SMITHSONIAN

CONTRIBUTIONS TO KNOWLEDGE.

VOL. III.

EVERY MAN IS A VALUABLE MEMBER OF SOCIETY, WHO, BY HIS OBSERVATIONS, RESEARCHES, AND EXPERIMENTS, PROCURES KNOWLEDGE FOR MEN.—SMITHSON.

CITY OF WASHINGTON:

PUBLISHED BY THE SMITHSONIAN INSTITUTION.

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ADVERTISEMENT.

This volume forms the third of a series, composed of original memoirs on different branches of knowledge, published at the expense, and under the direction, of the Smithsonian Institution. The publication of this series forms part of a general plan adopted for carrying into effect the benevolent intentions of James Smithson, Esq., of England. This gentleman left his property in trust to the United States of America, to found at Washington an institution which should bear his own name, and have for its objects the "*increase* and *diffusion* of knowledge among men." This trust was accepted by the Government of the United States, and an Act of Congress was passed August 10th, 1846, constituting the President and the other principal executive officers of the general government, the Chief Justice of the Supreme Court, the Mayor of Washington, and such other persons as they might elect, honorary members, an establishment under the name of the "Smithsonian Institution for the increase and diffusion of knowledge among men." The members and honorary members of this establishment are to hold stated and special meetings for the supervision of the affairs of the Institution, and for the advice and instruction of a Board of Regents, to whom the financial and other affairs are entrusted.

The Board of Regents consists of three members ex officio of the establishment, namely, the Vice-President of the United States, the Chief Justice of the Supreme Court, and the Mayor of Washington, together with twelve other members, three of whom are appointed by the Senate from its own body, three by the House of Representatives from its members, and six persons appointed by a joint resolution of both houses. To this board is given the power of electing a Secretary and other officers, for conducting the active operations of the Institution.

To carry into effect the purposes of the testator, the plan of organization evidently should embrace two objects—one, the increase of knowledge by the addition of new truths to the existing stock; the other, the diffusion of knowledge, thus increased, among men. No restriction is made in favor of any kind of knowledge, and hence each branch is entitled to, and should receive, a share of attention.

The Act of Congress, establishing the Institution, directs as a part of the plan of organization, the formation of a Library, a Museum, and a Gallery of Art, together with provisions for physical research and popular lectures, while it leaves to the Regents the power of adopting such other parts of an organization as they may deem best suited to promote the objects of the bequest.

After much deliberation, the Regents resolved to divide the annual income into two equal parts—one part to be devoted to the increase and diffusion of knowledge by means of original research and publications—the other half of the income to be applied in accordance with the requirements of the Act of Congress, to the gradual formation of a Library, a Museum, and a Gallery of Art.

The following are the details of the two parts of the general plan of organization provisionally adopted at the meeting of the Regents, Dec. 8th, 1847.

DETAILS OF THE FIRST PART OF THE PLAN.

I. To increase Knowledge.—*It is proposed to stimulate research, by offering rewards for original memoirs on all subjects of investigation.*

1. The memoirs thus obtained, to be published in a series of volumes, in a quarto form, and entitled "Smithsonian Contributions to Knowledge."

2. No memoir, on subjects of physical science, to be accepted for publication, which does not furnish a positive addition to human knowledge, resting on original research; and all unverified speculations to be rejected.

3. Each memoir presented to the Institution, to be submitted for examination to a commission of persons of reputation for learning in the branch to which the memoir pertains; and to be accepted for publication only in case the report of this commission is favorable.

4. The commission to be chosen by the officers of the Institution, and the name of the author, as far as practicable, concealed, unless a favorable decision be made.

5. The volumes of the memoirs to be exchanged for the Transactions of literary and scientific societies, and copies to be given to all the colleges, and principal libraries, in this country. One part of the remaining copies may be offered for sale; and the other carefully preserved, to form complete sets of the work, to supply the demand from new institutions.

6. An abstract, or popular account, of the contents of these memoirs to be given to the public, through the annual report of the Regents to Congress.

II. To increase Knowledge.—*It is also proposed to appropriate a portion of the income, annually, to special objects of research, under the direction of suitable persons.*

1. The objects, and the amount appropriated, to be recommended by counsellors of the Institution.

2. Appropriations in different years to different objects; so that, in course of time, each branch of knowledge may receive a share.

3. The results obtained from these appropriations to be published, with the memoirs before mentioned, in the volumes of the Smithsonian Contributions to Knowledge.

4. Examples of objects for which appropriations may be made:—

(1.) System of extended meteorological observations for solving the problem of American storms.

(2.) Explorations in descriptive natural history, and geological, mathematical, and topographical surveys, to collect materials for the formation of a Physical Atlas of the United States.

(3.) Solution of experimental problems, such as a new determination of the weight of the earth, of the velocity of electricity, and of light; chemical analyses of soils and plants; collection and publication of articles of science, accumulated in the offices of Government.

(4.) Institution of statistical inquiries with reference to physical, moral, and political subjects.

(5.) Historical researches, and accurate surveys of places celebrated in American history.

(6.) Ethnological researches, particularly with reference to the different races of men in North America; also explorations, and accurate surveys, of the mounds and other remains of the ancient people of our country.

I. To diffuse Knowledge.—*It is proposed to publish a series of reports, giving an account of the new discoveries in science, and of the changes made from year to year in all branches of knowledge not strictly professional.*

1. Some of these reports may be published annually, others at longer intervals, as the income of the Institution or the changes in the branches of knowledge may indicate.

2. The reports are to be prepared by collaborators, eminent in the different branches of knowledge.

3. Each collaborator to be furnished with the journals and publications, domestic and foreign, necessary to the compilation of his report; to be paid a certain sum for his labors, and to be named on the title-page of the report.

4. The reports to be published in separate parts, so that persons interested in a particular branch, can procure the parts relating to it without purchasing the whole.

5. These reports may be presented to Congress, for partial distribution, the remaining copies to be given to literary and scientific institutions, and sold to individuals for a moderate price.

The following are some of the subjects which may be embraced in the reports:—

I. PHYSICAL CLASS.

1. Physics, including astronomy, natural philosophy, chemistry, and meteorology.
2. Natural history, including botany, zoology, geology, &c.
3. Agriculture.
4. Application of science to arts.

II. MORAL AND POLITICAL CLASS.

5. Ethnology, including particular history, comparative philology, antiquities, &c.
6. Statistics and political economy.
7. Mental and moral philosophy.
8. A survey of the political events of the world; penal reform, &c.

III. LITERATURE AND THE FINE ARTS.

9. Modern literature.
10. The fine arts, and their application to the useful arts.
11. Bibliography.
12. Obituary notices of distinguished individuals.

II. TO DIFFUSE KNOWLEDGE.—*It is proposed to publish occasionally separate treatises on subjects of general interest.*

1. These treatises may consist of valuable memoirs translated from foreign languages, or of articles prepared under the direction of the Institution, or be procured by offering premiums for the best exposition of a given subject.

2. The treatises to be submitted to a commission of competent judges, previous to their publication.

DETAILS OF THE SECOND PART OF THE PLAN OF ORGANIZATION.

This part contemplates the formation of a Library, a Museum, and a Gallery of Art.

1. To carry out the plan before described, a library will be required, consisting, 1st, of a complete collection of the transactions and proceedings of all the learned societies in the world; 2d, of the more important current periodical publications, and other works necessary in preparing the periodical reports.

2. The Institution should make special collections, particularly of objects to verify its own publications. Also a collection of instruments of research in all branches of experimental science.

3. With reference to the collection of books, other than those mentioned above, catalogues of all the different libraries in the United States should be procured, in order that the valuable books first purchased may be such as are not to be found elsewhere in the United States.

4. Also catalogues of memoirs, and of books in foreign libraries, and other materials, should be collected, for rendering the Institution a centre of bibliographical knowledge, whence the student may be directed to any work which he may require.

5. It is believed that the collections in natural history will increase by donation, as rapidly as the income of the Institution can make provision for their reception, and, therefore, it will seldom be necessary to purchase any article of this kind.

6. Attempts should be made to procure for the gallery of art, casts of the most celebrated articles of ancient and modern sculpture.

7. The arts may be encouraged, by providing a room, free of expense, for the exhibition of the objects of the Art-Union, and other similar societies.

8. A small appropriation should annually be made for models of antiquity, such as those of the remains of ancient temples, &c.

9. The Secretary and his assistants, during the session of Congress, will be required to illustrate new discoveries in science, and to exhibit new objects of art; distinguished individuals should also be invited to give lectures on subjects of general interest.

In accordance with the rules adopted in the programme of organization, each memoir in this volume has been favorably reported on by a commission appointed for its examination. It is however impossible, in most cases, to verify the statements of an author, and, therefore, neither the Commission nor the Institution can be responsible for more than the general character of a memoir.

The following rules have been adopted for the distribution of the quarto volumes of the Smithsonian Contributions.

1. They are to be presented to all learned societies which publish Transactions, and give copies of these, in exchange, to the Institution.

2. Also, to all foreign libraries of the first class, provided they give in exchange their catalogues or other publications, or an equivalent from their duplicate volumes.

3. To all the colleges in actual operation in this country, provided they furnish, in return, meteorological observations, catalogues of their libraries and of their students, and all other publications issued by them relative to their organization and history.

4. To all States and Territories, provided there be given, in return, copies of all documents published under their authority.

5. To all incorporated public libraries in this country, not included in any of the foregoing classes, now containing more than 7000 volumes; and to smaller libraries, where a whole State or large district would be otherwise unsupplied.

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APPENDIX.

SMITHSONIAN CONTRIBUTIONS TO KNOWLEDGE.

OBSERVATIONS

ON

TERRESTRIAL MAGNETISM.

BY

JOHN LOCKE, M.D., M.A.P.S.
PROFESSOR OF CHEMISTRY AND PHARMACY IN THE MEDICAL COLLEGE OF OHIO.

ACCEPTED FOR PUBLICATION
BY THE SMITHSONIAN INSTITUTION,
JULY, 1851.

COMMISSION

TO WHICH THIS PAPER HAS BEEN REFERRED.

PROF. ELIAS LOOMIS,
JULIUS E. HILGARD, ESQ.

JOSEPH HENRY,
Secretary S. I.

OBSERVATIONS

MADE IN THE

YEARS 1845, '46, AND '47, TO DETERMINE THE MAGNETICAL DIP AND DECLINATION, AND INTENSITY OF MAGNETICAL FORCE IN SEVERAL PARTS OF THE UNITED STATES.

THE Observations here recorded form part of a series commenced in 1838, and continued annually for ten years. The results, from 1838 to 1844, inclusive, were published, in 1846, in the "Transactions of the American Philosophical Society."

The first paper on the subject, read to that Society April 19, 1844, is prefaced by some popular definitions of the elements of terrestrial magnetism, and by an account of the instruments used in making the observations. To this preface the reader is referred for the proper beginning of the subject to which the present pages form a continuation. But as my researches have since been, to a considerable extent, incorporated by Col. Sabine in his "Contributions to Terrestrial Magnetism," they have received additional value and interest by being now connected with other labors of the same kind throughout the enlightened world. It seems, therefore, not improper to quote so much of that paper as may show the degree of confidence to be placed in my results, and the basis upon which rests their connection with similar observations in this and other countries.

Corresponding Observations.—It so happened that Capt. Lefroy, R. A., in his magnetic researches, chiefly confined to the British Provinces of North America, made observations at several stations which were, unknowingly, occupied by myself, either before or after him. They were made with different instruments, and at different temperatures, and could be compared only after proper corrections and reductions. We both communicated our observations, independently of each other, to Col. Sabine, who reduced and compared them with very satisfactory results as regards their correspondence and the mutual support which they afford to each other. I copy the following from Col. Sabine's "Contributions to Terrestrial Magnetism," published in the "Philosophical Transactions" for 1846.

"*Total Intensity as observed by* Capt. LEFROY *and* Dr. LOCKE, *at Stations nearly identical.*

Station.	Observer.	Mag. force.	Observer.	Mag. force.
Detroit	LEFROY	1.814	LOCKE	1.815
Toronto	LEFROY	1.836	LOCKE	1.836
Princeton	LEFROY	1.783	LOCKE	1.783
Albany	LEFROY	1.797	LOCKE	1.792
New York	LEFROY	1.769	LOCKE	1.781
New Haven	LEFROY	1.773	LOCKE	1.773
Cambridge	LEFROY	1.777	LOCKE	1.774
Washington[1] . . .	LEFROY	1.772	LOCKE	1.773
Washington[2] . . .	LEFROY	1.778	LOCKE	1.800
Baltimore	LEFROY	1.782	LOCKE	1.784

[1] Grounds of the Capitol.

[2] Magnetic Observatory.

At several of the above places, the stations were not strictly identical; and it may be seen, from the results at Washington, what changes are often produced by a very short distance, such as from the Capitol to the Observatory; still, even here, Capt. Lefroy's results and my own both confirm the fact that the difference exists. It will be seen, also, that there is a discrepancy of 0.011 between us at New York, and likewise one of 0.009 at Philadelphia; but even that amount of difference will be found by the same observer, with the same instruments, at different times, in an identical locality.

Reduction of my Observations to the Arbitrary Scale most commonly used.—In the following tables, I have assumed the terrestrial magnetism at Longworth's Garden, in Cincinnati, as a provisional standard of comparison, or a base of all of my observations. It was, therefore, important that this standard or base should be strictly compared with other bases more generally connected and compared; and it was with this view that, at the request of Col. Sabine, I made observations at Toronto the base of the British observations in North America.

Col. Sabine has made the comparison as extensively as possible from the observations of Capt. Lefroy and myself; and his conclusions are quoted below, from the paper to which I have already referred, p. 313.

"Collecting into one view the results of the three comparisons, we have—

"1. By the direct comparison of the horizontal force at Cincinnati and Toronto, by Dr. Locke, 1.795.[1]

"2. By three intermediate stations, at which the ratios of the horizontal force were determined by Dr. Locke to the force at Cincinnati, and by Capt. Lefroy to the force at Toronto, 1.794.

"3. By six intermediate stations at which the ratios of the horizontal force were determined to the force at Cincinnati by Dr. Locke, and the ratios of the total force to its value at Toronto by Capt. Lefroy, 1.796.

"The total force at Cincinnati, the base station of Dr. Locke's survey, has, therefore, been taken at 1.795."

Hence, to reduce the total intensity at any station named in my paper to the comparative or "arbitrary scale," it is only necessary to apply the following simple equation—

$$x = \frac{1.795\, a}{1000},$$

in which $a =$ the tabulated total intensity at any station in my papers, and $x =$ the arbitrary or comparative quantity sought.

Explanation of the following Tables.—At the head of each is placed the date, the name of the place, the latitude and the longitude, either from the best observations or from the most approved maps—Tanner's being, for the most part, preferred. In the Iowa and Wisconsin region, Jackson's map was used, and in the region of Lake Superior, Capt. Bayfield's, as published by the Society for the Promotion of Useful Knowledge. In regions where nothing better was available, I have reduced the United States surveys, made by chain-measuring in the woods, to an approximate

[1] Total force at Cincinnati.

geodetic latitude and longitude. This I have done, especially in the upper peninsula of Michigan, taking the Sault St. Mary as the starting-point. But these latitudes and longitudes are, at best, only approximate.

The tabulated results are given in ten columns. In the first, is placed the dip or inclination, and sometimes, also, the variation or declination; in the second, the number designating the intensity needle; in the third, the epoch of commencing of vibrations of the intensity needles; in the fourth, the duration of 500 vibrations; in the fifth, the mean temperature, as indicated by the interior thermometer; in the sixth, the calculated duration of 500 vibrations, at the standard temperature of 60° F.; in the seventh, the square of the number found in the sixth; in the eighth, the horizontal intensity, that at Cincinnati, at some specified time, being reckoned 1000; in the ninth, the total intensity of force in terms of the above-named horizontal intensity at Cincinnati; in the tenth, the total intensity of force, that at Cincinnati being 1000.

VIII. Series for 1845.—Cincinnati to the White Mountains.

Dip.	No. of needle.	Epoch of commencing vibration. hrs. min. sec.	Duration of 500 vibrations.	Temperature.	Calculated duration at 60°.	Square of the preceding.	Horizontal intensity.	Total intensity: hor. being 1000.	Total intensity: that at Cincinnati = 1000.
136. **Cincinnati, Ohio**.—Lat. 39° 06′. Long. 84° 22′ W. April 23, 1845.									
70° 26′	4	11 27 5.4 P	1112	81.5	1110.45	12330992025			
Var. 4 4 E.	5	4 58 03.8	1349.4	82	1347.32	18152711824			
	6	5 28 02.4	1344.4	80.5	1341.97	18008834809	1000	2986.0	1000
137. **Marietta, Ohio**.—Lat. 39° 26′ N. Long. 81° 29′ W. April 28, 1845.									
71° 22′ 15″	4	1 52 57.6 P	1136.4	83.5	1134.66	12874533150	957.76		
Var. 2 25 E.	5	12 22 03.6	1380.4	84.5	1378.03	18989666809	955.46		
	6	12 53 00.8	1378.8	85.5	1375.71	18957709969			
						Mean	956.61	2994	1002.50
138. Near **Marietta**—On a hill below the Muskingum River. April 28, 1845.									
71° 23′ 02″ Var. 2 25 E.	5	6 00 04 P	1384	82.5	1381.82	19094265124	950.69	2982	999.87

REMARKS.

136. Cincinnati, Ohio.—Geology as heretofore described.

137. Marietta, Ohio.—The above observations were made on Marietta Island. Soil alluvium, underlaid at unknown depths by the rocks of the coal-formation, sandstone, shale, &c.

138. Near Marietta—Geology: rocks of the coal-formation. Clear.

Dip.	No. of needle.	Epoch of commencing vibration. hrs. min. sec.	Duration of 500 vibrations.	Temperature.	Calculated duration at 60°.	Square of the preceding.	Horizontal intensity.	Total intensity: hor. being 1000.	Total intensity: that at Cincinnati = 1000.
139. Wheeling Hill, Va.—Lat. 40° 08′ N. Long. 80° 47′ W. April 30, 1845.									
72° 13′ 45″	4	3 52 56.6 P	1159.6	78.0	1156.25	13369140625	922.3		
Var. 2 04 E.	5	4 21 04.0	1408.8	79.0	1406.80	19793113344	917.1		
	6	4 51 00.4	1404.4	78.0	1402.63	19673709169	915.1		
						Mean	918.2	3007	1007
140. Pittsburg, Pa.—Lat. 40° 26′ N. Long. 79° 58′ W. May 3, 1845.									
72° 46′ 45″	4	4 02 57.6 P	1178.0	74.0	1176.93	13851642249	890.2		
Var. 0 33 04 W.	5	4 29 00.8	1432.0	72.0	1430.80	20471886400	886.7		
	6	5 13 00.8	1428.8	71.5	1427.35	20373280225	883.9		
						Mean	886.9	2993.7	1003.4
141. Alleghany Summit, Pa.—Lat. 40° 27′ N. Long. 78° 10′ W. May 5, 1845.									
72° 27′ 05″	5	11 43 04.4 A	1418.4	58	1418.3	20115748900	902.41		
	6	12 43 04.0 P	1412.4	60	1412.4	19948737600	902.75		
						Mean	902.58	2993.2	1002.5
142. Cambridge, Mass.—Lat. 42° 22′ 15″. Long. 71° 7′ 21″. June 2, 1845.									
74° 19′ 26″	4	2 58 20 P	1244.0	87.0	1242.7	15443032900	798.48		
Var. 9 32 00 W.	5	3 34 00.8	1612.0	87.0	1509.15	22775337225	797.03		
	6	4 07 04.0	1508.4	87.0	1504.8	22644230400	790.87		
						Mean	795.46	2944.1	985.99
143. Portland, Maine.—Lat. 43° 41′ N. Long. 70° 20′ 30″. June 4, 1845.									
75° 13′ 10″	4	5 11 01.8 P	1277.2	79.5	1275.5	16269002500	755.95		
Var. 11 28 20 W.									
Portland Maine.—F. O. J. Smith. June 5, 1845.									
	5	12 59 00.0 P	1555.6	82.0	1553.2	24123302400	752.47		
	6	1 31 01.2	1548.0	82.0	1545.0	23870250000	754.44		
						Mean	753.46	2955.0	989.66

REMARKS.

139. Wheeling Hill, Va.—On the hill, immediately back of the town. Geology: sandstone and shales of the coal-formation. Cloudy, threatening to rain.

140. Pittsburg, Pa.—Locality: "Whale's back." Geology: a hill of shale belonging to the coal-formation.

141. Alleghany Summit, Pa.—Geology: sandstone and shale of the coal-formation.

142. Cambridge, Mass.—Within the new magnetical observatory of Harvard University, about one mile northwardly from the locality of the experiments of 1841. Geology: deep diluvium, superimposed on gneiss rocks.

143. Portland, Maine.—Geology: gneiss rock, traversed by veins of granite. Soil thin and wet. Clear, with some very slight showers.

Dip.	No. of needle.	Epoch of commencing vibration. hrs. min. sec.	Duration of 500 vibrations.	Temperature.	Calculated duration at 60°.	Square of the preceding.	Horizontal intensity.	Total intensity: hor. being 1000.	Total intensity: that at Cincinnati = 1000.
144. Locke's Mills, Maine.—Lat. 44° 23′ 34″ N. Long. 70° 44′ W. June 15, 1845.									
75° 50′ 40″	4	3 50 02.4 P	1302.4	77.5	1300.92	16923928464	728.60		
Var. 12 08 00 W.	5	5 23 01.6	1583.2	71.0	1582.00	25027240000	725.32		
	6	4 48 01.2	1577.2	74.0	1575.26	24814440676	725.74		
						Mean	726.55	2970.9	994.96
145. Charles R. Locke's, in Bethel, Maine.—Lat. 44° 27′ 46″ N. Long. 70° 51′ W. June 10, 1845.									
75° 51′ Var. 11 50 W.	4	5 11 05.2 P	1304.0	85.0	1302.00	16952040000	727.40	2975.5	996.51
146. Gorham, N. H.—Lat. 44° 27′ N. Long. 71° 13′ W. June 17, 1845.									
75° 33′ 25″	4	7 55 02.4 A	1278.4	65.0	1278.00	16568323524	744.24	2983.9	999.32
147. Mount Washington, White Mountains.—Lat. 44° 16′ 34″ Long. 71° 19′. June 18, 1845.									
75° 45′	5	4 14 03.2 P	1577.2	46.0	1579.14	24936831396	728.66	2960.0	991.5
	0	4 50 00.0	1572.4	44.0	1574.18				
148. Camp on Mount Washington, about one mile westwardly from the summit. June 19, 1845.									
75° 50′ 49″	5	2 44 01.2 P	1578.8	69.7	1577.73	24892319529	729.25	2981.6	998.66
149. Fabyan's Hotel, seven miles west of Mount Washington.—Lat. 44° 16′ 15″ N. Long. 71° 29′ W. June 20, 1845.									
75° 39′ 54″	4	7 55 02.0 A	1298.0	70.0	1297.15	16825981225	732.85		
Var. 11 32 00 W.	5	9 00 04.8	1573.2	68.0	1572.09	24714669681	734.46		
	6	9 32 03.2	1568.0	63.0	1567.60	24573697600	732.85		
						Mean	733.39	2960.3	991.41

REMARKS.

144. Locke's Mills, Maine.—Geology: deep drift, filled with large bowlders of granite and gneiss rocks, gravel, and sand, forming what is known by the name of "Pine plane." Mountains in the neighborhood, gneiss and granite, from 2000 to 3000 feet high.

145. Charles R. Locke's, in Bethel, Maine.—Geology: on the fertile alluvion of Sunday River; gneiss and granite at unknown depths, and in the adjacent hills and mountains.

146. Gorham, N. H.—Locality: at the bend of the Androscoggin, and near to the White Mountains. Geology: a mass of small bowlders and gravel; gneiss and gravel below.

147. Mount Washington, White Mountains.—Geology: gneiss rock, broken at the surface into a pile of huge angular masses, but solid and in place below.

148. Camp on Mount Washington.—Geology: gneiss rock of Mount Washington.

149. Fabyan's Hotel.—Geology: alluvion of the Amonoosuc River.

Dip.	No. of needle.	Epoch of commencing vibration. hrs. min. sec.	Duration of 500 vibrations.	Temperature.	Calculated duration at 60°.	Square of the preceding.	Horizontal intensity.	Total intensity; hor. being 1000.	Total intensity: that at Cincinnati = 1000.
150. Montpelier, Vt.—Lat. 44° 17′ N. Long. 72° 36′ W. June 25, 1845.									
75° 16′ 15″	5	9 27 08 A	1549.6	60.0	1549.60	24012601600	755.96		
	6	11 04 52	1547.0	58.0	1547.40	23944467600	752.11		
						Mean	754.03	2965.8	998.10
151. Burlington, Vt.—Lat. 44° 27′ N. Long. 73° 10′ W. June 26, 1845.									
75° 37′	5	10 51 05 A	1560.0	70.00	1559.00	24304810000	746.90		
Var. 9 22 W.	6	12 28 02 P	1556.0	74.75	1554.40	24161593600	745.30		
						Mean	746.10	2999.6	1003.5
152. Columbus, Ohio.—Lat. 39° 57′ N. Long. 83° 03′ W. July 19, 1845.									
71° 04′ 15″	5	6 37 01.2 P	1375.0	79.0	1371.37	18806556760	965.23		
Var. 2 29 21 E.	6	7 06 00.2	1368.8	74.5	1367.05	18682570250	963.64		
						Mean	964.43		995.66
153. Cincinnati, Ohio.—Lat. 39° 06′ N. Long. 84° 22′ W. August 12, 1845.									
70° 29′ 27″	5	12 59 00.0	1350.4	79.5	1348.56	18186140736	1000		
	6	1 33 03.6	1346.8	81.0	1344.31	18071693761	1000	2993.2	1000
154. Oxford, Ohio.—Lat. 39° 30′ 15″ N. Long. 84° 38′ W. August 29, 1845.									
71° 10′	5	5 28 58 P	1366.0	74.50	1364.62	18621877444	974.80		
Var. 4 50 E.	6	6 04 00.8	1363.0	73.00	1361.44	18535188730	971.60		
						Mean	973.20	3005.9	1005.6
155. Richmond, Ia.—Lat. 39° 49′ N. Long. 84° 47′ W. September 1, 1845.									
71° 20′ 20″	4	11 03 00.8 A	1136.4	94.00	1133.90	12857292100	959.06		
Var. 4 52 00 E.	5	2 01 40.4 P	1380.0	89.00	1377.20	18966798400	957.08		
	6	1 30 00.0 P	1376.4	92.00	1372.53	1883838609	955.96		
						Mean	957.37	2992.1	1002.00

REMARKS.

150. Montpelier, Vt.—Geology: talcose slate, highly inclined. Local attraction evident at the state-house.

151. Burlington, Vt.—Geology: limestone.

152. Columbus, Ohio.—Geology (upper silurian?): cliff limestone, horizontally stratified.

153. Cincinnati, Ohio.—The above observation will give a higher intensity at Cincinnati than was indicated April 23, and this I attribute to an error in the dip, which was taken by a needle known to be imperfect. Compared with the observation of April 23 as 1000, it equals 1002.3.

154. Oxford, Ohio.—Geology: blue limestone or lower silurian. Showers; some small rain during observations.

155. Richmond, Ia.—Done in the garden of Dr. Plummer. A blanket was stretched, to screen the apparatus from the sun; but it radiated heat so much as to raise the temperature above the surrounding medium. Geology: upper part of the blue limestone (lower silurian); horizontally-stratified rocks eight or ten feet below the surface. Clear, but with a disposition to showers.

Dip.	No. of needle.	Epoch of commencing vibration. hrs. min. sec.	Duration of 500 vibrations.	Temperature.	Calculated duration at 60°.	Square of the preceding.	Horizontal intensity.	Total intensity: hor. being 1000.	Total intensity: that at Cincinnati = 1000.
156. **St. Mary's, Ohio.**—Lat. 40° 32′ N. Long. 84° 19′ W. September 5, 1845.									
72° 00′ 20″	4	1 50 00.0 P	1153.0	78.0	1151.06	13249391236	923.14		
Var. 3 04 00 E.	5	2 28 03.0	1400.8	77.0	1399.03	19592849409	926.50		
	6	3 02 00.2	1396.2	78.0	1394.00	19432360000	923.14		
						Mean	925.45	3002.6	1005.6
157. **Carrolton, Ohio.**—Lat. 39° 38′ N. Long. 84° 09′ W. September 8, 1845.									
71° 10′ 00″	4	4 40 02.4	1130.8	75.25	1129.68	12761769024	966.25	2993.2	1002.4
Var. 4 45 27 E.									

REMARKS.

156. St. Mary's, Ohio.—Geology: deep diluvium of clay, sand, and gravel, superimposed on the cliff limestone, or upper silurian rocks.

157. Carrolton, Ohio.—Geology: blue limestone of Cincinnati; lower silurian.

IX. Series for 1846.—Made in the Service of the United States Coast Survey.

The following observations have been reported by me to Prof. A. D. Bache, the Superintendent of the Coast Survey, and they are the property of that department of our government. But, by the special permission of the Secretary, procured by the kindness of Prof. Bache, I am permitted to publish them here, in order to complete my series. The following tables do not, however, include all of the observations made by me for that survey, the results of the experiments with Lieut. Riddell's apparatus to determine absolute horizontal intensity of magnetic force being omitted. These results will appear in the course of the publications of the Coast Survey.

The *latitudes* and *longitudes* are in part those which have been determined by the Coast Survey. In other cases, they have been fixed by approximate admeasurements from the survey stations, and are probably correct within a small fraction of a mile. Those which are most doubtful, I have marked with the sign (?).

The *dips* or *inclinations* were determined by the same dip-circle heretofore used by me, but the needles had been recently repaired, and, unfortunately, gave unsatisfactory results. An expedient was, however, resorted to, which, especially in the last part of the series, enabled me to obtain a very close approximation to the true inclination. A particular account of this expedient will be given in this paper. (See article "Fort Delaware.")

The *declination* or "*variation*" was in all cases determined with the utmost care, as being of the greatest practical importance in forming the charts of the Coast Survey. The apparatus used for this purpose was the portable declinometer described by Lieut. Riddell, consisting of a tubular magnet, mounted and suspended as a collimator, and read by a theodolite telescope. The instruments at each station were mounted under a tent, with all necessary precautions of removing every iron or steel article, and adjusted sufficiently early in the day to begin with the maximum or eastern declination, and continue the readings, at least as often as every half hour, say from 8 A. M. until the minimum or extreme western reading in the afternoon about 2 P. M. Finally, after making the proper equations for the error of the theodolite, and for that of the zero of the scale of the collimator, the mean of the declination for the day has been tabulated as in the following paper. The azimuths, and, of course, the true meridian to which these declinations have been referred, are, in most cases, those of the Coast Survey, determined by intervisible stations, and accurate within ten seconds of space. In some few cases, where such azimuths could not be obtained, the meridian was determined by altitudes and azimuths of the sun, observed at the time by means of the theodolite.

The *intensity of magnetic force* has been determined, as heretofore, by oscillating three Hansteenian needles in the exhausted receiver invented by Prof. Bache. As my dip-needles were gone at the time, I could not make my usual comparative observations at Cincinnati, including the element of the dip.

Under these circumstances, I have compared the following series with Cincinnati, through observations previously made at Mrs. Morris's garden, at Washington Place, in Newark, N. J. By means of the observations made there in April 29, 1844, the dip at Cincinnati was calculated to be 70° 24′, which, although less by from 1′ to 3′ than has been usually observed, has still been found to be consistent with the observations previously made at Bloomingdale Asylum and at Girard College.

TABULATED RESULTS OF SERIES IX.

Dip.	No. of needle.	Epoch of commencing vibration. hrs. min. sec.	Duration of 500 vibrations.	Temperature.	Calculated duration at 60°.	Square of the preceding.	Horizontal intensity.	Total intensity: hor. being 1000.	Total intensity: that at Cincinnati = 1000.
158. **Finley's Station,** about 10 miles from Baltimore.—Lat. —° —′ —″ N. Long. —° —′ W. April 13, 1846.									
71° 46′ 50″	4	11 27 01.2 A	1157.6	50.25	1158.37	13418210569	914.05		
Var. 2 19 30 W.	5	10 44 01.2	1406.8	49.00	1407.88	19821260944	917.50		
	6	9 40 04.4	1401.2	48.00	1402.68	19675111824	918.50		
						Mean	916.69	2931.96	983.00
159. **Bloomingdale Asylum, N. Y.**—Lat. 40° 49′? N. Long. —° —′ W. April 27, 1846.									
72° 38′ 17″	4	10 46 01.2 A	1183.4	66.00	1182.94	13993470436	880.67		
Var. 5 12 27 W.	5	11 13 59.8	1436.0	66.50	1435.45	20605167025	882.60		
	6	12 47 00.2 P	1430.8	68.50	1429.73	20441278729	884.08		
						Mean	882.45	2957.20	992.00

REMARKS.

158. Finley's Station.—Geology primitive. Soil abounding with metamorphic small bowlders and pebbles, white, yellow, and brown, apparently not magnetic.

159. Bloomingdale Asylum, N. Y.—Geology primitive; prismatic gneiss rock, underlaying the soil, some trappean bowlders, but none near the instruments.

Dip.	No. of needle.	Epoch of commencing vibration. hrs. min. sec.	Duration of 500 vibrations.	Temperature.	Calculated duration at 60°.	Square of the preceding.	Horizontal intensity.	Total intensity: hor. being 1000.	Total intensity: that at Cincinnati = 1000.
160. Mount Prospect Station.—Lat. 40° 40′ 13″ N. Long. 74° 00′ 43″ W. May 5, 1846.									
72° 27′ 33″	4	12 23 02.8 P	1177.2	82.0	1175.52	13818472704	891.83		
Var. 5 54 04 W.	5	12 52 59.2	1430.4	81.5	1428.25	20398980625	891.52		
	6	1 24 01.6	1422.8	83.5	1419.92	20159658064	896.43		
						Mean	893.26	2963.85	994.22
161. Coles's Station, Staten Island.—Lat. 40° 31′ 50″ N. Long. 74° 16′ 50″ W. May 11, 1846.									
72° 36′ 03″	4	2 03 00.0 P	1179.2	54.5	1179.62	13915033444	885.64		
Var. 5 37 36 W.	5	3 16 01.2	1430.8	53.5	1431.45	20490491025	887.54		
	6	4 01 03.8	1426.6	52.0	1427.60	20380417600	886.72		
						Mean	886.63	2965.1	994.63
162. Newark, N. J.—Lat. 40° 44′ 49″? N. Long. 74° 10′ 00″? W. May 16, 1846.									
72° 50′ 30″	4	7 59 00.0 A	1189.2	68.25	1188.56	14126748736	872.36		
Var. 5 32 42 W.	5	8 29 59.8	1444.4	69.00	1443.49	20836633801	872.79		
	6	8 57 59.6	1440.4	69.80	1439.16	20711815056	872.53		
						Mean	872.56	2957.70	992.17
163. White Hill, N. J. (near Bordentown).—Lat. 40° 08′ 17″ N. Long. 74° 46′ 47″ W. May 20, 1846.									
72° 06′ 14″	4	11 04 01.2 A	1158.8	66.0	1158.35	13417747225	918.46		
Var. 4 22 28 W.	5	11 38 02.8	1412.4	65.0	1411.91	19934898481	912.27		
	6	6 18 02.0 P	1407.6	68.8	1406.73	19788892929	913 22		
						Mean	914.65	2976.5	998.46

REMARKS.

160. Mount Prospect Station.—Geology: a hill of sand and gravel, which commences at this point and extends interiorly into Long Island. The sand and gravel abound with small trappean and granitic bowlders.

161. Coles's Station, Staten Island.—Locality: the dip and intensity, by the Hansteenian needles, were taken in a grove about one-third of a mile northwardly from the station. Geology: the drifted materials of this neighborhood abounding with primitive and trappean gravel, and bowlders. The declination was taken precisely at the survey station, as indicated by latitude and longitude above.

162. Newark, N. J.—Geology: alluvial soil, sand and gravel superimposed on the new red sandstone in place. Had been some rain and wind.

163. White Hill, N. J. (near Bordentown).—At the station immediately on the bank of the Delaware. Geology: the tertiary marls of New Jersey.

Dip.	No. of needle.	Epoch of commencing vibration. hrs. min. sec.	Duration of 500 vibrations.	Temperature.	Calculated duration at 60°.	Square of the preceding.	Horizontal intensity.	Total intensity: hor. being 1000.	Total intensity: that at Cincinnati = 1000.
164. **White Hill,** Woodland Station, about half a mile east of the Survey Station.—Lat. 40° 08′ 17″? N. Long. 74° 46′ 46″? W. May 21, 1846.									
72° 01′ 23″	4	8 12 01.2 A	1163.2	66.0	1162.82	13521503524	911.41		
	5	8 43 00.8	1415.2	65.5	1414.80	20016590400	908.55		
	6	9 14 01.2	1410.4	67.0	1409.55	19868311025	909.57		
						Mean	909.84	2947.4	988.61
165. **Girard College, Philad.**—Lat. 39° 58′ 21″ N. Long. 75° 12′ 57″ W. May 23, 1846.									
72° 00′ 58″	4	9 02 00.0 A	1163.6	79.5	1162.13	13505461369	912.49		
Var. 3 50 44 W.	5	9 34 32.0	1414.4	84.0	1412.66	19956082756	911.31		
	6	10 13 02.8	1408.4	78.0	1406.63	19785079569	913.30		
						Mean	912.37	2955.1	991.31
166. **Wilmington.**—Lat. 39° 44′ 53″ N. Long. 75° 36′ 39″ W. May 29, 1846.									
71° 24′ 39″	4	8 06 01.6 A	1149.8	61.0	1149.73	13202010000	933.47		
Var. 2 31 46 W.	5	2 02 59.6 P	1396.8	68.0	1396.02	19488718404	933.16		
	6	2 38 04.0	1392.4	68.5	1391.36	19358826496	933.51		
						Mean	933.38	2931.85	983.50
167. **Smith's Quarry,** near Wilmington.—May 31, 1846.									
74° 11′ 41″!	4	1 49 03.2	1246.8	81.5	1246.00	15500250000	795.06	2912.3	976.95

REMARKS.

164. White Hill, Woodland Station.—Geology: same as above. Day exceedingly clear, calm, and fine. The mean of these two observations corresponds very well with surrounding observations, as follows:—

Dip,	72° 03′ 48″.
Horizontal intensity,	912.25.
Total intensity,	993.51.

165. Girard College, Philad.—At the usual locality in the yard of the Magnetical Observatory. It will be seen that the total intensity above is less than I have formerly made it to be at this station. I know of no circumstance which will account for this. I bring the various observations at this locality together that they may be compared at one view.

March 30, 1841.	Total intensity at Girard College,		994.78
March 31, 1841.	"	"	994.97
April 21, 1841.	"	"	993.24
May 15, 1842.	"	"	995.48
April 19, 1844.	"	"	991.84
May 23, 1846.	"	"	921.31
		Mean,	993.60

166. Wilmington.—Geology: a hill of trap, but the rock does not show itself at the surface, being covered with red clay. Dip and intensity evidently too low for the latitude.

167. Smith's Quarry.—Geology: the rock at this place is a solid mass of lienitic trap in place. It has a fine prismatic structure, which lies horizontally, in the direction of the meridian; and in this direction it possesses permanent polarity, which it retains after being quarried—even in small hand specimens.

