis* are always arranged in two parallel series and never form a flat or curved surface. This condition is comparatively rare, however, in the form isolated since not more than five per cent of the colonies show a tendency toward an arrangement of cells in two parallel series. This variety is of interest from the phylogenetic standpoint since it forms a transition stage between *Tetradesmus* and *Scenedesmus.*

6. **S. antennatus** de Bréb. (Pl. XXVIII: Figs. 56, 58.)

de Brébisson in Ralfs, 1848, p. 222; Pl. XXXV, Figs. 27A-27B. de Brébisson 1856, p. 412. Rabenhorst, 1868, p. 65. Cooke, 1882, p. 43; Pl. XIII, Fig. 7. Lagerheim, 1883, p. 66. de Toni, 1889B, p. 567. W. West, 1889A, p. 290. Roy, 1890, p. 338. W. West, 1892A, p. 194. W. West, 1892B, p. 738. de Wildemann, 1893A. West and West, 1897B, p. 500. Nitardy, 1898, p. 104. Balsamo, 1900, p. 266. West and West, 1901B, p. 119. West and West, 1902B, p. 64. Fournier, 1903, p. 28. Nitardy, 1904, p. 318. Selk, 1907, p. 5. Adams, 1908, p. 35. Gutwinski, 1909, p. 435. Comère, 1911, p. 50. Chodat, 1913, p. 18. Brunnthaler, 1913, pp. 166, 170; Fig. 4.

Scenodesmus antennatus. de Brébisson, 1856, p. 160. Archer, 1861, p. 753.

"Cellulis fusiformibus, 2–4–8 in seriem simplicem vel duplicem conjunctis, omnibus sublunulatis, plerumque ventricoses, utroque polo cuspidatis, apice globulum hyalinum gerentibus. Dimens. cell. 12–13 x 2.5–4 μ."

I am of the opinion that many of the recorders of this species had it confused with *S. obliquus* (Turp.) Ktz. In examining material with the lower powers of the microscope colonies of fusiform cells with globules on the ends are sometimes found but upon applying a magnification of 1000 diameters or over, this globule on the end disappears and the colony is found to be *S. obliquus*. Since many workers do not use a magnification of over 500 diameters, it is very probable that some have fallen into this error. The nearest approach to *S. antennatus* that I have seen is shown in Figure 58. In view of the fact that *S. antennatus* has been reported by certain of the more careful investigators, it seems very likely that the species exists and should be recognized.

GEOGRAPHICAL DISTRIBUTION

EUROPE. *Austria-Hungary* (Gutwinski, 1909). *England* (Cooke, 1882; Roy, 1890; W. West, 1889A, 1892B; West and West, 1897B, 1901B). *France* (de Brébisson, 1848, 1856; Fournier, 1903; Comère, 1911). *Germany* (Nitardy, 1898, 1904; Selk, 1907). *Ireland* (Adams, 1908; W. West, 1892A; West and West, 1902B).

7. **S. incrassatulus** Bohlin. (Pl. XXV: Figs. 9–10.)

Bohlin, 1897, p. 24; Pl. I, Figs. 45-51. Chodat, 1902, p. 211; Fig. 131. West and West, 1907, p. 229; Pl. XIII, Fig. 26. Brunnthaler, 1913, p. 166; Fig. 3.

"Sc. vel cellulis singulis vel cellulis in coenobia quaternis (nonnumquam binis) conjunctis, aut seriem rectam formantibus, aut subalternatim dispositis. Cellulis fusiformibus subacutis, binis mediis leniter, binis lateralibus magis curvatis, dorso convexis ventra rectis vel concavis. Membrana tenui, in apice incrassatula."

Dimens. cell. 17 x 5, 21 x 6, 23 x 5, 28 x 7, 24 x 8 μ.

GEOGRAPHICAL DISTRIBUTION

Brazil (Bohlin). *Burma* (West and West).

var. **Mononae** nov. var. (Pl XXIX: Figs. 81–83.)

Cellulis ovatioribus, minoribus. Dimens. cell. 11 x 3.5, 12 x 4, 12 x 4.5 μ.

I have isolated this alga but once, the source of the material being near the outlet of Lake Monona, Wisconsin. The cells have the characteristic concavity on the side towards the colony and the convexity on the other side. In my pure cultures, I have found the cells arranged in a linear series, but no marked alteration in them, while the terminal bulb is not very pronounced. The cells are much smaller than those of Bohlin, the largest measuring but 12 x 4.5 μ. The differences in both shape and size of the cells warrants the establishing of a new variety.

8. S. bijuga (Turp.) Lag. (Pl. XXV: Fig. 2.)

Lagerheim, 1893, p. 158. Lagerheim, 1900, p. 10. Borge, 1907A, p. 57. Borge, 1907B, p. 4. Collins, 1909, p. 168. Hayden, 1910, p. 44. Klugh, 1911, p. 97. Klugh, 1912, p. 115. Borge, 1913, p. 60.

Achnanthes bijuga. Turpin, 1828, p. 310; Pl. XIII, Fig. 4.

Achnanthes quadrijuga. Turpin, 1820, Fig. 6. Turpin, 1828, p. 310; Pl. XIII, Fig. 5.

Achnanthes quadralterna. Turpin, 1820, Fig. 8. Turpin, 1828, p. 311; Pl. XIII, Fig. 7.

Achnanthes octalterna. Turpin, 1820, Fig. 12. Turpin, 1828, p. 312; Pl. XIII, Fig. 8.

Bacillaria viridis. Leiblein, 1830, p. 316; Pl. I, Fig. 3.

S. obtusus. Meyen, 1829, p. 775; Pl. XLIII, Figs. 30-31. Meneghini, 1840, p. 209. Hassall, 1845, p. 393; Pl. XCII, Fig. 15. Ralfs, 1845, p. 404; Pl. XII, Fig. 8. Ralfs, 1846, p. 162; Pl. XV, Fig. 8. Ralfs, 1848, p. 193; Pl. XXXI, Figs. 16A-16C. Bailey, 1851, p. 29. Bailey, 1855, p. 12. Griffith and Henfrey, 1856, p. 656; Pl. X, Figs. 53-54. Archer, 1857, p. 40. Zanardini, 1857, p. 250. Grunow, 1858, p. 499. Reinsch, 1867, p. 80. Rabenhorst, 1868, p. 63; Figs. 34D-34E. Hohenbühel-Heufler, 1871, p. 318. Rostrop, 1871, p. 90. Olney, 1872, p. 135. Wittrock, 1872, p. 31. Archer, 1874, p. 329. Wood, 1874, p. 90. Kirchner, 1878, p. 98. Oudemans, 1879. Wille, 1879, p. 30. Cienowsky, 1881, p. 304. Wolle, 1881, p. 213. Cooke, 1882, p. 33; Pl. XIII, Fig. 5. Nordstedt, 1882, p. 46. Spencer, 1882, p. 296. Griffith and Henfrey, 1883, p. 679; Pl. XIV, Figs. 53-54. Artari, 1884, p. 132. Hansgirg, 1884A, p. 9. Boldt, 1885, p. 97. Griffith and Henfrey, 1885, p. 686; Pl. X, Figs. 53-54. Pâque, 1885, p. 52. Parfitt, 1886, p. 392. Beck, 1887, p. 274. Bennett, 1887, p. 9. Martel, 1887A, p. 340. Martel, 1887B, p. 11. de Toni et Levi, 1887, p. 1584. Alexenko, 1888, p. 158. Balsamo, 1888, p. 40. Bennett, 1888, p. 2. Harvey, 1888, p. 157. König,1888, p. 89. Loitlesberger, 1888, p. 224. Nordstedt, 1888, p. 19. W. West, 1888, p. 748. Heiden, 1889, p. 5. Riabinine, 1889A, p. 302. Riabinine, 1889B, p. 46. de Toni, 1889A, p. 70. Webber, 1889, p. 1012. W. West, 1889A, p. 290. Andersson, 1890, p. 5. Chmielweski, 1890, p. 92. Roy 1890, p. 338. W. West, 1890, p. 298. de Wildemann, 1890B, p.

155. Alexenko, 1891, p. 61. Beyerinck, 1891, p. 279. Ianouchkievitch, 1891, p. 289. Bennett, 1892, p. 5. Turner, 1892, p. 161. Weiss, 1892, p. 36. Franzé, 1893, p. 286. Schröder, 1893, p. 72. Stokes, 1893, p. 52. Alexenko, 1894, p. 72. Borge, 1894, p. 9. Alexenko, 1895, p. 93. Schröder, 1897A, p. 372. Schröder, 1897B, p. 487. Wille, 1897, p.26. Forti, 1898, p.118. Nitardy, 1898, p. 104. Zacharias, 1898, p. 93. Forti, 1899, p. 89. Iwanoff, 1899, p. 379. Marquand, 1901, p. 321. Balsamo, 1900, p. 266. Neuweiler, 1901, p. 45; Pl. III, Figs. 6-8. Larder, 1902, p. 59. Schmidle, 1902, p. 242. Volk, 1903, p. 103. Zacharias, 1903B, pp. 254, 262. Comère, 1904, p. 62. Dorogoslaisky, 1904, p. 224. Früh und Schröder, 1904, p. 364. Marquand, 1904, p. 269. Nitardy, 1904, p. 318. Schmidle, 1904, p. 30. Stadler, 1905, p. 236. Suhr, 1905, p. 252. Petkoff, 1906A, p. 359. Brown, 1908, p. 247. Quelle, 1908, p. 43. Andrews, 1909, p. 379. Chodat, 1909, p. 101; Pl. VII, Fig. F; Pl. XIII, Fig. C. Honigmann, 1909, p. 54. Smith, 1914A, p. 292; Pl. XVI, Figs. 24-42.

S. bijugatus. Kützing, 1833, p. 607. de Brébisson, 1839, p. 271. Lagerheim, 1883, pp. 60, 65. Wille, 1884, pp. 10, 30, 45. Hansgirg, 1886, p. 114; Fig. 61. Hansgirg, 1889, p. 132. de Toni, 1889B, p. 563. Hansgirg, 1890A, p. 111. Gutwinski, 1891, p. 302. Hansgirg, 1891, p. 317. Lemmermann, 1891, p. 148. W. West, 1891B, p. 421. Hansgirg, 1892B, p. 119. W. West, 1892A, p. 193. Lemmermann, 1893, p. 523. Möbius, 1894, p. 330. Schmidle, 1893A, p. 13. Schmidle, 1894, p. 43. Borge, 1895, p. 6. Lemmermann. 1895A, p. 41. West and West, 1895, p. 82. Boergesen, 1896, p. 36. Borge, 1896, p. 7. Lemmermann, 1896, p. 108. Zacharias, 1896, p. 76. Bohlin, 1897, p. 22. Farlow in Trelease, 1897, p. 196. Lemmermann, 1897, p. 108. Schröder, 1897C, p. 45. Strohmeyer, 1897, p. 6. West and West, 1897B, p. 500. Lemmermann, 1898A, p. 191. Mez, 1898, p. 149. Schröder, 1898, p. 23. Boergesen, 1899A, p. 135. Borge, 1899, p. 7. Garbini, 1899A, p. 15. Lemmermann, 1899, p. 112. Levander, 1899, pp. 49, 54, 63, 70, 80, 90, 93, 100. Marsson, 1899, p. 102. G. S. West, 1899, p. 220. Chodat, 1900, p. 3. Filarsky, 1900, p. 145. Lemmermann, 1900A, p. 68. Levander, 1900, p. 7. Schmidle, 1900C, p. (141). Schorler, 1900, p. 5. Boergesen, 1901A, p. 240. Borge, 1901B, p. 13. Dalla Torre und von Sarnthein, 1901, p. 34. Fanning, 1901, p. 617; Pl. XLV, Fig. 4. Marsson, 1901A, pp. 96, 101. Marsson, 1901B, p. 96. West and West, 1901A, p. 196. West and West, 1901B, p. 119. Wille, 1901, p. 11. Blumentritt, 1902, p. 86. Bohlin, 1902, p. 43. Gutwinski, 1902, p. 576. Riddle, 1902, p. 317. West and West, 1902, p. 181. West and West, 1902B, p. 63. Forti, 1902, p. 60. Boergesen and Ostenfeld, 1903, p. 615. Hansgirg, 1903, p. 1. Pascher, 1903, p. 175. Snow, 1903, p. 391. W. West, 1903, p. 100. Heering und Homfeld, 1904, p. 84. Lemmermann, 1904A, pp. 39, 71, 92, 158. G. S. West, 1904B, p. 220; Fig. 92C. West and West, 1904, p. 531. Hansgirg, 1905, p. 457. Huber, 1905, p. 57. Lemmermann, 1905B, p. 160. Lemmermann, 1905C, pp. 167, 168. Riddle, 1905, p. 268. Trotter, 1905, p. 45; Fig. 18. Volk, 1905, p. 64. West and West, 1905, p. 30. Hardy, 1906, p. 38. Pascher, 1906, p. 168. Ruttner, 1906, p. 10. Schorler, Thallwitz, und Schiller, 1906, p. 247. West and West, 1906A, p. 489. Buchanan, 1907, p. 81. Huber, 1907, p. 455. Larsen, 1907A, p. 358. Lauterborn, 1907, p. 123. Migula, 1907, p. 657; Pl. XXXII, Fig. 32; Pl. XXXV K, Fig. 10. Lemmermann, 1907B, p. 412. Selk, 1907, pp. 5, 57, 64, 73, 94, 98, 103, 112, 115. Teodoresco, 1907, p. 129. G. S. West, 1907, p. 138. West and West, 1907, p. 229. Adams, 1908, p. 35. Bernard, 1908, p. 183; Pl. XIV, Figs. 423-424. Huber, 1908, p. 313. Kolkowitz und Marsson, 1908, p. 514. Lemmermann, 1908A, p. 167. Marsson, 1908B, pp. 95, 120. Schneider, 1908, p. 46. Adams, 1909, p. 186. Bernard, 1909, p. 77; Pl. VI, Figs. 162-163. Borge, 1909, p. 16. Eyferth, 1909, p. 116. Gutwinski, 1909, p. 434. Honigmann, 1909, p. 54. G. S. West, 1909A, p. 16, 29. West and West, 1909A, p. 140. West and West, 1909B, p. 184. Ostenfeld, 1909, p. 174. Gugliemetti, 1910, p. 31. Kofoid, 1910, p. 31. Bachmann, 1911, p. 191. Comère, 1911, p. 51. Marsson, 1911, pp. 283, 285, 286. Conrad et Kufferath, 1912, p. 321. Griffith, 1912, p. 11. Brunnthaler, 1913, pp. 169, 171. Hardy, 1913, p. 93. Migula (no date) p. 37; Pl. IV, Fig. 6.

S. trijugatus. Kützing, 1833, p. 607; Fig. 97. de Brébisson, 1839, p. 271. Balsamo, 1900, p. 267.

S. Leibleinii. Kützing, 1833, p. 607; Fig. 98. Meneghini, 1840, p. 207. Balsamo, 1900, p. 266.

S. octalternus. Kützing, 1833, p. 609; Fig. 95. Balsamo, 1900, p. 266.

S. quadralternus. Kützing, 1833, p. 608; Fig. 94. de Brébisson, 1839, p. 271. Balsamo, 1900, p. 266.

Scenodesmus obtusus. Ehrenberg, 1834, p. 310. Kützing, 1845, p. 139. Kützing, 1849, p. 185. Nägeli, 1849, p. 91; Pl. V, Figs. A-1-a to A-1-m. Rabenhorst, 1850, p. 517. de Brébisson, 1856, p. 160. Archer, 1861, p. 753: Pl. I, Figs. 37-39. Kirchner, 1891, p. 18. Conn and Webster, 1908, p. 35; Pl. VI, Fig. 38.

Scenodesmus quadricauda var. *ecornis.* Ehrenberg, 1834, p. 311.

Arthrodesmus quadricaudatus ecornis. Ehrenberg, 1836.

S. quadrialternans var. *octalternus.* de Brébisson, 1839, p. 271.

S. quadrijugatus. de Brébisson, 1839, p. 271. Bailey, 1855, p. 12.

S. quadrijugatus var. *minor.* de Brébisson in Meneghini, 1840, p. 207.

S. quadricaudatus var. *ecornis.* Ralfs, 1845, p. 402; Pl. XII. Fig. 4C. Hassall, 1845, p. 392. Ralfs, 1846, p. 159; Pl. XV, Fig. 4C. Snow, 1903, p. 391.

S. quadricauda var. *ecornis.* Ralfs, 1848, p. 190; Pl. XXXI, Figs. 12H-12I. Schaarschmidt, 1884, p. 249. Parfitt, 1886, p. 392. Nordstedt, 1888, p. 19. Balsamo, 1900, p. 266. Dalla Torre und von Sarnthein, 1901, p. 35. Petkoff, 1906A, p. 358.

Scenodesmus caudatus var. *ecaudatus*. Kützing, 1849, p. 186.
Scenodesmus obtusus var. *binarius*. Kützing, 1849, p. 185.
Scenodesmus obtusus var. *biternarius*. Kützing, 1849, p. 185.
Scenodesmus obtusus var. *quaternarius*. Kützing, 1849, p. 185.
Scenodesmus obtusus var. *obliquus*. Kützing, 1849, p. 185.
Scenodesmus obtusus var. *ternarius*. Kützing, 1849, p. 185.
Scenodesmus obtusus var. *octonarius*. Kützing, 1849, p. 185.
Scenodesmus obtusus var. *alternans*. Kützing, 1849, p. 185.
Scenodesmus obtusus var. *obliquus duplex*. Kützing, 1849, p. 185.

Scenodesmus obtusus var. *Leibleinii*. de Brébisson, 1856, p. 160.

S. obtusus var. *ecornis*. Franzé, 1892, p. 149; Pl. III, Figs. 4, 13-14. de Wildemann, 1897C, p. 78.

S. variabilis var. *ecornis*. de Wildemann, 1893A. de Wildemann, 1893B, p. 91. Schmidle, 1895, p. 305. de Wildemann, 1895, p. 26. de Wildemann, 1897A, p. 60. de Wildemann, 1897B p. 49. de Wildemann, 1899, p. 11. Schmidle, 1900B, p. 126. Schmidle, 1902B, p. 125. Fournier, 1903, p. 28. Schodduyn, 1909, p. 166.

S. bijugatus var. *seriatus*. Chodat, 1902, p. 212. Migula, 1907, p. 658. Brunnthaler, 1913, pp. 169, 172.

S. obtusus var. *seriatus*. Reinhardt, 1905, p. 26.

S. bijugatus forma *seriatus*. Volk, 1905, p. 64. Larsen, 1907B, p. 104.

Steinella Graevenitzii. Bernard, 1908, p. 189; Pl. XIV, Figs. 463-466.

"Coenobiis 4–8 cellularibus; cellulis oblongo-ellipticis vel ovatis, utroque polo obtuso-rotundatis, aculeis carentibus, 7–18 x 4–7 (raro 10) μ, in seriem simplicem, rectam vel obliquam arcte laxeve conjunctis."

A well known species which I have not obtained in pure culture. The cells of several cultures which at first appeared to be *S. bijuga* were found on closer examination to have small spines on the ends, and it is probable that various investigators who have reported the species have failed to note these horns on coenobes with obtuse cells and so called the species *S. bijuga*. I have found the species fairly abundant in nature in this vicinity and can not explain why I have been unable to obtain it in pure culture.

The cells are arranged in either a linear or sub-alternating series. A strain was isolated with the cells constantly in two series, a condition which is found in nature and regarded by many as a normal variation of *S. bijuga* but I prefer to consider this as a variety (*platydisca*) of *S. arcuatus* Lemm., the reasons for which are given in the discussion of that species.

GEOGRAPHICAL DISTRIBUTION

EUROPE. *Austria-Hungary* (Alexenko, 1888, 1894, 1895; Beck, 1887; Blumentritt, 1902; Filarsky, 1900; Franzé, 1892, 1893; Grunow, 1858; Gutwinski, 1909; Hansgirg, 1884A, 1886, 1889, 1890A, 1891, 1892B, 1905; Ianouchkievitch, 1891; Loitlesberger, 1888; Pascher, 1903, 1906; Reinhardt, 1905; Riabinine, 1889A, 1889B; Ruttner, 1906; Stadler, 1905). *Belgium* (Conrad et Kufferath, 1912; Pâque, 1885; de Wildemann, 1890B, 1893B; 1895, 1897B). *Bulgaria* (Petkoff, 1906). *Denmark* (Chodat, 1900; W. West, 1891B). *England* (Bennett, 1887, 1888, 1892; Cooke, 1882; Griffith, 1912; Hassall, 1845; Larder, 1902; Marquand, 1901, 1904; Parfitt, 1886; Ralfs, 1845, 1846, 1848; Roy, 1890; G. S. West, 1899, 1904B; W. West, 1888, 1889A, 1890, 1892B, 1897B; West and West, 1901B, 1909A, 1909B). *France* (de Brébisson, 1856; Comère, 1904, 1911; Fournier, 1903; Schodduyn, 1909; Turpin, 1820, 1828). *Germany* (Ehrenberg, 1834; Eyferth, 1909; Heering und Homfeld, 1904; Heiden, 1889; Honigmann, 1909; Kirchner, 1878; Kolkowitz und Marsson, 1908; König, 1888; Kützing, 1845; Lauterborn, 1907; Leiblein, 1830; Lemmermann, 1891, 1893, 1895A, 1896, 1897, 1898A, 1899, 1901A, 1905B, 1905C, 1907B; Marsson, 1899, 1901A, 1901B, 1908B, 1911; Meyen, 1829; Migula, 1907; Nitardy, 1898, 1904; Quelle, 1908; Schmidle, 1893A, 1894; Schneider, 1908; Schorler, 1900; Schorler, Thallwitz und Schiller, 1906; Schröder, 1893, 1897A, 1897B, 1897C, 1898; Strohmeyer, 1897; Selk, 1907; Volk, 1903, 1905; Weiss, 1892; Zacharias, 1896, 1898, 1903B). *Holland* (Beyerinck, 1891; Oudemans, 1879). *Ireland* (Adams, 1908, 1909; Archer, 1857; W. West, 1892A; West and West, 1902B, 1909B). *Italy* (Balsamo, 1888; Forti, 1898, 1899, 1902; Garbini, 1899A; Gugliemetti, 1910; Hohenbühel-Heufler, 1871; Martel, 1887A, 1887B; Meneghini, 1840; Rabenhorst, 1850; de Toni, 1889A; de Toni et Levi, 1887; Trotter, 1905; Zanardini, 1857). *Montenegro* (Schmidle, 1900B, 1902B). *Norway* (Wille, 1901). *Roumania* (Teodoresco, 1907). *Russia* (Alexenko, 1891; Artari, 1884; Borge, 1894; Chmielweski, 1890; Cienowsky, 1881; Dorogoslaisky, 1904; Gutwinski, 1891; Iwanoff, 1899; Levander, 1899, 1900; Wille, 1879). *Scotland* (W. West, 1903; West and West, 1904, 1905, 1906A, 1909B). *Sicily* (Lemmermann, 1908A). *Sweden* (Andersson, 1890; Borge, 1895, 1907A, 1913; Lagerheim, 1883; Lemmermann, 1904A). *Switzerland* (Chodat, 1902, 1909; Dalla Torre und von Sarnthein, 1901; Früh und Schröter, 1904; Huber, 1905, 1907, 1908; Neuweiler, 1901; Schmidle, 1895; de Wildemann, 1897A).

AFRICA. *Abyssinia* (Lagerheim, 1893). *Azores* (Archer, 1874; Bohlin, 1902; Farlow in Trelease, 1897). *Madagascar* (West and West, 1895). *Lake Nyassa* (Schmidle, 1902; G. S. West, 1907).

Lake Rukuga (Schmidle, 1904). *Lake Tanganyika* (G. S. West, 1907). *Lake Victoria Nyanza* (Ostenfeld, 1909).

ASIA AND OCEANIA. *Afghanistan* (Schaarschmidt, 1884). *Australia* (Borge, 1896, 1911; Hardy, 1906, 1913; Möbius, 1894; G. S. West, 1909A). *Burma* (West and West, 1907). *Central Asia* (Schmidle, 1900C). *Ceylon* (West and West, 1901A). *East Indies* (Hansgirg, 1903). *India* (Turner, 1892). *Java* (Bernard, 1908; Gutwinski, 1902; de Wildemann, 1897C, 1899). *Johore* (Bernard, 1909). *New Zealand* (Nordstedt, 1888; Spencer, 1882). *Siam* (West and West, 1902). *Siberia* (Boldt, 1885).

AMERICAS. *Argentina* (Borge, 1899; Nordstedt, 1882; Wille, 1884). *Bolivia* (Borge, 1907B). *Brazil* (Bohlin, 1897; Wille, 1884). *Canada* (Klugh, 1911, 1912). *Montevidio* (Wille, 1884). *Pategonia* (Borge 1901B). *Paraguay* (Bohlin, 1897). *United States* (Andrews, 1909; Bailey, 1851, 1855; Borge, 1909; Brown, 1908; Buchanan, 1907; Collins, 1909; Conn and Webster, 1908; Fanning, 1901; Harvey, 1888; Hayden, 1910; Kofoid, 1910; Olney, 1872; Riddle, 1902, 1905; Smith, 1914A, 1914B; Snow, 1903; Stokes, 1893; Webber, 1889; Wolle, 1881, 1887; Wood, 1874).

POLAR AND SUB-POLAR REGIONS. Boergesen, 1899A. *Faeroes* (Boergesen, 1901A; Boergesen and Ostenfeld, 1903; Rostrup, 1871; Wille, 1897). *Greenland* (Boergesen, 1896; Larsen, 1907A, 1907B).

Var. **flexosus** (Lemm.) Collins. (Pl. XXV: Fig. 16.)

Collins, 1909, p. 168.

S. bijugatus var. *flexosus.* Lemmermann, 1898A, p. 191; Pl. V, Fig. 1. Lemmermann, 1899, p. 112. Lemmermann, 1900A, p. 95. Schmidle, 1900A, p. (111). Lemmermann, 1902, p. (251). Snow, 1903, pp. 375, 391; Pl. I, Fig. 4. Lemmermann, 1904A, p. 27. Lemmermann, 1905C, p. 167. Migula, 1907, p. 658; Pl. XXXV L, Fig. 6. Lemmermann, 1910A, pp. 294, 308. Lemmermann, 1910B, p. 332. Brunnthaler, 1913, pp. 169, 172; Fig. 26.

Coenobia 8–32 cellularum. Cellulis in leniter flexile spira dispositis. Long. cell. circa 17 μ. Lat. cell. 8 μ.

The cultural work of Miss Snow showing that a form exists in which there are normally 16–32 cells arranged in a loose spiral gives good grounds for the recognition of this variety.

GEOGRAPHICAL DISTRIBUTION

Germany (Lemmermann, 1898A, 1899, 1900A, 1902, 1905C; Schmidle, 1900A). *Paraguay* (Lemmermann, 1910A). *Sweden* (Lemmermann, 1904A, 1910B). *United States* (Collins, 1909; Snow, 1903).

Var. **minor** (Hansg.) nov. comb.

S. bijugatus var. *minor*. Hansgirg, 1886, p. 115. de Toni, 1889B, p. 564. Blumentritt, 1902, p. 86. Hansgirg, 1905, p. 457. Migula, 1907, p. 658.
S. bijugatus forma *minor*. Pascher, 1903, p. 175.
S. obtusus var. *minor*. Volk, 1903, p. 103.

Coenobiis 8–cellularum, 40–45 x 18 μ; cellulis ellipticis vel ovoidis, 10–12 x 6–9 μ; ceterum ut in var alternanti.

The cultural work of Chodat has shown that varieties may be distinguished in *S. bijuga* on the basis of cell size.

GEOGRAPHICAL DISTRIBUTION

Austria-Hungary (Hansgirg, 1886, 1905; Migula, 1907; Pascher, 1903). *Germany* (Volk, 1903). *Switzerland* (Blumentritt, 1902).

Var. **obtusiusculus** (Chodat) nov. comb.

S. obtusiusculus Chodat, 1913, p. 47; Figs. 24–34.
Dimens. cell. 7–5 μ, 6–3 μ.

Var. **alternans** (Reinsch) Borge. (Pl. XXV: Figs. 14–15.)

Borge, 1907A, p. 57. Collins, 1909, p. 168. Borge, 1913, p. 60.
S. alternans. Reinsch, 1866, p. 135; Pl. XX, Fig. D5. Reinsch, 1867, p. 81; Pl. VI, Fig. 3. Lagerheim, 1883, p. 65. Lagerheim, 1883B, p. 70. Lagerheim, 1887, p. 194. W. West, 1892A, p. 193. W. West, 1892B, p. 738. West and West, 1897B, p. 500. G. S. West, 1899, p. 221. Balsamo, 1900, p. 266. West and West, 1902B, p. 63. Snow, 1903, p. 391. W. West, 1903, p. 100. Adams, 1908, p. 35.
S. bijugatus var. *alternans*. Hansgirg, 1886, p. 114. de Toni, 1889B, p. 6. Lemmermann, 1893, p. 523. Schmidle, 1894, p. 43. Borge, 1895, p. 6. Bohlin, 1897, p. 22. Lemmermann, 1899, p. 112. Dalla Torre und von Sarnthein, 1901, p. 35. Chodat, 1902, p. 212. Bohlin, 1902, p. 43. Schmidle, 1903, p. 80. Lemmermann, 1904A, p. 39. Schmidle, 1904, pp. 4, 30, 32. Schmidle, 1904B, p. 7. Hansgirg, 1905, p. 457. Huber, 1905, p. 57. Volk, 1905, p. 64. Migula, 1907, p. 658; Pl. XXXV (K), Fig. 8. Huber, 1908, p. 313. Marsson, 1911, p. 263. Brunnthaler, 1913, pp. 169, 172; Fig. 25.
Selenastrum alternans. Weiss, 1892, p. 37.
S. bijugatus forma *alternans*. Pascher, 1903, p. 175.
S. obtusus var. *alternans*. Volk, 1903, p. 103. Reinhardt, 1905, p. 26.

"Cellulae omnes aequales late ellipticae usque ovato-ellipticae, cellularum poli rotundati, cellularum diameter transversalis duae partes diametri longitudinalis; familae plerumque ex cellulis octonis constitutae, cellalue singulae laterale accumbentes, perfecte alternates."

"Cellulae. longit. 13–16 μ; cellulae latit. 10–13 μ."

The typical fom of *S. bijuga* is known to have the cells arranged subalternately at times but the isolating of a strain where the cells are constantly arranged in an alternate position warrants the retention of the variety *alternans*. It is very probable, however, that in many cases the typical *S. bijuga* has been called *S. bijuga* var. *alternans*.

GEOGRAPHICAL DISTRIBUTION.

EUROPE. *Austria-Hungary*. (Hansgirg, 1886, 1905; Pascher, 1903; Reinhardt, 1905). *England* (G. S. West, 1899; W. West, 1892B; West and West, 1897B). *France* (Reinsch, 1866, 1867). *Germany* (Lemmermann, 1893, 1899; Marsson, 1911; Schmidle, 1894; Volk, 1903, 1905; Weiss, 1892). *Ireland* (Adams, 1908; W. West, 1892A; West and West, 1902B). *Scotland* (W. West, 1903). *Sweden* (Borge, 1895, 1907A, 1913; Lagerheim, 1883B; Lemmermann, 1904A). *Switzerland* (Chodat, 1902; Dalla Torre und von Sarnthein, 1901; Huber, 1905, 1908).

AFRICA. *Azores* (Bohlin, 1902). *Lake Nyassa* (Schmidle, 1903, 1904). *Lake Rukuga* (Schmidle, 1904).

AMERICAS. *Brazil* (Bohlin, 1897). *Paraguay* (Bohlin, 1897). *Puerto Rico* (Collins, 1909; Lagerheim, 1887). *United States* (Collins, 1909; Snow, 1903).

Var. **alternans** forma **parvus** nov. forma. (Pl. XXX: Figs. 106–108.)

Dimens. cell. 8–9 μ x 3.5–4 μ.

The cells of this strain isolated never reach the minimal dimensions as given by Reinsch so it is regarded as a form of *S. bijuga* var. *alternans*.

Var. **irregularis** (Wille) nov. comb. (Pl. XXVIII: Figs. 59–62.)

S. bijugatus forma *irregularis*. Wille, 1903, p. 92; Fig. 4.

Cellulis irregulariter dispositis in seriem duplicem aut alternatim. Dimens. cell. 10 x 6, 10 x 5, 8 x 4, 7.5 x 3.5 μ.

I have isolated this variety several times. The coenobia usually contain eight cells, arranged in an irregular double series, although four-celled coenobia where the cells are frequently alternate are not rare. The arrangement of the cells in a linear series is never found in this variety. The dimensions of the cells agree very well with those given by Wille.

9. **S. curvatus.** Bohlin. (Pl. XXVI: Figs. 17–18.)

Bohlin, 1897, p. 23; Pl. I, Figs. 41-44, 52. Chodat, 1901, p. 1309. Marsson, 1901A, p. 115. Chodat, 1902, p. 212; Figs. 132A-132F. Volk, 1905, p. 64. Fritsch, 1906, p. 205. Migula, 1907, p. 658; Pl. XXXV (L), Fig. 3. Brunnthaler, 1913, pp. 169, 171; Fig. 22.

"Sc. coenobiis e 8 (nonnumquam 4) cellulis in seriem duas, alternantes conjunctis, ad basim brevitor cohaerentibus, interstitia latitudini cellularum similia formantibus. Serie cellularum in orbem tres partes peripheriae circuli efficientem curvata. Cellulis subcylindricis, obtusis, in centrum coenobii leniter curvatis, chlorophoris singulo, pyrenoida singula includentis. Dimens. cell. 12–30 x 4–10 μ."

The cell arrangement forming about three-fourths of a cylinder, gives a very characteristic appearance to the coenobe, while the angular compression where the cells join one another makes a further difference between *S. curvatus* and *S. bijuga* var. *alternans* (Reinsch) Borge.

GEOGRAPHICAL DISTRIBUTION

England (Fritsch, 1906). *Germany* (Marsson, 1901A, Volk, 1905). *Paraguay* (Bohlin, 1897). *Switzerland* (Chodat, 1901, 1902).

10. **S. arcuatus.** Lemm. (Pl. XXVI: Figs. 19–20; Pl. XXIX: Figs. 94–98; Pl. XXX: Figs. 99–100.)

Lemmermann, 1899, p. 112; Pl. I, Figs. 2-4. de Toni et Forti, 1899A, p. 179. de Toni et Forti, 1899B, p. 791. West and West, 1900, p. 298. Lemmermann, 1904A, p. 158. Lemmermann, 1905B, p. 158, 162. Reinhardt, 1905, p. 26. Lemmermann, 1907B, p. 411. Migula, 1907, p. 658. Lemmermann, 1908A, p. 167. Marsson, 1908B, p. 116. Gugliemetti, 1910, p. 32. Lemmermann, 1910A, pp. 294, 298. Marsson, 1911, pp. 263, 286. Brunnthaler, 1913, pp. 169, 171; Fig. 23.

S. bijugatus var. *arcuatus.* Lemmermann, 1898B, p. 159. Lemmermann in Marsson, 1899, p. 172. Schmidle, 1900, p. (111). West and West, 1906B, p. 105; Pl. X, Figs. 12-14.

S. bijugatus forma *arcuatus*. G. S. West, 1907, p. 138. West and West, 1909B, p. 184.

Coenobia 4–16 cellularum, saepe 8. Coenobis curvatis planis, cum parvis foraminibus inter cellulas; cellulis in series duas, oblongi-ovatis vel sub-angulatis. Dimens. cell. 9 x 5, 8.5 x 6, 12 x 8, 15 x 9 μ.

This species was isolated from a plankton catch from Lake Mendota, Wisconsin. For the past five years this alga has been found occasionally during the summer months at this station, but nowhere else in this locality. The measurements of the cells as given by Lemmermann, 7–8 μ broad and 13–6 μ long, agree very well with the dimensions of the mature cells both in my pure cultures, and in the field.

The arrangement of the cells in the characteristically curved surface is quite striking and persits in the pure culture grown in both agar and liquid media. Surface views (Figs. 97, 99, 100) show this well but an end view of a colony (Fig. 95) bring it out even more strongly. Generally the cells are in two symmetrically arranged series with small angular interstices between them (Fig. 99), but irregularities occasionally appear (Fig. 94). A normal colony contains eight cells; very few have four cells (Fig. 96), and although colonies of sixteen cells are reported by Lemmermann I have neither found them in nature, nor in my pure cultures.

The systematic position of the form is a matter of dispute. It was first described by Lemmermann as a variety of *S. bijuga* (Turp.) Ktz., but later raised to specific rank. West and West have recently replaced it among the varieties of *S. bijuga*. This placing of *S. arcuatus* as a form or variety of *S. bijuga* has arisen from the conception that cells arranged in two series of four cells each are a normal variation of *S. bijuga* that may occur for one generation only. However, since I have been able to isolate a form in which this two-seried cell arrangement persists, although the cells do not form a curved plane, the arrangement of the cells in two series may be regarded as a specific character.

EUROPE. *Austria-Hungary* (Reinhardt, 1905). *Germany* (Lemmermann, 1898B, 1899, 1905B, 1907B; Marsson, 1908B, 1911; Schmidle, 1900). *Ireland* (West and West, 1906B, 1909B). *Italy* (de Toni and Forti, 1899B, Gugliemetti, 1910). *Sicily*

(Lemmermann, 1908A). *Sweden* (Lemmermann, 1904A; de Toni and Forti, 1899A).

AFRICA. *Lake Tanganyika* (G. S. West, 1907).

AMERICAS. *Paraguay* (Lemmermann, 1910A). *United States*

Var. **platydisca,** nov. var. (Pl. XXX: Figs. 101–105.)

Cellulae coenobium saepe 8, in seriam duas in uno plano, foramina inter cellulas parva. Dimens. cell. 8 x 4.5, 8 x 5, 9 x 5.5, 10 x 5.5, 11 x 6 μ.

The form which I have isolated in pure culture has been figured by Nägeli, West, and others as one of the normal variations of *S. bijuga* (Turp) Lag. However, since the cell arrangement shows a greater resemblance to *S. arcuatus* than to *S. bijuga,* this form is placed as a variety of *S. arcuatus.*

All the colonies in a culture have the cells arranged in the characteristic flat surface, thereby differing from the typical form. The interstices between the cells are much smaller and angular by compression, where the cells come in contact with one another.

The normal number of cells in a colony is eight (Figs. 101, 103–105) although four-celled coenobia have been found (Fig. 102). These, however, cannot be distinguished from the four-celled colonies of *S. arcuatus* except by the size of the individual cells, which average five microns shorter and two microns narrower than those of *S. arcuatus.*

This variety may have been described by Chodat as the variety *disciformis* of *S. bijuga* but his description "Cellules en petite thalle, 4–ou octocellulaire, polyhedrique par compression" is indefinite in that it may refer to the form under consideration or to *S. bijuga* var. *irregularis* (Wille).

11. **S. producto-capitatus** Schmula. (Pl. XXV: Fig. 11.)

Schmula, 1910, p. 85; Figs. 1-5. Brunnthaler, 1913, pp. 170, 172; Fig. 27. Chodat, 1913, p. 25.

"Cellulae singulae, aut in coloniis, quae duas tresve aut quator cellulas continent. Cellulae visae ab adversa parte (fronte) 11–14 μ longae, in media parte 3–3.5 μ latae, hinc ad extrema versus instar capitis dilatatae, productae et rotundatae sine aculus, praeditae membrane tenuissima, nucleo centralo et duobus pyrenoidibus. Cellulae a vertice rotundae et diametro 3–3.5 μ. A latere visae cellulae praebent in uno latere mediae partis maiorem expansionem quam in altero. In coloniis quatuor cellularum saepius a fronte duae cellulae sinistrae a duabus cellulis dextris ita differunt ut latus crassius ventris in iliis dextrosum in his sinistrorsum directum sit."

Known only from Schmula's description.

DISTRIBUTION

Germany (Schmula, 1910).

12. **S. denticulatus** Lag. (Pl. XXVI. Fig. 23).

Lagerheim, 1883, p. 61; Pl. II, Figs. 13-17. Schröter, 1884, p. 189. Hansgirg, 1886, p. 115. de Wildemann, 1888, p. 77. Hansgirg, 1889, p. 132. de Toni, 1889B, p. 564. Hansgirg, 1890A, p. 112. Hansgirg, 1891, p. 317. Hansgirg, 1892B, p. 119. W. West, 1892A, p. 193. W. West, 1892B, p. 738. Lemmermann, 1893, p. 524. de Wildemann, 1893A. Schröder, 1896, p. 46. Gutwinski, 1897A, p. 3. Gutwinski, 1897B, p. 134. Schmidle, 1897, p. 20. Schröder, 1897A, p. 372. Schröder, 1897B, p. 487. Schröder, 1897C, p. 45. West and West, 1897B, p. 500. Lemmermann, 1898A, p. 191. Boergesen, 1899B, p. 333. Garbini, 1899A, p. 15. Schröder, 1899, p. 22. Balsamo, 1900, p. 266. Chodat, 1900, p. 2. Boergesen, 1901A, p. 240; Pl. X, Fig. 5. Dalla Torre und von Sarnthein, 1901, p. 35. Lemmermann, 1901B, p. 80. West and West, 1901B, p. 120. Bohlin, 1902, p. 44. Forti, 1902, p. 60. Voigt, 1902, p. 76. West and West, 1902, p. 181. West and West, 1902B, p. 64. Pascher, 1903, p. 175. Volk, 1903, p. 103. Heering und Homfeld, 1904, p. 83. Hansgirg, 1905, p. 458. Huber, 1905, p. 57. Lemmermann, 1905B, pp. 158, 163. Lemmermann, 1905C, p. 167. West and West, 1905, p. 270. Lemmermann, 1906, p. 250. Ruttner, 1906, p. 10. Schorler, Thallwitz, und Schiller, 1906, p. 247. Borge, 1907A, p. 58. Larsen, 1907A, p. 358. Larsen, 1907B, p. 104. Lemmermann, 1907B, p. 412. Migula, 1907, p. 656. Adams, 1908, p. 35. Lemmermann, 1908E, p. 405. G. S. West, 1909C, p. 245. Gugliemetti, 1910, p. 31. Kofoid, 1910, p. 31. Bachmann, 1911, p. 191. Marsson, 1911, pp. 261, 286. Petersen, 1911, p. 160; Fig. 6. Griffith, 1912, p. 11. Brunnthaler, 1913, pp. 166, 170; Fig. 5.

S. denticulatus var. *genuinus*. Lagerheim, 1883, pp. 61, 56; Pl. II, Figs. 13-16.

Scenodesmus denticulatus. Kirchner, 1885, p. CLXXX.

S. denticulatus forma (un-named). Borge, 1891, p. 6; Pl. I, Fig. 1. Borge, 1895, p. 7.

S. hystrix var. *denticulatus*. Chodat, 1902, p. 215.

S. hystrix forma *denticulatus cohaerens*. Volk, 1905, p. 65. Selk, 1907, p. 6.

S. hystrix forma *denticulatus*. Volk, 1905, p. 65. Selk, 1907, pp. 7, 57, 68, 79, 85, 94, 99, 108, 115.
S. hystrix forma *denticulatus genuinus*. Selk, 1907, p. 68.

"Sc. cellulis quaternis, ovatis vel ovali-oblongis, cruciatim dispositis vel subalternantibus, utroque polo rotundatis et denticulus parvis, plerumque binis, instructis. Membrana cellularum subcrassa. Dimens. cell. 7 x 5, 10 x 7, 12 x 6, 13 x 9, 15 x 9, 15 x 11 μ."

Although this species occurs abundantly in this vicinity it has never been isolated in pure culture. For this reason the variations in the size of the cells cannot be given; so the existence of the variety *zig-zag*, described by Lagerheim, where the cells are about half as wide as the typical form, cannot be affirmed or denied. Another even more important point is whether or not the arrangement of the cells in a linear series or an alternating series is a constant character, or if the alternating type of colony gives rise to the linear type or vice-versa. G. S. West (1904B) shows a linear type of colony in which two daughter colonies are being liberated that have the alternating arrangement of the cells, a condition which corresponds with my observation made on material from the field. Until this question of cell arrangement has been definitely settled by cultural studies, it seems best to follow the general practice of recognizing both alternating and linear types as distinct.

GEOGRAPHICAL DISTRIBUTION

EUROPE. *Austria-Hungary* (Gutwinski, 1897A, 1897B; Hansgirg, 1886, 1889, 1890A, 1891, 1892B, 1905; Pascher, 1903; Ruttner, 1906). *Belgium* (de Wildemann, 1888). *Denmark* (Chodat, 1900). *England* (Griffith, 1912; W. West, 1892B; West and West, 1897B, 1901B). *Germany* (Heering und Homfeld, 1904; Kirchner, 1885; Lemmermann, 1893, 1898A, 1899, 1901B, 1905B, 1905C, 1906, 1907B, 1908E; Marsson, 1911; Migula, 1907; Schmidle, 1897; Schorler, Thallwitz und Schiller, 1906; Schröder, 1896, 1897A, 1897B, 1897C, 1899; Schröter, 1884; Selk, 1907; Voigt, 1902; Volk, 1903, 1905). *Ireland* (Adams, 1908; W. West, 1892A; West and West, 1902B). *Italy* (Forti, 1902; Garbini, 1899A; Gugliemetti, 1910). *Scotland* (West and West, 1905). *Sweden* (Borge, 1895, 1907A; Lagerheim, 1883; Petersen, 1911). *Switzerland* (Chodat, 1902; Dalla Torre und von Sarnthein, 1901; Huber, 1905).

AFRICA. *Albert Nyanza* (G. S. West, 1909C). *Azores* (Bohlin, 1902).

ASIA. *Siam* (West and West, 1902). *Siberia* (Borge, 1891).

AMERICAS. *United States* (Kofoid, 1910).

POLAR AND SUB-POLAR REGIONS. *Faeroes.* (Boergesen, 1899B, 1901A). *Greenland* (Larsen, 1907A, 1907B).

Var. **zig-zag** Lagerheim.

Lagerheim, 1883, p. 61; Pl. II, Fig. 17. Hansgirg, 1886, p. 115, de Toni, 1889B, p. 565. West and West, 1895, p. 82. Balsamo, 1900, p. 266. Pascher, 1903, p. 175. Volk, 1903, p. 103.

S. denticulatus forma *zig-zag.* Pascher, 1906, p. 169.

S. hystrix forma *zig-zag.* Selk, 1907, p. 57.

"S. denticulatus cellulis ovali-oblongis, quaternis, subalternantibus. Dimens. cell. 6 x 4, 10 x 5, 15 x 6 μ."

GEOGRAPHICAL DISTRIBUTION

Austria-Hungary (Hansgirg, 1886; Pascher, 1903, 1906). *Germany* (Selk, 1907; Volk, 1903). *Madagascar* (West and West, 1895). *Sweden* (Lagerheim, 1883).

Var. **linearis** Hansgr.

Hansgirg, 1886, p. 268. de Toni, 1889B, p. 565. W. West, 1892B, p. 738. West and West, 1895, p. 82. West and West, 1897A, p. 239. West and West, 1897B, p. 500. G. S. West, 1899, p. 211. West and West, 1901A, p. 197. West and West, 1901B, p. 120. West and West, 1902, p. 182. West and West, 1902B, p. 64. Volk, 1903, p. 103. Setchell and Gardner, 1903, p. 206. W. West, 1903, p. 100. G. S. West, 1904A, p. 287. G. S. West, 1904B, p. 220; Figs. 92I-92K. Hardy, 1906, p. 38. West and West, 1906A, p. 489. Migula, 1907, p. 656. G. S. West, 1907, p. 138. West and West, 1907, p. 229. Collins, 1909, p. 169. G. S. West, 1909A, p. 29. West and West, 1909B, p. 184. Brunnthaler, 1913, pp. 166, 170.

S. denticulatus var. *lineatus.* W. West, 1892A, p. 193; Pl. XVII, Fig. 7. Schmidle, 1893B, p. 545. Boergesen, 1896, p. 36.

S. bidentatus. Hansgirg, 1892, p. 229. Hansgirg, 1892B, p. 119. Schorler, 1900, p. 5. Pascher, 1906, p. 168. Migula, 1907, p. 656.

S. hystrix forma *denticulatus bicaudatus.* Volk, 1905, p. 65.

S. denticulatus forma *linearis.* Pascher, 1906, p. 168.

S. denticulatus var. *diengianus.* Bernard, 1908, p. 185; Pl. XIV, Fig. 448.

"Var. cellulis oblongis angustioribus, et in unam seriem ordinatis nec cruciatim nec alternatim; cum 2-3 dentibus parvis."

GEOGRAPHICAL DISTRIBUTION

EUROPE. *Austria-Hungary* (Hansgirg, 1886, 1892; Pascher, 1906). *England* (G. S. West, 1899, 1904B; W. West, 1892B; West and West, 1897B, 1901B). *Germany* (Schorler, 1900; Volk, 1903, 1905). *Ireland* (W. West, 1892A; West and West, 1902B). *Scotland* (W. West, 1903; West and West, 1906A, 1909B).

AFRICA. "*Libuna River*" (West and West, 1897A). *Madagascar* (West and West, 1895). *Lake Nyassa* (G. S. West, 1907). *Lake Tanganyika* G. S. West, 1907).

ASIA AND OCEANIA. *Australia* (Hardy, 1906; G. S. West, 1909A). *Burma* (West and West, 1907). *Ceylon* (West and West, 1901A). *Java* (Bernard, 1908). *Siam* (West and West, 1902).

AMERICAS. *Trinidad* (G. S. West, 1904A). *United States* (Collins, 1909; Setchell and Gardner, 1903).

POLAR AND SUB-POLAR REGIONS. *Faeroes* (Boergesen, 1899B). *Greenland* (Boergesen, 1896).

Var. **lunatus** West and West. (Pl. XXVI: Fig. 24.)

West and West, 1895, p. 82; Pl. V, Figs. 11-12. Balsamo, 1900, p. 266. Brunnthaler, 1913, pp. 166, 170. Chodat, 1913, p. 20.

Var. cellulis 2–4 in seriem rectam dispositis, cellulis medianis ellipticis rectis, terminalibus extrorsum lunatis, apicibus cellularum 3–denticulatis. Long. cell. 9.5–11 μ; lat. cell. 3.5–4 μ.

Known only from West and West's discovery of the variety in Madagascar.

13. **S. aculeolatus** Reinsch. (Pl. XXVI: Fig. 22.)

Reinsch, 1877, p. 238; Pl. VI, Figs. 1-2. Lagerheim, 1883, p. 65. de Toni, 1889B, p. 565. Lemmermann, 1893A, p. 41. de Wildemann, 1893B. Balsamo, 1900, p. 266. Chodat, 1902, p. 215. Migula, 1907, p. 656. Brunnthaler, 1913, pp. 166, 170; Fig. 8.

"S. cellulis oblongo-cylindricis utroque polo obtusorotundatis, spinulis compluribus brevioribus absque ordine dispositis armato. Longit. fam. 4–cellularis 19.6 μ. Latit. cellularum 13–16.8 μ. Specimina singula observata inter Spirogyram."

Because this species has been found but once since it was first described by Reinsch in 1877, and because the original description was based on a single specimen it might be placed among the doubtful species.

GEOGRAPHICAL DISTRIBUTION

Cape of Good Hope (Reinsch, 1877). *Germany* (Lemmermann, 1893A).

forma **brevior** West.

W. West, 1893, p. 100; Pl. CCCXXXIII, Fig. 13. Balsamo, 1900, p. 266. Brunnthaler, 1913, p. 166, 170.

"Forma cum cellulis brevioribus quam forma typica. Long. cell. (C. spin.) 10 μ. long. cell. (s. spin.) 8 μ. lat. cell. 5 μ."

The form *brevior* was reported from Scotland.

14. **S. acutiformis** Schröder. (Pl. XXVI: Figs. 28–29. Pl. XXIX : Figs. 84–89.)

Schröder, 1897C, p. 45; Pl. II, Fig. 4. Levander, 1899, pp. 63, 70, 80, 90. G. S. West, 1899, p. 221. Borge, 1901B, p. 13. West and West, 1901B, p. 121. West and West, 1902A, p. 182. West and West, 1902B, p. 64. Snow, 1903, p. 391. Lemmermann, 1904A, pp. 40, 70. G. S. West, 1904B, p. 221. West and West, 1905, p. 270. Hardy, 1906, p. 38. Borge, 1907A, p. 57. G. S. West, 1907, p. 138. Adams, 1908, p. 35. Lemmermann, 1908A, p. 167. Lemmermann, 1908E, p. 405. Borge, 1909, p. 16. G. S. West, 1909A, pp. 29, 38. Gugliemetti, 1910, p. 31. Bachmann, 1911, p. 191. Brunnthaler, 1913, pp. 168-171; Fig. 13. Chodat, 1913, p. 23.

S. hystrix var. *acutiformis.* Chodat, 1902, p. 215; Figs. 139B-139C. Heering und Homfeld, 1904, p. 83. Migula, 1907, p. 657; Pl. XXXV (L), Fig. 5. Bernard, 1908, p. 184; Pl. XIV, Figs. 438-447. Bernard, 1909, p. 78; Pl. VI, Figs. 168-170.

S. hystrix forma *acutiformis.* Volk, 1905, p. 64. Selk, 1907, pp. 57, 64.

S. hystrix forma *acutiformis cohaerens.* Selk, 1907, p. 6.

Coenobia 2–8 cellularum, cellulis fusiformibus. Membranae cellularum terminalum visae ab polo longitudinaliter costatae cum quatuor costis, cellulae interiores cum duabus costes. Dimens. cell. 5.5 x 16, 5.5 x 17, 6 x 18, 8 x 22 μ.

The length of cells that I have isolated agrees well with the dimensions given by Schröder (length 20 μ, width 15 μ), but they are much narrower, the widest cells being 8 μ. By comparing the length with the width in the figure given by Schröder, we find that the cells are about a third as wide as they are long, therefore being more nearly 6–8 μ than 15 μ wide. Under these conditions the form that I have isolated agrees perfectly with the *S. acutiformis* of Schröder.

The number of cells in the colonies of my cultures varies from two (Fig. 89) to eight (Fig. 84) with four the predominant number (Figs. 85–88). The ridges are quite prominent even from a side view and extend from one end of the cell to the other. They vary from one-half to one micron in width, and should be represented by two lines (Figs. 85–88) instead of by a single line as done by Schröder. Schröder has already pointed out that the number of ridges on the cell can best be determined from an end view which shows that the terminal cells of the colony have four ridges. This, however, is not universal since instances were found where the terminal cells had but three ridges (Fig. 88). The median cells always have a single ridge on each side.

GEOGRAPHICAL DISTRIBUTION

EUROPE. *England* (G. S. West, 1899, 1904B; West and West, 1901B). *Germany* (Heering und Homfeld, 1904; Lemmermann, 1908E; Schröder, 1897C; Selk, 1907; Volk, 1905). *Ireland* (Adams, 1908; West and West, 1902B). *Italy* (Gugliemetti, 1910). *Russia* (Levander, 1899). *Scotland* (West and West, 1905). *Sicily* (Lemmermann, 1908A). *Sweden* (Borge, 1907A; Lemmermann, 1904A). *Switzerland* (Chodat, 1902).

AFRICA. *Lake Nyassa* (G. S. West, 1907).

ASIA AND OCEANIA. *Australia* (Hardy, 1906; G. S. West, 1909A). *Java* (Bernard, 1908). *Johore* (Bernard, 1909). *Siam* (West and West, 1902). *Singapore* (Bernard, 1909).

AMERICAS. *Pategonia* (Borge, 1901B). *United States* (Borge, 1909; Snow, 1903).

15. **S. costatus** Schmidle. (Pl. XXVI: Figs. 26–27.)

Schmidle, 1895, p. 305; Pl. XIV, Figs. 5-6. Schmidle, 1900A, p. (111). Dalla Torre und von Sarnthein, 1901, p. 35. Simmer, 1901, p. 83. West and West, 1901B, p. 121. Bohlin, 1902, p. 44. Chodat, 1902, p. 216; Figs. 141A-141H. Lemmermann, 1902, p. (251). G. S. West, 1904B, p. 221. Borge, 1907A, p. 58. Migula, 1907, p. 657; Pl. XXXV (L), Fig. 2. Selk, 1907, pp. 5, 76. Gutwinski, 1909, p. 435. Brunnthaler, 1913, pp. 168, 171; Fig. 12. Chodat, 1913, p. 23.

S. costatus forma *typicus.* Schröder, 1898, p. 24.

"Cellulae adultae ellipticae vel semiovato-ellipticae et margine interiori leviter convexae, exteriori fere semicirculares, utroque polo ad apices liberos tuberculo ornatae, plerumque quaternae (raro octonae) in coenobium solide concretae, membrana crassa longitudinaliter costata, qua de cause cellulae e vertice visae rotundae margine exteriori 4–6–ies evidentur undulatae sunt.

"Cellulae (adultae) 8–12 μ latae. 20–22 μ longae cum tuberculis coenobium (quadricellulare) 35–24 aut 33–35 μ."

GEOGRAPHICAL DISTRIBUTION

EUROPE. *Austria-Hungary* (Gutwinski, 1909). *England* (G. S. West, 1904B; West and West, 1901B). *Germany* (Lemmermann, 1902; Schmidle, 1900A; Schröder, 1898; Selk, 1907). *Sweden* (Borge, 1907A). *Switzerland* (Chodat, 1902; Dalla Torre und von Sarnthein, 1901; Schmidle, 1895).

AFRICA. *Azores* (Bohlin, 1902).

Var. **sudeticus** Lemm.

Lemmermann, 1896, p. 108. Lemmermann, 1898C, p. 249. Schröder, 1898, p. 24. Schmidle, 1900A, p. (111). Migula, 1907, p. 657. Brunnthaler, 1913, pp. 168, 171.

S. denticulatus forma *Wildemanii.* Schröder, 1898, p. 24.

"Cellulae 7–8 μ latae, 13–15 μ longae; coenobia plerumque quadricellularia circa 21 μ lata, 26 μ longa."

GEOGRAPHICAL DISTRIBUTION

Germany (Lemmermann, 1896, 1898C; Migula, 1907; Schmidle, 1900A; Schröder, 1898).

16. S. **brasiliensis** Bohlin. (Pl. XXVI: Figs. 30–31.)

Bohlin, 1897, p. 22; Pl. I, Figs. 36-37. Lemmermann, 1899, p. 113. Marsson, 1899, p. 172. Lemmermann, 1900A, p. 98. Schmidle, 1900, p. (111). Lemmermann, 1901B, p. 80. Bohlin, 1902, p. 44. Lemmermann, 1902, p. (251). Snow, 1903, p. 391. Volk, 1903, p. 103. Lemmermann, 1907A, p. 267. Lemmermann, 1907B, p. 412. Schorler, 1907, p. 356. Lemmermann, 1908C, p.

357. Lemmermann, 1908E, p. 405. Schneider, 1908, p. 46. Borge, 1909, p. 16. Lemmermann, 1910A, p. 294. Borge, 1911, p. 204. Marsson, 1911, p. 286. Brunnthaler, 1913, p. 168; Fig. 15.

S. hystrix var. *brasiliensis.* Chodat, 1902, p. 215.

S. acutiformis var. *spinuliferum.* West and West, 1902, p. 182; Pl. IV, Figs. 46-49. Lemmermann, 1904C, p. 159.

S. hystrix forma *brasiliensis.* Volk, 1905, p. 65. Migula, 1907, p. 657. Selk, 1907, pp. 7, 73, 79, 91, 103, 108.

S. hystrix forma *brasiliensis cohaerens.* Volk, 1905, p. 65. Selk, 1907, p. 6.

S. acutiformis var. *brasiliensis.* West and West, 1905, p. 270; Pl. I, Figs. 8-9. West and West, 1907, p. 229. G. S. West, 1907, p. 138. G. S. West, 1909C, p. 245. West and West, 1909B, p. 184.

S. acutiformis var. *bicaudatus.* Gugliemetti, 1910, p. 31.

"Sc. coenobis e cellulis quaternis (vel octonis) in seriem simplicem, rectam conjunctis, oblongis, obtusis; membrana in utroque polo denticulis parvis instructis, costus tenerrimis quaternis, quarum binis lateraliter dispositis.

"Dimens. colon. 4–cellularum. 8–11, 14–16, 19–19, 22–23, 20–24 μ."

Although this form has not been obtained in culture I have observed it in nature. Ridges on the sides of the cell are the distinguishing character which separates this species from *S. denticulatus* Lag. Since cultures of other species of *Scenedesmus* made in connection with this study show that ridges are a character which remain constant in all descendants of a single mother cell, it is reasonable to assume that the lateral ridges are also constant on the cell walls of *S. brasiliensis*.

The identity of this form has not been disputed but there has been some question as to its systematic position. Chodat enlarged the *S. hystrix* of Lagerheim to include all forms with lateral ridges, while West and West have placed several laterally ridged forms among the varieties of *S. acutiformis* Schröder. Of the two the latter is the much more logical, but since lateral ridges are found in quite differently shaped cells, it is best not to group them as varieties but rather as separate species.

GEOGRAPHICAL DISTRIBUTION

EUROPE. *Germany* (Lemmermann, 1900A, 1901B, 1902, 1906, 1907B, 1908E, 1899; Marsson, 1899, 1911; Schmidle, 1900. Schneider, 1908; Schorler, 1907; Selk, 1907; Volk, 1903, 1905;)

Italy (Gugliemetti, 1910; Lemmermann, 1908C). *Scotland* (West and West, 1905). *Switzerland* (Chodat, 1902).

AFRICA. *Azores* (Bohlin, 1902). *Lake Albert Nyanza* (G. S. West, 1909C). *Lake Nyassa* (G. S. West, 1907). *Lake Tanganyika* (G. S. West, 1907).

ASIA AND OCEANIA. *Burma* (West and West, 1907). *Ceylon* (Lemmermann, 1907A). *Siam* (West and West, 1902).

AMERICAS. *Brazil* (Bohlin, 1897; Lemmermann, 1910A). *Paraguay* (Bohlin, 1897; Lemmermann, 1910A). *United States* (Borge, 1909; Snow, 1903).

17. **S. armatus** (Chodat) nov. comb. Pl. XXVIII: Fig. 53, Pl. XXIX: Figs. 90–93. Pl. XXX: Figs. 109–110.)

S. hystrix var. *armatus*. Chodat, 1902, p. 215; Fig. 140. Heering und Homfeld, 1904, p. 83. Reinhardt, 1905, p. 26. Migula, 1907, p. 657. Bernard, 1909, p. 78; Pl. VI, Figs. 171-175. Chodat, 1913, p. 24.

S. quadricauda var. *acutiformis*. Schmidle, 1900A, p. (111).

S. brasiliensis quadricauda. Volk, 1903, p. 103.

S. hystrix forma *armatus*. Volk, 1905, p. 64. Selk, 1907, pp. 7, 57, 64, 68, 73, 79, 85, 91, 94, 99, 103, 108, 115.

S. hystrix forma *armatus abundans*. Volk, 1905, p. 64. Selk. 1907, pp. 57, 68, 73, 79, 85, 91, 99.

S. hystrix forma *armatus bicaudatus*. Volk, 1905, p. 64.

S. hystrix forma *armatus cohaerens*. Volk, 1905, p. 64. Selk, 1907, p. 6.

S. hystrix forma *armatus setosus*. Volk, 1905, p. 65.

S. hystrix var. *armatus* forma *depauperata*. Wille, 1913, p. 146.

Cellulis 2–8 in seriem rectam vel subalternantibus dispositis, cellulis ovatis vel oblongi-ovatis, utroque polo cellulis terminalibus rotundatis cum uno aculeo, polo cellulis interioribus coenobius rotundatis sine aculeis. Membrana cellularum longitudinaliter costata in utroque parte.

Dimens. cell. 7 x 4, 9 x 4, 9 x 4.5, 11 x 4, 11 x 6, 12 x 8, 14 x 7 μ. Long. acul. 5.5–7 μ.

Previous to the beginning of the cultural work I had frequently observed in field material that lateral ridges appeared on four-celled coenobia which also bore a spine at each corner, but thought it was merely a passing condition in certain cells of *S. quadricauda* (Turp.) de Bréb. The isolation of several strains in which this lateral ridge constantly appears in all of the colonies, along with the four spines, has shown this to be a constant character warranting raising the variety *armatus* to specific rank.

These lateral ridges are not so prominent as in *S. acutiformis* Schröder and *S. brasiliensis* Bohlin and frequently can be seen only in the polar region (Figs. 90, 91); neither do they appear at the same place on all the cells of the coenobe, the median cells being ridged in the center of the side and the terminal cells generally nearer the outer edge of the coenobe. Ridges cannot always be distinguished on all of the cells (Figs. 109, 110) but no coenobia were found in which there was not an indication of ridges on one or more cells.

GEOGRAPHICAL DISTRIBUTION

Germany (Heering und Homfeld, 1904; Schmidle, 1900A; Selk, 1907; Volk, 1903, 1905). *Austria-Hungary* (Reinhardt, 1905). *Samoa* (Wille, 1913). *Singapore* (Bernard, 1909). *Switzerland* (Chodat, 1902).

Var. **Chodatii** nov. var. (Pl. XXX: Figs. 111–114.)

Cellulis longioribus atque angustioribus. Dimens. cell. 11 x 4, 12 x 3.5, 15 x 5 μ.

This variety was isolated but once, the material for the pure culture being collected on the Dane County Fair Grounds. The shape of the cells and the poles not being in lateral contact separate this from the foregoing.

Var. **subalternans** nov. var. (Pl. XXX: Figs. 115–120.)

Longitudo cellularum 3-plo latitudo; cellulis saepe pyriformis; subalternis dispositis. Dimens. cell. 9 x 3, 9 x 4, 11 x 5, 12 x 5.5 μ.

This is the only horn bearing strain isolated in which the subalternate arrangement of the cells in the coenobe is a constant character. Too much stress cannot be attached to this as a distinguishing characteristic; since occasional subalternating cell arrangements are found in many species. The pyriform character of the cells is much more pronounced in this variety than in the others of *S. armatus.* Certain colonies apparently have no lateral ridges (Figs. 119–120) but these instances are of very rare occurrence, while the horn on the pole of a median cell was found but once (Fig. 119).

18. **S. carinatus** (Lemm.) Chodat. (Pl. XXVI: Fig. 25.)

Chodat, 1913, pp. 23, 69.
S. opoliensis var. *carinatus.* Lemmermann, 1899, p. 113; Pl. I, Fig. 7. Marsson, 1901A, pp. 90, 101, 115. Marsson, 1901B, p. 96. Lemmermann, 1904A, pp. 8, 20, 84, 158. Lemmermann, 1904C, p. 159. Lemmermann, 1905B, p. 163. Migula, 1907, p. 655. Selk, 1907, p. 79. Lemmermann, 1908C, p. 357. Marsson, 1911, pp. 263, 265, 286. Brunnthaler, 1913, pp. 169, 171; Fig. 20.

Coenobia 4–cellularum. Cellulis fusiformibus, membrana longitudinaliter costata in utroque parte atque in utroque polo 2–3 denticulis parvis instructis. Omne cellulae terminale cum longo curvato aculeo atque dentibus in utroque polo.

The cells of this form possess the characteristic shape of *S. opoliensis* Richt., but there is a distinct longitudinal ridge on each side of every cell. Since cultural work on such forms shows that this longitudinal ridge is a constant character, and since the strains of *S. opoliensis* isolated do not show any, this form should be regarded as a distinct species.

GEOGRAPHICAL DISTRIBUTION

Germany (Lemmermann, 1899, 1905B; Marsson, 1901A, 1901B, 1911; Selk, 1907). *Italy* (Lemmermann, 1908C). *Java* (Lemmermann, 1904C). *Sweden* (Lemmermann, 1904A).

19. **S. hystrix** Lag. (Pl. XXVI: Fig. 35.)

Lagerheim, 1882, pp. 62, 65; Pl. II, Figs. 18. Lagerheim, 1886, p. 45. Lagerheim, 1887, p. 194. de Toni, 1889B, p. 565. de Wildemann, 1893A. de Wildemann, 1893B, p. 91. de Wildemann, 1895, p. 26. Bohlin, 1897, p. 22. Schröder, 1897A, p. 372. Schröder, 1897B, p. 487. Schröder, 1897C, p. 45. de Wildemann, 1897B, p. 50. Schröder, 1898, p. 23. Garbini, 1899A, p. 15. Lemmermann, 1899, p. 112. Schröder, 1899, p. 22. Balsamo, 1900, p. 266. Chodat, 1901, p. 1309. West and West, 1901B, p. 121. Forti, 1902, p. 60. West and West, 1902B, p. 64. Boergesen and Ostenfeld, 1903, p. 615. Fournier, 1903, p. 28. Volk, 1903, p. 103. Cozette, 1904, p. 273. G. S. West, 1904B, p. 221. West and West, 1904, p. 221. West and West, 1904, p. 531. Huber, 1905, p. 57. Lemmermann, 1905B, pp. 158, 160. Reinhardt, 1905, p. 26. Suhr, 1905, p. 253. Fritsch, 1906, p. 205. Pascher, 1906, p. 168. Brunnthaler, 1907, p. 207. Lemmermann, 1907B, p. 112. Teodoresco, 1907, p. 130. Adams, 1908, p. 35. Huber, 1908, p. 314. Lemmermann, 1908A, p. 167. Lemmermann, 1908C, p. 357. Collins, 1909, p. 169. West and West, 1909B, p. 184.

Conrad et Kufferath, 1912, p. 321. Brunnthaler, 1913, pp. 168, 171; Fig. 14. Chodat, 1913, p. 23. Reinhardt, 1913, p. 103.
S. hystrix (emend.). Chodat, 1902, p. 214; Figs. 138A, 138D-138J. Volk, 1905, p. 64. Migula, 1907, p. 657. Ostenfeld, 1907, p. 384.
S. hystrix var. *echinulatus*. Chodat, 1902, p. 215; Figs. 138K-138L. Migula, 1907, p. 657.
S. serratus var. *hystrix*. Hansgirg, 1905, p. 458.
S. hystrix forma *echinulatus cohaerens*. Volk, 1905, p. 64.
S. hystrix cohaerens. Volk, 1905, p. 64. Selk, 1907, pp. 5, 68.
S. hystrix forma *echinulatus*. Selk, 1907, pp. 61, 68, 76, 108.

"Sc. cellulis binis, quaternis, octonis, oblongo-cylindricis utroque polo obtusis, omnibus rectis, in seriem simplices rectam conjunctis, non alternantibus. Membrana cellularum aculeis parvis numerosis dense vestita.

"Dimens. cell. 12 x 3, 15 x 4, 17 x 6, 18 x 5 μ."

The emended description of Chodat in which a heterogeneous group is combined under the name *hystrix* is wholly without justification. Since the presence of short spines over the entire wall constitutes a very sharply defined character, classifying algae that are characterized by teeth at one end, by lateral ridges only, or by lateral ridges combined with long horns, in the same genus is highly confusing.

GEOGRAPHICAL DISTRIBUTION

EUROPE. *Austria-Hungary* (Brunnthaler, 1907; Hansgirg, 1905; Pascher, 1906; Reinhardt, 1905, 1913). *Belgium* (Conrad et Kufferath, 1912; de Wildemann, 1893B, 1895, 1897B). *England* (Fritsch, 1906; West and West, 1901B). *France* (Cozette, 1904; Fournier, 1903). *Germany* (Lemmermann, 1899, 1905B, 1907B; Schröder, 1897A, 1897B, 1897C, 1898, 1899; Selk, 1907; Volk, 1903, 1905). *Ireland* (Adams, 1908; West and West, 1902B). *Italy* (Forti, 1902; Garbini, 1899A; Lemmermann, 1908C). *Roumania* (Teodoresco, 1907). *Scotland* (West and West, 1904, 1909B). *Sicily* (Lemmermann, 1908A). *Sweden* (Lagerheim, 1883, 1886). *Switzerland* (Chodat, 1901, 1902; Huber, 1905, 1908).

POLAR AND SUB-POLAR REGIONS. *Faeroes.* (Boergesen and Ostenfeld, 1903).

ASIA. *Mongolia* (Ostenfeld, 1907).

AMERICAS. *Brazil* (Bohlin, 1897). *Paraguay* (Bohlin, 1897). *Puerto Rico* (Collins, 1909; Lagerheim, 1887).

20. **S. ornatus** (Lemm.) nov. comb. (Pl XXVI: Fig. 34.)

S. perforatus var. *ornatus* Lemm. Lemmermann, 1910A, p. 294, 309; Figs. 3–4. Brunnthaler, 1913, pp. 269, 171.

"Coenobium 8-cellularum, foraminibus anguste linearibus, 1.5–2 μ latis, praeditum. Aculi cellularum exteriorum ca. 20.5 μ longi, subrecti vel distincte curvati. Membrana cellularum dense et subtiliter punctata."

The present system of recognizing a cell wall completely covered with spines as a specific character warrants the raising of this variety to specific rank. Known only from Paraguay.

21. **S. insignis** (West and West) Chodat. (Pl. XXVI: Fig. 32.)

Chodat, 1913, p. 69.
S. quadricauda var. *insignis*. West and West, 1895, p. 83; Pl. V, Figs. 7-8. Balsamo, 1900, p. 266.

"Var. cellulis 4 in seriem rectam dispositis unaquaequa cellula cum spina brevi singula, 2 simul ad dextram, 2 simul ad sinistram, cellulis terminalibus spina singula longa sigmoidea alternatim disposita; membrana punctato-granulato. Long. cell. 10.5–12.5 μ; lat. cell. 4–5 μ."

So careful a description of the position of the horns as West and West have given is entirely superfluous since my cultural work with species of *S. longus* Meyen, where there are horns on all of the cells of the coenobe, shows that both the number and position of the terminal horns is variable. The character which does separate this form from all other species of *Scenedesmus* is the punctate-granulate membrane in combination with horns on the ends of all cells.

22. **S. granulatus** West and West. (Pl. XXVI: Fig. 33.)

West and West, 1897B, p. 500; Pl. VII, Figs. 1-2. G. S. West, 1904B, p. 221. Brunnthaler, 1913, pp. 166, 170; Fig. 11. Chodat, 1913, p. 24.

"S. cellulis plerumque quaternis, oblongis, diametro circiter 3-plo longioribus, polis conicis, in seriem rectam conjunctis; membrana cellularum granulata, granulis minutis in seribus tribus longitudinaliter ordinatis. Long. cell. 20–21 μ; lat. cell. 6–6.5 μ."

Known only from England.

23. **S. serratus** (Corda) Bohlin. (Pl. XXVIII: Figs. 55, 57.)

Bohlin, 1902, p. 44; Pl. I, Fig. 2. Brunnthaler, 1913, pp. 166, 171; Fig. 10. Chodat, 1913, p. 25.

Arthrodesmus serratus. Corda, 1839, p. 244; Pl. VI, Fig. 35.

Coenobia 4-cellularum. Cellulis oblongi-ovatis; membranae cellularum terminalum cum singula serie aculeorum parvorum ex polo ad polum; cellulis interioribus cum duabus seribus aculeorum; polis omnorum cellularum cum 3–4 dentibus. Long. cell. 15–20 μ; lat. cell. 4.5–7 μ.

Two colonies of this species have been found in material collected from the Yahara River above Lake Kegonsa (Wisconsin). The arrangement of the rows of spines on the sides of the cells (Fig. 57) and the teeth on the ends of the cells is the same as described by Bohlin, but the cells I have found are somewhat smaller being 10–12 by 3–3.5 μ.

The species has been found only in Austria (Corda), the Azores (Bohlin), and Wisconsin.

24. **S. abundans** (Kirchner) Chodat. (Pl. XXX: Figs. 133–136; Pl. XXXI: Figs. 137–140.)

Chodat, 1913, p. 77.

S. caudatus forma *abundans.* Kirchner, 1878, p. 98.

S. quadricaudatus var. *β.* Ralfs, 1845, p. 402; Pl. XII, Fig. 4B. Hassall, 1845, p. 392. Ralfs, 1846, p. 159; Pl. XV, Fig. 4B.

S. quadricauda var. *β.* Ralfs, 1848, p. 190; Pl. XXXI, Fig. 12G. Balsamo, 1900, p. 266.

Scenodesmus caudatus var. *minor.* Kützing, 1849, p. 186.

Scenodesmus quadricauda var. *β.* Archer, 1861, p. 753; Pl. I, Fig. 42.

S. quadricauda forma *abundans.* Lagerheim, 1883, p. 64; Pl. II, Fig. 20. Marsson, 1901A, pp. 96, 106. Chodat, 1902, p. 214. Pascher, 1903, p. 175. Collins, 1909, p. 169.

S. quadricauda var. *abundans.* Hansgirg, 1886, p. 115. de Toni, 1889B, p. 566. Gutwinski, 1891, p. 302. W. West, 1892A, p. 194. West and West, 1895, p. 83. West and West, 1897B, p. 500. G. S. West, 1899, p. 221. Lagerheim, 1900, p. 10. West and West, 1901A, p. 197. West and West, 1901B, p. 120. West and West, 1902B, p. 64. Volk, 1903, p. 104. West and West, 1904, p. 531. Fink, 1905, p. 25. Hansgirg, 1905, p. 458. Huber, 1905, p. 57.

Volk, 1905, p. 65. West and West, 1905, p. 270. Fritsch, 1906, p. 205. Schorler, Thallwitz und Schiller, 1906, p. 247. Borge, 1907A, p. 58. Borge, 1907B, p. 4. Buchanan, 1907, p. 81. Migula, 1907, p. 655. Selk, 1907, pp. 57, 68, 73, 98, 103, 108. Teodoresco, 1907, p. 130. West and West, 1909B, p. 184. Gugliemetti, 1910, p. 32. Klugh, 1911, p. 97. Borge, 1913, p. 60. Brunnthaler 1913, pp. 168, 171; Fig. 18.

S. caudatus var. *abundans.* Wolle, 1887, p. 172. Riabinine, 1889A, p. 303. Riabinine, 1889B, p. 47. Snow, 1903, p. 391. Dorogoslaisky, 1904, p. 224.

S. quadricauda var. *hyperabundans.* Gutwinski, 1890, p. 63. Schröder, 1879C, p. 45. Schmidle, 1900A, p. (111). Migula, 1907, p. 656.

S. quadricaudatus var. *abundans.* Lemmermann, 1893, p. 524.

S. caudatus var. *hyperabundans.* Bohlin, 1897, p. 23. Kaiser, 1908, p. 163.

S. quadricauda var. *setosus abundans.* Volk, 1905, p. 65.

Scenodesmus caudatus var. *abundans.* Conn and Webster, 1908, p. 35; Pl. VI. Fig. 32.

Cellulis ovatis vel oblongi-ovatis. Membranae cellularum terminalum cum aculeis in polis atque inter polos. Poli cellularum interiorum cum aculeis. Dimens. cell. 8 x 4, 9 x 4, 10 x 4, 10 x 5, 11 x 5.5, 12 x 7 μ. Long. acul. 4–7. 5 μ.

Supplementary spines on the middle of the terminal cells were noted quite early in the study of the genus, Ehrenberg (1838) figuring a colony of his *Arthrodesmus quadricaudatus* with a median spine on each of the terminal cells, in addition to the polar spines. Ralfs (1845) also gave figures of *S. quadricauda* (Turp) de Bréb. with the external cells having three spines and called it the variety β, but gave it no name. Kützing (1849) established his *Scenodesmus caudatus* var. *minor* on the strength of Ralf's figures, but the combination *S. minor* cannot be used to name this species since a *S. minor* has already been established by Kützing. Since *S. caudatus* forma *abundans* Kirch was the next name applied to this species the combination *S. armatus* (Kirch.) Chodat is the proper name.

The number and position of the spines in the forms which I have isolated is quite variable. There are always the two polar spines on the terminal cells but there may be one spine (Figs. 133, 138) or there may be two to three spines (Figs. 135, 139) in the middle of the cell. The two terminal cells of the same coenobe need not necessarily have the same number of horns. Figure 136 shows an instance in which one cell has three spines while the other has four. Although there is always one spine at the end of the pole, the position of which corresponds to that of *S. quadricauda*, there are frequently one or two more (Figs. 139, 133).

Correlated with the presence of numerous spines on the terminal cells is that of spines on the poles of the median cells. The number and position of these median polar spines is even more variable than is the case with the marginal terminal spines. There may be one or more on each pole of all median cells (Fig. 135); or one pole may possess one or more spines and the other none (Fig. 139). An extreme development of this condition is the presence of only one spine on the median cells of the coenobe. (Fig. 136).

GEOGRAPHICAL DISTRIBUTION

EUROPE. *Austria-Hungary.* (Gutwinski, 1890; Hansgirg, 1886, 1905; Pascher, 1903; Riabinine, 1889A, 1889B). *England* (Fritsch, 1906; Hassall, 1845; Ralfs, 1845, 1846, 1848; G. S. West, 1899; West and West, 1897B, 1901B, 1909B). *Germany* (Kaiser, 1908; Kirchner, 1878; Lemmermann, 1893; Marsson, 1901A; Schmidle, 1900A; Schröder, 1897C; Schorler, Thallwitz und Schiller, 1906; Selk, 1907; Volk, 1903, 1905). *Ireland* (W. West, 1892A; West and West, 1902B). *Italy* (Gugliemetti, 1910). *Roumania* (Teodoresco, 1907). *Russia* (Dorogoslaisky, 1904; Gutwinski, 1891). *Scotland* (West and West, 1901, 1905, 1909B). *Sweden* (Borge, 1907A, 1913; Lagerheim, 1883; Petersen, 1911). *Switzerland* (Chodat, 1902, 1913; Huber, 1905).

AFRICA. *Madagascar* (West and West, 1895).

ASIA. *Ceylon* (West and West, 1901A).

AMERICAS. *Argentina* (Borge, 1907B). *Brazil* (Bohlin, 1897). *Canada* (Klugh, 1911). *United States* (Buchanan, 1907; Collins, 1909; Conn and Webster, 1908; Fink, 1905; Snow, 1903; Wolle, 1887).

Var. **longicauda** nov. var. (Pl. XXX: Figs. 121–125.)

Dimens. cell. 7 x 3, 7 x 3.5, 8 x 4, 9 x 6 μ. Long. acul. 10–6 μ.

In this variety the spines are not as abundant as on the typical form, three to four being the usual number for the terminal cells, while rarely more than one is found at each pole of the median cells.

Var. **spicatus** (West and West) nov. comb. (Pl. XXVII: Fig. 51; Pl. XXXI: Figs. 141–146.)

S. spicatus. West and West, 1898, p. 335. West and West, 1901B, p. 120. G. S. West, 1904B, p. 220; Fig. 92L. Volk, 1905, p. 65. Brunnthaler, 1913, pp. 166, 170; Fig. 9. Chodat, 1913, p. 25.

"S. cellulis plerumque binis, ellipticis, diametro circiter 2-plo longioribus, supra marginem exteriori serie spinarum brevium 6–7 praeditis. Long. cell. 7.5–9 μ. Lat. cell. 4 μ. Long. spin. 2–2.5 μ."

The mature cells of the form which I have isolated in pure culture from the Yahara River below Lake Monona (Wisconsin) have practically the same dimensions as those given by West and West, being 3.5 x 7 to 4 x 10 μ with spines 2–2.5 μ long. The two-celled colonies in my cultures have the five to seven spines arranged as the authors describe (Figs. 143, 146), but four-celled colonies occur much more frequently than do the two-celled ones. The poles of the middle cells, in the four-celled colonies, each bear one or two spines, 2–3 μ long (Figs. 141, 142) and the outer margin of the terminal cells bears five to seven spines. The fact that four-celled colonies have spines on the middle cells as well as on the sides of the outer cells is sufficient warranty for regarding this as a variety of *S. abundans.*

Var. **brevicauda** nov. var. (Pl. XXX: Figs. 126–132.)

Dimens. cell. 5 x 2.5, 6 x 2.5, 6 x 3, 8 x 4, 8 x 5 μ. Long. acul. 1.5–3 μ.

Resembling the variety *spicatus* but different from it in the number of spines, the outer cells never having more than five spines. The cells in my pure cultures also are smaller than the variety *spicatus.*

Var. **asymmetrica** (Schröder) nov. comb. (Pl. XXVII: Figs. 45–46.)

S. quadricauda var. *asymmetrica.* Schröder, 1897C, p. 45; Pl. II, Fig. 5. Garbini, 1899B, p. 275. Schmidle, 1900A, p. (111). Migula, 1907, p. 655; Pl. XXXV (L), Fig. 5. Chodat, 1913, p. 22.

Coenobia plerumque 4-cellularum. Apices cellularum terminalium cum singulo aculeo. Omnes cellulae coenobi cum singulo aculeo, latitudinaliter disposito.

The arrangement of a single spine on one side only of the cell wall, in addition to spines on the four corners of the coenobe, is peculiar to this variety alone.

25. **S. longus** Meyen. (Pl. XXVIII: Fig. 54; Pl.: XXXI: Figs. 156–158.)

Meyen, 1829, p. 774; Pl. XLIII, Fig. 28. Kützing, 1833, p. 607. Meyen, 1835, p. 250.

Scenodesmus Naegelii. de Brébisson, 1856, p. 158.

S. quadricauda var. *Naegelii.* Rabenhorst, 1868, p. 65. de Toni, 1889B, p. 566. Hansgirg, 1905, p. 458. Brunnthaler, 1907, p. 207. Migula, 1907, p. 655. Brunnthaler, 1913, pp. 168, 171.

S. caudatus forma *setosus.* Kirchner, 1878, p. 98.

S. caudatus forma *horridus.* Kirchner, 1878, p. 98.

S. quadricauda forma *setosus.* Lagerheim, 1883, p. 63. Chodat, 1902, p. 214; Fig. 135. Pascher, 1903, p. 175. Collins, 1909, p. 169.

S. quadricauda forma *horridus.* Lagerheim, 1883, p. 64; Pl. II, Fig. 19. Chodat, 1902, p. 214. Pascher, 1903, p. 175. Collins, 1909, p. 169.

S. quadricauda var. *setosus.* Hansgirg, 1886, p. 115. de Toni, 1889B, p. 566. Gutwinski, 1891, p. 302. Lagerheim, 1900, p. 10. Volk, 1903, p. 104. Hansgirg, 1905, p. 458. Volk, 1905, p. 65. Migula, 1907, p. 655. Selk, 1907, p. 98. Teodoresco, 1907, p. 130. Borge, 1909, p. 16. Gugliemetti, 1910, p. 32. Brunnthaler, 1913, pp. 168, 171.

S. quadricauda var. *horridus.* Hansgirg, 1886, p. 115. de Toni, 1889B, p. 566. Borge, 1895, p. 7. Boergesen, 1899B, p. 333. Schorler, 1900, p. 5. Boergesen, 1901A, p. 240. Borge, 1901B, p. 13. Fritsch, 1902, p. 582. G. S. West, 1904B, p. 220; Fig. 92G. Hansgirg, 1905, p. 458. Migula, 1907, p. 655. Selk, 1907, p. 99. Borge, 1909, p. 16. West and West, 1909B, p. 184. Borge, 1911, p. 204. Brunnthaler, 1913, pp. 168, 171; Fig. 17.

S. caudatus var. *setosus.* Wolle, 1887, p. 172. Riabinine, 1889A, p. 303. Riabinine, 1889B, p. 47. Snow, 1903, p. 391. Dorogoslaisky, 1904, p. 224. Honigman, 1909, p. 54; Pl. II, Fig. 7.

S. caudatus var. *horridus.* Wolle, 1887, p. 172; Pl. CLVI, Fig. 15. Riabinine, 1889A, p. 303.

S. antennatus var. *rectus.* Wolle, 1887, p. 172; Pl. CLVI, Figs. 16-17. de Toni, 1889B, p. 567. Stokes, 1893, p. 51.

S. quadricauda var. *bicaudatus.* Hansgirg, 1890B, p. 9. Hansgirg, 1892, p. 230. Volk, 1903, p. 104. Volk, 1905, p. 65. Selk, 1907, pp. 68, 99, 108, 115. Migula, 1907, p. 655. Chodat, 1913, p. 22.

S. quadricauda var. *variabilis*. Hansgirg, 1892A, p. 230. Hansgirg, 1892B, p. 119. Migula, 1907, p. 655.

S. quadricaudatus var. *setosus*. Lemmermann, 1893, p. 524.

S. quadricaudatus var. *horridus*. Lemmermann, 1893, p. 524.

S. rectus. Balsamo, 1900, p. 267.

S. qaudricauda forma *Naegelii*. Chodat, 1902, p. 214; Fig. 135.

Scenodesmus caudatus var. *setosus*. Conn and Webster, 1908, p. 35; Pl. VI, Fig. 34.

Scenodesmus antennatus var. *rectus*. Conn and Webster, 1908 p. 35 Pl. VI, Fig. 39.

Coenobia 2–8 cellularum, cellulis oblongo-cylindricis vel ovatis, utroque polo rotundatis, chlorophoris singulo, pyrenoida singula. Apices cellularum cum singulo aculeo, aculeis 2–4 μ longis. Membrana cellularum sine aculeis inter apices. Dimens. cell. 8 x 4, 9 x 4, 11 x 5 μ.

This form is generally called *S. quadricauda* var. *horridus*, although Meyen was the first to maintain that spines on the poles of the central cells in the colony constituted a specific character. In his original description of the species, however, this is not mentioned but the revival of the name *longus* is warranted from his statement made in 1835 where he compares *S. quadricauda* (Turp) de Bréb. and *S. longus* by saying "Die Beiname quadricaudatus würde übrings nicht passend sein, denn wir haben schon mehrmals den Scenedesmus longus mit ausgebildeten 16 Härnern gesehen, indem nämlich jede Zelle 2 Härner zeigt. . ."

Scenedesmus Naegelii de Bréb. antedates Kirchner's description of supplementary spines on the poles of the middle cells in the colony. This species was founded on drawings by Nägeli of *S. caudatus* Corda, one of which is seen in my Pl. XXVIII, Fig. 54.

The varieties *horridus* and *setosus* of *S. quadricauda* described by Kirchner differ from one another in the number of spines on the poles of the median cells in the coenobe; the variety *horridus* having spines on both poles of all cells, whereas they do not occur on some of the median cells in the variety *setosus*.

Three different strains each having spines on both the middle and terminal cells as a constant character were isolated. This fact justifies regarding *S. longus* as a separate species. Conversely many different strains have been isolated in which the spines are found on the terminal cells of the coenobe only; so that the distinction between *S. longus* and *S. quadricauda* is very sharp.

The occurrence and number of spines on the median cells of the colony, however, is quite variable. Spines may occur on both poles of every cell in the colony (Fig. 157) or not (Fig. 156). Again there may be more than one spine at each pole of a cell, this cell being either terminal or median (Fig. 158).

GEOGRAPHICAL DISTRIBUTION

EUROPE. *Austria-Hungary* (Brunnthaler, 1907; Hansgirg, 1886; 1890B, 1892A, 1892B, 1905; Pascher, 1903; Riabinine, 1889A, 1889B). *England* (Fritsch, 1902; G. S. West, 1904B). *Germany* (Honigman, 1909; Kirchner, 1878; Lemmermann, 1893; Meyen, 1829; Schorler, 1900; Selk, 1907; Volk, 1903, 1905). *Italy* (Gugliemetti, 1910). *Roumania* (Teodoresco, 1907). *Russia* (Dorogoslaisky, 1904; Gutwinski, 1891). *Scotland* (West and West, 1909B). *Sweden* (Lagerheim, 1883; Borge, 1895). *Switzerland* (Chodat, 1902).

ASIA AND OCEANIA. *Australia* (Borge, 1911).

AMERICAS. *Canada* (Borge, 1909). *Pategonia* (Borge, 1901B). *United States* (Borge, 1909; Collins, 1909; Conn and Webster, 1908; Snow, 1903; Wolle, 1887).

POLAR AND SUB-POLAR REGIONS. *Faeroes.* (Boergesen, 1899B, 1901A).

Var. **brevispina** nov. var. (Pl. XXXI: Figs. 151–155.)

Cellulae longiores atque angustiores. Aculei breviores. Dimens. cell. 9 x 3, 9 x 4, 11 x 4, 11 x 4.5, 11 x 5 μ. Long. acul. 2 μ.

This variety differs from the foregoing in that the cells are longer and narrower with shorter spines, which are rarely absent from the median cells. The shortness of the spines suggests *S. denticulatus* Lag., but since they are not broad at the base this form is classed with *S. longus* instead of *S. denticulatus.*

Var. **minutus** nov. var. (Pl. XXXI: Figs. 147–150.)

Cellulis oblongi-ovalis longitudinibus circiter 2.5–plo latitudinibus. Aculei breves. Dimens. cell. 6.5 x 2, 7 x 2, 7 x 3, 8 x 3 μ. Long acul. 1.5–2 μ.

The largest cells found in pure cultures of this form do not reach the minimal size of the other varieties. The spines are quite like *S. longus* var. *brevispina* in size and arrangement.

Var. **ellipticus** (West and West) nov. comb. (Pl. XXVII: Fig. 44.)

S. quadricauda var. *ellipticum.* West and West, 1895, p. 83; Pl. V, Fig. 6. Balsamo, 1900, p. 266. G. S. West, 1904, p. 287 Collins, 1909, p. 169.

S. ellipticus. Chodat, 1913, p. 69.

"Var. cellulis perfecte ellipticis, 4 in seriem rectam dispositis, cellulis terminalibus spinis binis validis curvatis extrorsum, cellulis medianis spina singula curvata extrorsum alternatim dispositis ornatis. Long. cell. 14–15 μ; lat. cell. 7.5 μ."

Known only from Madagascar (West and West) and Barbados (G. S. West).

Var. **dispar** (de Bréb) nov. comb. (Pl. XXVII: Fig. 41.)

Scenodesmus dispar. de Brébisson, 1856, p. 159; Pl. I, Fig. 32. Archer, 1861, p. 753.

S. dispar. Rabenhorst, 1868, p. 65. Lagerheim, 1883, p. 65. de Toni, 1889B, p. 566. Balsamo, 1900, p. 266. West and West, 1902B, p. 64; Pl. I, Fig. 10. Adams, 1908, p. 35.

S. quadricauda var. *dispar* Brunnthaler, 1913, pp. 168, 171.

"S. corpusculis fusiformibus, oblongis, binis vel quaternis irregulariter alternantibus, duobus primis uno apice cuspidatis altero muticis, duobus aliis similibus sed reversis, extrimis dorsi apice cuspidatis."

The position of the spine is probably valueless in differentiating this from the other varieties. The pointed ends of the cells distinguish this variety from the others. It has been found in England (West and West) and France (de Brébisson).

var. **apiculatus** (West and West) nov. comb. (Pl. XXVI: Fig. 36.)

S. alternans var. *apiculatus.* West and West, 1894, p. 16; Pl. II, Fig. 38. West and West, 1897B, p. 500. West and West, 1902B, p. 63.

S. bijugatus var. *alternans* forma *apiculatus.* Chodat, 1902, p. 213. Brunnthaler, 1913, pp. 169, 172.

"Var. cum apiculo ad finem liberum utraeque cellulae. Long. cell. (Cum apice) 7.5–9.5 μ; lat, cell. 5–5.5 μ."

This variety has been found in England (West and West, 1894, 1897B) and Ireland (West and West, 1902B).

26. **S. quadricauda** (Turp.) de Bréb. (Pl. XXVII: Fig. 39; Pl. XXXI: Figs. 172–175; Pl. XXXII: Fig. 176.)

de Brébisson, 1835, p. 66. Meneghini, 1840, p. 206. Ralfs, 1848, p. 190; Pl. XXXI, Figs. 12A-12F. Bailey, 1851, p. 29. Griffith and Henfrey, 1856, p. 565; Pl. X, Fig. 50. Archer, 1857, p. 40. Rabenhorst, 1868, p. 65; Figs. 34G-34H. Hohenbühel-Heufler, 1871, p. 318. Olney, 1872, p. 135. Wittrock, 1872, p. 31. Archer, 1874, p. 329. Nordstedt, 1877, p. 15. Wille, 1879, p. 30. Vorce, 1881, p. 59; Pl. VII, Fig. 136. Cooke, 1882, p. 34; Pl. XIII, Fig. 8. Nordstedt, 1882, p. 46. Spencer, 1882, p. 296; Pl. XXIII, Fig. 11. Acheson, 1883, p. 418. Griffith and Henfrey, 1883, p. 679, Pl. XIV, Fig. 50. Martel, 1884, p. 188. Schaarschmidt, 1884, p. 249. Wille, 1884, pp. 30, 45. Boldt, 1885, p. 97. Cooke, 1885. Pâque, 1885, p. 52. de Wildemann, 1885, p. 123. Bennett, 1886, p. 3. Campbell, 1886, p. 93. Hansgirg, 1886, p. 115; Fig. 62. Parfitt, 1886, p. 392. de Toni et Levi, 1886, p. 67. Beck, 1887, p. 274. Bennett, 1887, p. 9. Jones, 1887, p. 115. Lagerheim, 1887, p. 194. Martel, 1887A, p. 340. Martel, 1887B, p. 11. de Toni et Levi, 1887, p. 1584. Balsamo, 1888, p. 40. König, 1888, p. 89. Nordstedt, 1888, p. 19. Hansgirg, 1889, p. 132. de Toni, 1889B, p. 565. W. West, 1889A, p. 290. de Wildemann, 1889, p. 8. Andersson, 1890, p. 5. Hansgirg, 1890A, p. 112. Roy, 1890, p. 338. W. West, 1890, p. 298. de Wildemann, 1890A, p. 137. de Wildemann, 1890B, p. 155. Borge, 1891, p. 6. Hansgirg, 1891, p. 317. Ianouchkievitch, 1891, p. 290. de Toni, 1891, p. 272. W. West, 1891A, p. 248. W. West, 1891B, p. 421. Hansgirg, 1892B, p. 119. Möbius, 1892, p. 435. de Toni, 1892, p. 108. Turner, 1892, p. 161. W. West, 1892A, p. 193. W. West, 1892B, p. 738. Lagerheim, 1893, p. 158. Schmidle, 1893A, p. 13. Borge, 1894, p. 9. Schmidle, 1894, p. 43; Tilden, 1894, p. 27. Borge, 1895, p. 7. West and West, 1895, p. 83; Pl. V, Figs. 4-5. Boergesen, 1896, p. 36. Borge, 1896, p. 7. Lemmermann, 1896, p. 108. West and West, 1896, p. 381. Zacharias, 1896, p. 75. Chodat, 1897, p. 291. Farlow in Trelease, 1897, p. 196. Gutwinski, 1897A, p. 3. Pitard, 1897, p. 516. Schmula, 1897, p. 35. Schröder, 1897A, p. 372. Schröder, 1897B, p. 487. Schröder, 1897C, p. 45. West and West, 1897B, p. 500. Chodat, 1898, pp. 166, 175. Forti, 1898, p. 118. Lemmermann, 1898C, p. 249. Mez, 1898, p. 149; Pl. IV, Fig. 167. Nitardy, 1898, p. 104. Schorler, 1898, p. 38. Zacharias, 1898, p. 93. Boergesen, 1899A, p. 135. Boergesen, 1899B, p. 333. Borge, 1899, p. 8. Forti, 1899, p. 89. Garbini, 1899A, p. 15. Garbini, 1899B, p. 275. Iwanoff, 1899, p. 379. Lemmermann, 1899, p. 113. Levander, 1899, pp. 49, 54, 70, 80, 93, 96. Marsson, 1899, pp. 171, 253, 254. Prowazek, 1899, p. 477. Schröder, 1899, p. 22. de Toni et Forti, 1899A, p. 179. de Toni et Forti, 1899B, p. 792. G. S. West, 1899, p. 221. Zacharias, 1899, pp. 81, 83, 88, 90. Amberg, 1900, p. 126. Balsamo, 1900, p. 266. Borge, 1900, p. 3. Chodat, 1900, p. 3. Filarsky, 1900, p. 145. Forti, 1900, p. 30. Lagerheim, 1900, p. 10. Lemmermann, 1900A, p. 95. Lemmermann, 1900B, p. 138. Lemmermann, 1900C, pp. 334, 335, 339. Levander, 1900, p. 20. Schorler, 1900, p. 5. Waldvogel, 1900, pp. 302, 311, 312. Boergesen, 1901, p. 240. Borge, 1901A, p. 101. Borge, 1901B, p. 13. Chodat, 1901, pp. 1309, 1310. Fanning, 1901, p. 117; Pl. XIV, Fig. 3. Garbini, 1901, p. 73. Lemmermann, 1901B, p. 80. Lemmermann, 1901C, p. 92. Levander, 1901, p. 22. Lindau, 1901, pp. 131, 136, 140, 150, 153, 156, 161. Marquand, 1901, p. 321. Marsson, 1901A, pp. 90, 96, 101, 106, 115. Marsson, 1901B, p. 96. Treboux, 1901, p. 478. West and West, 1901A, p. 197. West and West, 1901B, p. 120. Wille, 1901, p. 11. Blumentritt, 1902, p. 86. Chodat, 1902, p. 213. Forti, 1902, p. 60. Fritsch, 1902, p. 582. Gutwinski, 1902, p. 576. Larder, 1902, p. 59. Riddle, 1902, p. 317. Voigt, 1902, p. 76. West and West, 1902B, p. 64. Zykoff, 1902, p. 61. Amberg, 1903, p. 78. Boergesen and Ostenfeld, 1903, pp. 614, 615. Fritsch, 1903, p. 635, 643, 646. Gutwinski, 1903, p. 204. Lagerheim, 1903, p. 362. Lemmermann, 1903A, p. 346. Lemmermann, 1903B, p. 81. Lemmermann, 1903C, p. 119. Schmidle, 1903, p. 80. W. West, 1903, p. 100. Zacharias, 1903B, pp. 254, 262. Comère, 1904, p. 62. Heering und Homfeld, 1904, p. 83. Lemmermann, 1904A, pp. 27, 33, 37, 39, 55, 71, 72, 73, 75, 80, 87, 90, 92, 96, 158. Lemmermann, 1904B, pp. 300, 301, 302, 303, 305. Lemmermann, 1904C, p. 159. Marquand, 1904, p. 269. Moreto, 1904, p. 440. Nitardy, 1904, p. 318. Schmidle, 1904, p. 4, 30, 32. Skorikow, 1904, pp. 355, 360. G. S. West, 1904A, p. 287. G. S. West, 1904B, p. 220; Figs. 92D-92F. West and West, 1904, p. 531. Zacharias, 1904, pp. 193, 201, 212. Fink, 1905, p. 25. Forti, 1905, pp. 5, 9. Fritsch, 1905, p. 164. Huber, 1905, p. 57. Krause, 1905, p. 110. Lauterborn, 1905, p. 645. Lemmermann, 1905A, p. 630. Lemmermann, 1905B, pp. 158, 160, 162, 163. Lemmermann, 1905C, pp. 166, 167, 168. Riddle, 1905, p. 268. Skorikow, 1905, p. 105. Trotter, 1905, p. 45; Fig. 23. West and West, 1905, p. 270. Zacharias, 1905, pp. 268, 274. Fritsch, 1906, p. 205. Hardy, 1906, p. 38. Lemmermann, 1906, pp. 347, 350, 353. Pascher, 1906, p. 168. Petkoff, 1906A, p. 358. Ruttner, 1906, p. 10. Schorler, Thallwitz und Schiller, 1906, p. 247. Tanner-Fullmann, 1906, p. 158. West and West, 1906A, p. 489. Borge, 1907A, p. 58. Borge, 1907B, p. 4. Brunnthaler, 1907, p. 207. Buchanan, 1907, p. 81. Huber, 1907, p. 455. Krause, 1907, pp. 218, 220, 221, 222. Larsen, 1907A, p. 358. Larsen, 1907B, p. 104. Lauterborn, 1907, p. 137. Lemmermann, 1907A, p. 264. Lemmermann, 1907B, p. 410. Migula, 1907, p. 655; Pl. XXXII,

Fig. 16. Ostenfeld, 1907, p. 384. Le Roux, 1907, p. 244. Schorler, 1907, p. 356. Tanner-Fullmann, 1907, pp. 122, 124, 125, 232. G. S. West, 1907, p. 139. West and West, 1907, p. 229. Zacharias, 1907, p. 73; Fig. 34. Adams, 1908, p. 35. Bachmann, 1908, p. 44. Bloomfield, 1908, p. 782. Forti et Trotter, 1908, pp. 32, 77. Kolkowitz und Marsson, 1908, p. 514. Lauterborn, 1908A, p. 80. Lauterborn, 1908B, pp. 23, 27. Lemmermann, 1908A, p. 167. Lemmermann, 1908B, p. 126. Lemmermann, 1908D, p. 395. Lemmermann, 1908E, p. 405. Marsson, 1908A, pp. 30, 32, 40, 55. Marsson, 1908B, pp. 93, 95, 96, 107, 110, 111, 114, 116, 120. Ostenfeld, 1908, p. 348. Schneider, 1908, p. 46. Bernard, 1909, p. 77; Pl. VI, Figs. 164-167. Borge, 1909, p. 16. Chodat, 1909, p. 99; Pls. XI, XII. Collins, 1909, p. 169. Eyferth, 1909, p. 116; Pl. III, Fig. 21. Gutwinski, 1909, p. 435. Lauterborn, 1909, p. 539, 541. Marsson, 1909, pp. 545, 547, 557, 559, 561, 562. Ostenfeld, 1909, p. 174. G. S. West, 1909A, p. 29. G. S. West, 1909C, p. 245. G. S. West, 1909D, p. 69. West and West, 1909B, p. 184. Apstein, 1910, p. 667. Lemmermann, 1910A, p. 294, 298. Gugliemetti, 1910, p. 32. Hayden, 1910, p. 44. Kofoid, 1910, p. 31. Keissler, 1910, pp. 353, 357. Steuer, 1910, p. 430; Fig. 222F. Bachmann, 1911, p. 191. Brunnthaler, 1913, p. 168, 171. Chodat, 1913, p. 15. Smith, 1914A, p. 290, Pl. XVII. Smith, 1914B, p. 1193; Pl. LXXXIX.

Achnanthes quadricauda. Turpin, 1820, Fig. 13. Turpin, 1828, p. 311; Pl. XIII, Fig. 6.

S. magnus. Meyen, 1829, p. 774; Pl. XLIII, Figs. 26, 27, 29. Kützing, 1833, p. 606.

Scenodesmus quadricaudatus. Ehrenberg, 1834, p. 309. Kützing, 1843, p. 164.

Scenodesmus quadricauda var. *cornutus.* Ehrenberg, 1834, p. 311.

S. caudatus. Corda, 1834, p. 123; Pl. IV, Fig. 50. Zanardini, 1857, p. 250. Grunow, 1858, pp. 499, 502. Reinsch, 1867, p. 83. Kirchner, 1878, p. 98. Wolle, 1881, p. 213. Artari, 1884, p. 133. Hansgirg, 1884, p. 365. Wolle, 1887, p. 172. Alexenko, 1888, p. 159. de Wildemann, 1888, p. 71; Figs. 1-26. Heiden, 1889, p. 5. MacKenzie, 1889, p. 271. Riabinine, 1889A, p. 302. Riabinine, 1889B, p. 47. W. West, 1889B, p. 206. Chmielweski, 1890, p. 92. Alexenko, 1891, p. 62. Beyerinck, 1891, p. 279. Weiss, 1892, p. 37. Chodat et Malinesco, 1893B, p. 640; Figs. 1, 2, 6-8. Jeliffe, 1893A, p. 243. Kellermann and Werner, 1893, p. 389. Schröder, 1893, p. 72. Stokes, 1893, p. 72. Alexenko, 1894, p. 72. Jeliffe, 1894, p. 594. Alexenko, 1895, p. 92. Bohlin, 1897, p. 23. Jeliffe and Vogel, 1897, p. 724; Fig. 51. Iwanoff, 1899, p. 379. Jeliffe, 1899, p. 5. Senn, 1899, p. 72. Balsamo, 1900, p. 266. Neuweiler, 1901, p. 45; Pl. III, Figs. 9-10. Bohlin, 1902, p. 43. Skorikow, 1902, p. 563. Snow, 1903, p. 391. Comère, 1904, p. 62. Früh und Schröter, 1904, p. 364. Marsson, 1904, p. 139. Suhr, 1905, p. 252. Bachmann, 1908, p. 21. Brown, 1908, p. 21. Brown, 1908, p. 247. Quelle, 1908, p. 43. Kaiser, 1908, p. 163. Andrews, 1909, p. 379. Brown, 1909, p. 335. Honigmann, 1909, p. 54. Bethge, 1911, p. 498.

Arthrodesmus quadricaudatus. Ehrenberg, 1836. Ehrenberg, 1838, p. 150; Pl. X, Fig. 16. Bailey, 1841, p. 292; Pl. I, Figs. 18A-18B. Pritchard, 1841, p. 189. Cantor, 1842, p. 493. Ehrenberg, 1843, pp. 337, 338. Pokorny, 1854, p. 58.

S. quadricaudatus. de Brébisson, 1839, p. 271. Hassall, 1845, p. 392; Pl. XCII, Fig. 12. Ralfs, 1845, p. 402; Pl. XII, Fig. 4. Ralfs, 1846, p. 159; Pl. XV, Fig. 4. Reinsch, 1877, p. 238. W. West, 1888, p. 748. Lemmermann, 1891, p. 148. Lemmermann, 1893, p. 524. Lemmermann, 1895A, p. 41. Lemmermann, 1895B, p. 296. Tassi, 1895, p. 12. Schröder, 1896, p. 46. Lemmermann, 1897, p. 108. Strohmeyer, 1897, p. 6. Lemmermann, 1898A, p. 192. Balsamo, 1900, p. 267. Dalla Torre und von Sarnthein 1901, p. 35. Kellermann, 1902, p. 223. Snow, 1903, p. 391. Zacharias, 1903A, p. 203.

Scenodesmus caudatus. Kützing, 1845, p. 139. Kützing, 1849, p. 186. Nägeli, 1849, p. 91; Pl. V, Figs. 2A-2E. Rabenhorst, 1850, p. 517. Kirchner, 1891, p. 18. Conn and Webster, 1908, p. 35; Pl. VI, Fig. 38.

Scenodesmus quadricauda. de Brébisson, 1856, p. 158. Archer, 1861, p. 753; Pl. I, Figs. 40 ,41, 43.

S. caudatus forma *typicus.* Kirchner, 1878, p. 98.

S. quadricauda forma *typicus.* Lagerheim, 1883, p. 63. Chodat, 1902, p. 213; Figs. 133-134. Collins, 1909, p. 169. Petersen, 1911, p. 160; Fig. 3.

S. quadricauda var. *genuinus.* Hansgirg, 1886, p. 115. de Toni, 1889B, p. 566. Volk, 1903, p. 103. Hansgirg, 1905, p. 458. Stadler, 1905, p. 236. Volk, 1905, p. 65. Selk, 1907, pp. 8, 57, 68, 79, 85, 91, 94, 98, 103, 108, 115. Gugliemetti, 1910, p. 32.

S. caudatus var. *typicus.* Wolle, 1887, p. 172; Pl. CLVI, Figs. 11-14. Webber, 1889, p. 1012. Dorogoslaisky, 1904, p. 224.

S. obtusus var. *cornutus.* Franzé, 1892, p. 149; Pl. III, Fig. 7. de Wildemann, 1897B, p. 78.

S. variabilis var. *cornutus.* de Wildemann, 1893A. de Wildemann, 1893B, p. 91. Schmidle, 1895, p. 305. de Wildemann, 1895, p. 26. de Wildemann, 1896. de Wildemann, 1897A, p. 61. de Wildemann, 1897B, p. 49. de Wildemann, 1899, p. 11. Fournier, 1903, p. 28. Schodduyn, 1909, p. 166.

S. quadricauda forma *genuinus.* Pascher, 1903, p. 175.

S. quadricauda var. *typicus.* Migula, 1907, p. 655. Teodoresco, 1907, p. 129. Brunnthaler, 1913, pp. 168, 171; Fig. 16.

Scenodesmus caudatus var. *typicus.* Conn and Webster, 1908, p. 35; Pl. VI, Fig. 33.

S. genuinus. Kofoid, 1910, p. 31.

"Coenobiis e cellulis 2–8, cylindraceo-oblongis, utroque polo obtuso-rotundatis serie aut simplici aut duplici alternante dispositis constitutis; cellulis omnibus rectis, medianis inermibus, extimis utroque apice saepius dorso armatis." Dimens. cell. 11 x 3.5, 12.5 x 4.5, 15 x 6, 16 x 6, 16.5 x 6 μ. Long. acul. 10–12 μ.

This species is the most widely distributed of any of the genus. Calling anything with four horns *S. quadricauda* and failing to observe the accessory horns that separate this species from *S. longus* Meyen and *S. abundans* (Kirch.) Chod., probably accounts for many reports of it, although in spite of these possible errors of identification the species undoubtedly occurs in abundance everywhere.

Chodat (1913) has added considerably to the confusion in the systematic classification of the species *Scenedesmus* by his work in pure cultures. He describes many new species but since the bases for their specific differentiation is physiological rather than morphological, it is difficult to identify his species, especially since he gives no cell measurements. There is no justification for the establishing his *S. quadrispina*, *S. longispina*, and *S. nanus* as distinct species; since they are all so clearly related to *S. quadricauda*, in having spines only on the poles of the terminal cells. His work is of value to the systematist, however, in pointing out that it is possible to isolate strains which vary within certain spacial limits, while others with the same external morphological characters vary within other spacial limits. This is particularly true of the alga known as *S. quadricauda*.

Reinsch (1867) attempted to classify these varieties on the basis of their size but failed to name the different groups into which he separated them. Since his work was not done on material in pure culture, the limits he set for variations were largely a matter of judgment rather than accurate knowledge.

The varieties described here have all been obtained in pure culture; so that the exact limits of their variation is accurately determined. In spite of the fact that a considerable number of varieties of *S. quadricauda* are described I believe that field material can be identified by means of the cell measurements given.

The form for which the name *S. quadricauda* is retained has been isolated several times from various stations in this vicinity. It is selected as the typical form because its dimensions are about in the middle of those given by de Toni for the variations in size for the cells of *S. quadricauda*.

GEOGRAPHICAL DISTRIBUTION

EUROPE. *Austria-Hungary* (Alexenko, 1888, 1894, 1895; Blumentritt, 1902; Brunnthaler, 1907; Filarsky, 1900; Franzé, 1892; Grunow, 1858; Gutwinski, 1897A, 1909; Hansgirg, 1884, 1886, 1889, 1890A, 1891, 1892B, 1905; Ianouchkievitch, 1891; Beck, 1887; Pascher, 1903, 1906; Pokorny, 1854; Prowazek, 1899; Riabinine, 1889A, 1889B; Ruttner, 1906; Stadler, 1905). *Belgium* (Conrad et Kufferath, 1912; Pâque, 1885; de Wildemann, 1885, 1888, 1890A, 1890B, 1893B, 1895, 1897B). *Bulgaria* (Petkoff 1906A). *Denmark* (Chodat, 1900; W. West, 1891B). *England* (Bennett, 1886, 1887; Bloomfield, 1908; Cooke, 1882, 1885; Fritsch, 1902, 1903, 1905, 1906; Griffith, 1912; Griffith and Henfrey, 1856, 1883, 1885; Hassall, 1845; Larder, 1902; Parfitt, 1886; Pritchard, 1841; Ralfs, 1845, 1846, 1848; Roy, 1890; G. S. West, 1899, 1904B, 1909D; W. West, 1888, 1889A, 1890, 1891A, 1892B; West and West, 1897B, 1901B, 1909B). *France* (de Brébisson, 1856; Comère, 1904, 1911; Fournier, 1903; Reinsch, 1867; Le Roux, 1907; Schodduyn, 1909; Turpin, 1820, 1828). *Germany* (Bethge, 1911; Ehrenberg, 1834, 1837, 1838; Eyferth, 1909; Heering und Homefeld, 1904; Heiden, 1889; Honigmann, 1909; Kaiser, 1908; Kirchner, 1878; Kolkowitz und Marsson, 1908; König, 1888; Krause, 1905, 1907; Kützing, 1845, 1849; Lauterborn, 1905, 1907, 1908A, 1908B, 1909, 1911; Lemmermann, 1891, 1893, 1895A, 1895B, 1896, 1897, 1898A, 1898C, 1899, 1900A, 1900B, 1901B, 1901C, 1903C, 1904B, 1905C, 1906, 1907B, 1908D, 1908E; Lindau, 1901; Marsson, 1899, 1901A, 1901B, 1904, 1908A, 1908B, 1909, 1911; Meyen, 1829; Nitardy, 1898, 1904; Quelle, 1908; Schmidle, 1893A, 1894; Schmula, 1897; Schneider, 1908; Schorler, 1898, 1900, 1907; Schorler, Thallwitz and Schiller, 1906; Schröder, 1893, 1896, 1897A, 1897B, 1897C, 1899; Selk, 1907; Senn, 1899; Strohmeyer, 1897; Voigt, 1902; Volk, 1903, 1905; Weiss, 1892; Zacharias, 1896, 1898, 1899, 1903A, 1903B, 1904). *Holland* (Beyerinck, 1891). *Ireland* (Adams, 1908; Archer, 1857; W. West, 1892A; West and West, 1902B, 1909B). *Italy* (Amberg, 1903; Balsamo, 1888; Forti, 1898, 1899, 1900, 1902, 1905; Forti et Trotter, 1908; Garbini, 1899A, 1899B, 1901; Gugliemetti, 1910; Hohenbühel-Heufler, 1871; Lemmermann, 1908C; Martel, 1884 1887A, 1887B; Meneghini, 1840; Moreto, 1904; Rabenhorst, 1850; Tassi, 1895; de Toni et Forti, 1899B; de Toni et Levi, 1886, 1887; Trotter, 1905; Zacharias, 1905; Zanardini, 1857). *Norway* (Wille, 1901). *Roumania* (Teodoresco, 1907). *Russia* (Alexenko, 1891; Artari, 1884; Borge, 1894; Chmielweski, 1890; Dorogoslaisky, 1904; Gutwinski, 1891, Iwanoff, 1899; Krmpotić, 1913; Levander, 1899, 1900, 1901; Skorikow, 1902, 1904, 1905; Wille, 1879; Zykoff, 1902). *Scotland* (W. West, 1903; West and West, 1904, 1905, 1906A, 1909B). *Sicily* (Lemmermann, 1908A). *Sweden* (Andersson, 1890; Borge, 1895, 1900, 1907A; Lagerheim, 1883; Lemmermann, 1903B, 1904A; Petersen, 1911; de Toni et

Forti, 1899A). *Switzerland* (Amberg, 1900; Bachmann, 1908; Borge, 1901A, Chodat, 1897; 1898, 1901, 1902, 1909, 1913; Chodat et Malinesco, 1893B; Dalla Torre und von Sarnthein, 1901; Früh und Schröter, 1904; Huber, 1905, 1907; Neuweiler, 1901; Pitard, 1897; Schmidle, 1895; Tanner-Fullmann, 1906, 1907; Waldvogel, 1900; de Wildemann, 1897A).

AFRICA. *Lake Albert Nyanza* (G. S. West, 1909C). *Azores* (Archer, 1874; Bohlin, 1902; Farlow in Trelease, 1897). *Central Africa* (West and West, 1896). *Lake Chungruru* (Schmidle, 1904). *Cape of Good Hope* (Reinsch, 1877). *Congo Free State* (de Wildemann, 1889). *Madagascar* (West and West, 1895). *Lake Nyassa* (Schmidle, 1903, 1904, G. S. West, 1907). *Lake Rukuga* (Schmidle, 1904). *Lake Tanganyika* (G. S. West, 1907). *Lake Victoria Nyanza* (Ostenfeld, 1908, 1909; G. S. West, 1907). *Abyssinia* (de Toni, 1891, 1892).

ASIA AND OCEANIA. *Afghanistan* (Schaarschmidt, 1884). *Australia* (Borge, 1896, 1911; Hardy, 1906, 1913; Möbius, 1892; G. S. West, 1909A). *Burma* (West and West, 1907). *Ceylon* (Apstein, 1910; Lemmermann, 1907A; West and West, 1901A). *China* (Cantor, 1842; Gutwinski, 1903). *Hawaiian Islands* (Lemmermann, 1900C, 1905A). *India* (Turner, 1892). *Java* (Bernard, 1908; Gutwinski, 1902; Lemmermann, 1904C; de Wildemann, 1897B, 1899). *Manchuria* (Borge, 1899). *Mongolia* (Ostenfeld, 1907). *New Zealand* (Lemmermann, 1900C; Nordstedt, 1888; Spencer, 1882). *Siam* (Lemmermann, 1908B). *Siberia* (Boldt, 1885; Borge, 1891). *Singapore* (Bernard, 1909; Lemmermann, 1904C).

AMERICAS. *Argentina* (Borge, 1907B; Nordstedt, 1882; Wille, 1884). *Barbados* (G. S. West, 1904A). *Bolivia* (Borge, 1907B). *Brazil* (Bohlin, 1897; Nordstedt, 1877). *Canada* (Acheson, 1883; Borge, 1909; Klugh, 1911; MacKenzie, 1889). *Jamaica* (Lagerheim, 1887). *Montevideo* (Wille, 1884). *Paraguay* (Bohlin, 1897; Lemmermann, 1910A). *Pategonia* (Borge, 1901B). *United States* (Andrews, 1909; Bailey, 1841, 1851; Borge, 1909; Brown, 1908, 1909; Buchanan, 1907; Campbell, 1886; Collins, 1909; Conn and Webster, 1908; Ehrenberg, 1843; Fanning, 1901; Fink, 1905; Hayden, 1910; Jeliffe, 1893A, 1893B, 1894, 1899; Jeliffe and Vogel, 1897; Jones, 1887; Kellermann, 1902; Kellermann and Werner, 1893; Kofoid, 1910; Olney, 1872; Riddle, 1902, 1905; Smith, 1914A, 1914B; Snow, 1903; Stokes, 1893, Tilden, 1894; Vorce, 1881; Webber, 1889; W. West, 1889B; Wolle, 1881, 1887).

POLAR AND SUB-POLAR REGIONS. Boergesen, 1899A. *Faeroes* (Boergesen, 1899B, 1901A; Boergesen and Ostenfeld, 1903). *Greenland* (Boergesen, 1896; Lagerheim, 1903; Larsen, 1907A, 1907B).

Var. **quadrispina** (Chodat) nov. comb. (Pl. XXVII: Fig. 43; Pl. XXXI: Figs. 167–170.)

S. quadrispina Chodat, 1913, p. 58: Figs. 45–52.

Cellulis lati-ovatis. Longitudo cellularum 2-plo latitudo. Aculeis brevibus, latitudine cellulae atque longitudine aculei equale.

Chodat gives no measurements for his *S. quadrispina* but computations from his figures, which were magnified 800 diameters, shows that the cell dimensions are 8.5 x 3.7, 12.5 x 7, and 15 x 8.5 μ. The alga which I have obtained in pure culture corresponds very closely with this, the cell measurements being 8.5 x 3.5, 9 x 4, 9.5 x 4.5, 10.5 x 6.5, 11 x 6 μ so that it is quite probable that this alga is the same as that which Chodat had in pure culture.

Var. **parvus** nov. var. (Pl. XXXI: Figs. 162–166.)

Cellulis ovati-cylindricis. Longitudo cellularum 2–2.5-plo latitudo. Longitudine cellulae atque longitudine aculei equale. Dimens. cell. 5.5 x 3, 6 x 3, 7 x 3, 8 x 3 μ. Long. acul. 4.5 ad 8 μ.

The limits of this variety are quite sharply defined since the largest cells are as long and but slightly narrower than the smallest cells of *longispina*, the next smallest variety.

Var. **longispina** (Chodat) nov. comb. (Pl. XXVII: Fig. 42; Pl. XXXI: Figs. 159–161.)

S. longispina. Chodat, 1913, p. 60: Figs. 53-58.

Cellulis ovati-cylindricis. Longitudo cellularum 2.5-plo latitudo. Dimens. cell. 8. x 3.8, 8 x 4.5, 8.5 x 5, 11 x 5 μ. Long. acul. 7.5–9.5 μ.

Since Chodat gives no dimensions for the form he named *longispina* I have again computed them from his figures and find them to be 8.6 x 3.5, 9.5 x 3.7, 11 x 4.5 μ with spines 11–14 μ long. Although the spines in the form I have isolated are somewhat shorter the dimensions of the cells are sufficiently near those of *S. longispina* of Chodat to regard the two as identical.

Var. **Westii** nov. var. (Pl. XXXII: Figs. 177–180.)

Dimens. cell. 16 x 4.5, 17 x 5.5, 20 x 9, 22 x 8 μ. Long. acul. 12–16 μ.

The size of this variety approaches the variety *maximum* West and West but the largest cells in my pure cultures of the variety *Westii* fall somewhat short of the minimal limits set by West and West.

Var. **maximum** West and West. (Pl.XXVII: Fig. 40.)

West and West, 1895, p. 83; Pl. V, Figs. 9-10. Balsamo, 1900, p. 267. West and West, 1901A, p. 197. West and West, 1902B, p. 64. G. S. West, 1904B, p. 220; Fig. 92H. G. S. West, 1907, p. 139.

"Var. duplo-major, cellulis crassis, spinis longis validis extrorsum curvatis. Long. cell. 27–36 μ. Lat. cell. 9–11.4 μ."

This variety has been found in Madagascar (1895), Ceylon (1901A), Ireland (1902B), England (1904B), and several of the central African lakes.

27. **S. opoliensis** Richter. (Pl. XXVII: Fig. 49; Pl. XXXII: Figs. 181–184.

Richter, 1896, p. 7; Figs. A-E. Lemmermann, 1896, p. 108. Schmula, 1897, p. 35. de Wildemann, 1897C, p. 77. Lemmermann, 1899, p. 113. Schröder, 1899, p. 22. de Wildemann, 1899, p. 11. Zacharias, 1899, p. 83, 90. Chodat, 1901, p. 1310. Zacharias, 1901, p. 127. Lemmermann, 1902, p. (251). Snow, 1903, p. 391. Marsson, 1904, p. 146. Forti, 1905, p. 5. Lemmermann, 1905B, p. 158. Lemmermann, 1905C, p. 166. Volk, 1905, p. 65. Borge 1907A, p. 58. Lemmermann, 1907B, p. 412. Migula, 1907, p. 655; Pl. XXXV (L), Fig. 1. Selk, 1907, pp. 61, 68, 79, 85, 94, 99, 108. Kaiser, 1908, p. 163. Lemmermann, 1908D, p. 395. Honigmann, 1909, p. 54. Gugliemetti, 1910, p. 31. Marsson, 1911, p. 278. Petersen, 1911, p. 160. Brunnthaler, 1913, p. 169, 171; Fig. 19. Chodat, 1913, p. 22.

S. quadricauda var. *opoliensis.* West and West, 1901A, p. 197; Pl. XVII, Figs. 16-17. G. S. West, 1907, p. 139. G. S. West, 1909C, p. 245.

"S. in statu instructo cellulis quaternis cylindricis in seriem simplicem, mediis obliquis, externis gracilibus levissime incurvis vel subrectis, medio paulo turgidis utroque in rostrum semitruncatum plus minus attenuatis, adverso polo aculeo longo curvato instructis,cellulis mediis fusiformibus inermibus acutiusculis. Long. cell. sine acul. 17–28 μ; lat. 5–8 μ. Long. acul. 15–28 μ."

The alga has been isolated several times from various stations in this vicinity. The culture from which the drawings are made came from a collection of material near the outlet of Lake Monona, Wisconsin. The dimensions of the mature cells are within the limits given by Richter although the cells of the youngest colonies are smaller, measuring but 11 μ in length.

The navicular shape of the cells, their lateral contact in the median part, together with a beak-like instead of a curved end, separates this alga from *S. quadricauda* (Turp.) de Bréb.

The number of cells in the colony is generally four, although two-celled colonies are not uncommon. The spines in this species show a great variability in both number and size. This again is different from *S. quadricauda* where their number and position is constant. Usually the two terminal cells bear a spine at each end (Fig. 181), although this is not always the case (Fig. 182). The presence of the spines on the median cells is even more variable. Not a case was found where every cell in the colony bore a long spine at each pole, although some colonies very nearly approached this condition (Fig. 184). The median cells have spines at both ends or only on one (Figs. 182, 184). Again, there is a great difference in the length of the individual spines, some being very short while others are as long as the cells (Fig. 182). The short spines are found most frequently on the inner cells, although the outer cells may bear short spines in addition to the long spines. Richter noted this great variability in the presence of supplementary spines, his original illustrations showing conditions similar to those figured from my culture.

GEOGRAPHICAL DISTRIBUTION

EUROPE. *Germany* (Honigmann, 1909; Kaiser, 1908; Marsson, 1904, 1911; Lemmermann, 1896, 1899, 1902, 1905B, 1905C, 1907B, 1908D; Richter, 1896; Schmula, 1897; Schröder, 1899; Selk, 1905; Volk, 1905; Zacharias, 1899, 1901). *Italy* (Forti, 1905; Gugliemetti, 1910). *Sweden* (Borge, 1907A; Petersen, 1911). *Switzerland* (Chodat, 1901).

AFRICA. *Lake Albert Nyanza* (G. S. West, 1909C). *Lake Tanganyika* (G. S. West, 1907).

ASIA AND OCEANIA. *Ceylon* (West and West, 1901A) *Java* (de Wildemann, 1897C, 1899).

AMERICAS. *United States* (Snow, 1903).

28. **S. perforatus** Lemm. (Pl. XXVII: Fig. 47.)

Lemmermann, 1904C, p. 159. Migula, 1907, p. 657; Pl. XXXV (L), Fig. 7. Lemmermann, pp. 126, 131; Pl. III, Fig. 4. Bachmann, 1911, p. 191. Brunnthaler, 1913, pp. 169, 171; Fig. 21. Chodat, 1913, p. 25.

Coenobia plerumque 8-cellularum. Cellulis terminalibus capitatis, membrana cellularum versus coenobium concava, ex coenobium, convexo. Cellulis terminalibus cum aculeis curvatis, cellulis interioribus coenobi constrictes in medio parte. Foraminibus anguste linearibus inter cellulas.

Lemmermann has found this alga in Germany, Italy, Siam, Java and Singapore. *S. quadricauda* forma *major* (Pl. XXVII: Fig. 48) seems to be identical with this alga.

DOUBTFUL OR IMPERFECTLY DESCRIBED SPECIES

S. minor Ktz.

Kützing, 1833, p. 607; Fig. 99.

"Corpusculis ellipticis, non punctatis, minoribus."

S. parvulus Menegh.

Meneghini, 1837, p. 17. de Brébisson, 1839, p. 271. Meneghini, 1840, p. 271.

"Cellulis minimis, ellipticis, extrorsum lunulatis apice,rotundatis, binatim, concretis."

Scenodesmus didymus Ktz.

Kützing, 1845, p. 139. Kützing, 1849, p. 185.
S. didymus. Quelle, 1908, p. 43.

"Sc. catenulis ex cellulis binis aut senis geminatis, subglobosis, minutis, (diam. 1/600–1/400‴) composites."

Scenodesmus caudatus var. brachyurus. Ktz.

Kützing, 1849, p. 186.

"Minor, brevissime caudatus."

S. polymorphus. Wood.

Wood, 1869, p. 135. Wood, 1874, p. 91; Pl. XI, Fig. 1. Vorce, 1881, p. 31; Pl. VII, Fig. 31. Jones, 1887, p. 115. Wolle, 1887, p. 173. de Toni, 1889B, p. 567. Kellermann and Werner, 1893, p. 389. Stokes, 1893, p. 51. de Wildermann, 1893A. Balsamo, 1900, p. 266. Kellermann, 1902, p. 223.

"Cellulis fusiformibus vel ovatis vel ellipticis vel globosis, 4–12 μ diam. singulis vel 2–7 conjunctis, saepius spina singula, subinde utrinque biaculeatis; apicibus obtusis, subacutis vel acutissimis; aculeis gracillimis, valde acutis, rigidis, longiusculis."

This species of Wood's is a blanket description of a number of forms, but the ones most easily recognized from his figures are *S. quadricauda* (Turp.) de Bréb. and *Ankistrodesmus.*

S. bacilaris. Gutw.

Gutwinski, 1890, p. 63.

"Cellulae oblongae, utroque polo attenuatae protractae et rotundatae. Long. 12 μ; lat. 7 μ et apic. 2.4 μ."

S. bijugatus var. **disciformis** Chodat.

Chodat, 1902, p. 213. Migula, 1907, p. 658. Brunnthaler, 1913, pp. 169, 172.
S. bijugatus form *disciformis.* Volk, 1905, p. 64.

Mention has already been made of the fact that the description of this variety is so vague that it might mean *S. bijuga* var. *irregularis* or *S. arcuatus* var. *platydisca.*

S. bijugatus forma **verrucosa** Teodoresco.

Teodoresco, 1907, p. 129; Fig. 1.

Since the arrangment of the granulations on the cell wall is not described by Teodoresco the realtionship of this form to the others with granulations on their cell walls can not be determined.

S. costulatus Chodat.

Chodat, 1909, p. 102; Pl. XIII, Figs. A and B. Chodat, 1913, p. 38; Figs. 12-18, 21.

"Cellulis singulis ellipsoideo-fusiformibus, ventricosis, breviter acutis, in coenobium saepe obliquum lineare quadricellulare, uniseriatum vel oblique biseriatum vel irregulariter alternantibus more S. costati Schmidle, tabulare dispositis. Cellulae ca. 20–12 μ, majores quam in S. obliquo (Turp.) Ktz."

S. nanus Chodat.

Chodat, 1913, p. 61; Figs. 59-62B, 66-67.

A variety of *S quadricauda* (Turp.) de Bréb. but difficult to determine the exact limits of variation.

S. flavescens. Chodat, 1913, p. 76; Figs. 77-78. *S. sempervirens*, Chodat, 1913, p. 71; Figs. 63-69. *S. spinosus.* Chodat, 1913, p. 74; Figs. 70-74.

These three species described by Chodat are closely related to *S. abundans* (Kirch) Chodat but cannot be differentiated on the bases of their external morphology.

S. oblongus Chodat.

Chodat, 1913, p. 41; Figs. 19-20.

Closely related to *S. obliquus* (Turp.) Ktz. but Chodat's reasons for separating this species from *S. obliquus* are not known.

SPECIES EXCLUDED

S. bilunulatus (Turp.) Ktz.

Kützing, 1833, p. 608; Fig. 93. de Brébisson, 1839, p. 271.
Achananthes bilunate. Turpin, 1820, Fig. 5. Turpin, 1828, p. 313; Pl. XIII, Fig. 11.
Scenodesmus bilunulatus. Kützing, 1845, p. 140.
Scenodesmus dimorphus var. *bilunatus.* Kützing, 1849, p. 186.

Probably a species of *Ankistrodesmus* instead of *Scenedesmus.*

S. duplex Ktz.

Kützing, 1833, p. 609; Fig. 100.

It is impossible to say just what this form is, but it is not a *Scenedesmus*.

S. stomatomorphus (Turp.) Ktz.

Kützing, 1833, p. 607.
Achnanthes stomatomorpha. Turpin, 1820, Fig. 11. Turpin, 1828, p. 312; Pl. XIII, Fig. 10.

Now generally recognized as *Sphaerozosma stomatomorphum* (Turp.) Rabenhorst.

S. moniliformis (Turp.) Ktz.

Kützing, 1833, p. 607. Zanardini, 1857, p. 250. Balsamo, 1900. p. 266.
Tessarthonia moniliforme. Turpin, 1820; Fig. 1. Turpin, 1828, p. 316; Pl. XIII, Fig. 18.
Scenodesmus moniliformis. Kützing, 1845, p. 139. Kützing, 1849, p. 185.

Is *Cosmarium moniliforme* (Turp.) Ralfs.

Scenodesmus convergens (Ehr.) Ktz.

Kützing, 1843, p. 164.
Arthrodesmus convergens. Ehrenberg, 1838, p. 152; Pl. X, Fig. 18.

This is a very well recognized species of *Arthrodesmus* at the present day.

S. duplex (Ktz.) Ralfs.

Ralfs, 1848, p. 193; Pl. XXXIV, Fig. 17A.
Scenodesmus duplex. Archer, 1861, p. 753.
Raphidium duplex. Kützing, 1845, p. 144.

Is *Ankistrodesmus falcatus* var. *duplex* (Ktz.) G. S. West. This *S. duplex* should not be confused with the *S. duplex* described by Kützing in 1833.

S. radiatus Reinsch.

Reinsch, 1867, p. 81; Pl. VI, Fig. 6. Lagerheim, 1883, p. 65. Eichler und Raciborski, 1892, p. 16. Balsamo, 1900, p. 267.
S. bijugatus var. *radiatus.* Hansgirg, 1886, p. 115. de Toni, 1889B, p. 564. Migula, 1907, p. 658; Pl. XXXV (K), Fig. 7. Teodoresco, 1907, p. 129. Chodat, 1902, p. 213. Brunnthaler, 1913, pp. 169, 172.
S. bijugatus forma *radiatus.* Pascher, 1903, p. 175.
Selenastrum radiatum. Weiss, 1892, p. 37.

Although this form is now generally recognized as a variety of *S. bijuga,* I believe that it should be placed as a synonym of *Dimorphococcus lunatus* A. br.

S. rotundatus Wood.

Wood, 1874, p. 91; Pl. XI, Fig. 3. Wolle, 1887, p. 174; Pl. CLVI, Fig. 27. de Toni, 1889B, p. 567. Stokes, 1893, p. 51. de Wildemann, 1893A. Iwanoff, 1899, p. 379. Balsamo, 1900, p. 267.

Wood placed this species with *Scenedesmus* provisionally since he did not know where else to put it. The figures of Wood resemble *Richteriella,* while those of Wolle resemble *Golenkinia.* This species may safely be placed among the Phythelieae but the specific determination is perhaps difficult.

S. costatus. var. **coelastroides** Bohlin.

Bohlin, 1893, p. 42. Chodat, 1902, p. 216; Fig. 142. Migula, 1907, p. 657.
S. coelastroides. Schmidle, 1898, p. 9; Pl. I, Fig. 1. Chodat, 1913, p. 23.

This form belongs in the genus *Coelastrum* and not *Scenedesmus.*

S. variabilis de Wildemann.

de Wildemann, 1893A. de Wildemann, 1893B, p. 91. de Wildemann, 1895, p. 26. Cozette, 1904, p. 273. Loppens, 1908, p. 48.

This species is worthless. The varieties *cornutus* and *ecornis* are synonyms of *S. quadricauda* and *S. bijuga* respectively.

S. costatus var. **poriferus** Gutwinski.

Gutwinski, 1909, p. 435; Pl. VII, Fig. 5.

Is *Coelastrum Bohlinii* Schmidle and Senn.

S. obliquus var. **inermis** Playfair.

Playfair, 1912, p. 518; Pl. LVI, Fig. 9.

The shape of the cells differ from that of *Scenedesmus,* but so crude is Playfair's drawing that it is impossible to determine just what alga it is.

S. chlorelloides Chodat.

Chodat, 1913, p. 45; Fig. 23.

The alga is much more closely related to *Palmellococcus* than to *Scenedesmus.*

S. wisconsinensis (Smith) Chodat.

Chodat, 1913, p. 50; Figs. 35-37.
Tetradesmus wisconsinensis. Smith, 1913, p. 76; Pl. I, Figs. 2-20.

The constant occurrence of the cells in two parallel series excludes this species from the genus *Scenedesmus.*

SPECIES KNOWN IN NAME ONLY

S. apiculatus Corda.

de Toni, 1889B, p. 567.
Scenodesmus caudatus var. *apiculatus.* Kützing, 1849, p. 186.

S. ellipticus Corda.

de Brébisson, 1839, p. 271.

S. lacustris (?)

Bachmann, 1908, p. 44.

S. luna Corda.

Corda, 1838, p. 195; Pl. II (Ref. de Toni, 1889B, p. 568) Hansgirg, 1888, p. 116. de Wildemann, 1893A. Balsamo, 1900, p. 266.

S. nolatus Corda.

Balsamo, 1900, p. 266.

S. octodacrys de Bréb.

de Brébisson, 1835, p. 66. (Ref. Meneghini, 1840, p. 209).

S. ovalternus de Bréb.

de Brébisson, 1835, p. 66 (Ref. Meneghini, 1840, p. 209). de Brébisson, 1839, p. 271.

S. Pediastrum de Notaris.

Balsamo, 1900, p. 266.

S. quadricauda forma **multicauda** Schröder.

Dalla Torre und von Sarnthein, 1901, p. 35. Brunnthaler, 1913, p. 171.

S. quadricauda forma **plurimae** Schmula.

Schmula, 1910, p. 86.

S. senilis Corda.

Corda, 1839, p. 244; Pl. VI (Ref. de Toni, 1889B, p. 568). Hansgirg, 1886, p. 116. de Wildemann, 1893A.

S. setigera Lemm.

Dorogoslaisky, 1904, p. 224.

S. tetradacrys de Bréb.

de Brébisson, 1835, p. 66. (Ref. Meneghini, 1840, p. 209). de Brébisson, 1839, p. 271.

S. tetradacrys var. **duplex** de Bréb.

de Brébisson in Meneghini, 1840, p. 209.

S. tetrapenion de Bréb.

Meneghini, 1840, p. 207.

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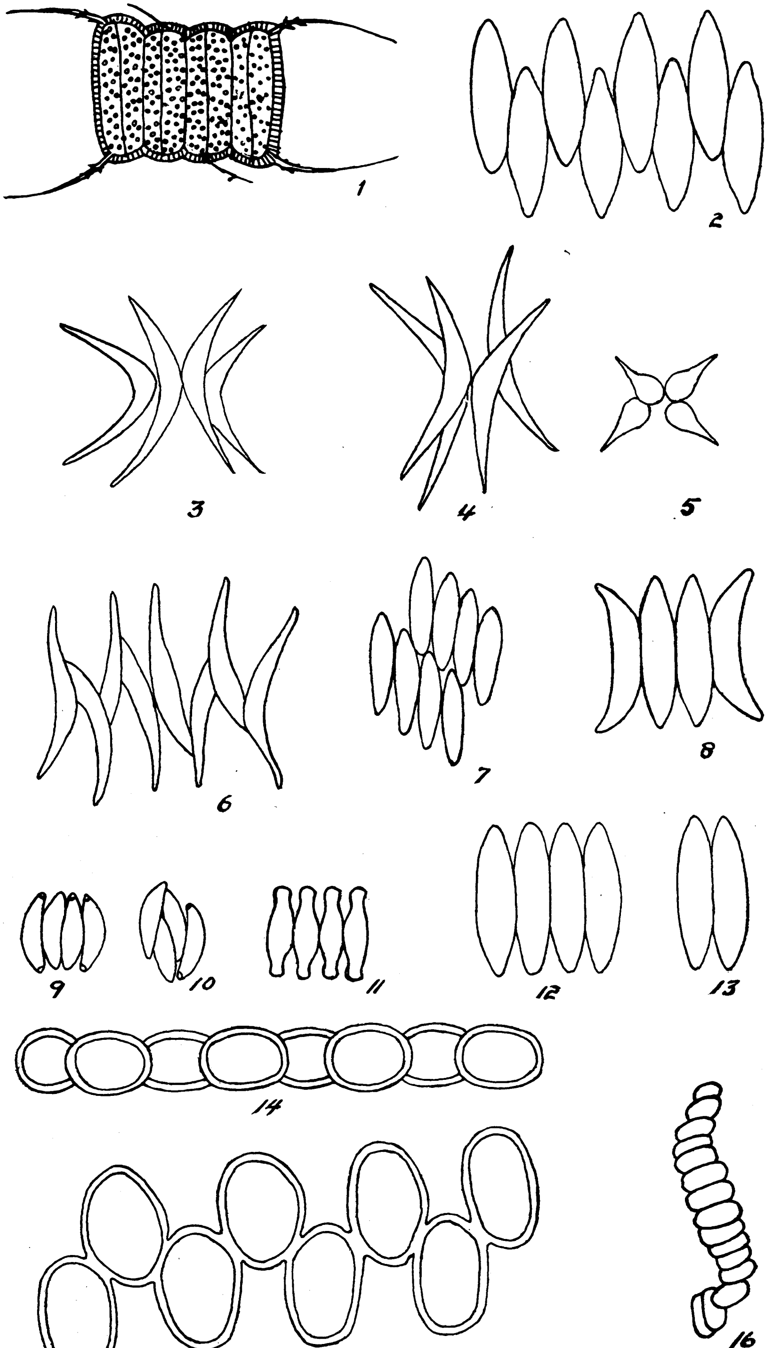
The numerals following the specific names refer to the page on which the literature for the species is cited.



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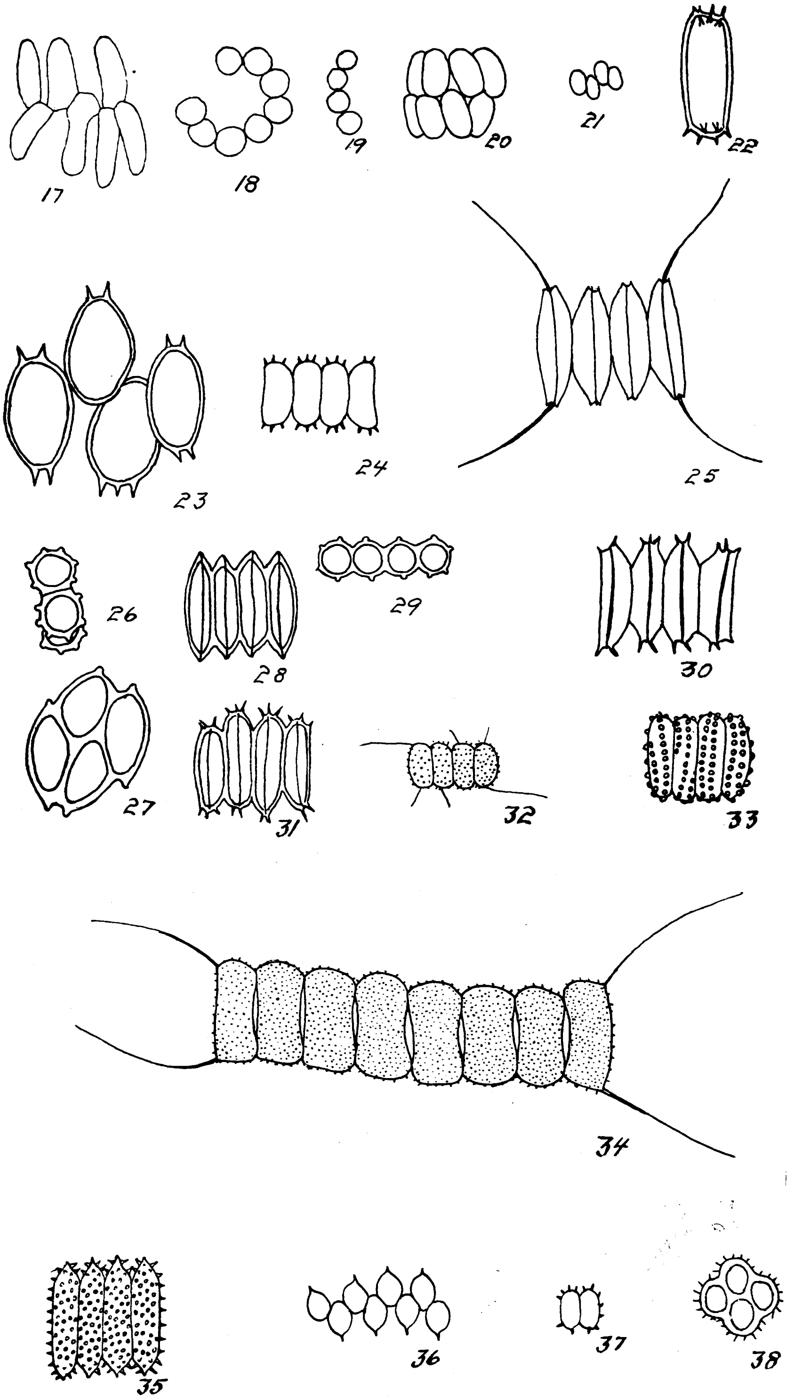

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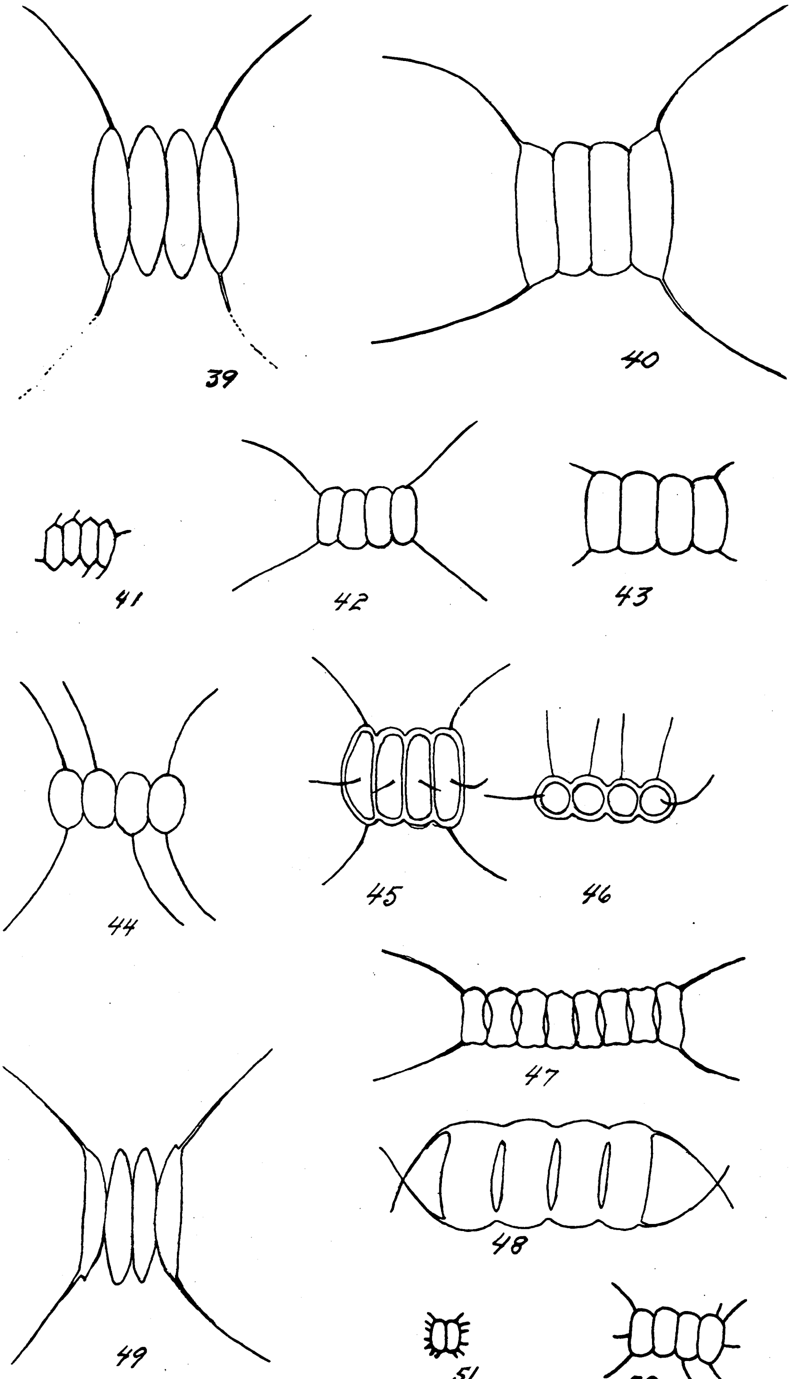

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DESCRIPTION OF FIGURES IN PLATES I TO XIX.

Figures 1-56 are redrawn from the original illustrations of the various authors. Figures 57 and 58 from material collected in the field. All others from material from pure cultures. All of the original figures were drawn with the aid of the Abbe camera lucida, the drawing being made at the level of the base of the microscope, and with the aid of the Leitz oil immersion objective $\frac{1}{16}$ and ocular 4 (except in figures 186-195 where ocular 1 was used). The drawings are reduced ½ in reproduction so that the magnification is about 1000 diameters with the 4 ocular and 500 diameters with the 1 ocular.

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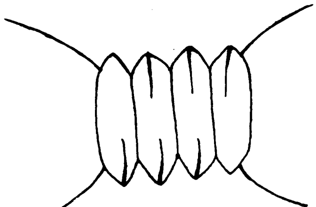
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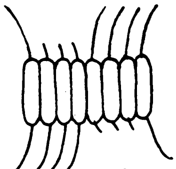
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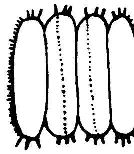
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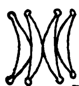
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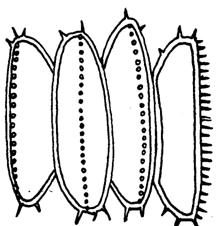
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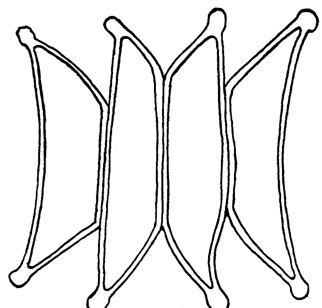
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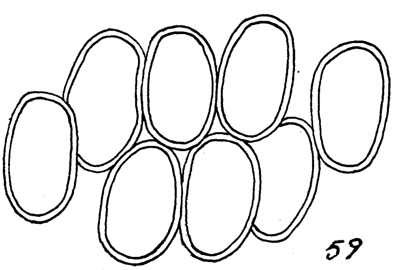
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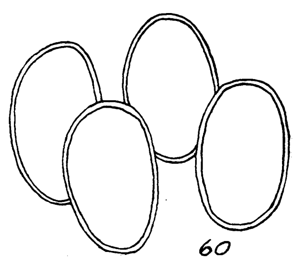
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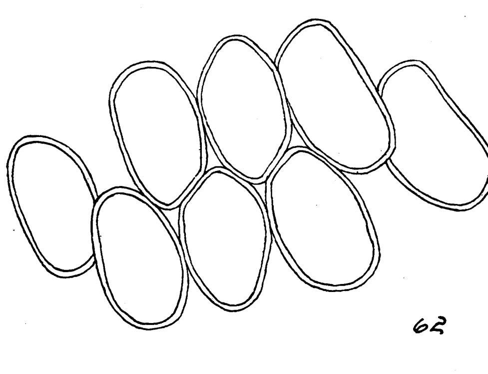
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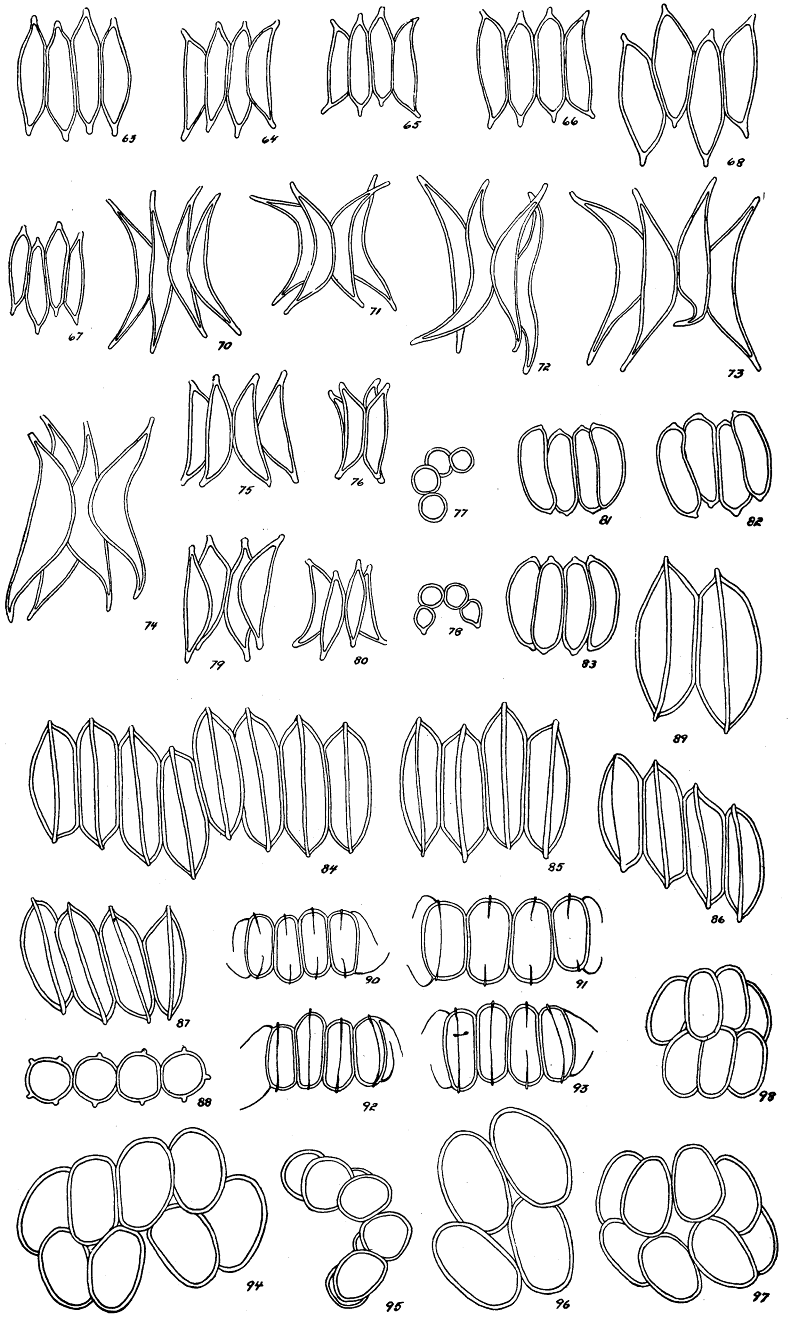

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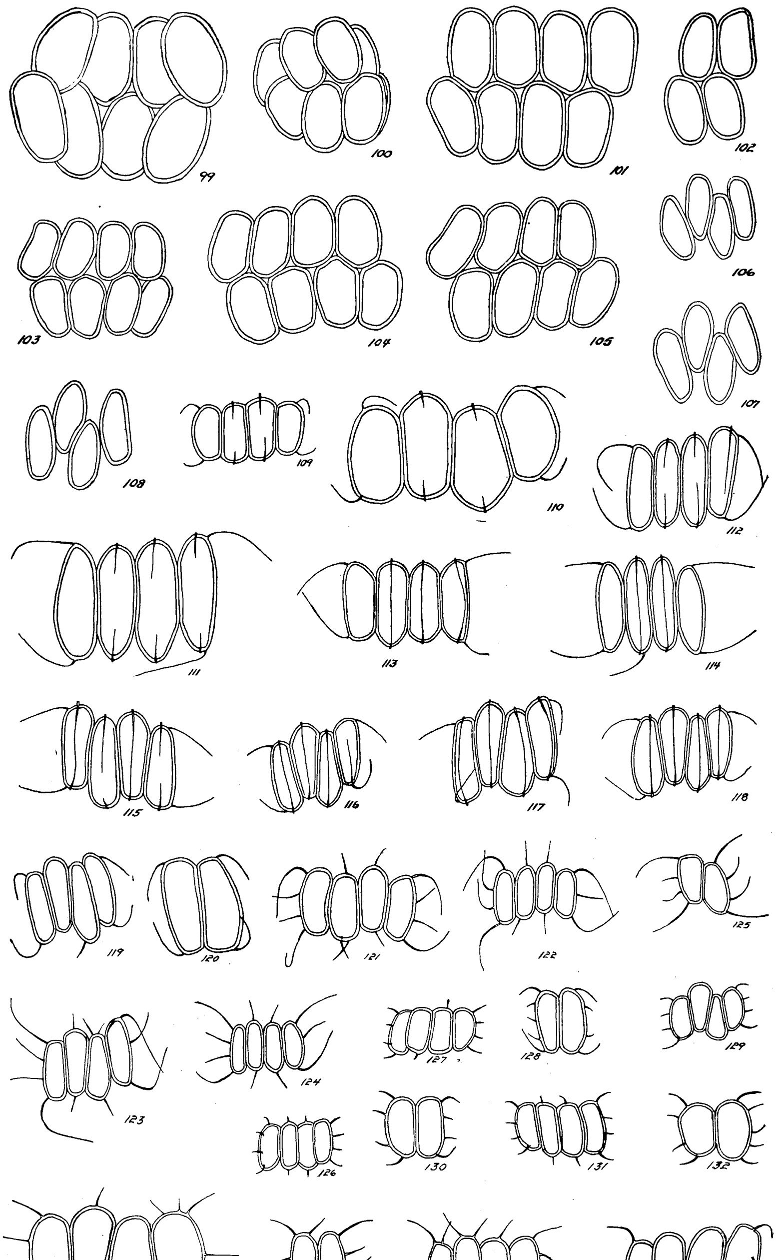

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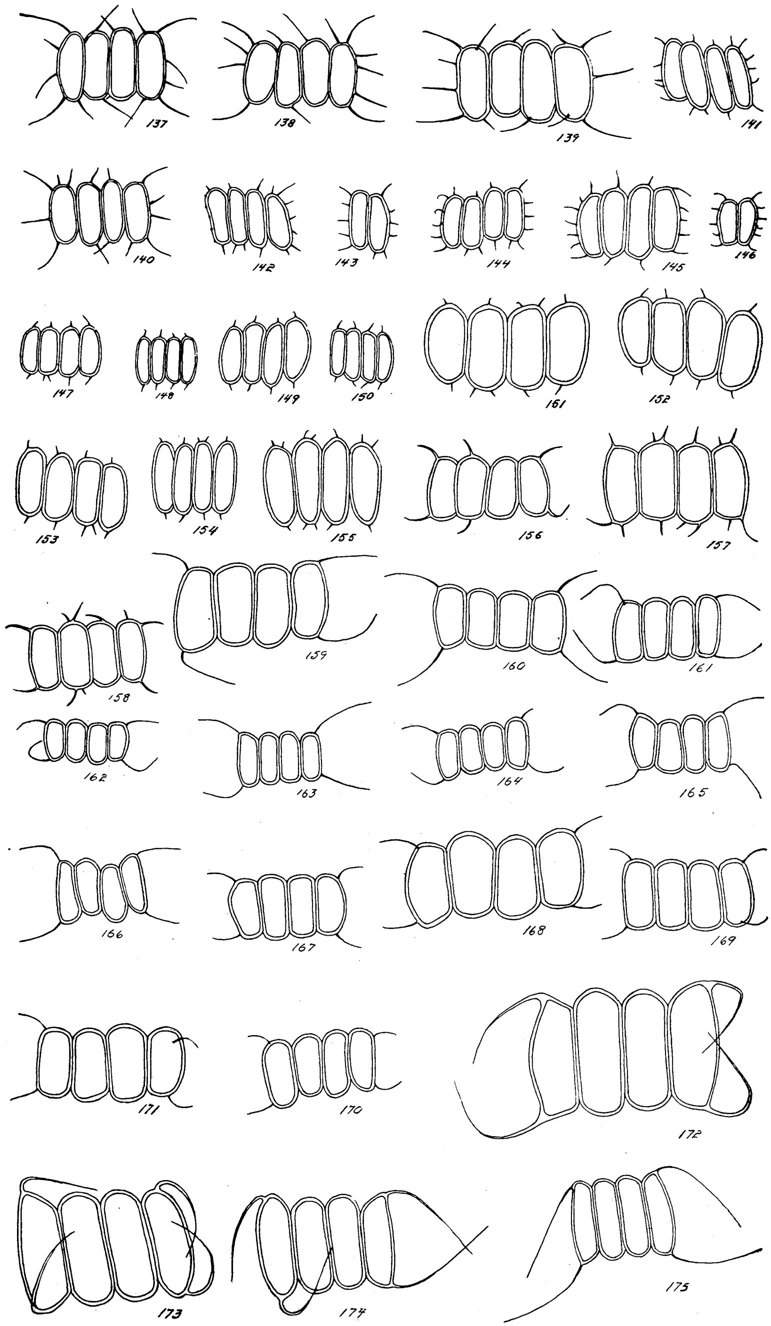

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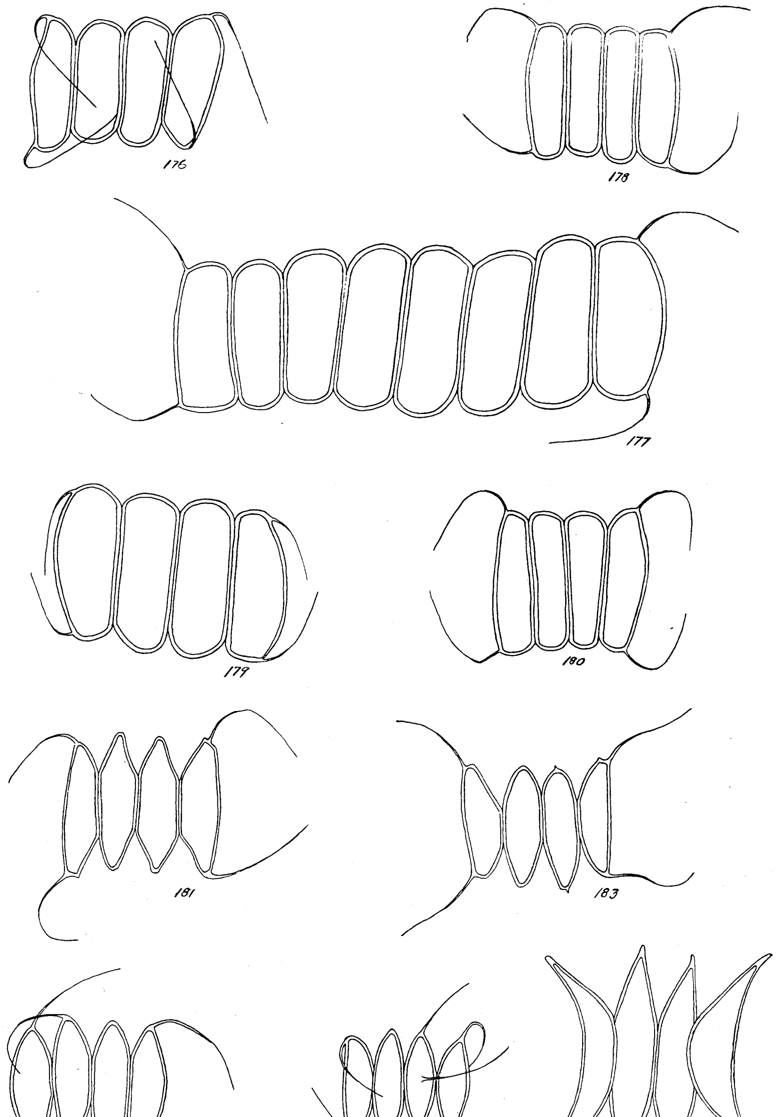

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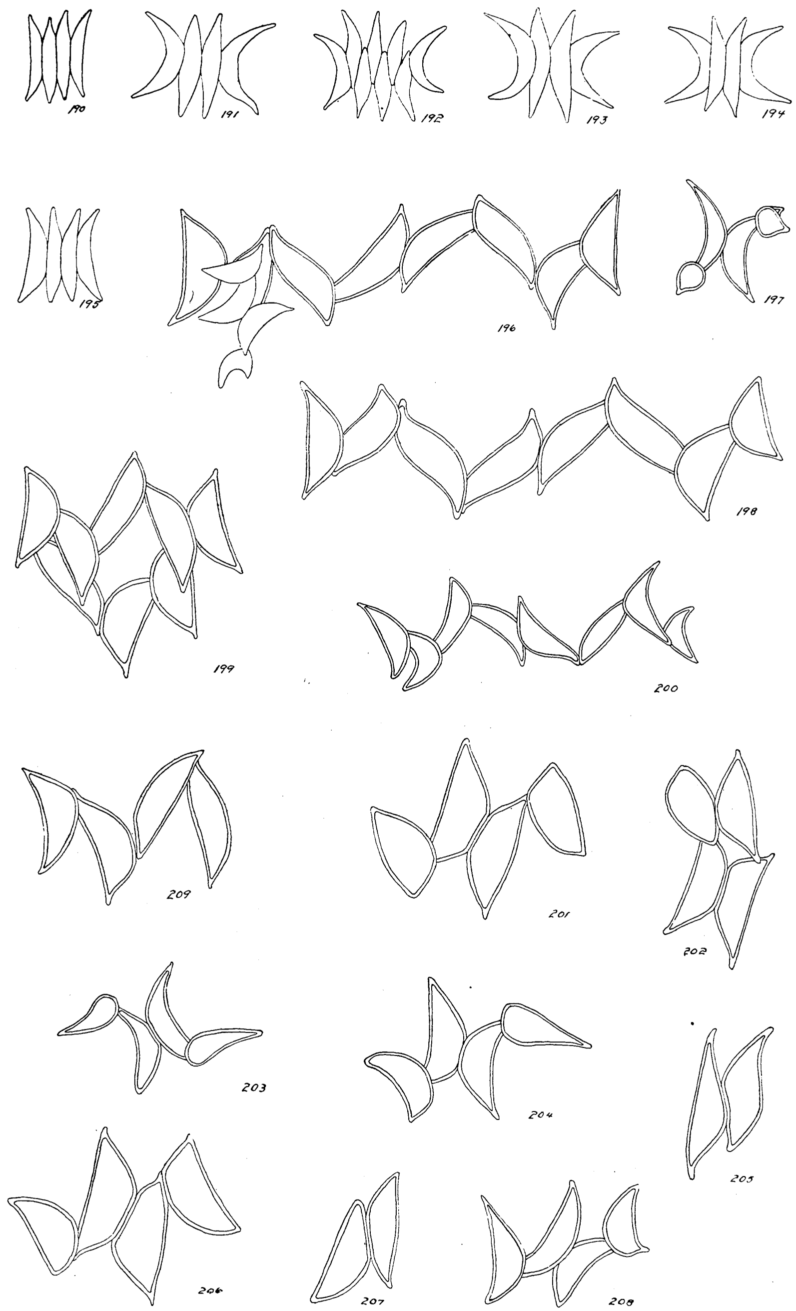

SMITH—SCENEDESMUS

A PRELIMINARY LIST OF ALGAE FOUND IN WISCONSIN LAKES

GILBERT MORGAN SMITH

Notes from the laboratory of the Wisconsin Geological and Natural History Survey IX.