Dip.	No. of needle.	Epoch of commencing vibration. hrs. min. sec.	Duration of 500 vibrations.	Temperature.	Calculated duration at 60°.	Square of the preceding.	Horizontal intensity.	Total intensity: hor. being 1000.	Total intensity: that at Cincinnati = 1000.
168. Brandywine River, near Wilmington. May 31, 1846.									
67° 30′ 00″	4	11 2 00.0 A	1053.0	74.0	1052.00	11067040000	1113.54	2909.8	976.11
169. Sawyer, Del.—Lat. 39° 42′ 53″ N. Long. 75° 42′ 39″ W. June 3, 1846.									
71° 57′ 26″	4	11 38 20.0 A	1160.0	79.0	1158.57	13422844449	918.11		
Var. 2 47 48 W.	5	12 19 02.0 P	1410.0	83.0	1407.73	19817037529	917.70		
	6	12 49 02.4	1404.0	84.5	1401.00	19630251664	920.60		
						Mean	918.80	2966.50	995.11
170. Church Landing, N. J.—Lat. 39° 40′ 56″ N. Long. 75° 33′ 23″ W. June 6, 1846.									
71° 23′ 58″	4	11 05 01.2 A	1142.0	83.0	1140.30	13002840900	947.76		
Var. 5 45 47 W.	5	11 37 17.0	1386.8	81.5	1384.71	19174217841	948.46		
	6	1 03 01.2 P	1382.0	82.5	1379.26	19023581476	949.96		
						Mean	948.73	2969.66	996.06

REMARKS.

So strong is this polarity in a specimen procured near the Wilmington station, that I was enabled, by a dexterous application of it towards the suspended dipping-needle, to bring that needle into an oscillation through more than half a circle. This specimen was found to contain small grains of black oxide of iron similar to those which constitute "black magnetic sand."

From Wilmington, I addressed a note to the Amer. Phil. Society, on the subject of the effects of magnetic iron sand in the trappean rocks. Indeed, the trappean rocks, so far as I have observed, seem to be the source and fountain of this sand. I found it abundant at the foot of the hills about Wilmington, where it had evidently washed down from the disintegrated trappean rocks forming the elevations. It abounds in the trap-rocks of Lake Superior, and can be gathered on all of the great lakes below, even upon the south shore of Lake Erie. The diluvial drift along the Ohio River contains it, and, after a shower, it can be collected by a magnet from the rain trenches formed in the fine sand. Dr. Jackson found that when the trap-rocks were smelted to procure copper which they contained, a button of pure iron was not unfrequently found as a result. The black magnetic sand, distributed from Lake Superior to Cincinnati, is accompanied by a garnet sand of a deep brown color and with translucent particles.

168. Brandywine River.—Locality: in a deep recess, almost a cavern, in the trap-rocks near the water's edge, about one-third of a mile above Riddle's Mill. This locality is not more than a half mile distant from "Smith's Quarry," and not over two miles from the Wilmington signal. Geology: the same as at Smith's Quarry. A strong local influence is here evinced by the extraordinary difference of the dip. Still, the law that I have heretofore alluded to is observed, viz., an increased dip at trappean pinnacles (Smith's Quarry), and a diminished dip at the base (Brandywine River). This is the most extreme case of the kind, the difference of dip being 6° 41′ 41″ in a distance of half a mile.

169. Sawyer, Del.—Geology: at the edge of the tertiary. No rocks or bowlders apparent.

170. Church Landing, N. J.—Geology: tertiary sands of New Jersey. No rocks; nothing especially magnetic apparent; still, there are local influences, for the declination is extraordinary, and, by partial trials at three localities, distant each about half of a mile, it was found to vary about 1°. From this, I infer that the magnetic rocks of Wilmington extend a moderate depth under the tertiary deposits at this place.

Dip.	No. of needle.	Epoch of commencing vibration. hrs. min. sec.	Duration of 500 vibrations.	Temperature.	Calculated duration at 60°.	Square of the preceding.	Horizontal intensity.	Total intensity: hor. being 1000.	Total intensity: that at Cincinnati = 1000.
171. **Fort Delaware, Pea-patch Island.**—Lat. 39° 38′ 16″ N. Long. 75° 36′ 52″ W. June 14, 1846.									
71° 33′ 42″	4	7 35 28.0 A	1152.0	88.5	1150.80	13243406400	930.55		
Var. 3 13 09 W.	5	8 40 32.4	1402.8	89.0	1399.90	19597200100	928.00		
	6	9 21 02.4	1396.0	88.0	1393.56	19420094736	930.56		
						Mean	929.70	2939.45	986.04

REMARKS.

171. Fort Delaware, Pea-patch Island.—Geology: Alluvial mud, at least 70 feet deep. Water diked out, and the experiments made at a point lower than high-water mark.

Remarks on a New Method of ascertaining the Magnetic Inclination.—It occurred to me at this place, as the needles had performed consistently at White Hill and at Girard College, where the dip is about 72°, that, at all places where the dip is less than 72°, the dip-circle might be turned in azimuth so much that the readings should always be near to 72°, and then use might be made of such points of the needle-pivots as had been proved to be good. I accordingly calculated a table, by which, when the approximate dip, by direct experiment in the magnetic meridian, had been ascertained, the azimuth in which the dip would be 72°, was given. This was afterwards applied in the following manner: Having ascertained the approximate dip by direct observation, the azimuth was set off as above, say eastwardly, and a reading noted; the dip-circle was then turned in azimuth to the magnetic meridian, where a second reading was noted; and, finally, it was turned in azimuth westwardly, equal to the first eastward azimuth, where a third reading was noted. This was repeated through all of the usual eight reversals and readings, thus producing three columns in the field-book, two in equal azimuth east and west, and one in the meridian. The mean of the readings in azimuth was then reduced by the ratio—

cos. az. : R : : *cot.* dip in az. : *cot.* dip in meridian.

The following is an example:—

Dip at Port Norris.

	Needle No 2.			*Needle No.* 1.		
	11° Az. E.	0° Az.	11° Az. W.	11° Az. E.	0° Az.	11° Az. W.
A. North, E.E.	72° 21′ 00″	72° 00′ 00″	72° 20′ 00″	71° 09′ 30″	71° 05′ 00″	71° 09′ 00″
E.W.	71 39 00	71 28 30	71 39 00	71 05 30	70 51 00	71 05 00
W.E.	72 15 00	71 57 00	72 11 00	71 04 30	70 45 30	71 05 30
W.W.	71 05 00	71 48 30	72 04 30	71 00 30	70 48 30	71 04 30
B. North, W.W.	71 53 00	71 40 00	71 57 30	72 41 00	72 16 30	72 38 30
W.E.	71 55 30	71 45 00	71 55 30	72 33 00	72 02 00	72 34 00
E.W.	72 04 30	71 41 30	71 58 30	72 46 00	72 29 30	72 44 30
E.E.	72 04 30	71 45 30	72 05 30	72 44 30	72 28 30	72 42 30
Mean	72 02 04	71 40 45	72 01 02	71 53 04	71 37 34	71 53 00
			72 02 04			71 53 04

Mean of readings in Az. 72 01 33 by No. 2. Mean of reading in Az. 71 53 02 by No. 1.

Then: as *cos.* 11°	9.9919466		And: as *cos.* 11°	9.9919466	
to R	10		to R	10	
so *cot.* 72° 01′ 33″	9.5111100		so *cot.* 71° 53′ 02″	9.5147644	
to *cot.* 71 42 42	9.5191634		to *cot.* 71 34 03	9.5228158	

As the above results, from the dip in azimuth, agree very nearly with the dip direct, I have included the last in the calculation, giving a double value to the mean of the readings in azimuth, as follows:—

71° 42′ 42″	71° 34′ 03″
71 42 42	71 34 03
71 40 45	71 37 34
3)215 06 07	214 45 40
Mean 71 42 02 by No. 2.	Mean 71 35 13 by No. 1.

Finally,

By No. 2, 71° 42′ 02″
By No. 1, 71 35 13

Mean, 71 38 37 = Dip at Port Norris.

It will be observed that the letters E.E., E.W., &c., stand for the position of the face of the dip-circle and of the needle; the first letter indicating the position of the instrument, and the second that of the needle.

Dip.	No. of needle.	Epoch of commencing vibration. hrs. min. sec.	Duration of 500 vibrations.	Temperature.	Calculated duration at 60°.	Square of the preceding.	Horizontal intensity.	Total intensity: hor. being 1000.	Total intensity: that at Cincinnati = 1000.
172. **Bombay Hook Lighthouse.**—Lat. 39° 21′ 43″ N. Long. 75° 33′ 22″ W. June 17, 1846.									
71° 38′ 21″	4	9 51 00.2 A	1156.0	81.25	1154.42	13326855364	924.72		
Var. 3 17 56 W.	5	10 20 01.4	1405.2	82.00	1403.00	19684090000	923.90		
	6	10 46 44.0	1400.8	89.00	1397.23	19520116729	925.79		
						Mean	924.80	2935.87	984.84
173. **Hawkins, N. J.**—Lat. 39° 25′ 30″ N. Long. 72° 20′ 07″ W. June 21, 1846.									
71° 43′ 41″	4	12 55 00.6 P	1153.4	82.25	1151.73	13264819929	929.05		
Var. 2 58 43 W.	5	1 24 04.4	1400.8	86.00	1398.46	19556903716	929.90		
	6	1 53 20.0	1397.2	86.00	1394.00	19432360000	929.97		
						Mean	929.64	2965.10	994.65

REMARKS.

172. Bombay Hook Lighthouse.—Geology: tertiary of New Jersey.

173. Hawkins, N. J.—Geology: tertiary. In this neighborhood there is some ferruginous sandstone, but it is hardly magnetic.

Dip.	No. of needle.	Epoch of commencing vibration. hrs. min. sec.	Duration of 500 vibrations.	Temperature.	Calculated duration at 60°.	Square of the preceding.	Horizontal intensity.	Total intensity: hor. being 1000.	Total intensity: that at Cincinnati = 1000.
174. **Pine Mount, N. J.**—Lat. 39° 24′ 57″ N. Long. 75° 23′ 01″ W. June 20, 1846.									
71° 41′ 22″	4	12 17 16.0 P	1152.8	94.0	1150.26	13230980676	931.42		
Var. 3 12 46 W.	5	12 44 04.4	1399.0	93.0	1395.77	19481738929	933.49		
	6	1 16 02.0	1395.8	93.0	1391.75	19369680625	932.98		
						Mean	932.62	2969.79	996.19
175. **Port Norris, N. J.**—Lat. 39° 14′ 30″ N. Long. 75° 04′ 00″ W. June 23, 1846.									
71° 38′ 37″	4	3 26 01.2 P	1153.6	70.0	1152.85	13290631225	927.23		
Var. 3 06 28	5	3 52 02.8	1401.2	72.0	1400.02	19600360004	927.85		
	6	4 18 03.6	1398.4	71.0	1397.05	19517487025	925.92		
						Mean	927.00	2943.65	987.45
176. **Egg Island Point Lighthouse, N. J.**—Lat. 39° 10′ 58″ N. Long. 75° 11′ 04″ W. June 24, 1846.									
71° 44′ 31″	4	5 17 00.0 P	1155.2	76.0	1154.00	13317160000	925.39		
Var. 2 59 20 W.	5	5 40 01.2	1404.0	75.0	1402.53	19670904009	924.52		
						Mean	924.95	2952.31	990.36
177. **Cape May Lighthouse, N. J.**—Lat. 38° 55′ 45″ N. Long. 75° 00′ 42″ W. June 28, 1846.									
71° 25′ 01″	4	7 34 03.0 A	1148.0	73.5	1147.00	13156090000	936.72		
Var. 3 03 23 W.	5	8 06 03.2	1395.6	77.5	1393.83	19427620689	936.09		
	6	8 43 05.2	1392.4	83.0	1389.60	19309881600	935.87		
						Mean	936.23	2937.72	985.48
178. **Town Bank.**—Lat. 38° 58′ 33″ N. Long. 75° 00′ 09″ W. June 30, 1846.									
71° 23′ 38″	4	5 43 36.0 P	1147.2	70.50	1144.62	13142788164	930.07	2915.00	977.85
Var. 3 01 10 W.									
Lewestown Landing.									
Var. 2° 47′ 44″ W. No observation for dip or intensity made here.									

REMARKS.

174. Pine Mount, N. J.—Locality: an isolated hill between 100 and 200 feet high. Geology: tertiary. A few inches beneath the surface is a hard iron ore, but, by trial, it appears to be incapable of attracting the magnet.

175. Port Norris, N. J.—Geology: tertiary or alluvial. Non-magnetic.

176. Egg Island Point Lighthouse, N. J.—Geology: tertiary on the sand-banks of the bay shore.

177. Cape May Lighthouse, N. J.—Geology: tertiary on the drifting sands of the bay shore.

178. Town Bank.—Locality: not at the survey "station," but at Price's, near half a mile to the east of it. Geology: tertiary.

Lewestown Landing.—Locality: on the sands of the usual landing, within half a mile of Lewestown.

Dip.	No. of needle.	Epoch of commencing vibration. hrs. min. sec.	Duration of 500 vibrations.	Temperature.	Calculated duration at 60°.	Square of the preceding.	Horizontal intensity.	Total intensity: hor. being 1000.	Total intensity: that at Cincinnati = 1000.
179. Pilottown, Del.—Lat. 38° 47′ 04″ N. Long. 75° 12′ 15″ W. July 3, 1846.									
71° 16′ 16″	4	2 23 59.8 P	1144.0	82 5	1142.33	13049178289	943.94		
Var. 2 41 56	5	2 50 00.2	1390.0	78.0	1388.25	19272380625	943.64		
	6	12 13 52.0	1384.8	78.0	1382.61	19115827600	945.38		
						Mean	944.19	3140.59	986.42
180. Chew, N. J.[1]—Lat. 39° 49′ 21″? N. Long. 75° 12′ 57″? W. July 15, 1846.									
72° 14′ 37″	4	11 03 35.6 A	1169.2	80.0	1167.68	13632565824	903.98		
Var. 3 20 22	5	11 23 37.2	1420.8	79.5	1419.00	20135610000	903.18		
	6	1 57 02.8 P	1416.0	75.4	1414.08	19996222464	903.75		
						Mean	903.64	2962.70	993.86
181. Vanuxem.—Lat. 40° 05′ 46″? N. Long. 74° 47′ 00″? W. July 10, 1846.									
72° 21′ 29″	4	8 20 00.8 A	1176.4	90.0	1174.10	13785108100	893.97		
Var. 4 20 32 W.	5	8 57 1.2	1429.2	91.5	1426.05	20336186025	894.27		
	6	9 55 01.2	1424.4	93.5	1420.20	20169680400	895.98		
						Mean	894.74	2952.32	990.36[2]

REMARKS.

179. Pilottown, Del.—Geology: tertiary. On an arable bank of an inlet.

180. Chew, N. J.—Locality: a hill, but, so far as could be seen, without hard rocks. Geology: tertiary. I conceive this to be a more unexceptionable locality than Girard College, and as it is south of it, and still exhibits a higher dip, I infer that the dip at that station is made by some local attraction too low for its geographic situation.

181. Vanuxem.—Locality: at Prof. Vanuxem's, about two miles above Bristol, Pa., and near the canal. Geology: diluvium of clay, sand, and gravel, superimposed on primitive rocks? At a distance of a mile or more to the north-west, a heavy dike or ridge of trap-rock crops out along the surface.

X. Series for 1847.

Ever since my journey to Lake Superior in 1844, I had been extremely desirous to make a further exploration of the extraordinary magnetism which I found to exist there. An appropriation for a geological survey of that region, in 1847, afforded the opportunity of attaching magnetical observations to those more specifically geological. Such, however, is the connection of the two subjects, and especially in that region, that the one is incomplete without the other. At the request

[1] The name of a coast survey station, derived, as many such names have been, from the name of some neighboring resident.

[2] This result disagrees with that obtained at Prof. Vanuxem's in 1842 (985); but it should be observed that the stations were not identical, this station (1846) being several hundred feet to the westward of the former. So near as I found we were to trappean rocks, it is not strange that so much difference should exist.

of the Secretary of the Smithsonian Institution, I was appointed Dr. Jackson's assistant, with the understanding that I was to perform both magnetical and geological duty. It was also the intention of the Hon. Secretary, Mr. Walker, as I am informed, that the magnetical observation should be communicated to the Smithsonian Institution. The rules of subordination, however, did not permit me to do otherwise than to report them to my superior; and, as Mr. Walker's term of office had in the mean time expired, the observations took their course, and were incorporated with the documents of Congress, and published without my supervision. By an oversight of my own, which I should have corrected instantly, had I seen the proof-sheets, the headings of the tables were omitted, and they were thus rendered unintelligible. Tl ere is, therefore, not only a propriety, but a necessity, for appending them to this communication, in order to their republication.

I have incidentally mentioned the connection of terrestrial magnetism with geology. This is intimate and practically important, and I have been particular in all my researches to note the geology of the station. I have elsewhere noticed that primitive or igneous rocks, and especially trappean rocks, are accompanied by extraordinary and evident magnetical effects. Nowhere in my researches are these effects more conspicuous than in the trappean developments of the region of Lake Superior. In the aqueous formations of the great valley of the Mississippi and its tributaries, where the rocks are horizontally stratified, the elements of terrestrial magnetism are so regularly graduated that, after making a few observations, and learning the rate of increase or decrease of any magnetic quantity corresponding to known distances and directions, one is enabled to calculate the one from the other—the magnetism from the distance, or the distance from the magnetism—with an approximate accuracy, within moderate distances; yet not, as some have supposed, with such precision as is reliable for the geodetic accuracy of latitude and longitude. But in the trappean regions of Lake Superior, the magnetic quantities are changed very abruptly in very short distances, and that, too, according to no known law. Yet, even here, when one passes from the upturned conglomerate alternating with, or traversed by, dikes of trap, and, perhaps, containing metalliferous veins of copper and silver, to the horizontally stratified sandstone—as at the Apostles' Islands or the Pictured Rocks—the magnetic elements become again consistent, and increase or diminish according to magnetic latitude and longitude. So constant and evident were these effects, that Dr. Houghton and Judge Burt, in their land surveys of those regions, relied upon a single magnetic element, the declination (variation), to indicate the general geology of rocks concealed under the soil of the tangled forests. Whenever the needle became so abruptly deflected by local attractions as to render the running of the lines by magnetic direction difficult, then they ventured to note "trap-rocks;" and the researches of subsequent geologists have not found any error in their decisions, thus founded on a single element of terrestrial magnetism. Some extraordinary magnetic manifestations, in connection with metalliferous veins, will be pointed out in the course of this paper.

Although the local variations of magnetism seem, in general, to follow no known law, yet the reader will see, by referring to the series for 1844, published in the "Transactions of the Am. Phil. Society" for 1846, that trappean hills and pinnacles have a special magnetism, the magnetic axis coinciding with the axis of form, being more or less vertical. Any limited portion of the earth resolving itself thus into a local magnet, may have its opposite poles accessible; while a corresponding column of the earth, having only its normal portion of terrestrial magnetism, will present, so far as our examination of heights and depths extends, only one pole; and that, scarcely affected by the small distance by which we are able to approach towards the neutral centre, may be considered the pole of a magnet of infinite length. Now, if we consider a trappean hill to be itself a magnet, presenting one pole at the base and the other at the summit, it follows that the indicated magnetism at the summit will be the normal terrestrial magnetism of that place *plus* the local polarity of the magnetical column of the trappean hill; while the indicated magnetism at the base will be the same normal terrestrial magnetism *minus* the local polarity of the same magnetical column.

It is not, however, the intention of this paper to speculate, or advance and advocate theories; and the previous remarks may be regarded rather as inviting the attention of the scientific reader to the very curious *facts* which I have ascertained at Snake Hill, the Palisades, Weasel Mountain, near Patterson, Smith's Quarry, and the Brandywine, near Wilmington, &c., than as with any desire to advocate pertinaciously a *theory* to account for the phenomena. (See "Trans. Am. Phil. Soc.," 1846, p. 322.)

Pole of Greatest Intensity of Magnetic Force.—That the pole of greatest magnetic force is far distant from the pole of convergence, or of dip, was first suggested by Col. Sabine, and has now been fully confirmed by him. To determine precisely the point of that pole is a far more difficult problem than to determine the pole of convergence. This difficulty arises from the complication of the force of local attractions, with what may be considered the force of the normal magnetism of the earth, and the impossibility, so far, of separating, by any reliable standard, the one from the other. As a figurative illustration of this subject, we may suppose the force of terrestrial magnetism to be represented by a prolate spheroid, and that the distance from the centre to any point of the surface is proportionate to the intensity. By means of local attractions, the surface of this spheroid would be rendered uneven and hilly, having table lands and low swamps, sharp pinnacles and deep pits, as it is with the surface of the earth. Now the magnetical surveyor comes upon this surface as if he descended from a balloon in the night, and ascertained the altitude of his point by a barometer, without any means of knowing the height of that point in reference to any standard, as "the level of the sea," and without knowing whether he has alighted upon a mountain or in a valley. His measures are, therefore, merely comparative amongst themselves. From a great many observations at different points, we may approximate to the law of curvature which shall represent the normal magnetism of the earth, if it be first assumed that this normal magnetism be represented by any regular curve. By means of this kind of calculation, Col. Sabine has inferred that the point or pole of maximum intensity of magnetic force is at latitude 52° 19′ N., and longitude 91° 59′ W., although no actual observations have been made within about three degrees of that point. It is not my purpose to attempt to show that Col. Sabine is in error in his calculation; on the other hand, I believe he is right, so far as observations have been made on which to found the calculations made. Nor have I made it at all a study to compare the general curvature which would best represent the magnetic quantities ascertained by experiment. No person, within my knowledge, is better qualified for this task than Col. Sabine. I merely wish a comparison of the magnetism of the region south of Lake Superior with that north of it, in order to show that, in the actual state of knowledge in 1844, I committed no absurdity in announcing that I had reached what was probably the point of maximum intensity at Lake Superior. The observations on trappean rocks are always irregular, so much so that one does not feel satisfied with a mean of a multitude of observations. I have taken, therefore, only those observations which were made on horizontally-stratified rocks of the aqueous formation. I refer especially to the observations made along the south shore of Lake Superior from Chocolate River to Little Taquammanon River. These I have compared with the observations made by Capt. Lefroy from Lake Superior to Hudson's Bay. This series of observations was made along a line nearly semicircular in form, beginning, say, at Fort William, Lake Superior, curving westward, and terminating at Hudson's Bay. This curved line passes around Col. Sabine's point of maximum intensity, in general as a centre, and about three or four degrees from that point. It embraces about thirty-two stations, the intensities of which I have grouped into parcels of about four, obtaining the mean in each case as below:—

INTENSITY AT CAPT. LEFROY'S STATIONS NORTH OF LAKE SUPERIOR, PROCEEDING TOWARDS HUDSON'S BAY.

1. Near Lake Superior	1.876
2. The mean of 4 next in order	1.861
3. " 4 "	1.859
4. " 4 "	1.860
5. " 4 "	1.860
6. " 4 "	1.869
7. " 4 "	1.867
8. " 5 "	1.869
9. " 4 "	1.872
Mean =	1.875

The second and the ninth groups are near the isodynamic line of 1.875 of Col. Sabine. The other intermediate groups are about half way between that of 1.850 and 1.875, and their mean is very nearly 1.862.

INTENSITY AT STATIONS OF DR. LOCKE'S SURVEY ON THE SOUTH SHORE OF LAKE SUPERIOR, WHERE THE GEOLOGY IS AQUEOUS AND NON-MAGNETIC.

	Lat. N.	Long. W.	
Train River	46° 30′	87° 01′	1.870
Grand Island	46 27	86 45	1.875
Chapel River, Pictured Rocks	46 43	86 40	1.883
Portal Rock, "	46 43	86 39 45″	1.883
Grand Marais	46 42	86 09	1.872
Two Heart River	46 43	85 38	1.868
Near White Fish Point	46 46	85 13	1.888
Little Taquammanon River	46 41	85 13	1.877
		Mean,	1.877
Mean of Capt. Lefroy's stations, as above			1.875
Col. Sabine's calculated maximum			1.878

The foregoing quantities do not differ among themselves more than observations at the same place by the same person will differ at different times.

It would seem, then, that, although the spheroid of magnetic force may have its pole at latitude 52° 19′ N., yet there is a high table-land, so to speak, extending to the south shore of Lake Superior, where there is a "district" intensity. It follows from these observations, that the figurative spheroid of magnetic force would be nearly level from the lake region to the above latitude; or, strictly, it would be spherical instead of spheroidal, on that special line, with, perhaps, a slight depression between the two points. The comparison which I have here used suggests the construction of a solid spheroid, on the surface of which the stations should have their proper angular distances as represented spherically by latitude and longitude, but with distances from the centre proportionate to the intensity of magnetic force. My line of observations along the north shore of Lakes Huron and Michigan, presented in the following tables, will give an idea of the rate of decrease of magnetic intensity southwardly from Lake Superior; and with quantities formed by taking means of groups of observations, judiciously selected at various points towards Hudson's Bay, as ordinates, would exhibit an instructive curve, in which the point at the south shore of Lake Superior would probably be prominent.

Dip.	No. of needle.	Epoch of commencing vibration. hrs. min. sec.	Duration of 500 vibrations.	Temperature.	Calculated duration at 60°.	Square of the preceding.	Horizontal intensity.	Total intensity: hor. being 1000.	Total intensity: that at Cincinnati = 1000.
182. **Fort Wilkins.**—Lat. 47° 28′ N. Long. 88° 45′ W. July 5, 1847.									
78° 03′ 00″		8 51 16.0 A	1319.9	71.5	1318.9	17394972100	712.14	3439.3	1149.6
183. **Horseshoe Harbor.**—Lat. 47° 28′ N. Long. 87° 57′ W. July 8, 1847.									
78° 15′ 05″	5	9 20 04.0 A	1690.4	81.5	1688	284934400	640.07		
	6	9 50 01.2	1686.0	88.5	1682	282912400	637.15		
						Mean	638.92	1339.7	1046.9
184. **Eagle River Mine.**—Lat. 47° 24′ N. Long. 88° 25′ W. June 30, 1847.									
77° 24′ 00″	4	3 03 00 P	1465.93	86.0	1463.45	21416859025	569.06		
	5	4 00 00	1791.22	87.5	1787.84	31963718656	570.83		
	6	4 40 00	1774.43	86.0	1770.37	31342099369	575.19		
						Mean	571.69	3108.8	1038.7

REMARKS.

182. Fort Wilkins.—Geology: Metamorphic conglomerate near to the trap.

183. Horseshoe Harbor.—Geology: conglomerate.

184. Eagle River Mine.—Range 31, township 57, section 30; United States survey. Locality: in the ravine of the river, and at an angle opposite to an adit. Geology: trappean rocks. Weather clear.

Dip.	No. of needle.	Epoch of commencing vibration. hrs. min. sec.	Duration of 500 vibrations.	Temperature.	Calculated duration at 60°.	Square of the preceding.	Horizontal intensity.	Total intensity: hor. being 1000.	Total intensity: that at Cincinnati = 1000.
185. **Eagle River,** a few rods eastward of the last, and on the high bank over the adit, being near the burying-ground.									
77° 39′ 00″	4	5 35 00	1359.12	62	1358.95	18467451025	670.77	3136.1	1048.1
186. **Eagle River Mine,** on a hill about three-quarters of a mile west of the works, as by the previous latitude and longitude.—July 1, 1847.									
77° 56′ 04″	4	7 49 00.0	1370.72	71.5	1669.70	18760780900	660.29		
	5	8 20 03.6	1668.80	74.0	1667.16	27794224656	656.50		
	6	8 44 03.6	1662.40	74.0	1660.74	27580633476	653.68		
						Mean	656.82	3141.9	1050.1
187. **Cliff Mine.**—Lat. 47° 24′ N. Long. 88° 26′ W. July 1, 1847.									
77° 46′ 20″	4	4 30 00 P	1380.33	53	1381.00	19067610000	649.67	3068.1	1025.4
77 37 37	4	5 56 00	1363.60	70	1362.72	1857776900	666.80	3111.4	1039.8
188. **Copper Falls.**—Lat. 47° 27′ N. Long. 88° 12′ 30″ W. July 2, 1847.									
78° 20′ 00″	4	3 32 01.2	1538.36	69	1537.44	19146256900	647.00	3125.5	1044.6
78 16 29	4	3 01 04.0	1372.8	76	1371.31	18804636700	658.75	3241.6	1083.2
189. **Baite du Gris** (*Encampment*).—Lat. 47° 24′ N. Long. 88° 06′ W. July 9, 1847.									
77° 06′ 30″	5	8 19 25 A	1620.39	69	1619.37	26223591969	695.00	3115.1	1041.1
190. **Sibley's Mine** (*Lac La Belle*).—Lat. 47° 24′ N. Long. 88° 08′ W. July 8, 1847.									
76° 13′ 26″	5	12 46 04	1557.36	77	1555.51	24195802500	754.1	3167.1	1058.5

REMARKS.

186. Eagle River Mine.—Geology: feldspathic greenstone.

187. Cliff Mine.—Range 32, township 58, section 36; United States surveys. Locality: inside of the mine. Geology: the instruments were placed on the immense mass of native copper which laid exposed in the gallery.

Second locality: outside of the mine, and over the vein on the highest point of the ridge. Geology: trappean.

188. Copper Falls.—Range 31 W., township 58 N., section 11. Geology: over the vein of metallic copper.

Second locality: in a wood one-fifth of a mile below the falls.

189. Baite du Gris (*Encampment*).—Range 29, township 58, section 34; United States surveys. Geology: sandstone, very near to the trap.

190. Sibley's Mine (*Lac La Belle*).—Range 29, township 58, section 32; United States surveys Geology: sienite, with sulphuret of copper.

Dip.	No. of needle.	Epoch of commencing vibration. hrs. min. sec.	Duration of 500 vibrations.	Temperature.	Calculated duration at 60°.	Square of the preceding.	Horizontal intensity.	Total intensity: hor. being 1000.	Total intensity: that at Cincinnati = 1000.
191. **Bohemian Mountain.**—Lat. 47° 25′ N. Long. —° —′ W. July 9, 1847.									
78° 30′ 38″	5	5 29 01 P	1445.52	80	1443.52	20837499904	875.63		
	6	5 54 06	1440.34	77	1438.19	20683904761	871.59		
						Mean	873.61	4281.9	1464.6
192. **East and West Vein Mendelbaum's Mine,** about half of a mile south of the Bohemian Mountain.—July 10, 1847.									
89° 02′ 00″	Dipping-needle vibrated 30 in one minute. This extraordinary result was obtained on a precipice looking southward, with a thin vein of blue sulphuret of copper traversing from east to west. From the above, and from the vibrations of the same needle at Cedar Swamp, on the lake margin, we deduce the total intensity (see below) 1182.4.								
193. **Cedar Swamp,** at the landing of Sibley's Mine, margin of Lac La Belle.—June 10, 1847.									
76° 52′ 41″	5	11 14 12	1617.38	82.5	1614.76	26074498576	699.8	3081.8	1030.0
194. **Mount Houghton.**—Lat. 47° 25′ N. Long. 88° 04′ W. July 10, 1847.									
77° 28′ 00″	5	5 31 01 P	1636.39	80	1634.10	26702828100	683.40	3149.2	1052.5
195. **Baite du Gris** (*Western Point*).—Lat. 47° 22′ N. Long. 88° 05′ W. July 12, 1847.									
77° 25′ 26″	5	7 45 03	1640.39	75	1638.67	26852393689	679 48	3120.9	1043.1
196. **South Part of Point Kewenon.**—Lat. 47° 26′ N. Long. 87° 51′ W. July 12, 1847.									
78° 30′ 39″	5	1 45 01 P	1689.6	87	1686.4	28439449600	641.57	3222.7	1077.1
197. **Point Kewenon,** north-east angle, about two miles north of the preceding.—July 13, 1847.									
78° 11′ 30″	5	5 24 05 A	1696.4	60	1696.4	287777296	634.03	3099.0	1035.7

REMARKS.

191. Bohemian Mountain.—Range 29, township 58, section 29; United States surveys. Geology: sienite.

193. Cedar Swamp.—Range 29, township 58, section 32; south part. The same needle which vibrated 30 in a minute at the above station, performed 28 vibrations in the same time. Of course, these are but approximations. They indicate a high intensity at the east and west vein. Geology: sandstone very near to the sienite, which rises very precipitously to the north.

194. Mount Houghton.—Range 29, township 58, section 32; United States surveys. Geology: a broad vein of red jasper.

195. Baite du Gris (*Western Point*).—Range 29, township 57, section 14. Geology: sandstone, nearly horizontal.

196. South part of Point Kewenon.—Range 27, township 58, section 27. Geology: sandstone, near the junction of trap.

197. Point Kewenon.—Geology: vesicular and amygdaloid trap, containing agates.

Dip.	No. of needle.	Epoch of commencing vibration. hrs. min. sec.	Duration of 500 vibrations.	Temperature.	Calculated duration at 60°.	Square of the preceding.	Horizontal intensity.	Total intensity: hor. being 1000.	Total intensity: that at Cincinnati = 1000.
198. **Traverse, Presq'Isle.**—Lat. 47° 11′ N. Long. 88° 23′ W. July 18, 1847.									
77° 08′ 29″	5	5 25 02 A	1631.4	64	1630.83	26596064889	686.04	3082.7	1030.3
199. **Mouth of Portage River, or "Entrance."**—Lat. 47° 01′ N. Long. 88° 30′ W. July 18, 1847.									
77° 00′ 30″	5	2 58 04 P	1620.8	74	1619.2	26217086400	695.95	3098.7	1035.6
200. **Anse.**—Lat. 46° 49′ N. Long. 88° 34′ W. July 19, 1847.									
76° 51′ 34″	4	4 31 03 P	1329.68	76.0	1328.39	17646199921	702.00		
	5	5 02 04	1613.52	74.0	1611.94	25983505636	702.21		
	6	5 29 36	1607.58	72.5	1605.82	25786578724	698.35		
						Mean	700.85	3082.6	1036.7
201. **Mouth of Huron River.**—Lat. 46° 56′ N. Long. 88° 09′ W. July 21, 1847.									
77° 10′ 48″	5	8 04 02 A	1630.4	73	1629.0	26536410000	687.58	3099.5	1036.9
202. **Mouth of Dead River.**—Lat. 46° 34′ 17″ N. Long. 87° 33′ W. July 23, 1847.									
77° 16′ 36″	4	9 50 00.0	1355.72	80.0	1353.96	18332076816	670.27		
	5	10 21 02.8	1644.40	79.5	1644.10	27030648100	671.31		
	6	10 47 01.0	1642.00	80.0	1641.10	26932092100	669.39		
						Mean	670.32	3043.1	1017.1
203. **Jackson Mining Co.'s Office.**—Lat. 46° 30′ N. Long. 87° 43′ W. July 26, 1847.									
77° 01′ 26″	5	7 15 05.6 A	1624	61	1624.3	26283504900	691.56	3080.0	1029.4
204. **Iron Mountain.**—Lat. 46° 27′ N. Long. 87° 49′ W. July 26, 1847.									
77° 58′ 10″	5	3 05 03 P	1698.4	60	1698.4	28835125600	632.78	3035.2	1014.4

REMARKS.

198. Traverse, Presq'Isle.—Range 31, township 55, section 16; United States surveys. Geology: horizontally-stratified sandstone.

199. Mouth of Portage River, or "Entrance."—Range 33, township 53, section 13. Geology: horizontally-stratified sandstone.

200. Anse.—Range 33, township 51, section 25; United States surveys. Geology: horizontally-stratified sandstone.

201. Mouth of Huron River.—Range 29, township 52, section 18 (?). Geology: sand, probably superimposed on horizontally-stratified sandstone.

202. Mouth of Dead River.—Range 25 N., 4th correction line, township 48, section 12. Geology: sand, superimposed on sienite.

203. Jackson Mining Co.'s Office.—Range 26, township 48, section 28, south-west part. Geology: metamorphic sandstone.

204. Iron Mountain.—Range 27, township 47, section 1. Geology: anhydrous peroxide of iron.

Dip.	No. of needle.	Epoch of commencing vibration. hrs. min. sec.	Duration of 500 vibrations.	Temperature.	Calculated duration at 60°.	Square of the preceding.	Horizontal intensity.	Total intensity: hor. being 1000.	Total intensity: that at Cincinnati = 1000.
205. **Loadstone Encampment.**—Lat. —° —′ N. Long. 87° 44′ W. July 27, 1847.									
42° 53′ 00″	5	10 16 00	822.00	60	822.00	65963284	2766.0	1261.6	
206. **East Branch of the Esconawby.**—Lat. 46° 24′ N. Long. 87° 47′ W. July 28, 1847.									
76° 14′ 21″	4	9 41 01 A	1304.3	62	1304.13	17007550569	728.36	3062.6	1023.6
207. **Falls of East Branch of Esconawby.**—July 29, 1847.									
76° 39′ 00″	5	7 58 08 A	1601.4	60	1601.4	25644819600	715.39	3098.3	1035.5
208. **Train River.**—Lat. 46° 30′ N. Long. 87° 01′ W. August 7, 1847.									
76° 41′ 37″	5	6 52 32 A	1593.63	55	1594.18	25414098724	717.95	3118.7	1042.4
209. **Grand Island.**—Lat. 46° 27′ N. Long. 86° 45′ W. August 8, 1847.									
76° 37′ 52″	5	7 01 03	1589.2	64	1583.76	25241383376	722.86	312.18	1045.1
210. **Chapel River.**—Lat. 46° 43′ N. Long. 86° 40′ W. August 11, 1847.									
77° 11′ 30″	5	5 37 02	1618.3	62	1618.08	26181828864	696.93	3143.7	1050.7
211. **At the Cave of Portal Rock,** about three-quarters of a mile to the north-west of the preceding. August 11, 1847.									
77° 12′ 48″	5	9 48 02.4	1621.61	64	1621.16	26281597456	694.27	3139.8	1049.4
212. **Grand Marais, East Point.**—Lat. 46° 42′ N. Long. 86° 09′ W. August 12, 1847.									
77° 18′ 03″	5	8 57 04 A	1631	64.5	1630.5	26574216256	686.61	3123.2	1043.6

REMARKS.

205. Loadstone Encampment.—Range 26, township 47, section 18. Geology: a loadstone in place, broken mostly into sharp angular fragments. Here were two poles, 17.67 feet apart, one attracting the north and the other the south pole of a magnetic needle. (See notes.)

206. East Branch of the Esconawby.—Range 26, township 46, section 6. Geology: probably sienite.

207. Falls of East Branch of Esconawby.—Range 26, township 46, section 30. Geology: porphyritic sienite.

208. Train River.—Range 20, township 47, section 32.

209. Grand Island.—Range 19, township 47, section 22, at the point west of Williams's.

210. Chapel River.—Range 18, township 48, section 35.

211. At the Cave of Portal Rock.—Geology: horizontal sandstone.

212. Grand Marais, East Point.—Range 13, township 49, section 4.

Dip.	No. of needle.	Epoch of commencing vibration. hrs. min. sec.	Duration of 500 vibrations.	Temperature.	Calculated duration at 60°.	Square of the preceding.	Horizontal intensity.	Total intensity: hor. being 1000.	Total intensity: that at Cincinnati = 1000.
213. **Near Double-Heart River.**—Lat. 46° 43′ N. Long. 85° 38′ W. August 13, 1847.									
77° 31′ 07″	5	5 21 00 A	1636.0	64.5	1635.50	26748602500	682.13		
	6	5 50 08	1632.2	66.5	1631.34	26616702056	677.41		
						Mean	679.72	3116.5	1041.5
214. **Two miles west of White Fish Point.**—Lat. 46° 46′ N. Long. 85° 13′ W. August 13, 1847.									
77° 32′ 00″	5	8 50 00.8	1639.6	65	1639	2686320000	679.22	3146.4	1051.6
215. **Little Taquamanon River.**—Lat. 46° 41′ N. Long. 85° 13′ W. August 14, 1847.									
77° 19′ 30″	5	4 46 00	1634.4	78	1632.47	26549583009	687.24	3132.1	1046.8
216. **St. Mary's River,** opposite Palmer's.—Lat. 46° 32′ N. Long. 84° 24′ W. August 20, 1847.									
77° 23′ 15″	5	8 33 15	1637.1	69.5	1637.01	26800964100	680.81		
	6	8 02 03	1631.2	66.5	1630.46	26583998116	678.19		
						Mean	679.00	3109.6	1039.3
217. **Drummond's Island.**—Lat. 46° 00′ N. Long. 84° 03′ W. August 25, 1847.									
77° 06′ 34″	5	11 48 03	1623.6	79.5	1621.44	26290376736	694.02		
	6	11 26 00	1617.6	79.0	1614.90	26079037636	691.27		
						Mean	692.64	104.5	1037.6
218. **Bruce's Mine,** at the landing—Lat. 46° 19′ N. Long. 83° 58′ W. August 22, 1847.									
77° 02′ 32.5″	5	6 28 02	1624.6	63	1624.26	26382205476	691.60		
	6	6 47 03.8	1614.6	60	1614.60	26069331600	691.54		
						Mean	691.58	3084.1	1030.7
219. **Bruce's Mine,** near the principal vein of ore.—August 23, 1847.									
77° 16′ 00″	6	6 16 02 A	1649.6	56	1650.18	27230940324	662.04	3003.6	1004.9
220. **Bruce's Mine,** at the basaltic bluffs, 40 rods north of the mine.									
74° 24′ 22″	6	9 51 01 A	1485.6	68	1484.56	22000371600	819.43	3049.5	1019.2

REMARKS.

213. Near Double-Heart River.—Range 10, township 49, section 1.
214. Two miles west of White Fish Point.—Range 6, township 51, section 31.
215. Little Taquamanon River.—Range 6, township 49, section 3.
216. St. Mary's River.—Range 2, township 48, section 29.
217. Drummond's Island.—Range —, township 42, section 31.
218. Bruce's Mine.—Geology: over a trappean dike, and near the lake.
220. Bruce's Mine.—Geology: pieces of basaltic rock, decidedly magnetic.

Dip.	No. of needle.	Epoch of commencing vibration. hrs. min. sec.	Duration of 500 vibrations.	Temperature.	Calculated duration at 60°.	Square of the preceding.	Horizontal intensity.	Total intensity: hor. being 1000.	Total intensity: that at Cincinnati = 1000.
221. **Island five or six miles north of Mackinaw** (*St. Martin's Island?*).—Lat. 45° 59′ N. Long. 84° 47′ W. August 28, 1847.									
76° 43′ 30″	4	3 18 02.4	1318.88	66	1318.34	17380203556	712.74		
	5	3 42 24.0 P	1599.61	66	1598.94	25566091236	713.68		
	6	4 05 05.0 P	1590.82	64	1590.25	25289268676	713.26		
						Mean	713.22	3106.0	1038.1
222. **Twenty-five miles west of Mackinaw,** on the lake shore.—Lat. 46° 03′ N. Long. 85° 21′ W. September 3, 1847.									
76° 55′ 31″	5	1 40 04.0	1609.6	67	1608.81	25882374400	704.96		
		2 02 01.6	1602.6	66	1601.75	25656030625	702.67		
						Mean	703.82	3111.1	1039.8
223. **Mouth of Seul Choix River.**—Lat. 45° 59′ N. Long. 86° 08′ W. September 6, 1847.									
76° 35′ 15″	5	9 38 04 A	1589.62	67	1588.74	25240947876	722.87	1041.3	
224. **Seven miles west of Seul Choix Point.**—Lat. 45° 58′ N. Long. 86° 15′ W. September 8, 1847.									
76° 25′ 37″	5	12 42 44.0	1590.62	60	1590.62	25300719844	721.17		
	6	12 57 59.2	1581.62	60	1581.62	25005096900	720.82		
						Mean	720.99	3071.8	1026.6
225. **Ministique River.**—Lat. 45° 58′ N. Long. 86° 29′ W. September 9, 1847.									
76° 24′ 09″	4	6 16 04 P	1303.70	60	1303.70	16997336900	728.79		
	5	5 49 05	1581.62	60	1581.62	25015218244	729.40		
	6	5 31 00	1574.62	61	1574.50	24790502500	727.21		
						Mean	728.47	3098.0	1035.4
226. **Moon Island.**—Lat. 45° 36′ N. Long. 87° 17′ W. September 11, 1847.									
76° 18′ 40″	5	11 31 08.0 A	1580.62	64.0	1580.22	24964000000	730.70		
	6	11 59 01.6	1574.62	65.5	1574.02	24774760000	727.60		
						Mean	729.15	3080.5	1029.6

REMARKS.

221. Island five or six miles north of Mackinaw. (*St. Martin's Island?*)—Range 2 W., township 41 N., section 9. Geology: cliff limestone, horizontally stratified.

222. Twenty-five miles west of Mackinaw.—Range 7 W., township 42 N., section 12; United States surveys. Geology: sand, superimposed on cliff limestone.

223. Mouth of Seul Choix River.—Range 13, township 40, section 11. Geology: cliff limestone.

224. Seven miles west of Seul Choix Point.—Range 14, township 41, section 10. Geology: sand, superimposed on cliff limestone.

225. Ministique River.—Range 26 W., township 41, section 18. Geology: sand, superimposed on cliff limestone.

226. Moon Island.—Geology: sand, superimposed on cliff limestone.

CLASSIFICATION AND COMPARISON OF THE PRECEDING RESULTS.

Kewenon Peninsula.

	Latitude.			Longitude.			Total Intensity.
Fort Wilkins	47°	28′	00″	88°	00′	45″	1149.6
Horseshoe Harbor	47	28	00	87	57	00	1046.9
Eagle River Mine	47	24	00	88	25	00	1038.7
"	47	24	00	88	24	45	1048.1
"	47	24	00	88	26	00	1050.1
Cliff Mine	47	24	00	88	28	00	1025.4
"	47	24	00	88	28	00	1039.8
Copper Falls	47	27	00	88	12	00	1044.6
"	47	26	50	88	12	00	1083.2
Baite du Gris	47	24	00	88	06	00	1041.1
Sibley's Mine	47	24	00	88	08	00	1058.5
Bohemian Mountain	47	25	00	88	08	00	1464.6
Mendelbaum's	47	24	00	88	08	00	1182.4
Landing near Sibley's	47	23	40	88	08	00	1030.0
Mount Houghton	47	25	00	88	04	00	1052.5
Western Point of Baite du Gris . . .	47	22	00	87	51	00	1048.1
Point Kewenon	47	26	00	87	50	00	1077.1
"	47	28	00	87	50	00	1035.7
Hawk's Bill	47	11	00	87	30	00	1030.3
Mouth of Portage River	47	01	00	87	30	00	1035.6
Anse	46	49	00	87	34	00	1036.7
Mean	47	22	36	88	12	24	1077.1
Total intensity reduced to arbitrary scale .	. . . .			. . . .			1.9334

REMARKS.

In April, 1844, I announced to the American Philosophical Society that, at Point Kewenon, I had probably reached the place or region of maximum intensity; at the same time qualifying that announcement on account of the want of more extended and multiplied research.

Since Capt. Lefroy has examined the region between Lake Superior and Hudson's Bay, Col. Sabine has calculated the maximum to be 1.878, and situated in latitude 52° 19′ and longitude 91° 59′.

The high intensity of Point Kewenon—determined by numerous observations made over a region of thirty miles in extent—must, then, be considered a case of extraordinary and extensive local attraction, the mean being higher than Col. Sabine's maximum. Indeed, the abrupt changes and extraordinary results along the trappean dikes and near the metallic veins are sufficient evidence of unusual magnetic forces, although they operate on a scale coextensive with the peculiar geological formations of trap and metalliferous conglomerate, occupying so large a portion of that peninsula.

If, however, we select such observations as were made on the horizontally-stratified sandstone of the peninsula, we find them not only consistent among themselves, but conforming to the results which Capt. Lefroy obtained between Lake Superior and Hudson's Bay. They are as follows:—

	Latitude.	Longitude.	Total intensity.
Baite du Gris	47° 24′ 00″	88° 08′ 00″	1041.5
" western part	47 22 00	88 05 00	1048.1
Hawk's Bill	47 11 00	88 30 00	1030.3
Portage River	47 01 00	88 30 00	1035.6
Anse	46 49 00	88 34 00	1036.7
	47 09 06	88 21 06	1038.3
Total intensity, reduced to arbitrary scale			1.8637

The observations at La Pointe and at Ontonagon River were made on the same sandstone. The results are as follows:—

	Latitude.	Longitude.	Total intensity.
La Pointe	46° 47′ 00″	90° 58′ 00″	1044.5
Ontonagon River	46 52 00	89 31 00	1039.0
	46 49 30	90 44 00	1041.7
Reduced to arbitrary scale, total intensity			1.870

South Shore of Lake Superior, from Chocolate River to Taquamanon.

	Latitude.	Longitude.	Total intensity.
Train River	46° 30′ 00″	87° 01′ 00″	1042.000
Grand Island	46 27 00	86 45 00	1045.000
Chapel River	46 43 00	86 40 00	1049.000
Portal Rock	46 43 00	86 39 45	1049.000
Grand Marais	46 42 00	86 09 00	1043.000
Two-Heart River	46 43 00	85 38 00	1041.000
Near White Fish Point	46 46 00	85 13 00	1052.000
Little Taquamanon River	46 41 00	85 13 00	1046.000
	46 39 22	86 09 50	1045.875
By arbitrary scale			1.877
Maximum of Col. Sabine			1.878

These observations, which are remarkably consistent, and made along a sandstone coast entirely unexceptionable as regards the geological formations, exhibit a mean within a unit of being equal to the maximum of Col. Sabine. Why it should be higher than a mean of the most unexceptionable observations on Kewenon peninsula, it is difficult to decide, unless the cold water of the lake, extending along so nearly a magnetic parallel, has some modifying influence.

It appears that the intensities, as indicated by No. 5, are higher than the mean where the three needles have been used. In order to be able to apply an equation where No. 5 alone was used, I have made comparisons of nine cases in which two or three needles were used. I find by the mean of this comparison that the ratio of the indications of No. 5 to those of the means of the several needles, is as 1 to 0.99852. The mean of total intensity at eight stations along the south shore of Lake Superior, from Train River to Little Taquamanon, by No. 5, is equal to 1046, or by arbitrary scale 1877.6, which, being reduced by the above coefficient, is 1874.8

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SMITHSONIAN CONTRIBUTIONS TO KNOWLEDGE.

RESEARCHES

ON

ELECTRICAL RHEOMETRY.

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Prof. Jas. Curley.

Joseph Henry,
Secretary S. I.

RESEARCHES

ON

ELECTRICAL RHEOMETRY.

INTRODUCTION.

THE mathematical theory of electric currents invented by Ampère is certainly one of the most wonderful creations of physico-mathematical science; but it is at the same time surprising that the experimental part should have acquired such extension, while the theoretical has remained almost in the same state in which it was left by its author and M. Savary. The difficulty of the analysis requisite for the solution of such problems, as well as the want of accurate means of verifying the results, may partly account for this fact. The celebrated mathematician, Prof. Plana, of Turin, was the first of late years to resume this subject, and to extend Ampère's principles by further analytical deductions. Some of the results of his profound investigations have been published in a few Italian journals,[1] which are but little known out of Italy, and some are as yet unpublished; we hope, however, that he will soon lay them all before the public for the benefit of science. Among the problems which he solved, but the solution of which has not yet been published, there is one which gave occasion to the present paper, and which is as follows: "Let us suppose a globe, surrounded by several electric currents, all meeting at its poles like the meridians of a sphere; when an element of an electric current is introduced into the globe, Mr. Plana finds that the action of the currents is greater near the poles than at the centre; and that, for instance, at nine-tenths of the polar radius, reckoning from the centre, it is three times greater than at the centre itself." The result is both beautiful and interesting, and deserves to be verified by experiments. He accordingly applied to Prof. Pianciani, who requested me to make the necessary experimental investigations on the subject. There was, however, no small difficulty in experimenting upon a very small element of a current, but I was assured by him that the ratio would be the same, even were I to use a small needle. The result of these experiments, as will be explained at large in this paper, was found to agree in great part with the theory, but, at the same time, not

[1] Giornale Arcadico, Tom. xi. Roma. Raccolta Scientifica del Dott. Palomba. 1846.

so fully as I desired. I was at a loss to know to what I should attribute the difference; being ignorant of the analytical proceedings and formulæ, I could not know how far the action on a magnet might agree with that on a single element, since more data were to be considered in the former case than in the latter. Having several times ineffectually applied to Mr. Plana for information on this point, I determined to seek the necessary illustrations in the analytical formulæ themselves, and applied myself to the solution of the problem in the most general manner, viz., to find the action of a closed current on a magnetic needle, whatever be its position relative to that of the current, seeing that the case of the globe could be reduced to this.

The result was what I expected, that the problem of Mr. Plana was but a particular case of the above, and that there is a considerable difference of action in the two cases, for in one the length of the needle and its two poles are to be taken into consideration, while in the other there is only a single element, the action of which is analogous to a single pole. With the solution of this problem I have since been led to a complete theory of the galvanometer in two cases, 1st, when the surrounding coil is a circle, and 2dly, when it is an ellipse. I am sorry that the formulæ which represent this action are not so simple as I should wish them to be, but I hope to be able to reduce them to a more convenient form for the ellipse. I trust my efforts will be well received by men of science in general, since the solution of this problem presents an easy means of measuring accurately and without difficulty the intensity of currents, together with a new confirmation of Ampère's principles.

This paper is naturally divided into two parts, the first containing the mathematical analysis, and the second the experimental researches. I shall at present confine my researches to the circle only, until the more simple results in the case of the ellipse shall provide me with the best combination of elliptical elements for the application of this curve to the galvanometer, it being the curve most useful in practice.

§ 1. General Formulæ for the Attraction of a Magnetic Pole on an Electric Current.

Let us consider an electric current circulating in a close curve, *MNQ* (Fig. 1), which we shall suppose to be plane for the sake of simplicity: let *P* be a magnetic pole, and *ba* any element *ds* of the current itself: it is required to find the expression of the force *P* on that element.

It is well known that Coulomb, inquiring into the law of attraction of two magnetic needles, found that their action could be represented very accurately by four forces acting in the inverse ratio of the squares of the distances; two being attractive, and two repulsive. This law was also received as certain by Poisson, who made it the basis of his calculations on magnetism, and found it to agree with experiment. Savary, in his memoir on the application of the calculus to electro-dynamic phenomena,[1] following Ampère's steps, and considering magnets as electro-dynamic coils, was led to the same conclusion as Coulomb. Savary's calculus, however, being only approximate, might have left a doubt whether this was exactly true beyond the limits of his approximation. And indeed the experiments showed a little deviation from the result of the calculus, because the centres of elementary forces, viz., the poles in magnets, are never exactly at the ends of the bar, but a little inside. Now, besides the reasons for this difference assigned by Ampère and Nobili, relative to the disposition of the currents in the body of the bar, Mr. Plana assured me that, pushing the approximations beyond the limits of the calculations of Savary, the centre of action is really found to be a little inward, a result which agrees with observation. We may therefore be assured that "*the action of a magnetic pole is a force acting in inverse ratio of the squares of the distances.*" Besides, Ampère and Savary[2] proved that the action of an electro-dynamic cylinder or coil on one element of an electric current, can be reduced to two forces acting in the inverse ratio of the squares of the distances of each pole from the element, and in the direct ratio of the sine of the angle comprised between the direction of the element itself and the line measuring its distance from the pole. As to the direction of this force, if *P* be one of the poles of the magnet, and $ab = ds$ the element of the curve described by the current, drawing a tangent *bt* to *ds* and a plane (*Pbt*) passing through the pole *P*, the resultant of the forces exerted by *P* on *ds* will be perpendicular to this plane at *b*; representing therefore by *v* the angle *Pbt*, and by *r* the distances *Pb*, the expression for the resultant will be

$$(1) \quad \phi = -\frac{k \sin. v ds}{r^2},$$

---

[1] Mémoire sur l'Application du Calcul aux Phénomènes Electro-Dynamiques. Bachelier, Paris, 1823.—See also Ampère's Recueil d'Observations Electro-Dynamiques, page 325; and Annales de Ch. et Phy. xxii. page 91.

[2] Théorie des Phénomènes Electro-Dynamiques, pp. 96, 98.

in which k is a co-efficient depending on the intensity of the current in the curve, and the magnetism in the needle.

For the other pole of the needle, marking with a dash the quantities analogous to those which compose formula (1), we shall have

$$(2)\quad \phi' = + \frac{k' \, sin.\, v' ds}{r'^2}.$$

The sign is opposite, because, if the force be attractive in the first case, it will be repulsive in the second.

The experimental confirmation of the preceding law was first established by Biot, and afterwards by Pouillet, in a series of very nice experiments, some of which are given by the latter in his *Traité de Physique.*[1] Notwithstanding this, we shall take this law as a mere hypothesis, upon which to base our calculations; the confirmation of theory by observation will show how far it extends, and whether it can be pushed to indefinite limits.

In order to transform the expression of the force into another, more suitable for analytical calculations, the following consideration will be useful. If we imagine a straight line having one of its extremities fixed at the point P, around which it may revolve, always touching the perimeter of the current MNQ, it will describe a conic surface, which will be generally oblique, having its vertex at P, and for its base the directrix MNQ, and the apothemes or sides of the cone will be the distances already indicated by r. If now we pass a plane tangent to the conical surface, it is evident that it will pass through the element ds, and the direction of the plane will be that of ds itself. Therefore the resultant of the forces of the magnetic pole, which must be perpendicular to the plane passing through r and ds, will be perpendicular to the plane touching the said conic surface in the point ds.

Let therefore A (Fig. 2) be the pole or vertex of the cone, and ab the element ds of the directrix MNQ, drawing to ba a tangent bT, and from the vertex A a line AP perpendicular to bT, which is tangent to the directrix in b, we have

$$AP = Ab \, sin.\, AbP = Ab \, sin.\, AbT, \text{ and making } AP = A,$$

we shall have

$$A = r \, sin.\, v, \text{ whence } sin.\, v = \frac{A}{r},$$

and substituting the value of $sin.\, v$ in (1),

$$(3)\quad \phi = \frac{k\, Ads}{r^3},$$

omitting the sign for the present, which will be restored positive or negative as circumstances require.

Now the quantity Ads is the double area of the infinitesimal sector of the conic surface, having ds for its base and A for its altitude; hence, if we call the whole conic surface S, we shall have

$$Ads = \tfrac{1}{2}\, dS,$$

---

[1] Pouillet, Traité de Physique, note Mathemat., liv. v. chap. 1.

and the preceding expression for the force will become

$$(4)\quad \phi = \frac{k\,\tfrac{1}{2}\,dS}{r^3},$$

which is a very elegant expression for the elementary force, being in the direct ratio of the differential element of the conic surface, having its vertex at the pole and its base in the perimeter of the current.

When the curve in which the current circulates is given, ds and A will be determined according to its nature, and if x, y, z are the co-ordinates of any point of the current and p, m, n those of the pole parallel to three rectangular axes, we shall have

$$(5)\quad r^2 = (x-p)^2 + (y-m)^2 + (z-n)^2.$$

In order to find the three components X, Y, Z of the force ϕ, parallel to the same axes, it will be sufficient to remember that ϕ is directed along the normal to the conic surface at ds. If therefore (Nx), (Ny), (Nz) indicate the angles made by the said perpendicular with the three axes, we shall have

$$(6)\quad X = -\phi \cos.\,(Nx),\ Y = -\phi\cos.\,(Ny),\ Z = -\phi\cos.\,(Nz).$$

The values of the cosines are very easily found by the analytical formulæ of the perpendiculars to the conic surfaces. Supposing that

$$(7)\quad \mu = 0$$

is the equation to the conic surface, we shall have

$$(8)\quad \begin{cases} Cos.\,(Nx) = \dfrac{1}{k^1}\cdot\dfrac{\delta\mu}{dx} \\ Cos.\,(Ny) = \dfrac{1}{k^1}\cdot\dfrac{\delta\mu}{dy} \\ Cos.\,(Nz) = \dfrac{1}{k^1}\cdot\dfrac{\delta\mu}{dz} \\ \text{where} \\ \qquad k^1 = \sqrt{\left(\dfrac{\delta\mu}{dx}\right)^2 + \left(\dfrac{\delta\mu}{dy}\right)^2 + \left(\dfrac{\delta\mu}{dz}\right)^2}. \end{cases}$$

If we take the plane of the curve as the co-ordinate plane xy, the condition of all its points lying disposed in this plane, requires that after the differentiations we should make $z = 0$ in equation (8).

Therefore in this hypothesis we shall have

$$(9)\quad \begin{cases} ds = \sqrt{dy^2 + dx^2} \\ r^2 = (x-p)^2 + (y-m)^2 + n^2. \end{cases}$$

The value of A will be found for every current, as will be shown hereafter.

§ 2. Differential Formulæ for Circular Currents.

We shall suppose the circular current to be lying in the plane XOY (Fig. 3), with the origin of the co-ordinates at the centre of the circle, the axis OZ being perpendicular to the plane of the circle. Let A be the pole of the magnet or the vertex of the cone, and AE its side; drawing from A a line AB perpendicular to the plane of the circle, this will be the absolute altitude of the cone, or the distance of the plane of the current from the pole, and from B drawing a perpendicular line BC on the axis OY, we shall have $BC = p$, $OC = m$. Also, drawing at E a tangent to the directrix, and from A the line AP perpendicular to it, this will be the altitude of the elementary sector of the conic surface, whose base is ds; we must determine the value of $A = AP$.

The right-angled triangle ABP gives

$$AP^2 = AB^2 + BP^2.$$

Let us draw from the centre of the circle the radius OE, which will be parallel to BP and the two similar triangles OTE, BTP right angled at E and P give

$$BP : OE :: BT : TO$$

$$\text{whence } BP = \frac{OE}{TO} \times BT = \frac{OE}{TO}(TO - BO) = OE - BO \cdot \frac{OE}{TO};$$

$$\text{therefore } \overline{AP}^2 = \overline{AB}^2 + \left(OE - \frac{BO \cdot OE}{TO}\right)^2:$$

$$\text{now, } \frac{OE}{TO} = cos.\ TOE = cos.\ (FOE) = cos.\ (GOE - FOG)$$

The angle GOE or its correspondent arc GFE is the distance of the element ds reckoned from the origin of the arcs, on the circumference, representing that angle by ω, we shall determine the value of FOG in the following way.

We have

$$BO\ cos.\ (\omega - FOG) = BO\ cos.\ \omega \cdot cos.\ FOG + BO\ sin.\ \omega\ sin.\ FOG.$$

and from the right-angled triangle BOC

$$OC = BO\ cos.\ FOG, \quad BC = BO\ sin.\ FOG$$

$$\text{therefore } BO\ cos.\ (\omega - FOG) = OC\ cos.\ \omega + BC\ sin.\ \omega$$

$$= m\ cos.\ \omega + p\ sin.\ \omega.$$

Substituting these values in the preceding equations, and making the radius of the circle $= R$, we shall have

$$A = AP = \sqrt{n^2 + (R - m\ cos.\ \omega - p\ sin.\ \omega)^2}.$$

Substituting also in the expression of r in (5) § 1, the values of the polar co-ordinates of the circle

$$(1)\quad x = R\ sin.\ \omega,$$

$$(2)\quad y = R\ cos.\ \omega,$$

we shall have

$$(3)\quad r^2 = R^2 + l^2 - 2\ pR\ sin.\ \omega - 2\ mR\ cos.\ \omega,$$

where for the sake of brevity

$$(4)\quad l^2 = m^2 + n^2 + p^2.$$

We have also in the case of the circle

$$ds = Rd\omega,$$

whereby the expression of the force (3) § 1, for the circular current will be

$$\phi = \frac{-kR\sqrt{n^2 + (R - m\ cos.\ \omega - p\ sin.\ \omega)^2} \cdot d\omega}{(R^2 + l^2 - 2\ Rm\ cos.\ \omega - 2\ Rp\ sin.\ \omega)^{\frac{3}{2}}}.$$

In order to find the components of this force parallel to the co-ordinate axes, the rule already given is to be followed. Let us take the equation of the surface of the oblique cone with a circular base, which in our case will be[1]

$$\mu = (pz - xn)^2 + (mz - yn)^2 - R^2\,(z - n)^2,$$

differentiating this equation successively, with respect to x, y, and z, and making $z = 0$ after the differentiations, because all the points through which the normal lines pass are in the plane xy, we shall have the following values of the partial differential co-efficients—

$$\frac{\delta\mu}{dx} = 2\,n^2\,x = 2\,n^2\,R\,sin.\,\omega,$$

$$\frac{\delta\mu}{dy} = 2\,n^2\,y = 2\,n^2\,R\,cos.\,\omega,$$

$$\frac{\delta\mu}{dz} = 2\,n\,(R^2 - px - my) = 2\,nR\,(R - p\,sin.\,\omega - m\,cos.\,\omega),$$

$$k'^2 = 4\,n^2\,R^2\,[n^2 + (R - p\,sin.\,\omega - m\,cos.\,\omega)^2].$$

Hence the values of the cosines of the angles made by the normal line with the co-ordinate axes, will be

$$Cos.\,(Nx) = \frac{n\,sin.\,\omega}{\sqrt{n^2 + (R - p\,sin.\,\omega - m\,cos.\,\omega)^2}},$$

$$Cos.\,(Ny) = \frac{n\,cos.\,\omega}{\sqrt{n^2 + (R - p\,sin.\,\omega - m\,cos.\,\omega)^2}},$$

$$Cos.\,(Nz) = \frac{R - p\,sin.\,\omega - m\,cos.\,\omega}{\sqrt{n^2 + (R - p\,sin.\,\omega - m\,cos.\,\omega)^2}},$$

and the three components of ϕ will be

$$(9)\quad \begin{cases} X = -\displaystyle\int \frac{k\,n\,R\,sin.\,\omega\,d\,\omega}{(R^2 + l^2 - 2\,Rm\,cos.\,\omega - 2\,Rp\,sin.\,\omega)^{\frac{3}{2}}} \\ Y = -\displaystyle\int \frac{k\,n\,R\,cos.\,\omega\,d\,\omega}{(R^2 + l^2 - 2\,Rm\,cos.\,\omega - 2\,Rp\,sin.\,\omega)^{\frac{3}{2}}} \\ Z = -\displaystyle\int \frac{k\,R\,(R - m\,cos.\,\omega - p\,sin.\,\omega)\,d\,\omega}{(R^2 + l^2 - 2\,Rm\,cos.\,\omega - 2\,Rp\,sin.\,\omega)^{\frac{3}{2}}} \end{cases}$$

where the integrals are to be taken between the limits $\omega = 0$, $\omega = 2\,\pi$.

The formulæ (5) are general, and include as a particular case those given by Savary in page 23 of the memoir already quoted, as will appear by making $p = 0$, which gives the case of Savary. Indeed, in this case they may be written

$$X = -\int \frac{k\,n\,R\,sin.\,\omega\,d\,\omega}{r^3},\quad Y = -\int \frac{k\,n\,R\,cos.\,\omega\,d\,\omega}{r^3},$$

$$Z = -\int \frac{k\,R\,(R - m\,cos.\,\omega)\,d\,\omega}{r^3},$$

which are the formulæ of Savary. The first integrated becomes $= 0$, as is evident from the symmetry of the figure in such a case.

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[1] See Moigno, Traité de Calc. Diff., I. p. 423, and others.—Davy's Elem. of Anal. Geom., p. 313.

§ 3. Integration of the Differential Equations for the Circular Currents.

The integrals of formulæ (5) can be obtained by means of the elliptical functions of the first and second kinds.[1]

In order, however, to reduce them to a more convenient form, we shall suppose

$$\frac{p}{m} = tang.\ \alpha,$$

whence we have

$$p\ cos.\ \alpha - m\ sin.\ \alpha = 0.$$

Let us also make

$$\omega = 2\ \psi + \alpha,$$

then for the quantity under the radical sign

$$R^2 + l^2 - 2\ R\ (m\ cos.\ \omega + p\ sin.\ \omega),$$

after this substitution, and the evolution of the sines and cosines of the sum of the arcs, and the reductions of the functions of double arcs to simple ones, we shall have

$$R^2 + l^2 - 2\ R\ (m\ cos.\ \alpha + p\ sin.\ \alpha) + 4\ R\ (m\ cos.\ \alpha + p\ sin.\ \alpha)\ sin.^2\ \psi;$$

in which making again the supposition of

$$\psi = \tfrac{1}{2}\ \pi - \phi,$$

and reducing the cosine to the sine, we shall have

$$R^2 + l^2 + 2\ R\ (m\ cos.\ \alpha + p\ sin.\ \alpha) - 4\ R\ (m\ cos.\ \alpha + p\ sin.\ \alpha)\ sin.^2\ \phi.$$

Let us now make for the sake of brevity

$$(1)\quad R\ (m\ cos.\ \alpha + p\ sin.\ \alpha) = h^1.$$

$$(2)\quad R^2 + l^2 + 2\ R\ (m\ cos.\ \alpha + p.\ sin.\ \alpha) = R^2 + l^2 + 2\ h^1 = h^2.$$

$$(3)\quad c^2 = \frac{4\ R\ (m\ cos.\ \alpha + p\ sin.\ \alpha)}{R^2 + l^2 + 2\ R\ (m\ cos.\ \alpha + p.\ sin.\ \alpha)} = \frac{4\ h^1}{h^2},$$

and remembering that the two suppositions successively made for ω and ψ are equivalent to the one,

$$\omega = 2\ \psi + \alpha = 2\left(\frac{\pi}{2} - \phi\right) + \alpha = \pi - 2\ \phi + \alpha,$$

whence

$$d\ \omega = -2\ d\ \phi,$$

we shall have the following equation:

$$(4)\quad \int_0^{2\pi} \frac{d\ \omega}{\left(R^2 + l^2 - 2\ R\ (m\ cos.\ \omega + p\ sin.\ \omega)\right)^{\frac{3}{2}}} = \int_0^{\pi} \frac{-2\ d\ \phi}{h^3\left(1 - c^2\ sin.^2\ \phi\right)^{\frac{3}{2}}}.$$

From the foregoing supposition we obtain also

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[1] Legendre, Traité des Fonctions Elliptiques, I, pp. 255, 257.

$$Sin.\, \omega = 2\, sin.\, \phi\, cos.\, \phi\, cos.\, \alpha - sin.\, \alpha + 2\, sin.^2\, \phi\, sin.\, \alpha$$
$$Cos.\, \omega = -2\, sin.\, \phi\, cos.\, \phi\, sin.\, \alpha - cos.\, \alpha + 2\, sin.^2\, \phi\, cos.\, \alpha$$
$$R\,(R - p\, sin.\, \omega - m\, cos.\, \omega) = R\Big(R + (1 - 2\, sin.^2\, \phi)\ (p\, sin.\, \alpha + m\, cos.\, \alpha)\Big)$$
$$= R^2 + h^1 - 2\, h^1\, sin.^2\, \phi;$$

therefore the expression of the three components will be

$$(5)\quad \begin{cases} X = \displaystyle\int_0^\pi \frac{2\, k\, n\, R\, (2\, sin.\, \phi\, cos.\, \phi\, cos.\, \alpha - sin.\, \alpha + 2\, sin.^2\, \phi\, sin.\, \alpha)\, d\,\phi}{h^3\, \Delta^3}, \\ Y = \displaystyle\int_0^\pi \frac{2\, k\, n\, R\, (-2\, sin.\, \phi\, cos.\, \phi\, sin.\, \alpha - cos.\, \alpha + 2\, sin.^2\, \phi\, cos.\, \alpha)\, d\,\phi}{h^3\, \Delta^3}, \\ Z = \displaystyle\int_0^\pi \frac{2\, k\, (R^2 + h^1 - 2\, h^1\, sin.^2\, \phi)\, d\,\phi}{h^3\, \Delta^3}, \end{cases}$$

where for brevity we have made

$$(6)\quad \Delta = \sqrt{1 - c^2\, sin.^2\, \phi}.$$

To integrate these formulæ further transformations must be made, only in order to reduce them to more simple forms. We have

$$(7)\quad d\,\frac{1}{\Delta} = \frac{c^2\, sin.\, \phi\, cos.\, \phi\, d\,\phi}{\Delta^3},\ \text{therefore} \int \frac{sin.\, \phi\, cos.\, \phi\, d\,\phi}{\Delta^3} = \frac{1}{c^2\, \Delta}.$$

We have likewise

$$(8)\quad \int \frac{-c^2\, sin.^2\, \phi\, d\,\phi}{\Delta} = \int \frac{(1 - c^2\, sin.^2\, \phi - 1)\, d\,\phi}{\sqrt{1 - c^2\, sin.^2\, \phi}}$$
$$= \int \frac{1 - c^2\, sin.^2\, \phi}{\sqrt{1 - c^2\, sin.^2\, \phi}}\, d\,\phi - \int \frac{d\,\phi}{\sqrt{1 - c^2\, sin.^2\, \phi}} = \int \Delta\, d\,\phi - \int \frac{d\,\phi}{\Delta}.$$

Hence

$$(9)\quad \int \frac{sin.^2\, \phi\, d\,\phi}{\Delta} = -\int \frac{1}{c^2}\, \Delta\, d\phi + \int \frac{d\phi}{c^2\, \Delta} = \frac{1}{c^2}(F - E),$$

making with Legendre

$$\int \Delta\, d\,\phi = E, \int \frac{d\,\phi}{\Delta} = F.$$

Again differentiating the quantity $\frac{cos.\, \phi\, sin.\, \phi}{\Delta}$, and reducing afterwards the terms to the common denominator Δ^3, and taking away the common factors in the last fraction, we shall have

$$(10)\quad d\,\frac{cos.\, \phi\, sin.\, \phi}{\Delta} = \left(\frac{1}{\Delta^3} - \frac{sin.^2\, \phi}{\Delta^3} - \frac{sin.^2\, \phi}{\Delta}\right) d\,\phi,$$

which by the algebraical division and convenient reductions will give

$$(11)\quad d\,\frac{cos.\, \phi\, sin.\, \phi}{\Delta} = \left[\frac{1}{\Delta^3}\left(1 - \frac{1}{c^2}\right) + \frac{1}{c^2\, \Delta}\ (1 - c^2\, sin.^2\, \phi)\right] d\,\phi.$$

Making

$$(12)\quad b^2 = 1 - c^2,$$

and integrating both members, and transposing the terms, we shall have

$$(13)\quad \int \frac{1}{\Delta^3}\, d\,\phi = \int \frac{\Delta\, d\,\phi}{b^2} - \frac{c^2 \cos.\phi \sin.\phi}{b^2\,\Delta} = \frac{1}{b^2} E - \frac{c^2 \cos.\phi \sin.\phi}{b^2\,\Delta}.$$

Substituting in (10) the values of the first and third terms as they are given by (13) and (9), we shall have

$$(14)\quad \int \frac{\sin.^2 \alpha\, d\,\phi}{\Delta^3} = \frac{1}{b^2 c^2}(E - b^2 F) - \frac{\cos.\phi \sin.\phi}{b^2\,\Delta}.$$

Observation.—The values of the integrals indicated by E and F are the values of the elliptical functions of the first and second kind, the angle ϕ being their amplitude and c their modules. This being always a fraction, can be expressed by the sine of an angle θ, that is, we may suppose

$$c = \sin.\theta.$$

b is also called the complement of the modulus; therefore we shall have

$$b = \sqrt{1 - c^2} = \cos.\theta.$$

As the integrals in ϕ are to be taken between the limits $\phi = 0$ and $\phi = \pi$, so at their limits E and F will be the double of the *complete functions* marked E^1, F^1. Their value is found in Legendre's Tables, t. 2, p. 288, for every degree of θ. Their logarithms for every tenth part of a degree of the modulus, page 222 et seq. They might be calculated by the formulæ

$$F^1 = \frac{\pi}{2}\left(1 + \left(\frac{1}{2}\right)^2 c^2 + \left(\frac{1.3}{2.4}\right)^2 c^4 + \left(\frac{1.3.5}{2.4.6}\right)^2 c^6 + \ldots\right),$$

$$E^1 = \frac{\pi}{2}\left(1 - \left(\frac{1}{2}\right)^2 c^2 - \left(\frac{1.}{2.4}\right)^2 3\, c^4 - \left(\frac{1.3}{2.4.6}\right)^2 5\, c^6 - \ldots\right),$$

whose second members are obtained by developing $\frac{1}{\Delta}\, d\,\phi$ and $\Delta\, d\,\phi$ by means of the binomial formula, and making $\phi = \frac{\pi}{2}$ after the integration; but easier formulæ are given in Legendre's work, which should be consulted in every case.[1]

After these preparations, the integration of formulæ (5), § 2, is easily performed. The value of X, for instance, may be written

$$X = \frac{2\,k\,n\,R}{h^3}\int\left[\frac{2 \sin.\phi \cos.\phi \cos.\alpha}{\Delta^3} - \frac{\sin.\alpha}{\Delta^3} + \frac{2 \sin.\alpha \sin.^2\phi}{\Delta^3}\right] d\,\phi.$$

The indefinite integral of which by formulæ (7), (13), (14), is

$$X = \frac{2\,k\,n\,R}{h^3}\left[\frac{2 \cos.\alpha}{c^2\,\Delta} - \sin.\alpha\left(\frac{1}{b^2} E - \frac{c^2 \cos.\phi \sin.\phi}{b^2\,\Delta}\right) + \right.$$

$$\left. 2 \sin.\alpha\left(\frac{1}{b^2 c^2}(E - b^2 F) - \frac{\cos.\phi \sin.\phi}{\Delta\, b^2}\right)\right] + \text{const.},$$

which being reduced to the due limits, all the algebraical terms vanish, and the integral becomes

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[1] Although several of the preceding transformations are found in Legendre's work, I did not think unfit to develop them here, because that work may not be in the hands of those who have to peruse this paper.

$$(15)\begin{cases} X = \dfrac{4\,k\,n\,R\,sin.\,\alpha}{h^3\,b^2\,c^2}\left[2\,E^1 - 2\,b^2\,F^1 - c^2\,E^1\right]; \\ \text{likewise} \\ Y = \dfrac{4\,k\,n\,R\,cos.\,\alpha}{h^3\,b^2\,c^2}\left[2\,E^1 - 2\,b^2\,F^1 - c^2\,E^1\right], \\ Z = \dfrac{4\,k}{h^3\,b^2\,c^2}\left[c^2\,(R^2 + h^1)\,E^1 - 2\,h^1\,E^1 + 2\,h^1\,b^2\,F^1\right], \end{cases}$$

whereby we can deduce the resultant

$$\phi = \sqrt{X^2 + Y^2 + Z^2},$$

whenever we know R, m, n, p, that is, the radius R, the distance below the centre, the length of the needle, and its deviation from the plane of the current. In the particular case of the middle of the needle being in the centre of the circle for an angle of deviation $= \delta$, and a length l, we shall have $p = 0$, $m = l\ cos.\ \delta$, $n = l\ sin.\ \delta$, $\alpha = 0$, $h^1 = R\ l\ cos.\ \delta$,

$$c^2 = \frac{4\,R\,l\,cos.\,\delta}{R^2 + l^2 + 2\,R\,l\,cos.\,\delta},$$

and the three (15) are reduced to the two last components Y and Z, as is evident on comparing the last formula of Savary, § 2. Further observations on this point will be made hereafter, when the force of the other pole and terrestrial magnetism will be taken into consideration.

§ 4. Differential Formulæ for Elliptical Currents.

When the current surrounding the needle runs in an elliptical conductor, the conical surface (§ 1) will be that of an elliptical cone; but as this may have either double or simple obliquity, we shall suppose it to have only the simple, in order to avoid a complication, which would lead to no advantage. We shall therefore suppose the axis of the cone inclined to the transverse axis only, and lying in a plane perpendicular to the plane of the curve.

We must first find the value of the perpendicular line A, which measures the height of the differential element of the conic surface.