At the request of Director Birge of the Wisconsin Geological and Natural History Survey, a phycological study of the lakes of the state was undertaken. This paper presents the results to date. The determination of the various phytoplankton is emphasized especially, and only cursory attention paid to littoral forms. Collections, employing the usual methods of obtaining plankton, were made during the summers of 1914 and 1915. The specific determinations are based on camera lucida drawings of living material; since I find that many of the finer points are lost on preservation. At present only the eastern half of the state has been studied, but it is expected that the survey will be extended to other sections. The thoroughness of the work varies from single plankton catches in some lakes, to close observation during an entire season on others. The Madison Four Lakes, Devil's Lake, and certain lakes of the Oconomowoc-Waukesha region have been studied the most thoroughly. In citing the distribution of various species the caption "along shore" has been used to include the algae epiphytic on rocks, those epiphitic on Phanerogams, and those which grow among the Phanerogams in sheltered places.

The large number of species new to North America is not surprising, when one considers that with the exception of Miss Snow's investigations of Lake Erie, there has been practically no systematic work done on North American phytoplankton. In the following list of species new to the continent, the plankton are indicated thus (*).

Myxophyceae: *Chroococcus minutus* var. *minimum* v. Keissler, **Ch. limneticus* var. *carneus* (Chod.) Lemm., **Ch. limneticus* var. *subsalsa* Lemm., **Microcystis aeruginosa* var. *major* (Wittr.), **M. incerta* Lemm., **Coelosphaerium Naegelianum* Unger, **Merismopedia punctata* Meyen, **Aphanocapsa pulchra* (Ktz.) Rab., *Dactylococcopsis raphiodes* Hansgr., *Gloeochaete Wittrockiana* Lag., **Lyngbya limneticus* Lemm., *Spirulina princeps* W. & G. S. West, **Anabaena planctonica* Brunnth., **A. affinis* Lemm., **A. spiroides* var. *crassa* Lemm., **A. macrospora* var. *robusta* Lemm., *Scytonema Arcangelii* B. & T.

Chlorophyceae: *Characium longipes* Rab., **Pediastrum intergum* Näg., **P. duplex* var. *reticulata* Lag., **P. duplex* var. *rotundatum* Lucks, **P. Kawraiskyi* Schm., **P. simplex* var. *clathratum* (Schr.) West, *Euastropsis Richteri* (Schm.) Lag., **Tetracoccus botryoides* West, **Dimorphococcus lunatus* A. Br., **Richteriella botryoides* (Schm.) Lemm.,* *R. quadriseta* Lemm., **Oocystis parva* W. & G. S. West, **O. elliptica* var. *minor* W. & G. S. West, **O. nodulosa* W. & G. S. West, **O. Novae-Semliae* var. *maxima* W. & G. S. West, **Chodatella ciliata* (Lag.) Lemm. **Ch. Droescheri* Lemm., **Ch. subsalsa* Lemm. **Tetraedron limneticum* Borge, *T. pusillus* (Wallich) W. & G. S. West, *Sorastrum americanum* (Bohl.) Schm., **Scenedesmus arcuatus* Lemm., **S. brasiliensis* Bohl., **S. acutiformis* Schröd. *S. serratus* (Corda) Bohl. *S. quadricauda* var. *maximum* W. & G. S. West, **Tetrastrum Staurogeniaeforme* (Schröd) Chod., **Crucigenia quadrata* Morren, **C. Lauterbornei* (Schm.) Chod. **A. Pfitzeri* (Schröd.) West, **Kirchneriella contorta* (Schm.) Bohl. *Zygnema pectinatum* var. *conspicuum* (Hass.) Kirch. *Debarya laevis* (Ktz.) W. & G. S. West, *Geminella interrupta* (Turp.) Lag. *Radiofilum conjunctum* Schm. *Radiofilum flavescens* West, **Herposteiron Hyalothecae* Hansg. *Herposteiron polychaete* Hansg.

Heterokonteae: *Characiopsis pyriformis* Borzi, *Mischococcus confervicola* Näg. **Ophiocytium capitatum* var. *longispinum* (Möb.) Lemm.

During the progress of this work about 90 lakes have been visited. The following are listed in Birge and Juday,[1] so that their location need not be mentioned.

[1] Birge, E. A. and Juday, C.; The Inland Lakes of Wisconsin. Wis. Geol. and Nat. Hist. Survey Bull. XXVII (Scientific Series, No. 9) 1914.

Adelaide, Beasley, Carroll, Catfish, Catherine, Cranberry, Devil's, Fowler, Geneva, Green, Kawaguesaga, Kegonsa, Lac la Belle, Long (Waupaca), Marl, Mendota, Minocqua, Monona, Mud (Waupaca), Nashotah (Upper and Lower), Nemahbin (Upper and Lower), Oconomowoc, Okauchee, Otter, Pewaukee, Plum, Pope, Poygan, Rainbow (Waupaca), Razorback, Rock (Vilas Co.), Round (Waupaca), Big. St. Germain, Squirrel, Star, Taylor, Tomahawk, Trout, Turtle (North and South), Waubesa, Waupaca Chain o' Lakes, Winnebago, Winneconne and Young's Lakes.

The following list comprises the lakes which are not listed in Birge and Juday. Since many of these are not named on published maps and several are known locally by various names, the exact location of each is given to avoid confusion.

Lake	County	Range	Town	Section
Bass (Big)	Vilas	E. 11	N. 40	20, 29
Beaver	Vilas	E. 5	N. 44	19, 30
Birch	Vilas	E. 5	N. 43	11, 14
Bullhead	Vilas	E. 6	N. 40	11
Cedar	Vilas	E. 6	N. 43	13
Clear	Oneida	E. 7	N. 39	9, 16, 17
Constance	Vilas	E. 5	N. 44	29, 30
Crystal	Vilas	E. 7	N. 41	27
Curtis	Oneida	E. 6	N. 39	8
Found	Vilas	E. 8	N. 40	14
Franklin	Oneida	E. 5	N. 39	10
George	Vilas	E. 5	N. 44	19, 30
Harris	Vilas	E. 5	N. 40	20, 29
Helen (Eagle River)	Vilas	E. 11	N. 40	19
Helen (Winchester)	Vilas	E. 5	N. 44	32
Hill	Oneida	E. 6	N. 39	9
Laura	Vilas	E. 8	N. 41	1, 12
Lost	Vilas	E. 8	N. 40	9, 10
McKenna	Vilas	E. 6	N. 39	26, 27
Marion	Vilas	E. 5	N. 44	19, 30
Mercer	Oneida	E. 5	N. 39	13, 14
Meta	Vilas	E. 11	N. 40	1
Mud	Vilas	E. 7	N. 39	5
Muskallonge	Vilas	E. 7	N. 41	21, 22
Nell	Vilas	E. 5	N. 44	27
No Mans	Vilas	E. 5	N. 44	24, 19
Old Taylor's	Waupaca	E. 11	N. 22	30
Pardee	Vilas	E. 5, 6	N. 44	19, 24
Rainbow	Vilas			
Rose	Vilas	E. 7	N. 40	10, 15
Rozen	Vilas	E. 7	N. 40	16
Silver	Waukesha	E. 17	N. 7	9, 16
Sishebogema	Vilas	E. 5	N. 39, 40	1, 2, 35, 36
Soft	Waukesha	E.17	N. 7	10
Speese	Oneida	E. 5	N. 39	10, 11
Sunday	Oneida	E. 5	N. 39	3, 10
Tamarack	Vilas	E. 5	N. 43	3, 10
Tank	Vilas	E. 6	N. 40	1

II. Systematic account of the algae found in Wisconsin lakes.

The present list comprises the Chlorophyceae, Myxophyceae and Heterokonteae of the collections. The Bacillariales and Desmidiaceae will be enumerated in a later paper. Several new species have been discovered during the course of the investigation but it has been thought advisable to exclude them for the present.

Class MYXOPHYCEAE
Order CHROOCOCCALES
Family CHROOCOCCACEAE
Genus CHROOCOCCUS Nägeli 1849.

Chroococcus turgidus (KÜTZING) NÄGELI, Gatt. einz. Algen, (1849) p. 46. G. S. West, Brit. Freshw. Algae, (1904) p. 352, fig. 166A. *Protococcus turgidus* Kützing, Tabulae Phycol. (1849) t. 6. fig. 1.

Plankton; Beasley and Oconomowoc Lakes. Along shore; Otter, Old Taylor's and Waubesa Lakes.

Chroococcus minutus (KÜTZING) NÄGELI, Gatt. cinz. Algen, (1849) p. 46. *Protococcus minutus* Kützing, Phyc. gener. (1843) p. 168. Kützing, Tabulae Phycol. (1849) t. 5.

Along shore; Rose Lake.

var. **minimus** V. KEISSLER, in Verh. d. k.-k. zool.-bot. Ges. in Wien, 51 (1901) p. 394, figs. 1–2.

Along shore; Adelaide and Sunday Lakes.

Chroococcus limneticus LEMMERMANN, in Bot. Cent. *76* (1898) p. 153. Lemmermann, in Forschungsbr. a. d. Biol. Stat. zu Plön, *7* (1899), p. 132, t. 1, figs. 22–23.

Plankton; Beasley, Kawaguesaga, Oconomowoc, Old Taylor's, Squirrel and Winnebago Lakes.

var. **carneus** (CHODAT) LEMMERMANN, in Arkiv. för Botanik, *2* (1903) No. 2, p. 101. *Chroococcus minutus* var. *carneus* Chodat, in Bull. Herb. Boiss. *6* (1898) p. 180.

Plankton; Big Bass, Harris, Mendota and Oconomowoc Lakes.

var. **subsalus** LEMMERMANN, in Forschungsbr. a. d. Biol. Stat. zu Plön, *8* (1901) p. 84. Lemmermann, in Arkiv för Botanik, *2* (1903) No. 2, p. 101, t. 1, fig. 9.

Plankton; Big Bass Lake.

Genus MICROCYSTIS Kützing 1833.

Microcystis aeruginosa KÜTZING, Tabulae Phycol. *1* (1849) p. 6, t. 8.

Plankton; Kegonsa, La Belle, Mendota, Otter, Old Taylor's, Pardee and Turtle (North) Lakes.

var. **major** (WITTROCK) nov. comb. *Polycystis aeruginosa* var. *major* Wittrock, in Hansgirg, Prodr. d. Algenflora v. Böhmen, *2*, (1892) p. 146.

Plankton; Lake Mendota.

Microcystis flos-aquae (WITTROCK) KIRCHNER, in Engler und Prantl, D. nat. Pflanzenfam. Teil. *1*, Abt. 1a (1900) p. 56, fig. 49N. *Polycystis Flos-aquae* Wittrock, in Wittrock et Nordstedt, Algae aq. dulc. exsicc. No. 298.

Plankton; Birch, Catfish, Found, Mud (Vilas Co.), Nashotah (Upper), Nemahbin (Lower), No Mans, Oconomowoc, Okauchee, Pardee, Plum, Rainbow, Rock (Vilas Co.), Rose, Saint Germain (Big), Sishebogema, Squirrel, Star, Tamarack, Turtle, (North and South), Waubesa and Winnebago Lakes.

Microcystis incerta LEMMERMANN, in Abh. Naturw. Ver. Bremen, *17* (1903) p. 342. *Polycystis incerta* Lemmermann, in Ber. d. D. bot. Ges. *19* (1901) p. 93, t. 4, fig. 8.

Plankton; Lake Winnebago.

Microcystis pulverea (WOOD) MIGULA, Kryptogamen-Flora Bd. *2*, Algen, Th. *1*; in Thomé, Flora von Deutschland, Deutsch-Österr. u. d. Schw. *6* (1907) p. 36. *Pleurococcus pulverus* Wood, in Smithsonian cont. to knowl. *19*, no. 241 (1874) p. 79. *Anacystis pulvera* (Wood) Wolle, Freshw. Algae of U. S. (1887) p. 329, t. 210. fig. 10.

Plankton; Pardee and Sunday Lakes.

Microcystis ichthyoblabe (KUNZE) KÜTZING, Phycol. gener. (1843) p. 170. *Palmella ichthyoblabe* Kunze, in Kützing, l.c. p. 170. *Polycystis ichthyoblabe* Kützing, Tabulae Phycol. *1* (1849) p. 7, t. 8.

Plankton; Catfish, Clear, Kawaguesaga and Minocqua Lakes.

Genus GOMPHOSPHAERIA Kützing 1836.

Gomphosphaeria aponina KÜTZING, Decades, *16* (1836) No. 151. Kützing, Tabulae Phycol. *1* (1849) p. 22, t. 31, fig. 3.

Plankton; Kegonsa, Mendota, Monona, Nemahbin (Lower), Otter, Pewaukee, Plum, Turtle (North and South), and Waubesa Lakes.

var. **cordiformis** WOLLE, in Bull. Torr. Bot. Club, *9* (1882) p. 25, t. 13, fig. 11.

Plankton; Round Lake.

Genus COELOSPHAERIUM Nägeli 1849.

Coelosphaerium Naegelianum UNGER, in Mitth. d. Naturw. Ver. f. Steiermark, Bd. *2*, Heft. 1, t. 2. Kirchner, in Engler und Prantl, D. nat. Pflanzenfam. Teil. *1*, Abt. 1a (1900) p. 56, fig. 50A. (As *C. Kuetzingianum*).

Plankton; Birch, Catfish, Catherine, Cranberry, Devil's, Found, Kawaguesaga, La Belle, Lost, Mendota, Minocqua, Monona, Mud (Vilas Co.). Nashotah (Upper and Lower), Nemahbin (Upper and Lower), No Mans, Oconomowoc, Okauchee, Otter, Pardee, Pewaukee, Plum, Rainbow, Rock (Vilas Co.), St. Germain (Big), Sishebogema, Squirrel, Tamarack, Turtle (North and South), Waubesa and Winnebago Lakes.

Coelosphaerium dubium GRUNOW, in Rabenhorst, Flora Eur. Algarum, *2* (1865) p. 55. Schmula, in Beiblatt zur "Hedwigia", *37* (1898) p. (47), figs. 1–2.

Plankton; Mud Lake (Vilas Co.)

Coelosphaerium Kuetzingianum NÄGELI, Gatt. einz. Algen, (1849), p. 54, t. 1, fig. C.

Plankton; Catfish, Cranberry, Kegonsa, Mendota, Oconomowoc, Pardee, Pewaukee, Rock (Vilas Co.), Sunday, Tamarack and Turtle (North and South) Lakes.

Genus MERISMOPEDIA Meyen 1828.

Merismopedia glauca (EHRENBERG) NÄGELI Gatt. einz. Algen, (1849) p. 55, t. 1, fig. D1. *Gonium glaucuum* Ehrenberg, Die Infusionsthierchen, (1838) p. 56, t. 3, fig. 5.

Plankton; George, Meta and Waubesa Lakes. Along shore; Found, Rose and Rozen Lakes.

Merismopedia punctata MEYEN, in Arch. f. Naturgeschichte, *5* (1839) Bd. 2, p. 67. Kützing, Tabulae Phycol. *5* (1855) t. 38.

Plankton; Big Bass Lake. Along shore; Minocqua Lake.

Merismopedia tenuissimum LEMMERMANN, in Bot. Cent. *76* (1898) p. 154. Lemmermann, in Forschungsbr. a. d. Biol. Stat. zu Plän, *7* (1899) p. 132, t. 1, fig. 21.

Along shore; Sunday and Waubesa Lakes.

Merismopedia elegans A. BRAUN, in Kützing, Species Algarum (1849) p. 472. G. S. West, Brit. Freshw. Algae, (1904) p. 348, fig. 162C.

Plankton; Green and Waubesa Lakes.

Genus APHANOCAPSA Nägeli 1849.

Aphanocapsa rivularis (CARMICHAEL) RABENHORST, Flora Eur. Algarum, *2* (1865) p. 49. *Palmella rivularis* Carmichael, in Hooker, Brit. Flora, *2*, pt. 1 (1834) p. 397.

Plankton; Oconomowoc Lake.

Aphanocapsa pulchra (KÜTZING) RABENHORST, Flora Eur. Algarum, *2* (1865) p. 49. *Palmella pulchra* Kützing, Species Algarum, (1849) p. 214.

Plankton; Beaver, Harris, and Winnebago Lakes. Along shore; Old Taylor's and Plum Lakes.

Aphanocapsa Grevillei (HASSALL) RABENHORST, Flora Eur. Algarum, *2*, (1865) p. 50. *Coccochloris Grevillei* Hassall, Brit. Freshw. Algae, (1845) p. 318, t. 78, figs. 7a–8.

Plankton; Muskallonge and Silver Lakes.

Genus DACTYLOCOCCOPSIS Hansgirg 1888.

Dactylococcopsis raphidioides HANSGIRG, Prodr. d. Algenflora v. Böhmen, *2* (1892) p. 139, fig. 49a.

Plankton; Mercer Lake.

Genus GLOEOTHECE Nägeli 1849.

Gloeothece linearis NÄGELI, Gatt. einz. Algen, (1849) p. 58, t. 1, fig. G2.

Plankton; Muskallonge and Harris Lakes. Along shore; Soft Lake.

Genus APHANOTHECE Nägeli 1849.

Aphanothece saxicola NÄGELI, Gatt. einz. Algen, (1849) p. 60, t. 1, fig. H2.

Along shore; Upper Nashotah and Sunday Lakes.

Aphanothece Castagnei (DE BRÉBISSON) RABENHORST, Flora Eur. Algarum, *2* (1865) p. 64. *Oncobrysa Castagnei*, de Brébisson, in Kützing, Species Algarum, (1849) p. 214. *Palmella Castagnei* (de Brébisson) Kützing, Tabulae Phycol. *1* (1849) t. 11, fig. 4.

Along shore; Helen (Eagle River), Laura, Muskallonge, Soft and Sunday Lakes.

Aphanothece microscopica NÄGELI, Gatt. einz. Algen, (1849) p. 59, t. 1, fig. H1.

Along shore; Lake Kegonsa.

Aphanothece prasina A. BRAUN, in Rabenhorst, Flora Eur. Algarum, *2* (1865) p. 65. Cooke, Brit. Freshw. Algae, (1882) p. 218, t. 88, figs. 3a–3b.

Along shore; Nemahbin (Lower), Rose, Sunday and Waubesa Lakes.

Family CHAMAESIPHONACEAE

Genus CHAMAESIPHON A. Braun und Grunow 1864.

Chamaesiphon confervicola A. BRAUN, in Rabenhorst, Flora Eur. Algarum, *2* (1865) p. 148.

Along shores; Lake Mendota.

Family CHROOCYSTACEAE

Genus GLOEOCHAETE Lagerheim 1883.

Gloeochaete Wittrockiana LAGERHEIM, in Öfvers. Kgl. Vet.-Ak. Förh. *40*, No. 2 (1883) p. 39, t. 1, figs. 3–4.

Along shore; McKenna Lake.

Order HORMOGONEAE
Family OSCILLATORIACEAE
Genus OSCILLATORIA Vaucher 1803.

Oscillatoria limosa (DILLWYN) C. A. AGARDH, Disp. algarum Sueciae, Pars. *4*, (1812) p. 35. Tilden, Minnesota Algae, *1* (1910) p. 65, t. 4, fig. 6. *Conferva limosa* Dillwyn, Brit. Confervae, (1802) t. 20.

Along shore; Lakes Kegonsa and Waubesa.

Oscillatoria tenuis C. A. AGARDH, Algarum decas secunda, (1813) p. 25. Gomont, in Ann. Sci. Nat. 7 Sér. Bot. *16* (1892) p. 220, t. 7, figs. 2–3.

Plankton; Lake Monona.

var. **tergestina** (KÜTZING) RABENHORST, Flora Eur. Algarum, *2*, (1865) p. 102. *Oscillatoria tergestina* Kützing, Tabulae Phycol. *1* (1849) p. 29, t. 39, fig. 8.

Plankton; Lake Geneva.

Oscillatoria curviceps C. A. AGARDH, Systema Algarum, (1824) p. 68. Gomont, in Ann. Sci. Nat. Sér. 7 Bot. *16* (1892) p. 213, t. 6, fig. 14.

Along shore; Upper Nemahbin Lake.

Genus LYNGBYA C. A. Agardh 1824.

Lyngbya limnetica LEMMERMANN, in Bot. Cent. *76* (1898) p. 154.

Plankton; Lake Geneva. Along shore; Soft Lake.

Genus SPIRULINA Link 1834.

Spirulina princeps W. & G. S. WEST, in Trans. Linn. Soc. London, 2 Ser. *6* (1901) p. 205.

Along shore; Beaver and Nemahbin Lakes.

Spirulina subsalsa OERSTED, in Natural Tidskrift (1842), p. 17, t. 7, fig. 4. Gomont, in Ann. Sci. Nat. 7 Sér. Bot. *16* (1892) p. 253, t. 7, fig. 32.

Along shore; Upper Nemahbin Lake.

Family STIGONEMACEAE

Genus STIGONEMA C. A. Agardh 1824.

Stigonema mamillosum (LYNGBYE) C. A. AGARDH, Systema Algarum, (1824) p. 42. Tilden, Minnesota

Algae, *1* (1910) p. 250, t. 15, fig. 22. *Bangia mamillosa* Lyngbye Tent. Hydrophyt. Danicae, (1819) p. 85, t. 25, figs. C1–C3.

Along shore; Razorback Lake.

Stigonema turfaceum (BERKLEY) COOKE, Brit. Freshw. Algae, (1884) p. 272, t. 111. fig. 2. Kirchner, in Engler und Prantl, D. Nat. Pflanzenfam. Teil 1, Abt. 1a (1900) p. 83, figs. 58G–58L. *Scytonema turfaceum* Berkley, in Eng. Bot. *2*, t. 2517, fig. 1.

Along shore; Adelaide, Beaver, Bullhead, Helen (Eagle River) and Sunday Lakes.

Genus HAPALOSIPHON Nägeli 1849.

Hapalosiphon aureus W. & G. S. WEST, in Jour. of Bot. *35* (1897) p. 241.

Along shore; McKenna and Speese Lakes.

Hapalosiphon hibernicus W. & G. S. WEST, in Jour. Roy. Micr. Soc. (1896) p. 163. G. S. West, Brit. Freshw. Algae, (1904) p. 321, fig. 147.

Along shore; Adelaide, Curtis and Razorback Lakes.

Family NOSTOCACEAE

Genus NOSTOC Vaucher 1803.

Nostoc pruniforme (L) C. A. AGARDH, Disp. Algarum Sueciae, Pars. *5* (1812) p. 45. Cooke, Brit. Freshw. Algae, (1882) p. 233, t. 92, figs. 7–9. *Ulva pruniformis* Linnaeus, Flora Suecica, p. 433.

Along shore; Plum, Rose and Sunday Lakes.

Genus ANABAENA Bory de St. Vincent 1823.

Anabaena flos-aquae (LYNGBYE) DE BRÉBISSON, in Mem. de la soc. Acad. de Falaise, (1835) p. 36. *Nostoc flos-aquae* Lyngbye, Tent. Hydrophyt. Danicae, (1819) p. 201, t. 68, figs. D1–D3.

Plankton; Catfish, Devil's, Kegonsa, Mendota, Nashotah (Upper), Oconomowoc, Okauchee, Pine, Squirrel, Waubesa and Waupaca Chain o' Lakes.

Anabaena planctonica BRUNNTHALER, in Sitzbr. d. Kais. Ak. d. Wiss. in Wien, *112*, Abt. 1 (1903) p. 292.

Plankton; Birch, Cranberry and Rock Lakes.

Anabaena affinis LEMMERMANN, in Abh. Nat. Ver. Bremen, *14* (1897) p. 261, t. 1, figs. 12–13, 16–17.

Plankton; Lost, Pardee and North Turtle Lakes.

Anabaena oscillardioides BORY DE ST. VINCENT, in Dict. Classique d'Hist. Nat. *1*, (1822) p. 308. Tilden, Minnesota Algae, *1* (1910) p. 193, t. 9, fig. 20.

Along shore; Franklin, Lee and Pardee Lakes.

Anabaena spiroides var. **crassa** LEMMERMANN, in Bot. Cent. *76* (1898) p. 155. Lemmermann, Algen *1* (1907) in Kryptogamenflora der Mark Brandenburg, *3*, p. 188, p. 159, figs. 15–16.

Plankton; Kegonsa, Monona and Big St. Germain Lakes.

Anabaena inaequalis (KÜTZING) BORNET ET FLAHAULT, in Ann. Sci. Nat. 7 Sér. Bot. 7 (1888) p. 231. G. S. West, Brit. Freshw. Algae, (1904) p. 328, figs. 150A–150D. *Sphaerozyga inaequalis* Kützing, Phycol. Gener. (1843) p. 211.

Along shore; Lake Kegonsa.

Anabaena macrospora var. **robusta** LEMMERMANN, in Bot. Cent. *76* (1898) p. 154.

Plankton; Squirrel Lake.

Anabaena Bornetiana COLLINS, in Erythea, *4* (1896) p. 120.

Plankton; George Lake.

Genus APHANIZOMENON Morren 1838.

Aphanizomenon flos-aquae (L) RALFS, in Ann. and Mag. of Nat. Hist. *5* (1850) p. 340, t. 9, fig. 6. *Byssus flos-aquae* Linnaeus, Species Plantar. (1753) No. 1168.

Plankton; Birch, Cranberry, Found, Kawaguesaga, Kegonsa, La Belle, Lost, Mendota, Monona, Mud (Vilas Co.), Oconomowoc, Okauchee, Pardee, Pewaukee, Plum, Squirrel, Turtle (South), Waubesa and Winnebago Lakes.

Family SCYTONEMACEAE

Genus SCYTONEMA C. A. Agardh 1824.

Scytonema Arcangelii BORNET ET FLAHAULT, in Ann. Sci. Nat. 7 Sér. Bot. *5* (1887) p. 92.

Along shore; Speese Lake.

Genus TOLYPOTHRIX Kützing 1843.

Tolypothrix tenius KÜTZING, Phycol. gener. (1843) p. 228. Kützing, Tabulae Phycol. *2* (1852) p. 9, t. 31, fig. 2.

Along shore; Plum and Squirrel Lakes.

Tolypothrix lanata (DESVAUX) WARTMANN, in Rabenhorst's Algen No. 768 (1858). Tilden, Minnesota Algae *1* (1910) p. 230, t. 14, fig. 1.

Along shore; Crystal and Razorback Lakes.

Tolypothrix distorta (HOFMANN-BANG) KÜTZING, Phycol. gener. (1843) p. 228. Tilden, Minnesota Algae, *1* (1910) p. 231, t. 14, figs. 2–4. *Conferva distorta* Hofmann-Bang, in Flora Danica *5* (1780) t. 820.

Along shore; Kegonsa, Marion, Plum and S. Turtle Lakes.

Family RIVULARIACEAE

Genus RIVULARIA (Roth) C. A. Agardh emend. 1824.

Rivularia echinulata (SMITH) BORNET ET FLAHAULT, in Bull. Soc. Bot. France, *31* (1884) p. 77. *Conferva echinulata* (*Rivularia echinulata* in index) Smith. in English Botany (1804) t. 1378.

Plankton; Kegonsa, Carroll, Mendota, Oconomowoc, Plum, Razorback, Soft, Trout and Waubesa Lakes.

Genus GLOEOTRICHIA J. G. Agardh 1842.

Gloeotrichia pisum (C. A. AGARDH) THURET, in Ann. Sci. Nat. *6* Sér. Bot. *1* (1875) p. 382. *Rivularia pisum* C. A. Agardh, Systema Algarum (1824) p. 25. Tilden, Minnesota Algae *1* (1910) p. 284, t. 19, fig. 6.

Along shore; Marion and Soft Lakes.

Class CHLOROPHYCEAE
Order VOLVOCALES

Family CHLAMIDOMONACEAE
Genus SPHAERELLA Sommerfelt 1824.

Sphaerella lacustris (GIROD-CHANTRANS) WITTROCK, in Hansgirg, Prodr. d. Algenflora v. Böhmen, *1* (1888) p. 105, fig. 52. *Volvox lacustris* Girod-Chantrans. Recherches chimiques et microscopiques sur les Conferves, Bysses, et Tremelles, (1802) p. 54, figs. 17–17'''.

Along shore; Lakes Mendota and Monona.

Family VOLVOCACEAE

Genus GONIUM Mueller 1773.

Gonium pectorale MUELLER, Vernium terrestrium et fluviatilum etc. *1* (1773) p. 60. Wolle, Freshw. Algae of the U. S. (1887) p. 163, t. 151, figs. 15–18.

Plankton; Lake Kegonsa. Along shore; Devil's, Mendota and Soft Lakes.

Genus PANDORINA Bory de St. Vincent 1824.

Pandorina Morum BORY DE ST. VINCENT, in Encyc. methodique, Hist. Nat. de Zoophytes *2* (1824) p. 600. Ehrenberg, Die Infusionsthierchen, (1823) p. 53, t. 2, fig. 33.

Plankton; Fowler, Kegonsa, Mendota, Nemahbin (Lower), Okauchee, Sishebogema, Turtle (South) and Winnebago Lakes.

Genus EUDORINA Ehrenberg 1832.

Eudorina elegans EHRENBERG, in Abh. d. Kgl. Ak. d. Wiss. zu Berlin, Jahrgang 1831 (1832) p. 78, t. 2, fig. 10.

Plankton; Catherine, Devil's, Fowler, Hill, Kawaguesaga, Kegonsa, La Belle, Nemahbin (Lower), No Mans, Okauchee, Rainbow, Sishebogema and Turtle (North and South) Lakes.

Genus VOLVOX L. 1758.

Volvox globator LINNAEUS, Systema Natura Ed. 10 (1758). p. 230.

Plankton; Kegonsa and Soft Lakes.

Order PROTOCOCCALES
Sub-order ZOOSPORINEAE
Family PALMELLACEAE
Sub-family TETRASPOREAE
Genus TETRASPORA Link 1809.

Tetraspora lubica (ROTH) C. A. Agardh, Systema Algarum, (1824) p. 188. Cooke, Brit. Freshw. Algae, (1882), p. 16, t. 6, figs. 3a–3b. *Ulva lubrica* Roth, Catalecta bot. *1* (1797) p. 204.

Along shore; Devil's Lake.

Genus APIOCYSTIS Nägeli 1849.

Apiocystis Brauniana NÄGELI, Gatt. einz. Algen, (1849) p. 67, t. 2, fig. A1.

Along shore; Meta, Nemahbin (Lower), Plum and Soft Lakes.

Sub-family PALMELLEAE

Genus PALMODACTYLON Nägeli 1849.

Palmodactylon varium NÄGELI, Gatt. einz. Algen, (1849) p. 70, t. 2, fig. B1.

Along shore; Devil's Lake.

Genus SCHIZOCHLAMYS A. Braun 1849.

Schizochlamys gelatinosa A. BRAUN, in Kützing, Species Algarum, (1849) p. 891. Cooke, Brit. Freshw. Algae, (1882) p. 11, t. 3, fig. 6.

Along shore; Devil's, Meta, Old Taylor's and Plum Lakes.

Genus SPHAEROCYSTIS Chodat 1897.

Sphaerocystis Schroeteri CHODAT, in Bull. Herb. Boiss. *5* (1897) p. 295, t. 9.

Plankton; Beasley, Catfish, Cranberry, Devil's, Found, Long, Mendota, Meta, Monona, Old Taylor's, Rock (Vilas Co.), Tamarack and Waubesa Lakes.

Genus BOTRYOCOCCUS Kützing 1849.

Botryoccus Braunii KÜTZING, Species Algarum, (1849) p. 892. Rabenhorst, Flora Eur. Algarum *3* (1868) p. 43, p. 8, fig. 14.

Plankton; Clear and Waubesa Lakes.

Sub-family GLOEOCYSTIDEAE

Genus GLOEOCYSTIS Nägeli 1849.

Gloeocystis gigas (KÜTZING) LAGERHEIM, in Öfvers. Kgl. Vet.-Ak. Föhr. *40*, No. 2 (1883) p. 63. G. S. West, Brit. Freshw. Algae (1904) p. 245, figs. 113f–113h. *Protococcus gigas* KÜTZING, Phycol. Germ. (1845) p. 145.

Plankton; Mendota and Oconomowoc Lakes. Along shore; Lake Kegonsa.

Genus PALMODICTYON Kützing 1845.

Palmodictyon viride KÜTZING, Phycol. Germ. (1845) p. 155. G. S. West, Brit. Freshw. Algae, (1904) p. 247, fig. 115.

Along shore; Otter Lake.

Family PLEUROCOCCACEAE

Genus TROCHISCIA Kützing 1845.

Trochiscia sporoides (REINSCH) HANSGIRG, in Hedwigia, *27* (1888) p. 129. *Acanthococcus sporoides* Reinsch, in Ber. d. D. bot. Ges. *4* (1886) p. 242, t. 12, figs. 24a–24b.

Along shore; Devil's Lake.

Trochiscia reticularis (REINSCH) HANSGIRG, in Hedwigia, *27* (1888) p. 129. *Acanthococcus reticularis* Reinsch, in Ber. d. D. bot. Ges. *4* (1886) p. 241, t. 11. figs. 12, 14.

Along shore; Devil's Lake.

Genus GLOEOTAENIUM Hansgirg 1890.

Gloeotaenium Loitlesbergerianum HANSGIRG, in Sitzbr. d. k. böhm. Ges. d. Wiss. in Prag, Jahrgang *1890*

(1890) p. 10. Transeau, in Bot. Gaz. *55* (1913) p. 66, t. 3, figs. 1–24.
Along shore; Kegonsa and Soft Lakes.

Family CHARACIACEAE

Genus CHARACIUM A. Braun 1849.

Characium longipes RABENHORST, Alg. Dec. *18* (1852) No. 171. A. Braun, Alg. unicell. (1855) p. 43, t. 5, fig. D.
Along shore; Helen and Sunday Lakes.

Family HYDRODICTYACEAE

Genus PEDIASTRUM Meyen 1829.

Pediastrum tetras (EHRENBERG) RALFS, in Ann. and Mag. of Nat. Hist. *14* (1844) p. 469, t. 12, fig. 4. *Micrasterias tetras* Ehrenberg, Die Infusionsthierchen, (1838) p. 155, t. 11, fig. 1.
Plankton; Lake Mendota. Along shore; Adelaide, Bullhead, Clear, Devil's, Monona, Muskallonge, Star and Waubesa Lakes.
Pediastrum biradiatum var. **emarginatum** (A. BRAUN) LAGERHEIM, in Öfvers. Kgl. Vet.-Ak. Förh. *39*, No. 2 (1882) p. 54. *Pediastrum rotula* var. *emarginatum* A. Braun, Alg. unicell. (1855) p. 102, t. 6, figs. 4, 8, 9, 11.
Along shore; Adelaide and Kegonsa Lakes.
Pediastrum intergum NÄGELI, Gatt. einz. Algen, (1849) p. 97, t. 5, fig. B4.
Plankton; Soft Lake.
Pediastrum Boryanum (TURPIN) MENENGHINI, in Linnaea *14* (1840) p. 210. *Helierella Boryana* Turpin, in Mem. de Mus. d'Hist. Nat. Paris, *16* (1828) p. 319, t. 13, fig. 22.
Plankton; Beasley, Catherine, Devil's, Found, Fowler, Geneva, Harris, Kawaguesaga, Kegonsa, La Belle, Marl, Mud (Vilas Co.), Muskallonge, Old Taylor's, Star, Taylor, Turtle (North and South), Waubesa and Winnebago Lakes.
var. **undulatum** WILLE, in Öfvers Kgl. Vet.-Ak. Förh. *36* (1879) No. 5, p. 28.
Plankton; Lake Winnebago.

Pediastrum duplex MEYEN, in Nova Acta Phys-Med. Ac. Caes. Leop.-Carol. *14*. 2, (1828) p. 772.

Plankton; Catherine, Helen (Eagle River), Kegonsa, La Belle, Lost, Mendota, Monona, Okauchee, Pardee, Soft, Taylor and Waubesa Lakes.

var. **clathratum** (A. BRAUN) LAGERHEIM, in Öfvers. Kgl. Vet.-Ak. Förh. *39*, No. 2 (1882) p. 56. *Pediastrum pertusum* var. *clathratum* A. Braun, Alg. Unicell. (1855) p. 93.

Plankton; Catfish, Cranberry and Mud (Vilas Co.) Lakes.

var. **reticulatum** LAGERHEIM, in Öfvers. Kgl. Vet.-Ak. Förh. *39*, No. 2 (1882) p. 56, t. z, fig. 1.

Plankton; Found, Kawaguesaga, Mendota, Pardee, Sishebogema, Turtle (South), Waubesa and Winnebago Lakes.

var. **rotundatum** LUCKS, in Jahrb. d. Westpr. Lehrervereins f. Naturkunde. *2–3* (1907) p. 31.

Plankton; Oconomowoc Lake.

Pediastrum Kawraiskyi SCHMIDLE, in Arb. d. Botan. Gartens zu Tiflis. *2* (1897) p. 269. Nitardy, in Beih. z. Bot. Cent. *32* (1914) p. 164, t. 5, fig. 5.

Plankton; Lake Winnebago.

Pediastrum simplex MEYEN, in Nova Acta Phys.-Med. Ac. Caes.-Leop. *14*, 2 (1829) p. 772, t. 43, figs. 1–5.

Plankton; Kegonsa, Monona and Winnebago Lakes.

var. **clathratum** (SCHRÖTER) G. S. WEST, in Jour. Linn. Soc. London, *38* (1907) p. 134. *Pediastrum clathratum* (SCHRÖTER) LEMMERMANN, in Forschungsbr. a. d. Biol. Stat. zu Plön, *7* (1899) p. 115.

Plankton; Green, Lost, Mud (Vilas Co.) Lakes.

Genus EUASTROPSIS Lagerheim 1894.

Euastropsis Richteri (SCHMIDLE) LAGERHEIM, in Tromsö Museums Aarshefter, *17* (1895) p. 20, t. 1, figs. 8–27. *Euastrum Richteri* Schmidle, in Flora *78* (1894) p. 60, t. 7, fig. 25.

Along shore; Lake Kegonsa.

Genus HYDRODICTYON Roth 1800.

Hydrodictyon reticulatum (L) LAGERHEIM, in Öfvers. Kgl. Vet.-Ak. Förh. *40*, No. 2 (1883) p. 71. *Conferva reticulata* Linnaeus, Spec. Plant. p. 1635.

Along shore; Lake Kegonsa.

Sub-order AUTOSPORINEAE

Family CHLORELLACEAE

Sub-family CHLORELLEAE

Genus CHLORELLA Beyerinck 1890.

Chlorella vulgaris BEYERINCK, in Bot. Ztg. *48* (1890) p. 758, t. 7, fig. 2.

Plankton; Lake Mendota.

Sub-family DICTYOSPHAERIEAE

Genus TETRACOCCUS W. West 1892.

Tetracoccus botryoides W. WEST, in Jour. Roy. Micr. Soc. (1892) p. 735, t. 10, figs. 43–48.

Plankton; Mendota and Sishebogema Lakes. Along shore; Clear and Devil's Lakes.

Genus DICTYOSPHAERIUM Nägeli 1849.

Dictyosphaerium pulchellum WOOD, in Smithsonian Cont. to Knowledge, *19*, No. 241 (1872) p. 84, t. 10, fig. 4.

Plankton; Birch, Catfish, Catherine, Clear (Vilas Co.), Cranberry, Kegonsa, Mendota, Monona, Muskallonge, Oconomowoc, Okauchee, Old Taylor's, Rock, Rose, Rozen, Tamarack, Turtle (North and South), Waubesa and Winnebago Lakes.

Dictyosphaerium Ehrenbergianum NÄGELI, Gatt. einz. Algen. (1849) p. 73, t. 2, fig. E.

Plankton; Clear, Kegonsa and Mendota Lakes.

Genus DIMORPHOCOCCUS A. Braun 1855.

Dimorphococcus lunatus A. BRAUN, Alg. unicell. (1855) p. 44. Rabenhorst, Flora Eur. Algarum *3* (1868) p. 36, p. 6, figs. a–c.

Plankton; Catfish, Kegonsa and Minocqua Lakes. Along shore; Rozen Lake.

Genus INEFFIGIATA W. & G. S. West 1897.

Ineffigiata neglecta W. & G. S. WEST, in Jour. Roy. Micr. Soc. (1897) p. 503. W. & G. S. West, in Jour. of Bot. *41* (1903) p. 80, t. 447, figs. 1–6.

Plankton; Devil's, Green, Kegonsa, Mendota, Mercer, Monona, Mud (Vilas Co.), No Mans, Pardee, Sishebogema, Turtle (South), Waubesa and Winnebago Lakes.

Sub-family MICRACTINEAE

Genus RICHTERIELLA Lemmermann 1897.

Richterialla botryoides (SCHMIDLE) LEMMERMANN, in Hedwigia, *37* (1898) p. 306, t. 10, figs. 1–6. *Golenkinia botryoides* Schmidle, in Allg. bot. Zeitschr. *2* (1896) p. 194.

Plankton; Green, Mendota, Pope and North Turtle Lakes.

Richterialla quadriseta LEMMERMANN, in Hedwigia, *37* (1898) p. 307, t. 10, fig. 7.

Plankton; Catfish and Cranberry Lakes.

Family OOCYSTACEAE

Sub-family OOCYSTEAE

Genus OOCYSTIS Nägeli 1855.

Oocystis parva W. & G. S. WEST, in Jour. of Bot. *36* (1898) p. 335.

Plankton; George, Mendota and Muskallonge Lakes.

Oocystis elliptica var. **minor** W. WEST, in Jour. Roy. Micr. Soc. (1892) p. 736. W. & G. S. West in Jour. Roy. Micr. Soc. (1894) p. 14, t. 2, fig. 26.

Plankton; Upper Nemahbin Lake.

Oocystis lacustris CHODAT, in Bull. Herb. Boiss. *5* (1897) p. 296, t. 10, figs. 1–7.

Plankton; Beasley, Birch, Catfish, Cranberry, Devil's, Fowler, Kawaguesaga, Kegonsa, Long, Mendota, Monona, Pardee, Taylor and Turtle (North and South) Lakes.

Oocystis nodulosa W. & G. S. WEST, in Jour. Roy. Micr. Soc. (1894) p. 15, t. 2, fig. 31.

Plankton; Lake Winnebago.

Oocystis Novae-Semliae var. **maxima** W. & G. S. WEST, in Jour. Roy. Micr. Soc. (1894) p. 13, t. 2, fig. 25.

Plankton; Found and Rock Lakes.

Genus EREMOSPHAERA DeBary 1858.

Eremosphaera viridis DE BARY, Unters. u. d. Fam. d. Conjugaten, (1858) p. 56, t. 8, figs. 26–27.

Along shore; Clear and Lee Lakes.

Genus NEPHROCYTIUM Nägeli 1849.

Nephrocytium Agardianum NÄGELI, Gatt. einz. Algen, (1849) p. 79, t. 3, fig. C.

Plankton; Lake Mendota. Along shore; Lower Nemahbin Lake.

Nephrocytium Naegelii GRUNOW, in Rabenhorst, Flora Eur. Algarum, *3* (1868) p. 52. Cooke, Brit. Freshw. Algae (1882) p. 26, t. 11, figs. 2a–2c.

Plankton; Lake Kegonsa.

Sub-family LAGERHEIMEAE

Genus CHODATELLA Lemmermann 1898.

Chodatella ciliata (LAGERHEIM) LEMMERMANN, in Hedwigia *37* (1898) p. 310. *Oocystis ciliata* Lagerheim, in Öfvers. Kgl. Vet.-Ak. Förh. *39*, No. 2 (1882) p. 76, t. 3, figs. 33–37.

Plankton; Kegonsa and Mendota Lakes.

Chodatella Droescheri LEMMERMANN, in Ber. d. D. bot. Ges. *18* (1900) p. 98, t. 3, fig. 12.

Plankton; Upper Nashotah Lake.

Chodatella citriformis SNOW, in Bull. U. S. Fish Comm. *22* (1902) p. 389, t. 2, figs. 8^1–8^3.

Along shore; Lake Waubesa.

Chodatella subsalsa LEMMERMANN, in Hedwigia, *37* (1898) p. 310. *Lagerhemia subsalsa* Lemmermann, in Forschungsbr. a. d. Biol. Stat. zu Plön. *6* (1898) p. 193, t. 5, figs. 2–6.

Plankton; Muskallonge Lake.

Sub-family TETRAEDRIEAE

Genus TETRAEDRON Kützing 1845.

Tetraedron minimum (A. BRAUN) HANSGIRG, in Hedwigia, *27* (1888) p. 131. G. S. West, Brit. Freshw. Algae, (1904) p. 231, fig. 101A. *Polyedrium minimum* A. Braun, Algarum unicell. (1855) p. 94.

Plankton; Mendota and Okauchee Lakes. Along shore; Clear, Muskallonge, Nemahbin (Lower), Old Taylor's, Rozen and Waubesa Lakes.

Tetraedron enorme (RALFS) HANSGIRG, in Hedwigia, *27* (1888) p. 132. *Staurastrum enorme* Ralfs, Brit. Desmidieae (1848) p. 140, t. 33, figs. 11a–11e.

Along shore; Lakes Kegonsa, Mendota and Waubesa.

Tetraedron trigonum (NÄGELI) HANSGIRG, in Hedwigia, *27* (1888) p. 130. *Polyedrium trigonum* Nägeli, Gatt. einz. Algen, (1849) p. 84, t. 4, fig. B1.

Along shore; Lake Mendota.

Tetraedron caudatum (CORDA) HANSGIRG, in Hedwigia, *27* (1888) p. 131. G. S. West, Brit. Freshw. Algae, (1904) p. 231, fig. 101B. *Astericium caudatum* Corda, in Almanach de Carlsbad, *9* (1839) p. 238, t. 1, figs. 1–2.

Plankton; Lake Mendota. Along shore; Muskallonge, Razorback and Waubesa Lakes.

Tetraedron limneticum BORGE, in Bot. Notiser, (1900) p. 5, t. 1, fig. 2.

Plankton; Clear, Mud (Vilas Co.) and Squirrel Lakes.

Tetraedron pusillum (WALLICH) W. & G. S. WEST in Jour. of Bot. *35* (1897) p. 237. *Micrasterias pusilla* Wallich, in Ann. and Mag. of Nat. Hist. *3* Sér. *5* (1860) p. 281, t. 13, fig. 13.

Along shore; Clear and Mendota Lakes.

Family COELASTRACEAE

Genus COELASTRUM Nägeli 1849.

Coelastrum microporum NÄGELI, in A. Braun, Alg. unicell. (1855) p. 70. Senn, in Bot. Ztg. *57* (1899) p. 53, t. 2, figs. 11–17.

Plankton; Mendota, Mud (Vilas Co.), Oconomowoc, Otter, Pope, Squirrel and South Turtle Lakes.

Coelastrum sphaericum NÄGELI, Gatt. einz. Algen, (1849) p. 98, t. 5, fig. C1.

Along shore; Lake Kegonsa.

Coelastrum proboscidium BOHLIN, in Bih. t. Kgl. Sv. Vet.-Ak. Handl. *23*, Afd. 3, No. 7 (1897) p. 33, t. 2, figs. 19–22. Senn, in Bot. Ztg. *57* (1899) p. 59, t. 2, figs. 18–22.

Plankton; Catfish, Clear, Cranberry, Found, Mercer, Minocqua and Old Taylor's Lakes.

Coelastrum reticulatum (DANGEARD) SENN, in Bot. Ztg. *57* (1899) p. 66, t. 2, figs. 1–10. *Hariotina reticulata* Dangeard, in Le Botaniste, *1* (1889) p. 162, t. 7, figs. 15–17.

Plankton; Lake Mendota.

Genus SORASTRUM Kützing 1845.

Sorastrum spinulosum NÄGELI, Gatt. einz. Algen, (1849) p. 99, t. 5, fig. D.

Along shore; Clear, Kegonsa, Plum and Rose Lakes.

Sorastrum americanum (BOHLIN) SCHMIDLE, in Engl. Jahrb. *27*, p. 230. Lemmermann, in Arch. f. Hydrobiol. u. Planktonkunde, *5* (1910) p. 310, fig. 5. *Selenosphaerium americanum* Bohlin, in Bih. t. Kgl. Sv. Vet.-Ak. Handl. *23* Afd. 3, No. 7 (1897) p. 40, t. 2, figs. 38–41.

Along shore; Devil's Lake.

Family SCENEDESMACEAE

Sub-family SCENEDESMEAE

Genus SCENEDESMUS Meyen 1829.

Scenedesmus obliquus (TURPIN) KÜTZING, in Linnaea, *8* (1833) p. 609. *Achnanthes obliqua* Turpin, in Mém. du Mus. d'Hist. Nat. Paris. *16* (1828) p. 312, t. 13, fig. 9.

Plankton; Lake Mendota. Along shore; Cedar, Helen (Winchester), Minocqua, Muskallonge and Waubesa Lakes.

Scenedesmus dimorphus (TURPIN) KÜTZING, in Linnaea, *8* (1833) p. 608. *Achnanthes dimorphus* Turpin, in Mém. du Mus. d'Hist. Nat. Paris, *16* (1828) p. 313, t. 13, fig. 12.

Along shore; Devil's, Found, Mendota and Waubesa Lakes.

Scenedesmus arcuatus LEMMERMANN, in Forschungsbr. a. d. Biol. Stat. zu Plön, *7* (1899) p. 112, t. 1, figs. 2–4.

Plankton; Cranberry, Long, Mendota, Meta, Pardee and North Turtle Lakes.

var. **platydisca** SMITH, in Trans. Wis. Acad. ined.

Plankton; George Lake. Along shore; Kegonsa and Rozen Lakes.

Scenedesmus bijuga (TURPIN) LAGERHEIM, in Nuova Notarisia, *4* (1893) p. 158. *Achnanthes bijuga*, Turpin, in Mém. du Mus. d'Hist. Nat. Paris, *16* (1828) p. 310, t. 13, fig. 4.

Plankton; Fowler Lake. Along shore. Clear, Helen (Winchester), Muskallonge, Mud (Waupaca Co.), Old Taylor's and Razorback Lakes.

var. **alternans** (REINSCH) BORGE, in Arkiv för Botanik, *6* (1906) No. 1, p. 57. *Scenedesmus alternans* Reinsch, in Abh. Senckenbergischen Naturf. Ges. *6* (1866) p. 135, t. 20, fig. D5.

Plankton; Muskallonge Lake. Along shore; Devil's Lake.

Scenedesmus denticulatus LAGERHEIM, in Öfvers. Kgl. Vet.-Ak. Förh. *39*, No. 2 (1882) p. 61, t. 2, figs. 13–17.

Plankton; Lake Mendota. Along shore; Clear Lake.

Scenedesmus brasiliensis BOHLIN, in Bih. t. Kgl. Sv. Vet.-Ak. Handl. *23*, Afd. 3, No. 7 (1897) p. 22, t. 1, figs. 36–37.

Plankton; Old Taylor's Lake. Along shore; Carroll, Devil's, Minocqua, Rozen and Waubesa Lakes.

Scenedesmus acutiformis SCHRÖDER, in Forschungsbr. a. d. Biol. Stat. zu Plön, *5* (1897) p. 45, t. 2, fig. 4.

Plankton; Lake Mendota. Along shore; Found Lake.

Scenedesmus serratus (CORDA) BOHLIN, in Bih. t. Kgl. Sv. Vet.-Ak. Handl. *27*, Afd. 3 No. 4 (1902), p. 44, t. 1, fig. 2. *Arthrodesmus serratus* Corda, in Almanach de Carlsbad, *9* (1835) p. 244, t. 6, fig. 35.

Along shore; Devil's, Kegonsa and Muskallonge Lakes.

Scenedesmus hystrix LAGERHEIM, in Öfvers. Kgl. Vet.-Ak. Förh. *39*, No. 2 (1882) p. 62, t. 2, fig. 18.

Along shore; Minocqua and Muskallonge Lakes.

Scenedesmus quadricauda (TURPIN) DE BRÉBISSON, in Mém. de la Soc. Ac. de Falaise, (1835) p. 66. *Achnanthes quadricauda* Turpin, in Mém. du Mus. d'Hist. Nat. Paris, *16* (1828) p. 311, t. 13, fig. 6.

Plankton; Clear, Green, Lost, Meta, Muskallonge, Nemahbin (Lower), Okauchee, Old Taylor's, Pope and Winnebago Lakes.

var. **longisina** (CHODAT) SMITH, in Trans. Wis. Acad. ined. *Scenedmus longispina* Chodat, in Matér. pour la flore cryptogamique Suisse, *4* Fasc. 2 (1913) p. 60, figs. 53–58.

Plankton; Lost and Mendota Lakes.

var. **quadrispina** (CHODAT) SMITH, in Trans. Wis. Acad. ined. *Scenedmus quadrispina* Chodat, in Matér. pour la flore cryptogamique Suisse, *4* Fasc. 2 (1913) p. 58, figs. 45–52.

Along shore; Laura and Muskallonge Lakes.

var. **Westii** SMITH, in Trans. Wis. Acad. ined.

Plankton; Meta Lake. Along shore; Adelaide Lake.

var. **maximum** W. & G. S. WEST, in Trans. Linn. Soc. Bot. *2* Ser. *5* (1895) pt. 2, p. 83, t. 5, figs. 9–10.

Along shore; Old Taylor's, Rozen and Sunday Lakes.

Scenedesmus armatus (CHODAT) SMITH, in Trans. Wis. Acad. ined. *Scenedesmus hystrix* var. *armatus* Chodat, in Matér. pour. la flore cryptogamique Suisse, *1*, fasc. *3* (1902) p. 215, fig. 140.

Plankton; Lake Mendota. Along shore; Clear and Waubesa Lakes.

Scenedesmus longus MEYEN, in Nova Acta Phys.-Med. Ac. Caes. Leop.-Carol. *14* (1829) p. 774, t. 43, fig. 28.

Plankton; Rock Lake. Along shore; Lake Waubesa.

Scenedesmus abundans (KIRCHNER) CHODAT, in Matér. pour la flore cryptogamique Suisse, *4* Fasc. *2* (1913) p. 77. *Scenedesmus caudatus* forma *abundans* Kirchner, Algen, in Cohn, Kryptogamen-Flora von Schlesien, *2* (Erste Hälfte) (1878) p. 98.

Along shore; Muskallonge and Sunday Lakes.

var. **brevicauda** SMITH, Trans. Wis. Acad. ined.

Plankton; Lake Mendota. Along shore; Monona and Waubesa Lakes.

Genus TETRADESMUS Smith 1913.

Tetradesmus wisconsinensis SMITH, in Bull. Torr. Bot. Club, *40* (1913) p. 76, t. 1, figs. 1–20.

Along shore; Kegonsa, Muskallonge, Star and Waubesa Lakes.

Genus TETRASTRUM Chodat 1895.

Tetrastrum Staurogeniaeforme (SCHRÖDER) CHODAT, in Matér. pour la flore cryptogamique Suisse, *1*, Fasc. 3 (1902) p. 208, p. 223, fig. 148^{12}. *Cohniella staurogeniaeformis* Schröder, in Ber. d. D. bot. Ges. *15* (1897) p. 373, t. 17, fig. 5.

Plankton; Lake Mendota.

Genus CRUCIGENIA Morren 1830.

Crucigenia quadrata MORREN, in Ann. Sci. Nat. *20* (1830) p. 415, t. 15, figs. 1–5.

Plankton; Pardee Lake.

Crucigenia rectangularis (NÄGELI) GAY, Recherches sur le dév. et la class. de quelques algues vertes, (1891) p. 100, t. 15, fig. 151. *Chloropedium rectangularis* Nägeli, in A. Braun, Alg. unicell. (1855) p. 70.

Plankton; Fowler, Kegonsa, Okauchee, Old Taylor's and Winnebago Lakes.

Crucigenia Lauterbornei (SCHMIDLE) CHODAT, in Matér. pour la flore cryptogamique Suisse, *1*, Fasc. 3 (1902) p. 206, fig. 127. *Staurogenia Lauterbornei* Schmidle, in Allg. Bot. Zeitschr. *2* (1896) p. 192, fig. 1.

Plankton; Lake Kegonsa.

Sub-family SELENASTREAE

Genus ANKISTRODESMUS Corda 1836.

Ankistrodesmus falcatus (CORDA) RALFS, Brit. Desmidieae (1848) p. 180, t. 34, figs. 3a–3d. *Micrasterias falcata* Corda, in Almanach de Carlsbad, *5* (1835) p. 198, t. 2, fig. 29.

Plankton; Kawaguesaga and Rock Lakes. Along shore; Clear, Devil's, Helen (Winchester), Kegonsa, Marion, Mendota, Minocqua, Old Taylor's, Razorback, Rozen and Waubesa Lakes.

var. **acicularis** (A. BRAUN) G. S. WEST, Brit. Freshw. Algae, (1904) p. 223, figs. 94B–94C. *Raphidium aciculare* A. Braun, in Rabenhorst, Die Algen Sachsens, Dec. *44* (1855) No. 442.

Plankton; Lakes Mendota and Waubesa. Along shore; Devil's Lake.

var. **spiralis** (TURNER) G. S. WEST, Brit. Freshw. Algae, (1904) p. 224. *Raphidium spiralis* Turner (1893).

Along shore; Old Taylor's and Soft Lakes.

var. **mirabilis** (W. & G. S. WEST) G. S. WEST, Brit. Freshw. Algae, (1904) p. 224, fig. 94E. *Raphidium polymorphum* var. *mirabile* W. & G. S. West, in Jour. of Roy. Micr. Soc. (1897) p. 501, t. 7, figs. 9–13.

Plankton; Devil's and Squirrel Lakes.

Ankistrodesmus Pfitzeri (SCHRÖDER) G. S. WEST, Brit. Freshw. Algae, (1904) p. 224, figs. 94G–94H. *Raphidium Pfitzeri* Schröder, in Verh. d. Nat.-Med. Ver. zu Heidelberg, N. F. *7* (1902) p. 152, t. 6, fig. 6.

Plankton; Clear, Cranberry, Devil's, Found, Harris, Muskallonge, No Mans, Oconomowoc, Okauchee, Pardee, and Sishebogema Lakes.

Genus ACTINASTRUM Lagerheim 1882.

Actinastrum Hantzschi LAGERHEIM, in Öfvers. Kgl. Vet.-Ak. Förh. *39*, No. 2 (1882) p. 70, t. 3, figs. 25–26.

Plankton; Kegonsa, Mendota and Waubesa Lakes.

Genus SELENASTRUM Reinsch 1867.

Selenastrum Bibraianum REINSCH, Die Algenflora d. mitt. Th. v. Franken (1867) p. 64, t. 4, fig. 2.

Plankton; Mendota, Meta and Squirrel Lakes.

Selenastrum gracile REINSCH, Die Algenflora d. mitt. Th. v. Franken, (1867) p. 65, t. 4, fig. 3.

Plankton; Lake Monona. Along shore; Clear and Rozen Lakes.

Genus KIRCHNERIELLA Schmidle 1893.

Kirchneriella obesa (W. WEST) SCHMIDLE, in Ber. d. Naturf. Ges. zu Freiburg i B. (1893) p. 15 (82), t. 7, fig. 2. *Selenastrum obesum* W. West, in Jour. Roy. Micr. Soc. (1892) p. 734, t. 10, figs. 50–52.

Plankton; Catherine, Rock, Squirrel, South Turtle and Winnebago Lakes.

Kirchneriella lunaris (KIRCHNER) MÖBIUS, in Abh. d. Senckenb. Naturf. Ges. *18* (1894) p. 331. *Raphidium convulutum* var. *lunare* Kirchner, Algen, I, in Cohn, Kryptogamen-Flora von Schlesien, *2* (Erste Halfte) (1878) p. 114.

Plankton; Found, Mendota, Meta, Pardee and Squirrel Lakes. Along shore; Kegonsa, Minocqua and Rozen Lakes.

Kirchneriella contorta (SCHMIDLE) BOHLIN, in Bih. t. Kgl. Sv. Vet.-Ak. Handl. *23*, Afd. 3, No. 7 (1897) p. 20. *Kirchneriella obesa* var. *contorta* Schmidle, in Flora, *78* (1894) p. 44, t. 7, fig. 2.

Plankton; Fowler, Mendota and Pardee Lakes. Along shore; Clear Lake.

Order CHAETOPHORALES
Family ULOTRICHACEAE

Genus GEMINELLA Turpin 1828.

Geminella interrupta (TURPIN) LAGERHEIM emend., in Öfvers. Kgl. Vet.-Ak. Förh. *40*, No. 2 (1883) p. 68, t. 1, figs. 30–35. Turpin, in Mém. du Mus. d'Hist. Nat. Paris, *16* (1828) p. 329.

Along shore; Soft Lake.

Genus RADIOFILUM Schmidle 1894.

Radiofilum conjunctivum SCHMIDLE, in Flora, *78* (1894) p. 48, t. 7, figs. 4–5.
Along shore; Plum Lake.

Radiofilum flavescens G. S. WEST, in Jour. of Bot. *37* (1899) p. 57, t. 394, figs. 10–11.
Along shore; Soft Lake.

Genus STICHOCOCCUS Nägeli 1849.

Stichococcus bacillaris NÄGELI, Gatt. einz. Algen, (1849) p. 77, t. 4, fig. G1.
Along shore; Lake Mendota.

Genus ULOTHRIX Kützing 1833.

Ulothrix zonata (WEBER UND MOHR) KÜTZING, in Flora, *16* (1833) p. 519. *Conferva zonata* Weber und Mohr, Naturhistorische Reise durch einen Theil Schwedens, (1804) p. 97, t. 1, fig. 7.
Along shore; Lakes Mendota and Monona.

Family ULVACEAE

Genus PROTODERMA Kützing 1843.

Protoderma viride KÜTZING, Phycol. gener. (1843) p. 295. G. S. West, Brit. Freshw. Algae (1904) p. 205, figs. 83A–83C.
Along shore; Lake Monona.

Family CHAETOPHORACEAE

Genus CHAETOPHORA Schrank 1783.

Chaetophora pisiformis (ROTH) C. A. AGARDH, Disp. algarum Sueciae, (1812) p. 43. Hazen, in Mem. Torr. Bot. Club, *11* (1902) p. 212, t. 38, fig. 1. *Rivularia pisiformis* Roth, Neue Beitr. Bot. *1* (1802) p. 272.
Along shore; McKenna and Sunday Lakes.

Chaetophora elegans (ROTH) C. A. AGARDH, Disp. algarum Sueciae, (1812) p. 42. Hazen, in Mem. Torr. Bot.

Club, *11* (1902) p. 211, t. 37, figs. 1–3. *Rivularia elegans* Roth, Neue Beitr. Bot. *1* (1802) p. 269.
Along shore; Green and Miner's Lake.

Genus MYXONEMA Fries 1825.

Myxonema lubricum (DILLWYN) FRIES, Systema Orbis Vegatabilis. Plantae Homonemeae, (1825) p. 343. *Conferva lubrica* Dillwyn, Brit. Conferveae (1806) t. 57.
Along shore; Geneva, Monona and Waubesa Lakes.

Genus DRAPARNALDIA Bory de St. Vincent 1808.

Draparnaldia plumosa (VAUCHER) C. A. AGARDH, Disp. algarum Sueciae, (1812) p. 42. *Batrachospermum plumosum* Vaucher, Histoire des Conferves d'eau douce, (1803) p. 113, t. 11, fig. 2.
Along shore; Devil's and Sunday Lakes.

Genus MICROTHAMNION Nägeli 1849.

Microthamnion Kuetzingianum NÄGELI, in Kützing, Species Algarum (1849) p. 352. Hazen, in Mem. Torr. Bot. Club, *11* (1902) p. 191, t. 26, fig. 1; t. 27, figs. 2–4.
Along Shore; Otter Lake.

Microthamnion strictissimum RABENHORST, Die Algen Sachsens, Dec. *82* (1859) No. 829. Hazen, in Mem. Torr. Bot. Club, *11* (1902) p. 191, t. 26, figs. 2–5.
Along shore; Tank and Plum Lakes.

Family CHAETOPELTIDIACEAE

Genus CHAETOSPHAERIDIUM Klebahn 1892.

Chaetosphaeridium globosum (NORDSTEDT) KLEBAHN, in Jahrb. Wiss. Bot. *25* (1893) p. 306, t. 14, fig. 5. *Herposteiron globosa* Nordstedt, in Minneskrift utgifven a K. Fysiografiska sällskapet i Lund med anledning af dess hundraärsfest d. 3 Oct. 1878, p. 23, t. 2, figs. 22–23.
Along shore; Plum and Razorback Lakes.

Chaetosphaeridium Pringsheimii forma **conferta** KLEBAHN, in Jahrb. Wiss. Bot. *25* (1893) p. 307, t. 14, fig. 11.

Along shore; Adelaide, Helen (Winchester), Helen (Eagle River), Soft and Sunday Lakes.

Family CYLINDROCAPSACEAE

Genus CYLINDROCAPSA Reinsch 1867.

Cylindrocapsa geminella WOLLE, Freshw. Algae of the U. S. (1887) p. 104, t. 91, figs. 1–17.

Along shore; Lake Kegonsa.

Family HERPOSTEIRACEAE

Genus HERPOSTEIRON Nägeli 1849.

Herposteiron confervicola NÄGELI, in Kützing, Species Algarum, (1849) p. 424.

Along shore; Helen (Winchester), Kegonsa, Mendota, Okauchee, Otter, Soft and Waubesa Lakes.

Herposteiron polychaete HANSGIRG, in Flora, *71* (1888) p. 214, t. 12, figs. 1–5.

Along shore; Plum Lake.

Herposteiron Hyalothecae HANSGIRG, in Sitzbr. d. k. böhm. Ges. d. Wiss. Prag. Jahrgang *1891* (1891) p. 309. Heering, in Pascher, Die Süsswasser-Flora Deutschlands, Österreichs, und der Schweiz. Heft. 6, Chlorophyceae *3* (1914) p. 129, fig. 184.

Plankton; North Turtle Lake.

Family COLEOCHAETACEAE

Genus COLEOCHAETE de Brébisson 1844.

Coleochaete pulvinata A. BRAUN, in Kützing, Species algarum (1849) p. 425. Pringsheim, in Jahrb. Wiss. Bot. *2* (1860) p. 33, t. 2, fig. 1.

Along shore; Mendota, Old Taylor, Razorback and Sunday Lakes.

Coleochaete soluta (DE BRÉBISSON) PRINGSHEIM, in Jahrb. Wiss. Bot. *2* (1860) p. 6, t. 1, figs. 2–3.

Coleochaete scutata var. *soluta* de Brébisson, in Ann. Sci. Nat. *3* Sér. Bot. *1* (1844) p. 30, t. 2, fig. 8.

Along shore; McKenna, Meta and Mendota Lakes.

Coleochaete scutata DE BRÉBISSON, in Ann. Sci. Nat. *3* Sér. Bot. *1* (1844) p. 29, t. 2, figs. 1–7.

Along shore; Kegonsa, Nemahbin, Mendota, Muskallonge, Soft and Sunday Lakes.

Order CONJUGALES

Family ZYGNEMACEAE

Sub-family ZYGNEMEAE

Genus ZYGNEMA C. A. Agardh 1817.

Zygnema pectinatum (VAUCHER) C. A. AGARDH, Synop. algarum Scand. (1817) p. 102. De Bary, Unters. u. d. Fam. d. Conjugaten, (1858) p. 77, t. 1, figs. 15–19. *Conjugata pectinata* Vaucher, Hist. d. Conferves d'eau douce, (1803) p. 77, t. 7, fig. 4.

Along shore; Fowler Lake.

var. **conspicuum** (HASSALL) KIRCHNER; Algen, in Cohn, Kryptogamen-Flora von Schlesien, *2* (Erste Halfte) (1878) p. 127. *Tyndaridea conspicua* Hassall, Brit. Freshw. Algae (1845) p. 164, t. 39, figs. 1–2.

Along shore; Fowler Lake.

Genus SPIROGYRA Link 1820.

Spirogyra porticalis (MUELLER) CLEVE, in Nova Acta Reg. Soc. Sci. Upsaliensis, Ser. *3*, *6* (1868) No. 11, p. 22, t. 5, figs. 8–13. *Conferva porticalis* Mueller, in Nova Acta Ac. Petrop. *3* (1785) p. 89.

Along shore; Fowler, Mendota, Nemahbin (Lower), Okauchee and Waubesa Lakes.

Genus DEBARYA Wittrock 1872.

Debarya laevis (KÜTZING) W. & G. S. WEST, in Jour. Roy. Micr. Soc. (1897) p. 476. *Zygonium Laeve* Kützing, Species Algarum (1849) p. 447. *Mougeotia laevis* (Kützing) Archer, in Quart. Jour. Micr. Sci. N. S. *7* (1867) t. 8, figs. 1–3.

Along shore; Miner's Lake.

Sub-family MESCARPEAE

Genus MOUGEOTIA (C. A. Agardh 1824) emend. Wittrock 1872.

Mougeotia laetevirens (A. BRAUN) WITTROCK, in Wittrock et Nordstedt, Algae aquae dulcis exsiccatae, No. 58. *Craterospermum laetevirens* A. Braun, Alg. unicell. (1855) p. 60. DeBary, Unters. u. d. Fam. d. Conjugaten, (1858) p. 81, t. 3, figs. 1–13.

Along shore; Sunday Lake.

Mougeotia viridis (KÜTZING) WITTROCK, in Bih. t. Kgl. Sv. Vet.-Ak. Handl. *1*, No. 1 (1872) p. 39. *Staurospermum viride* Kützing, Phycol. gener. (1843) p. 278. Cooke, Brit. Freshw. Algae (1882) p. 107, t. 44, figs. 2a–2c.

Plankton; Okauchee Lake. Along shore; Franklin Lake.

Family DESMIDIACEAE

Vacant.

Order SIPHONOCLADIALES
Family CLADOPHORACEAE

Genus CLADOPHORA Kützing 1843.

Cladophora glomerata (L) KÜTZING, Phycol. gener. (1843) p. 266. Collins, in Tufts Coll. Studies, *2* (1909) p. 350, t. 13, fig. 124. *Conferva glomerata*, Linnaeus, Systema Naturae, p. 721.

Along shore; Kegonsa, Monona, Geneva, Mendota and Waubesa Lakes.

Genus RHIZOCLONIUM Kützing 1843.

Rhizoclonium hieroglyphicum (C. A. AGARDH) KÜTZING, Phycol. germ. (1845) p. 206. G. S. West, Brit. Frshw. Algae (1904) p. 104, fig. 39A. *Conferva hieroglyphica* C. A. Agardh, in Flora, *10* (1827) p. 636.

Along shore; Mendota, Kegonsa, and Plum Lakes.

Family SPHAEROPLEACEAE

Genus SPHAROPLEA C. A. Agardh 1824.

Sphaeroplea annulina (ROTH) C. A. AGARDH, Systema algarum (1824) p. 76. Cooke, Brit. Freshw. Algea (1882) p. 134, t. 52. *Conferva annulina* Roth, Catalecta. Bot. *3* (1806) p. 7.

Along shore; Lake Mendota.

Order OEDOGONIALES
Family OEDOGONIACEAE

Genus OEDOGONIUM Link 1820.

Oedogonium plusiosporum WITTROCK, in Nova. Acta. Reg. Soc. Sci. Upsaliensis, *3* Ser. *9*, No. 3 (1875) p. 11. Hirn, in Acta. Soc. Sci. Fennicae, *27* (1900) p. 84, t. 2, fig. 17.

Along shore; Soft Lake.

Oedogonium nodulosum var. **commune** HIRN, in Acta. Soc. Sci. Fennicae, *27* (1900) p. 187, t. 30, fig. 185.

Along shore; Old Taylor's Lake.

Genus BULBOCHAETE C. A. Agardh 1817.

Bulbochaete mirabilis WITTROCK, in Öfvers. Kgl. Vet.-Ak. Förh. *27* No. 3 (1870) p. 137, t. 1, figs. 8–9.

Along shore; Big Bass Lake.

Class HETEROKONTEAE
Order CONFERVALES
Family CHLOROTHECIACEAE

Genus CHARACIOPSIS Borzi 1895.

Characiopsis pyriformis BORZI, Studii algolicii, *2* (1895) p. 153.

Along shore; Clear and Rozen Lakes.

Genus MISCHOCOCCUS Nägeli 1849.

Mischococcus confervicola NÄGELI, Gatt. einz. Algen. (1849) p. 82, t. 2, fig. D.

Along shore; Minocqua Lake.

Family TRIBONEMACEAE

Genus CHLOROBOTRYS Bohlin 1901.

Chlorobotrys regularis (W. WEST) BOHLIN, in Bih. t. Kgl. Sv. Vet.-Ak. Handl. *27*, Afd. 3, No. 4 (1901) p. 34. *Chlorococcum regulare* W. West, in Jour. Roy. Micr. Soc. (1892) p. 737, t. 10, fig. 55.

Plankton; North Turtle Lake. Along shore; Beaver Lake

Genus OPHIOCYTIUM Nägeli 1849.

Ophiocytium capitatum WOLLE, Freshw. Algae of the U. S. (1887) p. 176, t. 158, figs. 3–7.

Along shore; Minocqua, Plum and Razorback Lakes.

var. **longispina** (MÖBIUS) LEMMERMANN, in Hedwigia, *38* (1899) p. 32, t. 4, figs. 21–25. *Reinschiella longispinum* Möbius, in Abh. d. Senckenberg. Naturf. Ges. in Frankfurt a. M. 18 (1894) p. 331, t. 1, figs. 31–33.

Plankton; George Lake.

Ophiocytium cochleare (EICHWALD) A. BRAUN, Alg. Unicell. (1855) p. 54. Lemmermann, in Hedwigia, *38* (1899) p. 30, t. 3, figs. 10–12. *Spirodiscus cochlearis* Eichwald, in Bull. Soc. Imp. Natur. Moscou, *20*, pt. 2 (1848) p. 285, t. 8, fig. 4.

Along shore; Cedar Lake.

Ophiocytium arbusculum (A. BRAUN) RABENHORST, Flora Eur. Algarum, *3* (1868) p. 68. *Sciadium arbuscula* A. BRAUN, Algarum unicell. (1855) p. 49, t. 4, figs. 1–11.

Along shore; Rozen Lake.

Genus TRIBONEMA Derbes et Solier 1856.

Tribonema bombycina (AGARDH) DERBES ET SOLIER, in Suppl. Comptes Rendus de l'Acad. d. Paris *1*

(1856) p. 18, t. 4, figs. 16–21. *Conferva bombycina* C. A. Agardh, Synop. Alg. Scandinaviae (1817) p. 78.

Along shore; Franklin, Otter and Rose Lake.

Tribonema minus (WILLE) HAZEN, in Mem. Torr. Bot. Club, *11* (1902) p. 185, t. 25, figs. 7–8. *Conferva bombycina* var. *minor* Wille, in Öfvers. Kgl. Vet.-Ak. Förh. *36* No. 5 (1879) p. 65, t. 14, fig. 89.