Following the same proceeding as for the circle: If O, Pl. I. fig. 4, be the centre of the ellipse, A the pole, AB the height of the cone, tT a tangent line to the ellipse at E, drawing from A, a line AP perpendicular to this tangent and joining BP, we shall have

$$(1)\quad AP^2 = AB^2 + BP^2.$$

Letting fall from the centre a perpendicular OM to the tangent tT, it will be parallel to BP, and the two right-angled triangles TOM, TBP, will give

$$BP : OM :: BT : TO;$$

whence

$$BP = \frac{OM\,.\,BT}{TO} = \frac{OM}{TO}\,(TO - BO) = OM - BO\,\frac{OM}{TO}.$$

But from the theory of the ellipse, it is known that the perpendicular drawn from the centre to the tangent, and the normal N are the extremes of a geometrical proportion, of which the semi-conjugate axis is the mean; that is

$$OM = \frac{b^2}{N}.$$

Likewise, the distance of the tangent from the centre measured on the axis of the abscissus, is

$$OT = \frac{a^2}{x},$$

a being the semi-transverse axis of the ellipse: therefore, substituting these values in (1), and making $BO = m$, $BA = n$, we shall have

$$A^2 = \overline{AP}^2 = n^2 + \left(\frac{b^2}{N} - m\frac{b^2}{N} \cdot \frac{x}{a^2}\right)^2,$$

making also

$$a^2 - b^2 = e^2a^2,$$

and introducing the value of the normal in the ellipse,

$$N^2 = \frac{b^2}{a^2}(a^2 - e^2 x^2), \text{ whence } \frac{b}{N} = \frac{a}{\sqrt{a^2 - e^2 x^2}},$$

the value of A^2 becomes

$$A^2 = n^2 + \left(\frac{ab}{\sqrt{a^2 - e^2 x^2}} - m\frac{b}{\sqrt{a^2 - e^2x^2}} \cdot \frac{x}{a}\right)^2.$$

Taking now the equation of the ellipse

$$(2) \quad y^2 = \frac{b^2}{a^2}(a^2 - x^2),$$

and supposing

$$(3) \quad x = a \sin. \phi, \text{ we shall have } y = b \cos. \phi,$$

and ϕ will be the amplitude of the ellipse, and is reckoned on the circumference of a circle[1] circumscribed round the ellipse, beginning from the diameter of the circle corresponding to the conjugate axis, and terminated where the ordinate of the ellipse produced meets the circumference.

If O, Pl. I. Fig. 5, be the centre of the ellipse, and ANB' . . . the circle which circumscribes it, X the ordinate of the ellipse produced to N, $B'N$ will be the arc ϕ, and BON the corresponding angle, and $OX = a \sin. \phi$.

Hence, substituting for x its value

$$A = \sqrt{n^2 + \left(\frac{ab - mb \sin. \phi}{\sqrt{a^2 - a^2 e^2 \sin.^2 \phi}}\right)^2},$$

by the substitutions (3) we have also

$$ds = \sqrt{a^2 - e^2 a^2 \sin.^2 \phi} \,.\, d\phi;$$

therefore

$$(4) \quad Ads = \sqrt{n^2 (a^2 - e^2a^2 \sin.^2 \phi) + (ab - mb \sin. \phi)^2} \,.\, d\phi.$$

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[1] Legendre, i, page 15.

The value of r^2 in this case, according to the notations already given, and the positions of the assumed axes, becomes

$$r^2 = (x - m)^2 + y^2 + n^2,$$

that is, making also here

$$(5) \quad l^2 = m^2 + n^2,$$

and substituting from (3) for x, y,

$$(6) \quad r = \sqrt{b^2 + l^2 - 2\ am\ sin.\ \phi + (a^2 - b^2)\ sin.^2\ \phi};$$

therefore the expression for the force exerted by an element of an elliptical current on a magnetic pole will be

$$(7) \quad \Phi = \frac{k\,Ads}{r^3} = \frac{k\,d\,\phi \,.\, \sqrt{n^2\,(a^2 - (a^2 - b^2)\ sin.^2\ \phi) + (ab - mb\ sin.\ \phi)^2}}{(b^2 + l^2 - 2\ ma\ sin.\ \phi + (a^2 - b^2)\ sin.^2\ \phi)^{\frac{3}{2}}}.$$

In order to find the components, we shall take the equation of the surface of an elliptic cone, which is

$$(8) \quad \mu = b^2\,(mz - nx)^2 + a^2\,(pz - ny)^2 - a^2\,b^2\,(z - n)^2 = 0,$$

which, supposing $p = 0$ for the case of simple obliquity, and after differentiation, making $z = 0$, because all the points of the curve lie in the plane YX, will become

$$\frac{\delta\mu}{dx} = 2\ b^2\ n^2\ x = 2\ b^2\ a\ n^2\ sin.\ \phi,$$

$$\frac{\delta\mu}{dy} = 2\ a^2\ n^2\ y = 2\ a^2\ b\ n^2\ cos.\ \phi,$$

$$\frac{\delta\mu}{dz} = -2\ b^2\ m\,n\,x + 2\ a^2\ b^2\ n = 2\ a^2\ b^2\ n - 2\ b^2\ a\,m\,n\ sin.\ \phi,$$

$$k^{1}{}_{2} = 4\ n^2\ a^2\ b^2\ \left[n^2\,(a^2 - (a^2 - b^2)\ sin.^2\ \phi) + (ab - bm\ sin.\ \phi)^2\right];$$

hence the components are

$$\begin{cases} X = \int \Phi\,\dfrac{1}{k^1} \cdot \dfrac{\delta\mu}{dx} = -\displaystyle\int_0^{2\pi} \frac{k\,b\,n\ sin.\ \phi\ d\,\phi}{(l^2 + b^2 - 2\ am\ sin.\ \phi + (a^2 - b^2)\ sin.^2\ \phi)^{\frac{3}{2}}} \\ Y = -\displaystyle\int_0^{2\pi} \frac{k\,a\,n\ cos.\ \phi\ d\,\phi}{(l^2 + b^2 - 2\ am\ sin.\ \phi + (a^2 - b^2)\ sin.^2\ \phi)^{\frac{3}{2}}} \\ Z = -\displaystyle\int_0^{2\pi} \frac{k\,(ab - bm\ sin.\ \phi)\ d\,\phi}{(l^2 + b^2 - 2\ am\ sin.\ \phi + (a^2 - b^2)\ sin.^2\ \phi)^{\frac{3}{2}}} \end{cases}$$

in which the limits of the integrals are 0 and $2\,\pi$.

§ 5. Integration of Formulæ for the Ellipse.

The expression

$$(1) \quad T = \frac{d\,\omega}{(l^2 + b^2 - 2\ am\ sin.\ \omega + (a^2 - b^2)\ sin.^2\ \omega)^{\frac{3}{2}}}$$

after the substitution of

$$\omega = 90^\circ - 2\,\psi$$

and reduction of functions of double arcs to simple ones, will be transformed into

$$(2)\quad T = \frac{-2\,d\,\psi}{[l^2 + a^2 - 2\,am + 4\,(am - (a^2 - b^2)\,sin.^2\,\psi + 4\,(a^2 - b^2)\,sin.^4\,\psi)]^{\frac{3}{2}}}.$$

The denominator resolved as a quadratic equation gives

$$(3)\quad Sin.^2\,\psi = \frac{am - (a^2 - b^2)}{2\,(a^2 - b^2)}\left(-1 \pm \sqrt{1 - \frac{(l^2 + a^2 - 2\,am)\,(a^2 - b^2)}{(am - (a^2 - b^2))^2}}\right).$$

The quantity $l^2 + a^2 - 2\,am = l^2 + a^2 - 2\,a\,l\,cos.\,\delta$ being the square of the distance of the pole of the needle from the end of the transverse axis of the ellipse, is always positive as well as $a^2 - b^2$, therefore the sign of the root will depend principally on the term $am - (a^2 - b^2)$, and the cases are to be considered, for which different integrals are to be found, according as we have the value of $[am - (a^2 - b^2)]^2 >$ or $<$ or $= (l^2 + a^2 - 2\,am)\,(a^2 - b^2)$, and the roots of the equation (3) are real or imaginary, positive or negative. But it is evident that both roots cannot be real and positive at the same time when $am > (a^2 - b^2)$. The second member of (3) will always be a fraction, since the numerical value of the factor within the brackets cannot exceed 2 and be real, and the other factor which may be written $-\frac{1}{2}\left(1 - \frac{am}{a^2 - b^2}\right)$ is also a fraction less than $\frac{1}{2}$. Hence the roots will be 1st both negative, 2d both positive, and always < 1, 3d both imaginary. Formulæ may be easily found for these three cases.

1. Representing therefore by p^2 and q^2 the numerical value of the roots when both are negative, the integral may be written

$$(4)\quad T = \frac{-2\,d\,\psi}{(2\,e\,a)^3\,[(sin.^2\,\psi + p^2)\,(sin.^2\,\psi + q^2)]^{\frac{3}{2}}},$$

for $4\,(a^2 - b^2) = 2^2\,e^2\,a^2$, where we shall always suppose $p^2 > q^2$.

In order to reduce the last expression to the elliptic functions, let us make

$$tan.\,\psi = \frac{q}{\sqrt{q^2 + 1}}\,tan.\,\phi,$$

whence

$$(5)\quad Sin.^2\,\psi = \frac{q^2\,sin.^2\,\phi}{q^2 + cos.^2\,\phi},\quad cos.^2\,\psi = \frac{(q^2 + 1)\,cos.^2\,\phi}{q^2 + cos.^2\,\phi},\quad d\,\psi = \frac{q\,\sqrt{(1 + q^2)}\,d\,\phi}{q^2 + cos.^2\,\phi}.$$

By means of these the integral becomes

$$(6)\quad T = \frac{-2\,(q^2 + cos.^2\,\phi)^2}{(2\,ea)^3\,q^2\,p^3\,(q^2 + 1)^{\frac{5}{2}}}\cdot\frac{d\,\phi}{\Delta^3},$$

in which

$$\Delta = \sqrt{1 - c^2\,sin.^2\,\phi} \text{ and } c^2 = \frac{p^2 - q^2}{p^2\,(1 + q^2)}.$$

2. When both roots are positive, and $1 > p^2 > q^2$, making

$$Sin.^2\,\phi = \frac{q^2\,sin.^2\,\zeta}{1 - q^2\,cos.^2\,\zeta},$$

$$(7) \quad Cos.^2 \psi = \frac{1 - q^2}{1 - q^2 \, cos.^2 \zeta},$$

and T will become

$$(8) \quad T_2 = - \frac{2\,(1 - q^2 \, cos.^2 \zeta)^2}{(2\,ea)^3 \, p^3 \, q^2 \, (1 - q^2)^{\frac{5}{2}} \, cos.^2 \zeta} \cdot \frac{d\,\zeta}{\Delta^3},$$

$$\text{where } c^2 = \frac{q^2\,(1 - p^2)}{p^2\,(1 - q^2)}.$$

3. When both roots of the equation are imaginary, we shall make

$$Sin.^2 \psi = - u \pm v \sqrt{-1}:$$

making also $\sqrt{u^2 + v^2} = \mu$, $cos.\ \theta = \frac{u}{\sqrt{u^2 + v^2}}$, $sin.\ \theta = \frac{v}{\sqrt{u^2 + v^2}}$, the two binomial factors will be reduced to the trinomial one.

$$(9) \quad Sin.^4 \psi + 2\,\mu \, sin.^2 \psi \, cos.\ \theta + \mu^2,$$

in which $cos.\ \theta$ is positive or negative, according as $u > 0$ or $u < 0$.

Hence we shall have

$$T_3 = - \frac{2\,d\,\psi}{(2\,ea)^3\,(sin.^4 \psi + 2\,\mu \, sin.^2 \psi \, cos.\ \theta + \mu^2)^{\frac{3}{2}}}.$$

This quantity may be written

$$T_3 = - \frac{\frac{2\,d\,\psi}{cos.^2 \psi}}{(2\,ea)^3 \, cos.^4 \psi \left(\frac{sin.^4 \psi + 2\,\mu \, sin.^2 \psi \, cos.\ \theta + \mu^2}{cos.^4 \psi}\right) \sqrt{\frac{sin.^4 \psi + 2\,\mu \, sin.^2 \psi \, cos.\ \theta + \mu^2}{cos.^4 \psi}}}.$$

After convenient reductions by formulæ $\frac{1}{cos.^2} = sec.^2 = 1 + tang.^2$, making for the sake of brevity

$$(10) \quad \begin{cases} A^2 = 1 + 2\,\mu \, cos.\ \theta + \mu^2 \\ Cos.^2 \lambda = \frac{cos.\ \theta + \mu}{A}, \text{ whence } sin.^2 \lambda = \frac{sin.\ \theta}{A}, \end{cases}$$

it will be reduced to

$$T_3 = - \frac{2\,d\,tang.\ \psi}{(2\,ea)^3 \, cos.^4 \psi \, (A^2 \, tang.^4 \psi + 2\,A\,\mu \, cos.^2 \lambda \, tang.^2 \psi + \mu^2)^{\frac{3}{2}}}.$$

Let us now make

$$(11) \quad \begin{cases} Tang.\ \psi = \sqrt{\frac{\mu}{A}} \, . \, tang.\ \tfrac{1}{2}\,\sigma, \\ \text{whence} \\ Sin.^2 \psi = \frac{\mu \, sin.^2 \frac{1}{2}\,\sigma}{A \, cos.^2 \frac{1}{2}\,\sigma + \mu \, sin.^2 \frac{1}{2}\,\sigma} = \frac{\mu\,(1 - cos.\ \sigma)}{A\,(1 + cos.\ \sigma) + \mu\,(1 - cos.\ \sigma)}, \\ Cos.^2 \psi = \frac{A \, cos.^2 \frac{1}{2}\,\sigma}{A \, cos.^2 \frac{1}{2}\,\sigma + \mu \, sin.^2 \frac{1}{2}\,\sigma} = \frac{A\,(1 + cos.\ \sigma)}{A\,(1 + cos.\ \sigma) + \mu\,(1 - cos.\ \sigma)}. \end{cases}$$

These substitutions made in T_3 will give

$$(12) \quad T_3 = - \frac{[A\,(1 + cos.\ \sigma) + \mu\,(1 - cos.\ \sigma)]^2}{4\,(2\,ae)^3\,(A\,\mu)^{\frac{5}{2}}} \, \frac{d\,\sigma}{\Delta^3}.$$

The limits being $\sigma = 0$, $\sigma = 2\,\pi$, having made as before $\Delta = \sqrt{1 - c^2 \, sin.^2 \sigma}$, in which $c^2 = \frac{1}{2} \, sin.^2 \lambda$.

Having thus reduced the integral to elliptical functions, we may proceed to the determination of the components.

I. In the case of real roots, the supposition

$$\omega = 90° - 2\,\psi,$$

and the (5) give

$$Sin.\,\omega = cos.\,2\,\psi = (1 - 2\,sin.^2\,\psi) = 1 - 2\,\frac{q^2\,sin.^2\,\phi}{q^2 + cos.^2\,\phi}$$
$$= \frac{(q^2 + 1) - (2\,q^2 + 1)\,sin.^2\,\phi}{q^2 + cos.^2\,\phi}.$$

$$Cos.\,\omega = sin.\,2\,\psi = 2\,sin.\,\psi\,cos.\,\psi = \frac{2\,q\,\sqrt{q^2 + 1}\,.\,cos.\,\phi\,sin.\,\phi}{q^2 + cos.^2\,\phi}$$

$$ab - bm\,sin.\,\omega = ab - bm\left(\frac{(q^2 + 1) - (2\,q^2 + 1)\,sin.^2\,\phi}{q^2 + cos.^2\,\phi}\right)$$
$$= \frac{(ab - mb)\,(q^2 + 1) - (ab - (2\,q^2 + 1)\,bm)\,sin.^2\,\phi}{q^2 + cos.^2\,\phi}.$$

Combining these values with those of T in (6), we have for the three components the following values:

$$X = \int_0^\pi \frac{2\,.\,k\,b\,n}{(2\,ea)^3\,p^3\,q^2\,(q^2 + 1)^{\frac{5}{2}}}\,.\,\frac{[(q^2 + 1) - (2\,q^2 + 1)\,sin.^2\,\phi]\,[q^2 + cos.^2\,\phi]}{\Delta^2}\,.\,\frac{d\,\phi}{\Delta},$$

$$Y = \int_0^\pi \frac{4\,k\,a\,n\,q}{(2\,ea)^3\,p^3\,q^2\,(q^2 + 1)^2}\,.\,\frac{sin.\,\phi\,cos.\,\phi\,(q^2 + cos.^2\,\phi)}{\Delta^2}\,.\,\frac{d\,\phi}{\Delta},$$

$$Z = \int_0^\pi \frac{2\,k}{(2\,ea)^3\,p^3\,q^2\,(q^2 + 1)^{\frac{5}{2}}}\,.\,\frac{[(ab - bm)\,(q^2 + 1) - (ab - (2\,q^2 + 1)\,bm)\,sin.^2\,\phi]}{\Delta^2}$$
$$\frac{[q^2 + cos.^2\,\phi]}{}\,.\,\frac{d\,\phi}{\Delta}.$$

The value of Y will vanish at the limits, as appears also by the symmetry of the conductor. The values of X and Z must be reduced to more simple forms by reducing the cosines to sines, and dividing.

We shall therefore have, making $q^2 + 1 = g$,

$$X = \int_0^\pi \frac{2\,k\,b\,n}{(2\,ea)^3\,p^3\,q^2\,(q^2 + 1)^{\frac{5}{2}}}\,.\,\frac{g^2 + 2\,g^2\,.\,.\,sin.^4\,\phi}{\Delta^2}\,.\,\frac{d\,\phi}{\Delta}$$

$$= -\int_0^\pi \frac{2\,k\,b\,n}{(2\,ea)^3\,p^3\,q^2\,(q^2 + 1)^{\frac{5}{2}}}\,.\left(\frac{q^2 + g}{c^2}\,sin.^2\,\phi - \frac{2\,g^2\,c^2 - (q^2 + g)}{c^4}\right.$$
$$\left. + \frac{2\,g^2\,c^2 - (q^2 + g) - c^4\,g^2}{c^4\,\Delta^2}\right)\frac{d\,\phi}{\Delta},$$

$$Z = \int_0^{\pi} \frac{2\,k}{(2\,ea)^3\,p^3\,q^2\,(q^2+1)^{\frac{5}{2}}} \left(\frac{(ab - bm)\,g^2 - 2\,g\,(ab - bmg)\,sin.^2\,\phi}{\Delta^2} + (ab - (q^2+g)\,bm)\,sin.^4\,\phi \right) \frac{d\,\phi}{\Delta}.$$

Making, for the sake of brevity, in the value of X,

$$M = q^2 + g$$
$$N = 2\,g^2\,c^2 - (q^2+g),$$
$$P = 2\,g^2\,c^2 - (q^2+g) - c^4\,g^2;$$

and in the value of Z,

$$M^1 = ab - (q^2+g)\,bm,$$
$$N^1 = (ab - bmg)\,(1 - 2\,c^2\,g) - bmq^2,$$
$$P^1 = (1 - c^2\,g)\,\Big((ab - bm)\,(1 - c^2\,g) - 2\,bmq^2\Big);$$

and in both

$$\frac{2\,k\,b\,n}{(2\,ea)^3\,p^3\,q^2\,(q^2+1)^{\frac{5}{2}}} = Q,$$

we shall have

$$X = -Q \int_0^{\pi} \left(\frac{M\,sin.^2\,\phi}{c^2\,\Delta}\,d\,\phi - \frac{N}{c^4\,\Delta}\,d\,\phi + \frac{P\,d\,\phi}{c^4\,\Delta^3} \right),$$

$$Z = -\frac{Q}{bn} \int_0^{\pi} \left(\frac{M^1\,sin.^2\,\phi}{c^2\,\Delta}\,d\,\phi + \frac{N^1\,d\,\phi}{c^4\,\Delta} - \frac{P^1\,d\,\phi}{c^4\,\Delta^3} \right);$$

and taking the complete functions, as in § 3,

$$X = -2\,Q \left(\frac{M}{c^4}\,(F^1 - E^1) - \frac{N}{c^4}\,F^1 + \frac{P}{c^4\,b_1^2}\,E^1 \right),$$
$$Z = -2\,\frac{Q}{bn} \left(\frac{M^1}{c^4}\,(F^1 - E^1) + \frac{N^1}{c^4}\,F^1 - \frac{P^1}{c^4\,b_1^2}\,E^1 \right),$$

in which b_1 is the complement of the modulus in order to distinguish it from the semiarc, b.

II. In the same way we shall find X, Z for the case of both roots being positive, but, as it offers no difficulty, we shall only proceed to enlarge a little on the third case.

III. In the case of imaginary roots, the supposition $\omega = 90^\circ - 2\,\psi$ and (11) give

$$Sin.\,\omega = cos.\,2\,\psi = 1 - 2\,sin.^2\,\psi = 1 - 2\,\frac{\mu\,(1 - cos.\,\sigma)}{A\,(1 + cos.\,\sigma) + \mu\,(1 - cos.\,\sigma)}$$
$$= \frac{A\,(1 + cos.\,\sigma) - \mu\,(1 - cos.\,\sigma)}{A\,(1 + cos.\,\sigma) + \mu\,(1 - cos.\,\sigma)},$$

$$Cos.\,\omega = sin.\,2\,\psi = 2\,cos.\,\psi\,sin.\,\psi = \frac{2\,\sqrt{A\,\mu}\,\sqrt{(1 - cos.\,\sigma)\,(1 + cos.\,\sigma)}}{A\,(1 + cos.\,\sigma) + \mu\,(1 - cos.\,\sigma)}$$
$$= \frac{2\,\sqrt{A\,\mu}\,.\,sin.\,\sigma}{A\,(1 + cos.\,\sigma) + \mu\,(1 - cos.\,\sigma)}.$$

Hence from (9 § preced.) and (12),

$$X = \int_0^{2\pi} \frac{k\,b\,n}{4\,(2\,ae)^3\,(A\,\mu)^{\frac{5}{2}}} \cdot \frac{A^2\,(1 + cos.\,\sigma)^2 - \mu^2\,(1 - cos.\,\sigma)^2}{\Delta^2} \cdot \frac{d\,\sigma}{\Delta},$$

$$Y = \int_0^{2\pi} \frac{2\,k\,a\,n\,sin.\,\sigma}{4\,(2\,ae)^3\,A^2\,\mu^2} \cdot \frac{A\,(1 + cos.\,\sigma) + \mu\,(1 - cos.\,\sigma)}{\Delta^2} \cdot \frac{d\,\sigma}{\Delta},$$

$$Z = \int_0^{2\pi} \frac{k}{4\,(2\,ae)^3\,(A\,\mu)^{\frac{5}{2}}} \cdot \frac{[(ab - bm)\,A\,(1 + cos.\,\sigma) + (ab + bm)\,\mu\,(1 - cos.\,\sigma)]}{\Delta^2}$$

$$[A\,(1 + cos.\,\sigma) + \mu\,(1 - cos.\,\sigma)] \cdot \frac{d\,\sigma}{\Delta}.$$

Here also we find that Y vanishes at the limits. The values of X and Z, after being developed, consist of two parts; the one multiplied by $cos.\,\sigma$, and integrable by arcs of the circle and logarithms; the other wholly dependent upon elliptical functions. The first vanishes at the limits, and the second remains alone. The values are as follow:

$$X = \int_0^{2\pi} \frac{k\,b\,n}{4\,(2\,ae)^3\,(A\,\mu)^{\frac{5}{2}}} \left(\frac{(A^2 - \mu^2)\,(1 + cos.^2\,\sigma)}{\Delta^3} + \frac{2\,(A^2 + \mu^2)\,cos.\,\sigma}{\Delta^3}\right) d\,\sigma,$$

$$Z = \int_0^{2\pi} \frac{k}{4\,(2\,ae)^3\,(A\,\mu)^{\frac{5}{2}}} \left(\frac{(f\,A^2 + f^1\,\mu^2)\,(1 + cos.^2\,\sigma) + A\,\mu\,(f + f^1)\,sin.^2\,\sigma}{\Delta^3}\right.$$

$$\left. + \frac{2\,(f\,A^2 - f^1\,\mu^2)\,cos.\,\sigma}{\Delta^3}\right) d\,\sigma,$$

in the last of which we have made

$$f = (ab - bn),\; f^1 = (ab + bn),\; f + f^1 = 2\,ab.$$

Integrating between the limits $\sigma = 0$, $\sigma = 2\,\pi$, or what is the same, taking the complete functions as we have done already, we shall have

$$(14)\;\begin{cases} X = \dfrac{k\,b\,n\,(A^2 - \mu^2)}{(2\,ae)^3\,(A\,\mu)^{\frac{5}{2}}} \left(\dfrac{1}{b_1^2}\,E^1 + \dfrac{1}{c^2}\,(F^1 - E^1)\right), \\ Z = \dfrac{k}{(2\,ae)^3 (A\,\mu)^{\frac{5}{2}}} [(f A^2 + f^1 \mu^2)\left(\dfrac{1}{b_1^2}\,E^1 + \dfrac{1}{c^2} (F^1 - E^1)\right) + \dfrac{2\,A\,\mu\,ab}{b_1^2\,c^2}\,(E^1 - b_1^2 F^1)], \end{cases}$$

which are the two components in the case of the imaginary roots of equation (2), which will be an obvious case when the difference of the axes of the ellipse is great, and the length of the needle less than the transverse axis.

§ 6. Discussion of the Formulæ, and Equilibrium of a Magnetic Needle.

Formulæ (15, § 3) and (13, 14, § 5) contain the theory of forces acting on a magnetic pole of a needle, and it is very easy to deduce from them also the law of equilibrium of a needle, supported by a silk fibre or a pivot. De la Rives's floating ring, and the instrument called *compass of tangents*, are only particular cases thereof, and the theory of the common galvanometer is also dependent on the same. In the case of a floating ring, the magnet is fixed and the currents are movable; the contrary takes place in galvanometers, where the current is fixed and the needle is movable. This being the most interesting case, we shall consider it principally, as it will be very easy to apply the conclusions to the other. The case of a circular current having been more generally resolved, we shall discuss this first.

Let us consider a needle AB (Fig. 6) supported at its middle point C either by a silk fibre or a pivot: let us pass a plane through its natural position of equilibrium and that which it takes by the action of the currents, and let DE be the intersection of this plane with the plane of the currents XY. It is evident that each pole is solicited by three forces X, Y, Z, as well as by terrestrial magnetism and gravity, and the needle will be in equilibrio whenever the sum of their moments taken relatively to three orthogonal planes passing through C satisfy the conditions required in mechanics for the equilibrium of a free body, if the needle be only suspended by a silk fibre; or for a body movable on a point or an axis, if the needle be supported by a pivot or axis.

In order to find the direction of the forces X, Y, and ascertain the direction of their resultant, and their sign, let us join as before (§ 2) the centre O of the circle with the pole A and project the line $OA = l$ on the plane YX. Calling s the length of this projection and u the angle made by it with the axis OY, according to the denominations of that paragraph, we shall have

$$m = s \cos. u, p = s . \sin. u,$$

from which

$$\frac{p}{m} = tang. u;$$

therefore $u = \alpha$, and α is the angle made by the projection of l on the plane XY with the axis OY; this arbitrary quantity is then fully determined.

Therefore making for the sake of brevity

$$(1) \quad Q = \frac{4\, k\, R\, n}{h^3\, b^2\, c^2} (2\, E^1 - 2\, b^2\, F^1 - c^2\, E^1),$$

we can regard the forces X, Y, as components of a force Q acting parallel to the plane $X\,O\,Y$ and to the projection s, passing by the pole through which the resultant of all the forces passes. The force Q is evidently the component of the whole resultant ϕ resolved in the direction of a plane passing through the pole of the needle and the axis Z of the circle, and perpendicularly to that axis. According to the position of the poles $\sin. \alpha$ and $\cos. \alpha$ may change their signs, and so the values of X, Y, may change likewise; in Z, the sign of $\cos. \alpha$ is always to be combined with that of m, and as these signs change simultaneously, so there will be no difference in the product $m \cos. \alpha$ and in the terms depending on it.

In order to ascertain more speedily the equations of equilibrium of a needle, let us transfer the origin of the co-ordinate planes from O to C, the middle point of the needle which we shall suppose to be fixed. Let the new axes also be parallel to the former ones, and let the axis OX be parallel with the axis of rotation, around which the needle is movable: calling

$$X_0, \ Y_0, \ Z_0,$$

the co-ordinates of the point O relative to the new origin C; L half the length of the needle CA; d the angle of deviation of the needle from the plane of the circle, we shall have

$$Z_0 = CH, \ Y_0 = HG, \text{ and}$$
$$X_0 = OG.$$

From these we obtain

$$m = GK = HK - HG = CL - HG = L \cos. d - Y_0,$$
$$(2) \quad n = KA = LA - LK = L \sin. d - Z_0,$$
$$p = - X_0.$$

Likewise for the other pole

$$m^1 = DG = - L \cos. d - Y_0,$$
$$n^1 = BD = - L \sin. d - Z_0,$$
$$p^1 = - X_0.$$

These values must be substituted in XYZ to obtain the expression of the forces referred to the new origin.

For the purpose of avoiding a useless complication, we shall first consider a simple declinating needle, and suppose the plane of the currents to be vertical. In this case, if T represent the intensity of terrestrial magnetism parallel to the magnetic meridian, and d^1 the angle made by the circle with that meridian, the components soliciting each pole parallel to OZ, OY, will be

$$T \sin. d^1, \ T \cos. d^1.$$

Now the whole system of forces acting on a declinating needle, movable on a pivot without friction (marking them with the letters a, b, according as they belong to either the one or the other pole), will be as follows:

Parallel to OY

$$+ Ta \cos. d^1, - Tb \cos. d^1, + Ya, - Yb,$$

parallel to OZ

$$+ Ta \sin. d^1, - Tb \sin. d^1, + Za, - Zb,$$

parallel to OX

$$Xa, - Xb.$$

The last forces suppose the vertical magnetic component compensated by gravity, which is effected by a suitable suspension of the needle.

Multiplying each force by the distance of the pole to which it is applied from the co-ordinate plane to which the direction of that force is parallel, and which distance is $= \pm L \; sin. \; d$ or $\pm L \; cos. \; d$, as the case may be, we shall have its momentum, which tends to turn the needle round its centre of motion in that direction.

We shall find the equation, first for the case of the two first systems of forces.

The terrestrial component parallel to $O\,Y$ acts in the direction of this axis, while, on the contrary, that parallel to $O\,Z$ acts against it; the condition of equilibrium will then be—supposing both poles equally strong—

$$(3) \quad L \, sin. \, d \, (2 \, T cos. \, d^1 + (Ya + Yb)) - L \, cos. \, d \, ((Za + Zb) - 2 \, T sin. \, d^1) = 0.$$

If in this we substitute the value of Ya, Yb, from (1) and (2), making

$$Q^1 = \frac{4 \, k \, R}{h^3 \, b^2 \, c^2} \, cos. \, \alpha \, (2 \, E^1 - 2 \, b^2 \, F^1 - c^2 \, E^1),$$

we shall have

$$Ya + Yb = Qa^1 \, (L \, sin. \, d - Z_0) - Qb^1 \, (L \, sin. \, d + Z_0)$$
$$= (Qa^1 - Qb^1) \, L \, sin. \, d - (Qa^1 + Qb^1) \, Z_0.$$

Substituting this value in (3), the equation of equilibrium of the declinating needle will be reduced to

$$(4) \quad 2 \, T sin. \, (d + d^1) = (Za + Zb) \, cos. \, d - (Qa^1 - Qb^1) \, L \, sin.^2 \, d + (Qa^1 + Qb^1) \, Z_0 \, sin. \, d.$$

If NS (Fig. 7) represent the orthogonal projection of the magnetic meridian, DE that of the plane of the circular current, and AB that of the needle on the horizontal plane $Y\,O\,Z$, we shall have

$$NCD = d^1, \; ACD = d.$$

Formula (4) can be applied to the dipping needle, provided the plane of the currents be perpendicular to that of rotation; to the meridian line, SN, we must then substitute the line of inclination of the needle according to the latitude of the place, and that equation in such a case will be sufficient.

In the case of the declination needle suspended not by an axis, but on a pivot, the system of forces parallel to $O\,X$, combined first with those parallel to $O\,Y$, and then with those parallel to $O\,Z$, will give two other equations from which the inclination of the needle will be determined; but as these equations are of very little use in practice, and can easily be found after what we have said of equation (4), we shall omit them.

Formula (4) is reduced to a very simple one when the needle has its middle on the diameter of the circle $O\,X$, because then

$$Za = Zb, \; Qa^1 = - \; Qb^1, \; Z_0 = 0.$$

Therefore it becomes

$$(5) \quad T \, sin. \, (d + d^1) = Z \, cos. \, d - Q^1 \, L \, sin.^2 \, d,$$

Z being a function of L, d, p, R.

If, besides this, the needle be concentric with the circle, and the plane of the currents coincide with the meridian, then we have, $d^1 = 0$, and $Za = Zb$, and the formula will be reduced to this very simple one.

$$(6) \quad T \, tang. \, d = Z - Q^1 \, L \, sin. \, d \; tang. \, d,$$

where d is the deviation of the needle produced by the current.

If for the angle d, we use the absolute deviation D, from the magnetical meridian, in formula (5), it will become

$$d = D - d^1 \text{ and}$$

$$(7) \quad T \sin. D = Z \cos. (D - d^1) - Q^1 L \sin.^2 (D - d^1).$$

It is evident that these conclusions, and chiefly the (6), can be applied to an elliptical conductor; and so formulæ (4), (5), (6), express also the condition of equilibrium in the case of the ellipse, supposing, however, $p = 0$.

Our principal object being, for the present, to compare with theory the experiments of which we have spoken in the introduction, we shall not enter into further details by continuing the discussion of the formulæ. We may observe, however, by the way, that the formula supposed to represent electric forces in the compass of tangents, cannot be exact except by approximation, when the needle is exceedingly short in comparison with the diameter of the circle.

The value of the second member of equation (6) varies sensibly with the magnitude of the deviation, even for a needle 4 centim. long in a circle of 45 centim. diameter, when the deviations differ only 5 or 6 degrees, as we shall shortly see.

The compass of tangents, however, may be used in the same way as the compass of sines,[1] and then it is exact for every length of needle.

To prove this, it will be sufficient to cast a glance on the formulæ (5), and (6), because the value of $Z - Q^1 L \sin. d \tang. d$ when the needle is not concentric with the circle may be expressed by

$$k f (d, p),$$

and when it is concentric by

$$Z - Q^1 L \sin. d \tang. d = k f (d).$$

To another intensity and deviation we have

$$Z - Q^1 L \sin. d_1 \tang. d_1 = k_1 f (d_1).$$

Therefore from the (6)

$$(8) \quad \frac{Tang.\ d}{Tang.\ d_1} = \frac{k f (d)}{k_1 f (d_1)}.$$

As $f (d)$ differs from $f (d_1)$ when the value of the length of the needle is sensible, so the factor of the second member $\frac{f}{f_1}$ is never $= 1$ except when the needle is very short.

But using this instrument as the compass of sines used by Pouillet, in which the plane of the currents is always kept passing through the axis of the needle, then $d = 0$, and the formula (5) gives

$$T \sin. d^1 = Z.$$

the second member also is always constant since d is always the same and $= 0$, therefore $\cos. d = 1$ and

$$(9) \quad \frac{Sin.\ d^1}{Sin.\ d^1_1} = \frac{k f (0)}{k_1 f (0)} = \frac{k}{k_1}.$$

But we do not know how much we can trust to experiments made with this last apparatus, because, after the needle has reached the maximum of deviation, the

[1] For these two instruments, see Becquerel, Traité de l'Electr. et Mag.; t. v. p. 262.

slightest motion made with the circle of the currents in order to cause it to deviate more, very often produces a complete *fall* of the needle to within a very few degrees above zero, and thus it is very difficult to ascertain the maximum angles with sufficient accuracy. Besides, all those who know how difficult it is to settle the current exactly in the plane of the needle (even in the most simple case when it is in the magnetic meridian), will be persuaded that there is great difficulty—without a very excellent instrument and particular care—in keeping the currents always exactly in the plane of the needle. Practice, however, and good construction, may obviate considerably the errors due to those causes, and a good instrument cannot be too highly appreciated when it spares all the trouble of calculation.

Formula (5) combined with (7) et seq. give the angle at which the needle will rest after it has fallen from its maximum of deviation, since, dividing one by the other, T and k being the same in both numerator and denominator, we have

$$\frac{Sin.\ D}{Sin.\ d^1} = \frac{f(d)\ cos.\ (D - d^1)}{f(0)},$$

from which, measuring D, we can calculate what ought to be the angle d^1 which could not be accurately observed.

As from the formula we have deduced the explanation of this last case, so we could explain a similar phenomenon which takes place when the plane of the current is moved parallel to itself towards one of the sides of the needle; we might easily perceive that the deviation would increase until a certain maximum, after which the needle would fall all at once and deviate a very few degrees. To determine this limit, it is only necessary to ascertain the value of d when the plane of the circle is supposed to pass between the poles, and afterwards when it does not do so, the value of Z_0 being the same.

§ 7. Application of the Formulæ to our Experiments.

The problem of Mr. Plana having for its object to determine the intensity of action of several circular currents on the internal circumference of a globe, around which they are disposed like so many meridians, and particularly on the various points of its polar axis, it is evident that this is only a more complex case of our formulæ; in these, the angle d^1 varies within certain limits, and the sum of all the actions is to be considered. This aggregate action is regarded by Mr. Plana as exerted on a single element of a current, the verification of which by experiment is impossible, and therefore a magnetic needle was substituted. This, however, is obnoxious to a difficulty, because, although it is true, as Ampère proves,[1] that the action of the pole of a solenoid is, for different distances, in the same constant ratio with that of a simple element; yet, notwithstanding this, by using a needle, the problem is completely changed, by the introduction of two centres of action, acting at a certain distance from one another. This case, however, may coincide with that of

[1] Theorie, page 104.

a single element when the current is a simple circular line, whose plane passes through the middle of the needle, and the *length of the needle can be considered as infinitely small.* But in practice, all these conditions cannot be realized, since, using a single current, the effect is exceedingly small, and the errors of position have a great influence on the results. On the contrary, using a bundle of wires, in order to have a stronger effect, the problem is completely different, since each current cannot lie mathematically in the plane passing through the middle of the needle. The influence of all these circumstances was unknown to me when I made the first series of experiments; now, however, we can appreciate their influence and discover the causes of the discrepancies between the experiments and the numbers given by Mr. Plana.

Let us first consider the case of a single current, after which we shall consider that of a globe. Since the formula which expresses the intensities of the forces by means of the deviation of the needle is known, it will be very easy to verify by experiment Mr. Plana's problem. To do so, it will be sufficient to settle the needle in different points of the vertical diameter OX, and measure its deviation.

In fact, supposing the circle in the plane of the magnetic meridian, the formula (6) for a position p, and a deviation d, may be expressed by

$$T\ tan.\ d = k f(p, d),$$

and for another position by

$$T\ tan.\ d_1 = k_1 f(p_1, d_1);$$

whence k being $= k_1$,

$$(m)\quad \frac{tan.\ d}{tan.\ d_1} = \frac{f(p, d)}{f(p_1, d_1)},$$

the deviations being observed, and f calculated, this equation must be satisfied. If this happens, in fact, the formula is proved to be exact.

When I made the above experiments, I did not know these formulæ, and of course was obliged to have recourse to another expedient. I considered, also, that the measure of deviation could not be accurate enough in this case, because I was obliged to use small graduated circles, the construction of the machine not allowing of larger ones. If large circles could have been used, the want of formulæ would have been supplied by experimental tables of proportional degrees of force, as is done in Melloni's experiments, it being very easy to construct good ones. Another way seemed therefore preferable, which might be independent of the variations of angular deviation, and of every analytical expression of forces. It is the following:

Whatever may be the action of a current on a needle, it shall always be expressed by

$$k f,$$

k being the intensity of the current, and f a function dependent on the position of the needle relative to the circular current. If we change the place of the needle, and from the centre transfer it to another position, for instance, at $\frac{9}{10}$ths of the radius on the vertical axis OX, the new force acting will be

$$k f_1.$$

Now these two forces can be made equal to one another by varying the intensity of the current, and they will be equal to each other when they are in equilibrium with the same terrestrial magnetic force $T \tan. d.$ Diminishing, therefore, the intensity, k, until the deviation of the needle at the centre and near the circumference are the same, we shall have

$$kf = k_1 f_1, \text{ whence } \frac{k}{k_1} = \frac{f_1}{f}.$$

The difficulty is now reduced to determining the ratios of the intensity of the currents corresponding to the two positions. This may be easily done, following the principles of Ohm, and using the apparatus invented by Wheatstone for measuring the resistances of electric circuits. From Ohm's theory we know that the electrical forces or intensities k, k_1, are in inverse ratio of the total resistances in voltaic circuits; therefore, marking by ρ and ρ_1, the total resistance in our two cases, we shall have

$$(1) \quad \frac{k}{k_1} = \frac{\rho_1}{\rho}.$$

Combining this equation with the preceding, we shall have

$$(2) \quad \frac{f}{f_1} = \frac{\rho}{\rho_1};$$

that is, the functions f, f_1, are in direct ratio with the total resistances of the circuits.

The total resistance of a circuit comprehends the resistance of the voltaic battery used in the experiment, and of the connecting wires through which the electricity passes. All these resistances must be reduced to a certain unit of measure, and so we shall obtain what is called by Ohm the reduced length of the circuit. Some instruments are required for this purpose, and we shall explain in the next paragraph their construction and use.

These were the principles on which I made the first series of experiments, an account of which was published in the journal mentioned in the introduction,[1] but at that time I did not take note of the quantity of deviation of the magnetic needle used for investigating the action of the current, being satisfied with keeping it constantly *the same* in the same series of experiments, and measuring it only approximately, thinking that the absolute angle was of no very great importance.

Now, however, the analytical formulæ teach us that the absolute angle is one of the leading elements of calculation. I have therefore repeated a part of the experiments already made, in order to supply that defect, and have found by this means that the results are not greatly affected by an error of two or three degrees in the deviation, on account of the shortness of the needle and greatness of the circles employed, and thus the first experiments can also be usefully discussed.

It is also necessary to observe this angle in order to take the mean of several experiments, because if the angles are different the mean cannot be taken. It was, indeed, the sensible discordance of experimental results with each other, and with the numbers found by Mr. Plana, which stimulated me to inquire deeply into this matter. The result of the experiments agreed tolerably well with the numbers obtained from theory when the current was strong, but not so when it was weakened by the resistances introduced. On the contrary, they agreed perfectly

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[1] Raccolta Scientifica. Roma, Dec. 15, 1847.

well with each other when made in identical circumstances and with equal lengths of total resistance, but disagreed when the resistances were considerably different. I knew not to what cause to attribute these irregularities, whether to inexactness in the principles of Ohm, or to some unknown cause inherent in the experiments themselves; but the formulæ will show that it arose at least in part from the smaller deviation of the needle in one case than in the other. The breadth of the bundle of wires had also a certain influence that could not be conveniently appreciated without the use of the formulæ. But these things will be understood better after a complete exposition of the experiments, which will be given very soon.

We have considered until now a simple circular current, but the case of Mr. Plana, of a globe surrounded by currents passing through the poles, is very different from this; it can, however, be reduced to it with certain restrictions.

Let us suppose now only two circular currents, disposed around a globe, passing through the same poles, and disposed symmetrically on both sides of the magnetic meridian. It may be shown that, when the needle is very small in comparison with the diameter of the globe, the ratio of their action at different points of the polar diameter is equal to that of a single circular current, whose intensity is equal to the sum of both, and which is in the meridian plane. For, these currents making two equal angles $+ d^1$, $- d^1$ with the meridian, we have from formula (7), § prec., for the sum of their actions on the needle deviating D degrees,[1]

$$T \sin. D + T \sin. D = Z \cos. (D - d^1) + Z \cos. (D + d^1).$$

When the needle is very small, in comparison with the circles, and the angle D and d^1 are not very great, the values of Z differ but little from the mean value Z_m; therefore

$$2\, T \sin. D = Z (\cos. (D - d^1) + \cos. (D + d^1)) = 2\, Zm \cos. D \cos. d^1,$$

that is

$$T \tang. D = Zm \cos. d^1 = k f (D, p) \cos. d^1.$$

This formula, for another position of the needle, becomes

$$T \tang. D = k_1 f (D p_1,) \cos. d^1;$$

and when D is the same, we shall have

$$1 = \frac{k f (D, p)}{k_1 f (D, p_1,)}, \text{ whence } \frac{k}{k_1} = \frac{f (D, p_1,)}{f (D, p)}.$$

These results are confirmed by experiment, as we shall see.

§ 8. Description of the Instruments used to verify the Formulæ.

The apparatus required for these experiments consists of:—

1. A simple voltaic electromotor or battery of constant force.
2. One or two multiplicator galvanometers.
3. A rheostat, with its accessories.
4. A circle or globe, around which wires are coiled, adjustable on its stand.

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[1] The last term in the second member of equation (7) being omitted, as very small, in the experiments.

5. A magnetic needle, to be introduced into the globe or circle, to explore the force of the current in different places.

All these instruments are represented together in Pl. III., Figs. I. to V., and we propose to pass them in review.

I. *Electromotor*. Various electromotors or voltaic combinations, of quite recent invention, are considered as constant, and indeed they are so for a short interval of time, when the circuit is open and offers a great resistance to electricity. But having had several times the opportunity of using batteries of very different construction, I was taught by experience that none of them is perfectly constant, *and cannot be so*, especially when the circle of conductors is short, and presents a very small resistance. In an appendix to this memoir, an account is given of the comparative experiments made with all the most celebrated combinations, in order to ascertain their constancy. The result of these and other experiments proved that, when the connecting wire is long and thin, a nearly perfect constancy may be obtained during several hours, which is what is required for great accuracy in our experiments. We have preferred Daniell's combination to any other. The copper plate was a cylinder or rectangular case of that metal, holding a saturated solution of sulphate of copper, the zinc being in a bladder with a solution of chloride of sodium. For large plates, we used with great advantage, instead of the bladder, a bag of sail-cloth covered with a thick paste of flour and slaked lime, in equal proportions, which is applied to the bag when it is moistened, but is fit for use when it has been dried. We have found such a preparation to answer better for the separation of liquids than bladder itself, even when the canvas is not very thick. Its resistance is very little increased by that preparation; it resists a good deal less than an earthen cell, and after having been used once or twice, the bag acts better than the first time. The reasons for preferring this battery to the others were, 1st, its greater constancy, and the facility with which it can be kept in the same state, when compared with other combinations, caused by a certain quantity of sulphate kept in the corners of the element, as is seen in Fig. 1. 2d. There is no production of gas, deleterious to the health of the operator or injurious to the surrounding apparatus, as in Bunsen's and Grove's combinations. 3d. There are no fluctuations when the resistance of the circuit is suddenly changed, interrupted, or restored; but after all these alterations, when the resistance becomes the same, the needle points always to the same degree. These irregularities are chiefly remarkable in all those batteries where there is a large development of gas, and are very inconvenient for a good success in the experiments. Perhaps the different quantity of gas which is adherent to the plates, and is detached from them or increased during the alternations of force, is the origin of these fluctuations. The combination of platina and zinc with sulphuric acid, which is very constant when not touched, was found the most irregular by changing the resistance of the circuit, and was worse than that of copper and zinc.

Some preparatory experiments for ascertaining the constancy of the current, were made by introducing into the circuit all the resistances which were to be used, and the conclusion was that within six or seven hours there was no sensible variation; now the time occupied in a series of experiments was scarcely an hour, after sufficient skill was acquired.

The element of Daniell, used for the experiments on the globe, was composed of a copper cylinder eight inches (20 centimet.) high, and six inches wide. With a hollow cylinder of amalgamated zinc, equally high, and three inches in diameter (7.61 centimet.), the deviation was fixed to 20° of a galvanometer, bearing a rather short wire, equal in resistance to five turns of the rheostat, all the resistance of the circuit being seventy turns. In one experiment, the circuit was kept close during two days, after which the deviation had diminished 2°, and six turns more were to be uncoiled from the rheostat, to reduce the needle to the former deviation. After fourteen days, the current went on, not very much weakened, when, no more sulphate having been added, the almost pure water remained. Then a curious anomaly took place, viz., that the resistance of the pair appeared variable, and seemed to increase when the interposed resistance was greater. Whatever may be the cause of this irregularity, which deserves to be studied, it is evident that we can rely on the constancy of the battery for the time of the experiments.

To be more certain of this, a galvanometer was constantly kept for this purpose in the circuit, which was carefully observed at the beginning and at the end of every series. Besides, no series was commenced without keeping the circuit closed for a certain time, until the battery reached its constant state. If the difference between the observation of the strength of the battery made at the beginning and at the end of any series was greater than two turns of the rheostat, that series was excluded as not being a good one.

II. The *galvanometers* interposed in the circuit were Nobili's multipliers, some of which were constructed under his own direction, but their sensibility was too great for these experiments; this was diminished either by taking away the second needle, or disposing it at right angles with the other, or wholly inverting it. I preferred galvanometers with short and light needles, because they become stationary very soon, when those with long and heavy needles require a longer time. Now to save time in this matter is highly important, in order to avoid errors arising from a change of strength in the battery. Also, for the purpose of checking the vibrations of the needle, the graduation of the circles was made on pure copper plates. In the system of experiments which we have adopted, there is no need of observing every time on the galvanometer the absolute deviation of the needle, but only to see whether the current has the same degree of force; if not, it is to be reduced to the same intensity by regulating the length of the connecting wire. Hence the observations are free from errors due to imperfect graduation, or the eccentricity of the needle. To avoid also errors of parallax, the needle was observed through a microscope with crossed wires. (See Pl. III., Fig. II.) The magnifying power of the instrument was also very useful in appreciating better the least variations of the needle. As the diameter of the circles was greater than the length of the needles, a very fine glass wire was fastened to it with a little wax, in order to have a very nice index. By all these means together, a variation of a needle not greater than the finest line in a graduated circle could be distinguished very readily.

The galvanometers were always kept distant from each other, and were supported on brackets steadily fixed to a wall or on the sill of a window; care was taken to remove all iron from their neighborhood, but no sensible influence was discovered on the results, arising from this cause, on account of the system adopted of observing constant deviations; only strong magnets had a little influence, which of course were removed to a great distance.

III. *Rheostat.* This instrument is already known to philosophers, and is described by Wheatstone, its inventor, in the *Archives de l'Electricité.*[1] It is represented obliquely in Fig. III., and in erect position, that it may be seen better, in Fig. III. bis. It consists of two cylinders movable on their metallic axes; the cylinders are each a foot long and supported by a rectangular frame, on which they can be turned by means of two little cranks, *a*, *b*. The larger cylinder is about two inches in diameter, made of hard wood, and varnished. The smaller one is about an inch in diameter, and of copper. The wooden cylinder has a screw of a very fine thread from one end to the other; the copper cylinder is perfectly smooth and polished. A thin copper or brass wire attached with one end to the top of the wooden cylinder, and with the other to the end of the copper cylinder, unites them both, and can be coiled upon one or upon the other. When the apparatus is introduced into the circuit, it is evident that the part of wire coiled on the copper cylinder affords no resistance at all to the current, and it is as if it were not in the circuit. A divided scale, *mn*, is used to reckon the turns, and there is a circular division at the end of the wooden cylinder in *o* for enumerating fractions of turns by an index *i*, attached to the frame. Wheatstone used to put both cylinders in communication with the current through the Y's which support the pivots, but by working long, heterogeneous matters gather there, and the metal becomes soon oxidized by electric action, and the current is often interrupted. I preferred, therefore, to terminate both upper pivots by two wheels an inch and a half in diameter; these are immersed into two small troughs, filled with quicksilver, thus allowing a perfectly free passage to the current without sensible resistance or accumulation of heterogeneous obstacles.

It is indifferent whether the diameters of the cylinders be equal or not; but if the metallic one be smaller, the wire is coiled more tightly around the wood, which is very useful in order to have always the same length for the same number of turns.

Interposing this instrument in the circuit, and regulating the length of wire coiled on the wooden cylinder, the intensity of the current may be reduced to any degree required. If the length of that wire be not sufficient, several other coils may be introduced, whose resistance must have been previously determined.

To facilitate the introduction into the circuit of such coils as are seen in *R*, *R'*, Fig. III., a small parallelopiped *p*, *p'* was used, in which were several holes or cups containing quicksilver; the ends of the wires were immersed there, and a little bridge *B* made of a thick copper lamina or wire was used to connect different

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[1] Arch. de l'Electr., t. iv. No. 13, 1844, p. 102. Description de plusieurs instruments à procédés nouveaux pour déterminer les constantes d'un circuit voltaïque. See also Philosoph. Magazine.

holes or cups, and so one or more of the coils R, R' was easily excluded or included. To avoid the errors of a longer or shorter part of wire immersed in the quicksilver, the ends of the wires were made a good deal thicker than the rest.

The rheostat used in the experiments on the globe had a brass wire 0.0078 of an inch in diameter ($_{o,}{}^{mm}_{2}$). That used in the experiments on the circle had a copper wire 0.012 of an inch diameter ($_{o,}{}^{mm}_{3}$). It was chosen not very thin in order to avoid a part of the errors arising from the elevation of the temperature, and from small differences in the measure of length. On the contrary, had a thicker wire been used, it would have been necessary to introduce too great length of coil, and thus render the operations troublesome.

A rheostat joined with a galvanometer is a more convenient apparatus for measuring the forces of the currents than any other means used by the German or French philosophers for the same purpose. It is very regular in its action, and it is also very easy to discover by it the slightest variations of strength in the current, which would pass almost without observation, or certainly without exact appreciation with the galvanometer alone. If, for instance, the variation of a degree require ten turns of the rheostat, it is certain that the motion made by only a quarter of a turn will be easily perceived, and so $\frac{1}{40}$th of a degree will be easily appreciated, and even smaller fractions by means of the microscope, and this by using only common galvanometers, with a divided circle three or four inches in diameter; but by using an apparatus on a larger scale, more accuracy can be obtained. Thus the errors of measure are all rejected on the rheostat and on the resistances. When the total resistances of the circuit are small and short, the variation of the needle produced by the tenth of a turn is perceptible; but when resistances are very great, as for instance 200 or 300 turns, the variation of the needle produced by a quantity less than a turn is scarcely perceptible without the use of the microscope, but with it the variations of half a turn are sensible also in this case.

The method of determining the absolute resistance of coils and other wires entering the circuit, is the same as used by Wheatstone: the wire, whose resistance is required, is introduced into the circuit, the rheostat being near zero. The position taken by the needle is then observed carefully, and by the rheostat is reduced to a marked division. Then a bridge of thick copper ribbon is thrown across the two cups in which the ends of the wire are immersed; the needle of the galvanometer rises immediately, the resistance being now an unappreciable one, but coiling more wire on the wooden cylinder of the rheostat, it is reduced to the same degree as it was before: the number of turns to be introduced to obtain this constitutes the *reduced length* of that coil. It is necessary to have at least two of these coils whose resistance is less than that of the rheostat by a few turns, and two or three others equivalent to twice or thrice that resistance. By the same means the resistance of a galvanometer is also determined, using another galvanometer to measure the deviations; but we shall see hereafter a case in which only a single galvanometer is required to obtain the same result.

Thermo-electric piles were also used to appreciate better the resistance of wires, and the results were identical with those obtained with voltaic combinations. The thermo-electric pile belonged to a complete and very excellent apparatus of Melloni. The difficulty, however, of keeping a perfectly constant temperature in these piles, when made only for radiant heat, renders this way of finding resistances more difficult than the other, although they are very convenient on account of their small interior resistance. When sufficient care is used, the results cannot differ more than a tenth of a turn, or half a turn when resistances are very long.

The diameter of wires in the rheostat has been already given; I will only add that each turn of the rheostat used for the experiments made with the globe was 4.73 inches long ($12^{\text{centim.}}$), and that used for the circle 5.885 inches ($14.9884^{\text{centim.}}$).

IV. *Circle and Globe.* The circle on which the current is disposed was made of a wooden ring, half an inch thick, one broad, and 17.7 inches ($45^{\text{centim.}}$) in diameter. A greater thickness to make it stronger was not allowed by reason of the small distance from the currents at which the needle was to be settled. I observed, however, that small changes of figure did not alter sensibly the results. The sphere or globe also, which was enveloped by the wires, was likewise made with thin wooden circles, crossing one another at the poles under an angle of 30°, and connected at the equator with a full circle like the circles in armillary spheres. Several other small arcs of circles representing the parallel of a sphere, connected the two extreme meridians, so as to make a frame of two lunary surfaces[1] opposite to one another 60° wide. On this armature the copper wire was coiled, covered with silk. It was about 330 feet long (nearly 100 metres), 0.036 of an inch in diameter ($0.92^{\text{mm.}}$), making 68 turns, all crossing each other at the poles, and covering with the currents the whole of the above-mentioned surface. Both the radius of the circle and of the globe were equal, and divided into 10 equal parts. Some difficulty was found in the determination of the length of the polar diameter of the globe, on account of having to ascertain what point should be taken, as the mathematical pole or centre of action in the wires crossing at the poles and forming a bundle $6^{\text{mm.}}$ thick (0.236 in.). But it was evident that it could not fall far from the surface of the sphere. They were spread on that surface as soon as they had crossed one another, and it was therefore supposed to be at ⅓d of the said thickness, which quantity of $2^{\text{mm.}}$ added to the radius of the globe constituted the total radius used in the calculations $22.5^{\text{centim.}} = 8.8585$ inches. A true appreciation of the place of the real pole of all the currents surrounding the globe is a point of the utmost importance, as will be seen hereafter.

In the circle I found no such difficulty, having only used a wire making 38 turns, disposed in two layers occupying 0.38 inches in breadth ($9.65^{\text{mm.}}$), the diameter of the wire when uncovered being only $\frac{1}{40}$th of an inch. Half the thickness of both the layers was also considered in the measure of the radius of the circle.

The circle and the globe were both fixed upon a steady triangular stand, as is seen in Fig. IV., on which they could take all the positions required for the experiments. The stand could be made level by means of three brass screws *S*, *S*, *S*. The

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[1] Fuseaux, in French.

upper part of the stem AD is square, and the lower is a screw, so that by turning the nut C the table tt' and the globe or circle GG' are raised without any angular motion.[1] On this table tt' is a board $m'm''$ sliding in a dove-tail channel, by means of which the globe is moved eastward or westward; and a similar piece bb' movable in the same way on the board $m'm''$ permits motions towards south and north; the stand being conveniently fixed relatively to the magnetic meridian, all these motions are made with great facility. The positions of the globe are determined by scales divided into tenths of the radius, applied to every sliding piece, and to the square part of the stem. Every sliding part has also pressure screws, as V, v'. The circle or globe is steadily fixed to two arms bb', $b'b''$ placed at right angles to each other. It is placed in the vertical plane by a plummet, and the middle line of the wires made to coincide with the magnetic meridian by using a magnetic needle 14 inches long.

V. The contrivance for carrying the small magnetic needle, which is destined to measure the intensity of the currents, is represented in Fig. V. A board BB' is attached to the wall, and on it a sliding piece E, E' carries two hinges, around which the piece mpq is movable. Half a circle cc' against which a screw S presses, keeps it at any required angle. The board EE' which carries this part of the apparatus, is movable up and down in a dove-tail channel on the other board BB', and can be fixed to any height by the screw W. A strong brass bar qo, about 8 inches long, is attached to the arm pq, and supports near its extremity o a circular plate of copper 3 inches in diameter, and all the suspending apparatus for the needle. This consists of the said circular copper plate, on which the graduations for measuring the deviations of the needle are marked. This plate supports a glass cylinder g to protect the needle from the agitation of the air. Outside the glass a strong copper rod carries a mirror II' and sends out a small arm a, to which the silk fibre suspending the needle n is attached. The use of this mirror is to throw light on the circular divisions when the apparatus is placed opposite to a window, and also to give a reflected image of the circle which is to be observed with a telescope (Fig. VI). For this last reason the cylinder g is quite open at the top. By using the telescope we have the advantage of obtaining a magnified image of the circle, and therefore a more exact appreciation of the slightest variations of position in the needle; besides this, the errors of parallax in the reading of degrees are completely avoided. The reading itself is rendered very easy, which in some cases would be almost impossible, being prevented by the material body of the globe. But there is also a more important advantage, which is that the observer may be far from the globe, and look at the needle through the telescope while he turns the rheostat with his hand. In this way time and labor are saved, and the observations are more accurate.

Plate III., as we have said, represents all this apparatus together; the course of the current is indicated by the arrows. From the copper plate C it passes to the

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[1] In the figure we have delineated only one circle, because the entire globe would have hidden the principal part of the figure.

galvanometer, and from this to the rheostat, Fig. III., then through the coils RR' and afterwards to the globe, and returns back to the zinc Z.

The detailed description of these things, although tiresome, is by no means superfluous, since too much care cannot be taken in such complicated experiments, if we wish to avoid error. We shall see that, notwithstanding all this care, much more is yet to be done in order to make these experiments such as the importance of the subject requires.

§ 9. Description of the Experiments and Results obtained with the Circle.

The formula to be verified in order to find the intensity of action of a circular current on a needle placed in the different points of the vertical diameter OX of a circle or globe, is given in § 7, and is

$$\frac{k}{k_1} = \frac{f(d_1 p_1)}{f(d, p)} = \frac{\rho_1}{\rho}.$$

We must therefore determine the absolute resistance of the current when the needle is in the centre, and then when it is placed in any other point of the vertical diameter. The partial resistances which compose this total resistance are: 1st, the battery; 2d, the galvanometer; 3d, the rheostat; 4th, the wire surrounding the globe or the circle. In order to avoid many measurements, and the errors inseparable from them, we shall call the constant resistance of the circuit the four parts formerly mentioned. The rheostat is supposed to be at zero turns, that is, when there is only so much of its wire in the circuit as is sufficient to connect both cylinders, which will be about 4 or 5 inches.

I. *Method for determining the constant Resistance of the Circuit.*—The battery having been prepared and set in action some time before, the deviation of the galvanometer is carefully observed for the purpose of ascertaining its constancy. When it is perfectly stationary, I take a copper coil r, Fig. II., of a known resistance, and divide the current between it and the galvanometer, putting the ends a, b of the coil in the small cups a, b, full of quicksilver, in which the ends of the wires of the galvanometer are also immersed. Two ways being thus opened to the current, the deviation diminishes, and when the needle is still, its point of rest is carefully marked. If the needle is not on any well-marked point of the graduation, it is easily reduced to it by means of the rheostat, taking note, however, of the turns so introduced. The needle being perfectly still, the deviation is noted again. The coil r is taken away, the needle rises again, but coiling the rheostat wire on the wooden cylinder, its strength is easily reduced, so that the needle points again to the same division as before, when the current was divided. Now the rheostat is observed, and the number of turns noted. The constant resistance R will be given by the following formula:[1]—

[1] The principles from which formula (1) is deduced are expressed by Wheatstone in the beautiful memoir which we have already quoted; and several other papers on this subject may be seen in the *Archives*

$$R = \frac{r\,r^1}{g} + g - \rho, \quad (1)$$

where $\rho =$ the number of turns when the current was divided,
$g =$ the resistance of the wire of the galvanometer,
$r =$ the resistance of the dividing coil,
$r^1 =$ the number of turns developed when the current was not divided.

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de l'Eléctricité of De la Rive. It will not, however, be quite useless to those who may not have these works at hand to give a demonstration of it, which will be somewhat clearer than that which is in the latter journal. Ohm's rule states that the intensity of a current F is in direct ratio of the electromotive force E of the pair, and the inverse of the resistance R, so that we have

$$F = \frac{E}{R}.$$

In the case where a galvanometer whose resistance is g, and a wire whose resistance is x, are introduced into the circuit, we shall have

$$F = \frac{E}{R + x + g}. \quad (m)$$

Let $R^1 = R + \rho$, ρ being as above any number of turns of the rheostat, and let the current be supposed to be divided by means of two parallel conductors g and r: by this the resistance of the circuit itself is diminished; now we must find the value of a wire whose reduced length λ, is equal to the length of that portion of the circuit which has been so modified. [*Solution.*—As in general the quantities of currents Q and Q^1 which pass through every one of the conductors r and g are in inverse ratio of their resistances, we shall have

$$\frac{Q}{Q^1} = \frac{g}{r}, \text{ from which } \frac{Q + Q^1}{Q^1} = \frac{g + r}{r};$$

but by hypothesis λ is such that it is capable of giving a free passage to $Q + Q^1$, therefore

$$\frac{Q + Q^1}{Q^1} = \frac{g}{\lambda},$$

from which, together with the preceding equation, we have

$$\lambda = \frac{g\,r}{r + g}. \quad (n)]$$

Now let the current running through the galvanometer before the division be expressed by

$$F = \frac{E}{R^1 + g}.$$

After the division by the coil r, we must consider three parts of the circuit:—

1. That which was divided.
2. The galvanometer from which a portion of the current was taken.
3. The wire which divides the current.

The intensity in the first part of the circuit will be

$$F_1 = \frac{E}{R^1 + \lambda},$$

exactly the same as if instead of r and g parallel, we had substituted λ; representing the other two parts by F_2 and F_3, we shall have

$$\frac{F_2}{F_3} = \frac{r}{g}, \text{ whence } \frac{F_2}{F_2 + F_3} = \frac{r}{g + r} = \frac{F_2}{F_1},$$

which gives

$$F_2 = F_1 \frac{r}{g + r}$$

for the portion of current passing through the galvanometer. This value, after the substitutions of F_1 and λ, becomes

$$F_2 = \frac{E\,r}{R^1\,(r + g) + r\,g}.$$

Observation.—In practice, it is not necessary to keep any note of the primitive deviation of the galvanometer in order to determine the resistance of the circuit, that deviation being only useful to ascertain the constancy of the current, for which purpose any deviation observed in similar circumstances may be employed.

We shall subjoin an example to illustrate the method of conducting the experiment.

EXAMPLE.

			TURNS.
Divided current—galvanometer 76°—rheostat			6.0
Current not divided " do. "			11.7
Turns added	r^1	=	5.7
Resistance of the dividing coil . .	r	=	20.8
Do. of the galvanometer .	g	=	6.4
Total resistance	$R + \rho$	=	18.4
Subtracting ρ	ρ	=	6.0
Constant resistance	R	=	12.4
Another experiment afforded . .	R	=	12.7

The small difference, 0.3 turns, might easily be produced by a small error in the values of r or g, multiplied by the great resistance used the second time, which was = 98 turns. This also proves that it is not indifferent to introduce long resistances or short ones, but, for greater accuracy in practice, it is necessary to avoid all unnecessary lengths of wire.

As a source of error may arise from the multiplication of the slight inaccuracy in the values of r and g, so we have taken every care to eliminate these errors by the following means: A deviating wire whose resistance was equal to that of the galvanometer was used. To obtain this with greater accuracy, we adopted in the galvanometer a wire, exactly of the same length and diameter as that which was coiled on the cylinder r, Fig. II. By so doing, a part of the calculations is spared, and errors of measure are avoided, since formula (1) becomes $R + \rho = r^1 + g$, and so the number of turns r^1 expresses the total resistance of the circuit, minus that of the galvanometer.

But when it is not convenient to change the wire of the galvanometer, and there is no other galvanometer which can be used for determining the resistance of the

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Now our plan of experiments requires that, after suppressing the division of the current, we should add as many turns of the rheostat as may be necessary to reduce the intensity F to F_2: let therefore r^1 be the turns wanted; from the formula (m) we shall have

$$F_2 = \frac{E}{R^1 + g + r^1}.$$

From the equality of the 2d members of these two last equations we have

$$R^1 = R + \rho = \frac{r\,r^1}{g}$$

to which, adding the resistance of the galvanometer g, we shall have the *constant resistance* of the circuit expressed, as in the text.

former, or when its wire is too short to afford any accurate determination of it, the following method may be used, which we have found to supply better results than any other, and may be added to the others already known.

Let two experiments like those described above be made by introducing a different number of arbitrary turns ρ and ρ_1 into the circuit, we shall have the following equations (supposing $\frac{r}{g} = f$):—

$$R + \rho = f r^1,\ R + \rho_1 = f r_1^1,$$

from which we obtain

$$f = \frac{\rho - \rho_1}{r^1 - r_1^1},$$

and consequently knowing r,

$$g = \frac{r}{f}.$$

We subjoin experiments made in different days, and under circumstances very different from each other, because those made one after the other agreed together to tenths of a turn. This is not surprising, because from the form of the value of f, the errors equally affect the numerator and the denominator, and in practice it is easy to make observations, so that if there is a little error, it should be always on the same side. Besides, with this method there is no need of calculating the resistance of R, which is rather long.

EXPERIMENTS.

No. of Obs.	ρf	ρ^1	r^1	r^1_1	f
1	1.0	98.2	3.0	33.8	3.156
2	9.8	35.2	6.6	14.3	3.299
3	6.0	28.3	5.7	13.0	3.081

The difference between the maximum and minimum of these values is $= 0.217$, and their common mean $= 3.179$, which in practice we assume as $f = 3.18$.

II. *Determination of the Forces.*—After having settled the needle perfectly in the centre of the globe or circle, the current is transmitted through their wire, and the deviation of the needle carefully observed. If the needle does not point exactly to any division, it is easily reduced to it by the rheostat. As this angle is of great importance in calculations, in order to determine it more accurately and avoid the error of eccentricity of the needle, which is always sensible, by reason of the smallness of the circle, and also the errors caused by a slight aberration of the currents from the plane of the meridian, I proceeded as follows:—

1. The points were carefully marked to which the opposite ends of the needle corresponded when no current was running through the wires, and both positions noted.

2. Transmitting the current through the wire, the deviation of the opposite ends was noted, and their mean taken, which is the true angle of deviation as measured from the very centre of the circle.

3. The current was inverted, and the deviations of both ends of the needle on the other side of the meridian observed, and their mean taken.

4. Finally, the mean of the two preceding means was taken, and kept as the deviation of the needle from the meridian line, as the base of the calculation.

Having thus determined the deviation of the needle in the centre of the circle, the current is again made to run direct, and when the needle is fixed, the telescope is directed to that end of the needle which points to a division, and that point is taken as a fixed one, to which the needle must always be brought. The inspection of the other end is not wholly overlooked, but there is scarcely any necessity of observing it.

After this, the circle or globe is raised by turning the nut *C*, Fig. IV., until the needle corresponds to $\frac{2}{10}$ths of the radius. The deviation of the needle increases immediately, and a few turns of the rheostat are to be uncoiled from the metallic cylinder until it returns again to the former central deviation. The number of turns is carefully marked, and we proceed to another experiment by raising the globe or circle again until the needle is at $\frac{4}{10}$ths, and the same operation as before is repeated, and so on until it is settled at $\frac{9}{10}$ths; here it is necessary to use the utmost care to take an accurate measure, since the force varies rapidly, in consequence of the approach of the currents, and a small error in the position of the needle produces a great one in the result. Besides the total resistance in this case being very great, the needle is not sensible enough to small variations of resistance. This last cause, however, has a small influence on the final result. But in order to diminish these errors as much as possible, we made two observations of the force at $\frac{9}{10}$ths of the radius for each series of experiments. That is, after having measured it the first time, the needle was made to correspond to the centre again, its deviation being reduced to the fixed mark and placed again to the $\frac{9}{10}$ths. There was scarcely any necessity for repeating measurements for the other positions, the results being always identical.

Working thus by the direct reading of the rheostat, we have a portion of the *total resistance* of the same circuit. Thus if R mark the total resistance at the centre, the galvanometer included, x and y the turn of the rheostat at the centre and at any other position, the ratio of resistances will be

$$\frac{R+x}{R+y}=\frac{f}{f_1}.$$

To illustrate all this explanation of experiments, I shall extract from the journal of observations one of the experiments made on June 4, 1849, with all its details, that they may be sufficiently appreciated by the reader.

Series of Experiments made for the purpose of determining the Force of a Circular Current on different points of its Vertical Diameter.[1]

Diameter of the circle	$45^{\text{centim.}}$
Length of the needle	$4^{\text{centim.}}$

[1] As one part of these experiments was made and calculated with metrical measurements, we shall therefore use them in future.

Time, fifteen minutes past nine o'clock.

Turns of rheostat	9.00
Galvanometer of the circuit	31° 05′
Deviation of the needle	24° 59′

To find this last deviation we proceeded thus—

Position of equilibrium of the needle—pole	S.	6° 50′
	N.	181° 15′
Direct current (N. pole deviating E.)—pole	S.	31° 00′
	N.	207° 30′
Inverted current (N. dev. W.)—pole	S.	343° 05′
	N.	155° 30′
Hence for the deviation E.	N.	= 26° 15′
	S.	= 24° 10′
Common mean E.		= 25° 13′
For the deviation W.	N.	= 25° 45′
	S.	= 23° 45′
Common mean W.		= 24° 45′
Mean of both E. and W.		= 24° 59′

N.B. In practice, without exceeding the limits of errors, we can take 25° for the value of d, because fractions smaller than ¼th of a degree could not be appreciated in such a small circle but by estimation.

Determination of the constant Resistance of the Circuit.

	TURNS.
Divided current—galvanometer 24°—rheostat	11.00
Not divided current do. "	70.00
Constant partial resistance r^1 (¹)	= 59.00
Adding the galvanometer resistance g	= 1.25
Constant resistance	= 60.25

For the Determination of the Force on the Vertical Diameter of the Circle, $d = 25°$.

FIRST SERIES.

Position of the needle.	Reading of the rheostat.	Total resistance.	Ratios of resistances.
centre.	19.00	70.25	1.
2 tenths.	12.75	73.00	1.037
4 "	19.50	79.75	1.121
6 "	37.00	97.25	1.384
7 "	56.00	116.25	1.655
8 "	94.55	154.80	2.203
9 "	205.70	265.95	3.785
centre again.	11.20	71.45	1.00
9 tenths.	202.70	262.95	3.680

(¹) The resistance of the deviating wire is equal to that of the galvanometer.

Second series, half past ten o'clock.

Deviation of the needle determined as before = 17° 36′

For the Determination of Constant Resistance.

		TURNS.
Divided current—galvanometer 24°—rheostat	.	10.40
Not divided do. do. "	.	67.00
Resistance r^1	.	56.60
Adding the galvanometer's resistance	.	1.25
Constant resistance	.	57.85

For the Determination of Forces.

SECOND SERIES.

Position of the needle.	Reading of the rheostat.	Total resistance.	Ratios of resistances.
centre.	43.70	101.53	1.000
2 tenths.	47.30	105.15	1.035
4 "	58.10	115.95	1.102
6 "	86.00	143.85	1.416
7 "	105.00	162.85	1.603
8 "	172.60	230.45	2.329
9 "	406.20	464.05	4.570
centre again.	44.20	102.05	1.000
9 tenths.	400.80	458.65	4.740

Third series, half past eleven o'clock.

Deviation determined by the said operations = 25° 22′

		TURNS.
Divided current—galvanometer 24°—rheostat	.	10.00
Undivided current do. "	.	66.60
Resistance r^1	.	56.60
Adding galvanometer	.	1.25
Constant resistance	.	57.85

N. B. This is identical with the preceding one; the battery having reached its maximum of strength, it remains perfectly constant for all this time. This is not the first instance observed of this regularity.

For the Determination of Forces, $d = 25° 22'$

THIRD SERIES.

Position of the needle.	Reading of the rheostat.	Total resistance.	Ratios of resistances.
centre.	12.13	69.98	1.000
2 tenths.	15.85	73.70	1.053
4 "	22.00	79.85	1.142
6 "	38.80	96.65	1.381
7 "	56.00	113.85	1.641
8 "	93.50	151.35	2.163
9 "	198.70	256.55	3.666
centre again.	11.60	69.45	1.000
9 tenths.	199.30	257.15	3.590

N.B. It may be seen from this last, which is a repetition of the first (except a slight difference in the deviation), that the results agree well together when found with the same initial resistance, but there is a little difference when that is a good deal greater. The errors of observation cannot be more than $\frac{1}{10}$th in the ratio of the highest positions, which is partly due to the unavoidable errors arising from a little aberration in the position of the globe, as we have already stated, but there is also some other reason, which we shall discuss hereafter.

We add here two series more of experiments, made in different days, each one of which is the mean of two series made immediately the one after the other.

Fourth Series.			Fifth Series.	
Position of needle.	Total resistance.	Ratios of resistances.	Total resistance.	Ratios of resistances.
centre.	57.08	1.000	87.25	1.000
2 tenths.	58.35	1.022	89.35	1.025
4 "	71.38	1.268	99.85	1.144
6 "	84.58	1.481	119.35	1.367
7 "	101.28	1.774	149.25	1.609
8 "	129.58	2.270	200.25	2.282
9 "	210.48	3.687	359.05	4.103

	TURNS.
Constant resistance of the fourth series . . .	57.08
" " of the fifth " . . .	87.85
Deviation of needle, fourth series . .	30° 10′
" " fifth "	18° 02′

§ 10. Experiments with the Globe, and their Results.

The globe has already been described, § 8. The manner of conducting the experiments was the same as with the circle, but the deviations of the needle were not so accurately measured. This, however, makes but little difference when the degrees are about 25 and 30, as appears from the experiments of the circle. We must therefore allow something in the results for this inaccuracy, particularly as the experiments were made with great care in all other things. We shall enlarge upon the experiments here, since their comparison with our theory seems very interesting, and demands a new series of experiments to be made on a larger scale.

In investigating the action on the vertical diameter, the numbers found with the globe are not very far from those obtained with the circle; now this conclusion was already deduced from the theory, and thus we have here also a confirmation of our formulæ, in another general case.

The small difference observed between the circle and the globe arises from this: that the condition of a very small needle in comparison with the circle is not wholly fulfilled, and thus the function Z being smaller for the extreme circles, the total action must be less than if the circles were in the magnetic meridian.

Should I be able to repeat them again, I shall then enter into further details with regard to the calculations. The following tables contain the results of the experiments, made with a deviation between 30 and 35 degrees.

TABLE A.—*Containing the Intensity of Action of the Currents surrounding the Globes, when the Needle was placed on the Polar Diameter.*

Position of needle.	SERIES A. Tot. resist. at centre 28.91	B. 35.5	C. 35.2	D. 28.2	E. 21.3	Common means.	Difference between the maximum and minimum.
centre.	1.000	1.000	1.000	1.000	1.000	1.000	1.000
2 tenths.	1.043	1.057	1.029	1.018	1.042	1.036	0.039
4 "	1.148	1.194	1.142	1.100	1.147	1.158	0.052
6 "	1.409	1.428	1.387	1.422	1.406	1.411	0.041
7 "	1.671	1.662	1.585	1.633	1.666	1.642	0.086
8 "	2.125	2.112	2.029	2.063	2.136	2.093	0.007
9 "	3.170	3.228	3.228	3.173	3.133	3.180	0.115
9.2 "	3.308	3.42	3.793	3.854	3.332	3.541	0.546

It appears from this table that the values of the ratios of forces are less than we have found for the circle. These observations, though made on angles, a little different from one another, give results whose difference is not beyond the limits of the errors of observation, as appears from the column of differences, except in the last line of 9.2; both from a little variation of position which could not be accurately measured, and the influence of a smaller distance, the differences are considerable.

We have already spoken, in the preceding section, of the difficulty met with in the determination of the true centre of action inside the wires crossing at the poles. In order to appreciate, by means of the experiments, the difference arising from different suppositions on this point, we made two series of observations; in one we reckoned for the length of the radius of the globe, the distance of the centre from the inner layer of the wires, and in the other that from the most external one. The results were as follows:—

TABLE B.

Position of needle.	Reckoning from the inside.		Reckoning from the outside.		Common means.
	1st series.	2d series.	3d series.	4th series.	
centre.	1.000	1.000	1.000	1.000	1.000
6	1.355	1.362	1.394	1.545	1.416
7	1.591	1.552	1.694	1.790	1.656
8	1.975	1.978	2.288	2.410	2.162
9	2.904	2.895	3.434	3.640	3.215

The means are not very far from those already found, but only a little greater, which, however, must be the case, since the pole cannot be exactly in the middle of the wires.

After having thus determined the action of the polar diameter, we proceeded to examine that of the other two principal axes. What follows is a table of the intensity of action of the current on the horizontal diameters, which join the middle of the two lunary surfaces covered by the currents, and lying in the magnetic meridian.

TABLE C.