Along shore; Lake Kegonsa.

LIMNOLOGICAL APPARATUS

BY CHANCEY JUDAY

Notes from the Laboratory of the Wisconsin Geological and Natural History Survey. IX.

The following paper was prepared in response to a number of inquiries concerning limnological apparatus that have been received during the past few years. The first question that confronts the student who wishes to undertake a study of the biological problems presented by lakes is that of obtaining suitable apparatus for such investigations. This question is not always an easy one to solve since much of the apparatus can not be purchased in the market but must be especially constructed. This means that designs must be prepared for the various instruments desired and a mechanician employed to make them.

A few of the standard types of apparatus are here described and illustrated with the hope that it may contribute to the solution of some of these preliminary difficulties and thus aid in arousing a more general interest in work of this character.

PLANKTON NETS.

Three types of net have been designed to meet the requirements of the various studies that have been made on the plankton. One of them is a small net, shown in Plate XXXVI, fig. 1, which is used in making the regular plankton catches for studying the number and vertical distribution of the organisms. It is used where only a comparatively small quantity of water, 10 liters to 50 liters, is strained. The second type is a larger net, shown in Plate XXXVI, fig. 1, which is used when larger quantities of water, 1,000 liters or more, are strained. The third type is a simple closing

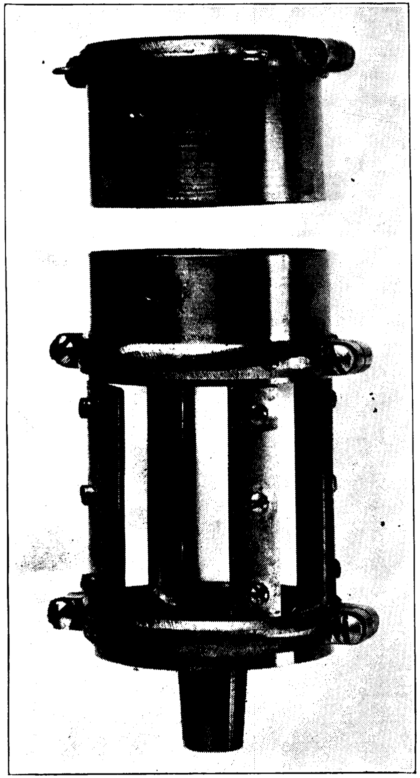

Fig. 1. Plankton bucket.

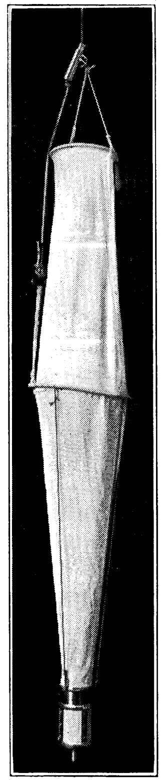

Fig. 2. Closing net, open.

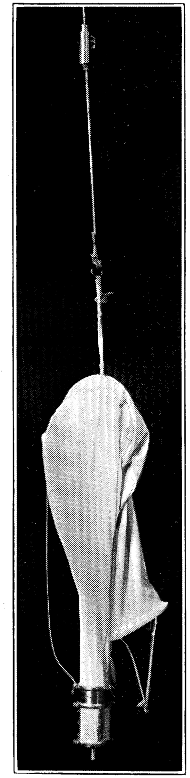

Fig. 3. Closing net, closed.

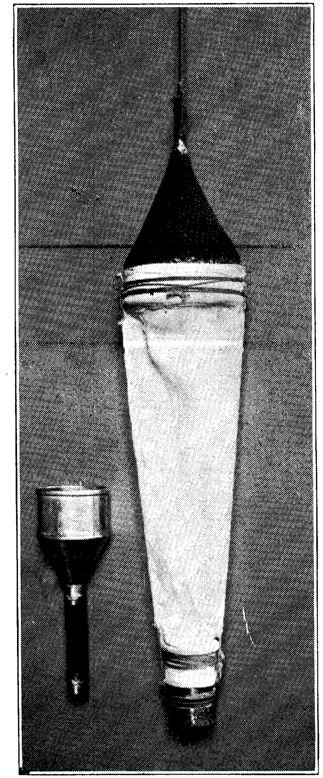

Fig. 4. Birge cone net and funnel.

JUDAY—LIMNOLOGICAL APPARATUS

net, Plate XXXIV, figs. 2 and 3, which serves for the study of the net plankton in deep lakes where it is not practical to use a pump, or in lakes where it is not convenient to carry a pump and hose. All of these nets consist of a truncated canvas cone, a straining portion made of No. 20 silk bolting cloth, and a detachable bucket at the bottom in which the catch is concentrated and then transferred to the preservative. Since the same bucket is used on all of the nets it may be well to describe it first.

THE PLANKTON BUCKET.

The bucket consists of a head portion (fig. 1, A, and Plate XXXIV, fig. 1) which is attached directly to the bolting cloth strainer and a detachable plankton bucket proper (fig. 1, B). The head and the wall of the bucket are made of telescope brass tubing of such sizes that the top of the bucket passes easily but snugly over the head piece. The surfaces which come into contact should be kept polished in order to insure ease of manipulation. The walls of the tubing are about 0.6 mm. thick.

The head piece, fig. 1, D, is 3.5 cm. long and has an outside diameter of 5.2 cm. A small peg about the middle serves for the attachment of the bucket by means of a bayonet joint and two pegs near its upper edge hold the clamp in position. This head is attached to the bolting cloth by means of a clamp, fig. 1, C, which consists of two semi-circular pieces of bronze with wings at their ends through which pass the screws that hold the two pieces together. The clamp is about 8 mm. wide and should be flush with the upper edge of the head. Each half is pierced by a small hole into which fits a small peg borne by the upper part of the cylinder. Three small loops of brass wire are soldered to this clamp into which lines from the framework at the top of the net are fastened. These lines are a little shorter than the bolting cloth cone and carry the weight of the bucket.

The tube part of the bucket is 9 cm. long and has an inside diameter of approximately 5.2 cm. The upper part which fits over the head is 2.8 cm. wide and has an L-shaped opening into which the peg in the middle of the head piece fits. (See fig. 1, B.) Below this part there are four windows each 3 cm. wide and 5 cm. long. The portions of tubing between the windows are about 1.1 cm. wide and soldered to them inside are semi-cylindrical pieces of brass wire

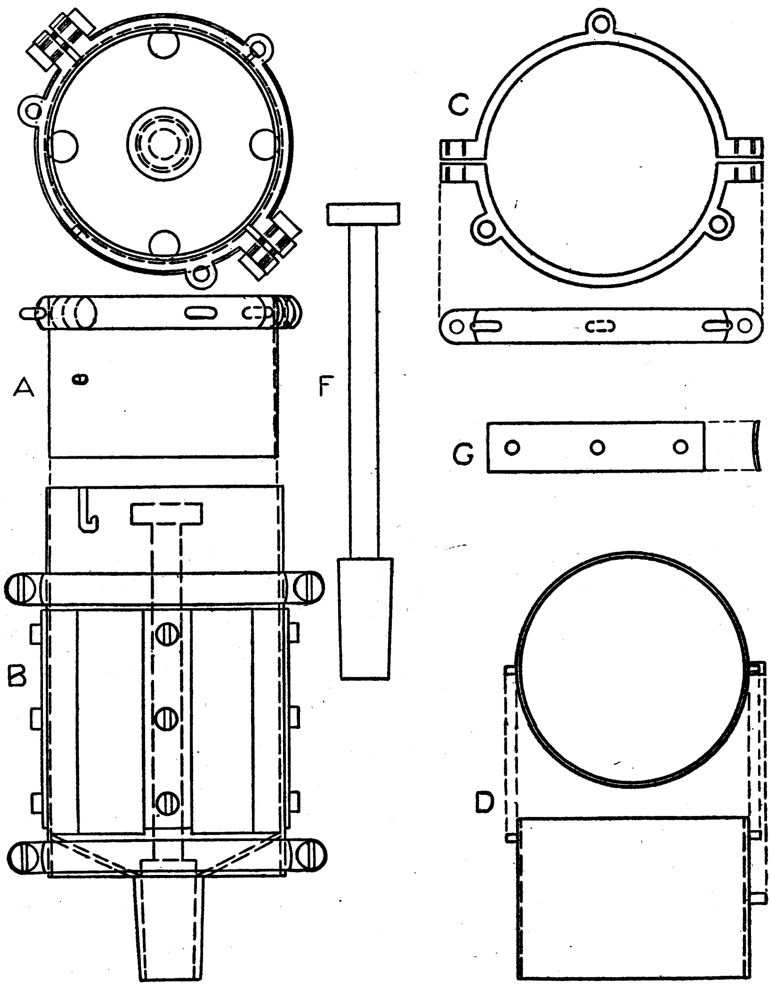

Fig. 1.—Plankton bucket showing parts.

having a diameter of 6 mm. These pieces of brass wire strengthen the strips of tubing and receive the screws of the side clamps which help to hold the bolting cloth in place over the windows. The bottom of the bucket consists of a piece of cast bronze which is soldered into the lower end of

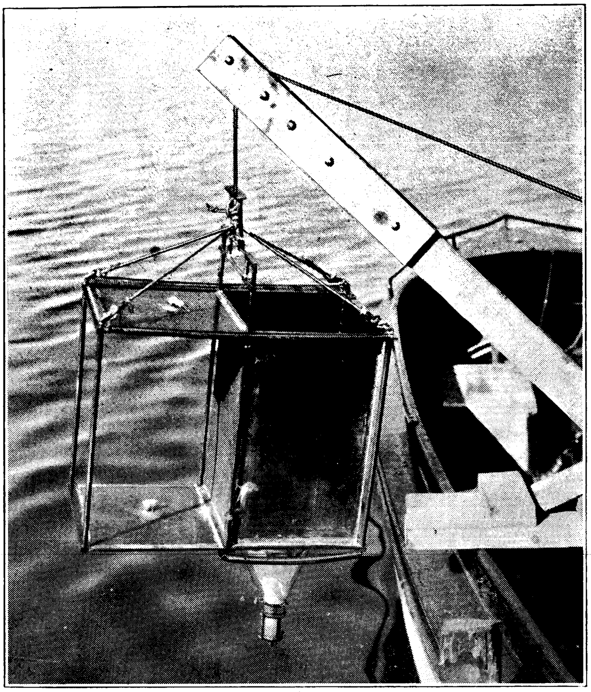

Fig. 1. Plankton trap.

Fig. 2. Plankton trap and equipment for operating it.

the tubing flush with the bottom of the windows. It slopes toward the center where there is an outlet tube about 2.3 cm. long. The upper diameter of this outlet is 1.2 cm., and the lower 1 cm., and its walls are a little more than a millimeter thick. The outlet is closed by a brass plug, the handle of which terminates in a milled head almost flush with the top of the bucket so that the plug can be readily removed. (Fig. 1, F.)

The bolting cloth which covers the windows is held in place by four brass strips which are as long as the windows and as wide as the tubing between the windows. (See fig. 1, G.) Each of these strips is attached to the bucket by three screws. At the top and bottom of the windows the bolting cloth is held in place by semi-circular bronze clamps about 8 mm. wide, which have wings at their ends for the screws which hold the two halves of the clamp together.

In this type of bucket it requires only a few minutes to renew the bolting cloth strainer. The new cloth is cut a little wider than necessary so that a free edge projects beyond the upper and lower clamps. It is wrapped around the bucket and the clamps at the top and bottom are adjusted, loosely at first, so that the cloth can be shifted into position. Then holes for the screws of the binding strips between the windows are burned with a hot wire and the strips are screwed on. Lastly the clamps are adjusted so that they are flush with the upper and lower edges of the windows and then they are drawn tight by means of the screws. The bolting cloth projecting beyond them is cut off with the point of a knife. The ends of the bolting cloth should overlap on one of the strips of tubing between the windows.

THE SMALL NET.

The small net consists of a truncated canvas cone about 12 cm. high and a bolting cloth cone about 30 cm. long (Plate XXXVI, fig. 1). The framework of the canvas cone is shown in fig. 2. It is made of brass wire 4 mm. in diameter and consists of an upper ring 12 cm. in diameter, a lower ring 18 cm. in diameter, and three connecting rods. The latter have loops at their ends and are fastened to the rings by means of pieces of smaller brass wire bent into the shape of a figure eight. These connecting loops fit loosely onto the connecting rods as well as onto the rings, thus making flexible joints, so that this part of the net is collapsible. The connecting loops are held in place by pieces of small brass wire soldered to the rings on either side of them. The small wires which are soldered to the upper ring are bent across from one side of the supporting wire to the other and thus form loops. Three short pieces of heavy fish line are fastened to these loops at one end and to a metal ring at

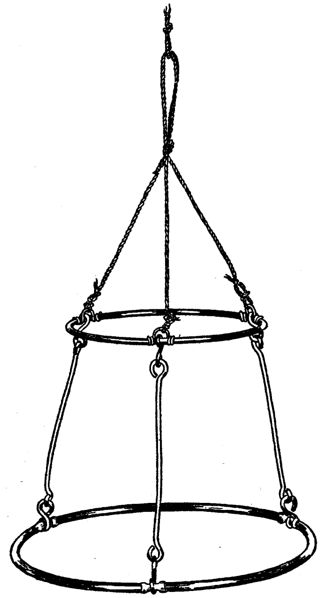

Fig. 2.—Wire frame for top of small net.

the other and the whole net is suspended from a piece of rope attached to the metal ring. The three pieces of fish line may also be tied in the form of a loop which serves for the attachment of the supporting rope. The canvas covering is on the inside of the framework and projects about 3 cm. below the lower ring for the attachment of the bolting cloth cone. The upper end of the canvas is turned outward over the upper ring and sewed in place below it. The canvas is attached to the lower ring by a piece of braid or a narrow strip of canvas which is sewed to the outside of the truncated cone both above and below the ring.

In making the bolting cloth cone it is best to use a pattern made of paper for cutting the cloth. In making the pattern an arc of a large circle is laid off on the paper with a pencil to which a piece of cord is attached. The radius of this circle can be determined by the folowing formula[1]: x: x plus i = r : R. In this formula x = the radius of the portion of the paper that is cut off for the bucket of the net; i = the length of the bolting cloth cone; r = radius of small or lower end of the bolting cloth cone, while R = that at upper or larger end. Substituting the values given above, we have x : x plus 30 = 2.5 : 9, from which x = 11.5, and 30 cm. plus 11.5 cm. = 41.5 cm., the radius of the large circle, or the length of the cord to be used in laying off the arc.

The width of the arc in degrees may be obtained from the following equation $\frac{x}{r} = \frac{360.}{a}$ Substituting the above values for x and r we have $\frac{11.5}{2.5} = \frac{360}{a}$ and $a = 78.2°$. This angular width is determined with a protractor. It is necessary, however, to make allowance for seams which will add fully 2 cm. to the length and nearly that much to the width of the arc. The pattern should be pinned together and then fitted onto the canvas cone in order to make sure that it is the right size.

The two sides of the arc of bolting cloth are fastened together with a French seam, using silk thread and as small a needle as possible so that the holes around the thread will be very small. In sewing the bolting cloth cone to the canvas cone, the former is turned inside out and passed up through the latter, small end first, until the upper edge of the bolting cloth is even with the lower edge of the canvas. The two are sewed together and the bolting cloth cone is then turned right side out, so that the seam is on the outside. The French seam should also be on the outside of the bolting cloth cone.

In making pump catches, the net is immersed in water up to the canvas cone and the desired amount of water is pumped into it. Care should be taken to prevent the stream of water from striking the bolting cloth directly. The pump is calibrated for the length of hose used and the quantity of water strained may be determined approxi-

[1] Apstein. Das Suesswasserplankton. Kiel, 1896.

mately by counting the number of strokes made with the pump for each catch. A more accurate method of procedure is to place the net in a pail which bears a calibration mark and the desired amount of water is pumped into the net. At first the water is pumped into the net very slowly and carefully so that the organisms will not be forced through the meshes of the net. The end of the discharge hose should be held so that the stream will strike the surface of the water as soon as a sufficient amount is pumped into the pail. A very convenient size of pail to use is a 12 quart one made of galvanized iron, with a 10 liter mark on the inside. Ten liters of water are sufficient for a catch in a lake that is rich in plankton but, if it is desirable to strain a larger quantity for a catch, the pail may be emptied and filled a second or a third time.

The catch is concentrated in the bucket and is then transferred to a bottle for preservation. If further concentration is desirable the material is transferred from the plankton bucket to a strainer made out of an eight dram (30 cc.) homeopathic vial, short form. In making the strainer, the bottom of the vial is removed by means of a file and a hot wire and a piece of No. 20 bolting cloth is tied over the mouth of the vial with heavy thread. Unless the catch is a very large one, substantially all of the water is removed from it and the material may be transferred from the strainer to an eight dram (30 cc.) homeopathic vial with 95 per cent alcohol. Enough water usually remains with the material to reduce the strength of the alcohol to 75 per cent, or 80 per cent, which is about the proper strength for preservation.

In this method of concentration some of the smaller organisms are lost through the meshes of the bolting cloth on the strainer, but it serves very well for the plankton crustacea. If it is desirable to avoid the loss of the smaller organisms captured by the net, it is best to transfer the material from the plankton bucket into a wide-mouth bottle with distilled water and a wash bottle. Then enough 95 per cent alcohol is added to make the strength of the mixture about 50 per cent. After standing a few hours most of the supernatant liquid may be siphoned off and the catch transferred to a 30 cc. homeopathic vial with 95 per cent

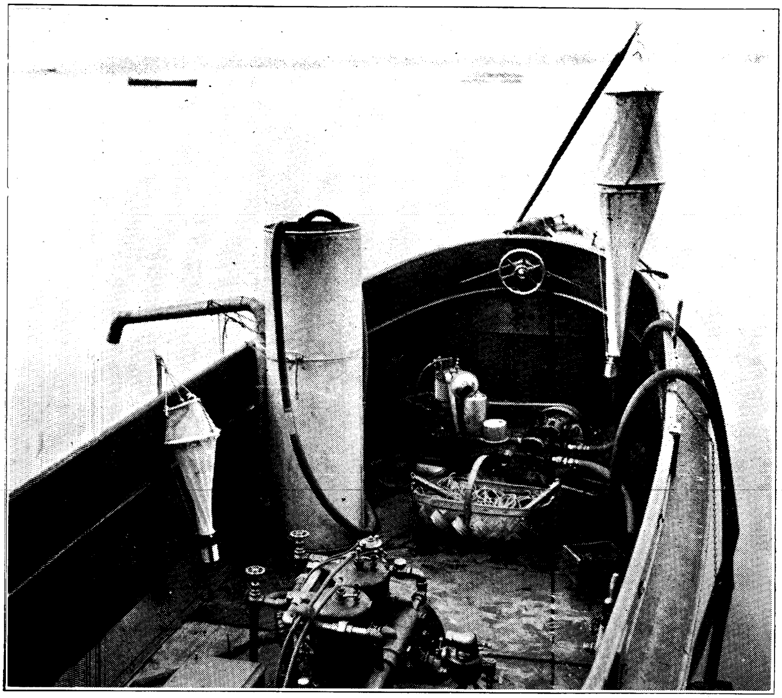

Fig. 1. Apparatus used for obtaining net plankton.

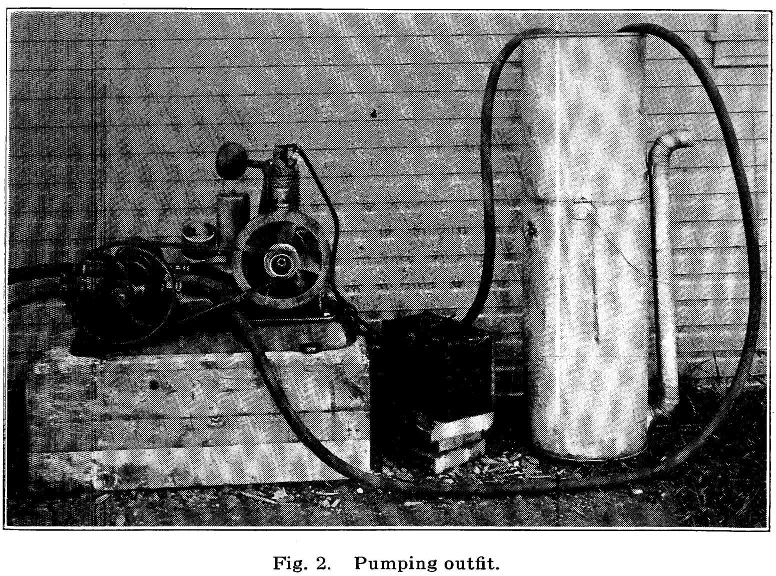

Fig. 2. Pumping outfit.

alcohol. These vials are more convenient than the larger bottles for storing a large number of catches.

THE LARGE NET.

In 1911 a study of the chemical composition of the net plankton was begun and, in order to obtain a sufficient amount of material for these analyses, it has been necessary to strain several thousand liters of water. This required a net with a fairly large straining surface and the large net was designed to meet this need. The opening of the truncated canvas cone is 25 cm. in diameter and the lower ring is 30 cm. in diameter, while the length of the cone is 33 cm. The length of the bolting cloth cone is 70 cm. (Plate XXXVI, fig. 1.) With the exception of size this net differs from the small one in only two minor points. The framework of the canvas cone consists simply of two brass rings and the whole net is suspended from three hooks attached to the upper ring. When in use the net is suspended inside the large can shown in Plate XXXVI, fig. 2 and the hooks are so adjusted in length as to fit over the top of the can.

THE CLOSING NET.

The closing net consists of a truncated cone made of heavy muslin or light canvas, a straining cone of bolting cloth, a removable bucket, and a simple release. (See Plate XXXIV, figs. 2 and 3.) The framework of the top cone consists of two rings of brass wire. The ring at the mouth of the net is 12 cm. in diameter, while the lower ring is 17 cm. in diameter. The upper cone is 40 cm. long. The bolting cloth cone has a length of 47 cm.

The release is made of brass and is shown in fig. 3 and Plate XXXVIII, fig. 3. It consists of an outer, hollow cylinder, a plunger, and a spring. The cylinder is 2.2 cm. in diameter and 5.8 cm. long. The opening within it is 1.6 cm. in diameter and extends down to within 4 mm. of the lower end. This last part is pierced only by a hole large enough to accommodate the line on which the release is used, which is 6 mm. in the one described. On one side of the cylinder a slot 3 mm. wide extends down from the top for a distance of about 3.7 cm. This slot is occupied by the curved, holding arm on the plunger, and is spanned by two loops of brass wire which project outward far enough to permit the passage of this arm. These loops of wire curve downward in order to facilitate the release of the ring that supports the top of the net. At another point in the upper half of the outside cylinder is another slot 1.5 cm. long, through which a screw passes to the plunger. This screw holds the plunger in place. The

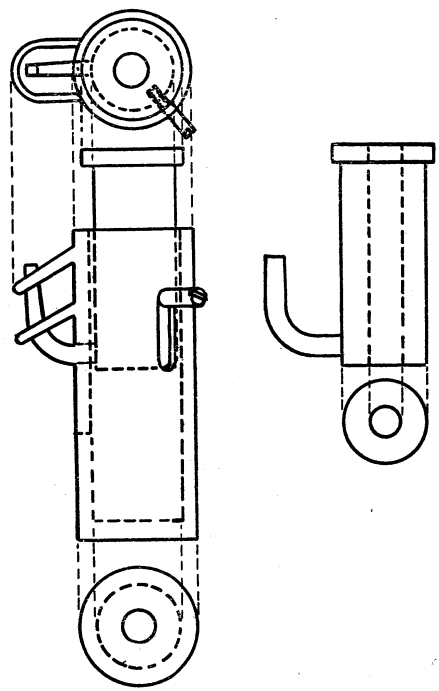

Fig. 3.—Release for closing net.

plunger is a brass cylinder a little less than 1.6 cm. in diameter and 4.2 cm. long. The upper 4 mm. has a diameter of 1.9 cm. and this flange prevents the messenger from driving the plunger entirely within the outer cylinder. The plunger is pierced by a hole just large enough for a rope. Near the bottom on one side, it possesses an arm which projects outward about 1 cm., and then upward about 1.5 cm. The plunger is actuated by a coil spring of brass wire which rests on the inner rim at the lower end of the outer cylinder. This arm passes through the wire loops on the outer cylinder and between them it holds the ring to which the three lines from the top of the net are attached.

The top of the net is supported by three pieces of heavy fish line which are attached to the ring at the mouth of the net at one end and to a small metal ring about 2 cm. in diameter at the other. A short line, about half as long as the truncated canvas cone and strong enough to carry the weight of the net, is attached to the lower ring of the canvas cone. This line possesses a small metal ring to which the hauling rope is attached. The latter first passes through the release and a simple loop knot is tied below it before the rope is fastened to this metal ring.

Then the knot in the hauling rope is adjusted so that the release is just far enough above the top of the net to hold it properly. In operating the net the plunger of the release is pushed down and the small metal ring attached to the top of the net is inserted between the wire loops on the side of the release. When the plunger is released the curved arm rises and holds the ring between the loops. The net is lowered carefully to the desired depth, and then hauled up to the point at which it is to be closed. A small brass messenger is sent down the line which releases the top of the net and permits the canvas part to fall and close the net as shown in Plate XXXIV, fig. 3. In order to facilitate the closing a small weight is attached to the ring at one side of the mouth of the net.

A number of tests have shown that no contamination results from lowering the net open, if due care is exercised in making the haul. In very rough weather, however, when the boat is being vigorously tossed about by the waves there is such a danger. Careful determination of the coefficient by means of a tube 3 m. long have shown that the straining efficiency of the net averages about 80 per cent.

THE BIRGE CONE NET.

This net is designed for making collections among the weeds along the shallow margins of lakes, or in ponds and pools. The cone top, (fig. 4, A), has a base of sheet copper 2.5 cm. wide and 8 cm. in diameter, with the lower edge turned over so as to form a smooth rim. To the inside of this copper band is soldered a loop of brass wire which lies under the cone and projects through its apex in a small loop to which the line is attached. The cone consists of brass wire netting with a 2 mm. mesh. It has a slant height of about 9 cm. At the base, this netting is soldered to the upper edge of the copper band and at the top to the wire loop. Two loops of wire are soldered to the copper band from which lines pass to similar loops on the bottom part of the net.

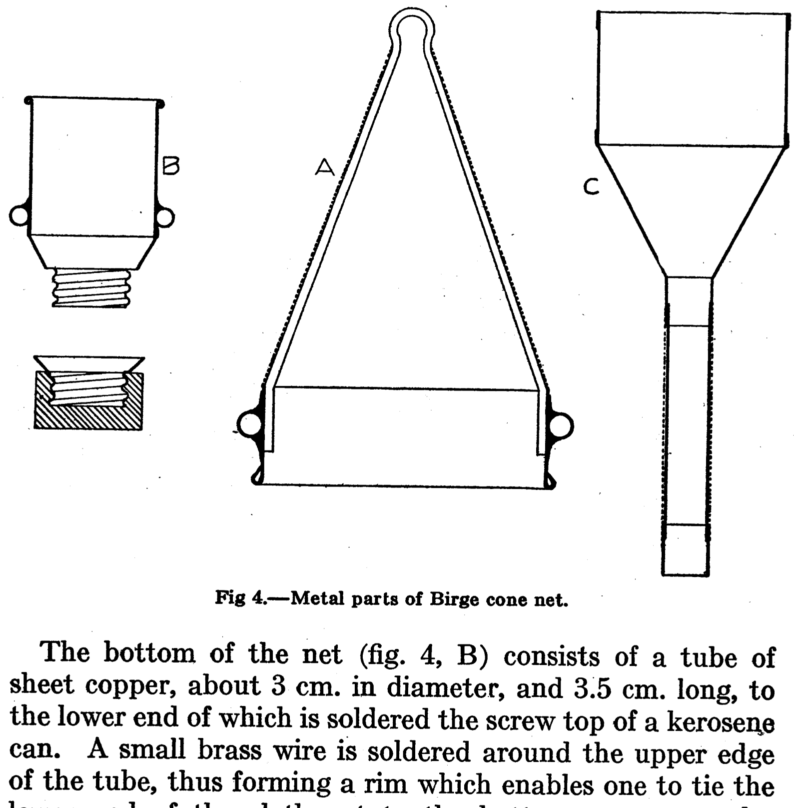

Fig 4.—Metal parts of Birge cone net.

The bottom of the net (fig. 4, B) consists of a tube of sheet copper, about 3 cm. in diameter, and 3.5 cm. long, to the lower end of which is soldered the screw top of a kerosene can. A small brass wire is soldered around the upper edge of the tube, thus forming a rim which enables one to tie the lower end of the cloth net to the bottom more securely. Toward the lower end of the tube there are two small loops of wire, to which lines from the top are attached. These lines are a little shorter than the cloth part of the net and thus carry the weight of the bottom. A piece of lead is soldered to the screw cap of the can top, and this extra weight causes the bottom to sink promptly so that the air is expelled from the net; otherwise the air in the net may keep it at the surface of the water.

The straining cone of the net is made of a good quality of rather loosely woven fabric, such, for example, as what is known as "India Linen." It has a band of heavier cloth at the top and also at the bottom where it is tied onto the metal parts of the net. Two extra seams along the sides of the net form compartments through which the lines supporting the bottom of the net pass. (See Plate XXXIV, fig. 4.)

The funnel that is used in connection with this net is shown in fig. 4, C. The straight part of this funnel is 5 cm. in diameter and 3.5 cm. long; the cone part has a slant height of 4 cm. Extending down from the apex of the cone is the straining tube which is 1.2 cm. in diameter, and 8 cm. long. The bottom of this tube, a cylinder 1.3 cm. long, is attached to the top by means of two strips of folded tin. Over the windows thus formed is soldered a cylinder of fine brass wire netting 5 cm. long. The diameter of the straining cylinder is such that it will pass freely into the neck of an 8 dram (30 cc.) homeopathic vial, short form. All of the funnel except the wire gauze is made of tin.

In making collections with this apparatus, several hauls are made with the net and the material is washed into a cup which is then filled with water and allowed to stand for a short time. The débris settles to the bottom, leaving the most of the organisms in the clear water above. The bottom part of the funnel is closed by holding it on the end of one's finger, and the water is drained off into the funnel. If any organisms remain, the cup is again filled with water which is also poured into the funnel after the débris has settled. A small portion of the débris should be added to the catch also since some organisms might seek refuge in it. The material that is caught in the funnel is then transferred either to a vial containing alcohol or formalin, or else to a small cloth bag. With a little practice one can readily transfer the tube from the finger to the mouth of the vial without losing any material. The wire gauze is then freed of organisms by rinsing it up and down in the alcohol or formalin in the vial. If one wishes to carry a large number of such catches in a small container, the material is transferred with a little water from the funnel to a small cloth bag about 4 cm. wide and 10 cm. long. The open end of the bag is securely tied with a string and the bag is then placed in the preserving liquid. A number placed on the bag with water proof ink enables one to keep a record of the catch. The net can be used as a tow net or can be thrown either from the shore or from a boat. In making catches among weeds, it is better to haul the net with a jerking motion rather than a steady pull, giving a brief time between jerks for the net to settle among the weeds.

THE PLANKTON TRAP.

A general idea of the plankton trap and the method of operating it may be obtained from Plate XXXV, figs. 1 and 2. The principle of it is similar to that of the tube trap used by Birge[1] for obtaining the coefficient of his plankton nets. It consists essentially of a box with upper and lower frameworks which carry sliding doors that close the ends of the box. The two parts of the framework are 33.7 cm. wide and 66 cm. long and they are made of brass bars, two side and three cross pieces, 6 mm. thick and 19 mm. wide. These frames are held together by pieces of brass tubing at the four corners. The box part is made of thin sheet brass and it is 30 cm. square by 50 cm. long so that it holds 45 liters of water. The top and bottom are closed by sliding doors which operate in grooves in the side pieces of the framework. The lower door has an opening 20 cm. in diameter from which a band of brass extends down 3 cm. and to this the net is attached by a clamp which is operated with a screw. Three ears on this clamp serve for the attachment of the lines which support the bucket of the net. Pieces of brass fastened to the back of the sliding doors project outward beyond the framework and serve for the attachment of the long coil-springs which operate the doors. In front these springs are attached to pieces of brass which project from the framework.

The doors fit tight enough to prevent contamination of the catch. A cover of sheet brass prevents organisms from entering the net when the bottom door is open. A hole in this cover which is protected by a small cloth bag, permits the air to escape from the net when the trap is lowered into the

[1] Trans. Wis. Acad. Sci., Arts, and Let., vol. XI, 1898, p. 278.

water. A hole in the top door similarly protected, permits the air to enter the trap when it is hauled out of the water. The release consists of two long pieces of brass tubing which are connected at the top by two shorter pieces of tubing. (See fig. 5.) The upper cross piece bears a small brass framework which is movable, backward and forward, as well as

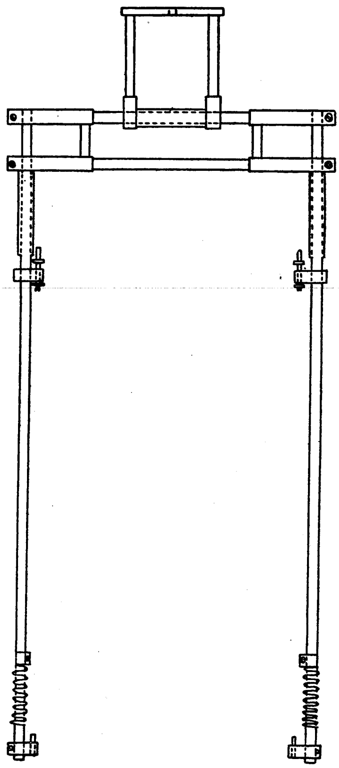

Fig. 5.—Release of plankton trap.

sidewise. The line supporting the trap passes through a hole in the upper piece of this small framework and is tied below to the two ropes which are attached to the four corners of the trap. Thus this cross piece receives the impact of the messenger. The two long pieces of tubing extend down on both sides through holes in the side pieces of the upper and lower framework. A clamp at the lower end holds them in place. They are supported at the bottom by two coil-springs which surround the tubes and rest in the top of the lower framework. The tension of these springs is controlled by two clamps on the tube. Two small pieces of brass are clamped onto the long tubes by screws just under the upper frame of the trap, and two just under the lower frame. At their inner ends they possess small pins which project up through the middle cross pieces of the frames and come in contact with the doors of the trap. The upper ends of these pins occupy shallow holes in the front edge of the doors when the latter are drawn back, and hold them open. The upper pins also have small coil-springs around them so that the lower door will not be released when the upper one is opened. The whole apparatus is suspended from two pieces of strong rope which are tied into eyes at the four corners of the upper framework.

The trap is operated from a framework which is clamped to the coaming of the launch. It is lowered and raised by means of an iron hose reel which is clamped to the framework. The rope from the reel passes over a pulley in the end of a mast which projects out far enough to let the trap clear the side of the launch.

This trap was designed for the purpose of ascertaining the degree of efficiency of both the hand and the power pumps in securing the more active swimmers among the plankton organisms. The opening is so large that there is relatively little disturbance of the column of water which passes through the open trap in its descent if the apparatus is lowered carefully. In making a catch the trap is lowered slowly and carefully to the desired depth and a messenger is promptly sent down the line to close it. Then the trap is hauled to the surface where the water inside is strained through the net attached to the bottom and the material is concentrated in the plankton bucket, from which it is transferred to the preservative. In this way 45 liters of water are obtained in situ for the catch. The apparatus can be operated successfully only when the weather is perfectly calm and thus any unusual disturbances resulting from wave action are avoided.

PUMPS.

In making small catches for a study of the quantity and the vertical distribution of the plankton organisms, a small semi-rotary, or clock pump and half-inch (1.25 cm.) garden hose are employed. The pump is attached to a framework consisting of half of a box as shown in fig. 6. The supporting box is made of fairly heavy boards so that the pump does not require an extra crate for shipment. A calibrated line is attached to the intake end of the hose so that the depth at which the water is obtained for the catch can be readily ascertained.

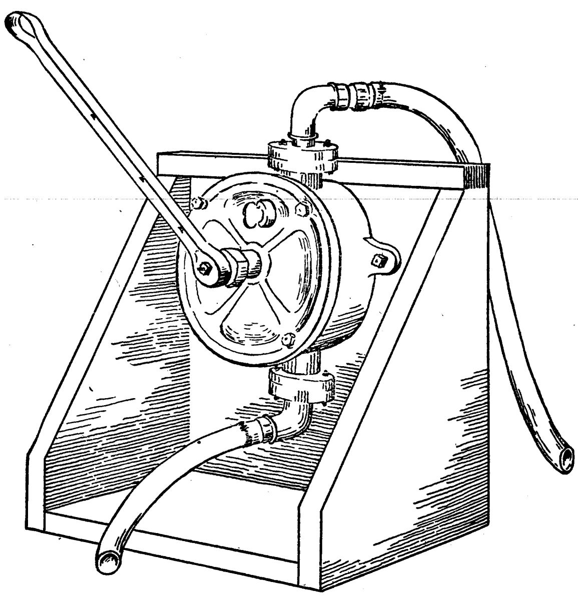

Fig. 6.—Hand pump.

In the spring of 1911, a study of the chemical composition of the net plankton of Lake Mendota was begun. It requires at least 5 grams of dry plankton for an analysis and it is ususally necessary to strain from 10,000 to 20,000 liters of water to obtain this amount. For obtaining large quantities of water from different depths, the apparatus shown in Plate XXXVI, figs. 1 and 2, is used. It consists of a small gasoline engine, the kind used in operating the ordinary milk separator, and two brass vane pumps, all mounted on a firm metal base when in operation. The engine is attached to the base with bolts so that it can be readily detached from the latter when the apparatus is put into or taken out of the launch.

At a speed of 300 revolutions per minute the capacity of each pump is about 30 liters per minute when the water is drawn through 30 m. (100 ft.) of hose having an inside diameter of 2.5 cm. (1 in.). The water is discharged into the large can and is strained through the large plankton net suspended therein. The effluent from the can discharges over the side of the launch. The arrangement of the pumping apparatus in the launch is shown in Plate XXXVI, fig. 1. The large plankton net was removed from the can so that it could be shown in the photograph.

CENTRIFUGES.

The plankton net retains only the larger organisms, such, for example, as the crustacea, the insect larvae, the vast majority of the rotifers, and the greater part of the large forms of algae. While the meshes of the No. 20 silk bolting cloth are very small, especially after it has been shrunk, yet a very considerable portion of the plankton material is lost by the net. This assemblage of organisms which escapes through the meshes of the net is called the nannoplankton. It consists of such forms as rhizopods, flagellates, ciliates, rarely a rotifer, and various forms of algae chiefly the smaller ones. The rhizopods are represented by an occasional amoeba; the flagellates by the various monads, and an occasional Ceratium, Peridinium, and Euglena; the ciliates by such forms as Paramoecium, Halteria, Coleps, and Vorticella. The algae belong to two general groups, namely, those which are so small that they are regularly lost by the net and those which are lost only by accident. To the former belong such forms as Ankistrodesmus, Oocystis, Chodatella, Sphaerocystis, and some species of Coelosphaerium and Microcystis. Those lost accidentally are young individuals or colonies, individuals so small that they are readily lost through the meshes of the net when the catch is being concentrated in the plankton bucket, elongated or rod-shaped individuals which pass through when they strike the net endwise, and fragments of the larger colonies. To this group belong such forms as Anabaena, Aphanizomenon, Melosira, Stephanodiscus, Cylotella, Tabellaria, and Fragilaria.

Various methods have been used for procuring the nannoplankton organisms. Those that have been used most frequently are as follows: 1. Filtering a certain quantity of water through hard surface filter paper and then washing the organisms off the paper. 2. Filtering a definite quantity of water through sand as in the Sedgwick-Rafter method. 3. The direct counting of the organisms. 4. The sedimentation of the organisms with a centrifuge.

When filter paper is used for concentration, some of the nannoplanktonts adhere very closely to the paper so that they can be removed with difficulty or not at all. Others become embedded in the meshes of the paper and are lost. In the sand filter many of the organisms adhere to the grains of sand and are lost. The direct count is the best procedure for the more abundant forms; but it is impractical for the rarer forms because it would be necessary to count a considerable number of samples in order to obtain a fair enumeration.

A centrifuge is very effective in securing the nannoplankton organisms, but a high speed type of centrifuge is required, one with a speed of not less than 3,000 revolutions per minute. The machine that is now in use in the Survey investigations has a speed of 3,600 revolutions per minute and carries two 15 cc. sedimentation tubes. At this speed most of the organisms are thrown down in six to eight minutes. A second run of this duration generally serves to recover the remainder of the material, but a third, or even a fourth run is sometimes required. It is desirable also to centrifuge a larger sample, say 50 cc. or 100 cc. in order to study the very rare forms.

The results of various investigators seem to indicate that the best procedure for an enumerative study of the nannoplankton is a combination of the direct count method and the centrifuge method, the former being used for the more abundant forms and the latter for those that are less abundant. It is best also to use 15 cc. and 50 cc. or 100 cc. samples of water for the latter. The enumerations both in the direct count and the centrifuge methods should be made in duplicate and, if convenient, in triplicate.

The Survey is also making a study of the quantity of nannoplankton contained in a body of water by determining the dry weight of it per unit volume of water. Chemical analyses of this material are then made for the purpose of ascertaining its food value. In order to secure enough material for such studies it is necessary to centrifuge from 1,000 to 1,500 liters of water and this requires an apparatus that will act continuously in separating the nannoplankton from this large quantity of water. For this work a De Laval clarifier and filter, belt style, A size, is used, in which the water is first centrifuged and then filtered. Fig. 7 is a sketch drawing, showing the equipment of the laboratory that is used in making these investigations. C is the clarifier-filter or centrifuge; M is the electric motor by which the centrifuge is driven through an intermediate; T is the tank into which the water is pumped from the dock by a pump marked P in the figure.

The sample of water is obtained from a regular station situated in the deepest portion of Lake Mendota and it consists of a certain quantity of water pumped from each meter between the surface and 20 meters, with the exception of 19 meters. The vane pumps described on p. 508 are used in procuring the sample. The water is strained through the large plankton net and it is caught in containers (milk cans) as it flows from the large can in which the net is suspended. It is then conveyed by launch to the laboratory dock where it is pumped into the tank. The launch carrying about 500 liters of water and the pumping apparatus is shown at the dock in Plate XXXVII, fig. 1.

The tank is made of galvanized iron and has a capacity of about 1,200 liters. It is mounted on a framework which rests on a platform scale so that the quantity of water used for a sample is readily ascertained by weighing. With the scale one can also readily ascertain the rate at which the sample is being centrifuged. The framework elevates the tank to such a height above the centrifuge that the water readily flows from the former to the latter through a hose, the rate of flow being regulated by a valve.

A sectional view of the bowl of the centrifuge is shown in Plate XXXVII, fig. 2. The water enters at A and passes down to the bottom of the clarifying compartment B where some of the material is deposited. Then it passes out to the periphery of this compartment, C, where the centrifugal force is at a maximum. By far the greater portion of the material is deposited here. The water next flows upward and toward

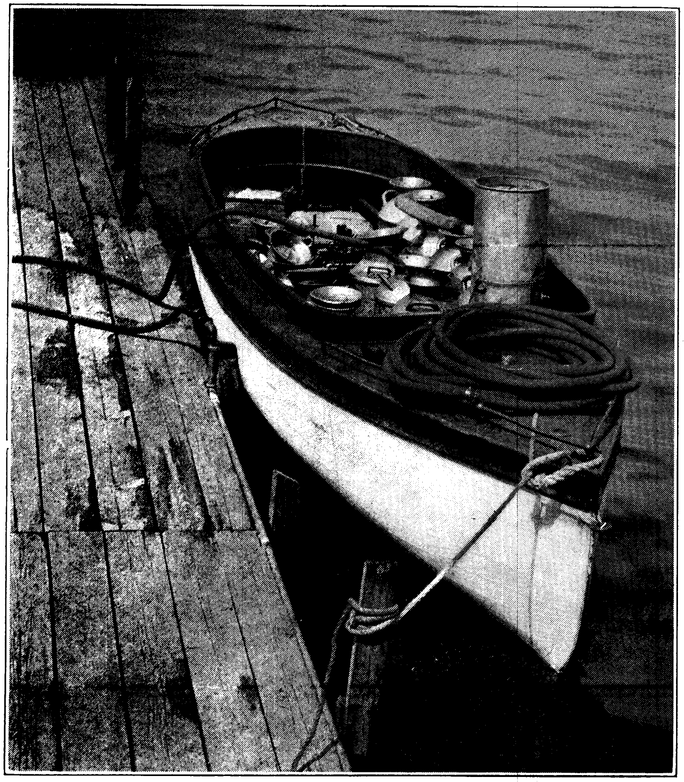

Fig. 1. Launch with pumping apparatus and a cargo of water.

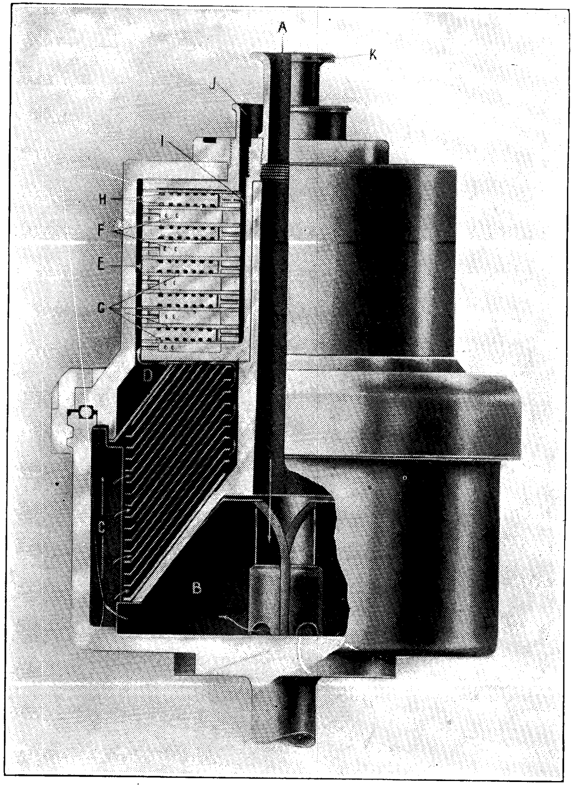

Fig. 2. Sectional view of bowl of contrifuge.

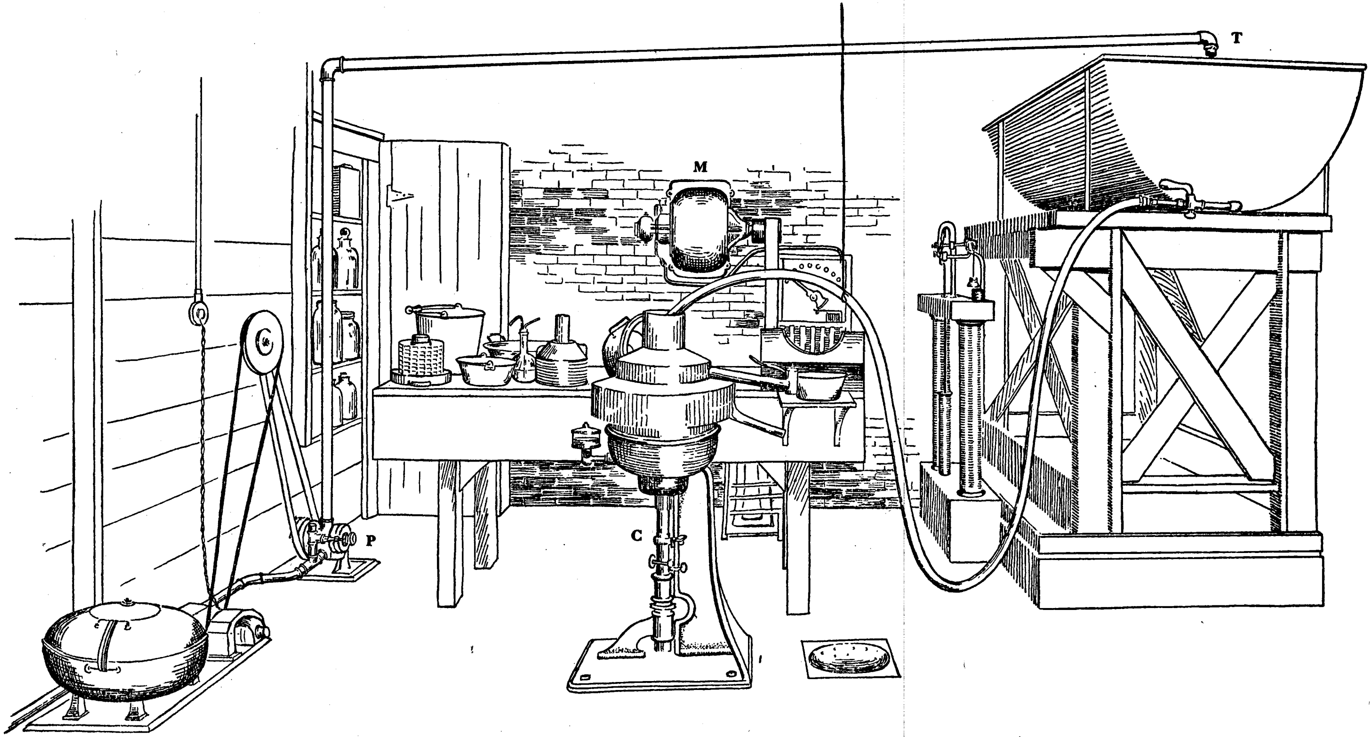

Fig. 7.—Sketch drawing of laboratory showing apparatus used in obtaining nannoplankton.

the center of the bowl between conical discs which divide it into thin layers. The friction of these discs causes the water to rotate rapidly and again subjects it to very great centrifugal action which removes the last portion of the material that is obtained in the centrifugal process. This material is deposited on the under side of the discs and most of it passes down and out to the pocket at C.

The centrifuged water passes to the center and is then forced upward and outward to chamber D from which it passes on into the filter compartment as shown by the arrows. The filter chamber is filled with a series of horizontal corrugated plates, nineteen in number, which possess perforated retaining rims at their outer and inner margins. The filter papers are placed between the corrugated plates and the perforations in the plates are arranged so that the water passes through the filter papers in its course through this chamber. This removes the final portion of organisms obtained in this process.

The material that is deposited on the conical discs and on the sides of the bowl is removed, together with the water remaining in the bowl at the end of the run, about 5.5 liters in all, and the whole is promptly evaporated to dryness at a temperature not exceeding 50° to 60° C. A little chloroform is added to prevent fermentation during evaporation. The material is then weighed and analyses are made to determine the percentages of nitrogen, ether extract, pentosan, crude fiber, and ash.

The nannoplankton shows marked variations in quantity during the year. The minimum amount is somewhat less than the quantity of net plankton and the maximum amount is from ten to fifteen times as great as that of the net plankton.

The amount of organic material that is deposited on the filter paper is ascertained by determining the quantity of nitrogen in them in excess of that of the blank papers.

COUNTING CELLS.

Various methods have been used for the purpose of indicating the quantity of plankton in a given volume of water, but the counting method seems to be the most satisfactory one, since it gives an idea not only of the total number of organisms present, but also of the relative abundance of the different forms. For those organisms which are so small that a compound microscope is necessary to count them, the regular Sedgwick-Rafter[1] counting cell and ocular micrometer are used. In counting the nannoplankton organisms the sample of water is thoroughly shaken in order to get a uniform distribution of the organisms. One cubic centimeter is then removed and placed in the cell. A number of squares, from 20 to 40, are counted in order to ascertain the number of the more abundant forms. For the less abundant forms, samples of water are placed in sedimentation tubes having a capacity of 15 cc. and centrifuged about 6 minutes at a speed of 3,600 revolutions per minute. The material collected in the bottom of the tube together with about 1 cc. of water, is removed with a pipette and transferred to a cell for counting. Frequently a second centrifuging is necessary in order to bring down all of the organisms. The mean of duplicate or triplicate determinations made in this manner will give a good idea of the abundance of the various forms in the sample of water.

The catch of net plankton is diluted to a definite volume, usually 10 cc. or 20 cc. depending upon the abundance of the material. Then it is thorougly shaken and 1 cc. is transferred to the Sedgwick-Rafter cell for the enumeration of the smaller organisms.

For the larger organisms, such as crustacea and rotifers, the material is again thoroughly shaken and 2 cc. or 4 cc., depending on the degree of dilution, are removed with a piston pipette for counting under the low power of a binocular microscope. The cell used in counting this material consists of a brass frame which is cemented to a regular glass slide with sodium or potassium silicate. This cement serves admirably for alcoholic material but it is so soluble in water that it can not be used for fresh or formalin material. The brass frame is 75 mm. long, 25 mm. wide, and 2 mm. thick, with an opening in the middle which is 63 mm. long and nearly 8 mm. wide. The width of this opening is such that it just covers the field of the binocular microscope, so that a form may be counted simply by passing the cell through the field of the binocular once.

[1] See Whipple, Microscopy of Drinking Water, p. 34, 1914.

A CASE FOR REVERSING THERMOMETERS.

The case used for the reversing thermometers belongs to the Tanner[1] type, with modifications which adapt it better to the work in hand. The main part of it consists of a brass tube 2.5 cm. (1 in.) in diameter and 30 cm. (12 in.) long. (Fig. 8 and Plate XXXVIII, fig. 1.) Elongated openings are cut in two sides of this tube so that the scale of the thermometer may be seen, and the lower end possesses several small holes which afford free entrance of the water to the chamber in which the bulb of the thermometer lies. The lower end of this tube bears a ring outside for the attachment of the line and a flat ring on which the lower coil-spring supporting the thermometer rests, is soldered inside the tube at this end. The upper end of this tube bears threads so that it can be screwed onto the top piece of the case. The latter is 2.8 cm. in diameter and 5.5 cm. long. On one side of the top is a triangular opening through which project the jaws that clasp the line and hold the thermometer in an upright position. These jaws are mounted on a pin and they are held into the upper, narrow portion of the opening by a spring, in which position they are closed. The inner ends of these jaws are bevelled on their proximal sides so that they open readily when the messenger forces them down into the wider portion of the triangular opening, and releases the line. The spring which supports the jaws is coiled around the pin which supports them, and a second pin a little lower down holds the loose ends of this spring. Below this second spring is a diaphragm, against which rests the coil-spring at the upper end of the thermometer. This diaphragm and the screw cap at the top of the case have fairly large openings in the center in order to let the water drain out of the case quickly. When it is desirable to use more than one thermometer on a line, a small curved arm (Fig. 8, B) is attached near the upper end of the long tube. When the thermometers are lowered, a messenger is hung onto this arm by means of a line so that when the upper thermometer overturns, the messenger for the second is released. In this way several thermometers may be used at the same time.

[1] Report of Com. of Fish & Fisheries for 1881, Pt. IX, 1884, p. 25 and pls. XIII, XIV, and XVI.

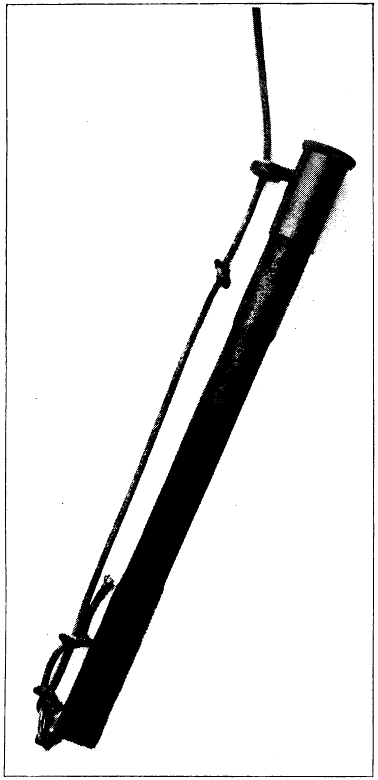

Fig. 1. Case of reversing thermometer attached to line.

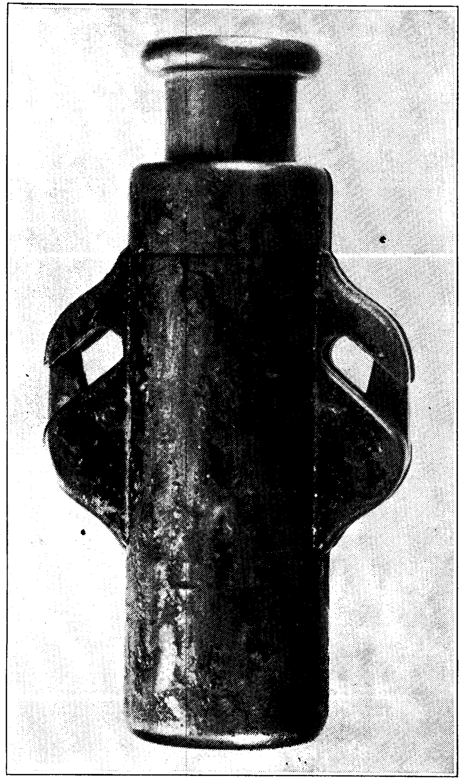

Fig. 2. Anchor release

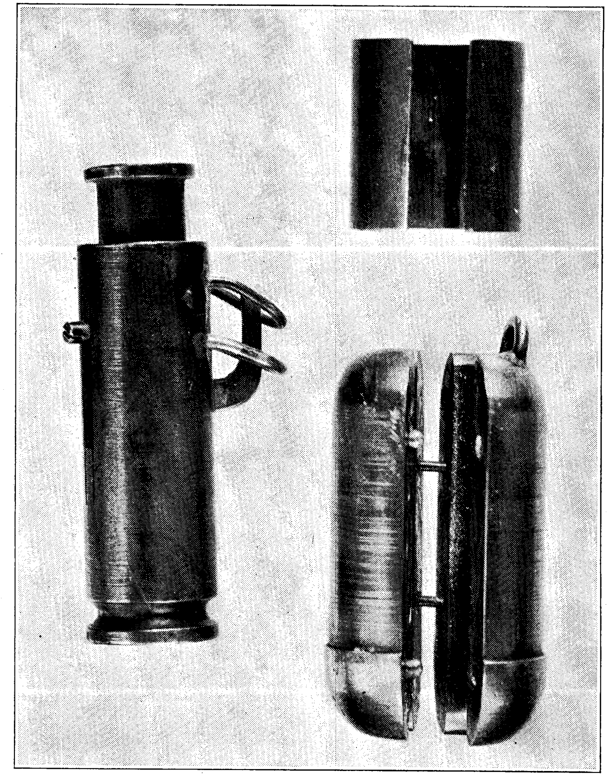

Fig. 3. Net release and split messenger.

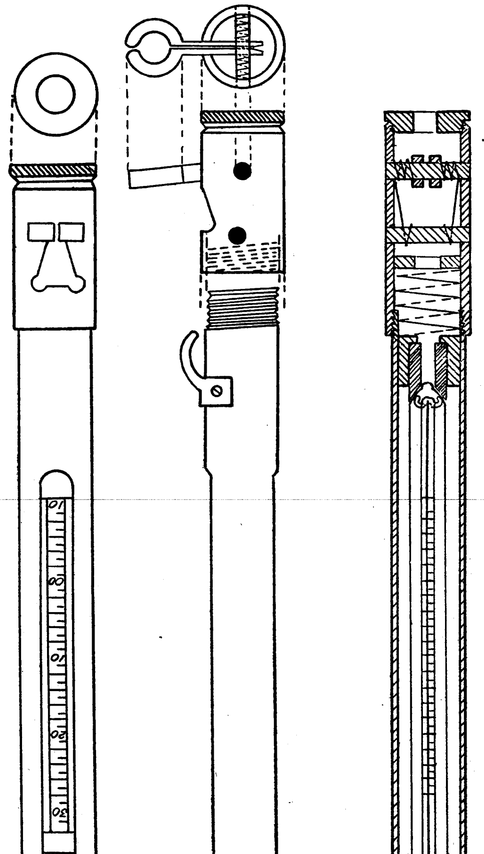

Fig. 8.—Case for reversing thermometer.

The thermometer is guided and supported in the case by two hollow brass cylinders which are lined with rubber tubing to prevent the thermometer from coming in contact with the metal. (Fig. 8, C.) This cylinder has a small rim on the inside at one end which prevents the rubber from passing entirely through it. The diameter of this cylinder is such that it will move freely inside the brass tube, or 2.2 cm. in the case described above, and its length is 1.5 cm. The opening of the rubber tubing in the lower cylinder is just large enough to let the bulb of the thermometer pass through, but it will not pass beyond the constriction in the glass tube surrounding the thermometer which is situated at the upper end of the mercury bulb. At the upper end the thermometer case passes far enough into the rubber lining of the cylinder to be held securely in place, but it does not pass entirely through it. These small cylinders rest upon coil-springs of brass wire at both the upper and the lower ends of the thermometer case. Sometimes the thermometer rotates to one side a little which makes it difficult to read the scale. This rotation is prevented by a wire soldered inside the tubing which fits into a groove in the small brass cylinder.

In order to prevent the messenger from striking the thermometer case, a bumper consisting of two rubber stoppers is placed on the line just above the releasing jaws. The messenger is stopped by a knot in the line a few centimeters below the jaws.

THE ANCHOR RELEASE.

The anchor release is a modification of the net release. (See fig. 9 and Plate XXXVIII, fig. 2.) It consists of three parts, an outer cylindrical piece, a plunger, and a spring. The outer part is 3.8 cm. in diameter and 10.5 cm. long. It bears projections on either side and these projections are separated into pairs by a slit 7 mm. wide which extends down from the top of the cylinder a distance of 8.3 cm. The cylinder is hollow, the opening being slightly more than 2.5 cm. in diameter, and extending to within 5 mm. of the lower end. The hole in this bottom part is just large enough to accommodate the rope on which it is to be used.

The plunger is 2.5 cm. in diameter and 8.5 cm. long. About 6 mm. at the upper end is larger in diameter, thus forming a flange which prevents the plunger from being forced entirely into the cylinder by the messenger. At the lower end the plunger possesses a pair of bent arms which occupy the slits in the outside cylinder. The plunger is supported by a

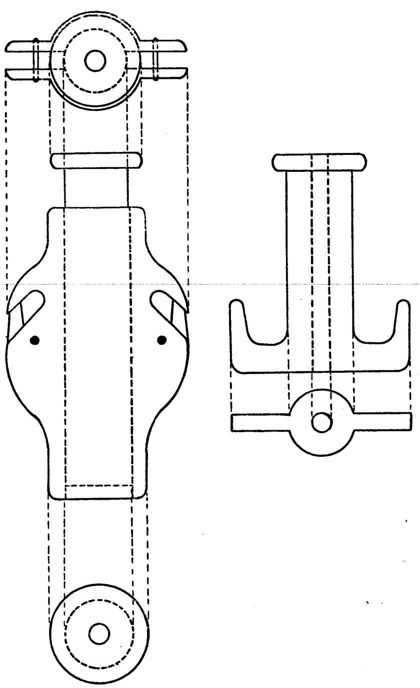

Fig. 9.—Anchor release.

coil-spring made of brass wire which occupies the lower part of the hollow in the outer cylinder. Two small pins in the lower pairs of side projections on the outer cylinder prevent the spring from raising the plunger too high. The plunger is pierced by a hole just large enough to accommodate the anchor rope.

The release is fastened onto the rope by passing entirely through the former, and tying a knot or two in the end. A line from the anchor is attached to the middle of a loop of rope about a meter long. One end of this loop is inserted in one jaw of the release and the other end is inserted in the other jaw. When the anchor is to be released the anchor line is hauled in until it becomes taut; then a messenger is sent down the line which trips the release and leaves only the rope and release to be hauled in.

The dimensions given are those of the first release of this type that was made. Experience has demonstrated that it is larger and heavier than necessary and a release about two-thirds or three-quarters as large would serve just as well for anchors weighing up to 35 kg. This release has been found very useful in lakes having a depth of 50 m. or more. A rock serves admirably for an anchor, and when this is abandoned, the only loss is the bit of line that is used to fasten it to the release.

MESSENGER.

Occasionally while making limnological observations it is convenient to have a messenger that may be put on or taken off the line at any point. Such a messenger is shown in Plate XXXVIII, fig. 4. The two halves are held together on one side by pins which serve as hinges. The heads of these pins are sunk into one side of the messenger so that it will open. On the opposite side, two short pins fit into two holes on the other half when the messenger is closed. A cylindrical clamp made of sheet brass keeps the messenger closed. A small loop of brass wire is soldered to the upper end of one half of the messenger. This serves for the attachment of a piece of line. When the closing net is being hauled in hand over hand, the loose end of this string is held between the teeth so that the messenger can be released quickly when the net has been raised to the desired point. These messengers are made of brass, and are about 2.5 cm. in diameter by 5.5 cm. long.

WILLIAM GAGER'S DEFENCE OF THE ACADEMIC STAGE

KARL YOUNG

The Puritan arraignment of the stage occupies a conspicuous position in the history of Elizabethan literature, and no one has ever denied its importance both as a phenomenon in sectarianism and as a source of information in regard to Elizabethan dramatic conditions. Only of late, however, have the several aspects of Puritan activity been clearly differentiated, and the avenues of investigation clearly marked. It now appears that the chief divisions of the attack upon the drama are the following: (1) a pamphleteering campaign, in which the earnest strictures of such men as Northbrooke, Gosson, and Stubbes were mildly answered by Lodge and Nashe; (2) legislative enactments of the civic authorities of large towns such as London, checked in some measure by influences from the Court; and (3) academic censure uttered within the walls of the two Universities. Of these three divisions of the conflict the one least adequately understood has been, until recently, the academic.[1] Of this aspect of the controversy Mr. Boas has now given a thoroughly adequate account,[2] in the course of which he has classified the materials, isolated the centers of controversial activity, and prepared the way for the publication of further documents.

From Mr. Boas's account it appears that the most important phenomenon in the attack upon the academic stage

[1] In regard to the pamphleteering campaign of Northbrooke, Gosson, Stubbes, and others see, for example, E. N. S. Thompson, *The Controversy between the Puritans and the Stage*, New York, 1903. The legislative restraints upon the Elizabethan stage are admirably expounded by Virginia C. Gildersleeve, *Government Regulation of the Elizabethan Drama*, New York, 1908.

[2] F. S. Boas, *University Drama in the Tudor Age*, Oxford, 1914.

occurred at Oxford, consisting essentially in an exchange of opinion between the Christ Church dramatist, William Gager, and the learned Dr. John Rainolds of Queen's College. The purpose of the present article is the publication of the one substantial contribution to the debate from the pen of Gager. By way of elucidating this document I undertake a brief review of the controversy upon the basis of the extant records.[1]

I. A letter, dated February 6, 1591/2, from Rainolds to Dr. Thomas Thornton of Christ Church.[2]

From this letter it appears that Dr. Thornton had invited Rainolds to be present at the performances of certain Shrovetide plays of William Gager, arranged for presentation on Sunday, Monday, and Tuesday, February 5, 6, and 7. After Rainolds had declined orally, Thornton repeated the invitation, thus inciting Rainolds to send the written refusal now before us.[3] The writer takes the following positions: (1) The wearing of woman's apparel by men is condemned by Scripture, by Christian writers, and by Church councils; (2) The acting of plays entails an undue waste of time and money; (3) Plays have a vicious moral effect upon actors and audience; (4) Actors were considered "infamous persons" even by the civil law of "whole common weales of heathens"; (5) The performance of plays on the Sabbath is a profanation of the day. Thornton did not show the letter to Gager, but merely informed him later that Rainolds had civilly declined on the ground that it was not his habit to attend plays.[4]

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[1] An admirable account is given by Boas, pp. 229-248. My own review rests upon that of Boas, and claims for itself no originality beyond that involved in the documenting of certain statements.

[2] This letter is found in Corpus Christi College MS. 352, pp. 11-14, and in Bodleian, Tanner MS. 77, fol. 35^r-36^v. It has been published from C. C. C. MS. 352 by the present writer, in *Shakespeare Studies, By Members of the Department of English of the University of Wisconsin*, Madison, 1916, pp. 108-111.

[3] Rainolds' letter begins as follows:

Syr because your curteous inviting of me yesterdaye againe to your plaies dothe shewe you were not satisfied with my answer and reason therof before geven, why I might not be at them: I have thought good by writinge to open that vnto yow which, if tyme had served to vtter them by word of mouthe, I doute not but yow would have rested satisfied therwith. [C. C. C. MS. 352, p. 11.] See *Shakespeare Studies*, p. 108.

[4] This statement rests upon the following passage in Gager's letter of July 31, 1592, quoted in full below:

II. The epilogue of *Momus*.[1]

Gager's three plays were performed as follows: on Sunday, February 5, *Ulysses Redux*;[2] on Monday, February 6, *Riuales;*[3] on Tuesday, February 7, Seneca's *Hippolytus*, to which Gager had added two scenes of his own.[4] At the close of *Hippolytus* Gager introduced upon the stage, by way of epilogue, the figure of *Momus*, who not only passed Gager's three plays in review, roguishly censuring each in detail, but also inveighed against acting and plays in general. In the form in which it was eventually published[5] the epilogue of

As for your late letter to owre goode frende, he never shewde it me, or towlde me the contents therof to this daye, I never hearde of it, till longe after. nay talkinge with hym of you, touchinge suche thinges, he towlde me, that he had invyted you to the Playes, but you most gently answered, that you never used to cumm to suche thinges, and therfor nowe would also abstayne. [C. C. C. MS. 342, p. 42.] See below, p. 605.

[1] The text of *Momus* is printed among the appendices in Gager's *Ulysses Redux*, Oxford, 1592, sig. F 3 verso-F6 verso, and is reprinted below.

[2] That this play was performed on Sunday is proved by the following passage in Gager's letter of July 31, 1592, printed in full below:

Wheras I sayde that there was no more tyme spent vpon owre Playes then was convenient, you replye that *It may be there was, evne some tyme that shoulde have byn spent in heeringe Sermons, the very day that my Ulysses Redux came vpon the Stage.* It may be there was not; and for any thinge that can be proved, or for any thinge that any man needed to be hindred from Sermons that daye for my *Ulysses*, it was not so in deede. sure I ame, that the gentelman that playde *Ulysses*, was at Sermon . . . . that accusation touchethe my poore vfortunate *Ulysses* only, not the other twoe. [C. C. C. MS. 352, p. 59.] See below, p. 629.

[3] This play was never printed, and no manuscript of it has been preserved. Some notion of its content, however, may be formed from references to the play in Gager's letter of July 31, 1592 (C. C. C. MS. 352, p. 57; see below p. 627) and in Rainolds' *Th' Overthrow of Stage-Playes*, [Middleburgh], 1599, pp. 115, 122, and from the *Prologus in Riuales Comaediam* printed in Gager's *Ulysses Redux*, Oxford, 1592, sig. F 2 recto. That *Riuales* was presented on Monday, February 6, 1592, is proved by the fact that Momus, speaking on Tuesday, February 7, introduces his strictures upon *Riuales* with the question, *Hesterna qualis exijt Comaedia*? See the complete text of *Momus* below, line 50. The play had been performed on June 11, 1582, before Albertus Alasco, Prince Palatine of Siradia in Poland, and it was revived in September, 1593, in a performance before Queen Elizabeth. See Boas, pp. 179-183.

[4] These two scenes are printed, under the title *Panniculus Hippolyto Senecæ Tragœdiæ assutus 1591*, among the appendices to Gager's *Meleager*, Oxford, 1592, sig. E 8 recto—F 5 verso.

[5] That the printed version of the *Epilogus Responsivus* differs somewhat from the version acted on February 7, 1592, appears from the following passage in Rainold's letter of July 10, 1592:

I am much to thank you, Maister D. *Gager*, for both your letters, and your *Tragedie:* the more, for that you *haue enlarged the answer to*

Momus includes an *Epilogus Responsivus* in which the contentions of Momus himself are met and held up to ridicule, Since the text of *Momus* is not generally accessible, and since it constitutes an important document in the controversy, it may be appropriately reprinted here:[1]

MOMUS

Tacete; quid vult stultus hic strepitus sibi?
Quid vester iste plausus, ac vanus fauor?
Indicia potiús certa iudicij mali.
Prauiq*ue* moris, quàm rei gestæ benè.
  Mordebat Aulum Marcus Albinum Cato,
Romana Græco gesta scripturum stylo,
Sic deprecantem, seq*ue* purgantem suis,
(Homo sum Latinus quippe, linguæq*ue* inscius)
Quia deprecari maluit culpam magis,
Qua*m* non patrare; similiter, vestri Gregis
Purgationem ferre quis talem potest?
Non histrioniam didicimus, Roscij
Nescimus artem. scilicet; nam quis Gregem
Vestrum coegit agere? quis scenam dare?
Veniam solemus expetere, simul & dare,
Peccare cùm vis cogit inuitos. at hoc
Quis vos coegit facere, cuî veniam statim
Peteretis, ignosciq*ue* cuperetis statim?
Non est modesti petere veniam crimini,
Sed abesse culpâ, sed facere munus suum.
Nec enim pudendo, sed quod ingenuum decet
Faciendo, verus esse censetur pudor.
Pilâ quiescat ludere, indoctus, pilæ;
Qui nescit histrioniam, è scenâ exeat,
Artemq*ue* tractet artifex omnis suam.
  Egregia verò laus, & ingenuum decens,
Agere histrionem lege famosum optimâ.
Quid habet modestum scena, quid non impudens?
Scurrilitatis ludus, ac lasciuiæ,
Ioci officina turpis, ac petulans schola.
Quis saltat, aut quis prodit in scena*m* probus?

Momus (as you signifie) because you *understood that I & others should aske why those thinges were not aunswered which were obiected.* [*Th' Overthrow of Stage-Playes*, p. 1.]

[1] As I have indicated above, the text of *Momus* is found among the appendices of Gager's *Ulysses Redux*, Oxford, 1592, sig. F 3 verso—F 6 verso. It appears that of this edition of *Ulysses Redux* only two exemplars are extant: one in the Douce Collection in the Bodleian Library (Douce P. 564), and one in the library of Bridgewater House. I am substantially indebted to Strickland Gibson, Esq., for his kindness in verifying my text from the Bodleian exemplar.

Præclara res est Mimus, & gestum assequi, <sig. F4 recto>
Simulare vultum, ac verba, testari Deos,
Et sub puellâ tegere iuuenem puberem,
An histrionia subit octaua, artium
Quæ liberales esse dicuntur? sed hâc
Quid arte in ipsâ præstitum recté fuit?
Quæ forma scenæ? quis suas partes bené
Perêgit actor? quot solæcismi, manu,
Vultuq*ue* facti? gestus huîc nimius fuit,
Huîc nullus, illi ineptus; hunc vox extulit,
Distituit illum. quàm tragica nimiùm fuit
Materia turpis? quám Seneca turget nimis?
Exaggerando quantus? & cumulus quasi[1]
Verborum, & vtris instar inflati tumens,
Et Cordubense pinguius quiddam sonans,
Idemq*ue* eodem semper amplificans modo.
Quid ille veteri pannus assutus nouus?
Quàm nec colore, nec pari lanâ fuit?
Hesterna qualis exijt Comædia?[2]
Amata sine riuale, Riuales, suis,
Bis cocta crambe, morsq*ue*, non Comædia.
Quàm blanda morum lena prauorum fuit?
Parumné vitia sponte iam pollent suâ,
Nisi prostitutis vim quoq*ue* theatrum afferat?
Lætitia nisi prorumpat in lasciuiam?
Sub specie inani carminum, & facundiæ?
Disertiorem scena num quenquam dedit,
Aut doctiorem? num bonum vatem extulit?
Tragœdiæ plausistis alternæ quoque;[3]
Nisi forté potiús illa sit Comædia,
Opima thuri præda, scombrisq*ue* aridis,
Exanguis, atq*ue* exilis, & serpens humi,
Affectuum tam vacua, tam neruis carens, <sig. F4 verso>
Vinumq*ue* referens latice dilutum nimis,
Cuî vix color maneret, aut minimus sapor.
Cuî Diua Elisa callidé iniecta, vndiq*ue*
Plausum imperauit, sibilo dignæ magis.
Mendicus Irus, dedecore Iambu*m* afficit,
Personæ vilis; quodq*ue* sublimi nefas
Su*m*mu*m* est Tragædo, Comicè risu*m* excitat,
Famelicus, ignauusq*ue*, pannisq*ue* obsitus;
Omniq*ue* Ulysses se nimis Scenâ ingerit,
Et instar vmbræ nusqua*m* abest, vsq*ue* obstrepit.
Illinè quod agat qui dedit, nihil est? suo,
Sempernè vestrum præferet dulce vtili?
Versus Latinos quis citra natus mare,

[1] Opposite this line, in the right-hand margin: *Hippolytus.*
[2] Opposite this line, in the right-hand margin: *Riuales.*
[3] Opposite this line, in the right-hand margin: *Vlysses Redux.*

Cum laude pangit? stultiùs nunquam inferas
Soli lucernam, guttulam, vasto æquori,
Quàm si camænâ furere Romanâ velis.
Poema quis mediocre vel tanti facit?
Namq*ue* vt papauer melle cum Sardo datum,
Gratasq*ue* crassum vitiat vnguentum dapes,
Festiq*ue* discors, & strepens mensis lyra,
Offendit aures, cæna quia poterat sine his
Iucunda duci: sic quoq*ue* hæc ars mollior,
Animis iuuandis nata, si summo parùm
Discessit, imam penitus ad terram cadit.
Huc tantus iste sumptus, in pauperculos
Magis elocandus, redijt? huc horæ bonæ,
Malé collocatæ? gestui huc tempus datum?
Huc ianitorum sudor, aditusq*ue*, obsiti,
Fractæ fenestræ, clamor, expectatio,
Strepitusq*ue*? ecce disperiam, nisi
Conducta placeat Scena denario magis.
Hoc placuit vnum, quod nihil Momo placet. <sig. F5 recto.>

EPIL*ogus* RESP*onsivus*

Vt nomen ipse, Mome, tacuisses tuum,
Verba indicassent, & styli durus tenor;
Ipsum esse Momum, lingua tam fœda arguit,
Et dira facies, & comæ color improbus.
Ardens capilli quis domet virus tui?
Obijcere tali me queam spectro, Deos,
Hominesq*ue*, Naturamq*ue*, carpenti impiè,
Odioq*ue* Dijs propterea, hominibusq*ue* optimis?
Semper triumphus quem fugere opimus fuit.
Quis huius oris spiritum effugiat grauem?
Quis placeat isti, cui Seneca placuit minús?
Quem nec cothurnus, nec leuis soccus iuuat,
Qui grande, turgens; humile, proiectum putat;
Qui turpe, lætum; ludicrum, petulans vocat.
Vulcanus, & Minerua, pelagiq*ue* arbiter,
Operum hunc suorum, quisq*ue* censorem tulit.
Vulcanus Hominem fecit; opus huic displicet,
Quód pectus Homini non fenestratum foret,
Vt cogitata quæq*ue* prostarent palám.
Domum Minerua struxit; haud placuit Domus,
Trusatilis quòd illa non esset, statim
Varianda, premeret forté si vicinia.
Taurum ecce finxit Arbiter; Taurus Dei
Haud placuit isti, scilicet quòd cornua
Non prominerent, vt oculis tutamina.
Ipsamq*ue* reprehendit Artificem omnium,
Quòd capite tauris cornua, haud armis daret;
Quia maius armis, quàm capite, robur vigens,

Grauiore tauros ageret in plagam impetu.
Sic matre Nocte genitus, ac Somno patre,
Nihil ipse præstans, optimos carpit tamen, <sig. F5 verso.>
Linguæq*ue* tactu fædat immundo omnia.
Quæ multa declamauit in Ludos probra,
Arrepta quæ congessit ex triuijs, licet
Ridendæ potiùs, quam refellenda æstimem,
Grauiora paucis excutere fas sit, tamen.
Agere histrionem lege damnatum piâ est;[1]
Famosus ergo est, quisquis in Scenam exijt?
Prætor negabit; Qui sui spectaculum
Mercedis ergô præbet, infamis siet.[2]
Non ergo quenquam Scena, sed quæstus, notat,
Quis hic rogauit sportulam, vel quis dedit?
Cui non patebant sponte, sine lucro fores?
At tegere iuuenem, veste muliebri. est nefas;[3]
Semperne? quid si cogeret lethi metus
Mutare vestem? publicum quid si bonum
Suaderet? id quod crebra testari potest
Historia, veste filius Amyntæ, indui[4]
Iuuenes muliebri dum iubet, tot fœminis
Claris pudorem seruat, & petulantiam
Persis superbam, cæde præclarâ, excutit.
Non ergo iuueni est grande simpliciter nefas
Mollem puellam induere; scelus est Clodio,
Non est Achilli; Clodius stuprum parat,
Vitam tuetur filius Thetidis suam.
Non ergo vestis fœminea, iuueni est scelus,
Sed praua mens, libido, malitia, ac dolus.
Nec habitus vllus, sed animus turpem facit.
Distincta sexum forma distinctum decet;
Virile non est fœminæ mores sequi,
Muliebre non est exequi munus viri.
Quid simile nobis obijcere quisquam potest?
Quid cogitatum tale? quis fraudem imputet? <sig. F6 recto>
Scurrile tu proferre ne verbum potes.
Libuitné defamare, quæ nescis, palam?
Nobisné verbo simplici standum est tuo?
Si iudicas, dignosce; si suades, proba.
Vnde hæc tyrannis, Mome, permissa est tibi?
Inscitia tibi vt impune sit, & animi stupor,
Pietas putetur? crimen est, quicquid tibi
Displicuit? an tu mentem habes solus piam?

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[1] Opposite this line, in the left margin: ff. De ijs qui notantur infamiâ l. 2. p.

[2] Opposite this line, in the left margin: Ait Prætor.