Position of needle.	1st series.	2d.	3d.	4th.	5th.	General mean.	Difference between max. and min.
centre.	1.000	1.000	1.000	1.000	1.000	1.000	1.000
2 tenths.	1.001	1.021	1.015	1.021	1.017	1.017	0.010
4 "	1.035	1.067	1.071	1.071	1.062	1.058	0.036
6 "	1.223	1.142	1.137	1.163	1.136	1.140	0.040
8 "	1.188	1.222	1.222	1.202	1.194	1.205	0.033

The rate of increase here is rather slow on account of the spreading of the wires, and the different distances of both poles. To calculate this exactly is very laborious, because the action of two circles equally inclined, is also in the case of the experiments not so very far from being equal to their sum collected on the meridian, as in the case of the polar axis.

Table for the Intensity of Action of the Current on a Diameter perpendicular to the preceding one.

TABLE D.

Position of needle.	1st series.	2d.	3d.	Means.	Difference.
centre.	1.000	1.000	1.000	1.000	1.000
2 tenths.	0.923	0.932	0.972	0.939	0.049
4 "	0.788	0.844	0.830	0.821	0.033
6 "	0.621	0.638	1.683	0.648	0.014
7 "	0.498		0.501	0.499	0.014

The rapid diminution of force is due to the shortness of the needle, in consequence of which a tenth of the radius of the circle sets both poles out of the circle, and their action becomes contrary.

Finally, we find the intensity outside the globe in the prolongation of the polar axis, as follows:—

TABLE E.

Position of needle.	1st series.	2d.	3d.	Means.
centre.	1.	1.	1.	1.
1 tenth.	2.225	2.255	2.258	2.239
2 "	1.116	1.091	1.063	1.090
3 "	0.665	0.671	0.629	0.656
4 "	0.442	0.452	0.417	0.437
5 "	0.306	0.316		0.311

All these experiments were made, keeping a deviation of about 30° as a standard, but several experiments made when the introduced resistance was very large, and consequently the deviation smaller, and not more than 17 or 15 degrees, gave ratios a good deal higher, and the ratio of the polar axis once amounted to 4, and very often to 3.94. We rejected those experiments as being made when the battery had lost its first strength, and we thought that such irregularities arose from the defect of constancy in the battery, or from the inexactitude of the law of Ohm in the case of long resistances. But the experiments of the circle and the theory teaches us what may be their true origin, as we shall see hereafter. In the mean time, while waiting until I shall be able to repeat on a large and full scale the abovesaid experiment, it may not be useless to observe the preceding results.

§ 11. CALCULATION OF THE FORMULÆ.

The results obtained by experiments are to be compared with those given by the formulæ. We must calculate two of them, viz., the more general (4), and the (6), which is but a particular case of the (4). Our discussion will be made principally on the (6), which supposes the middle of the needle to be on the vertical axis or diameter OX, because the most accurate series of experiments was made on this hypothesis; we shall afterwards discuss the other cases of the needle on the diameters OZ, OY.

Writing in formula (6) the value of Z, taken from (15, § 3), and omitting the last term in the second member as very small, we have

$$(6)\quad T\,tang.\,d = \frac{4\,k}{h^3\,b^2\,c^2}\left[(R^2 + h^1)\,c^2\,E^1 - 2\,h^1\,E^1 + 2\,h^1\,b^2\,F^1\right].$$

The computation of the formula being rather complicated, we tried several methods, and the following seemed to be the most convenient. The calculation is divided into two parts, the first being preparatory to the second; in the former, we find the values m, n, p, a, h, h^1, c, b; in the latter, we combine them, as is required by the formula itself.

The values of the radius of the circle R, the half length of the needle L, and its deviation from the magnetic meridian plane, are already given by observation with the quantity p, which is the distance of the middle of the needle from the centre of the globe, reckoned on the vertical axis OX. Let us take, for example, the case of the needle at nine-tenths of the radius, as we explained it in the description of the experiment, and let the deviation be 30°. Expressing all the numbers by centimeters, we have

$$R = 22.5,\ L = 2,\ p = \frac{9}{10} R = 20.25,\ d = 30°.$$

Remembering, also, that from § 3 we have

$$m = L\ cos.\ d,\ n = L\ sin.\ d,\ tang.\ \alpha = \frac{p}{m},$$

$$h^1 = R\ (p\ sin.\ \alpha + m\ cos.\ \alpha),\text{(1)}$$

$$h^2 = R^2 + m^2 + n^2 + p^2 + 2\ h^1,$$

$$c^2 = \frac{4\ h^1}{h^2}.$$

The calculation may be arranged as in the following example:—

Specimen of Calculation of the Formula (6), *the Needle being at* $\frac{9}{10}$*ths of the Radius, and* $d = 30°$.

$Log.\ cos.\ d = 30°$	$= 9.9375306$
$+ log.\ L = log.\ 2$	$= 0.3010300$
$log.\ m$	0.2385606
$log.\ p = log.\ 20.25$	$= 1.3064250$
$— log.\ m$	$= 0.2385606$
$log.\ tang.\ \alpha = 85°\ 6'\ 40''$	$= 1.0678644$
$log.\ p$	$= 1.3064250$
$log.\ sin.\ \alpha$	$= 9.9984172$
$log.\ s$	$= 1.3080078$
$+ log.\ R$	$= 1.3521825$
$log.\ h^1$	$= 2.6601903$
h^1	$= 457.288$
$2\ h^1$	$= 914.576$
$4\ h^1$	$= 1829.152$
R^2	$= 506.25$
$m^2 + n^2$	$= 4.00$
p^2	$= 410.0625$
$2\ h^1$	$= 914.576$
h^2	$= 1834.8885$

(1) After having made all the calculations, we observed, § 6, that m being $= s\ cos.\ \alpha$, and $p = s\ sin.\ \alpha$, we have $h^1 = R\ (s\ sin.^2\ \alpha + s\ cos.^2\ \alpha) = Rs$. This shortens a little the calculations, and the value of s taken from any of those two values can be introduced.

$log.\ 4\ h^1$	$= 3.2622488$
$log.\ h^2$	$= 3.2636092$
$log.\ c^2$	$= 9.9986396$
$log.\ c$	$= 9.9993198$
$c = sin.\ \theta = sin.\ 86° 47' 39''$	
$log.\ b = log.\ cos.\ \theta$	$= 8.7475917$
$log.\ b^2$	$= 7.4951834$

For the denominator, $h^3\ b^2\ c^2$.

$log.\ h^2$	$= 3.2636092$
$log.\ h$	$= 1.6318046$
$log.\ h^3$	$= 4.8954138$
$log.\ b^2$	$= 7.4951834$
$log.\ c^2$	$= 9.9986396$
$log.\ h^3\ b^2\ c^2$	$= 2.3892368$

For the numerator.

R^2	$= 506.25$
$+\ h^1$	$= 457.288$
$R^2 + h^1$	$= 963.538$
$Log.\ R^2 + h^1$	$= 2.9838684$
$log.\ c^2$	$= 9.9986396$
$log.\ E^1\ 86°.792$	$= 0.0025472$
$Log.\ (R^2 + h^1)\ c^2\ E^1$	$= 2.9850552$
$log.\ 2\ h^1$	$= 2.9612203$
$log.\ E^1$	$= 0.0025472$
$log.\ 2\ h^1\ E^1$	$= 2.9637675$
$log.\ 2\ h^1$	$= 2.9612203$
$log.\ F^1$	$= 0.6308795$
$log.\ b^2$	$= 7.4951834$
$log.\ 2\ h^1\ b^2\ F^1$	$= 1.0872732$
$(R^2 + h^1)\ c^2\ E^1$	$= 966.174$
$-\ 2\ h^1\ E^1$	$= 919.956$
$+\ 2\ h^1\ b^2\ F^1$	$= 12.2257$
Numerator	$= 58.4437$
$log.\ 58.4437$	$= 1.7667378$
$-\ log.\ h^3\ b^2\ c^2$	$= 2.3892368$
$log. f\ (d, p) = log. f\ (\frac{9}{10}, 30°)$	$= 9.3775010$

But from a preceding calculation made for the needle in the centre under the same deviation 30°, we found

$$Log. f\ (c, 30°) = 8.8445407;$$

hence the ratio of the forces will be obtained—

$$\begin{array}{lr} Log. f(\tfrac{9}{10}, 30^\circ) \quad \ldots\ldots & = 9.3775010 \\ -\ Log. f(c, 30^\circ) \quad \ldots\ldots & = 8.8445407 \\ \hline log.\ \Phi \quad \ldots\ldots & = 0.5329603 \end{array}$$

$$\Phi = \frac{f(\tfrac{9}{10}, 30^\circ)}{f(c, 30^\circ)} = 3.411582.$$

Observation.—From an accurate inspection of this calculation, it is evident that even the last figures of numbers and logarithms have a very great influence in the result; we had made some of these calculations limiting the numbers only to five figures, but the results were found sensibly different from those obtained with six figures, and the difference sometimes arose to two units in the first decimal note. This is principally due to the value of the modulus c and its complement b, which vary very rapidly as they approach to 90°, and their variation introduces a still greater one in the elliptic functions. The function F chiefly varies very rapidly near that limit, and the difference is already sensible at the third logarithmic figure, even for arcs differing less than a minute of a degree after 75°, and in general the difference of a minute in the arc θ induces a variation in the 4th decimal figure in the logarithms of both functions F^1 and E^1, through the whole quadrant. Now as the sine varies very slowly in the higher degrees, a little variation both in h^1 or h is sufficient to introduce a great difference in the arc. To this source of errors, we must add that which depends upon the tables of elliptical functions. These functions are only calculated for every tenth of a degree or 6 minutes, and very often we felt the necessity of having them calculated for smaller divisions. To compensate for this want of smaller fractions, we have taken the arithmetical parts of the first differences, as they are given in Legendre's tables, which are sufficiently accurate when the value of their logarithms is limited to seven decimal places; this, however, we confess is not quite exact, since it induces a small error in the last decimal places. It would have been, however, too tedious and troublesome to calculate by the formula of interpolation their proportional parts, and besides, this would have been a useless labor, since it is impossible to avoid errors of that order in a long logarithmic calculation. Consequently, we do not present our results as accurately exact even to the last figures, but we think that they will be so as far as the fourth.

To obtain greater exactitude, it is necessary to use larger tables having more than seven decimal places; but this is not required, until the degree of accuracy in the experiments is carried a good deal further than it was in our power to do.

The calculation for the central position of the needle is a good deal shorter, since $\alpha = 0$ and $h^I = Rm$ only.

In this manner we have calculated three series of experiments made with the circle on different points of its vertical diameter, and the result is given in the following table. The numbers represent the ratio of intensity of forces in different points of the diameter, that in the centre being taken as unity.

In the first horizontal line of the table is the number of the experimental series, as taken from the tables (§ preceding); in the second is the absolute value of the force for the centre; in the next line is the ratio between the central force and that of the new position. We have also given the numbers obtained from the experiments opposite to those given by observation, to render comparisons easy. We added at the end a comparison of the results belonging to the polar diameter of the globe.

Position of the needle.	Series 4th.		Series of 1.	Mean of 3d.	Series No. 5.		Globe.	
	$d = 30°$		$d = 25°$		$d = 17° 36'$		$d = 30°$	
	$Zc = 0.0699102$		$Zc = 0.0694633$		$Zc = 0.0696869$			
	calc.	observ.	calc.	observ.	calc.	observ.	calc.	observ.
4 tenths.	1.396	1.155	1.09824	1.1315	1.08817	1.144		1.158
6 "	1.40235	1.481	1.40694	1.382	1.48564	1.367		1.411
7 "	1.67597	1.774	1.69961	1.648	1.67551	1.609		1.642
8 "	2.23241	2.270	2.24484	2.1815	2.19097	2.289		2.093
9 "	3.41917	3.687	3.58416	3.675	3.8232	4.193	3.261	3.283
out 13						—	0.545624	0.656

This table shows that there is an agreement between the calculation and observation; the difference is at most the limits of errors probably committed in the observation, except in the positions nearer to the circumference, where the results of the experiments are always greater than those of calculation. The figure (9) shows the increase of intensity of forces from the centre to the circumference for a deviation of 30°.

We shall now proceed to take into consideration, very briefly, the result of calculation and experiment for some positions of the needle within the globe. The results belonging to the polar axis are given in the last two columns of the preceding table. We can observe that for the globe the numbers given by observation are smaller at $\frac{9}{10}$ths than those by calculation, but the reason is very apparent since we have seen that the action of two currents making equal angles at both sides of the meridian is not exactly the same as that of two equal currents disposed in the meridian plane, but must be a little less. Thus, if we suppose two circular wires inclined 30° on each side of the magnetic meridian, and the needle to deviate 30° likewise from it, we obtain for the ratio of forces between the centre and $\frac{9}{10}$ths, from one circle 4.737, and from the other 2.196, for the values of the function Z in formula (7), § 6, from which we conclude the ratio of forces = 3.261, a little smaller than with two parallel wires. What is said at the end of § 8 cannot therefore be extended to 30° of deviation. Besides this, table A, § 10, shows that a little variation of place near the pole produces a great difference in the result, and that such experiments must never be tried again with thick coils of wires.

As for the action of the globe on its other diameters, no exact coincidence may be expected between the formula and observation, since the divergence of wires has a sensible influence on it. The difference must evidently be greater along the diameter of the globe, which is parallel to the magnetic meridian, than along the other, because the needle is settled nearer the wires spread on the spherical surface in the first than in the second case. The tables C and D, § 10, contain some of the results, and Table E those obtained on the prolongation of the polar axis out of the globe. Let us compare the results of theory with the experiments in these cases also.

For the diameter parallel to the magnetic meridian, joining the middle line of the currents, the result for the value of the second member of formula (4), § 6, divided by *cos. d*, d being $=$ to 30° and $Z_0 = \frac{8}{10} R$, was

$$0.294965.$$

The ratio between this value and the double of that obtained for the central middle wire is

$$= 2.1047.$$

This is but little different (as it ought to be) from what we have found for the same position on the other vertical diameter, that being 2.2324; the cause of the difference is that one pole of the needle is farther from the currents than the other. This number, however, is considerably different from the experimental result; this being only

$$= 1.205.$$

We have already indicated that this depends upon the divergence of the wires.

Another position was calculated for the diameter perpendicular to the middle plane of the current, d being always $= 30°$ and $Z_0 = \frac{4}{10}$ths of the radius R. The calculation being made in the same manner by the formula (4), the result was

$$= 0.794529;$$

that of the experiments was

$$= 0.821.$$

Finally, a position was calculated out of the globe on the prolongation of the polar diameter, at 13 tenths of the radius from the centre. This gave by calculation

$$- 0.545,$$

and by observation

$$- 0.656;$$

the sign — indicates that the deviation is opposite to that which takes place inside the globe, which is really the fact, the difference of both being not beyond the limits of errors of observation. We think that our formula is demonstrated accurately enough.

The only thing left now is to compare our results with those of Mr. Plana. His results are

	According to Plana.	To our formula.
For $\frac{8}{10}$ths of the diameter . .	1.63	1.78
For $\frac{9}{10}$ths " " . .	3.00	3.18

These numbers are very different from those compared already with the experiments, but no wonder, since this is wholly a different problem. The ratio of forces is the same for a needle, and an element, if we suppose its middle on the axis OX; but besides this, we must suppose it infinitely short, then the quantities m, n, vanish, and the results are as assigned by the celebrated mathematician, so that this problem is but a particular case of our own, and may be resolved by the same formula, making due modifications for the different circumstances.

We must now discuss some circumstances which have not yet been taken into consideration, and upon which most probably depends the difference between observation and calculation.

§ 12. Remarks on some Anomalies presented by Observation.

The comparison of calculation with observation is sufficiently satisfactory, as we have seen; there is, however, a little difference between both and among the experiments themselves, when the needle is at $\frac{9}{10}$ths of the radius, which we can by no means be induced to attribute to errors of observation alone. Beginning with the considerations suggested by the differences of the observations, we observe that combining several series together, the results are almost identical when the total resistance at the centre is very nearly the same, but differ considerably when this varies. I thought in the beginning that this was due to the lesser deviation of the needle, and this engaged me in the long calculations already presented. This has certainly some influence, as appears from the above results of several series of experiments, in which to the deviations

$$60°;\ 30°;\ 25°;\ 17°\ 36';\ 0°,$$

correspond the values

$$2.196;\ 3.419;\ 3.584;\ 3.823;\ 4.738.$$

A small increment in the ratio is therefore given by calculation in the case of a small deviation, but not so great as it should be. A little variation also in the position of the needle has a great influence; thus if we reckon the distances from the inside layer of wires in the globe at $\frac{9}{10}$ths, we obtain by experiment the ratio $= 2.849$, but reckoning from the most outside layer we have it $= 3.537$; the mean of these is 3.243, not very far from what we found directly. It seems, therefore, that we must inquire for another cause. Comparing several results obtained with the globe, I perceived that using long constant resistances when the needle was at the centre, the ratio of forces became very great, and also for the globe sometimes reached the number 4.001; but I attributed it to some irregularity in the battery, and rejected those observations, as having been made with a Daniell's battery almost exhausted. On repeating them, however, the last time, I found the same difference, and being now sure of the good order of the battery, I cannot reject the results as erroneous. If this be the case, it is evident that making two series of experiments on the same deviation, but with different central resistances, we must have different results. For this purpose the series 2 and 5 (§ 9) were made where the difference of *half a degree* in the deviation can scarcely have any influence on the result: now the central resistance in the series 5th being 87.25 turns of the rheostat, the ratio of forces at $\frac{9}{10}$ths is 4.103; on the contrary, in the series 2d, the central resistance being 101.53, the ratio is 4.522.

As far, therefore, as we can judge from this induction, the cause of discordance is connected with the length of central resistance. It is now to be found how this may have any influence on the results, and the following considerations are the best which occurred to me on this subject, which I give only as conjectures, being ready to abandon them when better shall be presented.

As the origin of differences is connected with the length of resistances, so we are led to inquire into the law of Ohm, which is connected with them, rather than to suppose for the present any inexactitude in our formula or in Ampère's principles. Ohm's law, as we have said, is this simple one, that the forces are in inverse ratio of resistances; against this simple enunciation no objection can be raised, but it is not so when we consider the manner of estimating resistances. This is supposed to be for wires of the same metal, in inverse ratio of their section and direct of their length, and the experiments which I have made myself with short lengths proved it to be accurate, but I did not try wires longer than a few yards. I am not the first to suspect that the law of Ohm may not be accurate for great lengths of wire. Mariè, Davy, and several others thought so; but I have not been able as yet to see his original papers. However this may be, it is certain that, in establishing the law of Ohm, no consideration is made of the heat which is produced by the electric current passing through wires, and which increases their resistance very much.

Since the year 1846, I made the following experiment: I rolled a platina wire about 15 inches long in a spiral, and tried by the rheostat its resistance at the common temperature of 16°, and I found it equivalent to 3 turns of the rheostat. After this, I ignited it with a spirit-lamp in the middle, to avoid difference of temperature at the parts of junction with the rest of the circuit, and so avoid also thermo-electric currents; the needle of the galvanometer fell immediately several degrees, and 10 turns more of the rheostat were to be uncoiled from the wooden cylinder to reduce it to the former position. This shows an increase of resistance by heat, so that from 5 it was raised to 15 turns, that is, made three times greater. It was objected that the flame could disperse the electricity, but it should be remembered that dynamic electricity is not so easily dispersed as common electricity. To render, however, the experiment free from such an objection, I put the spiral in the focus of a large burning-glass, but then also a diminution of conductibility took place, although the wire did not appear red-hot. I met afterwards with an experiment of Sir Humphrey Davy, which proves the same conclusion. If a wire be raised only to a dark-red color by an electric current, and any portion of it be then raised to a white heat by a spirit-lamp, the remaining part of the wire loses the red heat. The explanation of this fact is very obvious: the resistance of the wire is increased in that portion by the heat of the lamp, and does not allow the passage free to a sufficient quantity of electricity to make it red. So that there is no question that heat diminishes the conductibility of wires.

It is therefore beyond controversy that heat increases the resistance of conducting wires, so that the real measure of resistance in Ohm's formula for a length of wire $= R$ will be $R + x$, x being a quantity function of the temperature produced by the current in the wire. Now from the experiments of Becquerel (*Archives de Electricité*, No. 8, 1843), it appears that the quantity of heat developed by a current is in the direct ratio of the square of the intensity, and the increase of resistance may be expressed by $x = qF^2$. Hence it is evident that instead of the formula assumed

$$F = \frac{E}{R},$$

we ought to assume this other

$$F = \frac{E}{R + qF^2},$$

if for R we wish to use the measured length of the wire.

This being well understood, it is easy to show that the influence of this cause should produce an apparent diminution of the ratio of forces given by experiments. For let the central intensity be expressed by i, and that at the other place (p) by F, we shall have

$$\frac{f(c)}{f(p)} = \frac{F}{i} = \frac{r + qi^2}{R + qF^2}.$$

But $i > F$ therefore if for a first approximation we suppose in this correction $F = \frac{E}{R}$, which is permitted on account of the smallness of q, we shall have

$$\frac{f(p)}{f(c)} = \frac{R + q\frac{E^2}{R^2}}{r + q\frac{E^2}{r^2}} = \frac{R}{r} - \frac{qE^2}{r}\left(\frac{R}{r^3} - \frac{1}{R^2}\right).$$

Overlooking, therefore, the correction for heat, we must have the ratios $\frac{R}{r}$ greater than those of the functions, when $R > r$, and the contrary if $R < r$, which agrees with experiment. Indeed, the ratio is found to be less when the resistance at the centre is greater than in the other position p, as it appears from the numbers, at 4 tenths of the axis perpendicular to the plane of currents in the globe. On these principles, and after the differences obtained, one might calculate the corrections to be presented for the increase of resistance due to the temperature, but before undertaking this, it would be necessary to examine more deeply several points on which this explanation is founded, which for the present we shall omit, it being an entirely new and interesting field for very important disquisitions.

I shall conclude this paragraph with a very interesting remark. Using Wheatstone's method for determining the resistance of a battery, we found it several times different, according to the length of constant wire which was coiled on the rheostat. The preceding observations give us the explanation of this fact, because no account was taken of the increase of resistance for the heating of the wire. Much more: these experiments may afford the value of the co-efficient of resistance by temperature, as it is very easy to understand.

§ 13. Theory of the Galvanometer.

The theory of the galvanometer is simply a corollary of what has been presented until now. The formulæ which we have given are not yet sufficient to calculate the force of the common galvanometers, having their wires disposed in rectangular frames. If we were to construct a frame of an elliptical form, we might apply the formulæ of § 6. The calculation being, however, very complicated, we shall rest satisfied here with giving the theory of the galvanometer reduced to its state of greatest simplicity, viz., that of a circular current, surrounding a magnetic needle, as is the case in the compass of tangents. The needle may be of any length, provided it be very fine, so that its poles may be regarded as the ends of an electro-dynamic cylinder of very small radius. The formula available for the calculation is the usual one, viz., (6) § 6, where p is made $= 0$.

I have endeavored to verify the formula for a few deviations, but not having at hand an apparatus sufficiently perfect, I shall give the results only as approximations. The most important point is to procure a current, which may be truly an exact multiple of another, without using the rheostat, without any change in the resistance, and also without making use of any apparatus, which depends upon a law of uncertain nature. For this purpose, I took a long copper wire, covered with silk, and at the distance of two metres from one of its ends, I formed a circle composed of eight rings of $17.76^{\text{centim.}}$ in diameter, then at the distance of other two metres I formed a circle equal in diameter to the first, but composed of only four rings, and finally at a distance equal to the preceding, I made another circle of a single ring. See Plate II., Fig. VIII. The mean diameter of the three rings was sensibly equal, but the wires being more than a millimetre in thickness, the circle of eight rings formed a considerable volume, in comparison with that of one wire only. These circles were successively placed round a compass, on which were marked the half degrees, and the smaller fractions were taken by approximation. Having charged a pile, the force of which was constant, and having taken due precautions for the exact measurement of the deviations of the needle in two opposite directions, we had the following results :—

Diameter of the circle . . . . . . $177.97^{\text{mm.}}$
Length of the needle . . . . . $81.38^{\text{mm.}}$

This length is the exact distance between the two poles, measured carefully several times, by help of the attraction on a small magnetized needle, as Coulomb used to do for the determination of the true places of the poles in a magnetic bar.

Deviations of needle.	Given proportion of the forces.		Difference.	Value of $f(c, d.)$
	From observation.	From calculation.		
10°	current 1	1.000		0.526
31° 18′	" 4	4.055	0.55	0.447
46° 18′	" 8	7.884	0.116	0.395

The sources of error are very numerous, and what is worse, they have a great influence on the results; an error of half a degree in the first and less deviation, which is the fundamental one, may alter the proportions at least one-tenth, and I have found that the difference of the radii in the different rings which compose the circle of eight, may have an influence on the hundredths of the above proportion.

From the short experiment which we have before us in the preceding table, we may perceive how rapidly the force of the current must increase in order to cause a corresponding increase in the deviation of the needle. I have made a first trial of a table of proportional degrees, which can be used for a circle and needle of the dimensions above given. I have taken for unity the force that produces a deviation of 10°, and I calculated some of the most remarkable positions of the needle, which I have marked with asterisks in the following table. The other numbers are deduced from the graphic construction founded on the numbers resulting from the calculus.

Table of Proportional Degrees.

Degrees.	Forces.
10°	1.*
13	1.4*
20	2.0
25	2.7*
30	3.6*
35	4.7
40	5.9*
45	7.9*
50	10.45
55	12.6
60	16.96*
65	18.6
70	23.33*
80	50.05*
81	56.00*(1)

The last numbers show the very rapid increase, which we have already mentioned. It is clear that this table can be used for every compass of tangents in which the proportions of the length of the needle to the diameter of the circle are such as has been supposed here, viz., as 1 to 2.18.

It remains, finally, to be seen whether the theory hitherto assumed by the philosophers about the compass of tangents is exact or not. It is taken for granted in this instrument that the intensity of the forces is in proportion to the tangents of the deviations produced. This is the same as supposing that in the formula (m, § 7) the function $f(c, d)$ which multiplies the quantity k is constant. Now, on comparing the values of $f(c, d)$ obtained in the case of the needle placed in the centre,

(1) I have made, by means of this compass, the comparison of various kinds of voltaic batteries. In the appendix, I shall give the results of their relative forces to be calculated by this table.

we perceive that it is not so, but that it varies with d. It is true that these deviations are small, and perhaps within the limits of inevitable errors in the observations until d does not exceed 30°, but for 60° there is more than a unit of difference in the ratio between the tangents and $\frac{kf}{k_1 f_1}$; we may therefore rest assured that this law is not exact except for small deviations; still, the proportion between the length of the needle and the radius of the circle is very small, viz., about $\frac{1}{11}$th, and the divergency would be much greater, if that proportion itself were greater. This may be clearly seen on comparing the preceding tables (pages 54, 55) with the proportions of the relative tangents, and they will be found very different.

Conclusion.

Those who have had sufficient patience to follow me in the aggregate of the calculations and experiments contained in this paper, will be convinced that certain branches of physics seem to be easy only when seen from a distance, but upon a closer inspection it will appear that great labor is requisite if we wish thoroughly to fathom them. It is, however, pleasing to observe that the most complicated phenomena are subject to invariable mathematical laws, which, though difficult to discover, are not the less interesting because they belong to a class of phenomena less splendid than the great planetary systems.

I am far from supposing that this memoir has sufficiently corresponded to the object intended. I rather look upon it as a mere sketch, which can be completed by such as are furnished with more accurate instruments; and I hope to be able to return to the subject myself, when I shall be less occupied than at present with the duties of my situation.

APPENDIX.

A Series of Experiments showing the relative strength and constancy of the several kinds of Voltaic Combinations for obtaining Electric Currents.

These experiments require very little explanation, except in a few cases. Grove's, Bunsen's, and Daniell's battery had all the same dimensions, when nothing is marked; they were charged in the usual way. The height of cylinders was $12^{\text{centim.}}$, the diameter of the larger receiver $8^{\text{centim.}}$, which was cylindrical.

Series C was made with a copper case $22^{\text{centim.}}$ high and long, and 3 broad. The sulphuric acid was diluted with five times its weight of water, and the solution of common salt was always saturated.

Wheatstone's combination consists of amalgam of zinc in an earthen cell, with copper outside, in a solution of sulphate of copper.

Bagration's is a plate of zinc in a case of copper, with clay watered with a solution of ammoniacal salt. After the first day, this preserved 6° for four months continually.

Each battery was left untouched from the beginning to the end of the experiment, if not noticed otherwise.

We mean by inverted battery when the + element is larger than the — one. The rheometer used was that described § 13. See note (1), page 55.

Time.	A. Grove's.	B. Bunsen's direct.	C. Daniell's direct.	D. Bunsen's inverted.	E. Daniell's inverted.	F Daniell's, with sulph. acid.	G. Earthen cell, solution com. salt.	Daniell's bladder, salt.	Daniell's, acid ⅕th, pasted bag.	Idem, salt.	Grove's, sulphuric acid only.	Bunsen's (11), sulph. acid only.	Volta's (16), inverted.	Wollaston.	Wheatstone.	Bagration.
0*h*. 0*m*.	53°	48½°	65°	45°	42°	34°	39°	50°	50°	64°	49°	50°	44¾°	59°	33°	27°
0 5	61½	60	65	48½	"	36	38	"	60	"	47	46	"	60	"	"
0 10	64	61	64½	"	43½	40	"	"	"	"	"	"	"	"	"	"
0 15	68	64	62	62	"	42	36½	"	65	"	"	41½	"	"	31¾	"
0 30	68	63	61½	68	50½	44	"	45¼	65	59	"	"	44⅔	"	36	"
0 45	68	58½	59	68½	"	41½	"	45	63	"	46	"	"	"	27	20
1 00	67½	"	"	66	49½	"	"	"	58½	"	45	"	44½	"	"	"
1 30	"	"	53	62	"	39	"	44	"	"	44¼	42	43½	"	"	"
2 00	"	"	"	"	"	"	"	"	"	"	"	"	42	"	"	17
2 30	"	"	"	49	"	"	"	"	"	"	"	39½	41½	38	½	"
3	47½	43	38	"	35	32	1	"	"	"	39½	39	"	"	"	"
3 30	"	"	"	43½	"	"	"	"	34	43½	"	38½	"	"	"	"
4	35	33	"	37½	"	4	"	"	33½	"	37½	"	40½	"	"	"
5	31	"	"	"	"	"	"	37	"	"	35	"	"	5	"	"
6	"	30	"	3½	30	"	"	"	"	"	"	36	"	"	"	"
8	40	30½	"	"	"	"	"	"	30	33½	"	"	"	"	"	"
10	"	40	29	"	"	"	"	"	"	"	29	33	38	"	"	"
14	"	"	"	"	"	"	"	"	"	"	"	"	"	"	"	"
18	"	"	"	"	"	"	"	½	5	"	"	"	"	"	"	6
25	"	"	4	"	½	"	"	"	"	4½	8	4	4	"	"	"

Second table of the Observations made in order to find the constancy of different Voltaic Combinations.

Time.	Daniell's large copper case, 1st day.	2d day.[1]	Volta, sulph. acid.	Grove, 1st day.	2d day.	Daniell's equal to Grove's in size.	Grove.	Bunsen's inverted, 1st day.	2d day.
0*h*. 0*m*.	77.45	77	82	49	48¼	33	57	51	
3 05	.45	"	80½	60½	"	"	"	53	
0 10	79.	"	77	65½	"	"	"		
3 30	79.2	"	70¼	68	"	40	"		
1	79.2	70¾	68	69¼	"	44½	"	53	39
1½	79.2	"	64	"	"	46½	55		
2	79.15	76¼	"	69¼	46¼	"		52½	38
3	79.15	"	55.41	70½	45½	49½			
4	79.18	"	49	71½	45	50		82½	
5	79.15	76	"	"	44	"	43	52¼	
6	79.10	"	"	"	43½	53		52	
7	79.2	"	35	68	42		41	"	
9	79.	74	"	65½	"	53		51	
11	78.45	"	23	62	37			50½	17
13	78.20	70	"	59	34				
15	"	"	"	"	"		28	58	
18	"	"	"	"	"		15		
20	"	"	11	50	"				
22	77.10	49.45	"	"	27				
23	77.	47.30	"	49	25½	40		45	
24	77.	44.25	8	48¼	24				

[1] No sulphate added.

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ERRATA.

Page 12, line 5th, for $\frac{sin.^2 \alpha\, d\,\phi}{\Delta^3}$, read $\frac{sin.^2 \phi\, d\,\phi}{\Delta^3}$.

Page 16, line 4th, for $4\,(am - (a^2 - b^2)\, sin.^2 \psi$, read $4\,(am - (a^2 - b^2))\, sin.^2 \psi$.

PLATE. I.

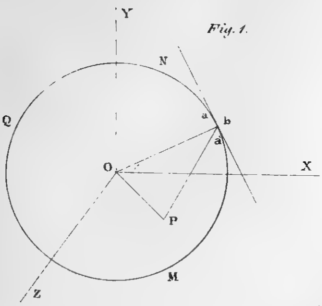


Fig. 1.

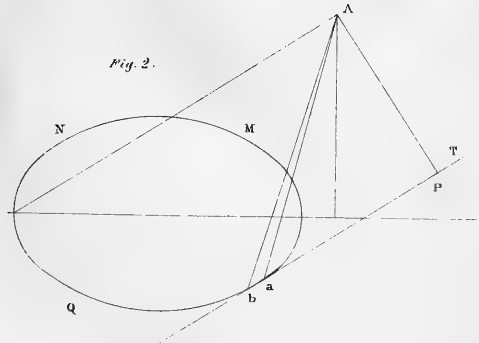


Fig. 2.

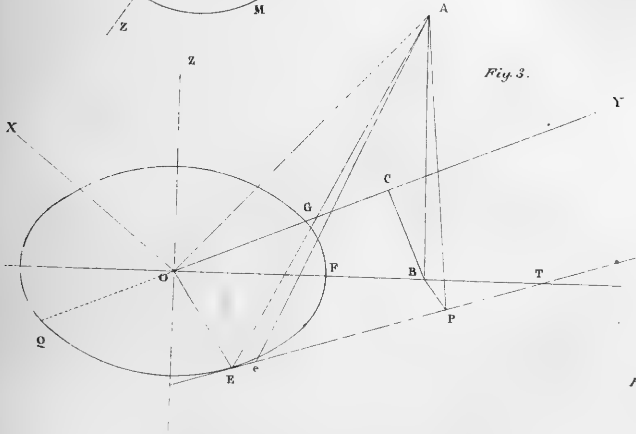


Fig. 3.

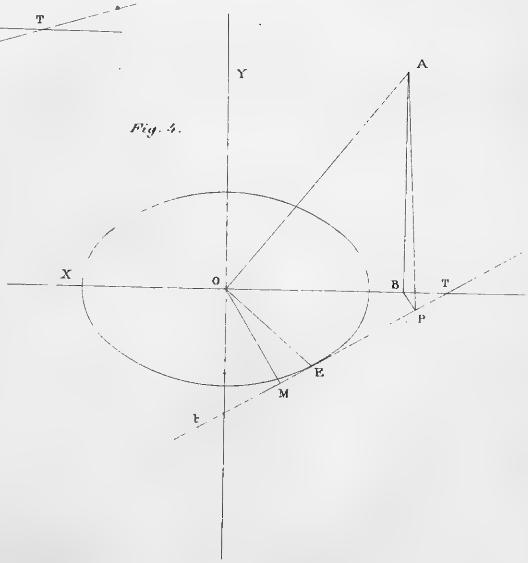


Fig. 4.

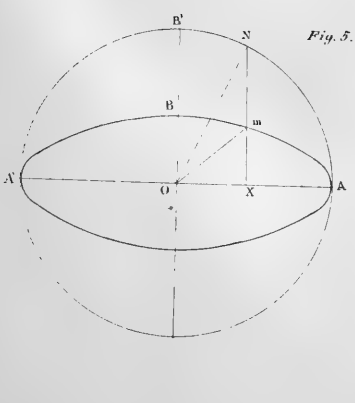


Fig. 5.

PLATE. II.

Fig. 6.

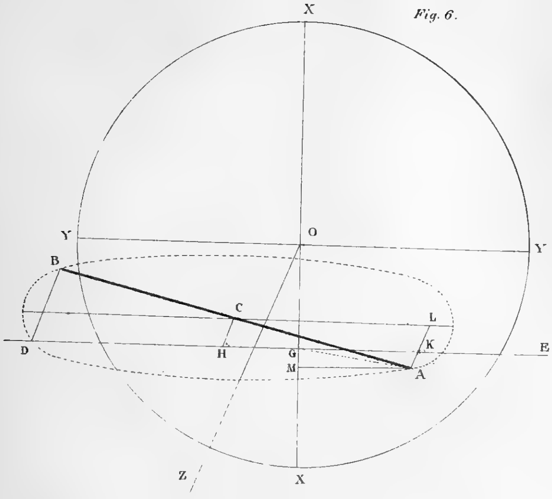


Fig. 7.

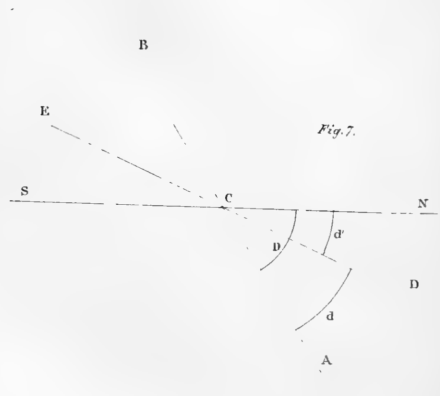
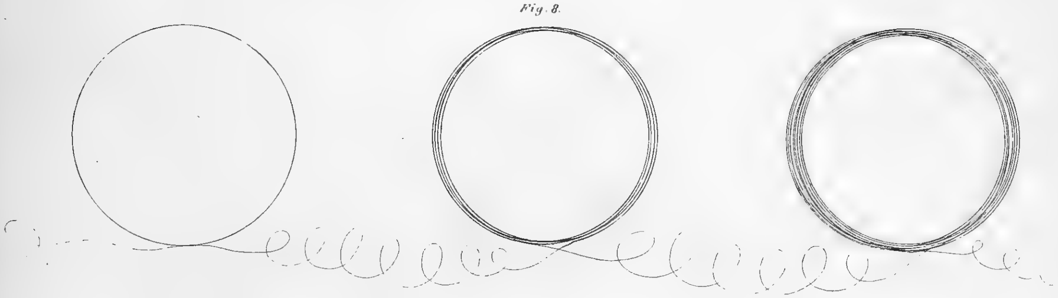


Fig. 8.



Curve representing the increase of force from the centre to the circumference of a circular current.

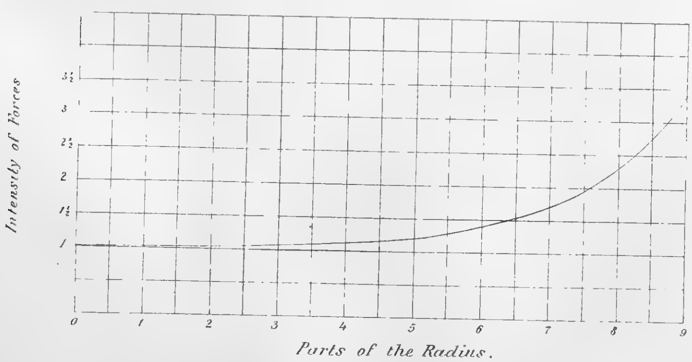


Fig. 9.

Plate III.

FIG. IV.

FIG. V.