[3] Opposite this line, in the left margin: Deuter. Cap. 22. Vers. 5.

[4] Opposite this line, in the left margin: Alexander, magni Alexandri proavus.

Maledicta textum glossa quæ vitiat bonum.
At grande factum est te*m*poris dispendium;
At, Mome, non est; Mome mentiris, nihil
Studijs remissum est publicis, id fabulis
Tempus tributum est, quod solet tribui iocis,
Somnoq*ue*, colloquijsq*ue*, doctoq*ue* otio.
Bené collocati temporis fructum, Chorus
Præstare noster, Mome, maiorem potest,
Quàm disciplinâ quispiam Momi editus.
An tu poësim despicere doctam audeas?
Senecamné tu recitare iacturam putes?
Cuius vel vnum, Mome, versiculum, tibi
Præpono, similibusq*ue* sexcentis tui.
Cuius vel vnum simile carminibus, meum
Benigna carmen malo posteritas legat,
Quam quicquid vnquam Momus ingenio efferat.
At sumptus ingens; at tibi gratis licet
Spectare, Mome; nemo te stipem rogat,
Nisi forté veniam, quam, tibi iuxta est graue,
Præbere vtramq*ue* sumptus est ingens tibi,
Nobis mediocris; nemo propterea minùs
Fouebit inopes; absq*ue* eo, nemo magis
Leuabit. (Ad quid ista perditio est, Here?)
Mala, Mome, vox est, est, vbi parcas, locus, <sig. F6 verso>
Suus est honesto sumptui, suus est iocis,
Ludis, choreïs; serijs etiam est suus,
Lachrymisq*ue* nobis temporis sine te, satis
Vtriusq*ue* ratio constat, haud Momo est opus.
Tu flere, vel ridere, flagitium putas?
Nos histriones, hanc Domum, Circum vocas?
Tu tollis hominem ex homine? tu parte alterâ
Constare credis? nostra tibi soli, impudens
Visa est iuuentus, ingenua, casta, elegans,
Generosa, docta? tu Domum tantam arguis?
Academiæ tu iudicia nihili facis?
Impuné damnas? turpe sit nostro Gregi
Egisse; num spectasse, tot doctis viris
Satis est decorum? vtrinq*ue* par surgit nefas,
Tu norma rerum, temporis, su*m*ptus, ioci?
An tu pudoris regula, decori artifex?
Morumnè tu mensura, vitæq*ue* arbiter?
Quæ dixit in nos alia, diluere haud placet;
Has esse partes arbitror vestras, Chorus
Ad vos recurrit noster, a vobis opem
Expectat, exposcitq*ue* suppetias malo;
Gregem tueri, muneris vestri putat.
Nam culpa vestri tot a candoris fuit,
Quæ nos cothurno, quæq*ue* nos socco induit,
Et dulce, si quid hinc fuit, vestrum fuit.
Authore tali, qualis hic cœtus coit,

Peccare si non fas sit, at certè licet
Redimere crimen, quicquid est, Scenæ grauis;
Censura vestrum nulla iudicium arguat.
  Proinde, disrumpantur vt Momo ilia,
Iterum benignus vndique applausus sonet.

It appears, then, that among the contentions advanced by Momus and ridiculed in the *Epilogus Responsivus* are the following: (1) Actors were condemned by ancient statutes; (2) It is impious for men to dress themselves as women; (3) Plays in general, and *Riuales* in particular, contain lascivious matter; and (4) The acting of plays entails a waste of time and money.

III. Lost correspondence between Gager and Rainolds.

Among the contentions of *Momus* one readily observes resemblances to certain of the positions taken by Rainolds in his letter to Thornton. It was inevitable, therefore, that when he heard of the *Momus* epilogue, Rainolds should suspect a burlesque of himself. Through a direct or indirect channel, in written or oral form, Rainolds' suspicion must have reached Gager, for when, some three months after the performance,[1] he sent a copy of the printed *Ulysses Redux* and *Momus* to Rainolds, he accompanied it by a letter in which he took pains to declare that in the comic figure he intended "not to note any man, but onely Momus."[2] It appears also that shortly after the performance of Gager's plays a young Fellow of Queen's College preached a sermon upon the passage in Douteronomy (xxii, 5) forbidding both men and women to clothe themselves in the apparel of the opposite sex.[3] Since this sermon met with Rainolds' approval,[4] and may have been instigated by him, we may regard it as part of his censure of Gager immediately after the performance of the plays.

IV. The printing of *Momus*, and its presentation to Gager.

Ulysses Redux was printed in May,[5] 1592, with the following title-page:[6]

[1] See below, p. 602.

[2] See below, p. 602.

[3] See Gager's letter of July 31, 1592, C. C. C. MS. 352, pp. 41, 63, printed below, pp. 605, 635.

[4] See *Th' Overthrow of Stage-Playes, p.* 16.

[5] The month is indicated by the ending of the prose dedication to Thomas Sackville: "Vale. Ex Aede Christi Oxonie sexto Idus Maij. 1592.

Vlysses Redux | Tragoedia Nova. | In Aede Christi Oxoniae | *Publice Academicis Re- | citata, Octavo Idvs* | Febrvarii. 1591. | [Device] | Oxoniae, excudebat Iosephvs Bar- | nesivs, M. D. LXXXXII.

As has been noted above,[1] this volume included the text of *Momus.*[2] Some time between May 10[3] and July 10[4] a presentation copy was sent to Rainolds, accompanied by a letter from Gager explaining that since the performance, the *Epilogus Responsivus* attached to *Momus* had been enlarged, and declaring that in *Momus* he intended no application to Rainolds.[5]

V. Rainolds' letter[6] of July 10, 1592, acknowledging the receipt of *Ulysses Redux* and of Gager's accompanying letter.

Honori tuo addictissimus, Guilielmus Gagerus." [*Ulysses Redux*, Oxford 1592, sig. A 4 recto.]

[6] A facsimile of the title-page, from the Bodleian exemplar, is given by Boas, opposite page 202. Boas (p. 197, note 1) observes that the date "Octavo IdvsFebrvarii. 1591.", i. e. February 6, 1591/2, must be erroneous, since *Ulysses Redux* was certainly performed on Sunday, February 5, 1591/2. See above, p. 595.

[1] See above, p. 595.

[2] It must be remembered, however, that in the performance, *Momus* was attached not to *Ulysses Redux*, but to *Hippolytus*.

[3] The date (sexto Idus Maij) of the dedication to Sackville.

[4] The date of Rainolds' letter of acknowledgment.

[5] These last facts are established by the following passage from Rainolds' communication of July 10, 1592:

I am much to thank you, Maister D. *Gager*, for both your letters, and your *Tragedie:* the more, for that you *haue enlarged the answer to Momus* (as you signifie) *because you understood that I & others should aske why those thinges were not aunswered which were obiected.* Indeed, as our Savior when he was smitten by one for speaking nought but reason, saide, *If I haue spoken evill, beare witnesse of the evill; but if well, why doest thou smite me*? so they, whose obiections against playes you attributed to the person of *Momus*, & thereby noted them as uniust reproovers, might iustlie say in my iudgement; *If our reasons be naught, discover their naughtines; if good, who doe you Mome us*? And what so euer others had cause to thinke of them selues, yet I must needes thinke my self touched therein: although I should yeeld unto your request (which I most gladlie doe) in that you pray me, *not to mistake your meaning;* protesting *your intent is not to note any man, but onely Momus.* [*Th' overthrow of Stage-Playes*, p. 1.]

[6] This letter, under the heading "Maister D. *Rainolds* aunswere unto Maister D. Gager, concerning Theater-sights, Stage-playes, &c.", occupies the first twenty-seven pages of a small volume bearing the following title:

Th' overthrow | of Stage-Playes, | By the way of controversie betwixt | D. *Gager* and D. *Rainoldes*, wherein all the reasons | that can be made for them are notably refuted; th' ob- | jections aunswered, and the case so cleared and re- | solved, as that the iudgement of any man, that |

Upon receiving a presentation copy of *Momus* and Gager's accompanying letter, Rainolds composed a letter to Gager, bearing the date July 10, 1592, which gives vigorous support to the strictures uttered by Momus and turned to ridicule in the *Epilogus Responsivus*. Following, in general, the order of *Momus*, the Queen's College scholar contends as follows:

1. Stage-players are infamous according to Roman civil law.[1]

2. The law of God forbids man to weare the apparel of women.[2]

3. In Gager's plays young men act the parts of base characters.[3]

4. In such plays time and money are wasted.[4]

5. Such plays profane the Sabbath.[5]

VI. Gager's reply,[6] dated July 31, 1592, to Rainolds' letter of July 10.

In the face of Rainolds' communication of July 10 Gager could not remain silent, and his letter of July 31 constitutes both a spirited reply to his opponent and a substantial

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is not froward and perverse, may | easelie be satisfied. | Wherein is manifestly proved, that it is not onely vnlaw- | full to bee an Actor, but a beholder | of those vanities. | *Wherevnto are added also and annexed in th' end certeine latine | Letters betwixt the sayed Maister* Rainoldes, *and D.* | Gentiles, *Reader of the Civill Law in* Oxford, | *concerning the same matter.* | 1599.

In 1600 the sheets of this book were reissued, with a new title-page naming Middleburgh as the place of publication. In 1629 a new edition was published from the press of the University of Oxford. See Boas, pp. 247-248. The edition of 1629 differs in no substantial respect from that of 1599. The page-numbers are identical.

[1] *Th' overthrow of Stage-Playes,* pp. 4-8.

[2] *Id.*, pp. 8-17.

[3] *Id.*, pp. 17-24.

[4] *Id.*, pp. 24-26.

[5] *Id.*, p. 21, where the matter is treated only incidentally.

[6] Corpus Christi College MS. 352, pp. 41-65. The text is written in the common Elizabethan cursive. A hand considerably later than that of the main text has supplied the following heading: "This is not printed, but must come in betweene Dr. Rainolds Answer to Dr. Gagers former letters, & Dr. Rainolds reply to this following treatise." Extracts from Gager's letter are given by F. S. Boas in *The Fortnightly Review,* August, 1907, pp. 309-319, and by the present writer in *Shakespeare Studies, By Members of the Department of English of the University of Wisconsin,* Madison, 1916, pp. 112-121. In the present article the complete document is published for the first time.

treatise of defence of academic drama and academic performances. The complete document stands as follows[1]:

Wheras, in the beginninge of your late letter,[2] or rather treatyse to me, Mr. J. Rainoldes, you wryte, that you are muche to *thanke me for my letters, & Tragedye;* it is as muche, at the most, as thay deserved; but that you add, you are so to doe the *more, for enlarginge the answere to Momus, for yours, and others askinge, why thinges by hym obiected, weare not answered,* I ame rather the more to thanke you, for your takinge it in so good parte. Howbeit, I would be very sorrye, that the comparyson, which in the behalfe of others, you drawe from owre Savioure,[3] should houlde agaynst me: for he indeede when he was smytten, might trulye saye, *if I have spoken evill, beare witness of the evill; but if well, why doste thou smyte me*? because he undoutedlye had sayde nothinge but reason, and therfore was most vniustly smytten. but for my obiections agaynst owre Playes, attrybuted to *Momus,* no man can rightely saye to me, *if owre reasons be naught, discouer theire naughtines; if good, why doe you Mome vs*? for firste, the obiections, in owre case, and agaynst vs, are most vntrwe, and I hope no man lyvinge shall soundely prove the contrarye: next, there is no man smytten by me, and therfor I shoulde be wronged if I shoulde be asked suche a question, withoute cause. I say, no man is smytten by me (muche lesse you, or any of yours) but onlye *Momus,* whoe can never iustly in suche sorte chalenge me, nor any man for hym. as for *They,* and *Vs,* I assure you I doe not knowe whome you meane by them, nor very well what. for when I wrote vnto you, that I had enlarged the answere to *Momus, because I vnderstood that you and others shoulde aske, why thos thinges weare not answered, that weare obiected;* by *others,* I did not meane suche, as I perceyve by you there are, which shoulde mislike owre Playes, but *others* of my frendes, that heeringe the obiections, towlde me, that thay coulde have wisshed, thay had byn then answered, leste any shoulde thinke thay had byn vttered in good erneste, or leste thay shoulde seeme to some, to carry a

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[1] In elucidation of Gager's text I print in the foot-notes pertinent passages from Rainolds' letter of July 10.

[2] I am much to thanke you, Maister D. *Gager,* for both your letters, and your *Tragedie:* the more, for that you *haue enlarged the answer to Momus* (as you signifie) *because you understood that I & others should aske why those thinges were not aunswered which were obiected.* [*Overthrow of Stage-Playes,* p. 1.]

[3] In deed, as our Savior when he was smitten by one for speaking nought but reason, saide, *If I have spoken evill, beare witnesse of the evill; but if well, why doest thou smite me*? so they, whose obiections against playes you attributed to the person of *Momus,* & thereby noted them as vniust reproovers, might iustlie say in my iudgement; *If our reasons be naught, discover their naughtines; if good, why doe you Mome us*? [*Overthrow,* p. 1.]

greater shewe of truthe, then thay cowlde well answere at the first sight. for till I vnderstoode it by you, and by a Preacher of late,[1] I did never thinke that eyther you, or any other in the Vniversitye had abetted *Momus* his obiections, or that owre Playes, had byn so muche disliked. if I had knowne it, I coulde easely have spared so thankeles a labor, to saye no more. but I hope it seemethe not so to evrye bodye, that also are not evrye bodye.

But whatsoever other men had cause to thinke, you had no ſust occasion to suspecte your selfe touched therin by me; no not for thos twoe inducements which you cheefely alleage to prove your coniecture. for wheras you write,[2] that you did *reprove Theater-sightes and Stage-playes, as hurtfull and pernicious many yeeres agoe, and this yeere, before the Playes, had wrytten to a good frende of owres, thos reasons which I make Momus use agaynst them,* and therfor you had cause to thinke, you weare *charged, noted, and stayned vnder the name of Momus;* to the first I answere; first I never red that which you wrote longe agoe in your Preface to your *Theses*, agaynst Playes. I may be ashamed perhapps so to excuse my selfe; but yet the acknowledgment of this blame, dothe <p. 42> make my testimonye in this case of more validitye. if I coulde otherwise have defended myn innocencye heerin, I woulde have avoyded this confession. but a truthe must be sayde, and the rather when it is to prove a truthe of greater moment. Then, if I had red it, when I was a very yunge man, and so careles of suche thinges, I might have forgotten it ere this, beinge wrytten so many yeers sence. Lastly I should have taken it as spoken agaynst *Histriones*, and not agaynst Schollares. and in deed for that I ever have hearde (as I. confesse I have hearde) of your mynd that way, I ever vnderstoode it, in that meaninge. As for your late letter to owre good frende, he never shewde it me, or towlde me the contents therof to this daye, I never hearde of it, till longe after. nay talkinge with hym of you, touchinge suche thinges, he towlde me, that he had invyted you to the Playes, but you most gently answered, that you never vsed to cum*m* to

[1] At least I could haue wished your censure had bene milder, if not in regard of a younger Preacher, who did so expound that text [Deut. XXII. 5] in a godly Sermon before your booke was printed: yet in consideration of that ancient Father, with many other worthy men, whose learned writinges doe glosse it in the same sort. [*Overthrow*, p. 16.]

[2] And what so euer others had cause to thinke of them selues, yet I must needes thinke my self touched therein: although I should yeeld unto your request (which I most gladlie doe) in that you pray me, *not to mistake your meaning;* protesting *your intent is not to note any man, but onely Momus.* For I did reprove [Side-note: Praefat. Thesiu*m* ad Acad. Oxon.] our *Theater-sights & Stage-playes,* as *hurtfull and pernicious,* [Side-note: Pestes scenicorum theatralia spectacula] many yeares agoe: and this yeare, ere your *Momus*, or any of your Enterludes came vppon the stage, I had (in letters written to our good friend Maister D. *Thornton*) alleaged those reasons, which you make *Momus* vse, against them. [*Overthrow*, p. 1.]

suche thinges, and therfor nowe would also abystayne, not bewrayinge to me, anye inklinge of suche your dislike, but muche com*m*endinge to me, your grave, wise, and gentle carriage of your selfe therin, and in all other matters. which as I acknowleged with hym; so to saye the truthe, I was very glad you did refuse to cum*m*, for no greater cause. not that in suche a matter, I ought to attribute more to the pryvate opinion, of one, or a fewe men (thoughe to yours, as muche as to any ones) then to the com*m*on iudgment of many others; but because I woulde offende neyther a fewe, nor any one man, specialye in suche a trifle, as I take this to be. besyde all this, it is most manifest, that the devyse of *Momus*, was conceyved and penned longe before the sendinge of that your letter, as many, and amonge others, owre good frende you mention, can testifye it. for I showde it hym a monthe before. hethertoe I trust appeeres no iust cause in me, why any man, and specialy you, should thinke, that vnder the name of *Momus*, you weare taxed in particular.

And to speake *Coram Deo*, my meaninge only was, if I had any meaninge or purpose at all, partely to move delight in the audytorye, with the noveltye of the invention and the person, beinge nowe foreweryed and tyred with the tediusnes of the *Tragedye*[1]; partely to obiect thos thinges agaynst owre selves, by owre selves, which might abate all suspition of any littell vayne glory or selfe pleasinge in vs, when thay should vnderstand, that owre dooinges displeased no man more, then owre owne selves and so by this meanes, as it weare with a slight, to shifte of all occasion of others ill speakinge, when we had prevented them with as ill as mought be, before. howsoever it was, I assure you I never had any serius thought of it, but esteemed it as a iest to serve a turne, littell thinkinge it should, or coulde be so taken, suche was my singlenes and simplycytye. and therfore I did not greatly care what I made hym to saye, as thinkinge any suche thinge became *Momus* well inoughe. whome notwithstandinge I brought not in, so muche in that sense, that *Aristotle* speaketh of,[2] as a reproover <p. 43> of the best and perfitest woorkes, of the most wise and skillfull (for I never tooke eyther owre selves, or owre Playes to be suche) but, as we com*m*only take hym, as a carper, and a pincher at all thinges that are done with any opinion of well dooinge. sum*m* thinges that he obiected, I willingely confesse weare trwe, as thos that did concerne owre owne want of skill in suche matters;

[1] *Hippolytus*, the last of the Shrove-tide tragedies, performed on Tuesday, February 7, 1592.

[2] Now *Æsopes* tale of *Momus* (as *Aristotle* sheweth in that your selfe mention of his reproving *nature for setting bulles hornes upon their heades, not upon their shoulders*) was devised to checke such as reprove vniustlie the best and perfitest works of the most wise and skilfull. [*Overthrow*, p. 1.]

summ*m*, and the most parte, weare false, as the applyinge of all thos reproches to vs, which are truly spoken agaynst *Histriones.* of which reproches, if I should be examyned vpon myn othe, wheare I harde them, and of whome, I must needes saye I harde them I knwe not wheare nor of whome; but that thay weare *arrepta ex triuijs*, that is thay weare com*m*on and tryviall speeches. and therfor I would you had not translated *arrepta ex triuijs*, rascall reproches. the wordes in Latyn naturaly sownde not so hardely. howe wordes are to be taken in charetye, you knowe better then I; in lawe and reason thay are ever with this rule to be interpreted; *Ab omnibus traditu*m *est, in quacunq*ue *materiâ, etiamsi pœna*m *irroget, eatenùs verba generaliter capi, quatenus sermonis proprietas ferre potest, nisi alia*m *loquentis mentem conijciamus. primus aute*m *intellectus proprietatis, est sua vniuscuiusq*ue *rei appellatio.*[1] nowe, *arrepta ex triuijs*, doe not most properly and principally signifye *Rascall reproches;* and no man can iustly coniecture that my meaninge was to vse any honest man with so ill termes, when I meant no man at all. for of all other affections, spite and mallyce, weare no counselors to that devyse, to the notinge of you, or any man ells. so that thoughe I knowe the wordes may be so properly translated, yet not to my mynde so properly, that is not so gentlye, as I meant them.[2]

But that I had no purpose by *Momus* syde to wound you, ac-

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[1] Gager's side-note: Alci: de verb. signif. l. I.

[2] To the which purpose sith you [p. 2] rehearse it also, and inferre vpon it, that *the man who taunteth playes with the rascall reproches* [Side-note, from *Momus*, line 130: Probr. Arrepta quæ congessit ex triviis.] there specified, *offendeth in the same sorte:* how can it bee avoided, but I, who had vttered those things against playes, though deeming them sounde reasons, not *rascall reproches*, must thinke my selfe charged vnder the name of *Momus*? vnlesse I should be so vnwise as to suppose, that my frende a lawier, saying, *If Sempronius borow a horse of Seius, and ride him a mile farder, then Seis was content he should, he committeth theft*, the speech doeth not charge me with theft, though I had done so, because the lawier meant not to charge me, whom he loueth, nor knewe perhaps that I had done it; but his meaning was to charge *Sempronius* onelie. Wherefore albeit you meane not to note any man but onelie *Momus*, as you protést, and I beleeue you: yet you meane withall (I trowe) the sáme that *Tullie*, when having reprooved the couetousnes of Chieftaines and Gouuernours of their warres, I (quoth hee) *name no man; Wherefore no man can bee angrie with me, unlesse he will confesse first of him selfe.* Which I doe not mention to proove that I haue cause of being angrie with you (be it farre from me,) although I confesse my selfe to haue written those things which they, who speake, are stained with *Momus* name by you; but onely to shewe that by your speach against *Momus*, notwithstanding your intent to note no man but him, yet you note vs all, in hím, as vniust reproovers of playes, who soeuer inveigh against them as he doeth. And this your selfe can not choose but see and graunt, if you call to minde your verses *ad Zoilum*, and Epistle *ad Criticum*. For you will professe (I hope) that your intent is not to note anie man but onely *Zoilus* and *Criticus:* Yet, if anie finde such fault with your *Tragedie*, as you controll them for: you will not denie but you meane to note him as a malitious *Zoilus*, and a Carping *Criticke*. [*Overthrow*, pp. 1-2.]

cordinge to the lawe of charytye, vpon my former protestation to you, you doe most gladly creditt me, as you wryte; and so trulye you may, and I hartely thanke you for it. for it was the greatest thinge that I desyred to prove vnto you, as a matter that I ought to thinke, if I woulde retayne the reputation of an honest man, shoulde neerly touche me; which beeinge cleered, as bothe in my conscience, and in your good mynde it is, I feare not any thinge ells greately in all this cause. ffor wheras you goe forwarde to prove by your Case of *Sempronius and Seius*, by a sayinge of *Tullie's* agaynst the gouernours of armyes in his tyme, and by myn owne wordes *Ad Zoilum* and *Ad Criticu*m, that thoughe I had no suche particular intent, yet in the generalytye *the censure lighted vpon you:* thoughe I ame hartelye sorry that it should so vnhappelye fall owte, yet all that may I grante withowte offence, I trust. for the mayne matter is not, whether you had occasion to thinke your selfe to be touched in the generalytye, or no, beinge of that opinion, you are; but whether the opinion be iustifiable, or no. you thinke, yea; I think, nay..if I should saye *Vni creditis*? the cause weare lost playnly on my syde. <p. 44.>

But because you assure me in your treatyse, that you mislike nothinge in intytlynge *Momus* to thos reasons which I make hym to vse, nor in myn answere to them; if I can prove his to be vnsownde, and my defence to be good; I will trye what I can doe, to showe, that the truthe in this controversye, belongethe rather to my answere, then to the reasons fathered on *Momus*[1]. Wherin I ame affected as if I weare advocate to a fayre mayden suspected and accused of incontinencye, whoe had gevne in wordes and gesture, as in strictnes of severytye thay mought be construed, some small shewe of lytenes, but whome notwithstandinge I weare fully perswaded, to be in deede, very honest; evne so I fare in this cause, whearin not one, but twoe fayre maydens, *Tragœdia* and *Comœdia*, are not only greevusly suspected, but vehemently and eloquently accused, not by evrye com*m*on Orator, but by *C. Cassius*, or *M. Cato*, of dissolute lyfe and manners, and may perhapps, I confesse, somtyme have gevne some littell suspition therof, beinge straytely examyned, but yet are suche, as by whome in my conscience I doe verely thinke, no suche thinges can well be prooved, as farr as we can be charged to be answerable for their acquayntance, vsage, and conversation amongst vs,

[1] I will assure you also that I mislike nothing in your entitling *Momus* unto our reasons of reproofe, or in your answere to them, if, as you approoue your cause of confidence on the one parte, so you shall on the other. For your protestation of your own conscience doeth binde me by the law of charitie to thinke that you haue done this in singlenesse of heart, without spite and malice. But the trueth of the thinges themselves, that you chalenge, belongeth to the reasons fathered on *Momus*, not to your aunswere, in my opinion. [*Overthrow*, p. 3.]

which in all my defence I desyre still to be vnderstoode. Wherfor not of a desyre to contende, specially with you, *quis talia demens Audeat, aut tecum malit contendere bello*? but vpon libertye gevne me by you, eyther to vse your advise, or gentlye to imparte to you, I will not say, *quid rectius*, but what I thinke; as you have followed my order, so will I followe youres; praying you to expecte no other answere at my handes, then I ame necessaryly inforced vnto, that is to the strencthninge and illustratinge of my former answeares, and no furder mayntenance of the whole cause.

Ffirst therfor wheras you denye me[1] that the *Prætor* dothe not distinguisshe, as I doe, be [t] weene thos that doe *prodire in scenam quæstus causâ*, and not *quæstus causâ*, but rather in expresse wordes saythe the contrarye, *qui in scenam prodierit infamis est;* it is very trwe, and I knwe that very well before. but because *Vlpian ad edictum Prætoris*,[2] dothe so expownde the *Prætor*, as it weare *ex æquitate Prætoriâ* and *ex responsis prudentum Pegasi et Neruæ filij* I thought it was as good lawe, and better verse, to saye, *Famosus ergo est quisquis in scenam exijt? Prætor negabit;* seeinge the meaninge of the *Prætor*, and so the *Prætor* hym selfe, is taken to denye it; as to saye *Vlpianus*, or *Pegasus & Nerua*

[1] To the first reason then (for I will take them in your owne order) that Stage-players are infamous *by the civill lawe*, you aunswere that *they are not all, but onely such as play for gaine sake:* [Side-note, from *Momus*, lines 134-135: Famosus ergo est quisquis in scenam exiit? Pretor negabit] which you avouch is proved by the *Prætors* wordes. But that which you make the *Prætor* say, as distinguishing, *Qui sui spectaculum Mercedis ergô præbet, infamis siet* [*Momus*, ll. 135-136]; the *Praetor* saith not. Nay, contrariwise he saith without all distinction, generallie and simplie: *Infamia notatur, qui artis ludicræ, pronuntiandive causa, in scenam prodierit.* And *Ulpian* (whose place you quote for proofe thereof) doeth report him so, with these verie words: *Ait Prætor, Qui in scenam prodierit, "infamis est."* But *Vlpian*, expounding these wordes of the *Prætor*, citeth some lawiers [Side-note: Pegasus & Nerva filius] saying, that *they are infamous, qui quæstus causa in certamina descendunt, præmium in scenam prodeunt:* and hereof you conclude, that *they, who come not foorth into the stage for gaine sake, are not infamous.* [Side-note, from *Momus*, l. 137: Non ergo quenquam scena, sed quaestus notat]. By which kinde of reasoning one might conclude likewise, that sith by the scripture a woman taking mony for prostituting her body to men is infamous: therefore she is not so, who doeth it freelie; much lesse, who giveth money to haue her lovers companie; whom yet the scripture counteth most infamous of all. Howbeit, had those lawiers, in adding, *quæstus causa*, intended your conclusion; which I knowe not whether they did, but admitte it: neverthelesse you know that a lawier also, [Side-note: Dionysius Gothofredus comment. in corp. iur. civ. edit. 2.] perhaps more learned then they, hath made this note thereon, *Immò & qui sine quæstu. omnes enim scenici probosi. August. lib. 2. de civit. Dei, cap. 11. & tribu moveri soliti. Livius Lib. 7.* wherein, as hee gathereth, that such as come vpon the stage without gaine, are prooved by *S. Augustin* and *Livie* to be infamous, because *S. Austin* and *Livie* doe shewe that all stage-players (free players not excepted) were branded with a marke of infamie & dishonestie, disfranchised in a sort: so he confirmeth hereby (which was and ought to bee the drift of his note) that by law the players without gaine are infamous, not onelie such as playe for gaine sake. [*Overthrow*, p. 4.]

[2] Gager's side-note: ff. De his qui not. infa. 1. § Ait Praetor.

filius negabunt. that *Vlpian* dothe approve the distinction of *Pegasus* and *Nerua*, it is evident; for if he had disliked it, or not allowed it, thoughe he alleged theire authoritye, yet he woulde in expresse wordes have refused it, as in many places of the *Ciuill Texte*, the like appeerethe. that *Pegasus* and *Nerua* doe so distinguisshe, it is as manifest; because otherwise *Vlpian* showlde repeate the *Prætors Edict* in vayne, and not <p. 45> interprete it which he professethe to doe. besyde that *Glossa communis, Baldus Petrus de Castro*, and all that I have seene vpon this lawe, doe so vnderstand this latter parte therof. lastely, in this very *Title De his qui notantur infamia*, and in the same places therof, *In certamen descendere*, and *In scenam prodire*, doe as thay saye in owre lawe *ambulare æquis passibus;* but it is most evident, that, *qui descendit in certamen depugnaturus cum bestijs dentatis, ac feris, virtutis ostendendæ, non mercedis causâ, non est notatus;* ergo *qui prodit in scenam pronuntiandi gratiâ, sine præmio, aut quæstu, non est notatus*[1]. and the reason of the favorable parte of the distinction may well, me thinkes, be gathered owte of the lawe which is *C. de spectaculis l. i. in fine. li. xi.* Neyther dothe *Dionysius Gothofredus*, whom you alleage, denye this distinction, but rather prove that *Pegasus* and *Nerua filius* doe so distinguisshe, in exceptinge agaynst the latter member, in his note, *Immó et qui sine quæstu.* whoe, to admytt your *perhapps, that he is a man more learned then Pegasus and Nerua filius*, the authors of this distinction, to gether with *Vlpian*, in not disallowinge it, approvinge the same (which notwithstandinge for some reasons I can not yet thinke to be soe) yet surely he is not of so greate authorytye, as the Texte it selfe, whatsoever any man may esteeme his learninge to be. and yet in some sense, his shorte, but quick note, *Immó et qui sine quæstu*, hurtethe not vs at all. for if he meanethe therby to taxe *Laberius, Lentulus, Nero*, and suche like, that did *exercere histrioniam*, thoughe *gratuitam;* his exception is most trwe, and it makethe not agaynst vs, or owre Texte. for this lawe releevethe them, that came *in Scenam*, to doe theire common wealthe honor, theire citizens honest pleasure and delyte, and theire Godds devowte servyce, with owte rewarde; not them that did so only to satisfye theire dissolute and lewde humors, as *Lentulus, Nero* and others did, whose examples can not be applyed agaynst them, or us; as shallbe heerafter shewed. but *Gothofrede* in deede fowndethe his sharpe note, upon a sayinge of *S. Austin, Ommes enim scenici probrosi;* and of *Livye, et tribu moueri soliti;* bothe which, it is playne, are to be vnderstood agaynst *Histriones;* and so theire authorytyes serve not to interprete owre Texte, wherof thay

[1] Gager's side-note: ff. De postul. l. 1. § Bestias. & fi De his qui nota. infa. l. 4.

coulde never dreame; and *Gothofrede* dothe gloze agaynst a manifest lawe, withowte gyvinge anye reason of his so dooinge.

Wheras therfore you inferr by this distinction of *quaestus causâ*, and *sine quaestu*, that *a man might likewise conclude, that sithe by the Scripture a woman takinge monye for prostitutinge her bodye to men is infamous, therfor she is not so that dothe it freely, muche lesse that givethe monye to have her lovers cumpanye, whome yet the Scripture countethe most infamous of all;* I vtterly denye that any suche consequence may be framed therbye. ffor it is not simplye able to cumm vpon the Stage, because the lawe allowethe it in some case, that is, when it is doone *sine quæstu;* but it is a thinge absolutely wicked for a woman to prostitute her selfe eyther freely or for rewarde, thoughe more wicked also for rewarde. nowe you assume that the one is as greevus a sin, as the other, or <p.46> at the leste, as absolutely a sin; which is the state of owre cause, and therfor you must prove it, for we can in no wise grante it you. wherfor you must evicte that it is simplye a vyle sin, in any case, and namely in owres, for any, thoughe freely, *prodire in scenam*; as it is for a woman freely to prostitute her bodye; and then I confesse that of my distinction so absurde an argument may be deduced. *Descendere in certamen, et prodire in scenam quæstus causâ, infamant;* ergo *Descendere in certamen, et Prodire in Scenam sine quæstu, non infamant*, is a good consequence, because the lawe so distinguishethe. but to say *A woman prostitutinge her body to men for monye is infamous;* ergo *she is not so that dothe it freelye*, is a wronge and a wicked consequation, for the reason before alleaged. Therfore the answere that I made to *Momusses* fyrst cheefe obiection, standethe good and fyrme, because the lawe led me by the hande vnto it. and if I had byn to answere in this question in owre *Acte*, the same beinge obiected, if I should not so have answered, I shoulde have byn thought never to have looked vpon the lawe, whence my question was taken. I thought it not meete, to enlarge myn answere furder, then *Momus* did inforce his obiection; but as he only proposed the lawe, so I only gave that answere, which the lawe in the same texte affoorded me; as one that sees no cause to dislike it, lesse dares dispute agaynst it, and hathe lesse authorytye to abolysshe it.

But you in a manner admyttinge that *Pegasus* and *Nerua filius*, in addinge *quæstus causâ*, intended my conclusion, yet not stayinge there, you goe abowte to overthrowe theire creditts, partely by opposinge and preferringe *Dionysius Gothofredus* to them, *a lawyer also*, as you say, *perhapps more learned then thaye*, whoe hathe made this note theron, *Immó et qui sine quaestu*, moved thervnto by a sayinge in *S. Austin*, and *Livye;* partely by the best interpretor of lawes, that is, the custome and the practyze of the *Romans*, [1]whoe thought that free Players also weare infamous; which you prove also owte of *S. Austin*, growndinge hym selfe upon *Tullye*, by *Livye*, *Cornelius Tacitus*, and *Juuenall;* partlye, and lastly, by the examples of them, whoe weare accownted infamous, for playinge, thoughe freely; as *Laberius*, *Lentulus*, certayne *Roman needy Sqyres*, and *Nero* hym selfe, whom by the opynion of all honest men, you prove to have byn branded with a perpetuall note of infamye for so dooinge. *Gothofrede* I

[1] And this doe their wordes, whom hee alleageth, implie, if they bee vnfolded and [p. 5] weighed indifferentlie, according to the rules of lawe for douts thence rising: to weet, that *custome is the best interpreter of lawes;* and, *autoritie of thinges still iudged of alike hath the force of law.* For *S. Augustin* groundeth his generall conclusion upon the ancient practise and order of the *Romans* testified by *Tullie:* who saith that their *auncestours, counting all kinde of stage playes shamefull and dishonest, agreed that such persons should not onely want the honour of other citizens, but also be disfranchised by the controlment and checke of Censors.* Neither were they checked with this reproch and ignominie of olde time alone, but in *Livies* age too; yea, before, and after; at least, with the blemish and staine in mens opinion, though not with the punishment. *Cornelius Nepos* saieth, that *to come on the stage & be a spectacle to the people, was counted no dishonestie or shame among the Græcians; among the Romans it was. Laberius*, a gentleman of *Rome*, taking pleasure in writing of poemes, when *Cæsar prayed him to playe them him selfe vpon the stage, he yeeleded as constrayned by the Princes request; but signified so much in his prologue, and declared withall what a blott it was unto him: Ego bis tricenis annis actis sine nota, Eques Romanus è lare egressus meo, Domum revertar mimus: nimirum hoc die Uno plus vixi, mihi quàm vivendum fuit. Juvenal,* rebuking men of noble parentage tainted with like dishonor, doeth touch them under *Lentulus* name, with this censure: *Laureolum velox etiam bene Lentulus egit, Iudice me dignus vera cruce.* So shamefull a matter seemed it to him for *Lentulus* to play the parte of *Laureolus* (one, who in a Tragedie was fained to be hanged, as *Melantho* in yours [*i. e.*, in *Ulysses Redux*]) that he thought him woorthie to be hanged in earnest for it . . . . The men of noble parentage, whom *Iuvenal* rebuked, were hired, as himselfe noteth; and the storie of *Nero*, who bought those needie squires to doe that seruice, recordeth: though *Iuvenal* adiudgeth them vnworthy of life, not onelie in respect that they played for their fee, but euen that they played too; as may appeare by that which foloweth, *Nec tamen ipse Ignoscas populo: populi frons durior huius, Qui sedet & spectat triscurria pratriciorum, Planipedes audit Fabios ridere potest qui Mamercorum alapas.* For seeing that he findeth fault with the people, who sate & beheld the fowle misorders & scurrilities (such as your *Antinous* & other wooers practise [*i. e.*, in *Ulysses Redux*]) of persons nobly borne; who heard the race of *Fabius* resembling & counterfaiting such base ridiculous things as are expressed in *Irus;* who could abide to laugh at blowes & whirrets, giuen to the *Mamercians*, as you would say unto *Ulysses:* he sheweth that the verie action it selfe, all regard of lucre, or what soeuer motiue had brought them to it, sett apart, was dishonorable & shamefull in his iudgement. But his like or sharper inveighing against *Nero*, touching whom he addeth, that *it was no marvell if noble men were stage-players when the Prince was a minstrell*, doeth put the matter out of doubt: in as much as he, comparing *Nero* to *Orestes*, both murderers of their mothers, maketh *Nero* worse in manie respectes, and this amongst them: *In scena numquam cantavit Orestes;* Wherein, by "*cantavit*," he meaneth not onely that *Nero* played a minstrels part vpon the stage, as *Phemius* on yours; but also that he played the partes of men and women, perhaps with song alone, as your *Hippodamia;* perhaps with song and speech both, as *Eurymachus;* but partes of Men and Women certainlie. [*Overthrow*, pp. 4-6.]

have allredye answered as it weare by the waye, by whome the rest of your authorityes also, and all your examples may receyve theire trwe, though shorte answere. ffor first I denye, that the *Romans* ever iudged, *omnes scenicos infames.* because Playes weare somtyme, as in a com*m*on plauge, instituted *ad placandos Deos,* and weare provided by greate Officers, of the com*m*on treasure; and so they are referred *ad religionem, et deuotionem.* somtyme thay weare sett owt at the pryvat cost of them that stood to the people for great Offices, or generally for the honor and sollace of the cytye; and so thay are referred to magnificence. for *magnificentia* is a goodly vertue, <p. 47> *et versatur circa sumptus amplos, non turpes aut infames,* because it is a vertwe; but *circa quæcunq*ue *in Rem* Publicam *honestæ laudis studio conferuntur;* amonge the which *Aristotle*[1] reckonethe, *Ludos splendide facere.* neyther is it to be thought, that *Æsopus* and *Roscius,* beinge bothe men of that fame, favor, wealthe, and entyre famyliarytye with the best, and wisest in theire tymes, weare reputed as infamous persons. what should I speake of so many *Circi, Theatra, Amphitheatra,* buylded by the greatest and bravest Romans, with so huge charge and sumptuousnes? which thoughe thay weare wonte vpon fowle abuses, or some other occasion, as you write, overthrowne by the *Romans* them selves, yet evne thos playes, for which thay weare abolished, weare *ex eo genere,* of whom thay might have sayde (as *C. Tacitus* dothe of *Astrologers*) *quod in ciuitate nostrâ et vetabitur semper, et retinebitur.* howsoever, I can not thinke, that eyther thay woulde have suffered suche thinges to be donne at all, if thay had iudged them ill; or to be performed by infamous personns, beinge matters of that state and magnificence, and, as thay thought, of that devotion, and necessytye. it weare not harde for me to heape vp many thinges to this purpose, but my desyre is no furder to approve theire iudgment heerin, then servethe for the necessarye defence of oure selves, and owre dooinges. Next I denye that we are to be termed *Scenici, or Histriones,* for cum*m*inge on the Stage once in a yeere, or twoe yeere, sevne, ten, or somtyme twentye yeeres. as he is not a wrastler that somtyme to prove his strencthe, tryethe for a fall or twoe, nor he a fencer, that somtyme takethe up the cudgells, to play a vennye; nor he a danser, that sometyme leadethe the measures or dansethe a galliarde; nor he a minstrell or a ffidler, that sometyme playethe on an instrument before manye; as I have often seene all thes doone by gentyllmen, withoute the leste suspition of discreditt or dishonestye. and yet if a man shoulde doe thes thinges vsually and in evry place, I thinke he might be noted to be a wrastler, a ffencer, a danser, and a ffidler. Besyde we differ from them in the manner

[1] Gager's side-note: Arist. Ethi. l. 4. c. 5.

of owre playing, in the ende, effectes, and other circumstances, as in the examination of your examples shall appeere. the which as you have alleaged to illustrate your authorytyes, as beeinge the men whom thay properly speake agaynst; so if I shewe that we are not to be likened to the*m*, neyther your authorytyes, nor your examples shall towche vs. ffirst therfor I saye, we differ from them alltogether in the manner bothe of settinge owte Playes, and of actinge them. thay did it with excessyve charge; we thriftely warely, and allmost beggerly; thay acted theire Playes in an other sorte then we doe, or can, or well knowe howe; but so exquisytly, and carefully, that we may seeme, compared with them, eyther for skill, or diligence, rather *Recitare*, which you doe not dislike,[1] then *Agere*. bothe which differences, in theire furniture, and action, I could easely prove vnto you, but that I knowe, you knowe them a greate deale better then I, and I desyre to be shorte. <p. 48.> Next, we are vnlike them in the ende and effectes of Playinge. for they came vpon the stage neyther of a devowte mynd toward their false Godds, nor of a magnificent towardes the peeple (for eyther of thes had byn then in them thought com*m*endable) but of a lewd, vast, dissolute, wicked, impudent, prodigall, monstrous humor, wherof no dowte ensued greate corruption of manners in them selves, to saye nothing heere of the behowlders. We contrarywise doe it to recreate owre selves, owre House, and the better parte of the *Vniversitye*, with some learned *Poême* or other; to practyse owre owne style eyther in prose or verse; to be well acquaynted with *Seneca* or *Plautus;* honestly to embowlden owre yuthe; to trye their voyces, and confirme their memoryes; to frame their speeche; to conforme them to convenient action; to trye what mettell is in evrye one, and of what disposition thay are of; wherby never any one amongst vs, that I knowe, was made the worse, many have byn muche the better; as I dare reporte me to all the *Vniversytye*. of whome some of them, have lefte vs suche domesticall examples and preceptes of well speakinge, as if many that dislike suche exercises, and others, and owre selves, had followed; so many solecismes in vttrance shoulde not be com*m*itted so often as there are. Lastly, we differ from them in many other circumstances. as namely thay frequented the Stage; we doe it seldome, somtyme not in seavne, ten, or twentye yeers; thay on the publick theater, not of the Citye only, but of the whole worlde; we in a pryvate house, and to a fewe, men of vnderstandinge; thay weare men growne, one of them three score yeers owlde, knightes, of noble houses, *Patricij;* and one of them *Emperour* of the worlde; in vs beinge yunge men, boyes, poore Schollers, all thes thinges are quyte contrarye. Therfor to com*m* to particular comparison as

[1] See below, p. 612 note 1.

you doe; whoe ever would resemble owre *Melantho*, with your *Laureolus*[1]? the on represented by an ingenuus boye, and for her lewdnes imagined to be hanged within; the other acted by *Lentulus*, a man noblye descended, expressinge perhapps openly one the Stage, the deformytye of the same punishment. what likenes is there betweene owre yonge men, puttinge on the persons of *Antinous*, and the rest of *Penelope's* wooers; and betweene gentyll-men of the noble race of *Fabius*, in their owne persons, not so muche cownterfettinge others, as expressinge their owne scurrilytyes? suche as owre *Antinous*, and the rest of the woers, can not iustly be charged with; no not owre *Irus*, or *Vlysses*[2]. for thoughe *Juuenal* thought it dishonorable and shamfull, as he well might, that noble men shoulde take blowes and whirrytts openly, and that the peeple should rather have pittyed, then liked suche behaviour in their nobylytye, yet he thought so rather in respect of the actors, beeinge <p. 49> suche as thay weare, that is, noble men (as it appeerethe by the whole drifte of his *Satyr*, alleaged by you so muche, which is not agaynst Playes, for them he nowhere, that I knowe, reprehendethe, but to shewe that trwe nobylytye is to be esteemed by the vertues of the mynde, and not by bludd, or ancyent howses) then for any other thinge, specialy if it weare no wurse, then is represented in owre *Irus* or *Vlysses*. for neyther would *Juuenal* hym selfe, if he weare alyve, reprehend eyther the speeches thay vse, or the devyse of bringinge them in so meane and beggerlye, because bothe are *Homer's;* neyther is their any suche thinge in their partes, that may make vs base or ridiculous, or scurryle, for representinge them. Vnhappy *Vlysses*, to whome as it was fatall ever to be in troble in his life, so is he more hardly dealt withall after his deathe, that his person may not honestly be resembled withowte note of infamye to the *Actor*. which if I had knowne, howsoever he returned *in Ithacam*, he shoulde never have cumne *in Scena*m by my means. Agayne, what resemblance is there betweene owre *Hippodamia* only singing, *Eurymachus* only sayinge, *Phemius* bothe singinge and sayinge, all three represented by suche as thay weare; and betweene *Nero*, playinge menn's, weemen's, and minstrells partes vpon the Stage in *Rome*[3]? lett us therfor consider breefely the force of your arguinge. Many noble men, and *Nero* hym selfe, weare infamous, for playinge, thoughe freely, menn's and weemen's partes, and specialye *Nero* for sing-inge like a fidler on the Stage; *Ergo* Schollers and the Students of Christchurche, are to be noted with a marke of infamye, for play-inge, thoughe *gratis*, suche partes as thay did in *Vlysse Reduce;*

[1] See above, p. 612, note 1.
[2] See above, *ibid.*
[3] See above, *ibid.*

and namely the one of owre *Choristers*, for playinge *Phemius;* notwithstandinge for his honesty, modesty, and good voyce, he is as wurthy to be delyvered from infamye, as *Phemius* hym selfe is fayned to be saved from deathe, for his excellent skill in Musicke, to say nothinge of the rest. I dare not denye this argument, because it is yours, I referr it to the charytable iudgment of my betters. In the meane tyme, I thinke it was a fowle shame for noble men and *Nero* to playe; but to playe noble men or *Nero* it is no shame for vs. as he saythe in the *Comedye, Duo cúm idem faciunt, sæpe vt possis dicere, Hoc licet impuné facere huic, illi non licet, Non quód dissimilis sit res, sed quód, qui facit.*[1] And therfor I did iustly conclude agaynst *Momus*, and better then *Nero* coulde, *Quis hic rogauit sportulam, vel quis dedit? Cui non patebant spontè sine lucro fores?*[2] Wherfor imagininge *M. Cato* to be the accuser in this cause, I may fittly saye vnto hym, thoughe in wordes sumwhat altered, as *Tullye* dothe in an other matter, *tolle mihi e causâ nomen Catonis, remoue, ac praetermitte authoritatem, congredere mecum criminibus ipsis. quid accusas Cato, quid affers in iudicium? quid arguis? histrioniam accusas; non defendo, sed famam pudorem, atque innocentiam. histrioniam veró ipsam, vel tecum accusabo, si voles*[3]. <p. 50>

In myn answere to the place of *Deuteronomye,*[4] you say my *Antecedent* is naught *beinge wayde in the skales of ye Sanctuarye; and ye consequution wurse, beeinge caled to the tryall of the touchestone of Logick*[5]. the *Antecedent* in deede is myne, but the conse-

[1] Gager's side-note: Ter. Adelph. Act. 5. Sc. 3.
[2] *Momus*, ll. 138-139.
[3] Gager's side-nate: Ora. pro Murena.
[4] Gager's side-note: Deu. 22.5.
[5] To the next, drawen from the best law indeed euen the lawe of God [Side-note: Deute. 22.5] which forbiddeth *a man to put on womans raiment;* [p. 9] a thing though not distaining all stage-playes, yet welnigh all, and there amongst all yours: you answer that it is not unlawfull simply and *alwayes, as if one doe it to saue his life, to benefit many;* & hereof you conclude that to do it in playes is not unlawfull. [Side-note, from *Momus*, 141-3, 148-9: Semperne? quid si cogeret lethi metus Mutare vestem? publicum quid si bonu*m* suaderet? and, Non ergo juveni est gra*n*de simpliciter nefas, Mollem puella*m* induere] Of the which enthymeme (to call the triall of your argumentes to the touchstone of Logicke) the consequution doutlesse is vnsound and naught, whatsoever the antecedent bee: and the antecedent, although in the balance of humane reason it may seeme to haue weight, yet if it be weighed in the skales of the sanctuarie, will proove vnsound and light too. . . . By conference and laying of which thinges together we are taught this difference betwene the morall law, and the ceremoniall, that the ceremoniall was not enioyned to be kept absolutelie and simply; and therefore when it could not bee kept without the breach of the morall lawe, the law of loue and charitie it yeelded thervnto: but the morall lawe is simply and absolutely enioyned to be kept, as a paterne of that [p. 10] holinesse which God requireth in his children, *Be yee holy, for I am holy;* and therefore, who so breaketh any part thereof, though to keepe an other parte, doeth defile himselfe, and displease the Highest. Now, the prohibition of men to be attired as wemen, wemen as men, belongeth to the morall, not to the ceremoniall law. For *Christ* hath delivered

quution is not. for in my answere I doe not thus argue; it is lawfull in suche and suche cases to putt on weemens rayment, er*go* it is lawfull to doe it in Playes; but thus, er*go* it is not simply vnlawfull so to doe. and so my consequution in *Logick* standethe good. The *Antecedent* also you denye me, because you prove the place of *Deuteronomye* to belonge to the lawe Morall and not Ceremoniall. I pray you gyve me leave to propose my contrarye dowte. the *Moral* lawe, as you truly saye, is the lawe of love and charytye, to the whiche whersoever the *Ceremonial* lawe is repugnant, there it gyvethe place to the *Moral.* the *Moral* lawe therfor is never contrary to love and charytye, in com*m*andinge or forbiddinge any thinge. but the place of *Deute.* beinge taken strictly, absolutely and in the rigor of the letter, may somtymes hinder the actions of love and charytye, bothe towardes owre selves and others, as in thos cases which bothe you and I propose; er*go* in that strictnes it belongethe rather to the lawe *Ceremonial,* thoughe the equytye therof pertaynethe to the lawe *Moral,* and so it is perpetualy and simplye to be observed. for I confesse vnto you that I doe not thinke, that it is an abomynation in the sight of God, for a yonge man eyther in iest in his pryvye chamber, to putt on his wyves petticote, or in ernest to clad hym selfe in her apparell for the safegarde of his goods, his owne lyfe by could or sworde, his wives and childrens, his fathers and mothers, no not for the saftye of his cuntrye, or the defence of the glorye of God. neyther dothe it therfor followe that men and weemen may indifferently weare eche others apparell. for simplye, or in the cases specifyde, to putt on weemens rayment, is not ordinaryly, vsually, and withowte Christian, and naturall modesty, or distinction of sexe, to weare suche apparell.

My twoe examples of *Alexander* the sonne of *Amyntas,* and of *Achilles* the sonne of *Thetis,* howsoever you may well drawe evill consequutions from their whole actions, yet in the circu*m*stance that I applye them for, thay are alleaged to good purpose[1]. for

us fro*m* the keeping of the ceremonial. . . . And hereof it foloweth that if a man might saue his life, or benefit many, by putting on womans raime*n*t, yet ought he not to do it, because it is euill. [*Overthrow,* pp. 8-10.]

[1] The argume*n*ts, wherby you striue to proue the contrarie, are drawen from two examples: One of the *Macedonians,* whose king *Amyntas* entertaining *Persian* ambassadors, & having at their request broght noble wemen to the banket, when the embassadours dalying with them did touch their brests, & offred some to kisse them; the kings sonne, misliking their lascivious actions, desired the*m* to giue the wemen leaue to go forth, prete*n*ding they should returne neater, & so by his directi*o*n there came in their steed yong men, attired like them, with daggers vnder their garmentes, who slew the embassadours as soone as they offered to touch them [side-note, from *Momus,* lines 144-147: Veste filius Amyntæ indui Iuvenes muliebri dum iubet, tot fæminis Claris pudorem servat, & petula*n*tiam Persis superba*m* cœde præclara excutit.]: The other of *Achilles,* whose mother *Thetis,* at the time of the *Troian* warre, knowing (as *Poëts* faine) that hee should [p. 12] dye at *Troy,*

Alexanders fact is commended as proceedinge from a most noble and a trwe heroicall mynd, and because it was better that the *Persian* Embasadours weare slayne, then that the chastityes of so many greate Ladyes should so dishonorably be eyther overthrowne, or so muche as assayled. and *Thetis* might well hyde her sonne *Achilles* in a maydens apparell in respect of motherly love and pittye, which she was to beare her sonne, knowinge as she did, that he should be <p. 51> slayne in that iornye to *Troy*, whether he was requested to accumpany the other *Grecian* Lordes; and yet it followethe not, neyther doe I like it shoulde, that therfor eyther *Alexanders* bowlde deede, should be drawne to the iustifyinge of suche thinges as you deduce owt of it; nor that by the example of *Achilles*, a man for feare of deathe, should use *Vettienus* his shiftes to stay at home, when his cuntrye hathe neede of his servyce in lawfull warrs, nor that a yunge gentillman, that is in love, may putt on a maydens rayment, as *Chærea* did the *Eunuche's* for his *Pamphilae's* sake. *Clodius* defyled *Caesars* wife by that means, and therfor I condemne his facte. *Achilles* so deflowred *Deidamia*, and I doe not approve hym therin; but I say it was not his mothers intent, that he should so be clad, to doe suche a deede, and he was likely to doe as muche in his owne likenes any where ells; and yet his mother, of only intent to save his life (for to that end only I propose the example) might lawfully use the pollycye she did, and he in that case might lawfully obaye her. Neyther dothe his owne speeche in your discourse of hym, nor *Chirons*, nor the wordes of *Calchas* prove the contrarye. for his owne wordes rather argue the haughty currage of his noble mynd, as fearinge lest it showlde

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if he went thither with the *Grecians*, did therevpon attire him (they say) as a woman, and committed him as her daughter to *Lycomedes* king of *Scyros*, there to bee kept safe from that danger [side-note, from *Momus*, line 151: Vitam tuetur filius Thetidis suam]. For hence you conclude that a man may lawfully putt on womans raiment to benefit others, to saue his life, because the *Macedonians*, by their young *Princes* motion, and *Achilles* did so. . . . You must remember therefore that wee are to liue by lawes, not by examples: and regard in *Macedonie* and *Greece*, as in *Rome*, *not what is done there, but what ought to bee done there.* Else. . . a man, whose countrie doeth need and craue his seruice in lawfull warre against their enemies, may, for feare of death, use *Vettienus* his shifts to keepe at home; a youth, that is in loue, may put on maidens raiment, as *Chaerea* did the *Eunuches* for his *Pamphilaes* sake; . . . For as [p. 13] hee whose fact your selfe adiudge wicked *Clodius* I meane [side-note, from *Momus*, lines 149-150: Mollem puellam induerė, scelus est Clodio; Non est Achilli: Clodius stuprum parat], did satisfie his vilanous lust with *Cæsars* wife by cladding him selfe in womans raiment: semblably *Achilles* deflowred *Deidamia*, king *Lycomedes* daughter, by the same occasion. And *Statius*, who reporteth the storie (so to terme it with you [side-note, from *Momus*, lines 143-144: Id quod crebra testari potest Historia]) most exactlie, saith that *Chiron*, the instructer and bringer vp of *Achilles*, would not haue suffered his mother to haue had him away, *Si molles habitus & tegmina fœda fateri Ausa foret:* that *Calchas* the *Prophet*, being filled with *Apollos* spirit, cryed out, *O Scelus, en fluxæ veniunt in pectora vestes: Scinde puer, scinde, & timidæ ne crede parenti.* [*Overthrow*, pp. 11-13.]

be cownted cowardyce in hym, then repell his kynde mothers drifte; and bothe *Chiron* and *Calchas* had a furder reache, then their wordes owtwardly importe, especially *Calchas;* for he, and perhapps bothe, knwe that *Troy* could not be destroyed till *Achilles* was fownde owte; and therfor more in regarde of suche a consequence, then for any thinge ells, *Calchas* so vehemently cryethe owte, *O scelus, en fluxæ veniunt in pectora vestes, Scinde puer, scinde, et timidæ ne crede parenti.* Notwithstandinge, I doe thinke it dishonorable for a noble man not only in wooman's apparell, but any way ells to hyde hym selfe to the savinge of his life, when his cuntrye standethe in need of his helpe; thoughe *Amphiaraus* and *Vlysses* did no better. but for a greate Lady to hyde her only yunge sonne, in a maydens apparell, to save his life, which otherwise he is sure to loose; the com*m*on wealthe standinge in no neede of hym, as we may imagin suche a one, and thoughe it falethe owte otherwise in examyninge my example, yet in that respecte only I vsed it; I doe not thinke but she may well doe it. And yet I did not use this example as a storye, as you note (*so to terme it with me*)[1] for I cowld never thinke otherwise of it then as of a fable. Neyther can thes my wordes, *id quod crebra testari potest Historia,*[2] imply any suche meaninge in me. for I vsed thos wordes in respect of the sondrye storyes that might be brought to this ende, not for any historycall truthe in the example. which I the rather vsed, because I thought it was best knowne, and thoughe it weare a fable, yet it had a resemblance of that, which might be trwe, which was inoughe for my purpose. And in deede, if I had thought that thes twoe examples should not have byn taken in my meaninge, that is, only in that circu*m*stance for the which I alleaged them, I cowlde have vsed many trwe storyes of bothe sexes, to the which, no suche exceptions coulde have byn taken.[3] <p. 52.>

Wherfor my twoe examples, beinge taken as thay ought to be, and in that vnderstandinge, that I applyed them for, this consequution rightely followethe, *Non ergo iuueni est grande simpliciter nefas, Mollem puella*m *induere*[4]. which proposition I assuminge to be trwe (as I thinke it is most trwe) I strayte fell to the expowndinge of the place in *Deute.* thus; *Non ergo vestis fæminea iuueni est scelus, Sed praua mens, libido, malitia, ac dolus, Nec habitus vllus,sed animus turpe*m *facit*[5]. that is, that the only puttinge on of weeme <n> s rayment, is not wicked, but the lewde ende to de-

[1] See above, p. 618, note.
[2] See above, *ibid.*
[3] Gager's side-note: Eucl. Megaren. Theop. Rex Spar: Antenor Cepha: Euphrosyna virgo Antioch: Theod. virgo & martyr. Eugenia Romana.
[4] *Momus*, ll. 148-149.
[5] *Id.*, ll. 152-154.

ceyve, the rather therby, and the more safely to be in the cumpanye of weemen, to bringe some bad purpose abowte; or of an effemynate mynd, to suffer his heare to growe longe; or to fryzell it, or in speeche, colour, gate, gesture, and behaviour to become womanishe; or ordynaryly so to converse amonge men and weemen, agaynst the course of all naturall and cyvill regarde, is an abomynation to the Lorde. other doe expownde the place, thus; that a man shall not putt on the ornamentes of a woman; nor a woman the armour of a man; and that this lawe was opposed agaynst the superstition of the Gentylls, amonge whome in the sacrifices of *Venus*, men clad them selves like weemen, with distaff and spindell, and suche like; and weemen in the sacrifices of *Mars*, putt them selves in armour. and therfor *Abomynation* in the Scriptures, say thay, is com*m*only taken for idolatrye, or for somethinge belonginge to idolatrye. all the devynes that ever I talked with of this matter, affirme the trwe meaninge of that place, to be contayned in thes senses rehearsed. wherfor though I grant, that, as you prove, (admyttinge that in case of necessytye a man may clad hym selfe in a woma<n>s habitt) he may not therfor doe ill in iest, and in a meryment; yet I answere, that we not offendinge agaynst the trwe vnderstandinge of the Text, because we doe not so of any ill intent, or any suche mynd, or that any suche effecte hathe followed in vs therof, or may in deede be sayde at all to weare weeme<n>s apparell, because wearinge implyes a custome, and a com*m*on vse of so doeinge, wheras we doe it for an howre or twoe, or three, to represent an others person[1], by one that is openly knowne to be as he is in deede; it is not ill in vs to doe so, thoughe it be but in myrthe, and to delyte: and therfor all that parte of your discourse, wherin you inforce by many authorytyes, that there must be a distinction in apparell twixt men and weemen, pertaynethe not to me: for how coulde I thinke otherwise? for this my verse, *Nec habitus ullus, sed animus turpem facit*, was not to fetche abowte my hidden conclusion, or to delyver a rule that it is no dishonesty for a man in all places to weare whatsoever apparell he will, if his mynd be chast, as you say; but served as a parte of that interpretation of the place, wherof I spake before. <p. 53.> And so the verse is as trwe for the matter, as it is for the forme: for no apparell simply defylethe the body, though the manner of wearinge it may. the manner consistethe in the circumstances of person, tyme, place, stuffe, fasshion, and suche like; which are of that force, that thay make the selfe same actions, in the selfe same man, good and evill. as for a Preacher, at servyce tyme, in his Churche, to walke vp and downe in his dublet and hose, with a coloured hatt on his head, and a brooche in it, weare a greate folly,

[1] Ms. porson.

thoughe he were never so godly; and yet at home, in his secrett chamber, he might withowte offence doe all thes thinges. in like sorte, for a boye to pray in the Churche openly, with a caule, or a frenchehoode on his head, as you wryte[1], thoughe his mynd weare never so chaste, it weare a greate fault; but it followethe not that therfor it is so, for a boy or a yonge man, to come on the Stage with a cawle or a frenchehood on his head. As for my *Epiphonema*[2], it is not eger, as you terme it; neyther did it isswe from the bitter fowntayn of cursed speakinge. but I vsed it only in a iest to *Momus*, as we commonly doe the owld sayinge, to the which I alluded, *maledicta glossa quæ corrumpit textum*. I thanke God I doe not vse to curse any man; and therfore I assure you, I had no other meaninge in it then I speake of. Wheras you saye[3] that *at least you coulde have wisshed myn answere had byn mylder, if not in regarde of a younger preacher, whoe did so expound that Texte in a godly Sermon before my booke was printed etc.* I answere that I only replyed to *Momus* his arguments, withowte any implyinge of the Preacher; whom I esteeme to be a good man, a good scholler, and a good preacher. notwithstandinge if not in respecte of me, never offendinge hym, in worde or deed, upon whome all the audyence knwe his sharpe reprehension cheefely lighted; yet in respecte of owre whole house, so longe after the thinges weare past, and allmost forgotten, hym selfe beinge but a younge man, and so for authorytye, or judgment, but as his equalls are, and so, in so dowtfull a matter, might be deceyved; me thinkes he might, and should have done well, to have spared so greevus a speeche, vttred so publickly, which if it shoulde come to dwe tryall, he coulde not iustifye. to whom nowe also I saye nothinge but this, that I must pray hym to pardon me, if yet, I can not see any sownde reason, why he, or any ffellowe of *Queens College*, or of any other house, to goe no higher, shoulde thinke his iudgment ought to be a peremptorye rule, and sentence from the which there should lye no furder

[1] Nowe, what if a man should preach or pray in the Church with such a veile as women beare in this respect; with a calle (for examples sake) or with a French hoode: shoulde he offende, or no? Your inference sayeth, Nay, vnlesse he weare it with a lewde intent, as *Clodius* did. For *no apparell, but the minde, doeth make a man dishonest* [Side-note, from *Momus*, lines 152-154: Non ergo velum fœminæ viro est scelus; Sed prava mens, libido, malitia, ac dolus: Nec habitus ullus sed animus turpem facit]: and therefore it is *no fault for a man* to pray with a *French hoode* on his head. [*Overthrow*, p. 15.]

[2] Wherfore you had done better service to the trueth, if, in steede of your egre knitting up of this point with this *epiphonema*, *Cursed is the glosse that corrupteth the good text* [side-note, from *Momus*, line 168: Maledicta textum glossa quæ vitiat bonum], you had obserued rather as *Tertullian* doeth, that *the good text* you speak of, I meane, the holy Scripture specifieth not any apparell *Cursed by God, but onely womans worne by man;* and had applied it also against mens wearing of it in stage-playes, as hee doeth. [*Overthrow*, p. 16.]

[3] See above, p. 605, note 1.

appeale, for all, but the *Students of Christchurche.* That you add, that *yet I shoulde have byn more mylde in consideration of S. Cyprian, of a Councell, and other woorthy men, whose learned writinges doe glosse that Texte in that sorte;* I answere, that with all humblenes, I reverence theire authorityes, and I trust I shall not seeme to any man to wronge them, if I followe the opinion of others, bothe very godly, and excellently <p. 54> learned, whoe doe interprete that *Texte* otherwise then he, or thay doe; specialy in a case, that touchethe me so meere, wherin I ame to defend my selfe, and many my good frendes, from the reproche of open infamye. I well wote it littell becom*m*ethe me to saye, *da veniam Cypriane;* but yet I ame perswaded, that *S. Cyprian* as a godly man, like a mighty streame, carried with a vehement and a perfett hatred, agaynst the detestable abuses of the heathen spectacles in his tyme, may be thought, withowte wronge to hym, rather to have taken whatsoever he mett withall, that might seeme to have any shewe agaynst them then that the place of *Deute:* in his proper and naturall sense, is so to be vnderstood. Lastly that you aske,[1] *what manner of glosse is myne, which deducethe owte of the generall affirmatyve, a particulare negatyve;* I say, that thoughe the proposition be generall affirmatyve, *All men are abomynation that putt on womans apparell,* yet because it receyvethe lymytation, bothe in the trwe interpretation, wheron I stande, and in all thos cases of necessytye mentioned before, this proposition is also trwe, which is a particular negatyve, *Some men are not abomynation that putt on weemens rayment.* it is trwe *that whoe forbiddethe the generall, will not have the speciall practised; and evry speciall is suspended, when the generall is suspended;* but thes rules are to be vnderstoode, of thos *Generalls,* that absolutely com*m*ande, and necessarylye comprehende their *Specialls, sub potestate suâ;* not thos *Generalls,* which must as it weare endure controllment, and suffer exceptions to restrayne their powre; which exceptions, thoughe thay must alwayes be, *de natura generis,* yet are thay not, *sub vi et potestate generis.* for generall propositions, bothe in Divinitye and Lawe, doe vsually admytt particular acceptations and lymytations, *quæ derogant generalitati,* of which sorte, this proposition which we have in hand, is; as there are many moe of like nature,

[1] But if our glosse be cursed, who say that in the general sentence of the Scripture, *All men are abomination that put on wemens raiment,* the speciall is comprised, *Players are abomination that put on wemens raiment;* a thing which your Law-glosses obserue vpon your [p. 17] lawes, as standing with reason, and therevpon doe gather (agreeablie to a rule of law) that he, who fordiddeth *the generall, will not haue the speciall practised;* and, *every speciall is suspended, when the generall is suspended:* what a maner a glosse is yours, which deduceth out of the generall affirmatiue a particular negative, that is, a flat contradictory; & turneth, *Al are,* into, *Some are not;* and delivereth as a rule that it is no dishonestie for a man to weare whatsoever apparell, if his minde be chast? [*Overthrow,* pp. 16-17.]

which I coulde alleage, to illustrat thes rules, but that thay are playne to you, and I ame weary allready, and have a greate way yet to goe, and feare that you are starke tyred with my tedious discourse.

Seeinge therfor that, as I take it, it is not proved vngodly for a boy or a yuthe, to putt on womanly rayment in owre case, it followethe that it is not the lesse vnlawfull for suche a one also to imitate womanly speeche, and behaviour, howe hardly so ever you thinke good to terme it. neyther dothe my glosse vpon the *Texte* allowe the contrary, as you wryte. for thes verses of myne, *Distincta sexu*m *forma distinctu*m *decet, Virile non est fæminæ mores sequi, etc.*[1] are also parte of my exposition of the *Texte* which is in controversye, and carrye no other sense then I have spoken of before. for thoughe different behavioure becum*m*ethe different sexes, and it beseemethe not men to followe weemens manners, in the com*m*on course of lyfe, to the pervertinge of <p. 55> the lawe of nature, honesty, and cumlynes, or for any evill purpose; yet a boy, by way of representation only, may not indecently imytate maydenly, or womanly demeannre. Ffor as for all that tracte of your discourse, concerninge the danger of wanton dansinge, of kissinge bewtifull boyes, of amatorye embracinges, and effectuall expressinge of love panges, wherby bothe the spectators in behowldinge, and the actors in the meditation of suche thinges, are corrupted, all which you prove by sondry examples and authorytyes[2]; it is more learnedly, and eloquently handled, then iustly applyed agaynst vs. it is easy for you, or any man of learninge to

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[1] *Momus*, ll. 155-156.

[2] Yet the third reason, wherein playes are charged, not for making young men come foorth in hoores attire, like the lewde woman in the *Proverbs;* but for teaching them to counterfeit her actions, her wanton kisse, her impudent face, her wicked speeches and entisements; should haue bene allowed even by your owne glosse and exposition of the text: sith you say vpon it, that *different behaviour becommeth different sexes, and, it beseemeth not men to folow wemens maners* [side-note, from *Momus*, lines 155-156: Distincta sexum forma distinctum decet, Virile no*n* est fœminæ mores sequi]. *Thetis* taught *Achilles* howe to play the woman in gate, in speech, in gesture: *Sic ergo gradus; sic ora, manusque nate feres, comitesque modis imitabere fictis.* And because his mother had not taught him enough, or he was but a bad scholer: *Deidamia* gaue him farder advertisements, how *he must hold his naked brest, his hands,* & so foorth. These are wemens maners vnseemelie for *Achilles* to imitate: he should not haue done it. How much lesse seemely then is it for young men to danse like wemen, though like those, who praised God with danses: and much lesse seemelie yet to danse like vnhonest wemen, like *Herodias*? whereby what a flame of lust may bee kindled in the hearts of men, as redie for the most part to conceue this fire, as flaxe is the other, Christian writers shewe in parte by *Herodes* example: but a Heathen *Poët* [side-note; Propertius lib. 2. eleg. 2.] more fullie by his owne experience; affirming that hee was not ravished so much with his mistresses face, though marvellous faire and beautifull, nor with her *heare hanging downe loose after facion about her smooth necke;* nor *with her radiant eyes, like starres;* nor *with her silkes,* & outlandish braverie; as hee was with *her galant dansing.* [*Overthrow*, p. 17.]

wryte or speake copiously, and truly agaynst the bad effectes of Stageplayes, in generall; but in owre cause, it is rather to be considered, how trwly, and charitably suche thinges may be applyed agaynst vs, then howe eloquently thay may be enforced. all truthe in deede, agrees with truthe; but evry truthe, proves not evrye truthe. for what proportion is there betweene thos thinges which you enlarge in your *Maior;* and thos thinges which in particular application agaynst vs, are vsed in your *Minor*? As first, owre younge men dansed only twoe solleme measures, withowte any lyter galliarde, or other danse, only for a *decorum,* to note therby vnto the auditorye, what revelinge thay weare to imagin the wooers vsed within. and yet truly if I might have over-ruled the matter, evne that littell also, had byn lefte owte; because I feared lest it shoulde be ill taken, thoughe I thought there was no ill in the thinge, as I nowe perceyve my feare was not vayne. but what are the leadinge or treadinge of twoe Measures, to the incom*m*odytyes of dansinge which you insinuate? what *Herode* coulde be inflamed? what *Propertius* ravished? what flame of lust kindled therby in menns hartes? what woundes of love imprinted? whose senses coulde be moved, or affections delyted more then ought to be, or may honestly be? what enemyes of chastetye made by this sight? what stronge or constant harte vaniquished, nay what reede shaken therby? what so muche as flaxe or towe sett on fyre? As for the danger of kissinge of bewtifull boyes, I knowe not howe this suspition shoulde reache to vs. for it is vntrwe, whoesoever towlde you so[1], that owre *Eurymachus* did kisse owre *Melantho.* I have enquyred of the partyes them selves, whether any suche action was vsed by them, and thay constantly denye it; sure I ame, no suche thinge was taught. if you coniecture there was kissinge because *Melantho* spake this verse, *Furtiua nullus oscula Eurymachus dabit,*[2] you may perhapps therby dislike my discretion for makinge a younge paynym Ladye, so to bewayle her shamfull deathe (thoughe I can not thinke yet, howe I shoulde mende it) yet, therby no kissinge can be proved agaynst vs, but that rather, that thinge only in wordes was expressed, which was thought decent for suche a one as she was, <p. 56> and in her case, to vtter. We hartely pray you, Sir, to make a greate difference

[1] Wherefore, in my iudg*m*ent considering what your selfe doo grant, or must by conseque*n*ce, such playes as bring in wooers masked, and dansing, using much vnmodest behauiour in woordes and deedes; young men in wemens raiment, and supposed to be gentlewemen, dansing with them; *Eurymachus* kissing of *Melantho,* and *Melantho* bewailing the case that *no more kissing nor dansing now,* when she must be hanged: *Riuales* fond, & amarous; mariners beastly dronken; *Phaedra* incestuously embracing, and endevouring to inflame her sonne *Hippolytus* with loue-speeches; the *Nurse,* and a new *Nymph* thereto, bringing fewell enough to heale [heate? See *Overthrow,* p. 104.] and melt a heart of yse or snow. [*Overthrow, p.* 20.]

[2] *Ulysses Redux,* Act. 5, sig. E 5 verso.

betweene vs, and *Nero* with his *Sporus* or *Heliogabalus* with hym selfe, or the *Cananytes, Jwes, Corinthians,* or them that cause their pages to weare longe heare like weemen, or *Critobulus,* kissinge the fayre sonne of *Alcibiades,* or any suche doggs. we hartely abhorr them; and if I coulde suspecte any suche thinge to growe by owre Playes, I woulde be the first that should hate them, and detest my selfe, for gyvinge suche occasion. you say owte of *Quintilian, nimium est quod intelligitur*[1]; and I may say, *nimium est quod dicitur.* we thanke God owre youthe doe not practyse suche thinges, thay thinke not of them, thay knowe them not. neyther can any man lyvinge, the rather for owre Playes, charge any one of vs with the leste suspition, of any suche abomynation. I have byn often moved by owre Playes to laughter, and somtyme to teares; but I can not accuse eyther my selfe, or any other of any such beastly thought, styrred vp by them. and therfore we should most vncharytably be wronged, if owre puttinge on of womanly rayment, or imytatinge of suche gesture, should eyther directly or indirectly be referred to the commandement, *Thou shalte not commit adulterye.* and yet if owre *Eurymachus* had kissed owre *Melantho,* thoughe *Socrates* had stood by, (and I would *Socrates* had stood by) he would perhapps have sayde he had done amysse, but not so dangerously as *Critobulus* did[2], because he might evydently perceyve, that no suche poyson of incontinencye could be instilled therby. As for the danger to the spectators in heeringe and seeinge thinges lyvely expressed, and to the actors in the ernest meditation and studye to represent them; I grant that bad effectes doe fall owte in thos Playes, agaynst the which suche arguments are iustly to be amplyfyde; but there is no suche myscheefe to be feared to enswe of owres. wherin for owre penninge, we are base and meane as you see; and specialy for womanly behaviour, we

[1] Among the kindes of adulterous lewdnesse howe filthie and monstrous a sinne against nature mens naturall corruption and vitiousnes is prone to; the Scrip [p. 11] ture witnesseth it in *Cananites, Jewes, Corinthians,* other in other nations, & one with speciall caution *Nimium est quod intelligitur:* thirdlie, what sparkles of lust to that vice the putting of wemens attire on men may kindle in vncleane affections, as *Nero* shewed in *Sporus, Heliogabalus* in him selfe; yea certaine, who grew not to such excesse of impudencie, yet arguing the same in causing their boyes to weare long heare like wemen: if we consider these things, I say, we shall perceiue that hee, who condemneth the female hoore and male, and, detesting speciallie the male by terming him a *dogge,* reiecteth both their offeringes with these wordes that *they both are abomination to the Lorde thy God,* might well controll likewise the meanes and occasions whereby men are transformed into dogges, the sooner, to cutt off all incitements to that beastlie filthines, or rather more then beastlie. [*Overthrow,* pp. 10-11.]

[2] When *Critobulus* kissed the sonne of *Alcibiades,* a beautiful boy, *Socrates* saide he had done amisse and very dangerously: because, as certaine spiders, *if they doe but touch men onely with their mouthe, they put them to wonderfull paine and make them madde: so beautiful boyes by kissing doe sting and powre secretly in a kinde of poyson, the poyson of incontinencie.* [*Overthrow,* p. 18.]

weare so careles, that when one of owre actors should have made a *Conge* like a woman, he made a legg like a man. in summ; owre spectators could not gretely charge owre actors with any such diligence in medytation and care to imprynt any passions; and so neyther of them coulde receyve any hurt therby. no not the nwe *Nymphe* in *Hyppolitus* whom you so muche note, was any wittye wanton, or any so dangerous a woman, as that *she brought fewell*[1] *inoughe to heate a harte of yse or snowe*[2]. the poore wenche I perceyve hathe byn hardely reported of to you, and worse a greate deale then she deserved, as you and the worlde shall one day see. in whose person the devyse was, partly to sett owte the constant chastetye or rather virginytye of *Hippolytus*, whoe neyther with honest love made to hym in the woods, nor with vnhonest attempts in the cyttye could be overcumme; partly to expresse the affection of honest, lawfull, vertuous, marriage meaninge love; for no other did she profer, and therfor me thinkes she is not, vnharde, to be reproched with the brode name of bawderye, wherof there is no one syllable in worde or sense to be founde in all her speches. *Erasmus* in that epistell wherin he shewethe the generall vse of his *Colloquia*, <p. 57> defendethe them, to be voyde of scurrylytye and obscenytye, wherwith amonge other thinges, thay weare charged. and yet that *Colloquye* which he entytlethe *Proci et Puellæ*, is all together of this argument, lyvely to expresse, as it weare in an image or picture, the affections of honest wooinge, to speake nothinge of other places. *Si res honesta est matrimonium*, sayth he, *et procum agere honestum est. quid facias istis ingenijs tetricis, et ab omnibus Gratijs alienis, quibus impudicum videtur, quiquid amicum est ac festinum*? this he thought, beinge nowe an owlde man, and, I thinke, a trwe bachiler. not unlike my answere to *Momus, Qui turpe, lætum; ludicrum, petulans vocat.*[3] Neyther doe I see what evill affections could be stirred vp by owre playes, but rather good. for in *Vlysse Reduce*, whoe did not love the fidelytye of *Eumæus*, and *Philætius*, towardes their Master; and hate the contrary, in *Melanthius*? whoe was not moved to compassion, to see *Vlysses* a greate Lorde, dryvne so hardly, as that he was fayne to be a begger in his owne house? whoe did not wisshe hym well, and all ill to the wooers, and thinke them worthely slayne, for their bluddye purpose agaynst *Telemachus*, and other dissolute behaviour, not so muche expressed on the Stage, as imagined to be done within? whoe did not admyre the constancye of *Penelope*, and disprayse the lytenes, and bad nature in *Melantho*, and thinke her iustly hanged for it? whoe did not prayse the

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[1] MS. swell.
[2] See above, p. 624, note 1.
[3] *Momus*, l. 110.

patience, wisdome, and secrecye, of *Vlysses* and *Telemachus* his sonne? lastly whoe was not glad to see *Vlysses* restored to his wife, and his goods, and his mortall enemyes overthrowne, and punsihed? In *Riuales*, what *Cato* might not be delyted to see the fonde behaviour of cuntrye wooinge, expressed by cyvill men, or the vanytye of a bragginge soldier? by the spectacle of the drunken mariners, if there were any drunkard there, why might he not the rather detest drunkennes, by seeinge the deformytye of drunken actions represented? possible it was not, that any man should be provoked to drunkennes therby. the *Lacedaemonians* are com*m*ended for causinge their slaves, beinge drunke in deed, to be brought before their children, that thay seeinge the beastly vsage of suche men, myght the more lothe that vyce; but we muche better expressinge the same intent, not with drunken, but with sober men, counterfettinge suche vnseemly manners, are the lesse therfor to be reprehended. In *Hippolytus*, what younge man did not wisshe hym selfe to be as chast as *Hippolytus*, if he weare not so allreadye? whoe did not detest the love of *Phaedra*? who dide not approve the grave counsayle of the *Nurse* to her in secrett? or whoe coulde be the worse for her wooinge *Hippolytus*, in so generall termes? the drifte wherof, if it had byn to procure an honest honorable marriage, as it was covertly to allure hym to inceste, he might very well have listned to it. whoe wisshethe not that *Theseus* had not byn so credulus? whoe was not sorrye for the crwell deathe of *Hippolytus*? thes and suche <p. 58> like, weare the passions that weare, or might be moved, in owre Playes, withowte hurte, at the leste, to any man. as in other *Tragedyes;* whoe dothe not hate the furye of *Medea*, the revenge of *Atreus*, the treason of *Clytemnestra* and *Ægistus*, and the crueltye of *Nero*? contraryewise, whoe dothe not pittye the rage, and the deathe of *Hercules*, the calamytye of *Hecuba* and her children, the infortunate valure of *Oedipus*, the murder of *Agamemnon*, the bannishment of *Octauia*, and suche like? and yet no man is to be reproched, for eyther affection. Wherfor as the younge men of owre house, are suche in deede, as I co*m*mended them for; so for me, or for any thinge donne on the Stage, by the grace of God thay may so remayne and continwe, and I hope shall ever be so reputed. And to shutt upp this poynte; as your *Athenian* boye was a wanton for prickinge owte quayles eyes withowte cause, yet me thinkes the sentence of the *Areopagitæ* was toe harde and cruell, to iudge hym worthy of deathe for it[1]; so thoughe evne owre

[1] The grave *Athenian* Iudges, *Areopagitæ* did never punish any (I trow) for killing quailes to supply his want. But, whe*n* a lewd boy did picke out quailes eyes of a wanton humor, they iudged him worthy of death for it. [*Overthrow*, p. 14.]

Playes, may perhapps of a wantonnes have as it weare pricked owte quayles eyes, that is, may have offended in some small matter, yet in my conscience, I thinke it a bitter doome, to condemne them therfor to hatefull infamye, a thinge to all honest myndes more intolerable, then deathe it selfe.

In your answere to my defence of owre not mysspendinge tyme aboute Playes, I must needes saye, you spare us not a whitt. if you had but sayde that owre playes, are toyes, vnnecessarye, vayne, or suche like; it had byn no more perhapps then in[1] strictnes, trwe. because *Vnum modó necessarium*; and he that had tryde[1] all thinges, of his owne wise experience pronouncethe, *Vanitas vanitatum, & omnia vanitas*, yea evne learninge, and wisdome, and all thinges ells, excepte the feare of God, which endurethe for ever. and I have harde a godly, and a learned preacher, whome you knowe, in the pulpitt affirme, that owre declamations, oppositions, suppositions, and suche scholasticall exercises, are no better then vayne thinges. but to compare owre Playes, to *ye wickednes of a foole committed in pastyme, to a madd mann's castinge of fyrebrandes, arrowes, and mortall thinges*, as you doe before; *or to the hauntinge of a dycinge house, or taverne, or stwes*, as in this place; *or to a schollers playinge at stooleball amonge wenches, at mumchance, at Mawe with idell lost companions, at Trunkes in Guile-halls, dansinge aboute Maypoles, riflinge in alehouses, carrowsinge in taverns, stealinge of deere, or robbinge of orchardes*, as afterwarde; I say to compare owre Playes to no better then thes thinges, it exceedethe the cumpasse of any tolerable resemblance. I cowlde have wisht that suche comparisons had byn forborne, if not for the Playes them selves, (thoughe also thay ought for the Playes them selves, beinge thinges that savor of some witt, learninge, and iudgment, approved vnto vs by longe continwance, recommended by owre cheefest governors, and donne in a learned, grave, worshipfull, and somtyme honorable presence, with suche convenient sollemnytye, honest preparation, ingenuous <p. 59> expectation, dwe regarde, modest reverence, silent attention, and the generall, as it weare, simmetrye and seemly carriage in them) yet in respecte of the actors, and owre whole House; of the spectators that sawe them, and hartely approved them, to whome it weare a foule shame, but to stand by as lookers on of thinges of suche nature; and lastly, of thos reverend, famous, and excellent men, for life, and learninge, and their places in the Churche of God, bothe of owre house, and otherwise of the *Vniuersitye*, that have byn, and nowe are lyvinge, with vs, and abrode, whoe have byn not only wryters of suche thinges them selves, but also actors[2]

[1] A rubbing of the manuscript renders the reading of these words doubtful.

[2] It is interesting to note that both Rainolds himself and Thornton had appeared as actors upon the stage. See Boas, p. 232.

and to this daye doe thinke well of them, to whome it weare a greate reproche, at any tyme to have byn acquaynted with thinges of so vyle, and base qualytye, and muche more, still to allowe of them. Wheras I sayde that there was no more tyme spent vpon owre Playes then was convenient, you replye[1] that *It may be there was, evne some tyme that shoulde have byn spent in heeringe Sermons, the very day that my Vlysses Redux came vpon the Stage.* It may be there was not; and for any thinge that can be proved, or for any thinge that any man needed to be hindred from Sermons that daye for my *Vlysses*, it was not so in deede. sure I ame, that the gentelman that playde *Vlysses*, was at Sermon, and divers others of the actors, as if neede were thay coulde prove, perhapps the rather, to avoyde suche a scandall. if any were awaye, thay might have other cause so to doe, thoughe (the more the pittye) it is no vnusuall thinge, for many other students, as well as owres, sometyme to mysse a sermon. and it may be, that some of them that mysliked owre Playes, weare not there them selves; it may be the same Sonday night thay were wurse occupyed then owre actors were; it may be, preventinge vs, playinge *Momus* parte in good ernest, which we afterwarde did but for pastyme. and yet that accusation touchethe my poore vnfortunate *Vlysses* only, not the other twoe. The sayinge of *S. Cyprian* agaynst a Stage-player, or of *Phædria* of hym selfe to *Parmino*, can not be iustly vsed agaynst vs. for he schoulde doe vs grete contumelye, that should thinke, or saye, that eyther we are *maisters not of teachinge but of spillinge children;* or that bothe tyme, and owre younge men weare cast awaye all together by thos exercises. But it is no marvayle that you implye so ill a conceyte of them, if you dowte that, as I answered *Momus, owre actors can shewe greater frute of their tyme well spent, then any that is bredd vp in Momusses discipline can.* for you pray God that thay maye[2], as dowtinge it

[1] *S. Cyprian* writing of a stage-player who made boyes effeminate by instructing them how to play the wemen, and to expresse & counterfeit vnhonest wanton gestures, saith, *he was a maister not of teaching but spilling children.* Whose words put me in minde that the losse of time should not haue bene obiected so much against your playes: seeing some of the players (if they were like the youthes whom *Cyprian* speaketh of) might reply as *Phædria;* when *Parmeno* did tell him that his gift bestowed on *Thais* would bee lost, *Ego quoque unà pereo, quod mihi est carius: ne istuc tam iniquo patiare animo. There was no more time spent about them* (you say) *then useth to be spent in sports, sleepe, talke, and learned releasing of the minde from studie.* [side-note, from *Momus*, lines 170-174: Nihil studiis remissum est publicis: id fabulis Te*m*pus tributum est quod solet tribui jocis, Sommoq*ue* colloquiisq*ue* doctoq*ue* otio.] It may bee that there was: euen some time that should haue bene spent in hearing Sermons the very day that your *Vlyssis redux* came on the stage. [*Overthrow*, p. 21.]

[2] You adde that *your actors can shewe greater fruite of their time well spent, then any that is bredde up by Momusses discipline can.* [Side-note, from *Momus*, lines 174-176: Bene collocati te*m*poris fructum chorus præstare noster, Mome, maiorem potest, quam disciplina quispiam Momi editus.] I pray God they

is not soe. thay coulde doe littell, if thay coulde not doe so muche, and a greate deale more, and better, whensoever thay shall be tryde. for what is the disciplyne of *Momus*, but the schoole of carpinge, nippinge, depravinge, and reprehendinge, of evrye good thinge? of all other thinges, I thought you woulde not, or coulde not have taken any exception, to that speeche of myne. for what dothe *Momusses* <p. 60> disciplyne touche you (from the which, I ame perswaded, you are as free, as any man lyvinge) or any other your frendes, whome you meane by *We, thay, Vs*? and I marvayle that vnder thos termes, you shoulde defende others agaynst me, whom I knowe not, in this case, whoe thay are, neyther whosoever thay are, have I willingely hurte them. but surely owre younge men shall the lesse esteeme the censure or the disciplyne of *Momus*, because thay are instructed and perswaded, that neyther *S. Cyprian*, nor the holy Ghost in your places alleaged, beinge rightly vnderstoode, doe importe owre Playes to have any affinytye at all wth *the strumpetts discipline mentioned in ye Prouerbes*. Wheras you wryte, meaninge me; *You demande whether we dare dispyse learned Poetrye;* I did not demande of you, or them, or any man, but *Momus*, any suche question; if I may be beleeved, as I see no cause why I shoulde not. for I was as sure, that you, or any learned man, did not dispyse it, as I was certayne that *Momus* did. *An tu poësin despicere doctam audeas*?[1] I sayd not *An vos;* but *An tu*? and I meant it no otherwise then I sayde it. Your difference betweene *Agere* and *Recitare*[2] I coulde not well be ignorant of before. but because *Agere* woulde not stande so well in that place of my verse as *Recitare* dothe[3]; and for that the worde is vsed in *Quintilian* not only *de scripto*; but also *memoriter recitare*,

may. Sure they shall the better if they bee informed that this which you terme the discipline of *Momus*, is not his, but *Cyprians*, who entitled the stage *a stewes of publicke shame;* or rather the holy *Ghosts*, who willeth vs *to abstaine from all appearance of evill:* and that the contrarie, for the loue whereof you would disgrace this, hath to great affinitie with the *strumpets discipline*, mentioned in the *Proverbs*. [*Overthrow*, p. 21.]

[1] *Momus*, 1. 177.

[2] But it is one thing to recite; an other thing to play: as you may learne by *Juvenal*, who dispraised not Poëts for reciting comedies, yet thought a ma*n* ought rather choose to dye the*n* play them: by *Plinie*, who esteemed (no dout) of stage-playing like a *Roman;* yet prayed others to recite, or praised them for doeing it, and did it him selfe; by *Scaliger*, who reporteth out of the same *Plinie* that a Latin comedie endited in such sort as the olde comedie of the *Greeke* was recited in his time at *Rome*, but not played. And if your tragedie had bene recited onely, as by the title [side-note: Vlysses redux, tragedia nova, in æde Christi Oxoniæ publice recitata.] a stranger might conceue, who knew not that it had bene played: surely for mine owne parte I would haue accounted it no more losse of time to haue heard you pronounce it then my selfe to reade it. But it beeing played as *Terences* were: a looser Poet then *Terence* would controll my iudgement and very iustly might, if seeing there is in it a *sweete Melantho, a lewde queane*, I should not thinke there came hurt by the playing of it. [*Overthrow*, p. 22.]

[3] See *Momus*, line 178: Senecamne tu recitare iacturam putes?

and the lawe vsethe the worde *Pronunciandi*, for *agendi causâ*, I knowe not yet, whether in a generall acceptation of the latter, I might not vse the wordes indifferently, bothe in my verse, and in my *Title*. but as *Horrace*, and *Persius* doe bitterly scoffe also at *Recitatores*, and the lawe in the generalyty of the terme, noteth also with infamye, them, *qui pronunciandi*, that is properly, *recitandi causâ, in Scenam prodeunt;* so the *Vniuersitye* woulde have thought it a more absurde thinge, to have hearde me, or any other, openly readinge my *Vlysses* to them, then to have seene it acted, as it was.

Ffinally, bothe you, and I agree, that relaxation from studyes is necessary in a good scholler, bothe for bodye, and mynde. and yet did I not conclude, as you make me, that therfor all recreations are honest[1]. for I never thought any suche thinge. but as my simple assertion, that there is a needfull tyme for sportes, dothe not therfor prove the lawfullnes of owre Playes, which before I presumed to be lawfull; so your incomparable, and harde comparisons, doe lesse argue their vnlawfullnes. and heere amonge other vnfitt recreations, besyde Playes, you vse many wordes agaynst dansinge, thoughe it be but as it weare by the waye. all which place dothe touche vs no neerer, then I have shewed before. for myn owne parte, I never dansed, nor ever coulde, and yet I can not denye, but I love to see honest dansinge. to omytt *Homer's* iudgment therof,[2] an excellent observer of *decorum* in all thinges; that learned Knight Sir Thomas Eliote amonge other thinges that he wrytethe in a booke of his, which I have seene, in the prayse of dansinge, I remember, comparethe the man treadinge the measures, to <p. 61> *Fortitude*, and the woman on his hande, to *Temperance* .and to speake my mynde playnly, and I trust withowte offence, I thinke (all circumstances observed, which I ame not nowe to sett downe, because the state of this question is not principally in hande) dansinge may be most honestly vsed of the meaner sorte, and most honorablye of the greatest. as I have often seene it donne, me thought, with that honor, regarde, reverence, modesty, cumlynes, and honest delyte, the number of the footinge marvyluslye well expressinge, answeringe, and as it weare actinge the measure and

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[1] Time of recreation is necessarie, I graunt: and thinke as necessarie for scholers that are scholers in deede, I meane, good students, as it is for any. Yet in my opinion it were not fit for them [p. 23] to play at stoole ball among wenches; nor at Mum-chance or Maw with idle loose companions, nor at trunkes in Guile-hals, nor to danse about Maypoles, nor to rifle in alehouses, nor to carowse in tavernes, nor to steale deere, nor to robbe orchardes. Though, who can deny, but they may doe these thinges, yea worse, even those *S. Paul* meant by chambering and wantonnes, and that in the most heinous degree, euen of incest, if your generall speech concerning recreation be not better limited? [*Overthrow*, pp. 22-23.]

[2] Gager's side-note: Odyss. θ

meaninge of the musick, together with the healthe, and activytye of bodye followinge therof; that I see no cause in reason, charytye, or christian libertye, why dansinge shoulde simply be condemned; thoughe also I doe not thinke, it a meete recreation for schollers, commonly to be vsed. but be it as it may (for what have I to doe to defende it?) yet to applye eyther the dansinge of thos noble *Romans*, whom *Nero* inforced to danse so publickly; or *Samsons* dansinge amonge the *Philistine's*; or the note of *Arius Montanus*, agaynst owre dansinge only of twoe sober measures, is a comparison withowte all measure.[1]

Like to it, is the bringinge in of your example of the *Prodigall* sonne, to elude my defence of owre charge bestowed on owre Playes[2]. for what simylitude is there, or can there be, betweene hym, that in suche a sorte, as he did, spent all, and brought hym selfe to the extremest myserye; and betweene owre expence? or howe coulde he so well have vsed my wordes agaynst any man, that had reprehended hym for his ryott, as thay weare vsed agaynst *Momusses* vnseasonable carpinge? the mony bestowde on owre Playes, was not, *to add watstfullnes to wantonnes*, but to procure honest recreation, with convenient expence. surely if the *Prodigall* sonne, had byn as moderatt, and as thriftye, in his spendinge at his boorde, as we weare in owre Playes, he might well inoughe have sayde, to any niggarde, that shoulde have vnwisely fownde falte with hym, as muche as you make hym to saye, not with the note of a prodigall, but with the commendation of an ingenuous, and a liberall disposition.

Wheras it is replyde to *Momus* obiectinge, that the monye had byn better bestowed on the poore, that for any charge we wear at, *nemo propterea minús Fouebit inopes, absque eo nemo magis Leuabit;* you thinke it *weakely mett with.* Why so? because, say you, *Nero peraduenture was eyther less able, or less willinge, to helpe the poore, by reason of fyve or sixe thousande powndes spent for a*

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[1] In so much that the *Romans*, whom *Nero* enforced, if they could doe no other service on the stage, to danse there at least, pronounced the dead happy, who by departure out of life had escaped that shame. The *Philistines* acounted it a meet dishonor for their greatest enemie, when they put *Samson* to it: if yet the playing & sporting before them, which they put him too, were so ignominious. All auncient lawes almost (as a learned man doeth note upon occasion of that concerning *Samson*) yea, and *reason it selfe doe brande with a marke of dishonestie and infamie, those that daunse publikelie; and persons of such showes and spectacles.* [*Overthrow*, p. 23.]

[2] Now, these things standing thus, what need I spend wordes in prooving of the fourth reason, namelie, that the charge of setting foorth such playes is mony cast away, and addeth wastfulnes to wantonnes, when your owne aunswere doeth strengthen it sufficientlie? For in that you say, *there is a time of sparing, a time of honest spending,* [Side-note, from *Momus*, lines 191-192: Est, ubi parcas, locus, suus est honesto sumptui] you graunt that vnhonest expense is still vnlawfull: as you haue cause to doe, seeing it is of riott condemned by our Sauiour in the prodigall sonne. [*Overthrow*, p. 24.]

Plaudite.[1] what *Nero's* ryotts weare that way, I can not iustly accownte; likely it is, thay weare very excessyve, that he would gyve so muche mony, as you speake of, to Captaynes of bandes, only to crye, excellent, excellent; besyde the rest of his charge, in settinge his Playes owte. there is no proportion, I knowe, betweene *Nero's* abylytye, and owres. but if *Nero* <p. 62> cowlde have as well spared suche huge summs of mony, which he spent that way often, as our House, with the cumpanye in it, and belonginge to it (thanked be God) can, ons in many yeers, thirtye powndes; *Nero* showlde have byn wronged greatly beinge an Emperour to have byn noted of wastfullnes, and if ever he had any suche good mynde, he mought never the lesse have releeved the poore. And therfore, *ad quid ista perditio est, Here? mala, Mome, vox est*[2]; servethe a turne well inoughe agaynst *Momus.* for thoughe I knowe there is an infinyte difference, betweene owres, and the action agaynst the which it was hypocrytically first vsed; yet I thinke it may also be applyed, agaynst eyther the nigardise, or the hypocrisye of any *Momus*, that shall condemne all expence, as cast awaye, that is somtyme, moderattly bestowed vpon honest sportes and pastymes, and not vpon the poore. a man may feast, and yet remember the affliction of *Josephe* toe. and monye may be spent on Playes, evne thirtye powndes, and yett the poore releeved, and no man the lesse liberall for them, or the more, if thay had not byn at all. for thoughe no cost can be so well bestowed, as that was vpon owre Saviour; yet it followeth not, that therfor no cost is at any tyme to be imployed vpon lawfull

[1] Wherefore, vnlesse that vnthrift might haue aunswered Christ or anie other reproouer, *Thou blamest me for wasting, but I wast none of thine: thou maist drinke with mee scotfree, if thou be a good fellowe, and welcome:* I see not how your aunswere to *Momus* [Side-note, from *Momus*, lines 184-185: At sumptus ingens: at tibi gratis licet spectare, Mome, nemo te stipem rogat.] can be iustified, *Thou sayest the charge is great; but thou mayest come, and looke on, Momus, and paye nothing, no man doeth aske thee a penie.* And that which hee obiecteth, *that it had bene better bestowed on the poore,* [Side-note, from *Momus*, lines 89-90: Huc tantus iste sumptus, in pauperculos magis elocandus, rediit?] is as weaklie mett with: in that you replie, *The charge, great to him, is meane & moderate to you; none will giue the lesse to the poore for that, none* [p. 25] *would haue given the more without it.* [Side-note, from *Momus*, lines 187-190: Sumptus est ingens tibi; Nobis mediocris: nemo propterea minus fovebit inopes; absque eo nemo magis levabit.] For *Nero*, being tickled with desire of prayse, and louing to heare men approoue his playing on the stage with clapping of their hands, and crying out, *Excellent, excellent,* did choose a lustie bande of valiant youthes to doe it, whose Captaines hee gaue three hundred pound a piece, or better. This, if we consider the millions that he wasted in prodigall giftes, was lesse charge to him, supposing it amounted to three thousande pound, or foure, or fiue, or more, then three or fower, or fiue, or a fewe more shillings is to some of yours. Yet the storie noteth it as part of his wastfulnes, and *Nero* peradventure was either lesse able or lesse willing to helpe the poore, by reason of that moony giuen for a *Plaudite.* [*Overthrow*, p. 24-25.]

[2] *Momus*, ll. 190-191.

recreations, suche as owre Playes weare, whatsoever is rather obiected, then proved, to the contrarye. All paynym and heathen iudgment, I have answered in the defence of my first reason. as for the ffathers and *Cowncells*, beeinge rightly vnderstoode, their forces are not bent agaynst vs. *S. Cyprian*[1] most eloquently, and godly, inveyethe agaynst the abuses of the *Tragicke buskin* in his tyme. so he dothe also in the same place, agaynst the evles of warr, of Judgment seates, of Judges, of Aduocates, of gowlde, and riches. shall we therfor conclude, there should be no warr, no trybunalls, no Judges, no advocates, no goulde, no riches; and likewise no *Tragicke buskin* in any sorte? no dowte the ffathers, as holy men of God, bothe in their Councells, and in their bookes, have decreed, and written, many zelous and most godly thinges, agaynst the theatrycall sightes of their tymes. but distinguisshe the tymes, the places, the qualytyes of the sightes and actors, and the vse, from the abuse; and it is evydent, by that which is sayde before, that we, and owre Playes are not reproched by them. And therfor I have not done the *Vniuersytye* wronge, in producinge the iudgment therof, to the approovinge of owre Playes. for thoughe, as you wryte[2] there *weare some which weare not present, because thay disallowed them, some disallowed them, that weare present;* yet, bothe thes putt together, if the greater parte may denomynate the whole, which did with their hartye applause approve them, I might withowte wronge, I ame sure, to the bodye of the *Vniuersytye*, <p. 63> demand of *Momus*, *Academiae tu iudicia nihili facis*? which question, I saye agayne, I asked not you, or any man ells, whome you meane by *Vs*, but *Momus* only; the offendinge of whome, I see no reason, why we, or any should greatly esteeme of, or regarde. for my selfe, I may trulye saye, that I never requested any man to owre Playes; neyther did I neede; thay woulde cu*m*me without biddinge, or sendinge for, more, and faster then somtyme we would willingely thay shoulde have donne. muche lesse needed thay to be *pressed to them, with greate importunytye.* I beshrowe them that did byd suche ghestes, whose roomthes, had byn better then their cumpanyes. for of all men, I woulde thay that dislike Playes, had not byn at owres; at leste, I woulde thay had more truly, and more charitably, for

[1] Gager's side-note: Ep. l. 2. ep. 2.

[2] The more sorie am I, that you conclude your answere to this and all the former reasons with alleaging the iudgement of our *Uniuersitie;* [Side-note, from *Momus*, line 202: Academiæ tu judicia nihili facis?] yea, with asking vs, whether *we set nothing by it.* Wherein first you doe the Vniuersitie wrong, in charging the body thereof with allowing that, which some were not present at, because they disallowed it, some disallow it who were present: as in part I knowe by a graue learned man, your good friend and mine, who shewed me his dislike of the representation of a [p. 26] morousnes and drunkennes, in *Rivales* both; the former, not in *Rivales* onely. [*Overthrow*, pp. 25-26.]

dansinge, kissinge, and other demeanour, reported to you of them, with suche a mynde as I will forbeare to speake of. if you had byn present your selfe, I ame so farr perswaded, of your *Candor*, wisdome, and gentill nature, that you would not have condemned them of suche thinges as infamous, howsoever in your iudgment you might deeme them otherwise, very defectyve, as we did, and doe. As for the opynion of the learned, grave frende, you meane, I knowe howe farr he did sumwhat dislike some co*m*micall action, in my heeringe, which is not heere to be repeated. but I ame sure, that bothe before, and after, he muche co*m*mended them to me, and furthred them with his adyvse, purse, and paynes, and would be sorrye that any speeche of his, shoulde be, by mistakinge, alleaged agaynst vs, whome he lovethe, as we love, and reverence hym.

Muche lesse have I done you, or any other iniurye, by *entwytinge you, as settinge nothinge by theire iudgment,* whoe dissent from you, and approve owre Playes; and so offendinge *agaynst the rule of charytye, when rather. I shoulde have thought, that you dissented from them, as Austin did from Cyprian, whose iudgment notwithstandinge he reuerenced, and made accownte of.* for first, I did not vse this verse, *Academiæ tu iudicia nihili facis*? to entwite any sorte of men. next, I did not thinke, till I harde of the Preacher, and receyved your letter, that there had byn so many as to make vp a number in this *Vniuersitye*, of whome owre Playes weare so mysliked, as nowe I perceyve there are, and yett but a number only. and to this daye, of my knowledge, I can not name any man that is of your opinion, besyde you twoe; so littell curious ame I in sowndinge other menns pryvatt thoughtes, as one, whoe, in thos thinges, this only ende proposed, if not *sine inuidiâ laude*m *inuenire*, as he saythe in the Comedye[1], yet to procure, I trust, honest contentment to my selfe, and my frendes, *aduorsus nemini.* Lastly I doe with <p. 64> all lowlynes of mynde, reverence yours, or any other godly learned manns iudgment, and doe rather mislike myne owne when it differethe from such a on's, then entwyte hym for dissentinge from myne. As for your sayinge owte of *S. Paule*, to them that are not of your opinion heerin, thay may saye the same to you, and others, *if ye be otherwyse mynded, God shall revelē the same evne to you.* Neyther can they take otherwise then in good parte, that you *preferr before them, the iudgment of the Churche, in so many Councells, and ffathers.* but thay thinke that thay have libertye, as well, in this, as in many other thinges, to interprete the voyce of the Churche, in the Councellsand *Fathers*, accordinge to that good measure of the Spyritt, which thay also have receyved. ffor your furder sayinge to me, and proposinge

[1] Gager's side-note: Ter. And. Act. 1. Sc. 1.

vnto me this verse (E*cclesiæ tu iudicia nihili facis*?) wheron you pray God I may thinke *religiouslye, wisely, and fruitefullye,* I hartely thanke you for it[1]. I trust I shall never despyse the iudgment of the Churche, wherof, I hope, I ame a member, and a sonne, thoughe an vntowarde on. for nexte beleevinge in, I most constantly beleeve *sanct*am *Eccelsia*m *catholica*m; as beinge perswaded, that he can not have God to his ffather, that refusethe the Churche for his mother. I weare very impudent, if I woulde take vpon me to advyse you; but yet lett me be bowlde to repeate some of thos wordes that *Tullye* dothe to *Cato*[2]; *Ego tuu*m *consiliu*m *propter singulare animi mei de tuâ virtute iudiciu*m, *vituperare non audeo; et ego te verissimé dixerim, peccare nihil, neq*ue *ullâ in re esse huiusmodi, vt corrigendus potiús, quá*m *leniter inflectendus esse videare; non quód tu vir melior esses, nec temperantior, ncc iustior,* (*neq*ue *enim esse potes*) *sed pauló ad lenitate*m *propensior.* which mynde in you, I ame so farr from dislikinge, that I admyre it; and muche the rather, because I ame fully perswaded, you are suche a one in deede, as *Tullye* saythe that *M. Ælius Tubero* was, *vitâ seuerus, & congruens cum eá disciplinâ, qua*m *colebat.*[3]

And thus, have I also answered your wrytinge; not so muche to patronage Playes, which I can forbeare, and thinke of them as thay are (for what have I to doe with them, more then an other?) as to defende owre House, my selfe, and many honest towardely younge men my frendes, whom for good causes I hartely love, from open infamye. wherwith, it not a littell greevethe me, and them, that thay shoulde in pryvate, but muche more in publicke be charged, to the generall reproche of owre House, and to the particular contumelye of dyvers in their persons, with many, if so harde a censure shoulde be by men of note, enforced and perswaded. <p. 65> ffor your care to approve your iudgment, and goodwill to me, as I humbly thanke you; so I ame very sorry that by any occasion of myne, you weare so farr trobled amydst your greate busines. your goodwill I doe and ever will most gladly embrace; and your iudgment toe, in this cause so farr, as you wryte in the generall agaynst *Histriones;* prayinge you to pardon me if, as I verely thinke, for good causes, I can not agree with

[1] But to them I say, with *Paul,* to the *Philippians, If yee bee otherwise minded, God shall reveile euen the same to you,* and I assure my selfe, they will take in good part, that I preferre before them the iudgement of the Church in so manie Councells, what Generall, what Provinciall, of *Constantinople, Laodicea, Carthage, Arles,* and *Aquisgranum,* to pertermitt the Fathers, of whom what one is otherwise minded? To your selfe I say farder, that in steed of your question proposed vnto us, *Academiæ tu judicia nihili facis?* I propose you an other vpon a surer ground, though in a verse like yours, and God graunt you may thinke religiouslie, wiselie, & fruitfullie thereof, *Ecclesiæ tu iudicia nihili facis?* [*Overthrow,* p. 26.]

[2] Gager's side-note: Orat. pro Marc.

[3] Gager's side-note: Cic. De cla. orato.

you in the particular applycation agaynst vs. which you may the rather doe, because you are not the worse for your opynion thoughe it be false, but we are no lesse then infamous if it be true. if I have greatly erred in any thinge, I shall better be reformed by pryvatt conference, then with any your furder replye in wrytinge. which I pray you therfor to forbeare, as also because I knowe you have, and I ought to have some thinge ells to doe, then to troble owre selves, specially you, and your better studyes, with a matter of this nature and moment. And so prayinge God to blysse you with constancye of mynde, and healthe of bodye, to goe forwarde in your godly and learned labours, I most hartely recom*m*end you to his grace and favor. *At Christchurche the laste of Julye 1592.*

Your very lovinge frende
WILLIA*m* GAGER.

VII. Rainolds' reply (May 30, 1593)[1] to Gager's letter of July 31, 1592.

Although Gager concluded his letter of July 31, 1592, by expressing the hope that his correspondent would thenceforth confine the controversy to "pryvatt conference," and would desist from "furder replye in wrytinge," Rainolds returned to the attack, on May 30, 1593, with a letter of portentous bulk and truculence. This rejoinder opens with the following paragraph:

Your request, Maister D. Gager, that I should forbeare farther reply in writing, and by word of mouth in private co*n*ference informe you, if you have greatlie erred in any part of your answer; brought into my mind the *Philosophers* censuring and checking of such as *offered sacrifice for health, and at their very sacrifizing did banket riotouslie against health.* For that which I wrote concerning things, the stage-playes, you draw vnto the persons, who played on the stage at *Christchurch,* as if I went to make the*m* and your house most vilanouslie infamous: and partlie by concealing, partly by perverting the drift & substance of my speeches, you seeke to smoother up and suppresse the trueth. Which being done in writing by you with care and diligence, not to be imparted vnto me alone, but to others also, as your selfe doe signifie: if I should note the fault thereof by worde of mouth, my plaister would be lesse a great deale then the wound, and therefore never reach to heale it: for woordes haue wings, and flie away, mens

[1] Printed in *Th' overthrow of Stage-Playes,* 1599, pp. 29-163, under the following heading: "Vnto this maister D. *Gager* replying and desiring Maister Rainoldes to forbeare, Maister *Rainoldes* did reioine as followeth."

writings doe remaine. But as farre as possiblie I may without neglect of the duetie I owe to God and to his Church, I yeelde to your request: that is, I will endeuour to make plaine vnto you the iniuries and wrongs that your aunswer doth me, as brieflie as the necessarie clearing of the truth, and scattering of the mistes whereby you goe about to darken it, will permit.

The communication thus introduced consists essentially in a minute dissection of Gager's letter, rather than in important additions to the matter of the argument.

To this violent utterance Gager offered no reply, and with it the direct controversy between the two men ceased.[1] Nor need one wonder at the subsequent reticence of the dramatist of Christ Church, for in "the iudgment of any man that is not froward and perverse" his one humane and temperate reply to his Puritan opponent had already amply justified the dramatic productions of his revered *Alma Mater*.

[1] The highly technical continuation of the controversy in the Latin letters passed between Rainolds and Albericus Gentilis is recounted by Boas, *University Drama in the Tudor Age*, pp. 244-248.

LEGENDS OF PAUL BUNYAN, LUMBERJACK

K. BERNICE STEWART AND HOMER A. WATT.

The following study of lumberjack legends has grown out of a little collection of these tales made in the lumber-camps by Miss Stewart, who for years has heard the stories told by the lumberjacks of Wisconsin and Michigan. Recently by corresponding with and interviewing lumbermen and others who are or who have been intimately connected with the lumber-camps we have added to the original collection a considerable number of new legends, besides many different versions of stories already in our collection, and a great deal of miscellaneous information about the hero, Paul Bunyan, and his blue ox. Some of these stories, as must be expected of any such series, are too coarse for publication. It has seemed to us, however, that for the most part the tales are quite wholesome; perhaps the circumstances under which they were collected have automatically excluded those of the rougher type. We realize, moreover, that our present collection represents only a comparatively small number of these stories; versions which have come to us from Oregon and Washington indicate that the tales are widely spread. We expect to continue our search for Paul Bunyan material, and shall be very glad to receive any information which will assist us. Communications should be addressed to Mr. H. A. Watt, Department of English, New York University, New York.

We wish to acknowledge our indebtedness to Mr. B. R. Taylor, Mr. M. W. Sergeant, and Mr. Harold Stark, students in the University who have recently lived in the lumber districts of northern Wisconsin, and who have heard Paul Bunyan tales from boyhood, to Mr. Douglas Malloch of Chicago for a copy of his poem, *The Round River Drive*, a metrical version of some of the tales which was published

in *The American Lumberman* for April 25, 1914, to the Red River Lumber Company of Minneapolis, Minnesota, and to lumbermen and others who have sent us material from the lumber districts.

The most significant of recent developments in the study of folk-lore and the popular ballad began with the discovery that the making of folk-tales and communal poetry did not cease entirely with the coming of the printing-press, but that in certain isolated communities unreached by the paralyzing contact of the printed sheet the process of communal composition has gone on, roughly, fragmentarily, perhaps, but none the less genuinely. Here in America there is a complete cycle of ballads celebrating the exploits of the outlaw Jesse James; Professor John Lomax has made an extensive collection of cow-boy songs; and the isolated mountaineers of Kentucky and Tennessee have many songs and tales, some curiously distorted fragments of old-world ballads, others quite local in subject-matter and tone. The student of folk-lore has come, in fact, to expect that wherever there is more or less permanent isolation from the outside world of large groups of people engaged in the same occupation or at least having a community of interests, there is almost certain to spring up in time tales peculiar to that community. It is not, accordingly, surprising that such legends exist among the lumbermen of the Great North, among a community shut off from the world for months at a time and bound together by peculiar bonds. It is among these toilers of the forests that the legends of Paul Bunyan have originated, Paul Bunyan, the greatest lumberjack who ever skidded a log, who with the aid of his wonderful blue ox and his crew of hardy lumbermen cleared one hundred million feet of pine from a single forty and performed other feats related about the roaring fires of the lumber shanties.

The legends of Paul Bunyan are widely distributed throughout the lumber districts of the North. The tales in our little collection have come from lumber-camps in the Northern Peninsula of Michigan and from the Saginaw Valley in the Southern Peninsula, from Langlade County and from camps along the Flambeau and Wisconsin rivers in Wisconsin, from northern Minnesota and from camps as far west as Oregon, Washington, and British Columbia.

It is quite apparent that the lumberjacks in their slow migration westward have carried the tales freely from camp to camp into all of the lumbering states of the North and into the forests of Canada.

The antiquity of the tales is more difficult to determine than the extent of their distribution. It seems certain, however, from the circumstances that they have been passed down from one generation of lumbermen to another for a long period of time, that these stories of Paul Bunyan date well back into the early days of lumbering in Michigan and were carried from Michigan to Wisconsin about the middle of the last century. It seems certain, too, that many of the tales now included in the Bunyan cycle were narrated long before Bunyan became the lumberman hero. Similar tales, lacking, of course, the local color of the Bunyan yarns, are to be found in the extravagant stories of Baron Munchausen and of Rabelais as well as in folk-tales from more settled parts of the United States of America. An extremely interesting study, so complex, however, that we have not yet completed it, is the tracing of the old world originals of the Bunyan stories to determine just to what extent the American tales are new and to what extent they were brought from France and England by early pioneers.

Whether Paul Bunyan ever lived or is as mythical as Sairey Gamp's Mrs. Harris we have not yet succeeded in definitely finding out. All lumberjacks, of course, believe, or pretend to believe, that he really lived and was the great pioneer in the lumber country; some of the older men even claim to have known him or members of his crew, and in northern Minnesota the supposed location of his grave is actually pointed out. A half-breed lumberman whom Miss Stewart interviewed asserted positively that there *was* a Paul Bunyan and that the place where he cut his hundred million feet from a single forty is actually on the map. We have found in several localities characters still living about whose prowess as lumbermen exaggerated stories are already being told; it is probable that the tales will continue to be told, with additions, after these local heroes have died. In a similar manner, we believe, did Paul Bunyan come into existence. He was probably some swamper or shacker or lumberjack more skilful and more clever than average, about whose exploits grew a series of stories; after his death his fame probably spread from camp to camp, more tales were added to those told about him, and thus, gradually, he became in time an exaggerated type of the lumberjack, and the hero of more exploits than he could possibly have carried out in his life-time.

The Bunyan stories are usually told in the evening around the fires in the bunk-houses. The older narrators speak in the French-Canadian dialect, and the stories are often full of the technical jargon of the woods. Usually the stories are told to arouse the wonder of the tenderfoot or simply as contributions in a contest in yarning. They are always of a grotesque and fabulous type, and they are all more or less closely related to the exploits of Bunyan and his lumbering crew. "That happened," says the narrator, "the year I went up for Paul Bunyan. Of course you have all heard of Paul." And so the tale begins. It is matched by a bigger yarn, and the series grows. Often the scene of the exploits narrated is quite fictitious, like the Round River, which is in section thirty-seven, or the Big Onion River, three weeks this side of Quebec. Often, too, the lumberjacks will tell of events that they say occurred on another lumbering stream than the one they are working on; thus the men of the Flambeau camps will tell of the deeds of Paul Bunyan on the Wisconsin River or on the Chippewa River. Sometimes the story-tellers will take Bunyan abroad and will tell of his doings, for example, among the big trees of Oregon, or they will tell of what happened when Paul was a boy on his father's farm. Usually, however, the tales are supposed to have occurred in the "good" days of lumbering, some forty or fifty years back when the country was new, and in localities not far from the camps in which the yarns are told.

But to our tales. Bunyan was a powerful giant, seven feet tall and with a stride of seven feet. He was famous throughout the lumbering districts for his physical strength and for the ingenuity with which he met difficult situations. He was so powerful that no man could successfully oppose him, and his ability to get drunk was proverbial. So great was his lung capacity that he called his men to dinner by blowing through a hollow tree a blast so strong that it blew down the timber on a tract of sixty acres, and when he spoke, the limbs sometimes fell from the trees. To keep his pipe filled required the entire time of a swamper with a scoop-shovel. In the gentle art of writing Bunyan had, however, no skill. He kept his men's time by cutting notches in a stick of wood, and he ordered supplies for camp by drawing pictures of what he wanted. On one occasion only did his ingenuity fail; he ordered grindstones and got cheeses. "Oh," says Paul, "I forgot to put the holes in my grindstones."

Bunyan was assisted in his lumbering exploits by a wonderful blue ox, a creature that had the strength of nine horses and that weighed, according to some accounts, five thousand pounds, and according to others, twice that. The ox measured from tip to tip of his horns just seven feet, exactly his master's height. Other accounts declare that the ox was seven feet—or seven ax-handles—between his *eyes*, and *fourteen* feet between his horns. Originally he was pure white, but one winter in the woods it snowed blue snow for seven days (that was the winter of the snow-snakes) and Bunyan's ox from lying out in the snow all winter became and remained a brilliant blue. Many of the Bunyan legends are connected with the feats performed by the ox. Bunyan's method of peeling a log was as follows: He would hitch the ox to one end of the log, grasp the bark at the other end with his powerful arms, give a sharp command to the animal, and, *presto*, out would come the log as clean as a whistle. On one occasion Paul dragged a whole house up a hill with the help of his ox, and then, returning, he dragged the cellar up after the house. Occasionally, as might have been expected from so huge a creature, the ox got into mischief about camp. One night, for example, he broke loose and ate up two hundred feet of tow-line.

One favorite tale connected with the blue ox is that of the buckskin harness. One day old Forty Jones of Bunyan's crew killed two hundred deer by the simple process of tripping a key-log which supported a pile of logs on a hill-side above the place where the animals came to drink. The skins were made into a harness for the blue ox. Some days later while the cook was hauling a log in for fire-wood, it began to rain, the buckskin began to stretch, and by the time the ox reached camp the log was out of sight around a bend in the road with the tugs stretching back endlessly after it. The cook tied the ox and went to dinner. While he was eating, the sun came out boiling hot, dried the buckskin harness, and hauled the log into camp. Another version of this tale is reported to us by Professor Beatty of the University of Wisconsin, who heard the story when he was a boy in Canada. Whether Professor Beatty's version is simply a detached member of the Bunyan story-cycle or whether, conversely, it existed originally as an independent tale and was later connected with the blue ox, we do not know. The latter explanation seems the probable one.

One tale of the blue ox had best be told in the words of the lumberjack who sent it to a friend of Miss Stewart's, in a letter written with very evident care and with every other word capitalized.

"Paul B Driving a large Bunch of logs Down the Wisconsin River When the logs Suddenly Jamed. in the Dells. The logs were piled Two Hundred feet high at the head, And were backed up for One mile up river. Paul was at the rear of the Jam with the Blue Oxen And while he was coming to the front the Crew was trying to break the Jam but they couldent Budge it. When Paul Arrived at the Head with the ox he told them to Stand Back. He put the Ox in the old Wisc. in front of the Jam. And then Standing on the Bank Shot the Ox with a 303 Savage Rifle. The Ox thought it was flies And began to Switch his Tail. The tail commenced to go around in a circle And up Stream And do you know That Ox Switching his tail forced that Stream to flow Backwards And Eventually the Jam floated back Also. He took the ox out of the Stream. And let the Stream And logs go on their way."

Most of the exploits of Paul Bunyan center at Round River. Here Bunyan and his crew labored all one winter to clear the pine from a single forty. This was a most peculiar forty in that it was shaped like a pyramid with a heavy timber growth on all sides. The attention of skeptics who refuse to believe in the existence of the pyramid forty is certain to be called by the story-teller to a lumberman with a short leg, a member, the listener is solemnly assured, of Bunyan's crew, who got his short leg from working all winter on one side of the pyramid, and who thus earned the nickname of "Rockin' Horse." From this single forty Bunyan's crew cleared one hundred million feet of pine, and in the spring they started it down the river. Then began the difficulty, for it was not until they had passed their old camp several times that they realized that the river was *round* and had no outlet whatever. According to another version this logging occurred on a lake with no outlet.

Bunyan's crew was so large that he was obliged to divide the men into three gangs; of these one was always going to work, one was always at work, and the third was always coming home from work. The cooking arrangements for so many men were naturally on an immense scale. Seven men with seven wheel-barrows were kept busy wheeling the prune-stones away from camp. The cook-stove was so extensive that three forties had to be cleared bare each week to keep up a fire, and an entire cord of wood was needed to start a blaze. One day as soon as the cook had put a loaf of bread into the oven he started to walk around the stove in order to remove the loaf from the other side, but long before he reached his destination the bread had burned to a crisp. Such loaves were, of course, gigantic,—so big, in fact, that after the crew had eaten the insides out of them, the hollow crusts were used for bunk-houses, or, according to a less imaginative account, for bunks. One legend reports that the loaves were not baked in a stove at all but in a ravine or dried river-bed with heat provided by blazing slashings along the sides.

Such a stove as Bunyan's demanded, of course, a pancake griddle of monstrous size. As a matter of fact, Bunyan's cook, Joe Mufferon, used the entire top of the stove for a griddle and greased it every morning by strapping hams to the feet of his assistant cooks and obliging them to skate about on it for an hour or so. Of this famous tale there are several versions. According to one the cook mixed his batter in a sort of concrete-mixer on the roof of the cook-shanty and spread it upon the stove by means of a connecting hose. A version from Oregon shows the influence of local conditions upon the Bunyan tales; from this version we learn that two hundred *Japanese* cooks with bacon-rinds or bear-steak strapped to their feet skated upon the stove before the cook spread his batter. In a Minnesota version Bunyan employs his twenty-four daughters for the same menial task. By mistake one day the nearsighted cook put into the batter several fingers of blasting-powder instead of baking-powder, and when the mixture was spread upon the griddle, the cookees made a very rapid ascent through the cook-shanty roof and never returned to camp.

Paul Bunyan's ingenuity in keeping his men supplied with food and drink appears best in the pea-soup lake story, of which there are several versions, and in the wondrous tale of the camp distillery. Near the Round River camp was a hot spring, into which the tote-teamster, returning one day from town with a load of peas, dumped the whole load by accident. Most men would have regarded the peas as a dead loss, but not so Paul. He promptly added the proper amount of pepper and salt to the mixture and had enough hot pea-soup to last the crew all winter. When his men were working too far away from camp to return to dinner, he got the soup to them by freezing it upon the ends of sticks and sending it in that shape. According to another version of the pea-soup lake story Paul deliberately made the pea-soup; he dumped the peas into a small lake and heated the mess by firing the slashings around the shore. In a Wisconsinized version of the Michigan tale the peas have become, for some reason, beans. A much exaggerated version of this story comes from northern Wisconsin. According to this account the tote-teamster was driving across a frozen lake when a sudden thaw overtook him. The teamster saved himself, but the ox was drowned. Bunyan dammed up the lake, fired the slashings around the shore, and then, opening the dam, sluiced down the river to his laboring crew an abundance of excellent hot pea-soup with ox-tail flavor.

The legend of the establishment of the camp distillery is one of the most entertaining of the Bunyan tales. Paul had trouble in keeping any liquor in camp because the men sent to town for it drank it all up on the way back. The following is Mr. Douglas Malloch's versified account of how he solved the difficulty:

> "One day the bull-cook parin' spuds
> He hears a sizzlin' in the suds
> And finds the peelin's, strange to say,
> Are all fermentin' where they lay.

Now Sour-face Murphy in the door
Was standin'. And the face he wore
Convinced the first assistant cook
That Murphy soured 'em with his look.
And when he had the peelin's drained
A quart of Irish booze remained.
The bull-cook tells the tale to Paul
And Paul takes Murphy off the haul
And gives him, very willingly,
A job as camp distillery."

Some of the tales of the camp exploits concern members of Paul Bunyan's crew rather than the hero himself. One of the men, for example, had two sets of teeth, and, walking in his sleep one night, he encountered the grind-stone and chewed it to bits before he was fully aroused to what he was doing. In the adventure of another member of the crew we have the familiar tale of the man who jumped across the river in three jumps. The crew sometimes showed ingenuity on their own account as when they rolled boulders down the steep sides of the pyramid forty, and running after them ground their axes to a razor edge against the revolving stones.

Connected very frequently with the Bunyan tales are accounts of fabulous animals that haunted the camp. There is the bird who lays square eggs so that they will not roll down hill, and hatches them in the snow. Then there is the side-hill dodger, a curious animal naturally adapted to life on a hill by virtue of the circumstance that it has two short legs on the up-hill side. Of this creature it is said that by mistake the female dodger once laid her eggs (for the species seems to resemble somewhat the Australian duck-bill) wrong end around, with the terrible result that the little dodgers, hatching out with their short legs *down* hill, rolled into the river and drowned. The pinnacle grouse are birds with only one wing, adapted by this defect for flight in one direction about the top of a conical hill. There is little doubt that these animal stories existed outside the Bunyan cycle, and are simply appended to the central group of tales.

The story of Bunyan's method of paying off his crew at the end of the season shows the hero's craftiness. Discovering in the spring that he had no money on hand, Bunyan suddenly rushed into camp shouting that they had been cutting government pine and were all to be arrested. Each man thereupon seized what camp property lay nearest his hand and made off, no two men taking the same direction. Thus Bunyan cleared his camp without paying his men a cent for their labor.

Not all of the Bunyan stories are concerned with Bunyan's life in the Round River or the Big Onion camps. There are several accounts of his exploits far from the forests of the north-central states. It is said that when he was once dredging out the Columbia River, he broke the dredge, and, sticking it into his pocket, walked to the nearest blacksmith shop in South Dakota, had it repaired, and returned to the Oregon camp before dark. Besides his blue ox Bunyan had, according to some versions, so many oxen that their yokes, piled up, made twenty cords of wood. One day he drove all of these animals through a hollow tree which had fallen across a great ravine. When he reached the other side, he found that several of the oxen had disappeared, and, returning, he discovered that they had strayed into a hollow limb. Occasionally one hears some account of Paul Bunyan's boyhood exploits on his father's farm. It is said that on one occasion he and his father went out to gather a huge water-melon which was growing on a side-hill above a railroad track. They carelessly forgot to prop the melon up before they severed the stem with a cross-cut saw, and as a result it broke loose, rolled down hill, burst open on striking the rails, and washed out two hundred feet of track. This tale and similar ones do not seem to belong strictly to the Bunyan cycle, but to be, rather, like the animal fables, mere appendages.

What is there in these exaggerated tales of interest to the student of literature? We believe, first, that, crude as they are, they reveal unmistakable indications of having grown up under the same principles of literary development which produced by a slow process legend-cycles much more romantic and famous. The tendency to group the tales about one hero is universal in legend, as is illustrated by the Arthurian and Robin Hood cycles, and less completely by the folk tales of Rübezahl, the spirit of the Riesengebirge of Germany, Puck, or Robin Goodfellow, and the strong man, Tom Hickathrift, of England. Moreover, like other legend groups, the Bunyan stories tend to be concerned with a single locality, Round River or Big Onion River. Finally, many of the legends are more or less closely connected with a single exploit, the clearing of the pyramid forty, in much the same way, to compare the little with the great, that Greek legends center in the Argonautic Expedition and the Trojan War, and Arthurian legends in the search for the Holy Grail.

Of more interest, however, is the remarkable quality of the exaggeration in the Bunyan legends. This quality is worth analysis not only because it shows universal tendencies, but because it is the basis of what has come to be known as typical American humor. The tendency in all legend is to exaggerate, to make the physical strength or craft of the hero much greater than normal, to make an Ajax or an Odysseus of him. But in classical romance and epic this exaggeration is a thing of slow growth. It happens naturally, through a desire to make the deeds of the hero seem more wonderful, and not deliberately, through a desire to arouse amusement by gross exaggeration; it is an apotheosis, not a caricature. The exaggeration in the legends of Paul Bunyan is certainly of a different sort from that in classical legend; it is more Munchausenesque. The teller of the tale of the pea-soup lake, and of the camp-distillery, and of the great Round River drive has two motives: first, he wishes to excite wonder; second, he wishes to amuse. In their wonder-motive the Bunyan legends belong to that numerous class of travelers' tales typified by the fabulous accounts in Mandeville and Hakluyt, and in the books of other collectors. They are stories designed to be swallowed by camp-followers and tenderfeet for the entertainment of hardened dwellers in the woods. In their humor-motive they belong to that large class of stories which depend for their effectiveness not upon true representations of facts but upon gross departures from normal standards. Humor is a difficult thing to define, but one of its important elements is certainly that surprise which comes from the sudden and unanticipated contemplation of an incongruous variation from the normal. Good taste has gradually set limits to what cultivated persons regard as legitimate humor, but the child still laughs at the drunkard and to some the abnormality of insanity is still amusing. Humor has, accordingly, very often taken the form of gross exaggeration or caricature, especially under the spur of a contest in yarning. This type of humor is typically American. It is really only a natural development of the attempt to "boom" new sections of the country by representing conditions as superior to what they actually are. It is but one aspect of the cheerful, rose-colored, but quite distorted optimism which aroused the disgust of Dickens and other Englishmen (see *Martin Chuzzlewit*) and has earned for Americans among Europeans whose boom days are over the name of braggart.

It is this quality of humorous exaggeration, then, and the idea of a contest in lying, which makes the Bunyan legend cycle typically American, or, it might be better to say, typically pioneer, in spirit. And the reader does not have to look far for American parallels. Mark Twain's books are full of tales of the same stamp; Owen Wister's *Virginian* teems with them; lately in Harry Leon Wilson's *Ruggles of Red Gap* we again meet this characteristically American type of story. The note is the same throughout,—gross caricature in fact and characters to arouse the wonder of the tenderfoot and to amuse the initiated by the mere bigness of the yarn.

The Bunyan cycle of legends certainly contains a great many tales which sound strangely familiar to the person who meets Bunyan for the first time. It is altogether probable, in fact, that a great many of these stories had their origin elsewhere than in the woods and have simply been added to the Bunyan collection. We have been told on good authority that a legendary blue ox exists in a certain mountain district of Tennessee and that in this same district not only the men but even all the animals have short legs to adapt them to hill-climbing. The tale of the man who jumped across the river "in three jumps" is, as has been pointed out, widely distributed. Some of the Bunyan stories, on the other hand, almost certainly originated in the woods. To Professor Cairns of the Department of English at Wisconsin we are indebted for an ingenious explanation of the possible origin of the tale of the pyramid forty and its prodigious supply of timber. In the early days of lumbering in the North more than one man staked out a claim on a single forty and, ignoring section lines, cut "government pine" for miles around, securing, it was humorously reported by those who knew but winked at the robbery, a great deal of timber from one forty. This cutting of government pine appears definitely in at least one Bunyan story, the tale of the method adopted by Bunyan to pay off his crew. Excepting for stories of this sort, however, which seem distinctly confined to the lumber districts, and which would, indeed, have little reason for existing elsewhere, the majority of the Bunyan legends are very likely adaptations of tales which have elsewhere an existence in some form.

CHAUCER'S BURGESSES

ERNEST P. KUHL

With the nine and twenty pilgrims who leave the Tabard on that April morning are five burgesses: the Haberdasher, Carpenter, Dyer, Weaver, and Tapicer. That Chaucer deliberately selected from the various guilds these five representatives no one, I believe, has hitherto suspected. It is one purpose of this paper to show the strong probabilities that this selection was carefully made.

A cursory glance at once reveals the fact that Chaucer did not choose representatives from the prominent companies of his day. If he had, he would of necessity have chosen from the victualling classes as well as from some of the prominent non-victualling classes. That there were at this time two factions is well known,—the victuallers and non-victuallers, or protectionists and free traders. First one faction was in power, then the other,—now up, now down, like the proverbial bucket in the well. Let us take a hasty glance at the civic history of London during these years. From 1377 to 1381 the victualling class (favored by the King) was in power. From 1381 to 1383 the non-victuallers (under the protection of John of Gaunt) had a representative as Mayor. In 1383 the former class again resumed power which it held for five years. After a year's administration under a goldsmith (1388–9) came a year under a grocer; then another year under a goldsmith, at which time the ardor of the strife began to subside.[1]

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[1] Introduction to *Letter-Book*, H, edited by R. R. Sharpe. The victualling class was in power, therefore, during the years when the *General Prologue* was probably written. The best brief account of the London Guilds is by George Unwin, *The Gilds and Companies of London*. London 1908(?). There is no large work on the subject that is reliable. Herbert's *History of the Twelve Great Livery Companies* (2 Vols. London, 1836–7), and

When the victuallers were in power prices of foods, especially fish, climbed the scale. In order to enhance the price, fish for consumption in London were hidden across the river in Southwark, till unfit for food.[1] When the free-traders resumed power prices naturally fell. There was to be no monopoly in the sale of fish, "but it shall be lawful for any freeman of the City to have vessels, nets, and other necessaries".[2] A loaf of bread or a draught of ale could be bought for a farthing, and a large number of coins (to the value of 80 lbs. sterling) of that denomination were minted at the Tower, "so that the baker and taverner should have no excuse for not giving change for a halfpenny."[3] The reasons of the non-victuallers are too obvious when one recalls recent spectacular attempts for publicity by one or two Mayors in our own country.

This clash between the two parties reached its height in October, 1386, when ten of the non-victualling companies openly denounced Mayor Brembre in Parliament.[4]

This brings us to our second point, viz.: that Chaucer does not choose from any of these petitioners. This is highly interesting, for some of these companies were indisputably weaker, others equally powerful, and one more powerful than those selected by the poet.[5] Before proceeding into the details of this petition let us recall that Chaucer sat at this meeting of Parliament, and therefore heard the complaints.

The ten companies who petitioned were the Mercers, Cordwainers, 'Foundours,' Sadlers, Painters, Armourers,

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Hazlitt's *Livery Companies* (London, 1892), are inaccurate in many places and wholly uncritical.

[1] *Letter-Book*, H, pp. 192 f.

[2] *Ibid.*, p. 191.

[3] *Ibid.*, p. 183. Cf. Intro. p. XXXIV. Even parsons had refused farthings "for the purpose of putting a stop to the currency of such small money . . . and also in order to make people offer more than a farthing." The Mayor and his Council ordain, however, that "thenceforth no one shall offer at vigils of the dead or like case more than one farthing a mass, and if he fail to obtain change for a halfpenny he shall leave without making any offering." *Ibid.*, p. 183.

[4] *Rot. Parl.*, III. pp. 225 ff. The Drapers, to whose company Northampton belonged, did not petition.

[5] If we omit the Mercers and Embroiderers (who were also aldermen) there were two, Cordwainers and Sadlers, who had four representatives to the Common Council, consequently as powerful as those selected by Chaucer. Mercers had six, therefore were more powerful. For a fuller discussion see *infra*, pp. 655ff.

Pinners, Embroiderers, Spurriers, and Bladesmiths. Their complaint was that Brembre with the aid of the King was using his influence against the wishes of the citizens. Let us look more in detail at some of the facts. Brembre, the Mayor of London,[1] was a grocer, consequently favored by the King. John Northampton was the leader of the non-victuallers, whose arch-supporter was John of Gaunt. A crucial moment in the strife between the two parties was reached 28 March (1386) when the Mayor and citizens stated upon oath that for the peace of the City, Northampton (who had been banished) should not approach within 100 miles of London.[2]

John of Gaunt, who had been the patron of Northampton, and had been doing his best for two years to free him, immediately became roused to indignation. Though he was preparing to leave for Spain on his wild-goose chase, he found time to defend his client. On the 7th and again on the 12th of May he wrote Brembre upbraiding him for his "unreasonable and outrageous conduct" in winning the King's confidence.[3] On 3 June a compromise was effected when the King "at the urgent prayer" of the Duke ordered Northampton to be set free.[4] 7 July Gaunt set sail.[5]

Furthermore, Brembre's relations with the King became more intimate as time went on. In this year the King's servants, including his esquires, were granted the dwellings above the City gates. Moreover, though Gaunt was gone, his cause was at once taken up by one of the noblemen. For the King, times were equally troublesome. At the meeting of Parliament (October and November, 1386) his power was noticeably checked. Loans of money were refused him. A committee was appointed to investigate his household expenses. Ten days later, however, the city loaned him £4000, and afterwards took an oath to support him. Chaucer, it must be remembered, sat in this Parlia-

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[1] He was succeeded 13 October (1386) by Nicholas Exton—another victualler (fishmonger). *Letter Book*, H, pp. 289–290. Exton went into office 28 October.

[2] *Ibid.*, pp. 279–282.

[3] *Letter-Book*, H, Intro. p. XLI.

[4] *Ibid.*, p. 307. Cf. p. XLI.

[5] Knighton, II. p. 207. Cf. S. Armitage-Smith, pp. 310-311. For additional details concerning this strife see my article on *Chaucer and Aldgate*, which will appear shortly.

ment. We of course do not know with whom he shared his sympathies. But I have shown elsewhere[1] that his loss of Aldgate in October and his royal preferments in December was probably the result of his having been a member of that fatal Parliament. Though he may have been neutral, we must not forget that Richard II was an erratic man. For Chaucer, therefore, to evade the ten companies who had established a precedent in presenting grievances against the King to Parliament was natural. A literary man does not court popularity by referring to enemies of his audience, —especially when it involves the loss of his house and income.[2] In his selection of the burgesses, therefore, Chaucer the artist becomes Chaucer the diplomat.

May we not go a step farther? We have seen that Chaucer did not select from the most powerful companies of his day; nor, on the other hand, from those companies—weak as well as powerful—who openly denounced Mayor Brembre in 1386. It will not, therefore, be without interest to glance at the companies from which he could select. We find that there is still a possibility of thirty or more. But we are at once confronted by another factor which determined the poet's selection, viz.: that from these thirty he chose the most prominent guilds. How can the comparative strength of these guilds, it may be asked, be determined?

The latter part of the fourteenth century was—as is well known—the age in which the guilds were to become all-powerful. A notable year in their development was 1376. At this time it was agreed that the Common Council of the City of London should be composed of men from the "sufficient" misteries,—"the greater misteries electing not more than six persons, and the rest, four or two, according to their size."[3] Fortunately there is preserved one list of

[1] See my article referred to in previous note.

[2] Particularly when there are plenty of other companies from which to choose!

[3] *Letter-Book*, H, pp. 39–40. The guilds had not had this power for a quarter of a century (*Ibid.*, Intro. p. IV). Agitation had existed for some time whether the Common Council should be made up of guilds or by wards. Party feeling continued to rise until whispers of the agitation reached the King. He threatened to deprive the citizens of their franchise unless they maintained peace in the meantime. The City assured him that no serious dissensions existed. This privilege remained with the guilds until 1384, though an attempt had been made to oust them in 1380 (*Letter-Book*, H, p. V). The complaints made in 1384 were that "matters

misteries with the number of councilmen each had. This is under date of 9 Aug. 1376.[1] The Common Council which met at that time had 156 members chosen from forty-seven guilds.[2] A few of the more prominent crafts had five or six representatives; about one-third had four; and the remainder had two or three. Now, if we rule out those who opposed Brembre in 1386, and at the same time those who had fewer than four representatives (which were the small and obscure companies) we have the following: Drapers, Goldsmiths, Tailors, Fullers, Masons, Skinners (Pelters), Girdlers, Ironmongers, Dyers, Weavers, and Tapicers.[3] It will be observed that the Haberdashers and Carpenters are not mentioned. Concerning the former some definite evidence exists which indicates that they were one of the powerful companies. In 1377[4] at a meeting of the Common Council we find that the Haberdashers had four representatives.[5] This at once places them with the more prominent companies. And, what is of unusual interest, of the thirteen companies who attended this meeting the Haberdashers, alone, had no representation in the Aldermancy, nor did they petition against Brembre in 1386.[6] They were, therefore, a powerful as well as a neutral company.

in the Common Council had been carried by clamour rather than by reason, and sometimes by members who were not qualified to sit, whereby tumults had arisen." (*Ibid.*, p. 227. Cf. Intro. p. VI). In 1385 it was found that the system of electing by wards worked so well by trial that it was moved the election (by wards) should continue "forever" (*Ibid.*, pp. 277–279). In 1389 another controversy arose, whether the Council should be vested in the guilds or wards. (*Ibid.*, p. 347). Nothing came of it however.

[1] *Ibid.*, pp. 41 ff.

[2] Grocers, Mercers, Drapers, Fishmongers, Goldsmiths, Vintners, Tailors, Pelters, Smiths,—six members each. Sadlers, Weavers, Tapicers, Fullers, Brewers, Girdlers, Dyers, Masons, 'Ismongers', (Ironmongers), Cordwainers,—four each. 'Chandelers de Su' (Tallow-chandlers), Salters, Butchers,—three each. 'Lethersellers,' 'Foundours,' 'Joignours,' 'Curreours,' 'Flecchers,' (Arrowmakers), Bakers, 'Brouderers' (Embroiderers), Haberdashers, Brasiers, Cappers, 'Peutrers,' 'Bowiers,' 'Hurrers,' Horners, 'Armurers,' 'Cutlers,' 'Spoirers,' 'Plomers,' Waxchandlers, Shearmen, Painters, Tanners, 'Pouchemakers,' Woodmongers, and 'Pynneres,'—two each.

[3] See previous note for list of guilds and the number of representatives each had.

[4] The next year.

[5] *Letter-Book*, H, p. 59. The others were: Mercers, Grocers, Drapers, Fishmongers, Vintners, Skinners, and Tailors, (six representatives each); Sadlers, Haberdashers, Girdlers, Chandlers, and Cordwainers (four each); Armourers (two).

[6] See previous note.

With the Carpenters, however, it is entirely different. Curiously enough there was no guild by that name. There are, however, contemporary references to carpenters. For instance, there are extant three wills of persons who pursued this rather obscure calling.[1] The City records, however, reveal nothing which can throw any light, for they appear to have been "carpenters" and nothing more.[2] Nor is it possible to associate them with the joiners who had a guild. Old Mother Hubbard, of course, employed the services of a joiner where we to-day should consult a carpenter. It is probable, therefore, that the "Carpenter" was a later and hasty addition.[3]

This list of twelve from which the poet might choose is still formidable enough. But, Chaucer tells us that

"Ech was worthy for to ben an alderman."

We are now in a position to ask what guilds in the reign of Richard II had representatives in the aldermancy. The following occur: Mercers, Grocers, Fishmongers, Drapers, Goldsmiths, Vintners, Skinners, Stockfishmongers, Pepperers, Ironmongers, Wax-chandlers, Tailors, Armourers, 'Broderers', Woolmongers, and Girdlers.[4] Now, what remains of this once formidable list has dwindled down to six,—Fullers, Masons, and Haberdashers, Dyers, Weavers, and Tapicers.

To apply this method of elimination to Chaucer's selection may seem like subjecting the poet to a method which he never dreamed of. It can hardly appear thus, however, when one recalls that he chose no representative from the victualling classes, none from the ten companies who op-

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[1] Thomas Oxenford (*Cal. Wills, Court of Hustings*. Ed. R. R. Sharpe, London, 1889–1890, II. p. 374), John Wolfey (*Ibid.*, p. 385), John Mendeham (*Ibid.*, p. 388). There are scattering but minor references in *Letter-Books*, G, H, and I, to these people, but nothing that will help us. On one occasion one of them was associated with a "timbermonger."

[2] The editor of the *Letter-Books*, to whom I have written, has not been able to give me the desired information.

[3] Professor Frederick Tupper informs me that he has good evidence that the "Carpenter" is an afterthought. W. C. Hazlitt (*The Livery Companies*, etc., p. 405) says that Carpenters were contractors on their own account. Hazlitt, however, is very unreliable, in this respect like Herbert.

[4] Beaven, *The Aldermen of the City of London*, Part I. London, 1908, pp. 392 ff. For a further discussion of "Aldermen" see *infra* pp. 665ff. The Girdlers had their first representative in 1397, however (*Ibid.*, I. p. 351). They joined with the Ironmongers in 1399 (*Ibid.*, p. 403). These two had probably been in sympathy for some years.

posed Brembre in 1386, none from the smaller and obscure companies, and none from those who had representatives in the Aldermancy. These facts are manifestly significant. That Chaucer should have known the ins and outs of fifty guilds and condensed in a few lines—or even in a single line—information which shows complete mastery of the municipal situation is little short of surprising.

That Chaucer's choice was deliberate we can test in another way. *A priori* we have a right to assume that he would select the most powerful companies.[1] He cannot, of course, select those companies represented in the Aldermancy. But there are as a matter of fact no large non-victualling companies (having more than four representatives in the Common Council) that had no representatives in the Aldermancy. Consequently his choice is limited to those companies with four or fewer members in the Council. But here he deliberately avoids the ten companies who petitioned against Brembre,—two of which (Sadlers and Cordwainers, having four members each) were as powerful as those selected by the poet. When one recalls that there were only six other companies, Fullers and Masons and the four chosen by Chaucer, who had four representatives, it would seem as if the poet's choice was made with extraordinary care.

If the conclusion of this paper, thus far presented, is sound, the *General Prologue* was not written before the latter part of 1386.[2] This confines its limits, therefore, to two years.[3]

Is it idle to ask why he did not include the Fuller and the Mason?[4] He probably thought that five was a sufficient number, as in fact it was. When we ask why he chose the particular four he did, it is not so easy to give a reply. However, it is doubtful if a Fuller or Mason, any more in the fourteenth century than now, held a position equal to that of those selected by the poet. In a fairly careful search

[1] For discussion see pp. 652f.

[2] On the question whether the *Prologue* was written continuously see Tatlock, *The Development and Chronology*, etc., p. 143 n. 2.

[3] That it was not written after 1388 is now well known.

[4] Though the Girdlers had their first representative in the Aldermancy in 1397, they joined with a company (Ironmongers) in 1399 that had had representatives earlier. The Girdlers, therefore, were on the border line.

of contemporary documents no references to the eight councilmen[1] from the guilds of the Fullers and the Masons are found that pertain to other than affairs of their respective guilds.[2] The only exception might be in the case of the Dyers. But here again we should probably say that a person engaged in the fulling of cloth would not, other things equal, be the equal socially of a Dyer of cloth. There is, as a matter of fact, an interesting entry preserved which indicates that the Dyers carried on business for themselves. In 1383 (Chaucer was Comptroller at this time) a London Dyer (Henry Grenecobbe) had permission to "take, custom free, five sacks of wool from the Isle of Thanet, . . . to London, there to be made into cloth."[3] But let us grant that the poet did have two alternatives when he made his selection. The important thing is the fact that this selection was carefully made, which is at the same time a full reply to those critics who have wondered why so few political allusions are to be found in the *Canterbury Tales*.[4]

II

We are now prepared to take up the individual guilds and discuss their representatives to the City Council, as well as the "Masters" of the various crafts. Obviously, one should hardly expect to find much material on an obscure burgher of the fourteenth century. To be sure, if Chaucer had included among the nine and twenty pilgrims representatives from the more prominent companies, the material would be plentiful enough. But, as we have just seen, our poet was extremely cautious in his selection. Instead of choosing from prominent companies he saw fit to select from those—by no means obscure—which appeared neutral to the two factions which were striving for supremacy at the time the *Canterbury Tales* were taking shape.

[1] For names see *Letter-Book*, H, p. 43.

[2] There is one exception of minor importance. J. Lesnes was on a commission pertaining to guardianship (*Ibid.*, p. 29). This sort of thing was very common, as dozens of other cases occur in the *Letter-Book*.

[3] *Cal. Pat. Rolls*, 1381-5, p. 306.

[4] For a discussion of this latter point see Hulbert, *Chaucer's Official Life*, Menasha, Wisconsin, 1912, pp. 70–71. Coulton (p. 69) states that "Professor Raleigh has pointed out that his (Chaucer's) avoidance of all but the slightest allusions to even the greatest of contemporary events may well seem deliberate." Professor Legouis likewise in his admirable study of *Chaucer* (Paris, 1910) speaks of Chaucer's silence (pp. 26-8). Chaucer's silence becomes, to a certain extent, explicable when one recalls the facts I have just pointed out.

Instead, therefore, of considering an individual haberdasher or dyer, we shall consider the respective guilds and several members from each guild. In this way it may be possible to throw light in such a way as may serve to illuminate the descriptions of the prosperous and self-satisfied craftsmen who appear in the *General Prologue*.[1]

The Haberdashers,[2] as has been noted, had two representatives in the City Council of 1376,—Robert de Lynne and Thomas Botstone.[3] The latter does not appear to have been prominent. At any rate no other reference to him seems to occur. As to Lynne, however, we are more fortunate. In 1378 he was a "maintainer in a plaint."[4] He was sufficiently prosperous in 1379 to be mentioned as "one of the good folk" of London who lent the City 5 marks.[5] He likewise continued to be a member of the Common Council after the election by Wards instead of by Misteries. For example, he was one of the two dozen summoned in 1384 from Farndone Ward.[6] He was again a member in 1386[7], and in 1388[8]. The following interesting entry will throw light on the standing of the burgesses in Chaucer's day. In 1380 Henry

[1] I have consulted, for the several dozen individuals under discussion, all contemporary documents where one might expect information. When the *Calendar of Close Rolls*, which are now being published, will have completed this important gap to a student of Chaucer, much information should come to light.

[2] There were two kinds of Haberdashers: sellers of small wares, as needles, tapes, buttons, etc., and those who dealt in hats (*Letter-Book*, H, p. 366 n.). In 1391 a maker of caps was charged with making caps falsely, i. e., "they had been fulled by the feet instead of by hand" (*Ibid.*, p. 366). The spelling "aberdasher" occurs (*Cal. Pat. Rolls*, 1377-81, p. 449). It is not recorded in the *N. E. D.*, and I have found no other instance.

[3] *Letter-Book*, H, p. 43.

[4] *Ibid.*, p. 114. This unlawful intermeddling became so common that Parliament in 1377 strictly forbade the practice (*Letter-Book*, H, p. 93, note 3). Three pages (*Ibid.*, pp. 112-115) are devoted to London burgesses who were maintainers, an excellent proof they had money. Frequently the suit was between parsons.

[5] *Letter-Book*, H, p. 126. Hugh Fastolf and Richard Morell (cf. my article on *Some Friends of Chaucer* in P. M. L. A. XXIX, 2, pp. 270 ff.) lent a like amount (*Ibid.*, p. 125). This was the amount given by most of the individuals. None gave any less, and only a few gave more.

[6] *Ibid.*, p. 239.

[7] *Ibid.*, p. 281.

[8] *Ibid.*, p. 332.

de Ferrers,[1] knight, was pardoned for assaulting "with a baslard" the servant of Robert Lynne "aberdasher."[2]

In 1377 the Haberdashers sent four men to the Common Council, but their names are not recorded.[3] From time to time the guild chose masters to govern its craft. The earliest record apparently is in 1328, when they elected three of their members as masters.[4] The next mention is in 1371, when their ordinances were approved, including the names of those sworn to govern the mistery. There were four at this time,—Thomas Botulston, Richard Spenser, John Polstede and Richard Marchal.[5] The latter was mainpernor for a "clerk" in 1376.[6] At the supplication of a knight, Marchal was pardoned in 1389 for the killing of another.[7] Of the other three nothing seems to be recorded with the exception of Richard Spenser. He likewise was a mainpernor (in 1385), for the prior of Michelham, Surrey.[8] A will, dated 1376, bequeaths property in London to Spenser.[9] The following will not be without interest in throwing light on the financial standing of some obscure burgesses. In 1392 Richard Spenser and others are given a license "for the alienation in mortmain . . . of (1) eight messuages, six tofts, 274 acres of land, 2s. 9d. of rent, pasture for 60 beasts . . . and pasture for 800 sheep . . . to the prior and convent of Michulham . . . in full satisfaction of a license granted to them by the late King . . . to acquire lands, tenements and rents of the yearly value of 10 marks."[10]

In 1384 the masters sworn to govern the mistery were: John Silbourne, William Craft, and Michael Mordone.[11] Of these Craft alone seemed prominent enough to find his way into the records. In 1365,[12] and again in 1371,[13] he was a

[1] "Ferrers" was a common name in the royal household.

[2] *Cal. Pat. Rolls,* 1377-81, p. 449. The spelling "aberdasher" is not recorded in *N. E. D.*

[3] *Letter-Book,* H, p. 59.

[4] *Ibid.*, E, p. 233.

[5] *Letter-Book,* G, p. 283.

[6] *Cal. Close Rolls,* 1374-7, p. 347.

[7] *Cal. Pat. Rolls,* 1388-92, p. 21.

[8] *Ibid.*, 1385-9, p. 72.

[9] *Cal. of Wills,* London 1889–1890, 2 Parts. II. p. 191.

[10] *Cal. Pat. Rolls,* 1391-6, p. 184. The present parish of Mickleham is 2½ miles from Dorking,—21 miles SSW of London.

[11] *Letter-Book,* H, p. 250. On Craft see *Ibid.*, p. 135.

[12] *Ibid.*, G, p. 191. Cf. p. 221.

[13] *Ibid.*, p. 286.

surety. In the following year (1385) four new masters were sworn: Roger Crane, "Sayeure" Neumann, John Fairauntre, and John Pountfret.[1] Crane was a surety in 1371.[2] That he was a man of means we can infer from the following. In 1398 his executor, William Crane, is suing the widow of Roger and her present husband for £32.[3]

The career of John Pountfret[4] was more eventful. In 1380 he was an executor,[5] and a member of the Common Council in 1384.[6] He was one of those summoned to the King's Council at Reading in 1384;[7] apparently a member of the Common Council in 1385.[8] In the following year he was among those (from Bridge Ward) summoned "to attend in the Chamber of Common Council at the Guildhall", for the purpose of determining whether John Northampton and his associates should be allowed to remain within forty miles of the City.[9] In 1386 he was one of a number (Hugh Fastolf,[10] William More,[10] Henry Vanner,[10] John Organ[10], *et al.*) who "entered into a bond in the sum of £10, . . . for the sum of £500 borrowed . . . in order to safeguard the City."[11] Again in this year (1386) he was among those (Henry Vanner, William Venour, *et al.*) appointed to see that the schedule of murage chargeable on goods be carried into effect.[12] In 1388 he was summoned to the Guildhall by the Mayor and Aldermen "to consult on certain matters touching the coming Parliament (at Cambridge) and the City itself."[13]

The Weavers were an ancient organization in London. As early as 1347 we learn of foreign weavers in the City who

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[1] *Ibid.*, H, p. 273. Not until 1394 were masters again appointed. (*Ibid.*, p. 416); then again in 1416 (*Ibid.*, I, p. 144).

[2] *Ibid.*, G, p. 286.

[3] *Cal. Pat. Rolls*, 1396–9, p. 438.

[4] Pountefreyt, Pountfract, Pontefreit, Pounfret, etc.

[5] *Cal. Pat. Rolls*, 1377-81, p. 493.

[6] *Letter-Book*, H, p. 235. Cf. p. 238.

[7] *Ibid.*, p. 246.

[8] *Ibid.*, p. 270.

[9] *Ibid.*, p. 281.

[10] See Index to the *Life Records of Chaucer* (*Modern Philology*, Vol. X, No. 4, pp. 527 ff.).

[11] *Letter-Book*, H, p, 287.

[12] *Ibid.*, p. 299.

[13] *Ibid.*, p. 333. Cf. p. 332. There was also a John Pountfreyt, saddler (*Ibid.*, pp. 42, 108, 393); another, a cornmonger (*Ibid.*, p. 443). Cf. *Calendar of Wills, Court of Hustings*, etc. II. p. 877 (Index).

are to be ruled in the same manner as "denizen (privees)[1] weavers of the City, and that neither should work by night at any time of the year."[2] Five years later the foreign weavers were given permission to carry on their business in England, and likewise to elect masters to supervise their craft.[3] Though they had their craft, they had no representatives, as did the native weavers, in the Common Council.[4] This, of course, was owing to the fact that the native workmen were jealous of their continental neighbors. Chaucer, ever on the alert, tells us that the Wife of Bath

> Of clooth-making, . . . hadde swiche an haunt,
> She passed hem of Ypres and of Gaunt.

This is a distinct appeal to the new sense of nationalism which England was feeling in the latter half of the fourteenth century.

The native weavers, on the other hand, sent four members to the City Council in 1376,—John de Bathe[5] (what relation to the good Wyf?), John Gyle, William Goryng, and William Godhewe.[6] Their careers in the affairs of the City and Guild resemble those of the Haberdashers. Whenever important matters were under consideration at the Guildhall they were summoned.[7] Goryng and Bathe were sufficiently prominent to be masters of the guild at one time or another.[8] The latter, a resident of Aldersgate Ward,[9] was granted a pardon in 1378 for the killing of another.[10] In an interesting will we infer that he was a well-to-do person. He left certain shops to the church of St. Botolph in Aldersgate; to the prior of another church he leaves all his "lands and tenements in Westchepe, Goderounlane, and elsewhere

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[1] i. e., native.
[2] *Letter-book*, F, p. 173. It has not been thought necessary to go into details concerning the masters of each mistery. The Weavers, Dyers, and Tapicers likewise elected their masters from time to time. (See *Ibid.*, H, Index).
[3] *Ibid.*, G, p. 130.
[4] *Ibid.*, H, p. 524 (Index).
[5] Or Baathe.
[6] *Letter-Book*, H, p. 42.
[7] See Index to *Letter-Book*, H.
[8] *Ibid.*, pp. 202, 318, 346.
[9] *Ibid.*, p. 239.
[10] *Cal. Pat. Rolls*, 1377–81, p. 294.

in the parish of St. Vedast," and to his wife his dwelling-house in Aldersgate.[1]

The Dyers first came into prominence in 1376, when they sent four members to the Council.[2] They seem to have been prominent before this time, however, for their wrongdoings, for we learn that in 1362 ordinances were set out for checking the malpractices of the Dyers as well as of the Weavers.[3] In a petition presented "by good folks of the 'Lethersellers' and 'Pouchmakers' " in 1372 was an article that the "Dyers might be prevented from cheating their customers."[4] The members to the Council in 1376 were John Claveringe, Henry Grenecob, Nicholas Maynard, and Richard Godard.[5] Grenecob, of the four, is of most interest. In 1383 he had permission to bring into London, custom free, five sacks of wool, there to be made into cloth. One of his mainpernors was Richard Godard.[6] In 1398 Grenecob is suing for a debt of £10.[7] Otherwise the record of the Dyers, particularly that of Clavering, does not differ greatly from those guilds already considered. No better proof exists that Chaucer deliberately chose his representatives.

The Tapicers are the last to be considered. Their four Councilmen in 1376 were Giles de Kelseye, Richard Dicoun, Thomas Bonanture, and John atte Dyke.[8] Their careers, likewise, are strikingly similar to those already discussed. Wills of Kelseye, Dyke, and Bonanture are preserved. Kelseye makes bequests to the church in which he wishes to be buried; likewise "to divers orders of friars in London, and for maintenance of Chantries, repair of poor churches, decayed bridges, roads, and other pious and charitable objects."[9] In other respects his will parallels that of Bathe.[10] Bonanture owned numerous possessions, including a brewery and "bakehouse." He also owned lands in Berking

[1] *Cal. of Wills, Court of Hustings,* II. p. 284. The name "Bathe" was prominent in London (*Ibid.,* Vols. I and II. Index).

[2] *Letter-Book,* H, p. 43.

[3] *Ibid.,* G, p. 140.

[4] *Ibid.,* G, p. 293. Cf. p. 295.

[5] *Ibid.,* H, p. 43.

[6] *Cal. Pat. Rolls,* 1381–5, p. 306.

[7] *Ibid.,* 1396–9, p. 305.

[8] *Letter-Book,* H, p. 42.

[9] *Cal. of Wills, Court of Hustings,* II. p. 200.

[10] See *supra* under Bathe.

(Essex), and elsewhere.[1] Dyke owned lands in Kent, and likewise had a brewery.[2] All three were residents in the same parish.[3]

To repeat, in conclusion, it must have impressed the reader that the four guilds selected by Chaucer are of the same rank,—strikingly so. They are not the smallest companies, nor are they the largest. But they *are* the largest that were not involved in the political squabbles of the day. All this, of course, is significant in showing that Chaucer's choice was deliberate.[4]

It is convenient here, before passing on to more general matters, to interpret some of the lines in the description of the burgesses. In the discussion of Aldermen[5] I assumed that the allusion in lines 371–2[6] was political. Since another interpretation has been the accepted one,[7] it will be necessary to take this matter up in detail. To discuss the point, however, we must first of all dispose of the two preceding lines:

> Wel semed ech of hem a fair burgeys
> To sitten in a yeldehalle on a deys.[8]

Professor Skeat thought this referred to the banquets which the various guilds held from time to time in their guildhalls.[9] He was unaware of the fact, however, that the Common Council of the City held its meetings in the Guildhall (modern "City Hall").[10] Before rejecting Skeat let us render the

[1] *Cal. of Wills*, etc., p. 311.