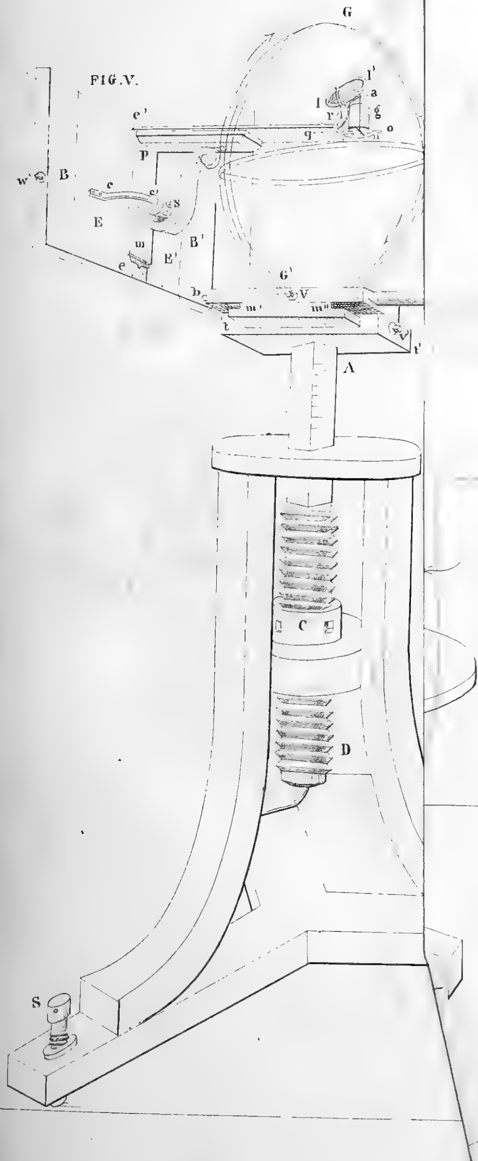
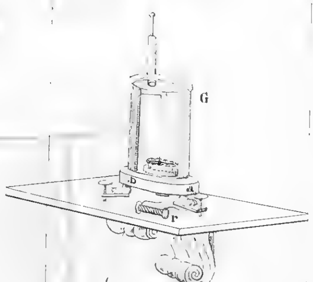


FIG. II.



Lith. of Sarony, New York.

Plate III.

FIG. IV.

FIG. V.

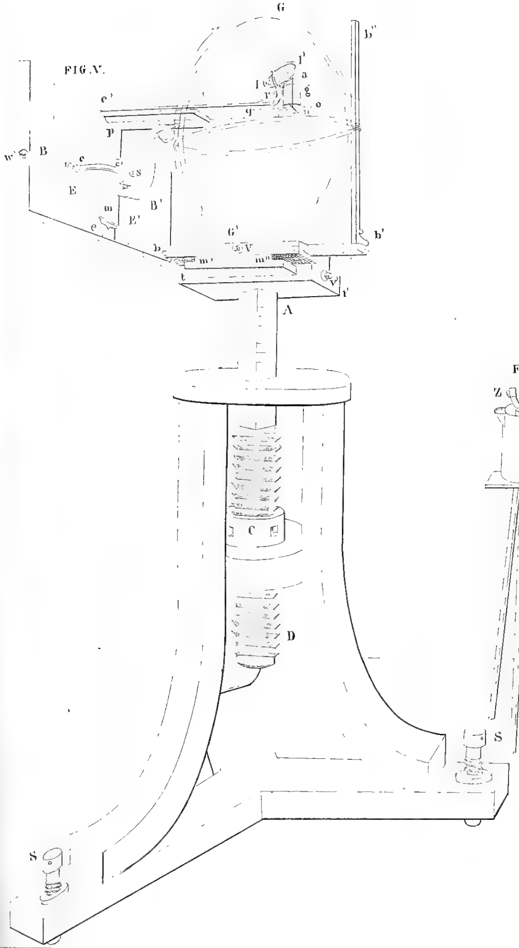


FIG. I.

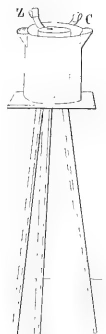


FIG. VI.

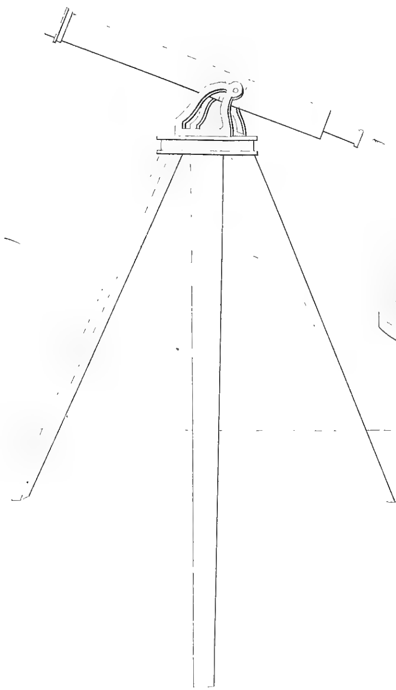


FIG. III. bis

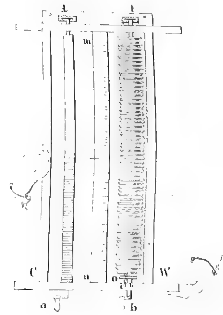


FIG. III.

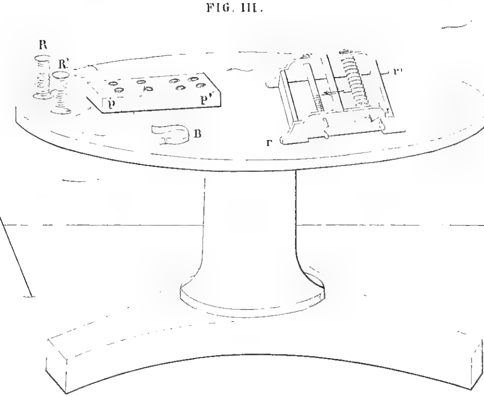
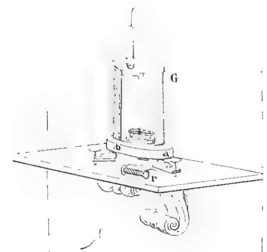


FIG. II.



Lith. of Sarony, New York

CONTRIBUTIONS

TO THE

NATURAL HISTORY OF THE FRESH WATER FISHES

OF

NORTH AMERICA.

BY

CHARLES GIRARD.

I.

A MONOGRAPH OF THE COTTOIDS.

ACCEPTED FOR PUBLICATION

BY THE SMITHSONIAN INSTITUTION,

DECEMBER, 1850.

COMMISSION

TO WHICH THIS PAPER HAS BEEN REFERRED.

DR. JARED P. KIRTLAND,
DR. J. E. HOLBROOK.

JOSEPH HENRY,
Secretary.

PREFACE.

I HAVE selected the Artedian genus Cottus as the subject of my first monograph, on account of the interest which attaches to the questions involved in its investigation. The first of these questions is to ascertain whether there really exists but one single species of the genus in Europe, and another in America. The second, whether indeed the same species is common to both countries, as was at one time supposed.

My investigations embrace, and, I hope, solve both of these questions. The materials made use of are numerous and of special value; some of them absolutely essential to the proper determination of the above-mentioned points.

As far as it has been in my power, I have consulted the original documents, and their authors themselves. Thus I owe to Professor S. S. Haldeman an authentic individual of his *C. viscosus*. Through the kindness of Professor James Hall, of Albany, I have studied the specimen drawn and described by Dr. De Kay under the name of *Uranidea quiescens*, which proved to be a true Cottus. Mr. W. O. Ayres has placed in my hands specimens of his *C. gobio* from the State of Connecticut. From information communicated by Dr. J. P. Kirtland, of Cleveland (Ohio), I have identified his *C. gobio*. Rev. Z. Thompson, of Burlington (Vt.), has sent me a species hitherto undescribed. Specimens caught near the White Mountains were communicated by Dr. D. Humphreys Storer. I have made a complete study of the species brought by Prof. Agassiz from Lake Superior.

In examining the collection of fishes in the Academy of Natural Sciences of Philadelphia, with the assistance of Dr. J. Leidy, I found one specimen by which I became fully satisfied of the existence of two species in the tributaries of the Ohio River. But the most important contributions have been from the collection of Professor S. F. Baird, now at the Smithsonian Institution. Numerous specimens of *C. viscosus* and others have enabled me to give the anatomical details contained in Chapter II.

I beg all these gentlemen to accept the assurance of my deepest gratitude, and to receive my labor with the same indulgence which they have shown towards me during its elaboration.

Most of my descriptions rest upon the examination of numerous specimens: a few of them are drawn from one individual, but the species will appear distinct enough to be justified.

Those ichthyologists who may deny the validity of all the species of the genus Cottus which I adopt, considering some of them as mere varieties, must still acknowledge that these varieties are worthy of being known.

There are two species of Cottus proper, the originals of which I have not seen, viz.: *C. cognatus*, Rich., and my *C. Fabricii* (*C. gobio*, Fabr.). No specimens of either of these species are preserved in any American collection.

An intimate knowledge of the Cottoids will enable us more readily to appreciate the specific characters of a great many other groups, whose geographical distribution is less extensive, but in which the species are altogether as numerous and as uniform. The species of a genus are generally uniform whenever they are numerous: this is a necessary consequence. When the type possesses but a few characters, it is not liable to so many diversities amongst the species, and these characters, in being shared, appear as if exhausted, leading superficial observers to the belief that species pass into each other by gradual steps.

Not only among fishes, but in other classes also we meet with natural groups composed of numerous species, which are allowed to vary beyond the limits of their circle of activity, and for the study of which great skill must be displayed in order to recognize the species in the midst of these variations.

CHAPTER I.

ON THE FRESH WATER COTTOIDS IN GENERAL.

§ 1. Zoological Considerations.

For nearly a century a single species of fresh water Cottoid was known in Europe, a small fish very common there in rivers and lakes, and whose obtuse form and flattened head (which is broader than the body) brought it to the notice of every one. A long time before ichthyologists gave it a systematic name, many nations, including the French, English, Danes, Swedes, Germans, Italians, Hungarians, and Russians, had assigned to it a vulgar one in allusion to the breadth of the head, which in fact is the chief character of the genus; and this generic character, so clear and so precise, involved the apparent uniformity among the species. For this reason the species were not at first distinguished, being referred from vague recollection, and from the opinion of the people, to the *C. gobio* of Artedi and Linnæus. Thus the same species was believed to inhabit the fresh waters of nearly the whole ancient hemisphere, in Europe from Sweden to Italy, and from France to Siberia. Cuvier, however, after having enumerated the localities which the *C. gobio* inhabits, adds: "But perhaps it would be necessary to see together and to compare individuals from countries so remote from each other, in order to ascertain that they do not present some differences which have escaped isolated observers."[1] From this moment suspicion began to be entertained: this was to be the prelude to new researches.

Thus eight years after these lines were written, Mr. Heckel,[2] taking up the study of the Cottoids, distinguished three new European species; namely, his *Cottus affinis, microstomus,* and *pœcilopus.* The first inhabits Scandinavia, and had been referred by Eckström[3] to *Cottus gobio,* and in fact it is the fish that Artedi and Linnæus had in view, though not specially, since they gave to their species, as geographical range, the whole continent of Europe. *Cottus microstomus* is from the vicinity of Cracow, and *C. pœcilopus* from the Carpathians in Upper Hungary.

Some time afterwards the same naturalist wrote to Ch. L. Bonaparte that *C. gobio* from Italy was a distinct species, and gives to it the name of *C. ferrugineus.*[4]

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[1] Histoire Naturelle des Poissons, iv., 1829, 8vo., p. 150; 4to. ed., p. 110.

[2] Ichthyologische Beiträge, in Ann. des Wien. Mus., vol. ii., 1837, p. 150.

[3] Fiskarne i Mörkö Skärgard, p. 139.

[4] Catalogo Metodico dei Pesci Europei di *Carlo L. Principe Bonaparte,* Napoli, 1846.

In our *Revision of the genus Cottus*,[1] we advanced the opinion that this species would be found distinct, not knowing at that time that it had been already named.

These were progressive steps in European ichthyology, but there still remains carefully to compare with the above species, the *C. gobio* of England, France, Denmark, Germany, and Russia, in order to ascertain whether several species are not still confounded. We have already remarked a certain disagreement on this subject among authors. Cuvier makes the positive remark that the *C. gobio* has only three soft rays to the ventral fins, whilst Dr. Richardson mentions four as belonging to the English species examined by him, and which is the same as the one described by Mr. Yarrell. This also has but six spinous rays to the first dorsal, and sixteen soft and articulated, but unbranched rays, to the second dorsal. The assertion of Cuvier, that the first dorsal of *C. gobio* counts from six to nine spinous rays, is a fact to be verified anew: perhaps the above English species is taken into account in the formula. Moreover, Cuvier says, positively, that the rays of the centre of the second dorsal dichotomize at their extremity. Finally, in the *C. gobio* of the Seine the upper rays of the pectorals are branched, whilst they are all simple in the English species spoken of by Dr. Richardson.

Should these differences prove constant, and we have no doubt they will, they are more than sufficient for specific distinction, and we are satisfied of the existence of two species of Cottus in the British Islands, for we find mentioned sometimes three and sometimes four rays to the ventrals of the so-called *C. gobio*. This character, which proves safe among American species, will no doubt be a sure guide in a critical review of the European ones. We have seen a mutilated specimen of an English Miller's Thumb with evidently branched pectoral rays, therefore differing from the one alluded to by Sir John Richardson. The Miller's Thumb from the Seine again differs from that of the Danube. Those of the Rhine, of the Rhone, and the south of France generally, deserve a special attention, as well as the one mentioned by Reisinger in his *Ichthyologiœ Hungariœ*, which seems to attain a very large size. In fact, the Cottoids of all the European and Asiatic rivers and lakes should be compared directly. It is only after this is done that we shall be prepared to establish safe comparisons between the species of one continent and another.

Now, if we recapitulate the European species, we find five of them to be well determined and named. In addition, we have two species in England as alluded to above, which are distinct from *C. gobio* of the Seine; thus giving seven species. Then, in central Europe several other species will probably be found distinct. *C. pœcilopus* must be compared with the *gobio* of Reisinger, of the Danube. Be it remembered that the latter spawns in March and April. A comparison of the *C. gobio* from the Seine (spawning in May, June, and July) with that of the south of France, and then again with that of the Swiss lakes and the rivers of continental Europe, would no doubt add to the number of species. It would be interesting to know whether the Miller's Thumbs exist southwards of the Pyrenees, in Spain and Portugal, as well as in Greece and Asia Minor.

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[1] Nouveaux Mémoires de la Société Helvétique des Sciences Naturelles, vol. xii., 1851.

We may thus expect in Europe a number of species nearly equivalent to that of America, and we shall find among them species with four soft rays to the ventrals, and others with only three. Whether the lateral line will be found extending to the tail in all of them, is a point worthy of attention.

Let us return for a moment to Mr. Heckel's paper. Six species are found mentioned there, of which four belong to Europe, *C. gobio, microstomus, pœcilopus,* and *affinis,* and two to America, *C. cognatus* and a new species which the author calls *C. gracilis.* Now, in his synoptic list, this latter is the only one which has but three soft rays to the ventrals, whilst the other five have four. Mr. Heckel does not tell us whence he obtained the *C. gobio* which he had before him, which would be of great importance to us, for we have seen that it is not perfectly identical with that of the Seine, since Cuvier allows to this latter only three soft rays in the ventrals, and Mr. Heckel cites four of them. In the *C. affinis* the rays of the ventrals are divided; in *C. gobio, microstomus, pœcilopus,* and *cognatus,* they are simple. The upper rays of the pectorals are branched in *C. gobio* and *microstomus;* they are all undivided in the *C. pœcilopus* and *cognatus.*

Thus we see Mr. Heckel borrowing the specific characters from the structure of the fin rays. He says he has examined a large number of fishes in order to ascertain the variations which the rays undergo during their growth. He has observed that in his *C. gobio,* for instance, the bifurcation of the rays commenced only when the fish had acquired half its size, whilst he has never seen the least trace of division in the *C. pœcilopus* even at a size much beyond that at which the phenomenon takes place in the *C. gobio.* From this fact he concludes that there are constant characters of which we may avail ourselves for the distinction of species. He denies the influence of climate on the division of the rays, as for instance, that this division would take place under warmer climates, and he cites as a proof of the contrary the *C. pœcilopus,* the most southern of his species, whose rays are undivided, whilst they are branched in the more northern *C. microstomus.*

When a genus happens to be as uniform as that of Cottus, it is a natural and necessary consequence that we should take into consideration the minutest details in discriminating the species. Did the Cotti present themselves uniform from one extremity to the other of Europe, and were the species of America or of Asia more diversified in their forms, there would be less reason for our undertaking so minute a study of them. But their uniformity in all parts of the globe where they have been observed is such as to lead us to researches of details; for, howsoever a question of that nature be definitively solved, be it in favor of a single species or of a multitude, these researches will lead us to the understanding of the ichthyic signification of the genus to which they have reference, and to its distribution over the surface of our globe.

C. gobio, L. has been cited by Oth. Fabricius as an inhabitant of Greenland. This is undoubtedly a particular species, which we shall mention hereafter.

Again, *C. gobio* was thought to inhabit the United States, and as the present labor was undertaken with a view to verify the assertion, we have no remarks on this subject to make in this paragraph.

The Cotti of Asia are little known, the centre of this great continent not having yet been sufficiently explored. We may expect many species from the rivulets of the highlands and slopes of mountains, as well as in the valleys; for Pallas cites a *C. gobio*, L. in the lake Baïkal and the fresh waters of Siberia; but it is more than probable that this is a distinct species. He describes another under the name of *C. minutus*, which was sent to him by Merk as coming from the fresh waters which empty into the Ochotsk sea. It resembles so closely *C. gobio*, described in the *Histoire Naturelle des Poissons*, that Cuvier himself says that he dares not separate it. And yet he does not identify it absolutely with the *C. gobio*, leaving for it a place apart in making the observation that "its snout is perhaps a little less pointed, and the spines above its nostrils a little larger," without giving his opinion on the value of these differences. The size of the specimens which he has examined measured three inches, and if this be the common size, the species is smaller than the *C. gobio* of the Seine, and many others.

There is, in this reserve of Cuvier, not to identify definitively two fishes of such distant countries, and nevertheless so similar to each other; there is, I say, included in this reserve, the whole spirit of modern science, a spirit profoundly philosophical, the spirit of future progress.

We have deemed it necessary to make several generic divisions of the species hitherto comprised in the genus Cottus. This part of our labor was published in the *Proceedings of the Boston Society of Natural History*,[1] and we think it in place to transcribe here the historical paragraph which relates to that question, since it might be controverted by some one.

Artedi established the genus Cottus in 1738 with the following characters: gill membrane containing six distinct bony rays; head larger than the body, depressed and acute. Two dorsal fins; the anterior composed of flexible spines. Ventral fins small, having only four soft rays. Skin scaleless.[2]

He places in the first rank the fresh water species having *two spines* on the head, of which *C. gobio* is the type, being the only one known at that time. Next to this, the species with more spines on the head, including not only the salt water species having a smooth skin, but two others, which have since become, one the type of the genus *Aspidophorus*, the other the type of the genus *Callionymus*. Artedi himself went thus beyond the limits of his genus by placing in it the two last species, as their body is covered with scales.

Linnæus[3] alters Artedi's genus by giving as the only character for it, "a spiny head broader than the body." Linnæus went farther; he transposes the species and places at the head *C. cataphractus*, the type of the genus *Aspidophorus*, of later date, and which Artedi placed at the end of the genus Cottus. His third species belongs now to the genus *Batrachus*, and the fourth to the genus *Platycephalus*: the *C. gobio* is the last.

Oth. Fabricius[4] followed the example of Linnæus.

But Cuvier[5] recalls that the primitive type of the genus Cottus was *C. gobio*

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[1] Vol. iii., 1850, pp. 183, 303, and vol. iv., 1851, p. 18.
[2] Genera Piscium.
[3] Systema Naturæ, ed. xii.
[4] Fauna Grœnlandica, 1780, p. 159.
[5] Histoire Naturelle des Poissons, iv., 1829, pp. 142, 150.

from the fresh waters of Europe. Following Artedi's method, he describes first the fresh water and next the salt water species. Nevertheless, when writing the history of this genus, he did not find it necessary to separate generically these two groups, although he had already pointed out their principal difference. Two species only were known to him, one of them (*C. minutus*, Pall.), very imperfectly.

On ascertaining the actual number of species to be so large, and each group still maintaining constant generic differences, we concluded to give the name of Acanthocottus to the marine species, which, generally speaking, are of a larger size than those living in fresh water. They are characterized by having many spines to the opercular apparatus; the preopercular itself having several of them always strongly developed. The surface of the head, and often the circumference of the orbits also, are either armed with spines, or else serrated or notched in different ways. The nasal and turbinal bones are in most of the species surmounted by a spine or ridge. The head itself is rather higher than broad; sometimes much deformed, with proportionally large eyes, and a deep occipital depression, as for instance, in *A. ventralis* and *claviger*. The mouth is always more deeply cleft than in the fresh water species (*Cottus* proper), but the dentition, as a whole, is nearly the same. The nostrils open exteriorly by two apertures quite distant from each other, the anterior tubular, and much larger than the posterior, which is even with the surface of the head, and situated close to the orbits. The body is scaleless; the back is often arched, and the first dorsal fin almost as high as the second. Some species have three, others four, soft rays to the ventral fins. The lateral line runs uninterrupted and distinct from the head to the base of the caudal fin.

The name of Cottus is retained for the fresh water species, the subject of the present monograph, and as the generic characters will be given hereafter, it is unnecessary to present them in this place.

Not long since, the generic name of *Uranidea* was given to a species of our genus Cottus, and had the name of Cottus belonged to the marine species of the group, instead of being founded on the fresh water *C. gobio*, the new name *Acanthocottus* would have been unnecessary. In that case we might have called the fresh water species *Uranidea*, and the marine ones, *Cottus*, with equal propriety, although the original idea of the genus Uranidea was a mistake of its author.

We have formed another genus under the name of Cottopsis, to include one single species, the *Cottus asper*, originally placed in the genus Cottus by Sir John Richardson, afterwards in the genus *Trachidermis*, by Mr. Heckel, and again by Sir John Richardson, in that of *Centridermichthys*. The genera Trachidermis and Centridermichthys have proved to be identical,[1] and in addition, to have no immediate affinities with *C. asper*. The history of the genus Cottopsis will be found in Chapter IV. Finally, we have established the genus Triglopsis[2] for an entirely new fish discovered by Prof. Baird in Lake Ontario. It comprehends as yet, only one species, the description of which will be found in Chapter V.

The manner in which the characters are shared by the genera of Cottoids, either

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[1] Proc. Bost. Soc. Nat. Hist., iii., 1850, p. 302.

[2] Proc. Bost. Soc. Nat. Hist., iv., 1851, p. 19.

marine or fluviatile, shows a very intimate relationship, both amongst themselves and the neighboring groups of Scorpænoids and Sciænoids.

The typical genus of the marine division is that of Acanthocottus, numerous in species, and distributed over the arctic and temperate regions of both hemispheres. In the Pacific Ocean we have the genera *Trachidermis* and *Podabrus*, composed each of but a few species confined to the seas of China and Japan. The first is a diminutive of Acanthocottus, from which it differs in having a prickly skin and teeth on the palatine bones. The second is intermediate between Trachidermis and Acanthocottus, without forming, however, any direct passage from one to the other; it has the smooth skin of Acanthocottus and the palatine teeth of Trachidermis. As to the general form and physiognomy, one would consider Podabrus as the eccentric type of Acanthocottus: the two species which it embraces, differing greatly from each other in that respect.

The genera *Hemitripterus* and *Hemilepidotus* exhibit a tendency towards Scorpænoids; both are provided with teeth on the palatine bones, the skin of the former being somewhat prickly, and that of the second, partly covered with scales.

The typical genus of the fresh water division is that of Cottus, numerous in species, distributed over the whole range of the temperate region of both hemispheres. On the north-western shores of America there is the genus Cottopsis, the amplification of Cottus, provided with a prickly skin and teeth on the palatines, like Trachidermis.

Finally, the genus Triglopsis seems to recapitulate both Acanthocottus and Cottus, and to foreshadow the group of Sciænoids.

Thus eight genera, five marine, and three from the fresh water, constitute actually a natural group to which the name of Cottoids is well appropriated.

§ 2. Genealogy of the Cottoids.

The history of the Cottoids prior to our epoch rests, as yet, only upon the discovery of a few fossils in Europe. The family appeared for the first time on the surface of the globe, sometime during the last period of the cretaceous epoch, where it was represented by two genera, *Pterygocephalus* and *Callipteryx*, precursors of the group of *Triglidæ;* their affinities leave no doubts on this point. But these two genera die out with the end of their epoch.

To them succeeds the genus Cottus in the tertiary epoch, where it was the only one of the family, and, indeed, had but few known species. Two of these, *Cottus brevis* and *C. papyraceus*, Agass., come nearest to *C. gobio* and other fresh water species of the genus now living, and a third species, *Cottus aries*, Agass., is more intimately related to *Cottus scorpioides* and *bubalis*, precursor of the marine type of the genus, which we now call *Acanthocottus*.

It is not improbable that Cottoids may have existed in North America before the present epoch. The study of the cretaceous and tertiary deposits situated within the limits of the zone inhabited by living species will furnish us information on this point.

The geological researches on the Asiatic Continent, have not yet furnished us with a single palæontological fact which could lead us to suppose that Cottoids have existed there at an epoch prior to the present. On the other hand, we have no reasons to pronounce their total absence in the strata of that continent, since living species are found in its rivers and lakes.

§ 3. Geographical Distribution.

The fresh water Cottoids are distributed all over the cold regions of the Temperate Zone of the northern hemisphere, in Asia, in Europe, and in America. They do not generally associate with the Acanthocotti and other allied genera, beyond the arctic circle, around the polar seas, nor do they follow the other representatives of the family in the warm region of their geographical range.

In Asia, entirely towards the east, in the neighborhood of the Ochotsk Sea, between the 50th and 60th degrees of latitude we find the *C. minutus* of Pallas. That illustrious traveler cites the *C. gobio* in the Lake Baïkal, and in the fresh waters of Siberia, which will probably prove to be a new species, if not identical with his *C. minutus.*

To the north of Europe, in Scandinavia, we have the *C. affinis*, Heck. More to the centre and to the east of that continent, in Poland, the *C. microstomus*, Heck., and still more in a southerly direction, in Hungary, the *C. pœcilopus*, Heck., but confined to the chain of Carpathian Mountains.

In the central and western part of Europe, from and including the British Isles, to the chains of the Alps and Pyrenees, a single species is cited, the *C. gobio*, L. But we know already that Great Britain has peculiar species even if the *C. gobio* should prove to be an inhabitant.

Finally, we find on the southern slope of the Alps, in *Laggo Maggiore*, and in the north of Italy, another species, the *C. ferrugineus* of Heckel.

The Cotti of America are almost parallel with those of Europe. In the north of the continent, and near the arctic circle, is found the *C. cognatus*, Richards. In Greenland, and detached from the continent, but nearly in opposition to *C. affinis* of northern Europe, we have *C. Fabricii.* Southwards, but still in a comparatively eastern range, in the basin of Lake Superior, we meet with two species, the *C. Richardsonii*, confined to the northern shore and the *C. Franklinii* inhabiting the southern and eastern shores. Again, in the water emptying into Lake Huron the *C. Alvordii*, and in the depths of Lake Ontario, *C. formosus.* Along the western slope of the Green Mountains, occurs the *C. gobioides* and on the eastern slope of the same range, *C. boleoides.* In Massachusetts, New York and Connecticut we have the *C. gracilis*, Heck. East of the Alleghany range, are found in Pennsylvania the *C. viscosus*, and in James River (Virginia), the *C. meridionalis.* West of the Alleghanies we know of the existence of two species, one, *C. Bairdii*, in the northern, the other, *C. Wilsonii*, in the eastern tributaries of the Ohio.

The southern limit where Cotti have been observed, is the State of North Carolina; but we do not know yet to which species they belong.

Again, in Lake Ontario we find a species combining such characters as to constitute a genus by itself, the genus *Triglopsis* associated there with a species of Cottus proper.

Passing to the western coast of the American Continent, beyond the Rocky Mountains, between the latter and the shores of the Pacific, we shall find in the Columbia River another species with a special combination of generic characters, the *Cottopsis asper*, associated with a yet undescribed species of Cottus proper, collected by the naturalists of the United States Exploring Expedition. The published ichthyology of that exploration will soon make us acquainted with other members of the Cottoid group.

If we take a glance on a chart at the localities of the North American Continent where Cottoids have been observed, we shall find extensive tracts which still remain unexplored; all the country west of the Mississippi and Ohio, and in a northerly direction to Lake Superior. Then, again, the British Possessions, that region of numberless lakes, must contain some of these fishes, since we see that one species extends as far north-west as Great Bear Lake, the northernmost of all. Between Lake Superior, the mouth of the Columbia River, Great Bear Lake, and Labrador is included a vast area where Cottoids will undoubtedly be found hereafter, as well as within the limits of the western part of the United States, between the Mississippi and Ohio, to the shores of the Pacific. But how far south they occur we cannot yet tell with certainty. We know that fresh water Cottoids belong chiefly to the temperate zone, having been observed from the arctic circle to the 45° of latitude in the eastern hemisphere, and to the 35° in the western hemisphere.

§ 4. Habits, Food, and Use.

We have not had the satisfaction of observing ourselves the Miller's Thumbs of this continent in their natural medium. All authors agree in saying that clear and limpid waters with stony or sandy bottoms, are the places most preferred by these fishes. The small rivulets of cold water descending along the slopes of mountains are often their favorite residence, although likewise frequently inhabitants of large lakes. They keep sheltered under stones, which must be removed when in search of them. When uncovered, they sometimes dart away with great rapidity, in search of another hiding place; and sometimes they wait motionless until started. In Europe, there is scarcely a boy living in their vicinity who does not hunt them by uplifting carefully and slowly the stones of the shores of lakes, or at the bottom of rivulets, and transfixing the fish when motionless, by means of a fork attached to a stick.

They are of little use to man, not to say in the economy of nature. The marine species are dreaded, being exterminated by fishermen, and generally thrown away when sufficiently mutilated. Sometimes, however, we see the head only cut off, and the body brought home for the table. The flesh of the fresh water species is delicate and much esteemed in some countries of Europe, where they occur in large numbers. Undoubtedly they would be much more sought for, if not generally so scarce and of a size too small to repay the trouble of hunting them. In fact, they are only accidentally taken either with the hook or the net, and must be, as already remarked, sought for under stones. In the United States where the markets are abundantly supplied with larger fishes, the Miller's Thumbs pass entirely unnoticed.

Some species spawn in the spring, others in summer, from the month of March to July. When only one species was admitted in both continents, the difference of latitude in America was called on to explain the difference in spawning. Thus, to see the Cottus of the State of Connecticut spawn in March and April, and those in the Great Bear Lake only in May, appeared quite natural. But how explain the fact, that in the Seine, at Paris, the *C. gobio* spawns in May, June, and July, whilst in the State of Connecticut it spawns in March and April? The isothermal of Paris, it is well known, passes below that of any part of Connecticut. The Cotti of the Danube again, spawn in March and April.

It has for a long time been known that certain fishes construct nests, such as Sticklebacks. Others take care of their spawn and young; so do the lump-fish, the cat-fishes, and, according to Fabricius, the male of his *C. gobio* does the same. We know nothing of the behaving of other Cottoids in this respect.

The food of Cottoids consists generally of crustaceans, insects and of their larvæ. Fabricius says that his *C. gobio* feeds on ammodytes (Sand eel) *Holothuria priapus* (Sea cucumber), worms and small fishes. Sir John Richardson tells us that fragments of small fish were found in the stomachs of *C. cognatus*. We have examined the contents of the stomach of many marine and fresh water Cottoids, and in the Acanthocotti of the Boston Bay found them to consist of crabs (*Pilumnus Harrisii*); in *Cottus viscosus* and *gracilis*, of insects and larvæ, and in *Triglopsis Thompsonii* of shrimps. We have never found any indications of fishes.

CHAPTER II.

ANATOMICAL OBSERVATIONS.

§ 1. General Remarks.

It is not our intention in this place, to present the Anatomy of the Cottoids further than what may be necessary to the complete Zoological discrimination of the genera and species. Nevertheless, if we have given more anatomical detail than may be necessary for the above object, we would have this considered as so much towards a complete anatomy, which we trust may some day be furnished.

§ 2. The Bony Frame of Cottus viscosus.

Plate III. Fig. 1—9.

The skeleton (Fig. 1), is intended to give a general idea of the internal frame. The first vertebra is concealed by the scapular; the first and eighth ray of the first dorsal fin are omitted by accident.

The skull (Fig. 6—9), or that part of the head composed of the occipitals, parietals, frontals, mastoids, vomer, nasal, ethmoid, petrosals, and sphenoid, may be subdivided into two regions. An anterior region composed of the vomer, nasal, ethmoid, prefrontals and part of the sphenoid constituting an arcade over the eyes, on both sides of which are the orbits. The posterior region is more bulky; it is the solid box which contains and protects the brain.

Seen from above (Fig. 6), and below (Fig. 7), the general form of the cranial box is a little longer than wide, and the width behind, on the occipital region, is considerably greater than in front, near the orbits. The upper surface is smooth, a little depressed in the middle, whilst the occipital region is rather convex, (Fig. 9.) The profile (Fig. 8) shows more accurately the extent of the two regions; the orbito-frontal arcade having exactly the same length as the cranial box; besides, we observe a character which is peculiar to *C. viscosus*, at least amongst the species figured on Plate III, that is the great convexity of that arcade. The same character is very likely to be found in all the species whose external features exhibit a very truncated snout, such as *C. Alvordii*, *C. meridionalis*, &c.

The movable bones of the left side of the face and head in general are represented isolated in Fig. 5^a. The *premaxillary* (22) has the form of a right angle; both of its branches being of equal length. The horizontal one is a flat ellipsoidal piece provided with card-like teeth. The vertical portion is composed of a spine and a flattened process situated behind the spine, but in close contiguity with it, and reaching only to half the height of the latter. The *maxillary* (21) which constitutes with the premaxillary the upper jaw, is articulated anteriorly with the vertical branch of the premaxillary, and a little covered by the suborbitals. Its posterior extremity is kept movable on the membrane, which forms the angle of the mouth. Its form is elongated, slender, a little curved, subcylindrical, flattened behind, and provided in front with an articulating trifid head.

The vault of the palate is formed by three bones, closely soldered together, constituting an arcade, which rests behind on the hypotympanic and pretympanic, abutting in front against the vomer and premaxillary. The first of these bones is the *palatine* (20), irregular in shape, and provided with several flat, wing-like expansions, on which no teeth can be seen. The *entopterygoid* (23), and *pterygoid* (24), come next to the palatine; they are both of nearly the same length, and so intimately connected that we did not venture to separate them for fear that we should break the only specimen which was at our disposal. The pterygoid is uniformly elongated and flattened; the entopterygoid is flattened and elongated also, but terminated posteriorly in an expansion, crescent shaped behind, resembling somewhat a forked caudal fin.

The *dentary* (32), is not quite as much curved as exhibited in the figure. Teeth exist on the whole width and length of the upper branch, which extends a little more backwards than the lower one.

The *articular* (29), has still adherent to it the *angular* (30), at its lower and inferior corner, and the *splenial* (31) inwardly and above, which for the same reason as mentioned in the case of the pterygoid and entopterygoid, we did not attempt to separate. The angular and splenial are very small bones, insignificant in their shape, which could only have been drawn of natural size with great difficulty. Our object is to signalize their presence and their homology. The articular itself is a stout and well developed bone, and so characteristic in all osseous fishes that it could hardly be mistaken. The *hypotympanic* (28), irregularly triangular in shape, is provided at its summit with a rounded head which articulates on the articular and splenial. The body of that bone is a flat disk protected on each side by a spine which extends a little beyond the central disk. Above the hypotympanic, and encroaching into the forked extremity of the entopterygoid, is the *pretympanic* (27), a very thin leafy bone, so delicate that in detaching it from its neighbors it is constantly torn along the edges. As represented in the figure, the outline above has lost its actual shape. The *mesotympanic* (26), is likewise almost a mere membrane, or a thin cartilage, in the middle of which two points of ossification are distinctly seen. The mesotympanic forms the continuation of the lower extremity of the epitympanic. The *epitympanic* (25), itself, articulates above with the mastoid. It is somewhat covered by the upper part of the preopercular. The epi-, meso-, pre-, and hypotympanics are all intimately connected, and form the back roof of the mouth, limited behind by the concavity of the preopercular. The palatine arcade extends from its anterior edge to the vomer and premaxillary, thus continuing the roof to the anterior part of the mouth. The upper angle of the preopercular is attached to the medial crest of the epitympanic, whilst the lower angle articulates on the body of the articular.

The *preopercular* (34), is an exact crescent, on the convexity of which is situated the conical spine, directed obliquely upwards. The insertion of the spine is above the middle of the crescent. The concavity of the latter is occupied by a thin expansion of that bone, making the direct continuation of the tympanic wall.

The *opercular* (35), is articulated to the posterior articulating process of the epitympanic. It is irregularly triangular like the hypotympanic and formed likewise of an articulating head at its summit, and of two branches, between which is a thinner expansion of that bone.

The *subopercular* (36), is provided at its lower edge with a spine whose point is directed downwards and forwards, a little more conspicuous than in the figure. That bone sends off two branches, a spiny one directed upwards which unites with the inner edge of the opercular, and another thin and membranous, running all along the posterior and free edge of the same bone, and in fact, constituting the actual edge of the opercular.

The *interopercular* (37), is an elongated and narrow piece, very uniform in shape, pointed forwards, truncated behind, extending from the subopercular behind, to the hypotympanic and articular, in front. In a fleshy specimen it is not apparent, being covered by the lower branch of the preopercular. When the skin is removed its edge may then be seen.

Amongst the bones of the head and face there still remain to be mentioned those which have been classified under the special denomination of dermo-skeleton.

To the dermo-skeleton belongs the lateral line which is described below in § 9, and figured on Plate II, Fig. 11. When the lateral line enters the head, it passes under the suprascapular into the mastoid groove, the posterior portion of which is covered by two thin and small bones, our *supramastoids* (8′ 8′). From the mastoid groove a cartilaginous or bony tube composed of two pieces, runs downwards into the preopercular. These two tubular pieces we call the *supratympanics* (72, 72′), being the supra temporals of Prof. Owen.

In advance of the mastoid groove, and above the epitympanic, there are two other small tubular and horizontal pieces, our *supralachrymals* (73^a 73^b), of which the *lachrymal* (73), is the direct continuation downwards. The latter forms the posterior edge of the orbit.

The *suborbitals* (73′), are two in number; the posterior one is placed obliquely across the cheek, from the preopercular spine to the orbit, where it meets the lachrymal tube, which passes directly into the anterior suborbital, forming the inferior edge of the orbit. In advance of the latter, and near the centre of the snout, the *turbinal* (19) may be seen, small, irregular, with acute angles. Between the latter and the prefrontal there exists a very small, insignificant *supraorbital* (71).

The *hyoidean arch* is represented in Fig. 5^b. The *stylohyal* (38) is only half ossified; it is slender and elongated, resting upon the epihyal. The *epihyal* (39), is broad, short, and subtriangular, giving points of attachment to two of the branchiostegals. The *ceratohyal* (40), is the largest bone of the hyoidean arch, elongated, narrower at the middle, and broad on both extremities. Four branchiostegals are attached to its lower edge.

The *basihyal* (41) is situated immediately above and in advance of the cerato-hyal; its upper surface is flattened, subtriangular, and even with that of the cerato-hyal. In advance of both the ceratohyal and basihyal, a small subconical *glosso-hyal* (42) may be seen. It does not extend into the tongue, which is not prominent in these fishes, but remains at the base of that organ, rather to indicate a plan of structure than to perform any active function. The thin and flattened *urohyal* (43) is situated between, and extends below, the glossohyal.

The *branchiostegals* (44) are six in number, slender, cylindrical, and curved.

The *branchial arches* (Fig. 5[c]) are situated inwardly and behind the hyoidean arch, with which they are closely connected: their constituent bones we have now to enumerate.