[2] *Ibid.*, p. 369.

[3] S. Dionisius Backchurch. For a list of other tapicers who lived in this parish see *Ibid.*, pp. 41, 131, 179.

[4] This is entirely in keeping with Chaucer's method throughout. Professor Skeat has pointed out (Vol. V. p. 36), that Chaucer's pilgrims were of a "superior estate." Professor G. L. Kittredge in his brilliant study on *Chaucer and his Poetry* (Harvard University Press, 1915, p. 32) states that Chaucer always had such "stupendous luck" in seeing the best.

[5] See *supra*.

[6] Everich for the wisdom that he kan
Was shaply for to been an alderman.

[7] See reference to Hinckley, *infra*.

[8] 369–370.

[9] Vol. V. p. 36.

[10] The earliest reference to "Guildhall" is in 1269. (*A Descriptive Account of the Guildhall of the City of London* by J. E. Price, London, 1886, p. 45). Two additional references to the City Hall in Chaucer's day—"Gyhalde" (*Life Records*, p. 191), "Guyldehall" (*Rot. Parl.*, III. p. 225)—furnish variants in spelling.

verses into modern English. "Each of them seemed a capital freeman of the City to sit on the raised platform (dais) in a guildhall"—says the poet.

Of course the entire Common Council (150 members) did not sit in a body on the dais. This distinction belonged only to the Mayor and to the Aldermen. The Reverend Mr. Beaven, in a letter to the present writer,[1] makes this plain when he says: "In the Court of Common Council consisting of Lord Mayor, Aldermen, and Common Councillors, the Lord Mayor presides and he and the Aldermen occupy seats on the dais by prescriptive right. The Common Councillors have seats "on the floor"; indeed that phrase is constantly used to denote a Councillor as distinguished from an Alderman."

The passage, therefore, seems to mean: each of the worthies was fit to be an Alderman or a Mayor. Either interpretation will satisfy, though the reference to the Aldermen seems preferable.[2]

That the allusion is political is strengthened by the following lines:

> Everich for the wisdom that he kan
> Was shaply for to been an alderman.

Here we are on a definite footing and can reject Professor Skeat altogether. Hinckley[3] was the first to suggest that Chaucer used "Alderman" in its modern sense of "municipal magistrate," instead of "head-officer of the guild,"—Pro-

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[1] I wish to express here my thanks to the great authority on the municipal history of London for his courteous and generous attention to my letter of inquiry. Without his assistance this portion of my paper would have been materially weakened.

[2] As a matter of fact the Sheriffs also sat on the dais. But there is no Sheriff between 1371 and 1407 who did not also attain Aldermanic rank. That is, a Sheriff who was not an Alderman when he entered office became one soon afterwards. There were 74 Sheriffs between 1371 and 1407. (Beaven, II. p. XXXVII. This statement in substance has been repeated by the authority just cited in response to my inquiry.) For the list of Sheriffs see Index to *Letter-Book*, H.

[3] *Notes on Chaucer*, Northampton, Mass., 1907, p. 28. This admirable book unfavorably reviewed in the *Athenaeum* (Aug. 29, 1908), has recently come into its own. See Professor Karl Young, *Kittredge Anniversary Papers*, Boston, 1913, p. 405 n. Hinckley's observations on the sixteen grocer Aldermen, however, based on the article in *Dict. Natl. Biog.* under Brembre are erroneous. For a correct statement of the facts see Beaven, *The Aldermen of the City of London*, Part I. London, 1908, p. 390 n. Cf. *Letter-Book*, H, p. VII.

fessor Skeat's interpretation. With the aid of the Reverend Mr. Beaven's exceedingly helpful book[1] one is able to prove conclusively that Chaucer's reference is political. The following guilds had representation in the Aldermancy between 1377 and 1400: Mercers,[2] twenty representatives;[3] Grocers, nineteen; Fishmongers, nine; Drapers, eight; Goldsmiths, eight; Vintners, eight; Skinners, seven; Stockfishmongers, six; Pepperers, two; Ironmongers, two; Waxchandlers, Tailors, Armourers,[2] 'Broderers,'[2] Woolmongers and Girdlers, one each. It will be observed that the particular guilds referred to by Chaucer had no representation, nor were they to have until a century later.[4] This is, therefore, one of the few political allusions to be found in the *Canterbury Tales*. The lines, therefore, appear to mean: each of the five burgesses was a capital freeman to sit on the rostrum as an Alderman (or a Mayor) and,—*moreover*, everyone knew enough to be an Alderman.[5]

If the above interpretation is correct, one is tempted to ask if any evidence exists that Chaucer's burgesses were attempting to gain the Aldermancy. We know

> hir wyves wolde it wel assente.[6]

One bit of evidence, at any rate, has come down to us. In 1397, we are told, the elections of Aldermen in the past had

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[1] *op. cit.* pp. 392 ff. I have not counted those who were re-elected, but none as far back as 1365 belonged to other companies than those mentioned above. One alderman of Tower Ward, John Morton, for the year 1377, I have not been able to identify. His predecessors and successors at Tower Ward were either grocers, mercers, or fishmongers. These were the prominent companies, and Morton probably belonged to one of them.

[2] Among those who entered a petition against Brembre in Parliament (1386). The Mercers and 'Broderers' had representatives in the Aldermancy at the time. (Beaven, I. pp. 336, 354.)

[3] Does not include those who had been re-elected. Cf. note 2.

[4] The Haberdashers were the first to be represented,—in 1471 (Beaven, I. p. 346). The Dyers first in 1601 (*Ibid.*, I. p. 349). Weavers in 1626 (*Ibid.*, I. p. 353). Carpenters in 1711 (*Ibid.*, I. p. 352). The Tapicers later lost their identity. It is curious to note that Chaucer's guildspeople had a greater number of representatives in the Common Council than some of those who were represented in the Aldermancy. For example, the Wax-chandlers.

[5] If Chaucer had the Aldermen in mind in the previous stanza, this is a sort of incremental repetition, as Professor Kittredge has pointed out to me. I am indebted to Professor Kittredge for suggestions in the interpretation of these lines.

[6] A. 374.

been "headstrong, partial, and imprudent." And, as a consequence, "damages, dissensions, and perils . . . had oftentimes happened in divers Wards" by reason of such elections.[1] Though this complaint came ten years after the *General Prologue* was written, it is not without significance. As a matter of fact, between 1376 and 1384 there had been a great deal of discussion as to the tenure of office for an Alderman. In 1376 a Charter was issued by Edward III setting forth that no Alderman should hold office for more than a year.[2] In the following year, the Common Council of the City passed a resolution that "Aldermen who had misbehaved themselves and been removed from office should on no account be re-elected, but that an Alderman who had conducted himself well might be re-elected after the lapse of a year."[3] In 1384 Mayor Brembre issued a "precept" for the election of an alderman as follows: "Either one who is already or has been an Alderman, or some one else."[4] He thereby ignored the year's interval, and by what authority is not known. The King assented to this particular election "and is willing that the same mode . . . shall continue, provided it appear to the members of the next Parliament for the better government of the City."[5] Parliament sanctioned the change[6] later in the year (1384).[7] Though we do not know Brembre's motives, they undoubtedly were selfish. At any rate the very fact that a victualling mayor of his own motion disregarded an existing law and issued his own precept which was condoned by the King would not reduce friction among the guilds. Chaucer's non-victuallers may have chafed more, and probably did chafe more, than the records reveal.

Moreover, it is interesting to note that no new aldermen had been elected between 1383 and 1388, save one in 1387.[8]

[1] *Letter-Book*, H, p. 436.

[2] *Letter-Book*, H, p. 58 n. 2. Cf. Beaven, II. p. XIX; also Birch, *Historical Charters of the City of London*, London, 1884, pp. 65, 66.

[3] *Letter-Book*, H, p. 60.

[4] *Ibid.*, p. 228.

[5] *Ibid.*, p. 231.

[6] *Letter-Book*, H, p. IX.

[7] Beaven, II. p. XIX. In 1394 annual elections ceased and an alderman henceforth could not be removed without just cause (*Letter-Book*, H, pp. 409-410). This law is still operative (Beaven, II. p. XIX).

[8] Beaven, I. p. 400. Cf. pp. 398-400. This was in March. In 1388 two new aldermen were elected, and but one in 1389. It is interesting to note that all four were members of non-victualling guilds.

Did the Londoners desire an infusion of new blood in the Aldermancy? Or was Chaucer's reference a sly thrust at the Mayor's precept of 1384? If the latter, it is a capital touch.[1]

That there was rivalry because it implied a minimum bank account seems certain. Though Chaucer does not tell us that a burgess to be an alderman must have a certain amount of worldly goods, he implies it.

> For catel hadde they ynogh and rente.[2]

As a matter of fact, a minimum *was* necessary. Earlier in the century a law was passed stating that each alderman must have three horses.[3]

Nor was the spectacular element absent in an Alderman's career. Though not of great importance its social influence was not negligible. Fortunately there is preserved a highly interesting entry which throws light on this point, as well as on the feeling of civic consciousness which was developing at this time. Incidentally, the Host's

> And who so wole my Juggement withseye
> Shal paye al that we spenden by the weye,[4]

is apropos. In 1382[5] the Mayor and Aldermen agreed unanimously that "for the dignity of the said city" all the Aldermen "should be arrayed upon the Feast of Pentecost (Whit Monday)..... in cloaks of green lined with green taffeta, or tartaryn." Anybody who refused was to pay a penalty which was to be determined by the Mayor and such Aldermen as were properly garbed. But on the appointed Mon-

[1] Chaucer, it may be observed, exhibits his usual subtlety in his allusions to contemporary events.

[2] A. 373.

[3] *Letter-Book*, C, p. 154. Cf. *Liber Albus*, I. p. XLVII. In an ordinance of 1397 a man to be an alderman had to be "fit in morals and worldly goods." (*Letter-Book*, H, p. 436). This ordinance implies a minimum. Though little information exists we discover, beginning with the next century, some interesting facts. For example, in 1469 a man to be an alderman must have £1000; in 1710, £15000; in 1812, £30000. Aldermen frequently refused to serve (Beaven, II. p. XXXIX). For enviable privileges of an alderman see *Liber Albus*, I. pp. 32 ff. Among other privileges they were not required to pay anything for the enrollment of their charters or deeds (*Ibid.*, p. 35). There were heavy penalties for insulting an alderman (*Ibid*). See oath taken by aldermen (*Ibid.*, pp. 307-8). That they were not to sell victuals while in office is of interest.

[4] A. 805-6. Cf. 833-4.

[5] Riley, *Memorials of London*, p. 466. *Letter-Book*, H, p. 188 contains a summary of the incident.

day when the distinguished men met in St. Peter's, Cornhill, "to go in procession from thence through the City, according to the ancient custom, to the Church of St. Paul," John Sely[1] appeared in his business suit.[2] Punishment was meted on the spot. It was decided then and there that Sely should give a dinner at his home[3] on the following Thursday to his fellow Aldermen and the Mayor. Not only that, but he "was to line his cloak in manner aforesaid; and so it was done." Moreover, *any* alderman in the future who is not properly attired for a procession shall pay a like penalty.[4]

Every scrap of evidence one can find indicates that the guildspeople had sufficient property and income. As has been pointed out[5] the guilds became all-powerful after 1376. They had gained not only in worldly goods but in municipal power as well. Though the King had favored the stronger (victuallers) for a number of years, Chaucer lived to see the day when the purchasing power of all London guilds was curbed. This was in 1391. In this year Parliament enacted a statute whereby the guilds were to be "subject to a license of amortization." Sharpe points out that this indicates "that up to that time they had enjoyed unlimited power of acquiring property in mortmain without such license."[6]

This statute, presumably the result of jealousy,[7] had its beginnings in 1388. In November of that year (shortly after the meeting of Parliament at Cambridge) "under the auspices of the lords appellant"[8] "an important step was taken towards regulating not only the Guilds of the City of

[1] Alderman of Walbrook.

[2] "Cloak that was single and without a lining."

[3] "At his house, and that at the proper costs of the said John."

[4] Cf *in passim* the apprentice in the *Cook's Prologue.* (A. 4365 ff).

[5] See pp. 1 ff.

[6] *Letter-Book,* H, p. XLIX. Cf. *Stat., 15 Richard II,* Cap. V. Some of the guildspeople held property to the uses of religious houses. For a discussion of this complicated and vague question see text. Sharpe (*Letter-Book,* H, XLIX) quotes Stubbs (*Const. Hist.,* III. pp. 586, 590) in saying that jealousy on the part of the governing body of the City provoked this statute. The reason given is, the City enjoyed no such privilege. This however does not seem to me a sufficient reason for the governing body of London was composed of guildspeople. I have not been able to find the reference to Stubbs.

[7] See previous note.

[8] The proceedings unfortunately are not set forth in the Rolls of Parliament (Cf. *Letter-Book,* H, pp. XLVIII, 336).

London, which had occasioned so much disquietude of late years (and which the lords had already shown a desire to take in hand), but also all kindred associations throughout the country, for the King issued writs to the Sheriff of every county to make a return of all Guilds within his bailiwick, with full particulars of their origin, government, and possessions."[1] Sharpe thinks that one "of the chief enactments (in 1391) was the interpretation of the Statute of Mortmain as comprising property held by laymen to the uses of religious houses or by perpetual corporations, such as guilds and fraternities."[2]

One record, of extraordinary interest because unique, is preserved which indicates that the women had a direct interest in the business affairs of that day. In 1372 an arrangement was made between the Dyers, Leathersellers, and Pursers of the Bridge defining their respective duties and obligations. Of the three dyers who subscribe the Articles,

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[1] Two separate writs dated 1 November were sent to the Mayor, and Sheriffs of London; one bids them "for certain reasons laid before the King and his Council at the last Parliament held at Cambridge, to make proclamations for all Masters, Wardens, and Surveyors of misteries and crafts in the City and suburbs who have in their possession any charters or letters patent from the King.....touching the said misteries and crafts, to bring into the King's Chancery such charters"—before Feb. 2, 1389. The other writ is for all "Masters and Wardens of guilds and fraternities in the City and suburb" to make returns of their foundation, government, and property. (*Letter-Book*, H, pp. XLVIII, 336). See Toulmin Smith, *English Gilds* (E. E. T. S., Vol. 40, pp. 127-131), for a translation of these writs. The guilds were to make returns of the "true annual value of the said lands, tenements, and possessions and the true worth of the said goods and chattels" (*Ibid.*, p. 128). Sharpe says (*Letter-Book*, H, p. XLVIII) that the "first writ applied to the Guilds which controlled the various trades and crafts of the City, but which also possessed incidentally a religious and social element; the second referred to unchartered associations formed solely for religious and social purposes. No returns to the first writ appear to be extant (if, indeed, they were ever made), whilst only thirty-one returns have been discovered to the second writ. Among the latter are returns of four fraternities bearing the names of craft Guilds, viz: the Whitelawyers, the Barbers, the Cutlers, and the Glovers, but only as social and religious associations. A seventeenth-century copy of the return made by the fraternity of Barbers is printed in Mr. Sidney Young's "Annals of the Barber-Surgeons" (pp. 30-34). A copy of Young's *Annals* is in the Harvard Library. To what extent the guilds had a social and religious purpose is not known. See Miss S. E. Moffat, *London Fraternities in the Fourteenth Century* (printed in *The Clare Market Review*, May, 1906). A copy of this article is in the library of Harvard University. Cf. Hinckley, *Notes*, etc., p. 27.

[2] *Letter-Book*, H, p. 371, n. 4.

the wives are associated as parties.[1] Were the wives, one is tempted to ask, assisting their husbands in the dyeing of materials, in order to purchase the required number of horses?

Observation has been made that some of the burgesses owned property outside of London, and that one man in particular[2] held lands in Kent. This at once raises the question in what part of Kent, and if along the Pilgrim's Road. One interesting entry to the student of Chaucer is preserved. In 1374 Giles de Kelseye[3], "tapicer", and citizen of London, Thomas Hermesthorp, formerly a parson of London, and William Bollok receive from the latter's brother John, a "tapicer," "lands, rents and services in Hallyng, Cokelston and Rochester."[4] Hallyng lay six miles south of Rochester, and Cokeleston apparently was on the Isle of Sheppey. Rochester, of course, was the chief city between London and Canterbury, and readers of Chaucer will recall the Host's "Lo! Rouchestre"[5] uttered with evident national pride.

Possession of property along the Pilgrim's Road was common enough. Highly interesting is the fact that a number of the poet's fellow Justices of Peace owned land along the route, and in some cases actually lived on the Road. At Ospringe, for example, Sir Arnold Savage, Robert Bealknap, and others acquired a manor in 1374.[6] Thomas Shardelowe lived at Dartford.[7] Arnold Savage was of an old family that had long been settled two miles from Sittingbourne[8] (at

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[1] A complete translation of the Articles is set forth in the *History of the Leathersellers Company*, by W. H. Black, London, 1871, pp. 15 ff. Cf. *Letter-Book*, G, p. 293. The Dyers were somewhat notorious, also, for cheating their customers. This complaint was included in the Articles. The names of the Dyers are: "John Blackthorne and Agnes his wife, Robert Whitynge and Lucy his wife, and Richard Westone, 'dier,' and Katherine his wife."

[2] Dyk. See *supra*.

[3] See *supra*.

[4] *Cal. Close Rolls*, 1374–7, pp. 96 f. In his will he makes bequests to Dyk and his wife, and to his sister,—the wife of Kelseye (*Cal. of Wills*, etc., II. p. 179). This intimacy between people of the same guild is not without interest.

[5] B. 3116.

[6] *Cal. Close Rolls*, 1374–7, pp. 107 ff. Ospringe was one of the halting-places for pilgrims. Dartford and Rochester were the other two. See Skeat, V. p. 415.

[7] *Cal. Pat. Rolls*, 1381–5, p. 409.

[8] *Dic. Natl. Biog.*, L. p. 335. On Sittingbourne see D. 847.

Bobbing)—likewise mentioned in the *Canterbury Tales.* Eleanor, sister of Arnold Savage, and William, son of Lewis Clifford (a known friend of Chaucer), were joint owners of property at Bobbing.[1] John Cobham lived at Cooling (Cowling) near the Pilgrim's Road.[2] Thomas Brokhull, presumably the father of the poet's fellow J. P., owned a manor six miles south of Dartford.[3] Simon Burley had interest in the manor of Parrok near Gravesend.[4] Six prominent Justices of the Peace, therefore, lived or owned property on or near the Pilgrim's Road, and some actually lived at the usual halting places for the night. This is manifestly significant. That Chaucer in making a pilgrimage to Canterbury was entertained by one of his colleagues we like to imagine. At any rate, the minute knowledge necessary for the portrait of the Franklin was not got in London. The poet not only saw this country gentleman enjoy his morning draught, but he also heard belated travellers ask for a night's lodging. Nor are these facts which one ordinarily gleans at midday. Furthermore, not to press the point, when Chaucer pays the Franklin the great compliment of being the Saint Julian does he not infer that this worthy gentleman lived on the Pilgrim's Road?[5] What other highway in Kent would be so likely to have belated travellers? Finally, it may be observed that Chaucer succeeded Shardelowe (who lived at Dartford) as J. P., when the latter died. Shardelowe was an old man who had been J. P. for years, and

Ful ofte tyme he was Knyght of the shire.[6]

Mention has been made of the fact that Kelseye left money for the repair of bridges. What bridges we do not know. From other sources, however, we may infer that one of them was the bridge over the Medway between Strood and Rochester,—the bridge the Pilgrims had to cross. That some of the London burgesses did contribute towards its construction or repair we do know. In 1373

[1] *Dic. Natl. Biog.*, L. p. 336. The source of information is not given.
[2] *Dic. Natl. Biog.*, XI. p. 156.
[3] *Cal. Close Rolls,* 1364–8, pp. 199–200.
[4] *Cal. Pat. Rolls,* 1381–5, p. 160.
[5] Assuming of course that the Franklin was a resident of Kent.
[6] In my doctoral dissertation on *Illustrations in Chaucer,* which I hope to publish shortly, I have made a fuller biography of Shardelowe.

Thomas atte Legh, a stockfishmonger, left 40 shillings towards the work;[1] John Rous, a fishmonger, left money in 1381 for like purpose;[2] and likewise a London skinner in 1386.[3] Three similar bequests were made in the first quarter of the fifteenth century.[4] The burden of the expense, however, was carried by Sir John Cobham (fellow J. P. of Chaucer) and Sir Robert Knolles—two famous knights of the fourteenth century—who rebuilt the bridge in 1388.[5]

The matter of wearing apparel is not without interest also. When but a comparatively few wills are preserved one should not expect many by obscure people. And such is actually the case. Even when the will is given it is likely to be brief or the trade of the testator omitted.[6] However, a sufficient number of interesting wills have come down to us which make pertinent some scattering observations. A very interesting will of a London tailor,[7] dated 1393, exists. John Dymmok, "tailour", leaves among other things "a girdle of black silk harnessed with silver." Also "a long gown of striped cloth......furred with *bever*, a silver girdle, a *baselard* harnessed with silver, a doublet with coat of mail, a *palet* with hood." He likewise leaves several robes and another basilard with silver trimmings. He therefore owned two girdles and two basilards "harnessed with silver."[8] A "clothpakker" (fuller) in 1418 leaves a "girdle garnished with silver and . . . baselard garnished with silver."[9] In glancing through other wills one is impressed by the number of silver girdles, daggers, spoons, cups, etc., which tradespeople possessed,—even "*bedes* of haumbre."[10] Chaucer's people had knives (presumably the basilards, used for protection against robbers) capped, as the poet tells us, not with brass but with silver. The Reve from the "north contree" had a rusty sword, however,—another reason for his shyness.

[1] *Cal. of Wills*, etc., II. p. 154.

[2] *Ibid.*, p. 225.

[3] *Ibid.*, p. 261.

[4] *Ibid.*, pp. 392, 428, 433. The bridge was in need of repair a good deal of the time apparently.

[5] *Dic. Natl. Biog.*, XXXI. p. 285. Both men were natives of Kent.

[6] In many cases, through the aid of the *Letter-Books*, I have been able to identify the man's business.

[7] Tailors had six representatives in the Common Council.

[8] *Cal. Wills, Court of Hustings*, II. pp. 303–4.

[9] *Ibid.*, 414–5.

[10] *Ibid.*, p. 233. Cf., in general, pp. 182, 199 f, 205, 207 f, 238, 240, 261 f, 277, 299 f, etc.

Money frequently was left for persons to make pilgrimages to shrines. In one will, made by a vintner in 1361, twenty shillings were left to anyone willing to walk to Canterbury "with naked feet;"[1] forty shillings to anyone willing to go to "S. Mary de Walsingham."[2] A silver girdle and forty shillings are left in 1373 by a brewer to anyone who will go to Santiago[3] (Spain). Ten marks are left in 1376 by a woolmonger for the like purpose[4] (to Santiago). A mercer in 1384 leaves bequests for sending two pilgrims to Rome, there to remain forty days.[5] A draper, in 1383, makes provision for someone to go to Rome in case he die before he can perform the vow in person.[6] A poulterer in 1397 makes provision for sending a pilgrim to Rome.[7] It will be observed that no one belonging to a small non-victualling company left a will of this sort. Drapers and mercers, of course, were among the wealthiest. The victuallers, however, fared particularly well in Chaucer's day,—even as to-day.

[1] *Cal. Wills,* II. p. 41. Cf. p. 105.
[2] *Ibid.*, p. 107.
[3] *Ibid.*, p. 163.
[4] *Ibid.*, p. 221.
[5] *Ibid.*, p. 243.
[6] *Ibid.*, p. 251.
[7] *Ibid.*, p. 335.

ON A NEW MYXOSPORIDIAN, *HENNEGUYA WISCONSINENSIS*, N. SP., FROM THE URINARY BLADDER OF THE YELLOW PERCH, *PERCA FLAVESCENS*

JAMES W. MAVOR AND WILLIAM STRASSER

University of Wisconsin

The myxosporidian to be described was found in the uninary bladder of a yellow perch, *Perca flavescens*, caught in Lake Mendota, Wisconsin, and examined on April 15th, 1915. The fish was a male 22 cm. in length. After the discovery of the parasite in this specimen, the urinary bladders of twelve other yellow perch were carefully searched in the latter part of April and May for the myxosporidian, but without success. The latter fish were, however, all under 15 cm. in length.

Diagnosis of Henneguya wisconsinensis n. sp.

The myxosporidium (Fig. 1, *a*, *b*, and *c*) is usually elongated and has the general form and shape of a limax amoeba. It may reach a size of 300 x 70 μ. Ectoplasm and endoplasm are clearly to be distinguished. The pseuopodia are lobose.

The pansporoblast contains two sporoblasts.

The spores (Fig. 3, *c*) are ovoid, bilaterally symmetrical, and have a bifurcated caudal filament extending from the posterior end. The two polar capsules are situated near together in the broader, anterior end. The filaments can be seen in the fresh state within the polar capsules as spirals,

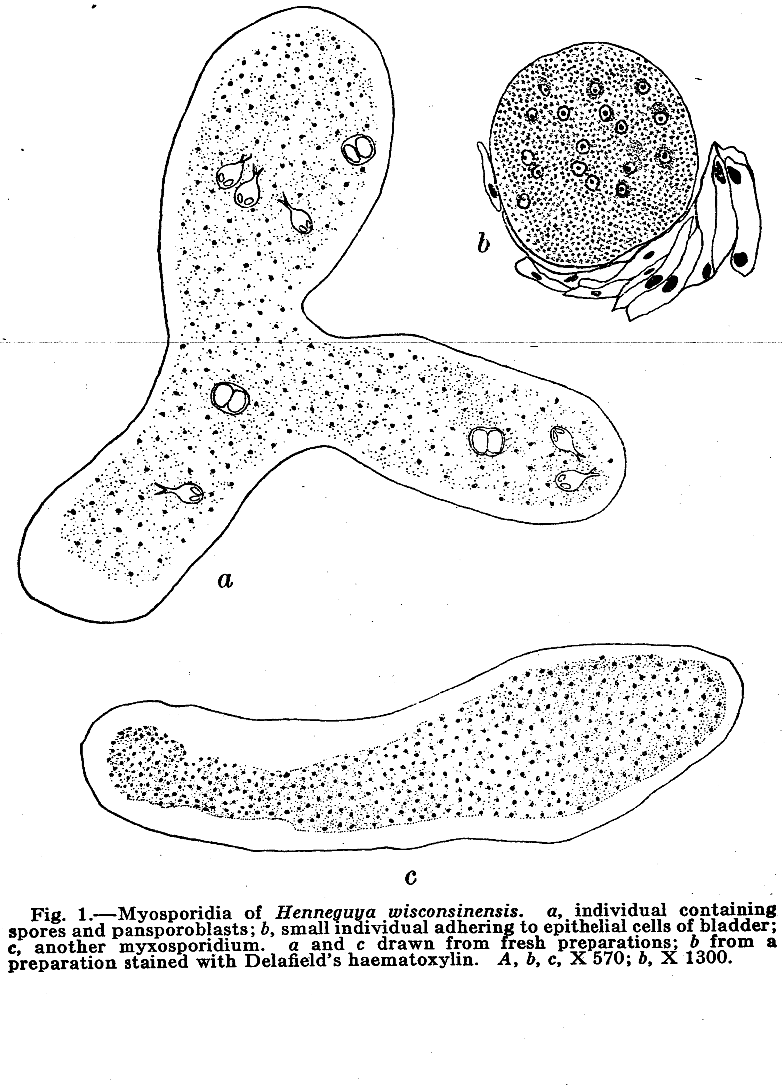

Fig. 1.—Myosporidia of *Henneguya wisconsinensis*. *a*, individual containing spores and pansporoblasts; *b*, small individual adhering to epithelial cells of bladder; *c*, another myxosporidium. *a* and *c* drawn from fresh preparations; *b* from a preparation stained with Delafield's haematoxylin. *A*, *b*, *c*, X 570; *b*, X 1300.

each composed of five coils. The dimensions of a typical spore are:

length to end of cavity	11.5 μ
width to end of cavity	7.0 μ
tail	9.6 μ
length of polar capsules	3.5 μ
width of polar capsules	2.5 μ
calculated length of polar filaments[1]	30-40 μ

Observations on the Structure of the Parasite

The structure of the nuclei in the myxosporidium and in the pansporoblasts presents certain points of interest. These nuclei measure from 1.2 μ to 2.3 μ in diameter. In the resting state they consist of a peripheral layer of relatively large

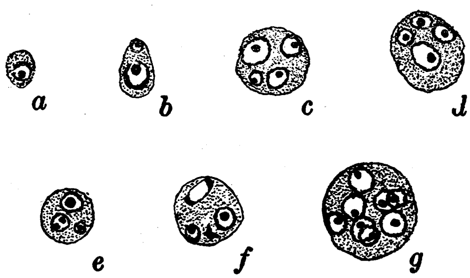

Fig. 2.—Stages in the sporogenesis of *Henneguya wisconsinensis*: *a—g*, drawn from a preparation stained with Delafield's haematoxylin, X 1300.

chromatin granules arranged under the membrane and surrounding a clear area which may be either centrally or eccentrically situated. In the center of this clear area is an endosome or "Binnenkorper" (Fig. 1, b). The division stages have not been studied in this species as the material appeared not to be promising in this respect.

The writers have not studied the sporogenesis of this form at length, partly because the senior author (Mavor, 1916) has already in the press a paper dealing with this phase of the life-cycle in another genus, and partly because the material did not seem promising in this respect. Certain stages have, however, been found in the plasmodium. The propa-

[1] We have since found a spore with an extruded filament measuring 33μ in a stained preparation.

gative cells (Keysselitz, 1908) contain a single nucleus enclosed in a well defined mass of protoplasm (Fig. 2, *a*). The division of the nuclei of these clls has not been observed but cells containing a large and a small nucleus are abundant (Fig. 2, *b*). Cells containing two large and two small nuclei are also to be found and identified as the beginning of the pansporoblasts (Fig. 2, *c*, d). Whether such cells arise from the union of two binucleated cells as described for *Myxobolus*

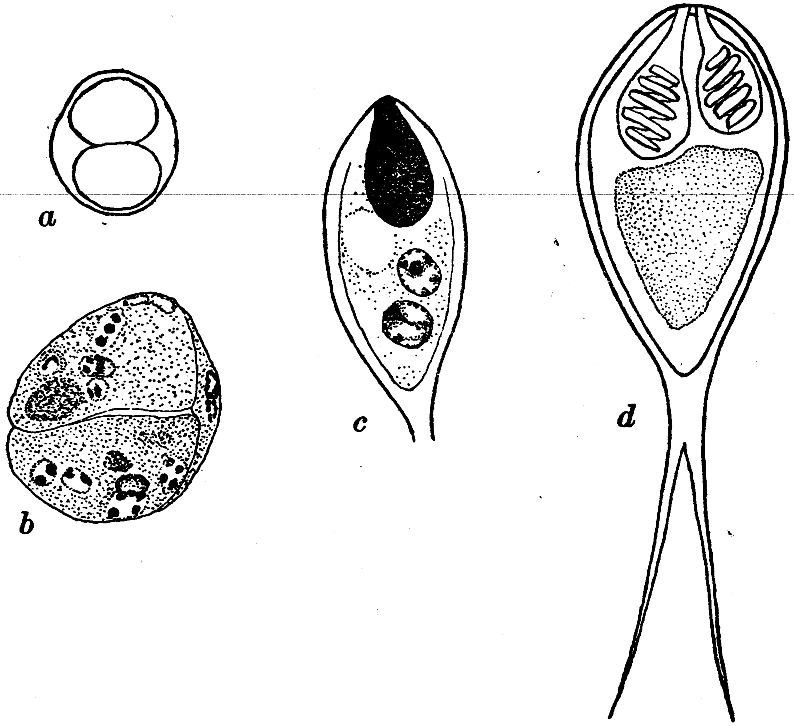

Fig. 3.—Stages in the sporogenesis of *Henneguya wisconsinensis*: *a* and *b*, pansporoblasts; *c* and *d*, spores; *a* and *d* from fresh preparations, *b* and *c* from a preparation stained with Delafield's haematoxylin. *a*, X 1100, *b*—*d*, X 4000.

pfeifferi by Keysselitz (1908) we are not able to say. The occurrence of stages containing three nuclei makes this doubtful (Fig. 2, *e*, *f*). Later stages in the development of the pansporoblasts (Fig. 3, *a* and *b*) show that two sporoblasts are developed in each pansporoblast. The fully developed spores show two nuclei in the sporoplasm.

It has not been possible to decide whether or not the myxosporidium occurs attached to the walls of the urinary bladder. The occurrence in smears of myxosporidia imbedded in masses of epithelial cells of the urinary bladder suggests that this may be the case (Fig. 1, *b*).

The Systematic Position of the Parasite

So far as the writers are aware the genus *Henneguya* contains eighteen species which are as follows (Auerbach1910, Labbé, 1899, and Gurley, 1894):

1. *H. psorospermica* Thél.	from	*Lucius lucius* and *Perca fluviatilis.*
2. *H. media* Thél.	"	*Gasterasteus aculeaetus* and *G. pungitius.*
3. *H. brevis* Thél.	"	*Gasterasteus aculeatus* and *G. pungitius.*
4. *H. schizura* Gurley	"	*Lucius lucius*
5. *H. creplini* Gurley	"	*Acerina cernua*
6. *H. linearis* Gurley	"	*Pimelodus sebae* and *Platysoma fasciatum*
7. *H. strongylura* Gurley	"	*Synodontis schall*
8. *H. monura* Gurley	"	*Aphredoderus sayanus*
9. *H. kolesnikovi* Gurley	"	*Goregonus lavaretus*
10. *H. macrura* Gurley	"	*Hybognathus nuchalis*
11. *H. zschokkei* Gurley	"	*Coregonus lavaretus*
12. *H.* sp. Borne	"	*Leuciscus rutilus*
13. *H.* sp. Clap.	"	*Leuciscus rutilus*
14. *H. nusslini* Schubert and Schröder	"	*Trutta fario*
15. *H. acerinae* Schröd.	"	*Lucioperca lucioperca Acerina cernua*
16. *H. tenius* Vaney et Conte	"	*Acerina cernua*
17. *H. legeri* Cépède	"	*Cobitis barbatula*
18. *H. gigantea* Nemeczek	"	*Lucioperca sandra*

Henneguya wisconsinensis differs from Nos. 1, 2 and 5 in having a broader and less elongated spore, from No. 3 by the shape of the anterior end of the spore, from No. 4, 6, 8, 9, 10, 11, 14, 15, and 18 in having shorter caudal filaments, from Nos. 7, 16 and 17 in having larger spores. The spores of No. 13 (Gurley, 1894, p. 246, Pl. 30) are very similar in shape and size to those of our parasite but are not so wide. No description is given by Borne of the parasite recorded by him, No. 12, from *Leuciscus rutilus*.

No species of *Henneguya* or other myxosporidian is recorded as occurring in the urinary bladder of the European perch, *Perca fluviatilis*, L., the only species of myxosporidian recorded from this fish being *Henneguya psorospermica testa* L. Cohn and *H. psorospermica minuta* L. Cohn, both from the gills. The spores of *H. psorospermica testa* L. Cohn are described as similar to those of *H. psorospermica typica* Thél., which measure 29–38 μ by 15–20μ, and are therefore much larger, and proportionately narrower than those of our American parasite. The spores of *H. psorospermica minuta* L. Cohn are also much larger and narrower than *H. wisconsinensis* measuring 28μ by 10–11 μ.

The American and the European perches, *Perca flavescens* and *Perca fluviatilis, S.* respectively are undoubtedly very closely related if not identical. It is difficult to believe that the urinary bladder of *Perca fluviatilis* has not been searched by some one of the many European workers on protozoan parasites. The occurrence of *H. wisconsinensis* in the American perch and its apparent absence in the European species is therefore of considerable systematic interest.

The classification of the species described is as follows:

Phylum *Protozoa*
Class *Sporozoa* Leuckart
  Sub-Class *Neosporidia* Schandinn
    Order *Cnidosporidia* Doflein
      Sub-Order Myxosporidia Bütschli
        Legion *Polysporea* Doflein
          Family *Myxosporidia* Thelohan
            Genus *Henneguya* Thelohan
              Species *wisconsinensis* n. sp.

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A TRUE BIT OF INSTRUCTION SHOWING WHY WE ARE UNDER OBLIGATIONS TO PAY TAXES AND TITHES FOR THE PRESERVATION OF CHRISTIAN PEACE AND THE AVOIDANCE OF TROUBLE

Written by Joannes Landtsperger, an humble servant of Christ, 1528

ERNST VOSS

PREFACE

Since many in their misunderstanding of the Holy Scriptures or of the Word of God are complaining of being unjustly burdened by taxes and tithes, (a condition of affairs which has been brought about by sermons preached some time ago) and since because of this overburdening they are causing seditions and revolts against the power, which God, according to the teachings of Christ, Peter and Paul, has given to the worldly magistracy—revolts whose causes can be attributed mainly to a lack of foresight on the part of inexperienced preachers, although other troubles not here mentioned also contributed their share; and since things have come to such a pass that true preachers (at whose door these troubles surely cannot be laid) must become apprehensive and cannot feel sure of their ground, *I* have purposed writing a short admonition in my sympathy and love for the brethren, in order that all country pastors, who cannot be so well versed in these matters, may meet or answer unitedly the question of tithes and taxes, put to them by their parishioners or others, and that they in turn may be able to write about them; in order that those under them may not conclude from the varying answers and the misunderstandings that they themselves (i. e. the preachers) hold opposite views and continue to lead others astray—as is now the common report. I shall briefly show how much God's Word may effect in such, and afterwards let other scholars determine its value.

A PRELIMINARY QUESTION DESIGNED TO GIVE A BETTER UNDERSTANDING OF THE TREATISE.

Some clamor loudly and ask: If God has made all things common possessions, whence this holding of property and this paying of tithes and taxes.

Answer: God made all things else, before man, and finally he made man of the dust of the earth, naked and bare: thus we were born into this world and thus we must leave it, as Job says. Then God made Adam a lord and a ruler over all things and subjected everything to him to be used by him at his pleasure. Consequently the earth and everything contained therein belongs to God, and no man either by the act of creation or by nature is superior to another; for they are all of the same earthly origin. Therefore none may say by authority of divine or natural law: this or that is mine, lest he usurp that which belongs to the Lord. But since Adam was by God ordained lord over all things, he could at his pleasure give to his children, being after God the highest ruler in temporal matters: thus Cain and Abel his (first) oldest sons held their possessions separate (Abel was a shepherd and Cain a tiller of the soil) and each gave to God of his substance. It is apparent that by their temporal gifts they recognized God as Lord of all things which he had subjected to Adam. The sons of Noah acted in like manner after the flood.

Likewise, Abraham, Gen. XIII, divided his land with his brother's son Lot, giving him his choice, although Abraham was the ruler. This was done by order of the spirit to bring about peace between Abraham's and Lot's herdsmen, both of whom, to please their lords, desired the best pastures. Hereby one can see that each had his own cattle and that only the pastures were held in common. And if to-day conditions were such that temporal possessions would be communal, everyone would want the best of everything and many a man would use up as much as ten would otherwise, and there would be neither rest nor peace among men.

For the same reason the promised land was given to the children of Israel through Joshua acting under God's orders, as is clearly recorded in the fifth book of Moses and in the book of Joshua. No portion, however, was given to the tribe of Levi, for God purposed to sustain *it*, by that which by nature belonged to it, as will be shown later in this treatise. Afterwards disposition was made of the temporal things, and the people were ruled by Judges as is seen in the book of Judges. Later, God, heeding the clamor of the people, gave the power into the hands of kings, and it is only by virtue of their ordination that one is justified in saying, this or that is mine, (I. Kings, 8.) Such is the human law, which God through worldly kings has given to mankind; Christ did not abolish it, but confirmed it, and Peter and Paul interpreted it, as will be seen further on in this treatise.

As for the objection advanced by some, e. g., the Anabaptists: In the Apostolic Age all things were communal and none said this thing or that belongs to me. Acts ii, 6.

Answer: Luke inserts *that* to show how united in Christ the believers were, and how unhindered by worldly considerations they put their trust wholly in Christ, and leaned on his Word, although there was no command to the effect that all things were to be held in common. Everyone waited patiently for that which was to be given to him, (to everyone according to his needs) and nobody appropriated his portion to himself. Even then there arose a murmuring that things were not being done justly, whereupon Peter spoke: It is not reason (American Revised has *fit*) that we should leave the Word of God and serve tables. (Acts 6.) And he commanded them to elect of their number seven men of good report, who were reputed to be full of the Holy Ghost, and these were to be entrusted with the office of giving to everyone impartially according to his needs.

Whence it is evident and clear that from the beginning of the world up to the present time nothing temporal has been communal in the sense that everyone might make use of it, according to his pleasure; but there have always been worldly magistrates to decide over things: of whom Adam (as stated above) was the first who received power from God over all creatures. And it is proper that as Adam dealt toward his children, all succeeding generations should be treated. However, God *created all things* to be held in common in the sense that everyone, (whom God has given temporal possessions) is bound by law of God and nature to divide his property with the poor and needy who have nothing; for man is only a dispenser of his possessions and he is ordained by God to rule over them and not to let them rule over him.

There is another question in this connection: If one has bought a tithe and paid cash for it, must he give it back to the church, from which he bought it, and thus be deprived of his principal (Hauptsumme)?

ANSWER IN A FEW WORDS.

If the tithe is a product of the soil, and belongs to God, to be used to sustain His ministers and the poor, no man has the power to sell it, for in reality it is not his (as will be seen later). No man shall sell that which does not belong to him, nor shall anyone wittingly buy it. But in case one should have used it for some years, so that it would have become the equivalent of the principal[1] or more, he is bound both by divine and natural law to give it back without any recompense;[2]
in case, however, it should be less than the principal (the amount first tithed) the difference must be given to him and he must give up his tithe. All this is to be done in the spirit of honesty and truth. How the magitracy acts in this matter with its indulgences, contracts and agreements, is of little concern to me. I intend to be troubled by temporal possessions, *only in so far* as the tithes are wrongfully used and the buyers are deprived of what belongs to them. In case a servant of the church sells the tithe, which belongs to him for his life-time only, for a longer period than he should have use of it, he is a spiritual thief, for he has sold something which does not belong to him, but to God, to be used to

[1] Principal in this connection—the amount (first) tithed.

[2] Explanation. A bushel of corn, the original tithe of ten bushels would in a short time equal the ten bushels, the amount first tithed. It must then be given back. The example chosen, is not very happy, because of the reproductive ability of corn.

sustain His ministers and the needy. And accordingly it belongs to the one who succeeds him in the ministry and to the poor.

In case the tithe-exactor is the king, he who has been given the tithe by the king, may sell the use of it for his life-time but no longer, and then only with the permission of the king, who has given it to him as a fief. Therefore let everyone be careful of what he buys.

ANOTHER QUESTION.

In case the tithe on the possessions of the poor, in reality should not be exacted, might not the church officers be allowed to distribute it to the ministers and the poor, according to their needs. Answer: If the magistracy and the congregation should command it, it would be proper and in accordance with the Holy Scriptures, Acts VI, if they distributed it with reference to the need and if they took no benefit to themselves unless they themselves were needy.

Now let us find out in all brevity on what Scriptural grounds taxes or tributes, which belong to the magistracy are justified. Saint Paul, Romans XIII, teaches subjection to worldly authority and power. For there is no power but of God; the powers that be are ordained of God. Whosoever resisteth the power, resisteth the ordinance of God' And thereafter he says: Wherefore ye must needs be subject not only for wrath but for conscience sake. Herein can be seen that it is incumbent upon us to be subject not only for wrath's sake, in our fear or love of men, but also for conscience sake, as God-fearing men, doing His pleasure for this is well pleasing unto the Lord. Col. III. Eph. VI. For worldly authority (an instrument in God's hand) exists to promote peace among men, in order that the church may live and flourish in peace. Therefore the conscience is in love and duty bound to do God's pleasure and be subject to it. For he who does not love peace is not a Christian, wherefore, as Paul says, ye must pay taxes and tribute for they are instruments for the maintenance of peace. Render therefore to all their dues: tribute to whom tribute is due; custom to whom custom; fear to whom fear; honor to whom honor. Owe no man anything, but to love one another; for he that loveth another hath fulfilled the law. We see that obedience to worldly authority is comprehended in the commandment of love, and all the commandments in the words: Thou shalt love thy neighbor as thyself. Love worketh no ill to his neighbor; therefore love is the fulfilling of the law, and he who acts contrary to it, shall be punished by worldly authority, for the worldly authority does not bear a sword in vain. Hebr. XIII. Paul has taken the commandment of obedience to worldly authority from the first book of Samuel or from Kings, the VIII chapter, where God made known to the people through the prophets, what power and rights the kings were to have over life and limb and temporal possessions and over their children, because the children of Israel desired a king, who was to lead them in battle and be a protector and defender such as other nations had, and they willingly took the yoke upon themselves. And this law together with other external subjection Christ (because he would not act against his Father's will) has not taken from us, but confirmed. Matt. XXII. Render unto Caesar the things which are Caesar's. And Christ observed it when He commanded Peter to give tribute for him and for himself, although Christ born of kingly parentage was not bound to give it, though Peter, of course, was, but Christ did not want to give offense. And that is what Paul, taught by Christ, would have, when he says that Christ has not freed us in temporal things, but has subjected us to powers in all things that are contained in the first book of Kings VIII. Therefore he who teaches otherwise gives evidence that he understands neither the Old nor the New Testament. Let him who has a Bible look into the VIII chapter of the first book of Samuel.

There is still the tribute from feudal lands which one has for his use and his sustenance. I do not believe that any one would be so petty-minded as to refuse to give it. Should he be so disposed let him give his land back to his liege-lord who will readily be able to find one who will give it willingly. This is not a question of usury. I have taken up briefly those points which have the cause of complaints on the part of the poor.

Concerning tithe-giving, some say, it is not commanded in the New Testament; therefore nobody is bound to give it, for Christ has absolved us from it with His blood. Others maintain that since the Levitic priesthood is no more, tithes which were given to them by the law of Moses should no longer be exacted, for we who believe in Christ are all priests.

Answer: The tithe was given by the dictates of nature and its laws, without doubt by the direction of the Spirit, even before the law of Moses was given, for natural law teaches that one should recognize in God the Giver of all things and that man has nothing by himself, but everything by God and from Him.

For God who looketh on the heart alone needs no external token, and not the amount which one gives, but the spirit in which one gives it will be the determining factor with Him. But since Abraham (who was godly and to whom God spoke and to whom after Noah He gave His first promises and into whose hands he delivered his enemies) gave tithes of all his booty to Melchizedek a priest of the Most High who said to him, Blessed be Abraham of the most high God, possessor of heaven and earth: And blessed be the most high God which hath delivered thy enemies into thy hands. And thus the name tithe came into usage and (as Paul says) in the land of Abram tithes were given to the tribe of Levi, which tribe was given tithes according to the law of Moses, as will be seen later. None the less is Christ an eternal priest after the order of Melchizedek, the blessed son of Abram, to whom the tithes now belong, in order that His poor and His servants may live therefrom as well as all of Abram's children after the spirit and after the flesh who believe in God. Whoever would be a Christian and a follower of Christ, into whose name he has been baptized, should willingly give tithes, that is, by gifts and works, according to his means be helpful to servants of the Word and to poor Christians. He who would be a child of Abram, let him do the works of Abram which are like unto the faith. John VIII. If ye were Abram's children, etc.

Likewise Jacob (when in his sleep he saw a marvellous vision and when God spoke to him and gave him a promise) vowed a vow and said: If God will be with me, and will keep me in this way that I will go, and will give me bread to eat, and raiment to put on, so that I may come again to my father's house in peace; then shall the Lord be my God: And this stone which I have set for a pillar, shall be God's house: and of all that thou shalt give me I will surely give the tenth unto thee. (Gen. 28. According to this text we see that votum, a vow, is an acknowledgment of something which a man owes, or which he is in duty bound to do, as to pray, as David says in Psalms, I will pay my vow unto the Lord now in the presence of all His people. Likewise Jacob speaks here intending to do what he says afterwards. The fact that he put a condition to it, If God, etc., did not result from doubt but from true faith, as if he were to say: I see by this wonderful vision that the ladder reaches from heaven to earth, etc., and I trust in the promise of the Lord and believe that He will be my God as He was the God of Abram and of Isaac my father and that He will be with me, etc. If such will be the case, the Lord will be my God, not as though before he was not his God, but he resolves to erect a house of worship to God, wherein God should be praised and preached and then he resolves to give the tithes of all that God would give him to the ministers and the servants of the Word; just as his father Abram gave tithes to Melchizedek (who praised and blessed God in Abram's presence and who told of His power and might. Likewise Noah was a minister of righteousness as Peter bears testimony in his second Epistles. (2. Act. 2)

Likewise Jacob acknowledges here that he was under obligations to pay tithes to God for His gifts. He gave to his offspring no commandment or law, but an example by which he showed that giving was a natural law when one was thankful. But when this custom of giving was no longer being observed, and in fact had died out in Egypt, God gave a commandment through Moses, denominating those to whom the tithe should be given and those who should use it, namely, the Levites, the descendants of Levi, the third son of Jacob, who were continually in the service of the Lord and who were to instruct the people in His law. Therefore they received no share in the division of the land as did the other tribes, but the Lord was their share and they were the Lord's. For Levi means an addition and it became their duty to perform the offices of worship which Jacob instituted. Therefore God purposed to sustain them by the tithes which by natural laws belonged to Him.

All this Jacob saw (as a prophet) in spirit, for the worship of God has continued uninterrupted until Christ fulfilled it for eternity.

And therefore the tithe has not been done away with, as some have said in their misunderstanding of the Scriptures. Let us look at the words of Christ concerning it. Matt. XXIII. Luke XI.

Matt. XXIII. Christ says among other things: Woe unto you, scribes and Pharisees, hypocrites, for ye pay tithe of mint and anise and cummin. Luke says: rue and all manner of herbs, and pass over judgment and the love of God. Matthew: And have omitted the weightier matters of the law, judgment, mercy and faith: these ought ye to have done and not to leave the other undone.

Here Christ neither forbids nor rejects tithes, because the giving of tithes is implanted and grounded in the law of nature, as are the ten commandments, and its observance Jacob signified as true worship, for with the ten commandments it is counted in the moralia of the law (which are enduring and binding) and not in the ceremonia which Christ has abolished, as the Apostles recognize through the Holy Spirit and explain. Acts XV. Therefore Christ punished the Pharisees not because they paid tithes of little things, but because, as hypocrites commonly do, they made *those* matters of conscience and because they would not observe the more important matters, judgment, mercy, faith, and the love of God, as Paul Luke says.

Therefore if the tithe serves love and mercy (it is grounded in the law of nature) and is a work of faith, which God sets above everything else and looks upon as the giver of all things and accordingly one is bound in ordinary love to give it for the sustenance of poor ministers, servants of God and other needy people (for of such is the kingdom of heaven), and no Christian should set his face against doing it. And thus it became a custom not long after the Apostles' time in the beginnings of the church, as soon as Christ could be preached and confessed openly, at the time of Constantine and later, as the councils (whose decrees should not be disregarded if they are in accordance with the scriptures and with faith, love and mercy) clearly show. We find it also in the writings of the old teachers, in those of Hieronimus and Ciprianus who wrote in right understanding of the Holy Scriptures. For the tithes are taxes or tributes for the poor. xvl. q. i. c. dec. This is founded on what Christ says: Inasmuch as ye have done it unto one of the least of these my brethren ye have done it unto me. Since by natural law the tithe belongs to God, as has been proved, and since He does not need it, and since all that is done for the poor is done unto God; therefore God receives the tithe through the poor as He did through the Levites under the law. For we who believe in God are all priests. Therefore the tithe belongs to the poor and to the servants of the Word of God, and he who deprives them of it is a spiritual thief and robber, quia sacrilegium commitit. And unless the tithes are thus used they are not possessed according to divine or natural laws or according to any rights which are pleasing to God. But since the churches are under different government and each has its own minister it belongs rightfully only to baptizing-churches (Touffkilchen) and to those in which God's word is preached. And the preacher who has no other means should have his necessities provided for from it and the remainder should go to the poor: should he have, however, by heritage or otherwise enough to sustain him, he should not take the tithe or other property of the church as Hieronimus says in the chapter Quicunq; de decimis, but should give it to the poor, quia bona Ecclesiae, sunt bona pauperum.

Hence it follows in the first place that the tithe should not be sold from the church to which it belongs: for it is a fundamental law that none has the right to sell the possessions of another, unless he be empowered by the latter to do it, for his benefit.

In the second place no rich man who has enough or an abundance should buy or take a tithe unless he should use it for the benefit of the poor or the furtherance of God's Word. For all that (which in accordance with natural law) belongs to God's servants and to His poor, God will give: for that which is done unto them is done unto Christ, Matt. xxv. Therefore one should not use it against God or to dishonor Him, for example, by living in pride or to the flesh or in hatred, or by inconveniencing and harming one's neighbor: as happens in war, when the poor who should be helped are ruined and when husbands and fathers are killed.

Therefore it follows in the third place that the tithes should not be given to the rich who would merely make a display with it and would not help the poor with it; whether they be noble or plebeian, spiritually or worldly minded, whether they live in monasteries or cloisters, unless they distribute it among the poor and sustain the ministers of the churches to which they belong and from which they take the tithes. This is certainly true and is sanctioned both by natural and divine law, and neither worldly law nor custom should be opposed to it as I have clearly shown in a sermon on the love of God and one's neighbor (published in the year xxiv, (1524).

In case one should look upon the tithe as a temporal possession (as though God had given through the *kings*, so that one might be justified in saying this is mine, (not as though *God* had given everything) the HOLY Scriptures decree that one is bound according to the plan of God to give it to the king when he shall demand it, as we read in the eighth book of Samuel: And he will take your fields, and your vineyards, and your oliveyards, even the best of them, and give them to his servants. And he will take the tenth of your seed, and of your vineyards, and give them to his officers (i. e. eunuchs), and to his servants. And he will take the tenth of your sheep: and ye shall be his servants. Accordingly the tithe belongs to the king, if it has been pledged before the people of his kingdom: if it has not, it should not be exacted as a new burden, unless it is done for lawful reasons: and when the deficits are made up it should be discontinued: because of all this he the king is called a protector and defender by human laws. How much more is not God the giver of all things by natural divine rights. And since God cannot be against Himself, Christ has not absolved us from that order but rather subjected us to it. And if we were real Christians, it would make our hearts glad: as it did the Apostles, who were glad that they were worthy to suffer for Christ.

In order, however, that ye may note from what Christ has absolved us, give heed to the brief conclusion.

Christ has not absolved us from any temporal, external thing, which He took upon Himself or did for us (with the exception of the circumcision, which gave way to baptism: but He gave to us an example which we should follow, as

Peter says. For these things are our Crosses, which we should bear after Him (as Christians dead to themselves who care little how they are treated), for Christ sought nothing Himself but did everything for us. Therefore we should not be mindful of ourselves, but should live for Him who died for us. II Cor. v, and he who does not do this, is not a true Christian: Christ had done no violence, neither was any deceit in His mouth, and therefore deserved neither bodily death nor eternal death, but nevertheless He suffered and died for our transgressions, in order to deliver us from sin and the devil and his power and from eternal death and from temporal death (which He himself suffered). And such is the Christian's freedom, which we have in Christ if we live in faith. But suffering, tribulations and trials he has bequeathed to us, so that we should not forget that we should have suffered forever and died, had not Christ died for us: therefore we should be thankful to Him, and should put our faith and trust in Him, and recognize in Him our only Savior, Mediator and Hope. Nor has He taken from us temptation of our fleshly lusts, in order that we should not forget that we have an enemy who will make us brave so that we will fight valiantly and receive the crown, and be watchful and ready to resist: and if we find ourselves insufficient for the conquest that we will call upon the Father in His Name and ask for power from Him, and say with Paul: But thanks be to God, which giveth us the victory through our Lord Jesus Christ, Amen.

He was also subject to worldly authority (instituted by God) and gave tribute, not with the purpose of absolving us from it, but of teaching us humility and obedience Therefore let everyone be ashamed of himself who would be greater and better than his Lord and Master. I have tried to do this briefly (to avoid discord and trouble) and I know that what I have said is in accordance with the Scriptures and is the certain truth. But if anyone should have his doubts concerning the old tithe regulations, let him come to me, and I will clear matters up for him, or let him read the law of the spirit Extra de decimis et primitiis, and XVI. q. j. and he will find out for himself, and I commend it to the further consideration of scholars: and I ask all readers to take careful note and not to pass judgment before due reasoning, for it is a question about which much is written, God be praised in eternity, Amen. Anno. M. D. XXVIII.

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SOME TENDENCIES IN HISTORY

DANA CARLTON MUNRO

In this Academy of Sciences, Arts, and Letters it has been very exceptional that the president should be other than a scientist; and no presidential address has ever been delivered by an historian. Professor W. F. Allen was president, but died during his term of office. It is a matter of regret that he did not have occasion, from the fruits of his ripe wisdom, to make such an address. Except for the fact that there are so many here who knew Professor Allen intimately, while I have only admired him from a distance, I should feel it a privilege this evening to appraise his work and show the extent of our indebtedness to him. If the department of history at Wisconsin has won for itself an enviable place in this country it is very largely due to Professor W. F. Allen. A generation ago probably history was nowhere in America better taught than here. Frederick Jackson Turner, Professor Allen's favorite student, acquired from him the inspiration which has resulted in noteworthy contributions to history. In this, a valedictory, the temptation is strong to laud the work of each of the three historians whose achievement and reputation brought me to Wisconsin, W. F. Allen, F. J. Turner, and Reuben Gold Thwaites. But the second has written in felicitous phrases of the last, and I feel my own inability. The thought of the work done by these men, each one a pioneer in his field, has led me to choose as my subject Some Tendencies in the Study of History. Not that all of these tendencies are new; many of them are old; but a survey of the field will bring out the present day point of view, which may be interesting to this audience of men working mainly in other fields.

In any discussion of modern historiography, we naturally begin with Edward Gibbon. At the centenary of his death, the President of the Royal Historical Society declared that the Decline and Fall of the Roman Empire was the "grandest historical achievement as yet accomplished on this planet." Frederick Harrison wrote, "It is no personal paradox, but the judgment of all competent men, that the Decline and Fall of Gibbon is the most perfect historical composition that exists in any language." The statements of these scholars are corroborated by the popular estimation of Gibbon's work. Its vogue is extraordinary; more than a century and a quarter after its first publication it is still one of the best sellers.

What has caused this? Partly his grasp of the subject and the style in which he presented it; surely not his definition of history, which he describes as "little more than the register of the crimes, follies, and misfortunes of mankind." Yet this idea of history has persisted down to the present day, and disasters are better remembered than great achievements of the human intellect which have made further progress possible. Many students can give the date of the great plague in London, of which Defoe wrote:

> "A dreadful plague in London was,
> In the year Sixty-Five,
> Which swept an hundred thousand souls
> Away: yet I alive."

Some can recall that the great fire came the following year. How many, even among scientists, know that these years, 1665 and 1666, were the date of Newton's great achievements, the infinitesmal calculus and the law of gravitation? But Gibbon did not follow his definition; he wrote genetic history, and he laboriously dug out the facts from the documents; so that his "superhuman accuracy" has become proverbial. This delving after the actual facts distinguished Gibbon in an age when the greatest writers were inclined to deal with the philosophy of history.

The list of those who have written philosophies of history is an imposing one: St. Augustine, Otto of Freising, Bolingbroke, Montesquieu, Herder, Hegel, to mention only a few. This tendency also has continued to the present day. One common form is "the assumption that a transcendental cause, Providence, guides the whole course of events towards an end which is known to God." As an illustration may be given

Charles Kingsley's Roman and Teuton, where in one chapter, "the strategy of Providence," the author tries to show how the Germans were led by Providence to form repeatedly a sort of flying wedge which hit the weakest point in the Roman line of defense. This style of interpretation has been and still is very popular; most of the church histories have been written from this point of view; and the tendency has survived among those who reject any theological bias. Many of the disciples of Hegel "tacitly assumed that every social fact has its *raison d'etre* in the development of society—that is, that it ends by turning to the advantage of society." "This," as Seignobos says, "is the fundamental idea of . . . Ranke, Mommsen, Droysen, Cousin, Taine, Michelet." In the same category is the "theory of the *ideas* which are successively realized in history through the medium of successive peoples; (following out Vico's thesis "that changes in civilization could be interpreted according to an ordered sequence which has its moving force in the growth and change of the collective mind of mankind from generation to generation,") the historical mission (*Beruf*) which is attributed to nations" such as the characterization of the Phoenicians as the missionaries of civilization, of Rome as the strong right arm which spread Greek civilization. This idea will long continue, however hard the historians may strive to introduce correct notions, for it is still a very popular conception that "*Die Weltgeschichte ist ein Weltgericht.*"

Fortunately the French Revolution directed men to a study of constitutional history. Some were eager to destroy all the foundation of society and to rebuild; many zealous reformers set to work on *a priori* notions, in a way that is familiar to us all. But the thoughtful were keen enough to know that it was necessary to study the past and to build in accordance with the stubborn facts; that rash innovations bear in themselves the seeds of their own destruction. Consequently the disorders of revolutionary Europe led to a study of the forms of government and therefore laid the greatest emphasis upon political and constitutional history.

This movement found especial acceptance in Germany, which led the way in this field of history, as in so many others. Emerging from the crushing ordeal of the Napoleonic wars, the Germans began a systematic study of their own history, and in particular, of the period of German glory, when the Holy Roman Empire was dominant. The formation of the *Gesellschaft für ältere deutsche Geschichtskunde* was one of the patriotic achievements of Stein and his associates, and resulted in the publication of the stately volumes of the *Monumenta Germaniae Historica.* Ranke's seminar trained a host of able men to investigate the sources, and its influence, through direct apostolic succession, may be noted in universities in every civilized country. In company with hundreds of others, I can say that I was a student of one of Ranke's students; his inspiration is spreading in constantly widening circles of waves, which will eventually reach the most distant shores.

With one group of the Germans we are especially concerned at the present day, the so-called Prussian school, represented by Droysen, Sybel, and Treitschke. Their work was the blending of history and politics and, in the case of the last especially, making history a vehicle for patriotic teaching. Freeman became the great exponent of this idea for England and the United States with his favorite phrase displayed on the walls of the historical seminar at Johns Hopkins, "History is past politics; politics is present history." With such god-fathers, it is no wonder that this conception has had great currency, although comparatively few historians could be found now who would consider the statement either sufficient or satisfactory. We are more inclined to agree with Burke, who wrote a century ago: "Political arrangement, as it is a work for social ends, is only to be wrought by social means. Mind must combine with mind"; or with Oliver Cromwell, who said, "What liberty and prosperity depend upon are the souls of men and the spirits—which are the men. The mind is the man."

During the first half of the nineteenth century there were improvements in methods of work, due especially to Ranke's leadership, a change of conceptions on account of the rise of romanticism, which resulted in a new idea of the Middle Ages; a growing interest in the middle class, especially voiced by Guizot; and some very promising attempts to include new material in the scope of history. But, on the whole, histories were written along some one or other of the general lines laid down above.

In the second half of the nineteenth century new tendencies became prominent and older ones took on a new form. For various reasons history became popular; consequently many attempted to write history who had no qualifications for their task except their own ignorance. But these we can neglect, in order to consider some of the new tendencies which were to transform the concept of history and to some extent to denature it. One of the influential factors in England and America was the work of Henry Thomas Buckle, who published, in 1857, the first volume of his *History of Civilization in England.* Almost immediately he became famous. "His first volume went through three editions in a little over three years." "His works have been translated into French, German, Spanish, Dutch, and Russian." He was hailed as a prophet and guide, because he attempted to place history on a scientific basis. His thesis outlined very briefly, is that: It is the historians' task to discover the laws of history, The supreme principle is the law of progress. Progress rests upon knowledge. Intellectual progress is greater than moral progress; but intellectual progress is possible only through accumulation of riches, and these depend upon soil and climate. Therefore, the physical agents are the first conditions of all progress. Much of this was not new, but it was new to English readers. After Buckle's death in 1862 his fame began to wane and historians showed his inconsistencies and his indiscriminate choice of material. Lord Acton wrote: "Mr. Buckle, if he had been able to distinguish a good book from a bad one, would have been a tolerable imitation of M. Laurent."

Possibly Lord Acton's judgment is too severe, and recently many have consciously or unconsciously imitated Buckle. His disciple and biographer has claimed that he was the first to show that history could be interpreted only through political economy and statistics, and economists have often followed in his footsteps. But the economic interpretation of history really goes back to Adam Smith and his Wealth of Nations, published in 1776. In this work Adam Smith attempted to trace the "rise and fall of nations to their economic and commercial equipment and policy." This idea was restated as early as 1845 by Karl Marx who "maintained that the only sound and ever valid explanation of the past must be economic." This point of view has often been promulgated since and is held by many. One historical student writes, "Few, if any, historians would agree that everything can be explained economically, as many of the socialists and some economists of good standing would have us believe"; "But in the sober and chastened form in which most economists now accept the doctrine, it serves to explain far more of the phenomena of the past than any other single explanation ever offered." After such a statement as this, it is refreshing to read the words of one of the leading economic historians, Werner Sombart, who declares that the economic interpretation of history is no more true and no more false than any other single point of view in the interpretation of history. With this we will gladly agree.

Those who seek to explain history by geographical or physiographic factors are also, to some extent, imitators of Buckle, although Michelet has been far more influential in emphasizing the importance of geography in history. In the hands of masters the physiographic interpretation has added largely to our knowledge of the course of history, and no historian now would neglect the study of geography. Unfortunately some of the enthusiasts in this country have been led into exaggerations; so that there have been battles royal in which Professor Burr of Cornell has been the protagonist for history. He answers some of the exaggerations in the following passage: "When the historian Buckle sought to reduce all history to geoography and maintained that civilization must begin where facility of nourishment leaves most ample leisure, it was the great geographer, Oscar Peschel, who exclaimed against the wildness of his reasoning, and who pointed out that there is a land (New Guinea) where there exists a plant (the sago palm) which is almost solid nutriment, and where the labor of a man can in one day win him food for eighteen, leaving him the other seventeen for the development of the civilization in which the Papuans should accordingly have led the world. It was another great geographer, Friedrich Ratzel, who organized into the new science of anthropo-geography what Mr. Buckle sought to make the basis of history, and protested that in this science one must never speak of geographic necessity, but only of possibility, or at most of probability. And there is hardly one of the younger European leaders in geographic science who has not taken occasion within the last dozen years thus to protest against wild assertions as to 'geographic influence.'"

Teaching history as a patriotic task found many advocates, even before it was given such standing by the members of the Prussian School. Napoleon naturally thought of this as the chief duty of the historians in his empire, and expected every university lecturer to pay a tribute to him and his work. Bancroft's History of the United States was written largely from this standpoint and found, and still finds, many imitators. Some of the states insist upon having their own state history taught for this reason.

If time permitted, it would be possible to enumerate other modes of approach to history. Professor Dunning in his presidential address before the American Historical Association said: "In these days no science is sure of its footing until it has proclaimed its special interpretation of history. The economic, the sociological, the metallurgical, the pathologic, the meteorological, the astronomical, the geological, and for aught I know, the geometrical interpretations are in heated rivalry." It is not necessary to follow out all of these "sundryological interpretations" of history to indicate how greatly its field has been broadened, and confused, by the workers in other branches. Possibly each one has added something of value; possibly amid the chaff some grains of wheat may be gleaned. Let us hope so!

But now we must turn to the present status of history and plot the course which the student must steer. What is his goal and how is he endeavoring to reach it? What freight has been added to his cargo from the other sciences and which are the most precious commodities? What instruments of precision has he for directing his course or determining his position? Only a partial answer can be attempted this evening.

The first point which forces itself upon our attention is the present interest in general history. While nationalism and therefore national history were dominant in the first three-fourths of the nineteenth century, the expansionist tendencies which became influential towards the close of the century have had a profound influence upon the study of history. It has become necessary to include the whole world in its scope. At the International Congress of Historical Studies in 1913, Bryce, in his presidential address said: "The world is becoming one in an altogether new sense. . . . As the earth has been narrowed through the new forces science has placed at our disposal . . . the movements of politics, of economics, and of thought, in each of its regions, become more closely interwoven. Whatever happens in any part of the globe has now a significance for every other part. World history is tending to become one history." Realizing this, scholars have joined in preparing authoritative general histories of various types, such as the Oncken in Germany, the Lavisse and Rambaud in France, *The Cambridge Modern History* and *The Cambridge Medieval History* in England. In this country, because of our poverty in historians, it was necessary to meet this need by translating and revising a German work. But the United States has felt this influence and has provided for a richer opportunity in the elementary and high schools and for a greater variety of instruction in the universities. The development of the European field has been the most striking feature of the historical work in our universities in the last quarter century. Recently Asiatic and South American history are being added. In the study of our own history, the same influence has been felt, especially in the colonial period. In this field the work of our own Professor Root is significant. No one of his students will ever believe that our history can be understood as that of an isolated section; the necessity of studying the administration and history of other English colonies in order to understand our own has been made so clear.

Abroad it has been much more marked; e. g., as Professor Kune Meyer has recently stated here, the study of Celtic history and literature received a strong impulse from the German scholars; and they have been studied as part of the general European history. Byzantine history, which was long left mainly to Greeks and Russians, received a new setting from the English Finlay, and now is studied by a host of scholars, especially in Russia, Germany, France, and England. It has been found advisable to establish a special periodical, the *Byzantinische Zeitschrift*, in which articles in any language can be published. Another interesting illustration is the *Revue de Synthèse Historique*, founded toward the close of the last century, to serve as a medium for the study of all the inter-relations of history and allied subjects. In fact, we are all interested now both in general history and in history in its broadest conception. When we study any episode, although we may have to isolate it partially for the purpose of study, we are not concerned with it as an isolated phenomenon, but for the light which it may throw upon the whole course of events.

In the present status of history man is the center. As Lord Morley says, "To leave out or lessen personality would be to turn the record of social development into a void." This may sound like a truism; but in the "sundryological interpretations" of history this has not been recognized. Some have attempted to make geographical influences the center; others, society rather than man; still others have chosen this or that factor to be emphasized. Moreover, the man whom we study is not "the economic man," that much used figment of the imagination which never existed anywhere. We hold that man is not a mere creature of economic necessity, and that the pursuit of wealth has never been the exclusive motive of men's exertions. This again is a truism which every one knows, but plausible presentations of other points of view have obscured it, and some books receive great commendation which derive all our institutions from the economic needs of man, entirely neglecting his complex and ever-varying motives and ideals. Moreover, we have not realized sufficiently man's own creative work, by which each generation is being shaped anew; the action of man upon himself, which Michelet summed up in the phrase, "Man is his own Prometheus."

Our aim then is to study the life and activities of men. There is nothing new in this general statement. "The Romanticists (in the early years of the nineteenth century) grasped the cardinal truth that the historian had to reconstruct the life and achievements of the peoples." Ranke wrote, "History must not be content to exhibit the outward succession of events, each in its own figure and coloring, but it must pierce into the deepest and most secret movements of human life, it must discover what in every age the race has struggled for and attained; and this not by the way of philosophical speculation but of the critical study of facts." The point mainly to be insisted upon is that the men must be studied in their own environment from the standpoint of their own age, not from the point of view of our age. This may seem self-evident, but it is only recently that this idea has been accepted, and as yet it is not generally followed. Motley would have been indignant at such a notion. Lord Acton in his inaugural address at Cambridge twenty years ago urged his hearers, "Never to debase the moral currency or to lower the standard of rectitude," but to judge men of all ages and countries by the final maxim which governed their own lives, "to suffer no men and no cause to escape the undying penalty which history has the power to inflict on wrong." "If we lower the standard in history we can not uphold it in Church and State." In his presidential address before the American Historical Association, Mr. Lea answered his friend, Lord Acton, and stated that, "The historian should so familiarize himself with the period under treatment that, for the time, he is living in it, feeling with the men whose actions he describes, and viewing events from their standpoint. Thus alone can he give us an accurate picture of the past, making us realize its emotions and understand the evolution of its successive stages." Professor Dunning a few years later again emphasized this standard. "The business of the historian who studies the sixteenth century is to ascertain the scope and content of the ideas that constituted the culture of that period. Whether these ideas were true or were false, according to the standards of any other period has nothing to do with the matter. That they were the ideas which underlay the activities of the men of this time is all that concerns the work of the historian."

These ideals and aims make history a difficult subject. As man's life is so complex, and his actions are determined by such varying motives, history must necessarily be complex. The causes of events are not easy to ascertain, and frequently must be sought in the far distant past. A man's statement of why he himself did something must be interpreted from his whole mental attitude, which was partly the product of his education and environment, and partly of his own individuality. In our attempts to understand the men of a past age we lay stress upon their habits and daily life, but also more and more upon their ideas and ideals. "What it is important for us to know with respect to our own age, or every age, is *not its peculiar opinions, but the complex elements of that moral feeling and character, in which as in their congenial soil opinions grow.*" "No presentation of history can be adequate which neglects the growth of the religious consciousness, of literature, of the moral and physical sciences, of art, of scholarship, and of social life." It is significant of the trend of our interests that the last two presidents of the American Historical Association have emphasized in their presidential addresses the necessity of studying the spiritual motives by which men have been actuated. In this field of endeavor Ranke's warning must be heeded, these factors must be discovered not by the way of philosophical speculation, but by the critical study of facts.

Where can the facts be ascertained? At first historians trusted almost wholly to the writings which had an avowed historical purpose, especially histories and biographies; Herodotus, Thucydides, Livy, Tacitus, Plutarch, Suetonius, Bede, Villehardouin, Clarendon, and similar authors. And the tendency was to follow the author who wrote in the most pleasing or striking style; for centuries William of Tyre was followed for the first crusade with practically no attempt to get back to the sources which he used, although the latter were easily accessible in print. Gradually, however, scholars began to consult annals, chronicles, constitutions, treaties, letters, monuments, coins, weapons, and other historical remains. But still the preference was given to the written account, especially chronicles and memoirs, or recollections. This was natural, because it seemed possible to use these without much preliminary criticism. Careful scholars generally ascertained whether the author was a contemporary, whether he intended to be truthful, what his sympathies were, and summed up their criticisms, as Potthast did, in brief formulas: e. g. "trustworthy"; "very naive"; "written in barbaric, but sincere language"; "full of meat and remarkably well-written." Little attention was paid to the rules of evidence.

Later a reaction set in. Historians began to realize that recollections were seldom accurate, that the human memory could not be trusted, that every writer colored the events, consciously or unconsciously. They demanded that history should be reconstructed from the more objective records, especially the documents, inscriptions, and similar historical remains. This tendency was of the greatest possible import, because such sources required much deeper study and more skill; the methods employed in the criticism of these reacted favorably upon the use of chronicles and memoirs.

Certain classes of sources came into special favor because they could be tested more thoroughly and the facts which were obtained had more objectivity. This was especially true of the legal documents. In the words of Mr. Henry C. Lea: "The history of jurisprudence is the history of civilization. The labors of the lawgiver embody not only the manners and customs of his time, but also its innermost thoughts and beliefs, laid bare for our examination with a frankness that admits no concealment. These afford the surest outlines for a trustworthy picture of the past, of which the details are supplied by the records of the chronicler." Here, as often, Mr. Lea avoided the extreme views held by partisans and stated effectively the truth, that the records of the chroniclers are necessary for the completeness of the picture, although the legal documents are a more trustworthy guide for the general outline. It is noteworthy, too, that Mr. Lea was seeking to know "not only the manners and customs," but also the "innermost thoughts and beliefs." This was his lifelong interest, and in his zeal he examined many sources which he was the first to use.

Historians are working towards this goal and literally everything which has reached us from the past is a source to be used in our study. This evening I want to illustrate this general statement by laying stress upon one class of sources which has been somewhat neglected: what we may call, although inexactly, literary sources. These are especially valuable to those historians, an ever increasing number, who are seeking to discover what in each age the people have struggled for; the ideas which were going out and those which were coming in; the motives and aspirations for which men have been willing to live and to die. In this search, literary sources can not be neglected. "For literature is the wisdom of man and the history of man. 'It acquaints the mind,' I am quoting a man of affairs, the President of the United States,—'by direct contact with the forces which really govern and modify the world from generation to generation. There is more of a nation's politics to be got out of its poetry than out of all its systematic writers upon public affairs and constitutions.' " "A literature is but the means by which the aspirations and ideals of a nation find expression in an abiding form." "No literature is merely fortuitous or accidental, but springs from the very heart of the nation in which it lives." A wide acquaintance with the literary sources of any given period will enable the historian to enter into the life of that age and to realize its wonderful complexity. He will not be likely to select any single one of the sundryological interpretations of history, but will soberly try to discover which ones from the many divers ideals actuated the leaders and how far the masses were responsive, and thus to determine why events took the course that they did. He will also learn incidentally many facts about the daily life and actions which will enable him to understand more fully the conditions of the age. A study of the *Fabliaux*, the laughable stories told in verse in the twelfth and thirteenth centuries, will illuminate the rise of the merchant class, the decline of the lesser nobility, the growth of opposition to the Church, the decay of feudalism and chivalry. Moreover, it will make the student realize that these unnamed and unknown merchants were real men, with a sense of humor and a point of view, in some respects, curiously like that of our own west in the latter half of the nineteenth century.

Caution is necessary. Literary sources have been used more frequently and more fully for classical history than any other, mainly because until recently Greek and Roman history have been given over to scholars better versed in the literature than in other sources. Their treasure trove has been rich, but their writings have often needed correction from the other material which has been preserved. The *Monumentum Ancyranum*, with its bald statements, is as necessary for the understanding of the Augustan Age as the great masterpieces of Vergil and Livy. Literary sources have been less used in the study of medieval and modern times, although not by any means wholly neglected. Professor Turner has often illustrated the Western spirit in the United States by the literary efforts of the people who have made the West.

Possibly the general thesis can be illustrated most easily by taking the recent period, with which you are all familiar, and suggesting some of the writings, which are equally familiar, which will be useful to the future historian trying to understand the age in which we have been living. For the religious interests of the age he must take note of the encyclicals of the popes, the works on modernism, the literature of the missions, and the devotional books which have appeared in such great numbers, including *Science and Health;* but also he must read Mark Twain's writings, *The Warfare of Science and Theology, Robert Elsmere, The Case of Richard Meynell, The Inside of the Cup*, articles in the religious periodicals, and some of the sermons published in the Monday papers,—by no means an easy task. For the social movements he must read works on suffrage, feminism, the sex problem and eugenics; muck-raking articles; writings on the peace movement and war poems; biographies of working men;—these are only illustrations from a vast mass. To understand our complex problems of sectionalism, such books as *Tillie, a Mennonite Maid, Letters of a Homesteader, The Country of the Pointed Firs, The Leopard's Spots*, the writings of Bret Harte, Richard Malcolm Johnston, George Egbert Craddock, and others. By taking these few illustrations for a few problems, I have probably succeeded in one point at least, and that is in bringing out the complexity of the subject; and this complexity is not peculiar to our own age, but is true of every period in history.

This is now recognized by historians and the result is a realization of the necessity of a long preparation. We need not dwell upon such elementary requisites as the knowledge of languages, geography, economics, and psychology. For different fields of history various auxiliary branches must be mastered; archaeology, philology, epigraphy, paleography, chronology, diplomatics, genealogy, numismatics, sigillography, heraldry; fortunately all of these are not necessary in any one branch of history. But all students need to study bibliography and criticism or historical method; for the first excellent tools have been provided, especially in the last twenty years. After Mr. Lea had examined Langlois' *Manual of Bibliography*, he said, "If I could have had such a book fifty years ago, it would have saved ten years of my life." The catalogues of manuscripts which are being published by carefully trained archivists save many students months of useless searching. The work done for the Carnegie Institute by Professor Fish in Rome, Professor Paxson in London and other workers in Spain, France, Germany, England, Holland, Mexico, and other countries has revealed the existence of much new material for the history of the United States. This work and the labors of Professor Burr as historical expert for the Venezuela commission have shown that a man may need a knowledge of philology, paleography, chronology, and diplomatics to study American history. In the case of the Venezuela boundary dispute, the work of the trained expert was of the greatest utility in enabling the commission to reach a correct decision. (It may be of interest in this connection to recall that our own Tank library of Dutch history was exploited in connection with this question, although most of the work was done in the Dutch archives.)

Training in historical method, in the rules of criticism, is indispensible. Ranke's seminar with his three criteria of criticism, precision, and penetration, did much to establish standards of workmanship. Since his day, methods have greatly improved. Rules have been established which make it relatively easy to teach the art of criticism. But it is only by long practice that the art can be mastered, because our natural tendencies lead us astray. "For historical criticism is antagonistic to the normal bent of the mind." "It is not a natural habit; it must be inculcated, and only becomes organic by dint of continued practice." "Many centuries and whole eras of brilliant civilization had to pass away before the first dawn of historical criticism was visible among the most intellectual peoples in the world." Moreover, this criticism demands detachment; it has been peculiarly depressing in the present war to see how many eminent historians in different countries, even our own, have stultified themselves by neglecting the most ordinary rules of historical method.

This last thought leads to a consideration of some of the present tendencies which are dangerous. First we may note the disposition to laud the most recent history as preeminently worthy of study. This theory has been widely accepted by pedagogues and unfortunately has been advocated by a large group of historical students, one of whom "declares roundly that he has no real interest in anything that happened prior to 1870." He does not realize that he can not really know the truth about any of the international complications, or about many of the other events, since 1870. The documents in the archives of the various nations can not be consulted, because each nation establishes "a dead line," usually about fifty or sixty years back, and allows no access to the material since. In connection with the present struggle several of the warring nations have published books of some color, white, orange, gray, etc., giving a part of the diplomatic correspondence prior to the outbreak of the war. Each is carefully edited in order to produce the desired impression, and any trained observer notes at once the incompleteness of each collection. Some supplementary material, real or fictitious, has come to light since the publications, but the whole mass is inadequate and probably no one of us will ever have access to the suppressed material. Our grandchildren will be able to form a more correct idea of the causes which precipitated the conflict. Studying the diplomatic history of the last fifty years is like studying the nervous system of an animal without having access to the spinal cord or brain.

Moreover, exclusive devotion to recent history is a denial of the historical-mindedness which has been called the predominant characteristic of the present era. "An ironical lawyer assures us that it would be better to be convicted of petty larceny than to be found wanting in 'historical-mindedness!' " This devotion is partly due to a pride in our own advance and a contempt for the unenlightened ages which have gone before. Far more true was the saying of Bernard of Chartres, 800 years ago, "We are like pigmys mounted upon the shoulders of giants, so that we can see more and farther than they could; yet not by virtue of the keenness of our eyesight nor through the tallness of our stature, but because we are raised and borne aloft upon the giant mass." This tendency to study only recent history is particularly dangerous, because it is in line with many other ideas in education, and appeals to those who are seeking the line of least resistance. We are reminded of John of Salisbury's criticism of his teachers in the twelfth century; he said that they might have accomplished good work, "had they stood as fast upon the tracks of the elders as they rejoiced in their own discoveries."

I am not arguing that we should not study the most recent history. It is the history of greatest interest to us, and it is vitally necessary that we should understand it as fully as possible. But in order to do this, the background and remote causes must be mastered and our own period must be placed in its proper relation to what has gone before. Only the observer trained in the study of the past can hope to interpret recent events; and he will be very humble in doing so, because he knows how inadequate the sources are, and how great the chances of error. Each new fact necessitates a reconsideration of his hypotheses and frequently the abandonment of some of his tentative conclusions.

Closely akin to the interest in recent history is the overemphasis upon the new facts that are gleaned by the use of instruments of greater precision than our fore-runners knew. It is very easy now to point out the errors made by the great masters in the past, to correct and amplify their statements by the use of better methods and of sources recently come to light. Great is the pride of the scholar who shows how inaccurate his predecessors have been. Yet his work is frequently like the extraction of gold from the tailings left by the original process of mining. The work is well worth doing, and the results are valuable; but the total output is usually small compared with the rich store of metal secured by the original worker. Too frequently the point of view expressed by the saying, "A poor thing, my lord, but mine own," with the emphasis upon the last clause and not the first, has prevailed, and the emphasis has been laid upon the less important. Becuase of this tendency, many of the books on history, and some of the university courses, have been of little value. But probaly history is not more afflicted in this respect than most of the other branches of learning.

Other misleading tendencies might be cited; these two have been chosen because they are especially likely to interfere with the progress of our study. The historian's aim must be to understand the past, to interpret it sympathetically, and to co-ordinate his results, so as to lay a firm foundation for future work. His attention must be directed to man and his achievements and failures. The study must embrace all the remains of men's activity. In presenting the results, however, a careful discrimination must be made between the facts which are significant and those which are of little value. In this process the student shows his real ability; he may know all the rules of criticism, he may have mastered all the necessary auxiliary sciences, he may have exploited all the sources, but if he is not competent to judge which facts should be selected, what material should be used, he will never be a historian. If he has this ability and can present his results in a clear and attractive style, his work may live for a century, or more.

The last statement implies that we have not reached a final stage in our historical work. Most certainly not! This is the greatest inspiration to the historian! He can not tell what the next step will be; he can not tell whether it will be possible, as some hope, to frame "descriptive formulae, qualitative and quantitative," which will enable us to make history more objective and more accurate. He has no means of knowing the sources whence new aid will come. In the last twenty years the unearthing of papyri in Egypt has enabled historians to begin a re-examination of Roman history with notable results. The recent development of statistics has furnished a more exact instrument for testing historical facts. The study of tribal customs and folk lore has added something and promises more. It is certain that each generation will re-interpret the history of the past. The historian can only hope that his own product may be of some use to the future worker; he has the consolation of knowing that if his task is done honestly he is helping in a work which will always interest and command the services of men of like mind, a goodly fellowship. As in his daily investigation he is associating sympathetically with the men of former ages and of by-gone civilizations, so by his written words he may hope to live in future generations and to aid them. Is not this the goal for which every sincere worker in any branch of knowledge is striving?

PROCEEDINGS OF THE ACADEMY,

1914, 1915, 1916.

FORTY-FOURTH ANNUAL MEETING, 1914.

The forty-fourth annual meeting of the Wisconsin Academy of Sciences, Arts, and Letters, in conjunction with The Wisconsin Archeological Society, The Wisconsin Audubon Society, The Madison Mycological Society, The Wisconsin Mycological Society and The Wisconsin Natural History Society, was held at Milwaukee, on Thursday and Friday, April 9th and 10th, 1914, in the Trustees' Room of the Public Museum.

First Session, Thursday, April 9, 2 p. m.

The first session was held at 2 o'clock on Thursday, April 9th, President Dana C. Munro presiding. The following programme was presented:

1. Some Problems Involved in the Cultivation of Medicinal Plants. Edward Kremers.
2. The Garden City Movement in England and Germany. L. S. Smith. Illustrated.
3. The Significance of Highway Maintenance in the United States. L. S. Smith. By title.
4. A New Indicator for Acids and Alkalis. A. F. Gilman.
5. Origin of the Republican Party. A. F. Gilman.
6. Some Variations Noted in Gall Stones. G. A. Talbert.
7. Geologic Occurrence of Radium Ores. Rufus Mather Bagg. Illustrated.
8. The Relation of the Corpus Christi Procession to the Corpus Christi Play in England. Merle Pierson.
9. Some Versions of English Ballads Collected in Milton. Mabel Maxson.
10. William Gager and the Academic Drama at Oxford. Karl Young. By title.

SECOND SESSION, THURSDAY, 7:30 P. M.

The second session was held on the evening of Thursday April 9th, at 7:30 o'clock, when Professor S. W. Williston of the University of Chicago, delivered a lecture on Early Land Animals of North America. This lecture was fully illustrated by many restorations of early extinct animals, for the most part made by the lecturer. The lecture was well attended by the public, and was most interesting and valuable.

THIRD SESSION, FRIDAY, APRIL 10, 9:30 A. M.

The third session was held at 9:30 o'clock on Friday, April 10th, Dr. George P. Barth presiding. The following programme was presented:

11. The Climate of Madison, Wis. 1. A Discussion of the Observations of Temperature, 1869 to 1913. ERIC R. MILLER.
12. The Approach to Popular Literature. ARTHUR BEATTY.
13. A Method for Determining Approximate Metabolic Demands of Plants for Soil Water. H. E. PULLING. By title.
14. Physiological Changes Causing Black Heart in Potato Tubers. E. T. BARTHOLOMEW. By title.
15. Further Studies on Wisconsin Tremellineae. E. M. GILBERT. By title.
16. Successful Method for Growing *Clitocybe illudens* and *Armillaria mellea*. V. H. YOUNG. By title.
17. The Effect of Lateral Pressure on the Formation and Direction of Growth of Plant Organs. J. B. OVERTON. By title.
18. The Development of Botanical Microtechnique. GILBERT M. SMITH. By title.
19. The Reaction of Pigment Cells in the Trout to Chemical Stimuli. JOHN M. LOWE.
20. Fertilization in the Parasitic Copopeda. *Lernaeopoda Edwardsii Olsson.* NATHAN FASTEN.
21. Mutation and Atavism in Plants. HOWLAND RUSSEL.
22. Heat Budgets of European and American Lakes. E. A. BIRGE.
23. Physiological Age as Determined by Growth of Epiphasis of Wrist Bones. A. H. YODER.
24. On Habits and Relationship of Some Muscoid Flies. SIGMUND GRAENICHER.

25. Field Record of the Wisconsin Mycological Society for the Season of 1913. DR. LEWIS SHERMAN.
26. Species of Clitocybe in the Region of the Great Lakes. EDWARD T. HARPER. By title.
27. Notes on Parasitic Fungi in Wisconsin. J. J. DAVIS. By title.
28. American Water-Mites of the Genus Atractides. RUTH MARSHALL. By title.
29. The Land Vertebrates of Ridgeway Bog, Wisconsin; their Ecological Succession and Source of Ingression. HARTLEY H. T. JACKSON. By title.

FOURTH SESSION, FRIDAY, 2 P. M.

The fourth session was held at 2 o'clock on Friday, April 10th, President Dana C. Munro presiding. The session was opened by the annual report of the Secretary and the annual report of the Treasurer, both of which are appended to these minutes.

The report of the Committee on the relations between the Wisconsin Academy of Sciences, Arts and Letters, and affiliated societies, which was appointed at the meeting of 1913, was presented by the chairman as follows:

> "That the Secretary of the Academy be requested to make a complete survey of the state with a view of recording all societies of the state engaged in scientific, art or literary work, their memberships, dues, publications and affiliations with organizations outside of the state of Wisconsin.
>
> (Signed) J. J. DAVIS, *Chairman*."

The members of the committee were as follows:

Dr. J. J. Davis, Chairman, and Prof. W. S. Marshall, representing the Wisconsin Academy of Sciences, Arts and Letters; Dr. George P. Barth and Mr. Henry L. Ward, representing The Wisconsin Natural History Society; Dr. Lewis Sherman and Mr. W. H. Ellsworth, representing The Wisconsin Mycological Society; Mr. H. L. Skavlem and Mr. C. E. Brown, representing The Wisconsin Archeological Society.

The report of the Auditing Committee was received and adopted. This will be found immediately following the Treasurer's report.

The report of the Membership Committee was read by the Secretary. In accordance with the report of the Committee and upon motion, the Secretary was instructed to cast the ballot of the Academy for the following named persons as members of the Academy:

Harris Merrill Barbour, Milton.
Elbert T. Bartholomew, Madison.
Lelia Bascom, Madison.
Harry Kendall Bassett, Madison.
Harold Gibson Brown, Madison.
Charles Henry Bunting, Madison.
William Clifton Daland, Milton.
R. W. Fairchild, Stevens Point.
Alfred James Herrick, Stevens Point.
H. S. Hippensteel, Stevens Point.
D. Nelson Inglis, Milton.
Aaron Guy Johnson, Madison.
Ivey Foreman Lewis, Madison.
Mrs. Lois Kimball Mathews, Madison.
J. W. Mavor, Madison.
Mabel Maxson, Milton.
Mrs. Ellen Torrelle Nagler, Madison.
Merle Pierson, Jefferson.
Annie Pitman, Madison.
Milo M. Quaife, Madison.
Gilbert Morgan Smith, Madison.
A. A. Trever, Appleton.
Charles Francis Watson, Stevens Point.
Alfred Edward Whitford, Milton.
Albert Henry Yoder, Whitewater.
Casimir Douglass Zdanowicz, Madison.

The following programme of papers was presented:

30. A Wisconsin Collection of Native Copper Implements. H. P. HAMILTON.
31. Indian Earthworks and Sites in Adams County. H. E. COLE.
32. Archaeological Researches in Western Wisconsin. GEORGE H. SQUIER. By title.
33. The Fond du Lac Cache of Copper Implements. W. A. TITUS. Read by C. E. BROWN.
34. Cairns and Garden Beds in Winnebago County. GEORGE R. FOX.
35. The Racial Characteristics of Wisconsin's Population. ELLIS B. USHER.
36. Picture Writing by the Esquimaux. GEORGE A. WEST.

37. Archaeological Evidences in Door County. J. P. SCHUMACHER. By title.
38. Investigation of the Antiquities of Juneau County. IRA M. BUELL. By title.
39. Archaeological Researches in the Northwest Wisconsin Counties. CHARLES E. BROWN. By title.
40. Survey of the Antiquities of the Green Lake Region TOWNE L. MILLER. By title.
41. Extension of the Range of Indian Garden Beds and Corn Fields in Wisconsin. CHARLES E. BROWN.
42. Some Problems in Bird Protection. VICTOR KUTCHIN. By title.
43. Vanishing Horse-Sense. VICTOR KUTCHIN. By title.
44. The Struggle for Game Conservation and Game Breeding Foci. A. C. BURRILL.
45. Enforcement of the McLean Law for a Protection of Migratory Birds, etc. E. A. CLEASBY. By title.

Papers 42 and 43 were not read, as Mr. Victor Kutchin was prevented from being present by illness.

Paper 45 was not presented, as Mr. E. A. Cleasby could not leave Iowa at this time because his presence was necessary to provide for the adequate protection of birds. In his absence, Mr. A. C. Burrill read a letter from Mr. Cleasby, gave an explanation of the present situation in Iowa, and presented in some detail the national work for the protection of birds which is being done by Mr. Cleasby.

The dinner for the Academy which was given in the Hotel Wisconsin was attended by some thirty-five members and was very enjoyable. Matters of interest to the participating societies were discussed informally.

The Academy then adjourned, to meet in 1915 in Madison.

REPORT OF THE SECRETARY—1913–1914.

Honorary Members	6
Life Members	12
Active Members	201
Corresponding Members	42
Total	261
New Applications for Membership	22
Total	283
Resignations since March, 1913	5
Deceased since March, 1913	5
Dropped for nonpayment of dues	18
Total	28
Active Members paid to end of 1911	9
Active Members paid to end of 1912	23
Active Members paid to end of 1913	154
Active Members paid to end of 1914	14
Active Members paid to end of 1915	1
	201
New Applicants paid to end of 1914	9

ARTHUR BEATTY, *Secretary.*

TREASURER'S REPORT—1913–1914.

Receipts.

To balance on hand, March 17, 1913	$ 48.87
Receipts from dues and sales of Transactions, March 17, 1913, to April 6, 1914	235.18
Interest on bonds accrued to April 1, 1913	134.70
Interest on bonds accrued to April 1, 1914	137.00
Bonds matured, April 1, 1913	500.00
Bonds matured, April 1, 1914	600.00
Total	$1,655.75

Disbursements.

By expenses	$ 236.97
By Investment in Madison City bonds, April 1, 1913	527.00
By Investment in Madison City bonds, April 1, 1914	700.00
Total	$1,463.97
Balance on hand, April 6, 1914	191.78
Total	$1,655.75

Permanent Investment, 24 Madison City bonds....$2,400.00

ARTHUR BEATTY, *Secretary.*

MILWAUKEE, April 10, 1914.

To the Wisconsin Academy of Sciences, Arts and Letters,
Gentlemen:

Your auditing committee has compared the report of the Treasurer with the books and vouchers and the bonds in his possession and find that the report is correct.

J. J. DAVIS,
HENRY L. WARD.

FORTY-FIFTH ANNUAL MEETING, 1915.

The forty-fifth annual meeting of the Wisconsin Academy of Sciences, Arts, and Letters, in conjunction with the Wisconsin Archeological Society, with the Wisconsin Audubon Society, the Madison Mycological Society, the Wisconsin Mycological Society, and the Wisconsin Natural History Society, was held at Madison on Thursday and Friday, April 1 and 2, 1915, in the Biology Building of the University of Wisconsin. The first session was held at 2 o'clock on Thursday, April 1, President Dana C. Munro, presiding. After some preliminary business, the following programme of papers was presented:

First Session, April 1—2 p. m.

1. Paul Bunyan, Lumberjack. Bernice Stewart. Twenty minutes.
2. The Allegory of the Text of the Vision of Piers the Plowman. Samuel Moore. Fifteen minutes.
3. The Officium Stellae. Karl Young. By title.
4. Methods of Measuring Intelligence. M. V. O'Shea. Thirty minutes.
5. Recent Excavations and Bible Lands. L. B. Wolfenson. Thirty minutes. Lantern slide illustrations.
6. Cyclical Unemployment; Causes and Suggested Remedies. Wilford I. King. Fifteen minutes.
7. Some Features and Functions of a Museum of Natural History. Henry L. Ward. Ten minutes.
8. Wild Life Conservation in Wisconsin. Marie Dickore. Ten minutes.
9. Wild Life Conservation in Mississippi. Victor Kutchin. Ten minutes. (Read by Marie Dickore.)
10. Results of Federal Protection under the McLean Migratory Bird Law. A. Cleasby. Ten minutes. (Read by Marie Dickore.)
11. Plant Pigments Other Than Chlorophyll. Nellie Wakeman. By title

12. A New Control for the Imported Onion Maggot. J. G. SANDERS. Five minutes.
13. Notes on Wisconsin White Grubs and June Beetles. J. G. SANDERS. Five minutes.

SECOND SESSION—7 P. M.

The annual dinner of the Academy was given in the University Club, at which thirty-four members and friends were present. Professor D. C. Munro, President of the Academy, delivered his address as retiring President, on "Some Tendencies in History."

THIRD SESSION, APRIL 2—9:30 A. M.

The third session began at 9:30 o'clock, President Munro presiding. The following programme of papers was presented:

14. How American Cities May Secure Better Pavements at Less Cost. LEONARD S. SMITH. By title.
15. Investigations of Certain Cabbage Diseases. L. R. JONES and M. P. HENDERSON. By title.
16. The Cisco of Lake Mendota. GEORGE WAGNER. Ten minutes.
17. The Net Plankton of Devils Lake. EFFIE RIGDEN MICHENER and C. JUDAY. Ten minutes.
18. Limnological Apparatus. C. JUDAY. Ten minutes.
19. Memory and Color Discrimination in Mud Minnows. GERTRUDE M. WHITE. Fifteen minutes.
20. The Effect of Potassium and Sodium Chlorides on the Pigment Cells of the Trout. JOHN N. LOWE. Ten minutes.
21. Report on the Finding of Fossil Bones in the Vicinity of Madison. A. R. CAHN and C. L. TURNER. Fifteen minutes.
22. The Development of the Embryo of *Sphagnum subsecundum.* G. S. BRYAN. Fifteen minutes. Lantern slide illustrations.
23. On Morbid Changes in the Cells of Leaves due to Injury. J. B. OVERTON and W. E. SLAGG. Ten minutes.

24. Further Cultural Studies in Protococcales. GILBERT M. SMITH. Ten minutes.
25. The Development of the Embryo of *Dioscorea villosa.* PEARL M. SMITH. By title.
26. Some New Cases of Apogamy in Ferns. W. N. STEIL. Ten minutes.
27. The Anatomy of a Peridermium Gall of the Jack Pine. ALBAN STEWART. By title.
28. Studies of some Agarics Fruiting in Culture. V. H. YOUNG. Ten minutes. With photographs.
29. An Easy Method for Determining the Isotonic Coefficients of Solutions. H. E. PULLING. By title.
30. Studies of the Life History of the Organism causing the Crown-gall of Alfalfa. ORVILLE T. WILSON. By title.
31. Some New American Water Mites. RUTH MARSHALL. By title.
32. Notes on Parasitic Fungi in Wisconsin, III. J. J. DAVIS. By title.
33. A Century of the United States Pharmacopoeia. EDWARD KREMERS. 1. Galenicals: Aceta, Clycerite, Liquors, H. A. LANGENHAN. By title.
34. A List of Birds Observed at Pelican Lake, Wisconsin. ROLAND E. KREMERS. By title.
35. A List of Plants Collected at Pelican Lake, Wisconsin. ROLAND E. KREMERS. By title.
36. The Periodicity and Distribution of Radial Growth in Trees and their Relation to the Development of "Annual" Rings. J. G. GROSSENBACHER. By title.
37. Life History, Natural Enemies and the Poisoned Bait Spray as a Method of Control of the Imported Onion Fly (Phorbia Cepetorum Meade), with notes on other Onion Pests. HENRY H. P. SEVERIN and HARRY C. SEVERIN. By title.
38. Species of Lentinus and Parrus in the Region of the Great Lakes. EDWARD T. HARPER. By title.

FOURTH SESSION—2 P. M.

The fourth session was held at 2 o'clock, Mr. Henry L. Ward, presiding. The Secretary presented the following report for 1914:

Honorary Members	6
Life Members	12
Corresponding Members	42
Active Members	216
Total	276
Members resigned	4
Total	272
New Applications for Membership	11
Total Membership	283

The report of the Membership Committee was read by the Secretary. In accordance with the report of the Committee and upon motion, the Secretary was instructed to cast the ballot of the Academy for the following named persons as members of the Academy:

Bachhuber, Leo J., Madison.
Bonnell, J. K., Madison.
Bryan, George S., Madison.
Burke, R. P., M. D., Montgomery, Ala.
Ibsen, Hemen, Madison.
Langenhan, H. A., Madison.
Lowe, J. N., Madison.
Oberholser, Harry Church, Washington.
Toole, Eben Henry, Madison.
Usher, Ellis B., Milwaukee.
Whyte, William, M. D., Madison.

(Signed) ARTHUR BEATTY, *Secretary.*

The Treasurer presented the following report for 1914:

Receipts.

Received from dues and initiations	$161.10
Received from sale of Transactions	3.00
Received from interest on bonds	137.44
One bond matured	100.00
Total	$401.54

Balance on hand, April 8, 1914	191.78
Total	$593.32

Disbursements.

Secretary-Treasurer's Allowance	$200.00
Expenses of meeting, 1914	18.08
Bond	100.00
Safety deposit box rent	3.00
Total	$321.08
Balance on hand, April 1, 1915	272.24
Total	$593.32

(Signed) ARTHUR BEATTY, *Treasurer.*

The Auditing Committee presented their report as follows:

The undersigned, your auditing committee, have examined the accounts and accompanying papers of your treasurer, and find the same in every respect true and correct.

We also find on hand 24 bonds of the City of Madison. We suggest that a record of these bonds be kept in the books of the Treasurer.

(Signed) HENRY L. WARD,
GEORGE WAGNER.

The report of the Nominating Committee, appointed to nominate officers of the Academy for a term of three years was presented:

President, HENRY L. WARD, Milwaukee.
Vice-President of Sciences, C. E. ALLEN, Madison.
Vice-President of Arts, A. C. CLAS, Milwaukee.
Vice-President of Letters, FRANK G. HUBBARD, Madison.
Secretary, ARTHUR BEATTY, Madison.
Treasurer, ARTHUR BEATTY, Madison.
Curator, C. E. BROWN, Madison.
Librarian, WALTER M. SMITH, Madison.

Committee on Publication.

President, ex officio—*Secretary*, ex officio, C. E. ALLEN Madison.

Committee on Membership.

Secretary, ex officio
A. C. BURRILL, Madison.
A. F. MCLEOD, Beloit.
HELEN SHERMAN, Milwaukee.
L. R. INGERSOLL, Madison.

Committee on Library.

The Librarian, ex officio,
PAUL H. DERNEHL, Milwaukee.
GEORGE WAGNER, Madison.
MILO M. QUAIFE, Madison.
C. A. YOUTZ, Appleton.

(Signed) E. A. BIRGE,
J. J. DAVIS,
CHAS. S. SLICHTER.

The report of the Nominating Committee was adopted.
The meeting for the year 1915 was declared adjourned.

ARTHUR BEATTY, *Secretary.*

FORTY-SIXTH ANNUAL MEETING, 1916.

The forty-sixth annual meeting of the Wisconsin Academy of Sciences, Arts and Letters, in joint session with the Wisconsin Archeological Society and the Madison Mycological Society was held at Madison on Thursday and Friday April 13 and 14, 1916, in the Biology Building of the University of Wisconsin. The following programme was carried out, the President occupying the chair:

FIRST SESSION, THURSDAY, APRIL 13—2:30 P. M.

GENERAL BUSINESS.

Secretary's Report for the Year 1915.

Honorary Members	6
Life Members	12
Corresponding Members	43
Active members	216
Total	277

New Applications		14
Total		291

Changes since Last Annual Report.

New Members taken		6
Active Members in 1915		216
		222
Death	1	
Resigned or Dropped	4	
Transferred	1	
	6	
Total		216

Membership Accounts, April 8, 1916.

1 membership paid in full to the end of 1917.
11 memberships paid in full to the end of 1916.
151 memberships paid in full to the end of 1915.
21 memberships paid in full to the end of 1914.
32 memberships not paid since the end of 1913, or 1912, or 1911.
4 applicants for membership have already paid their dues.

The following applicants for membership were presented on behalf of the Committee on Membership:

Solomon F. Acree, Madison.
Edgar A. Baird, Madison.
Henry A. Burd, Madison.
Andrew Grover Du Mez, Madison.
James Johnson, Madison.
E. P. Kuhl, Minneapolis, Minn.
John Robert Moore, Madison.
H. H. Morris, Madison.
L. H. Pammel, Ames, Iowa.
A. S. Pearse, Madison.
A. W. Schorger, Madison.
F. T. Thwaites, Madison.
Nellie A. Wakeman, Madison.
H. F. Wilson, Madison.

Upon motion these applicants were declared members of the Academy.

I regret to report the death on July 21, 1915, of Dr. Lewis Sherman of Milwaukee. By his death the Academy loses a valuable member.

The name of past President D. C. Munro, now of Princeton University, Princeton, New Jersey, is transferred from the Active to the Corresponding Membership.

ARTHUR BEATTY, *Secretary.*

TREASURER'S REPORT FOR 1915.

Receipts.

Received from dues and initiations	$ 222.00
Received from sale of transactions	4.68
Received from interest on bonds	141.00
Ten bonds matured April 1, 1916	1,000.00
	$1,367.68
Balance on hand, April 1, 1915	272.24
	$1,639.92

Disbursements.

Secretary-Treasurer's Allowance	$ 200.00
Safety-Deposit Box Rent	3.00
One bond purchased	109.00
Ten bonds purchased	1,080.00
Two bonds purchased	218.00
	$1,610.00
Balance on hand April 8, 1916	29.92
	$1,639.92

Report of the Auditing Committee, April 14, 1916.

The undersigned, having audited the accounts of the Treasurer, find the same true and correct in every respect. They have also examined the bonds held by the Treasurer for the Academy and find the amounts thereof to be as stated in the Treasurer's Report.

They wish to call attention to the laudable manner in which the Treasurer has collected dues that had remained unpaid for a number of years.

(Signed) GEORGE WAGNER,
R. H. DENNISTON.

Presentation of Papers.

1. More About Paul Bunyan, Lumberjack. K. Bernice Stewart and H. A. Watt. Twenty minutes.
2. Eight Unedited Letters of Joseph Ritson. Henry A. Burd. Twenty minutes.
3. Shakespeare's Sonnets and Plays. Arthur Beatty. Fifteen minutes.
4. Dom Garcie and Le Misanthrope. C. D. Zdanowicz. Fifteen minutes.
5. The Relation of De Roode en Witte Roos to the English Dramatic Tradition of Richard III. O. J. Campbell Jr. By title.
6. The Dramatic Songs of Shakespeare's Predecessors. John Robert Moore. By title.
7. Chaucer's Burgesses. E. P. Kuhl. By title.
8. Thomas Murner, A Christian and Brotherly Admonition to the very Learned Doctor Martinus Luther, etc. 1520. By title.
9. Consultum Theologicum D. D. Hunnii P. M. an liceat ultra sortem erogatae Pecuniae accipere Pensiones, ad instantiam Illustris et magnifici Dn. Georgij Horovathi. Augustae Vindelicorum Typis Johannis Praetorij Anno M D C XXII. Ernst Voss. By title.

The first paper on the programme was discussed by Dean Birge, Dr. Watt, Professor Wagner and Professor Overton.

Second Session, Friday—9:30 p. m.

10. Studies in the Psychology of Fishes. Gertrude M. White. Twelve minutes.
11. The Life History of the Oyster. T. C. Nelson. Twenty-five minutes. Lantern slide illustrations.
12. On a New Myxosporidian, Henneguya Wisconsinensis, p. sp. a parasite of the Urinary Bladder of the Yellow Perch, Perca fluvescens, in Wisconsin. J. W. Mavor and William Strasser. Fifteen minutes. Lantern slide illustrations. Read by William Strasser.

13. On Lymphocystis vitrei, n. sp., a New Disease producing Sporozoan from the Pike-perch, Stizostedion vitreum, and the Epidemic Produced by it in the Waters of Northern Wisconsin. J. W. MAVOR and S. M. FEINBERG. Lantern slide illustrations. By title.
14. The Cell Structure and Zoospore Formation of Pediastrum Boryanum. GILBERT M. SMITH. Ten minutes.
15. A Preliminary List of Algae Found in Wisconsin Lakes. GILBERT M. SMITH. By title.
16. Studies in the Conjugation of the Black Molds. E. A. BAIRD. Ten minutes.
17. The Host Plants of Thielavia Basicola, Zopf. JAMES JOHNSON. Twenty mintues. Lantern slide illustrations.
18. Notes on Parasitic Fungi in Wisconsin, IV. J. J. DAVIS. By title.
19. Peculiarities in the Sex Organs of Venturia inaequalis. C. N. FREY. Ten minutes.
20. Apogamy in a Fern, Nephrodium hertipes. W. N. STEIL. Ten minutes.
21. Reproduction in Aphanomyces, a Fungus Parisitic on Spirogyra. E. M. GILBERT. Ten minutes.
22. Some Factors Affecting Enzyme Formation in Certain Fungi. V. H. YOUNG. Ten minutes.
23. Phytochemical Classics. EDWARD KREMERS. I. The Discovery of the Basic Properties of Morphine by Sertuerner. NELLIE WAKEMAN. By title.
24. A Century of the United States Pharmacopoeia. EDWARD KREMERS. II. Galenical Oleoresins. A. G. DU MEZ. By title.
25. A List of the Aphidae of the World, with Host Plants. H. F. WILSON. By title.
26. A Glacial Gravel Seam in Limestone at Ripon. F. T. THWAITES. Ten minutes. Lantern slide illustrations.
27. Further Studies of the Body Cells Found in Cow's Milk. W. D. FROST. By title.
28. A Quantitative Study of the Bacteria in Various Milks as Determined by Different Methods. W. D. FROST. By title.

AFTERNOON SESSION, FRIDAY—2 P. M.

29. An Hereditary Nervous Defect in Guinea Pigs. H. L. IBSEN and L. J. COLE. Ten minutes. Read by H. L. IBSEN.
30. Mendelian Inheritance in Soy Beans. L. J. COLE and C. M. WOODWORTH. Fifteen minutes. Read by C. M. WOODWORTH.
31. The Winter Temperature of the Mud at the Bottom of Lake Mendota. E. A. BIRGE. Fifteen minutes. Lantern slide illustrations.
32. The Nannoplankton of Lake Mendota. C. JUDAY. Ten minutes.
33. The Preparation of Selenic Acid. VICTOR LENHER and H. H. MORRIS. Five minutes. Read by H. H. MORRIS.
34. Contributions to the Chemistry of the Conifers. A. W. SCHORGER. By title.
35. The Ghost Ceremony of the Pomo Indians of California. SAMUEL A. BARRETT. Twenty minutes. By title.
36. Life and Customs of the Tarahumari Indians of Northern Mexico. R. M. BAGG. Twenty-five minutes. Lantern slide illustrations.
37. California Midden Mounds. I. M. BUELL. Twenty-five minutes.
38. Boundaries of the Effigy Mound Region in Wisconsin. CHARLES E. BROWN. Fifteen minutes.
39. Norwegian Newspapers of the United States. A. O. BARTON.
40. Indian Sites on the Wolf River in Shawano and Waupaca Counties. GEORGE R. FOX. By title.

The paper by Mr. Juday on the Nannoplankton of Lake Mendota was discussed by Dean E. A. Birge.

EVENING SESSION, FRIDAY—7 P. M.

The annual dinner of the Academy was held in the University Club at 7 o'clock, Friday, April 14, President Henry L. Ward, presiding. Thirty-five members were present. Dean E. A. Birge discussed the matter of the publications of the Academy, and Professor George Wagner spoke of the exchange list of the Academy. This subject was further discussed by Dean E. A. Birge, Professor E. B. Skinner, and President H. L. Ward. Librarian Walter M. Smith gave an account of the growth of the Academy Library and made a statement concerning the binding of exchanges. He stated that all the exchanges in common use are now bound, and can be used with facility. Mr. H. E. Cole of Baraboo was called upon for some of his bear stories, and these proved to be very entertaining. Mr. H. E. Skavlem of Janesville responded to the chairman's request for reminiscences of the early days of the Academy. Mr. Skavlem spoke most interestingly of Professor Thure Kumlien, Mr. P. R. Hoy and Increase Lapham. His racy account of the personality and activities of these men was a rare treat.

At a somewhat late hour, the President declared the forty-sixth annual meeting of the Academy adjourned.

ARTHUR BEATTY, *Secretary.*

LIST OF OFFICERS AND MEMBERS, CORRECTED TO JANUARY 1, 1917.

OFFICERS.

President, HENRY L. WARD, Milwaukee.
Vice-President, Sciences, C. E. ALLEN, Madison.
Vice-President, Arts, A. C. CLAS, Milwaukee.
Vice-President, Letters, FRANK G. HUBBARD, Madison.
Secretary, ARTHUR BEATTY, Madison.
Treasurer, ARTHUR BEATTY, Madison.
Curator, C. E. BROWN, Madison.
Librarian, WALTER M. SMITH, Madison.

COMMITTEE ON PUBLICATION.

The President, ex officio,
The Secretary, ex officio,
C. E. ALLEN, Madison.

COUNCIL.

The President, Vice-President, Secretary, Treasurer, Librarian and Past Presidents retaining their residence in Wisconsin.

COMMITTEE ON LIBRARY.

The Librarian, ex officio,
PAUL H. DERNEHL, Milwaukee.
GEORGE WAGNER, Madison.
MILO M. QUAIFE, Madison.
C. A. YOUTZ, Appleton.

COMMITTEE ON MEMBERSHIP.

The Secretary, ex officio,
A. C. BURRILL, Madison.
A. F. MCLEOD, Beloit.
HELEN SHERMAN, Milwaukee.
L. R. INGERSOLL, Madison.

Past Presidents.

HONORABLE JOHN W. HOYT, M. D., LL. D., Washington, D. C., 1870–75.
DR. P. R. HOY, M. D.,* 1876–78.
PRESIDENT A. L. CHAPIN, D. D.,* 1879–81.
PROFESSOR RONALD D. IRVING, Ph. D.,* 1882–84.
PROFESSOR THOMAS C. CHAMBERLIN, Ph. D., Sc. D., LL. D., Chicago, Ill., 1885–87.
PROFESSOR WILLIAM F. ALLEN,† 1888–89.
PROFESSOR EDWARD A. BIRGE, Ph. D., Sc. D., LL. D., Madison, 1889–90.
LIBRARIAN GEORGE W. PECKHAM, LL. D., Milwaukee, 1891–93.*
PRESIDENT CHARLES R. VAN HISE, Ph. D., LL. D., Madison, 1894–96.
PROFESSOR C. DWIGHT MARSH, A. M., Ph. D., Washington, D. C., 1897–99.
PROFESSOR CHARLES S. SLICHTER, M. S., Madison, 1900–1902.
DR. JOHN J. DAVIS, M. D., Racine, 1903–1905.
PROFESSOR LOUIS KAHLENBERG, Ph. D., Madison, 1906–1909.
PRESIDENT SAMUEL PLANTZ, Ph. D., D. D., LL. D., Lawrence College, Appleton, 1910–1912.
PROFESSOR DANA C. MUNRO, A. B., A. M., Princeton, New Jersey, 1913–1915.

HONORARY MEMBERS.

CHAMBERLIN, THOMAS CHROWDER, Hyde Park Hotel, Chicago, Ill.

A. B. (Beloit); Ph. D. (Wisconsin, Michigan); LL. D. (Michigan, Beloit, Columbia, Wisconsin); Sc. D. (Illinois). Head of Geological Department and Director of Walker Museum, University of Chicago, Consulting Geologist U. S. Geological Survey; Consulting Geologist, Wisconsin Natural History Survey; Geological Commissioner, Illinois Geological Survey; Editor, *Journal of Geology*.

GARLAND, HAMLIN, New York, N. Y.

Vice-President, International Institute of Arts and Letters. Chairman of Cliff-Dwellers, of Chicago.

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*Deceased. †Deceased December 9, 1899. Professor Birge elected to fill unexpired term.

JORDAN, DAVID STARR,

President Emeritus of Stanford University, Stanford University, Cal.

M. S., Cornell University, 1872; M. D., Indiana Medical College, 1875; Ph. D., Butler College, 1878; LL. D., Cornell University, 1886, Johns Hopkins University, 1902, Illinois College, 1903; Instructor in Botany, Cornell University, 1871–72; Professor of Natural History, Lombard University, 1872–73; Principal of Appleton (Wis.) Collegiate Institute, 1873–74; Lecturer in Marine Botany at Penikese, 1873–74; Teacher of Natural History, Indianapolis High School, 1874–75; Professor of Biology, Butler College, 1875–79; Instructor in Botany, Harvard Summer School, Cumberland Gap, 1875–76 Assistant to U. S. Fish Commission, 1877–81; Professor of Zoology, Indiana University, 1879–85; President of Indiana University, 1885–91; President of the California Academy of Sciences, 1891–98, 1901–03, 1908; U. S. Commissioner in charge of Fur Setl. Investigations, 1896–98; of Salmon Investigations, 1904; International Commissioner of Fisheries, since 1908; President of the American Association for the Advancement of Science, 1903–09.

TRELEASE, WILLIAM, Urbana, Ill.

B. S. (Cornell); S. D. (Harvard); LL. D. (Wisconsin, Missouri, Washington University); Professor of Botany University of Wisconsin, 1883–5; Professor of Botany Washington University 1885–1913; Director Missouri Botanical Garden, 1889–1912; Professor of Botany University of Illinois, 1913–1916; Vice-President Association Internationale des Botanistes and Chairman American Board of Editors, Botanisches Centralblatt.

WHEELER, W. M., Forest Hills, Boston, Mass.

Ph. D. Professor of Economic Entomology, Harvard University.

LIFE MEMBERS.

BIRGE, EDWARD ASAHEL, 744 Langdon St., Madison

A. B., A. M. (Williams); Ph. D. (Harvard); Sc. D. (Western University of Pennsylvania); LL. D. (Williams). Professor of Zoology and Dean of the College of Letters and Science, University of Wisconsin; Secretary of Commissioners of Fisheries, Wisconsin; Director and Superintendent, Wisconsin Geological and Natural History Survey; Member, Wisconsin State Board of Forestry; Wisconsin Conservation Commission, Vice-President, Phi Beta Kappa.

DAVIS, JOHN JEFFERSON, 629 Mendota Court, Madison

B. S. (Illinois); M. D. (Hahnemann). Physician. Curator of Herbarium, University of Wisconsin.

FLINT, ALBERT STOWELL, 450 Charter St., Madison

A. B. (Hard); A. M. (Cincinnati). Astronomer, Washburn Observatory, University of Wisconsin.

HOBBS, WILLIAM HERBERT,
820 Oxford Road, Ann Arbor, Mich.

B. S. (Worcester Polytechnic Institute); A. M., Ph. D. (Johns Hopkins). Professor of Geology, University of Michigan.

HOYT, JOHN WESLEY, Washington, D. C.

A. M. (Ohio Wesleyan); M. D. (Cincinnati); LL. D. (Missouri) Chairman of the National Committee of Four Hundred to Promote the Establishment of the University of the United States.

MARSH, CHARLES DWIGHT,
3430 Brown St., N. W., Washington, D. C.

A. B., A. M. (Amherst); Ph. D. (Chicago). Physiologist in Bureau of Plant Industry, United States Department of Agriculture.

PLANTZ, SAMUEL, 545 Union St., Appleton

A. M. (Lawrence); Ph. D. (Boston); D. D. (Albion); LL. D. (Baker). President, Lawrence College.

SHARP, FRANK CHAPMAN, 27 Mendota Court, Madison

A. B. (Amherst); Ph. D. (Berlin). Professor of Philosophy, University of Wisconsin.

SKINNER, ERNEST BROWN, 210 Lathrop St., Madison

A. B. (Ohio); Ph. D. (Chicago); Associate Professor of Mathematics, University of Wisconsin.

SLICHTER, CHARLES SUMNER, 636 Frances St., Madison

B. S., M. S. (Northwestern). Professor of Applied Mathematics, University of Wisconsin; Consulting Engineer.

VAN CLEEF, FRANK LOUIS,
39 For Green Place, Brooklyn, N. Y.

A. B. (Oberlin, Harvard); Ph. D. (Bonn). Chief of Sixth Division and Translator in Office of Commissioner of Records, Kings County.

VAN HISE, CHARLES RICHARD, 772 Langdon St., Madison

B. Met. E., B. S., M. S., Ph. D. (Wisconsin); LL. D. (Chicago, Yale, Harvard, Williams, Dartmouth). President, University of Wisconsin; Consulting Geologist, Wisconsin Geological Survey; President, Board of Commissioners, Wisconsin Geological and Natural History Survey; President, Wisconsin State Board of Forestry.

ACTIVE MEMBERS.

ACREE, SOLOMON F., 627 Mendota Ct., Madison

Professor of the Chemistry of Forest Products, University of Wisconsin.

ALLEN, BENNETT MILLS, Lawrence, Kansas

Ph. B. (De Pauw); Ph. D. (Chicago). Professor of Zoology University of Kansas.

ALLEN, CHARLES ELMER, 2014 Chamberlin Ave., Madison

B. S., Ph. D. (Wisconsin). Professor of Botany, University of Wisconsin.

ARZBERGER, EMIL GODFREY, Washington, D. C.
Ph. B. (Wisconsin). Bureau of Plant Industry.

BAGG, RUFUS M. JR., 466 Alton St., Appleton
Professor of English, Lawrence College.

BAIRD, EDGAR A., 740 Langdon St., Madison
Instructor in the University of Wisconsin.

BARBER, W. HARLEY, 120 Thorn St., Ripon, Wis.
A. B. (University of Wisconsin); M. A. (University of Wisconsin). Registrar and Professor of Physics, Ripon College, Ripon, Wis. Member of City Council.

BARDEEN, CHARLES RUSSELL, 25 Mendota Court, Madison
A. B. (Harvard); M. D. (Johns Hopkins). Professor of Anatomy, and Dean of the Medical School, University of Wisconsin.

BARRETT, S. A., Public Museum, Milwaukee
B. S., M. S., Ph. D. (University of California). Anthropologist; Curator of Anthropology, Public Museum, Milwaukee.

BARTH, GEORGE P., 302 21st St., Milwaukee
Physician.

BARTHOLOMEW, ELBERT T., 803 State St., Madison
Assistant Professor of Botany, University of Wisconsin.

BASCOM, LELIA, 139 W. Gilman St., Madison
Instructor in English, University of Wisconsin.

BEATTY, ARTHUR, 1824 Vilas St., Madison
A. B. (Toronto); Ph. D. (Columbia). Assistant Professor of English, University of Wisconsin.

BLACKSTONE, DODGE PIERCE, 921 Wisconsin St., Berlin
A. B., A. M., C. E. (Union).

BLEYER, WILLARD GROSVENOR, 625 Langdon St., Madison
B. L., M. L., Ph. D. (Wisconsin). Professor of Journalism, University of Wisconsin.

BONNELL, JOHN K., 625 Mendota Court, Madison
B. A., Ph. D. Instructor in English, University of Wisconsin.

BRAUN, ADOLPH R., 832 38th St., Milwaukee
Graduate of National German-American Teachers' Seminary, Milwaukee. Teacher of Modern Languages, Milwaukee High School.

BROWN, CHARLES E., 910 Van Buren St., Madison
Secretary and Curator, Wisconsin Archaeological Society; Chief, State Historical Museum.

BROWN, CHARLES NEWTON,
Van Hise Ave. and Roby Road, Madison
LL. B. (Wisconsin). Lawyer.

BROWN, EUGENE ANSON, 2115 Jefferson St., Madison
M. D. (Hahnemann). Physician and Surgeon; Secretary of Board of Federal Pension Examiners, Madison District.

BROWN, HAROLD GIBSON, Annapolis, Md.
Instructor in English.

BRYAN, G. S., 803 State St., Madison
Instructor in Botany, University of Wisconsin.

BUEHLER, HENRY ANDREW, Rolla, Mo.
B. S. (Wisconsin). Geologist; State Geologist of Missouri.

BUNTING, CHARLES HENRY,
2020 Chadbourne Ave., Madison
Professor of Pathology, University of Wisconsin.

BURD, HENRY A., 223 S. Mills St., Madison
Instructor in English, University of Wisconsin.

BURKE, RUSH PEARSON,
602–4–6 Bell Building, Montgomery, Ala.
M. Sc., M. D. Physician and Surgeon.

BUSSEWITZ, M. A., Milwaukee
Professor, Milwaukee State Normal School.

CAIRNS, WILLIAM B., 2010 Madison St., Madison
A. B., Ph. D. (Wisconsin), Assistant Professor of American Literature, University of Wisconsin.

CAMPBELL, O. J., JR., 15 E. Gilman St., Madison
Ph. D. (Harvard). Assistant Professor of English, University of Wisconsin.

CARR, MURIEL B., The Irving, Madison
B. A. (McGill). Instructor in English, University of Wisconsin.

CHANDLER, ELWYN FRANCIS, University, N. D.
A. B., A. M. (Ripon). Professor of Mathematics, University of North Dakota; Assistant Engineer, United States Geological Survey.

CHASE, WAYLAND J., 141 Summit Ave., Madison
A. B., A. M. (Brown). Associate Professor of History, University of Wisconsin.

CLAS, ALFRED CHARLES,
Flat 2, St. James Ct., 815 Grand Ave., Milwaukee
Architect (Ferry & Clas), 419 Broadway, Milwaukee; Member, Board of Park Commissioners.

CLAWSON, ARTHUR BROOKS,
1884 Monroe St., N. W., Washington, D. C.
A. B. (Michigan). Department of Agriculture, Washington.

COLE, LEON J., 1915 Keyes Ave., Madison
A. B. (Michigan); A. M. (Harvard); Ph. D. (Wisconsin). Associate Professor of Experimental Breeding, University of Wisconsin.

COMPTON, J. S., Eureka, Illinois

CONKLIN, G. H., 1204 Tower Ave., Superior
Practicing Physician.

COOL, CHARLES DEAN, 1607 Adams St., Madison
A. B. (Michigan); A. M. (Harvard); Ph. D. (Wisconsin). Assistant Professor of Romance Languages, University of Wisconsin.

CULVER, GARRY EUGENE, 1103 Main St., Stevens Point
A. M. (Denison). Professor of Physical Science, State Normal School.

DALAND, WILLIAM CLIFTON, Milton
M. A., D. D. President and Professor of the English Language and of Biblical Literature, Milton College

DEAN, ALLETTA F., The Hamilton, Madison
Ph. B., Ph. M. (Wisconsin).

DENNIS, ALFRED LEWIS PINNEO,
518 Wisconsin Ave., Madison
A. B. (Princeton); Ph. D. (Columbia). Professor of European History, University of Wisconsin.

DENNISTON, ROLLIN HENRY, Science Hall, Madison
Ph. G., B. S., Ph. D. (Wisconsin). Assistant Professor of Botany, University of Wisconsin.

DERNEHL, PAUL HERMAN,
717–718 Majestic Building, Milwaukee
B. S. (Wisconsin); M. D. (Johns Hopkins). Physician.

DODGE, B. O., New York, N. Y.
Ph. B. (Wisconsin); Ph. D. (Columbia). Instructor in Botany, Secretary-Treasurer Torrey Botanical Club. Department of Botany, Columbia University.

DODGE, ROBERT ELKIN NEIL, 15 W. Gorham St., Madison
A. B., A. M. (Harvard). Assistant Professor of English, University of Wisconsin.

DOWLING, LINNAEUS WAYLAND, 2 Roby Road, Madison
Ph. D. (Clark). Associate Professor of Mathematics, University of Wisconsin.

DOWNES, ROBERT HUGH, 53 West Algoma St., Oshkosh
B. L. (Wisconsin).

DU MEZ, ANDREW GROVER,
Langdon Apartments, 612 Howard Pl., Madison
Director of School of Pharmacy, University of the Philippines.

ELLSWORTH, WILLIAM H., 3302 Wells St., Milwaukee
President, Ellsworth and Thayer Manufacturing Company.

ELY, RICHARD THEODORE, 205 Prospect Ave., Madison
A. B., A. M. (Columbia); Ph. D. (Heidelberg); LL. D. (Hobart). Professor of Political Economy, University of Wisconsin.

FARLEY, JOHN HERBERT, 482 South St., Appleton
A. M. (Lawrence). Professor of Philosophy, Lawrence College.

FERRY, GEORGE BOWMAN, Woodland Court, Milwaukee
Architect (Ferry & Clas).

FINGER, WILLIAM, 177 34th St., Milwaukee
Insurance, Loans and Real Estate Broker.

FINKLER, ADOLPH, 612 Commerce St., Milwaukee
Secretary, Albert Trostel and Sons Company; President, Board of Trustees, National German-American Teachers' Seminary; President, Board of Trustees, German-English Academy.

FISCHER, RICHARD, 119 East Johnson St., Madison
Ph. C., B. S. (Michigan); Ph. D. (Marburg). Professor of Chemistry, University of Wisconsin.

FISH, CARL RUSSELL, 244 Lake Lawn Pl., Madison
A. B. (Brown); A. M., Ph. D. (Harvard). Professor of American History, University of Wisconsin.

FLING, HARRY R., 601 Jackson St., Oshkosh
A. B. (Bowdoin). Professor of Biology, State Normal School.

FROST, WILLIAM DODGE, 310 N. Orchard St., Madison
B. S., M. S. (Minnesota); Ph. D. (Wisconsin). Professor of Bacteriology, University of Wisconsin.

GAY, LUCY MARIA, 216 N. Pinckney St., Madison
B. L. (Wisconsin). Assistant Professor of Romance Languages, University of Wisconsin.

GILBERT, EDWARD MARTINIUS, 25 Spooner St., Madison
A. B. (Wisconsin). Assistant Professor of Botany, University of Wisconsin.

GILMAN, ALBERT G., Ripon, Wis.
Professor of Chemistry, Ripon College.

GLOYER, WALTER O., Geneva, N. Y.
B. A., M. A. (Wisconsin). Associate Botanist, New York Agricultural Experiment Station.

GRAENICHER, SIGMUND, 116 Harmon St., Milwaukee
Ph. D. (Basel); M. (Munchen). Curator, Public Museum.

GREGORY, JOHN GOADBY, 717 Jefferson St., Milwaukee
Associate Editor, *Evening Wisconsin.*

GRIGGS, HORACE WILLIAM, 2421 Sycamore St., Milwaukee
Roundhouse Foreman, C., M. & St. P. Ry. Co.

GUTSCH, MILTON R., Austin, Tex.
Professor of History, University of Texas.

GUYER, MICHAEL F., 138 Prospect Ave., Madison
Professor of Zoology, University of Wisconsin.

HAASE, EWALD, 182 Wisconsin St., Milwaukee
Secretary, Milwaukee Gas Light Company.

HAERTEL, MARTIN H., College Hills, Madison
Ph. B. (Chicago); Ph. D. (Wisconsin). Assistant Professor of German, University of Wisconsin.

HAESSLER, LUISE, Park Ave. and 68th St., New York, N. Y.
A. B. (Chicago). Assistant Professor of German, Normal College of the City of New York.

HALL, EDWARD BENNINGTON,
747 N. Main St., Springfield, Mo.
B. S. (Drury). Assistant Professor, Geology and Mineralogy, Drury College, Springfield.

HARPER, EDWARD T., Geneseo, Illinois

HEDDLE, JOHN R., 1625 Monroe St., Madison

HERRICK, ALFRED JAMES, Stevens Point
Teacher of Physics and Agriculture, State Normal School.

HOHLFELD, ALEXANDER RUDOLPH,
104 Breese Terrace, Madison
Ph. D. (Leipzig). Professor of German, University of Wisconsin; President, Modern Language Association of America; Member of Board of Administration, National German-American Teachers' Seminary, Milwaukee.

HOLMES, SAMUEL JACKSON, Berkeley, California
B. S., M. S. (California); Ph. D. (Chicago). Professor of Zoology, University of California.

HOTCHKISS, W. O., Madison
Geologist, State Highway Commission.

HUBBARD, FRANK GAYLORD, 2006 Monroe St., Madison
A. B. (Williams); Ph. D. (Johns Hopkins). Professor of English, University of Wisconsin.

HUMPHREY, CLARENCE J., Madison
Pathologist, Forest Products Laboratory.

HUTTON, ANDREW J., Box 378, Waukesha
Superintendent, Wisconsin Industrial School for Boys.

IBSEN, H. L., Madison
Assistant in Experimental Breeding, University of Wisconsin.

INGERSOLL, LEONARD R., 1933 Westlawn Ave., Madison
B. S. (Colorado College); Ph. D. (Wisconsin). Associate Professor of Physics, University of Wisconsin.

JACKSON, HARTLEY H. T., Washington, D. C.
U. S. Biological Survey.

JANA, ASHUTOSH, Haria, Bengal, India

JASTROW, JOSEPH, 237 Langdon St., Madison
A. B., A. M. (Pennsylvania); Ph. D. (Johns Hopkins). Professor of Psychology, University of Wisconsin.

JENKS, JUDGE ALDRO, Dodgeville, Wis.

JOHNSON, AARON GUY, 1910 Westlawn Ave., Madison
Plant Pathologist, University of Wisconsin.

JOHNSON, JAMES, 131 Lathrop St., Madison
Assistant Professor of Horticulture, University of Wisconsin.

JOLIVETTE, HALLIE D. M., 900 Campus Ave., Pullman, Wash.

JONES, LEWIS R., 1731 Regent St., Madison
Ph. B., Ph. D. (University of Michigan); Sc. D. (Honorary, University of Vermont). Professor of Plant Pathology, University of Wisconsin.

JUDAY, CHANCEY, 35 Lathrop St., Madison
A. M. (Indiana). Biologist, Wisconsin Geological and Natural History Survey.

KELLEY, FRANK J., 1019 W. Johnson St., Madison
Assistant in Experimental Breeding, University of Wisconsin.

KIND, JOHN LOUIS, The Irving, Sterling Court, Madison
A. B., A. M. (Nebraska); Ph. D. (Columbia). Associate Professor of German, University of Wisconsin.

KREMERS, EDWARD, 1720 Vilas St., Madison
Ph. G., B. S. (Wisconsin); Ph. D. (Gottingen); D. Sc. (Michigan). Director of Course in Pharmacy and Professor of Pharmaceutical Chemistry, University of Wisconsin.

KUHL, E. P., Minneapolis, Minn.
University of Minnesota.

KUTCHIN, MRS. HARRIET LEHMANN, Green Lake, Wis.
A. B. (Ripon); A. M. (Northwestern). Engaged in zoological research.

LANGENHAN, H. AUGUST, 1821 West Lawn Ave., Madison
Instructor in Pharmacy, University of Wisconsin.

LANNERD, WILLARD, 748 Villa St., Racine
B. S. (Purdue). Instructor in Science and Mathematics, Racine High School.

LEITH, CHARLES KENNETH, 240 Langdon St., Madison
B. S., Ph. D. (Wisconsin). Professor of Geology, University of Wisconsin; Non-resident Professor of Structural and Metamorphic Geology, University of Chicago.

LENHER, VICTOR, 158 Summit Ave., Madison
Ph. D. (Pennsylvania). Professor of Chemistry, University of Wisconsin.

LEONARD, WILLIAM ELLERY, 2015 Adams St., Madison
A. B. (Boston University); M. A. (Harvard); Ph. D. (Columbia). Assistant Professor of English, University of Wisconsin.

LIGHTY, WILLIAM HENRY, Highlands, R. F. D. 7, Madison
Ph. B. (Cornell). Secretary of Correspondence-Study Department, University of Wisconsin.

LLOYD-JONES, CHESTER, 151 Summit Ave., Madison
Associate Professor of Political Science, University of Wisconsin.

LOWE, JOHN N., 1302 W. Washington Ave., Madison
Instructor in Zoology, University of Wisconsin.

MCALLISTER, FRED, Austin, Texas
Department of Botany, University of Texas.

MCCASKILL, VIRGIL E., Superior
President, State Normal School.

MCGILVARY, EVANDER BRADLEY, 1902 Arlington Place, Madison
A. B. (Davidson); A. M. (Princeton); Ph. D. (California). Professor of Philosophy, University of Wisconsin.

MCKENNA, MAURICE, 152 S. Main St., Fond du Lac
Lawyer; President, Bar Association of Fond du Lac County.

MCLEOD, ANDREW FRIDLEY, Beloit
Ph. D. (Wisconsin). Professor of Chemistry, Beloit College.

MCMINN, AMELIA, 172 21st St., Milwaukee
B. S. (Wisconsin). Instructor in Biology, State Normal School, Milwaukee.

MARQUETTE, WILLIAM GEORGE, New York, N. Y.
Ph. G. (Northwestern); B. S., Ph. D. (Wisconsin). Assistant Professor of Botany, Columbia University.

MARSHALL, RUTH, De Kalb, Ill.
B. Sc., M. S. (Wisconsin); Ph. D. (Nebraska). Teacher, Northern State Normal.

MARSHALL, WILLIAM STANLEY, 139 E. Gilman St., Madison
B. S. (Swarthmore); Ph. D. (Leipzig). Associate Professor of Entomology, University of Wisconsin.

MASON, MAX, 152 W. Gorham St., Madison
B. S. (Wisconsin). Professor of Mathematical Physics, University of Wisconsin.

MATHEWS, MRS. LOIS KIMBALL, Lathrop Hall, Madison
Dean of Women, Associate Professor of History, University of Wisconsin.

MAURER, EDWARD ROSE, 167 Prospect Ave., Madison
B. C. E. (Wisconsin). Professor of Mechanics, University of Wisconsin.

MAVOR, J. W., Schenectady, N. Y.
Union College.

MAXSON, MABEL, Milton
M. A. Instructor in English, Milton College.

MEACHEM, JOHN GOLDESBROUGH, JR., 745 College Ave., Racine
M. D. (Rush). Physician.

MEAD, WARREN J., 922 Van Buren St., Madison
Assistant Professor of Geology, University of Wisconsin.

MERRILL, MRS. SHERBURNE S., 3355 Grand Ave., Milwaukee
First Vice-President, Wisconsin Humane Society; Second Vice-President, Woman's Club of Wisconsin; President, Public School Art League.

MEYER, BALTASAR HENRY, Washington, D. C.
B. L., Ph. D., LL. D. (Wisconsin). Member Interstate Commerce Commission.

MILLER, WILLIAM SNOW, 2001 Jefferson St., Madison
M. D. (Yale). Associate Professor of Anatomy, University of Wisconsin.

MONROE, C. E., 512 Van Buren St., Milwaukee
A. B. (Oberlin College); LL. B. (Michigan University). Lawyer.

MOORE, JOHN ROBERT, Cambridge, Mass.

MOORE, SAMUEL, Ann Arbor, Mich.

A. B. (Princeton); Ph. D. (Harvard). Associate Professor of English, University of Michigan.

MORRIS, H. H., 423 N. Lake St., Madison

Assistant in Chemistry, University of Wisconsin.

MORRIS, WILLIAM AUGUSTUS PRINGLE, Howard Place, Madison

A. B. (Hamilton). Lawyer.

MUTTKOWSKI, RICHARD ANTONY, Columbia, Mo.

Department of Zoology, University of Missouri.

NADER, JOHN, 991 New York Ave., Rosebank, N. Y.

Architect and Civil Engineer.

NAGLER, MRS. ELLEN TORELLE, 438 W. Washington Ave., Madison

NAYLOR, WILSON SAMUEL, Appleton

Professor, Lawrence College.

NEILSON, WALTER HOPPER, 114 Garfield Ave., Milwaukee

M. D. (Rush). Dean of the Medical Faculty and Professor of the Principles and Practice of Medicine and Clinical Medicine, Milwaukee Medical College.

OBERHOLSER, HARRY CHURCH, Washington, D. C.

Assistant Ornithologist, U. S. Biological Survey.

OLIN, JOHN MYERS, 130 Prospect Ave., Madison

A. B., A. M. (Williams); LL. B. (Wisconsin). Lawyer; Professor of Law, University of Wisconsin.

O'SHEA, M. VINCENT, 140 Langdon St., Madison

B. L. (Cornell). Professor of the Science and Art of Education, University of Wisconsin.

OVERTON, JAMES BERTRAM, 512 Wisconsin Ave., Madison

Ph. B. (Michigan); Ph. D. (Chicago). Professor of Plant Physiology, University of Wisconsin.

OWEN, EDWARD THOMAS, 614 State St., Madison

A. B., Ph. D. (Yale). Emeritus Professor of French and Linguistics, University of Wisconsin.

OWEN, RALPH W., Eau Claire

Litt. B. (Princeton); M. A. (Wisconsin).

PAMMEL, L. H., Ames, Iowa

Professor of Pathology, General and Systematic Botany, Iowa State College.

PARKER, FLETCHER ANDREW, 14 W. Gilman St., Madison

Professor Emeritus of Music, University of Wisconsin; Vice-President, Music Teachers' National Association.

PARKINSON, JOHN BARBER, 516 Wisconsin Ave., Madison
A. B., A. M. (Wisconsin). Vice-President and Professor Emeritus of Constitutional and International Law, University of Wisconsin.

PAXSON, FREDERICK L., 629 Frances St., Madison
Ph. D. (Pennsylvania); Professor of American History, University of Wisconsin.

PEARSE, A. S., 2240 Rowley Ave., Madison
Associate Professor of Zoology, University of Wisconsin.

PEASLEE, LEON D., Milwaukee
Curator of Education, Public Museum.

PELTIER, GEORGE L., Auburn, Alabama
Illinois Agricultural Station.

PHILLIPS, JAMES DAVID, 1925 West Lawn Ave., Madison
B. S. (Illinois). Professor of Drawing, University of Wisconsin.

PIERSON, MERLE PIERSON, 15 W. Dayton St., Madison

PITMAN, ANNIE, 414 N. Henry, Madison
B. A., Ph. D. (Wisconsin). Assistant Professor in Latin, University of Wisconsin.

PORTER, WILLIAM, 735 College Ave., Beloit
A. B., A. M., D. D. (Williams). Professor Emeritus of Latin, Beloit College.

PRETTS, WILLIAM WALTER, Platteville
B. S. (Wisconsin); M. D. (Northwestern). Physician and Surgeon.

QUAIFE, MILO M., 1901 Vilas St., Madison
Secretary, State Historical Society.

REED, GEORGE MATTHEW, 809 Virginia Ave., Columbia, Mo.
A. B. (Geneva); A. M., Ph. D. (Wisconsin). Assistant Professor of Botany, University of Missouri.

RICE, OLE S., Madison
B. S. (Wisconsin). Library Clerk, Office of State Superintendent of Public Instruction.

ROEDDER, E. C. L. C., 1614 Hoyt St., Madison
A. B., A. M., Ph. D. (University of Michigan). Associate Professor of German Philology, University of Wisconsin.

ROHDE, HUGO W., 1275 Stowell Pl., East Milwaukee
Chemist, Schlitz Brewing Company.

SAMMIS, J. L., 234 Breese Terrace, Madison
Associate Professor of Dairying, University of Wisconsin.

SANBORN, JOHN BELL, Wisconsin Building, Madison
B. L., M. L., Ph. D. (Wisconsin). Lawyer; Treasurer, Wisconsin State Bar Association; Lecturer, University of Wisconsin Law School; Member, Wisconsin Council, American Bar Association.

SCHINNER, AUGUSTIN, RIGHT REVEREND, 840 Downer Ave., Milwaukee
D. D., Bishop.

SCHLUNDT, HERMAN, Columbia, Mo.
Professor of Chemistry, University of Missouri.

SCHORGER, A. W., 2021 Kendall Ave., Madison
Lecturer in Forest Products, University of Wisconsin.

SHERMAN, HELEN, 176 Mason St., Milwaukee
B. S., A. M. (Wisconsin).

SHOWERMAN, GRANT, 410 N. Butler St., Madison
A. B., A. M., Ph. D. (University of Wisconsin). Professor of Latin, University of Wisconsin.

SIEKER, WILLIAM CHRISTIAN, 1542 Prospect Place, Milwaukee
B. S. (Wisconsin). Secretary and Treasurer, Manthey-Sieker Company.

SLAUGHTER, MOSES STEPHEN, 633 Frances St., Madison
A. B., A. M. (De Pauw); Ph. D. (Johns Hopkins). Professor of Latin, University of Wisconsin.

SMITH, CORNELL RAE, Milwaukee
Assistant Geologist, Public Museum.

SMITH, ERASTUS GILBERT, 649 Harrison Ave., Beloit
A. B., A. M. (Amherst); A. M., Ph. D. (Gottingen). Professor of Chemistry, Beloit College.

SMITH, GILBERT MORGAN, 1606 Hoyt St., Madison
Instructor in Botany, University of Wisconsin.

SMITH, WALTER MCMYNN, 127 Langdon St., Madison
A. B. (Wisconsin). Librarian, University of Wisconsin.

SMYTHE, SIDNEY T., Delafield
A. B., A. M. (St. Stephen's); B. D. (Nashotah); D. D., Ph. D. (Hobart). President, St. John's Military Academy; Member, Committee on Canons, Protestant Episcopal Church.

SNOW, BENJAMIN WARNER, 221 Langdon St., Madison
Ph. D. (Berlin). Professor of Physics, University of Wisconsin.

SPENCER, MATTHEW LYLE, 8 Alton Place, Appleton
A. B., A. M. (Kentucky Wesleyan College); A. M. (Northwestern University); Ph. D. (University of Chicago). Professor of English, Lawrence College.

SQUIER, GEORGE HULL, Trempealeau
Dairyman.

STARR, WILLIAM J., 135 Marston Ave., Eau Claire
LL. B. (Columbia). Member, Board of Commissioners of Fisheries, Wisconsin; President, Eau Claire Public Library.

STEIDTMANN, E., 2002 Monroe St., Madison
A. B., A. M., Ph. D. (University of Wisconsin). Assistant Professor of Geology, University of Wisconsin.

STICKNEY, M. E., Granville, O.
Denison University.

STOUT, ARLOW BURDETTE, 924 Clymer Place, Madison
A. B. (Wisconsin). Instructor in Botany, University of Wisconsin.

TALBERT, GEORGE A. Ripon
B. S., M. S. (Ohio Wesleyan). Instructor in Biology, Ripon College.

TELLER, EDGAR EUGENE,
228 Elmwood Ave., Buffalo, N. Y.

THORKELSON, HALSTEN JOSEPH BERFORD,
1526 W. Washington Ave., Madison
B. S., M. E. (Wisconsin). Business Manager, University of Wisconsin.

THWAITES, F. T., Turvillwood, Madison
Curator of Geological Museum, University of Wisconsin.

TITUS, W. A., 54 Oak Ave., Fond du Lac
Manufacturer. Member of Board of Visitors, University of Wisconsin.

TOOLE, EBEN H., Turvillwood, Madison

TOOLE, WILLIAM ALEXANDER,
Pansy Heights, Baraboo, Wis.
Pansy Specialist.

TREVER, A. A., 368 State St., Appeton
Ph. D. (Chicago). Professor of Greek, Lawrence College.

TURNEAURE, FREDERICK EUGENE,
166 Prospect Ave., Madison
C. E. (Cornell). Professor of Engineering and Dean of the College of Engineering, University of Wisconsin.

UPDIKE, EUGENE GROVER, Rev.,
148 Langdon St., Madison
Pastor, First Congregational Church, Madison.

USHER, ELLIS B., Colby and Abbott Building, Milwaukee
Publicity Agent.

VAN VLECK, EDWARD BURR,
519 North Pinckney St., Madison
A. B., A. M. (Wesleyan); Ph. D. (Gottingen); LL. D. (Clark). Professor of Mathematics, University of Wisconsin; Editor, *Transactions of the American Mathematical Society.*

VAUGHAN, R. E., 1118 W. Johnson St., Madison
Assistant Professor of Plant Pathology, University of Wisconsin.

VOGEL, MRS. GUIDO CHARLES,
409 Terrace Ave., Milwaukee
B. S. (Wisconsin).

VORHIES, CHARLES TAYLOR, Salt Lake City, Utah
B. S. (Iowa Wesleyan). Professor of Zoology, University of Arizona.

VOSS, ERNEST KARL JOHNANN HEINRICH,
175 Nelson Ave., West Lawn Heights
Ph. D. (Leipzig). Professor of German Philology, University of Wisconsin; Vice-President, Germanic Museum Association.

WADMOND, SAMUEL C., Delavan
Vice-President, Jackson and Jackson Company, Delavan; Secretary of Board, Aram Public Library, Delavan.

WAGNER, GEORGE, 1901 Jefferson St., Madison
Ph. C. (Michigan); A. B. (Kansas); A. M. (Michigan). Assistant Professor of Zoology, University of Wisconsin; Ichthyologist, State Geological and Natural History Survey.

WAKEMAN, NELLIE A., 1814 Ray St., Madison
Instructor in Pharmacy, University of Wisconsin.

WARD, HENRY LEVI,
Milwaukee Public Museum, Milwaukee
Director, Milwaukee Public Museum; Vice-President, Wisconsin Natural History Society.

WATSON, CHARLES FRANCIS, Stevens Point
Teacher of Geography, State Normal School.

WATT, HOMER A., Newark, N. J.
A. B. (Cornell University); A. M., Ph. D. (Wisconsin). Assistant Professor of English, New York University.

WEIDMAN, SAMUEL, 410 North Henry St., Madison
B. S., Ph. D. (Wisconsin). Geologist, Wisconsin Geological and Natural History Survey.

WEST, GEORGE A., 97 Wisconsin St., Milwaukee
Lawyer; President, Board of Trustees, Milwaukee Public Museum.

WHITFORD, ALFRED EDWARD, Milton
M. A. Professor of Mathematics and Physics, Milton College.

WHITSON, ANDREW ROBINSON, Route 7, Madison

B. S. (Chicago). Professor of Soils and Drainage, University of Wisconsin; Field Agent, United States Department of Agriculture.

WHYTE, WILLIAM F., 1108 Garfield St., Madison

M. D. Physician. President, State Board of Health of Wisconsin.

WILSON, H. F., 425 Sterling Pl., Madison

Professor of Economic Entomology, University of Wisconsin.

WINCHELL, ALEXANDER N., 200 Prospect Ave., Madison

B. S. and M. S. (University of Minnesota); D. Sc. (University Paris) Professor of Mineralogy and Petrology, University of Wisconsin, Geologist, Oregon Bureau of Mines and Geology.

WOLFENSON, LOUIS B., 1113 W. Dayton St., Madison

Assistant Professor of Hebrew and Hellenistic Greek, University of Wisconsin.

WOLL, FRITZ WILHELM, Davis, Calif.

B. S., Ph. B. (Christiana); M. S., Ph. D. (Wisconsin). Professor in the California State Agricultural College.

WRIGHT, CLEMENT BLAKE BERGIN, 284 Martin St., Milwaukee

A. B., A. M. (Toronto); B. D. (Nashotah); Ph. D. Kansas City); Clergyman; Canon, Milwaukee Cathedral; Secretary, Diocese of Milwaukee; Librarian, Diocesan Library.

YOUNG, KARL, 433 Lake St., Madison

A. B. (Michigan); A. M. and Ph. D. (Harvard). Professor of English, University of Wisconsin.

ZDANOWICZ, CASIMIR DOUGLASS, 2006 Chadbourne Ave., Madison

Assistant Professor of Romance Languages, University of Wisconsin.

ZIMMERMAN, OLIVER BRUNNER, International Harvester Corporation, Chicago, Ill.

B. S., M. E. (Wisconsin). International Harvester Corporation.

CORRESPONDING MEMBERS

ABBOTT, CHARLES CONRAD, Trenton, N. J.

M. D. (Pennsylvania).

ARMSBY, HENRY PRENTISS, State College, Pa.

B. S. (Worcester Polytechnic); Ph. B., Ph. D. (Yale); LL. D. (Wisconsin). Director of Institute of Animal Nutrition; Expert in Animal Nutrition, United States Department of Agriculture.

BENNETT, CHARLES EDWIN, 1 Grove Place, Ithaca, N. Y.
A. B., Litt. D. (Brown). Professor of Latin Language and Literature, Cornell University.

BRIDGE, NORMAN, Auditorium Building, Los Angeles, Cal.
A. M. (Lake Forest); M. D. (Northwestern, Rush). Emeritus Professor of Medicine, Rush Medical College. Physician.

CAVERNO, CHARLES, Lombard, Ill.
A. B., A. M. (Dartmouth). Professor Emeritus, Ripon College.

CHANDLER, CHARLES HENRY, New Ipswich, N. H.
A. B., A. M. (Dartmouth). LL. D. (Colorado). Clergyman, retired.

COULTER, JOHN MERLE, University of Chicago, Chicago, Ill.
A. B., A. M., Ph. D. (Hanover); Ph. D. (Indiana). Professor of Botany and Head of Department, University of Chicago.

CROOKER, JOSEPH HENRY, 820 South St., Roslindale, Boston, Mass.
D. D. (St. Lawrence, Nashville). Minister, Unitarian Church.

DAVIS, FLOYD, 317 Iowa Loan and Trust Building, Des Moines, Iowa
Ph. B., C. E., E. M. (Missouri); Ph. D. (Miami). Analytical and Consulting Chemist.

EATON, EDWARD DWIGHT, Beloit
A. B., A. M. (Beloit); B. D. (Yale); LL. D. (Wisconsin); D. D. (Northwestern, Yale). President, Beloit College.

ECKELS, WILLIAM ALEXANDER, Easton, Pa.
A. B., A. M. (Dickinson); Ph. D. (Johns Hopkins). Associate Professor of Greek, Lafayette College.

FALLOWS, SAMUEL, 2344 Monroe St., Chicago, Ill.
A. B., A. M., LL. D. (Wisconsin); D. D. (Lawrence, Marietta). Presiding Bishop. Reformed Episcopal Church; President, Board of Managers, Illinois State Reformatory.

HARPER, ROBERT AYLMER, New York, N. Y.
A. B. (Oberlin), Ph. D. (Bonn). Professor of Botany, Columbia University.

HENDRICKSON, GEORGE LINCOLN, 68 Trumbull St., New Haven, Conn.
A. B. (Johns Hopkins); L. H. D. (Western Reserve). Professor of Latin, Yale University.

HODGE, CLIFTON FREMONT, 3 Charlotte St., Worchester, Mass.
A. B. (Ripon); Ph. D. (Johns Hopkins). Professor of Physiology and Neurology and Professor of Biology in the Collegiate Department, Clark University.

HOLDEN, EDWARD SINGLETON,
United States Military Academy, West Point, N. Y.

B. S., A. M. (Washington); Sc. D. (Pacific); LL. D. (Wisconsin, Columbia). Astronomer; Librarian, United States Military Academy, West Point.

HOSKINS, LEANDER MILLER,
365 Lincoln Ave., Palo Alto, Cal.

M. S., C. E. (Wisconsin). Professor of Applied Mathematics, Leland Stanford Jr. University.

IDDINGS, JOSEPH PAXON,
5730 Woodlawn Ave., Chicago, Ill.

Ph. B. (Yale). Professor of Petrology, University of Chicago, Geologist, United States Geological Survey.

KINLEY, DAVID, Urbana, Ill.

A. B. (Yale); Ph. D. (Wisconsin). Dean of the Graduate School and Professor of Economics, University of Illinois.

LEVERETT, FRANK, 312 N. Thayer St., Ann Arbor, Mich.

B. Sc. (Iowa Agricultural). Geologist, United States Geological Survey; Lecturer in Geology, University of Michigan.

LIBBY, ORIN GRANT, Grand Forks, N. D.

B. L., M. L. (Wisconsin). Professor of History, University of North Dakota, State Historical Society of North Dakota.

LURTON, FREEMAN ELLSWORTH, Fergus Falls, Minn.

B. S., M. S. (Carleton); A. M. (Upper Iowa); Ph. D. (Gale). Superintendent of Public Schools; Member, Board of Directors, Fergus Falls Public Library.

LUTHER, GEORGE ELMER,
262 South College Ave., Grand Rapids, Mich.

Cashier, People's Savings Bank; Treasurer, Historical Society of Grand Rapids.

MARX, CHARLES DAVID, Palo Alto, Cal.

B. C. E. (Cornell); C. E. (Karlsruhe). Professor of Civil Engineering, Leland Stanford Jr. University.

MCCLUMPHA, CHARLES FLINT,
56 Church St., Amsterdam, N. Y.

A. B., A. M. (Princeton); Ph. D. (Leipzig). Treasurer, McClumpha Company; Member, Fort Johnson Club; Treasurer, Amsterdam Free Library; Historian, Montgomery County Historical Society; Member, New York State Historical Society.

MOOREHOUSE, GEORGE WILTON,
2069 East 96th St., Cleveland, O.

B. L., M. L. (Wisconsin); M. D. (Harvard). Physician to the Dispensary of Lakeside Hospital and Western Reserve University.

MUNRO, DANA CARLETON, Princeton, N. J.

A. B., A. M. (Brown). Professor of European History, University of Wisconsin.

NEHRLING, HENRY,
Palm Cottage Experiment Garden, Gotha, Orange Co., Fla.

OLIVE, EDGAR W., Brookings, S. D.
Professor of Botany, South Dakota Agricultural College.

PEET, STEPHEN DENISON, 438 57th St., Chicago, Ill.
A. M., Ph. D. (Beloit). Clergyman; Editor, *American Antiquarian and Oriental Journal.*

POTTER, WILLIAM BLEECKER,
1225 Spruce St., St. Louis, Mo.
A. B., A. M., M. E., Sc. D. (Columbia). Mining Engineer and Metallurgist.

POWER, FREDERICK BELDING,
535 Warren St., Hudson, N. Y.
Ph. G. (Philadelphia College of Pharmacy); Ph. D. (Strassburg). Director of Wellcome Chemical Research Laboratories, London, England.

SALISBURY, ROLLIN D., 5730 Woodlawn Ave., Chicago, Ill.
A. M., LL. D. (Beloit). Professor of Geographic Geology, Head of the Department of Geography and Dean of the Graduate School of Science, University of Chicago; Geologist, United States Geological Survey and State Geological Survey of New Jersey.

SAWYER, WESLEY CALEB, 725 Asbury St., San Jose, Cal.
A. B., A. M. (Harvard); A. M., Ph. D. (Gottingen). Professor of French and German and Lecturer on Teutonic Mythology, University of the Pacific.

STONE, ORMOND, University Station, Charlottesville, Va.
A. M. (Chicago). Director of the Leander McCormick Observatory and Professor of Practical Astronomy, University of Virginia.

TOLMAN, ALBERT HARRIS,
5750 Woodlawn Ave., Chicago, Ill.
A. B. (Williams); Ph. D. (Strassburg). Associate Professor of English Literature, University of Chicago.

TOLMAN, HERBERT CUSHING, Nashville, Tenn.
A. B., Ph. D. (Yale); D. D. (Nashville). Professor of Greek, Vanderbilt University; Canon, All Saints' Cathedral.

TOWNLEY, SIDNEY DEAN, Ukiah, Cal.
B. S., M. S. (Wisconsin); Sc. D. (Michigan). Astronomer in Charge of International Latitude Observatory; Lecturer in Astronomy, University of California; Editor of Publications, Astronomical Society of the Pacific.

TURNER, FREDERICK JACKSON, Cambridge, Mass.
A. B., A. M. (Wisconsin); Ph. D. (Johns Hopkins); LL. D. (Illinois); Litt. D. (Harvard). Professor of American History, Harvard University; President, American Historical Association; Member, Massachusetts Historical Association; American Antiquarian Society; Colonial Society of Massachusetts; Wisconsin Historical Society; Mississippi Valley Historical Society, etc.

VAN DE WARKER, ELY, 404 Fayette Park, Syracuse, N. Y.
M. D. (Albany Medical and Union). Surgeon, Central New York Hospital for Women; Consulting Physician, St. Ann's Maternity Hospital; Senior Surgeon, Women's and Children's Hospital; Commissioner of Education, Syracuse.

VERRILL, ADDISON EMERY,
86 Whalley Ave., New Haven, Conn.
B. S. (Harvard); A. M. (Yale). Professor of Zoology, Yale University, Curator of Zoology, Yale University Museum; President Connecticut Academy of Arts and Sciences.

WINCHELL, NEWTON HORACE,
501 East River Road, Minneapolis, Minn.
A. M. (Michigan). Geologist and Archaeologist.

YOUNG, ALBERT ADAMS,
531 South Claremont Ave., Chicago, Ill.
A. B., A. M. (Dartmouth); B. D. (Andover). Clergyman.

MEMBERS DECEASED.

Information of whose decease has been received since the issue of Volume XVII.

BRINCKLEY, WILLIAM JOSHUA, Milwaukee
Lecturer, Public Museum.
Deceased May 1, 1916

HARWOOD, MARY CORINTHIA, Ripon
Professor, Ripon College.
Deceased October 19, 1914

HIPPENSTEEL, H. S. Stevens Point
Professor of Literature, State Normal School, Stevens Point.
Deceased, April 25, 1916

SHERMAN, DR. LEWIS, Milwaukee
Physician and Pharmacist.
Deceased July 2, 1915

EXTRACTS FROM THE 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, * * *[1] 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 contributions to science, literature, and the arts.

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[1] Here follow the names of forty others. Sections 5, 6, 8 and 9 are omitted here as of no present interest. For the charter in full see *Transactions*, vol. viii, p. xi, or earlier volumes.

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 7. Any existing society or institution 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.

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 may be issued in two consecutive parts; so that a publication may 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 statutes 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 1913.

CHAPTER 771.

SECTION 19. That part of section 20.31 of the statutes relating to printing for the Wisconsin Academy of Sciences, Arts, and Letters is amended to read: "not more than two thousand copies * * * *of each number as issued*, of the transactions of the Wisconsin Academy of Sciences, Arts and Letters * * * *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 science, 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 illustrations 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.