The *basibranchials* (45) are not completely ossified; between the hypobranchials all along the medial line there exists a narrow band of cartilaginous substance, in which we observe small points of ossification, which represent these bones. The *hypobranchials* (46) are entirely ossified; the anterior one is the longest, the fourth, or last, is rudimentary, the second and third are soldered together, forming a flat expansion with two articulating surfaces, for two ceratobranchials. The anterior hypobranchial is flattened in the same manner as the following ones. The *ceratobranchials* (47) are simple, arched, provided on their concavity with small tubercles, on which minute needles may be seen. The respiratory fringes occupy their convexity, which is grooved for the passage of the blood-vessel carrying that fluid into the fringes. The *epibranchials* (48) differ very much in shape; the two anterior ones are elongated, almost straight, whilst the two others assume an irregular trifid appearance. The *pharyngobranchial* (49), irregularly quadrangular, is placed above the epibranchials, giving to the latter their upper point of attachment. The surface of that bone is beset with card-like teeth, though much smaller than those which exist on the jaws. The pharyngobranchial in *C. viscosus* is symmetrical, that of the left side is perfectly separated from that of the right. Besides, we observe here, two others, ovoid, symmetrical pieces (49′) called by some *inferior pharyngeals*, and considered by others as a branchial arch, a cerato-branchial, beset with teeth. We leave to further investigation the decision of this question.

For the *scapular arch* we must return to our Fig. 5[a]. We have already alluded to the peculiar situation of the *suprascapular* (50) which covers the paroccipito-mastoid groove articulating with both the paroccipital and the mastoid above, whilst to its external edge it holds the scapular. The suprascapular is irregularly quad-rangular, provided above with a slender process curved upwards and inwards. The *scapular* (51) is elongated, subtriangular, and thin. The *coracoid* (52) is crescent-shaped, flattened vertically on the middle, and horizontally on both extremities. The upper extremity is considerably overlapped by the scapular, and provided on the inner edge with a slender and acute spine, on which the latter rests. The *epi-coracoid* (58) is attached to the edge behind the union of the scapular and the coracoid. It is a cylindrical, needle-like appendage, which is kept within the thickness of the skin of the thoracic region. It has nearly twice the size represented on the figure. There is no bone in the scapular arch which we can homologize with the humerus unless the so-called epicoracoid should answer for it. Indeed, we cannot help thinking that this styliform, rib-like bone (the epicoracoid) is the humerus itself, which having no part to perform in the plan of structure of Cottoids and others, has lost its primitive shape to assume that of the lowest production of the bony frame, a pleurapophysis, or a dermal spine. The *ulna* (54) above, and *radius* (55) below, having between them the *carpals* (56), three in number, build up a thin osseous band fixed by one edge to the convexity of the coracoid, whilst to the other edge the rays of the pectoral fin, the *metacarpophalangeals* (57), articulate.

The *ventral fins* (Fig. 5^d), are attached to the scapular arch itself, immediately under the head. The *pubic bones* (63) are elongated, subtriangular, in close contact with each other, and penetrating forwards between the coracoids, above the junction of these latter bones. Their central portion is very thin, whilst the edges are stout, the outer one sharply carinated. The rays or *metatarsophalangeals* (70) articulate immediately on the posterior extremity of the pubic bones. The outer one is a hard and unjointed spine, the head of which is lodged in a notch of the pubic bone. The other rays, the true metatarsophalanges, three in number, are soft and jointed.

The vertebral column is composed of thirty-one vertebræ, eleven of which are abdominal, (eight thoracic, three pelvic,) and twenty caudal. There are eleven pairs of ribs attached to the abdominal vertebræ; the pelvic vertebræ, in addition to the ribs, have suspended underneath, a pair of slender rib-shaped bones, very much inclined backwards. The *centra* of the thoracic vertebræ are subcircular, possessing only neurapophyses, which constitute a semi-lunar neural arch, of considerable development (Fig. 5^e β). Some of them may occasionally exhibit minute knobs on the sides, indicating the situation of the parapophyses. The seventh and eighth vertebræ show the first rudiment of hæmapophyses; their neural arch has become narrower and higher. The neural spines (*n s*) are intimately soldered with the neural arches throughout the whole length of the vertebral column.

The anterior pair of ribs is inserted at the basis of the neural arch itself, above the body of the vertebra, with its extremity fixed to the scapular arch by means of ligaments; the following pairs are merely kept within the fleshy walls of the abdomen, whilst their point of attachment to the vertebræ is gradually lower and lower till it takes place on the hæmal process of the pelvic vertebræ, after having passed through all the intermediate steps from the neural arch above. Figs. 30 and 31 exhibit the insertion of the first and last ribs of *Acanthocottus virginianus;* their larger size permits the illustration of this fact better than in the case of *C. viscosus.* The three pelvic vertebræ of *C. viscosus* are represented in Fig. 5^e (δ) in connection with two caudal ones. Under the middle one, and detached from it, is a pelvic appendage, the insertion of which is shown in the case of the tenth vertebra (α) having immediately above it the pair of ribs, the last but one of the series. The neural canal is growing narrow and high, diminishing gradually towards the tail (ε). The neural arch and neural spine (*n s*) become more erect and more slender (compare β with ε). The caudal vertebræ, when seen in profile, appear more compressed than the abdominal ones; this is owing principally to the more erect position of the neural arch, and to the presence of hæmapophyses, building up a hæmal arch terminated by hæmal spines (*h s*), also intimately soldered together. The anterior hæmal arches are very much bent backwards, in the same manner as the anterior neural arches, but they soon become less so. The hæmal canal itself, likewise diminishes backwards. The neural and hæmal spines of the last vertebra but one (γ) are flattened and expanded. The terminal caudal vertebra is reduced to a very small centrum, which seems to be absorbed by caudal plates (n' h'), on the edge of which the rays of the caudal fin (d n') are inserted. The upper edge of n', and the lower of h' exhibit a rudimentary spine, no doubt the first indication of the rudimentary rays of each caudal lobe.

The ribs themselves or pleurapophyses (*pl*) are needle-like, a little curved, and diminish gradually in length backwards.

The interneural spines (*i n*) are variable in form, stouter under the first dorsal fin.

The interhæmal spines (*i h*) are more uniform.

The dermo-neural (*d n*) and dermo-hæmal (*d h*) spines, are all very much alike, the only difference consisting in the spiny or bony nature of those belonging to the first dorsal fin.

§ 3. Comparisons between the Skulls of different Cotti.

Plate III. Fig. 6—21.

The skull of *C. viscosus* (Fig. 6—9) as described above (p. 14) must be recalled to mind in order to understand these comparisons.

The chief difference between *C. viscosus* and *C. Franklinii* (Fig. 10—13) consists in the fronto-orbital arcade which forms nearly a straight line along the declivity of the snout (Fig. 12). Besides, this region is a little shorter than the cranial box itself. The upper surface is likewise depressed, and the depression extends backwards on the occiput, so that the latter region appears more convex in *Cottus Franklinii* (Fig. 13). The cephalic channels of the lateral line are more developed than in *C. viscosus;* the upper view (Fig. 10) exhibits very plainly this difference by the reduced smooth surface in the middle, and the larger holes along the circumference. The acoustic capsule differs also in both of these species. We might even notice a difference in shape in the front of the vomer, which, in all the species, bears a narrow band of teeth.

In *C. Wilsonii* (Fig. 14—17), the fronto-orbital arcade is still lower than in *C. Franklinii,* and passes gradually to the upper surface of the skull without the slightest rising above it. This region again is of the same length as the cranial box itself. The upper surface of the skull is flat and perfectly even; being a little lower near the orbit than on the occiput; it has a slight sloping forwards (Fig. 16). This character will likewise be found on those species the external appearance of whose snout is rather elongated. Seen from behind (Fig. 17) the upper part seems more convex than it is in reality; this apparent convexity being given to it by the mastoid crests.

The front of the vomer is different both from *C. viscosus* and *C. Franklinii.* The acoustic capsules rise also more above the surface of the sphenoid.

Of *C. Richardsonii* (Fig. 18—21) we had only a small specimen to carry out our osteological comparisons. The skull resembles more that of *C. Franklinii* than any other; but the upper view (Fig. 18) shows the difference between the two species. In *C. Richardsonii* the form is subcircular, the width near the orbits being equal to that on the occipital region.

Thus we see that species which zoologically differ from each other most, such as *C. Franklinii* from *C. Richardsonii,* and *C. viscosus* from *C. Wilsonii,* are those in which the skull presents the least difference.

§ 4. Comparative Osteology of Cottus viscosus and Acanthocottus virginianus.

Plate III. Fig. 5—9 and 26—32.

Nothing is more alike than the general plan of arrangement of the bony frame in *C. viscosus* and *A. virginianus.* The differences must be sought for in the special structure of the regions, and in the preponderance of some of the bones, especially in those of the head.

In comparing the skull of *Cottus viscosus* (Fig. 6—9) with that of *Acanthocottus virginianus* (Fig. 26—29), the most striking difference is found to consist in the fronto-orbital arcade, which is much broader in the latter (Fig. 26) than in the former (Fig. 6). The snout is likewise more developed in Acanthocottus, the nasals occupying the whole space between the external projection of the prefrontals and the vomer. The turbinals in Acanthocottus are ossified, quadrifid, intimately connected with the prefrontals and nasals, and surmounted with a stout spine. The nasal spines themselves are partly concealed by the turbinals. The orbital rim rises above the middle smooth region of the arcade. A small spine directed backwards and outwards exists on the postfrontal, whence a ridge extends along the upper surface of the skull, to the supraoccipital, where a similar spine is seen. Thus the upper surface of the cranial box of Acanthocottus differs from that of Cottus by the presence of spines and ridges. The frontal region, however, is flat and smooth. The skull in Acanthocottus is proportionally more elongated; the orbito-frontal arcade and the snout together, much longer than the cranial box. The latter is also proportionally narrower near the orbits than on the occipital region. In height, the proportions do not differ much.

The vomer in Acanthocottus is provided along the medial line of its upper surface with a sharp carina extending to the whole length of that bone. Anteriorly there exists a pair of nearly vertical and approximated processes, behind which, and more apart, another pair is seen obliquely inclined backwards and outwards.

On the sides of the head there is the same number of bones, occupying the same relative position. As to their shape or form, some vary but very slightly, whilst others assume a quite different character. Thus the preopercular is provided with a very much elongated spine, stouter than the body of the bone itself. Immediately underneath, there is a second small but stout spine; both are directed backwards. The lower and anterior extremity of the preopercular is terminated by an acute spine. The upper angle of the opercular terminates by a stout spine similar to that of the preopercular, although less powerful. The subopercular is provided with a slender and acute spine, directed upwards along the anterior edge of the opercular. Finally, the posterior extremity of the interopercular is very acute.

On the other hand, the suborbitals do not present any striking difference. The upper branch of the dentary is a little shorter than the lower one; the mucous channel of this bone is quite prominent. The horizontal branch of the premaxillary is a little longer than the vertical one. The hypotympanic is provided along its lower edge with a stout, acute and slightly curved spine, grooved underneath for the reception of the lower branch of the preopercular. The mesotympanic is entirely ossified, lying nearly horizontally above the hypotympanic spine.

The scapular arch and pectoral fins are similarly constructed in Cottus and Acanthocottus.

The position of the ventral fins is identical. The pubic bones alone differ somewhat in shape, being almost three-winged in Acanthocottus.

The vertebral column of *A. virginianus* is composed of thirty-six vertebræ, five more than in *C. viscosus*. Of this number twelve are abdominal, nine thoracic, and three pelvic, each bearing a pair of ribs; the pelvic vertebræ being provided as in *C. viscosus* with styliform pelvic bones directed obliquely backwards, the extremities of which are fixed to the hæmapophysal arch of the caudal vertebræ by means of ligaments. The caudal vertebræ are twenty-four in number, four more than in *C. viscosus*. The structure of the vertebræ themselves is very similar. In the first place the insertion of the ribs takes place in the same way, the anterior pair on the neural arch (Fig. 30), the posterior ones on the hæmal arch (Fig. 31), whilst the intermediate pairs are attached on the body itself of the vertebræ, at different heights. The pelvic appendages are not represented on Fig. 31; their position is the same as in *C. viscosus* (Fig. 5^d—α), immediately under the ribs. The sole difference is, that in *A. virginianus* the pelvic vertebræ have a complete hæmal arch, so that all the pelvic bones are inserted on it, whilst in *C. viscosus* the first pair is nearer the centrum, the hæmal arch of the ninth vertebræ being incomplete. Fig. 30 exhibits rudiments of parapophyses. A caudal vertebra is represented in Fig. 32, in order to show the neural canal somewhat different from that of *C. viscosus*. The neural arch and spine are more erect (Fig. 30), and the neural canal higher than broad; whilst in the caudal vertebræ (Fig. 32), this is broader than high, exactly the reverse of its structure in *C. viscosus*.

§ 5. The bony frame of Triglopsis Thompsonii.

Plate II. Fig. 11; and Plate III. Fig. 22—25.

The external delicate appearance of our fish is a direct reflex of its internal frame, which is composed of pieces of an extreme delicacy.

With reference to the general figure of the skeleton (Plate II., Fig. 11), we ought to make the remark that the two posterior rays of the second dorsal have been omitted in the engraving, and thus it is not sufficiently near to the base of the caudal. The interhæmal spines are represented a little too much inclined, so that, while the anterior edge of the anal fin is correctly situated, the anterior interhæmal spine ought to abut against the first caudal vertebra, thus three vertebræ more backwards, instead of seeming apparently connected with the three pairs of pelvic appendages, the extremities of which alone should abut against the anterior interhæmal, leaving the latter behind them. The insertion of the ribs is more correct than in *C. viscosus*, although the anterior pair should come higher and reach the neural arch. The fins have been cut off from want of space.

The skull (Plate III, Fig. 22—25) exhibits that remarkable feature in the structure of the genus Triglopsis which reminds us of Sciænoids, and consists in the presence on the upper surface (Fig. 22), and on the face, of large mucus holes, communicating directly with the lateral line. The general form of the cranial box is elliptical, the upper surface smooth in the middle, flat, slightly dipping in front. On both sides the mucus channel is open from the paroccipitals to the post-frontals, into which it passes, until it meets its fellow of the other side, and takes with it a parallel course through the fronto-orbital arcade to the snout. In fact, that arcade is entirely transformed into a double channel whose walls are extremly thin and semi-transparent. The turbinals are in their respective place on Fig. 22; the nasals are not very conspicuous, and are covered in this case by the turbinals, which occupy exactly the same position as in Acanthocottus (Fig. 26), where the turbinals are also united to the upper part of the snout. The cranial box itself is so thin as to shrink in drying when all soft parts, internal and external, are removed. The lower surface (Fig. 23) is very smooth; the acoustic capsules are proportionally large, although not very conspicuous on the figure, as they had shrunk since they were prepared for the purpose of being drawn. In the profile view (Fig. 24) the proportional length of the cranial box and the orbito-frontal arcade is very obvious; the former being shorter and less elevated near the orbit than on the occipital region.

A character belonging to the *vomer* (12) and which may vanish away during the preparative process of the skull, is represented on Plate II, amongst the movable bones of the head. This consists in the presence on the anterior and median line of that bone, of a narrow elliptical band of teeth similar to those which exist on the front of the same bone.

The *premaxillary* (22) has the general appearance of an open triangle; its ascending branch is shorter than the horizontal one; and terminates in a point, behind which there is a flat and much shorter process. The horizontal branch is likewise expanded, although the very tip terminates in an acute angle. The *maxillary* (21) is an elongated and curved bone, narrow on its middle, provided in front with a trifid articulating head, whilst its posterior extremity is flattened, truncated, and movable into the membrane which forms the angle of the mouth.

The *palatine* (20) is provided posteriorly with a needle-like spine which extends backwards in contiguity with the styliform pterygoids. The *entopterygoid* (23) is blade-shaped and has the transparency of the thinnest membrane. The *pterygoid*

(24) is pointed forwards and triangular posteriorly. The *dentary* (32) is remarkable for its broad lower branch entirely hollow; the upper branch which bears the teeth is scarcely more compact, and a little shorter. The teeth themselves are exceedingly small and slender. The *articular* (29) participates in the broadness of the dentary, is hollow like the latter, and provided with two spiny processes. The *angular* (30) is a small scaly bone of little importance. The *splenial* has escaped our notice; whether removed in preparing the skeleton, or entirely wanting, we are not prepared to tell. To judge of it from its appearance in *C. viscosus*, it would play no important part in the structure of this region. The *hypotympanic* (28) is bifid on its posterior angle, and provided with a comparatively stout lower branch. The *pretympanic* (27) and *mesotympanic* (26), which fill up the space between the concavity of the preopercular behind, the hypotympanic underneath, the pterygoids in front, and the epitympanic above, are almost membranous. Their shape on the figure is rather ideal, as they had shrunk a few hours after preparation, so as to become shapeless. The *epitympanic* (25) is everywhere so characteristic as not to be mistaken. It is provided with similar articulating heads or processes as in *C. viscosus*, and connected with the same bones.

The *preopercular* (34) constitutes one of the characteristic features of this genus. Its shape is as usual, crescentic; a broad channel passes through its centre, and the posterior edge, or else the convexity of the crescent is furnished with four spines or rather four acute processes, thinner, if possible, than the body of the bone itself. The two superior spines are directed obliquely upwards, the uppermost is the largest; the two inferior ones, very minute, are directed downwards. The *opercular* (35) is comparatively small, semi-membranous, uniform, and spineless. The *subopercular* (36) and *interopercular* (37) are likewise semi-membranous, very small and uniform; their shape is accurately figured.

The lateral line in *T. Thompsonii* (Fig. 11, *l l*) acquires a very great development. When the skin is removed it appears like a uniform tube, cartilaginous in its structure, exhibiting along the exposed sides, a series of very large holes, which correspond to the external pores of the skin. It can be separated from the lateral muscle in an unbroken chain (*l. l.*) from the tip of the caudal, where it terminates, to the mastoid groove, where it is attached. Here it passes into the head and from the mastoid groove a transversal supraoccipital canal establishes the first communication between the right and left. The suprascapular forms an arch or bridge under which the lateral line proceeds forwards. When in front of the suprascapular the channel is covered by the scale-shaped *supramastoid* (8′). A more considerable branch runs into the preopercular, passing through the *supratympanic*, a tubuliform bone, which was not preserved on the specimens at our command. From the preopercular, the channel passes into the articular, and thence into the lower jaw, or dentary. In advance of the supratympanic tube, and horizontally, we have the *supralachrymals*. The *lachrymal* (73) which limits the posterior edge of the orbit is soldered to the posterior *suborbital* (73′) thus forming a channel which from the supralachrymal tubes, passes under the eye and into the *turbinal* (19) situated above the snout. From the supralachrymal tube an upper branch of the channel passes into the postfrontals towards the orbito-frontal arcade, and through the latter into the nasal cavity, thus meeting the suborbital branch on the snout. The *supraorbital* we were at a loss to find.

The hyoidean apparatus is composed of the usual bones. The small *stylohyal* (38) is nearly straight; the *epihyal* (39) subtriangular, bearing two branchiostegals. The *ceratohyal* (40) is the longest, and attached to it are the four remaining branchiostegals. The *basihyal* and *glossohyal* are seen, one in front, the other above the anterior extremity of the ceratohyal. The *urohyal* (43) is provided with an elongated membranous appendage underneath. The *branchiostegals* (44) are cylindrical and slightly curved.

In the branchial arches, the small *basibranchials* (45) are scarcely to be distinguished, this series of bones forming a cartilaginous band in the midst of which minute surfaces of ossification alone are discernible. The *hypobranchials* (46) are independent from each other, short, thin, and flattened, varying somewhat in shape. The *ceratobranchials* (47) are very slender, slightly convex, provided on both sides and inwardly with little tubercles beset with extremely minute teeth. The *epibranchials* (48) are the most variable of all the bones constituting an homonyme series. The *pharyngobranchial* (49) is subquadrangular, the entire exposed surface of which is covered with minute teeth. The *inferior pharyngobranchials* (49′) are elliptical and beset with teeth similar to those of the pharyngobranchials.

The *suprascapular* (50) is as usual, situated above the paroccipito-mastoid groove; but its centre is hollow. The *scapular* (51) is subtriangular, thin and flat. The *coracoid* (52) is likewise very thin, flattened upon different planes, and crescentic. The *epicoracoid* (58) is styliform and a little longer than represented on the figure. The *ulna* (54), the *radius* (55), and the *carpals* (56), are altogether in a cartilaginous state. The ulna and radius are contiguous and form a band along the coracoid, thus preventing the carpals from coming into contact with the latter. The carpals themselves are surrounded by a thin semi-membranous edge, on which the *metacarpophalangeals* (57) articulate.

The ventral fins are connected with the lower part of the scapular arch. The *pubic bones* (63) are subtriangular, furnishing posteriorly a point of attachment to the *metatarsophalangeals* (70). The external and shorter one is bony and unjointed, whilst the three remaining ones are soft and jointed.

The vertebral column is composed of thirty-nine vertebræ, twelve of which belong to the abdominal region, and twenty-seven to the caudal. Accordingly, there are twelve pairs of ribs corresponding to the twelve abdominal vertebræ, three of them being provided with pelvic appendages. The centrum is circular; the vertical diameter of the middle of the body of the vertebræ, however, is greater than the transverse. The neurapophyses and hæmapophyses generally are quite uniform, slender, and little prominent. The neural spines (*n s*) are scarcely apparent on the anterior thoracic vertebræ (1, 2). The same enlarged figures exhibit the peculiar shape of the neural arch seen from behind (1) and in profile (2), together with the insertion of the ribs (*pl*). The numbers 1 to 12 appended to the vertebræ do not indicate their rank in the series. Numbers 3 to 12 are of natural size, and were intended to illustrate their special structure all along the column; but the figures are altogether too small. Numbers 1, 2 and 3 belong to the thoracic region. The enlarged one (1, 2) is the sixth; whilst number 3 is the second. The numbers 4, 5 and 6, are pelvic vertebræ; and 7 to 12 belong to the caudal region.

The first pelvic vertebra (4) shows the first traces of hæmapophyses; the second and third (5, 6) have a complete hæmal arch on the base of which the pelvic appendages (4) are inserted. The hæmal arches of the caudal vertebræ, as well as the hæmal spines (*h s*) are but little developed. The hæmal spines are soldered with the arches. The neural and hæmal arches and spines are flattened near the tail. The caudal plates (*n' h'*) of the last vertebra (12) are subtriangular and elongated; the uppermost lined with a few rudimentary rays.

The ribs or pleurapophyses (*pl*) are slender, flexible, elongated, and curved, needle-shaped spines. The anterior pair is fastened to the scapular arch.

The interneural and interhæmal spines are uniform, elongated and slender, differing scarcely from the ribs themselves.

§ 6. Triglopsis Thompsonii compared with Cottus viscosus, and with Acanthocottus virginianus.

The plan of structure of the bony frame of the three genera of Cottoids which we have had an opportunity of examining, is identical in its main features.

The general form of the skull of *T. Thompsonii* resembles more that of *A. virginianus* than that of *C. viscosus* or any other species of Cottus. The chief difference consists in the absence of spines, and in this respect *T. Thompsonii* comes nearer to *C. viscosus* than to *A. virginianus*. The turbinals in the latter are strong and spiny, whilst in the two others these same bones are weak, thin, scaly and deprived of spines. The cephalic channels of the lateral line are identical in the three genera, but reaches its maximum of development in Triglopsis, whilst it is much less apparent in Cottus and Acanthocottus. The suborbital series is the same in the whole group, only a little modified in the shape of its constitutive pieces and their degree of union. The hyoidean and branchial arches are identical. The opercular apparatus assumes differences by which the genera may be distinguished. In *T. Thompsonii* the preopercular is provided with four needle-like spines, short and flexible. *C. viscosus* has only one well-developed spine, whilst in *A. virginianus* besides the stout spines of the preopercular, we see the opercular, the subopercular, the interopercular, and the hypotympanic, provided with similar spines; the mesotympanic and pretympanic are also more compact, and better defined in the latter species.

The scapular arch has the same general structure; but in *A. virginianus* the angles of the suprascapular and scapular are more acute and spine like; in *T. Thompsonii* the ulna and radius coalesce, thus establishing a separation between these bones and the coracoid.

The ventral fins in the three genera have the same position under the head and the same connection with the scapular arch. The pubic bones articulate together into a triangular piece which penetrates forwards above the union of the coracoids. There exists in all, an external and unjointed ray with three or four jointed ones.

The number of the vertebræ varies in the different genera according to the length of their body. That number even varies amongst the different species of the same genus. But the centrum of the vertebræ themselves is very much alike in all Cottoids. The axis of each vertebra is provided with a minute hole, thus establishing a direct communication through the centre of the vertebral column, from the occiput to the tail. The shape of the neural canal is subjected to some variation, according to the greater or less development of the neural arches and neural spines.

The ribs, or pleurapophyses are identical in form, structure and position in *T. Thompsonii*, *C. viscosus*, and *A. virginianus*. Their absolute number may vary according to similar variations in the number of abdominal vertebræ. As far as our investigations go, we found constantly three pelvic vertebræ, calling by that name such vertebræ as are provided underneath the ribs with rib-shaped, or styliform bones, of which there are constantly three pairs, bent backwards and kept within the muscular wall of the pelvis. In the figures of *C. viscosus* and *T. Thompsonii*, they are represented hanging down, in order to render them more conspicuous. The caudal vertebræ, again, are liable to some variation in number.

The interneural, and interhæmal spines, as well as the dermo-neural and dermohæmal ones, present the greatest similarity in the whole group.

§ 7. The encephala of Cottus viscosus, C. gracilis, C. gobioides, Triglopsis Thompsonii, Acanthocottus virginianus, and A. variabilis, compared.

Plate III. Fig. 33—48. (Figs. 36—45 are represented twice natural size.)

In the genus Cottus the brain or encephalon fills up the whole cavity of the skull, the upper roof of which is almost in contact with the upper surface of the encephalon, which can be seen through the frontal bones, as soon as the skin is removed. The layer of cellular fat is consequently very thin, as the space itself is exceedingly reduced.

In the genus Acanthocottus, the cavity of the skull would contain a brain twice as large. The space all around, is occupied by cellular fat filling up completely the entire cavity. When the upper roof of the skull is cut off the encephalon is not exposed unless that fat is removed.

In the genus Triglopsis, we have an intermediate stage; the cavity of the skull is still larger than the bulk of the encephalon and the remaining space filled by a similar fat.

If we were to establish a series, we would not hesitate in placing Acanthocottus below, next Triglopsis, and Cottus above.

But let us now glance at the brains themselves, and see how far they can be available in comparative zoology.

The different regions of the encephalon are closely grouped together. There exist no rhinencephalic crura carrying off the rhinencephala or olfactory lobes at a certain distance from the prosencephala. The rhinencephalic lobes are brought into close contact with the prosencephala, sometimes partly overlapped by the latter (in *Cottus viscosus, gracilis,* and *Acanthocottus variabilis*) and sometimes entirely exposed (in *Cottus gobioides,* and *A. virginianus*). The proportional development of the prosencephalon and mesencephalon varies in both Cottus and Acanthocottus; the former, always larger than the latter, acquires a greater proportion in *C. viscosus* and *gracilis* than in *C. gobioides,* and in *A. variabilis* than in *A. virginianus.*

Thus, so far, we have no generic difference in the encephala of Cottus and Acanthocottus. Indeed we have not investigated in that respect the whole range of species, and perhaps characters will hereafter be detected.

The encephalon of Triglopsis is more characteristic; its longitudinal axis is proportionally greater than in both Cottus and Acanthocottus, a character which we might have anticipated in comparing the structure of the skull and the external appearance of the head.

The most interesting result which we have derived from the study of the brains of Cotti is the fact that differences are found between the species which we had established, guided chiefly by zoological characters, sometimes most minute.

If we compare the encephalon of *C. viscosus* (Fig. 43—45) with that of *C. gracilis* (Fig. 39—41) we find a cerebellum of nearly the same size and form; but the mesencephalic or optic lobes are oblong in the former, and circular in the latter. The prosencephala differ most: irregularly triangular in shape in both species, their surface in *C. viscosus,* is raised into three nearly equal hillocks, one at each corner. In *C. gracilis* we perceive only one tubercle-like elevation, situated at the outer and posterior angle, whilst the inner edge of the prosencephalon forms a uniform, longitudinal ridge, the posterior extremity rather projecting beyond and between the mesencephala.

The rhinencephala in both species are partly covered by the prosencephala, and a little more so in *C. viscosus* than in *C. gracilis.* The medial line of separation between these two lobes is rather indistinct on the figure of *C. viscosus* (Fig. 43). The hypoaria in both species do not differ much, but the hypophysis in *C. viscosus* is smaller, circular and quite distant from the hypoaria and hæmatosac, whilst in *C. gracilis* the hypophysis is oblong, partly incased between the hypoaria and close to the hæmatosac.

Behind and between the hypoaria there exists an odd, very small lobe, a little more conspicuous in *C. viscosus* than in *C. gracilis.* That lobe does not exist in the two species of Acanthocotti figured on our plate, whilst in Triglopsis it acquires a development greater than the hypoaria themselves.

In *Cottus gobioides* (Fig. 42) the prosencephalon is irregularly quadrangular, very uniform above and proportionally smaller than in the two preceding species. The mesencephalon is oblong as in *C. viscosus,* and the cerebellum circular, more like that of *C. gracilis.* The rhinencephalic lobes are not completely exposed in advance of the prosencephala. In its general feature it resembles more *A. variabilis* (Fig. 46) than either of the true Cotti. The want of materials, and especially of recent specimens, has prevented our making a more complete study of it as well as of our giving a better illustration.

The difference between the encephala of *A. variabilis* (Fig. 46—48) and *A. virginianus* (Fig. 33—35) are so obvious that they need scarcely to be pointed out. As usual, the cerebellum varies but little. The mesencephalon is elliptic in the former and ovoid in the latter. The prosencephalon of *A. variabilis* is uniform above, whilst in a *A. virginianus* it assumes a character similar to that of *C. viscosus* with this difference, that the posterior and inner hilly protuberance acquires a much greater development, and seems to absorb the two others. In advance of the prosencephala the pyriform rhinencephalic lobes are seen completely exposed and free. The same lobes are in close contact and slightly overlapped in *A. variabilis.* The hypophysis in *A. virginianus,* is exceedingly small compared to its size in *A. variabilis,* where it is greater than the hypoaria, on which it encroaches considerably. It is regularly oblong shaped.

The encephalon of *T. Thompsonii* may readily be distinguished from that of either Cotti or Acanthocotti. The epencephalon exhibits a more prominent swelling on the sides of the medulla oblongata. The cerebellum and mesencephala are subcircular, the latter resembling most those in *C. gracilis.* The prosencephalon is proportionally much more developed than either in Cotti or Acanthocotti, and appears also more separated from the mesencephalon. At the inner and posterior edge, a circular swelling exists, looking like a smaller pair of lobes superadded on that region. The rhinencephalon is so much overlapped that it is only apparent in the view from underneath (Fig. 37). The hypophysis is of medium size, situated in advance of the mesencephalic lobes. The hypoaria seem rather secondary in importance; they are absorbed by the development of a medial lobe faintly indicated in *C. viscosus* and *gracilis,* behind and below the hypoaria. In *T. Thompsonii* the medial lobe is larger than the hypoaria themselves, which are partly covered by it. The hæmatosac is seen above, overlying the anterior portion of the medial lobe. Immediately in advance of the hæmatosac, on the hypoarian floor, a small spherical swelling is slightly indicated, and surrounded in front by a ridge delineating the anterior limit of this floor.

Without having contemplated the comparative study of the cephalic nerves in this memoir, we have allowed them to be represented in the case of *A. variabilis* (Figs. 46—48), in which we had a fair chance to observe them. This may be interesting to anatomists, who might wish to compare their development and distribution with that of other groups.

§ 8. The muscular system of Cottus viscosus.

Plate III. Fig. 1—4.

It has been shown by recent labors that the fleshy mass which extends from head to tail, all along the sides of the body of fishes, does not constitute a single muscle (the so-called *lateral muscle*), but is actually composed of a series of vertical muscles, the vertical flakes or segments, which correspond generally in number to that of the vertebræ. These flakes or segments (*myocomma*), extending from the dorsal line down to the ventral line, are characterized by inflexions or curves, forming sometimes gentle undulations and sometimes angles more or less acute.

Now these angles, these curves, delineate organic regions in the body, and, having satisfied ourselves that a wide field of inquiries and philosophical deductions is connected with the morphology of the muscular system, we did not hesitate in giving figures of the general appearance of the fleshy parts in a species of the genus Cottus. If, instead of reproducing over and over the same figure, anatomists had given us each time another, we would possess now very important data for the understanding of the muscular masses, not only in the class of fishes but also in vertebrata generally. Fishes, reptiles, birds, and mammals being constructed upon the same plan, there is a morphology to be traced throughout those four classes; and, besides, each class has to be thoroughly investigated in this respect.

As we are not prepared, on account of the scarcity of materials, to say anything general on the class of fishes, and as it is not within the limits of this work to enter into such inquiries, we shall limit ourselves to a mere sketch of our views.

In *C. viscosus* (Plate III. Fig. 3), the muscular flakes of both sides are seen to meet along the back under the shape of an acute angle directed backwards, indicating the *dorsal line.* The *region of the back* is indicated by another bending of the flakes forwards. The next curve, the convexity of which is directed backwards, takes place on the line of separation of the back and abdominal region (Fig. 1). The *abdominal region* itself is marked by a very open curve, convex forwards, extending down till another smaller curve appears, separating the abdominal from the *ventral region* on which the flakes gently undulate (Fig. 2).

On the tail, or *caudal region,* the bending of the flakes is more uniform than on the trunk; but the tail, it must be remembered, is a mere appendage, although an organic region too. This region is always much developed in osseous fishes as well as in many cartilaginous, continuing the trunk backwards. In some cartilaginous fishes, it is very slender and filiform. In some reptiles it vanishes completely; in birds it is most diminished, and in many mammals it reappears under a very disproportionate shape, whilst in others it again loses its importance. The muscular system of that region is accordingly liable to corresponding variations.

The morphology of the caudal region constitutes no serial law, whilst the morphology of the muscular flakes, along the trunk in fishes and the localization of the muscular masses in the other classes of vertebrata, will illustrate an organic gradation.

The fins and rays are put into motion by sets of muscles independent of the flakes, the description of which cannot find any place here. We would only glance at the branchiostegal apparatus (Plate III. Fig. 4), the rays of which are distended or retracted by transversal, thin muscular bands, attached above at the inner surface of the opercular, uniting below with the transversal fibres of the isthmus. Fig. 2 also exhibits the general outline of the glosso-hyoidean muscle, much developed in Cottoids.

Between the skin and the flakes there exists a thin layer of muscular fibres, the muscles of the skin. In *C. viscosus* they cover completely the flakes all along the region of the back, the fibres running from one side to the other in passing uninterrupted between the rays of the dorsal fins. The same is observed on the lower part of the tail from the anus to the caudal fin. On the abdomen and belly the layer is so thin that the flakes are exposed as soon as the skin is removed.

§ 9. The skin and the lateral line in Cottoids.

The skin in Cottoids is generally scaleless, and, in most cases, smooth. The Hemilepidoti of the marine tribe constitute the single exception, and even here they exist merely in bands or patches scattered over the body. The fresh-water species, however, are absolutely scaleless.

In several Cotti, the skin on the thoracic region is beset with very minute asperities, perceptible only to the touch when the finger is passed from behind forwards.

On examining under the microscope the skin overlying the head of Cotti, we observe in its thickness small irregular star-like ossifications which are more developed in Acanthocotti so as to become sensible both to the touch and naked eye. In Triglopsis, the skin does not, even under the microscope, exhibit anything in its muscular texture; whilst in Cottopsis its whole surface is prickly from head to tail. There can be no doubt that those prickles are the same parts which we observe on the thoracic region of Cotti, only in Cottopsis they assume their maximum of development. Not having the opportunity of examining their structure in Cottopsis, we cannot venture any opinion as to their signification; whether the homologues of true scales or a production of the skin peculiar to fishes unprotected with scales.

The lateral line in Cottoids has a very remarkable structure, which could hardly have been suspected had the discovery of the genus Triglopsis not been made. Its beauty and development in the latter is such as to leave no doubt that it forms a regular, cartilaginous tube, with a series of quite large openings outwards (Plate II, Fig. 11, *l l*) communicating through a corresponding series of pores of the skin, with the surrounding medium. The removal of the skin exposes this tube, which still adheres to the sides by the layer of dermic muscles; after this layer is removed, the cartilaginous tube may be detached from the tail forwards, where it is seen to be united with the head. It passes through a channel of the occipital bones, sending down a branch along the preopercular, into the lower jaw. Proceeding forwards it branches off again in advance of the orbit, one branch running along the upper edge of that cavity into the nostrils, the other following its lower edge through the chain of suborbital bones into the nostrils also.

That the lateral line in Triglopsis is intended to supply water to the system, there can be no doubt; and as little, that it answers the same end in other fishes. Its structure may be diversified according to the natural groups; this constitutes its morphology; but its philosophic meaning is the same throughout the whole range of the class.

§ 10. The alimentary canal, urinary bladder, and ovaries, in Cottoids.

Knowing the animal diet of Cottoids, we may expect a narrow and short alimentary canal. Its entire length from the pylorus to its posterior opening does not exceed the length of the trunk, the head and caudal fin excluded.

On exposing the splanchnic organs by the removal of the walls of the abdominal cavity, from below, the liver is seen occupying the anterior and left portion of that cavity, covering completely the stomach, whilst the right portion is occupied by the winding of the intestine. Posteriorly are the ovaries, a right and a left, which when containing eggs fill up the cavity in that region, leaving a narrow passage to the intestine along the medial line of the belly.

In *Cottus viscosus* the general form of the stomach is subcircular, or rather elliptical. The cardia is proportionally prominent and directed forwards, at the termination of which, and around the pylorus, are four elongated, pyloric, nearly equal appendages. Here the intestine runs backwards, then forwards again, and finally takes a straight course towards the vent, thus bending twice upon itself. Its anterior half is much broader than the posterior one.

In *Acanthocottus virginianus* and *Triglopsis Thompsonii* it differs but little; the pyloric appendages of Acanthocottus are proportionally much shorter and thicker, and variable in length.

In Triglopsis these appendages are seven in number, six developed ones nearly equal in size, intermediate in length between those of Cottus and Acanthocottus, and a rudimentary one. The pyloric appendages present some variations which make scattered observations very uncertain when used in the characterization of the groups.

The urinary bladder is very thin, pyriform, or elongated, situated above the ovaries. Cottoids have no air bladder.

The kidneys are so close together that they seem to constitute a single organ, slender and elongated in shape; they extend nearly to the two-thirds of the abdominal cavity adhering to the vertebral column.

The ovaries are pouch-like bodies, having a common duct. Sometimes after the spawning season, when they are reduced to their smallest size, they appear then under the shape of two elongated and cylindrical processes, differing only from the urinary bladder, by the thickness of their walls. When expanded by the development of the eggs, the walls become so thin and transparent that their contents may easily be seen. In this state these organs are elliptical.

At the upper wall of the ovarian sac there exist membranous folds in which the eggs are developed; the lower wall remains free from any such folds. When the eggs are mature, and ready to leave the body, they separate from these folds; but instead of dropping into the abdominal cavity, as is the case with many fishes, they are kept in the ovarian pouch, which leads into the single oviduct, whose opening is placed behind the vent.

The eggs themselves are very large compared to the size of the fish.

The spermaries are very slender, much elongated, extending from the œsophagus to the posterior part of the abdominal cavity. They not only differ from ovaries by their shape, but also by their color, which is generally deep brown, contrasting with the yellowish appearance of the ovaries.

§ 11. Respiratory apparatus.

This apparatus is composed of four branchial bony arches provided upon their convexity, with respiratory fringes in full activity. A fifth rudimentary row of fringes may be seen within the thickness of the membrane lining the inner wall of the opercular; but these fringes are not free and take no part in the aerification of the nutrient fluid. On each side, and internal to the fringes, there is along the concavity of the arches, a row of tubercles covered with minute card-like teeth, perhaps only needle-like asperities, for they are not inserted on the tuberculous bone, but belong to the overlying membrane, to which they adhere when the latter is removed. The inner arch possesses only one row of these tubercles, being united to the hyoidean apparatus by a membrane which leaves to the arch but little motion.

CHAPTER III.

ON THE GENUS COTTUS, Artedi.

§ 1. ZOOLOGICAL CHARACTERS.

RESTRICTED within the limits which we have assigned to it,[1] the genus Cottus still comprehends a considerable number of species which, although apparently cast in the same mould, are nevertheless distinct, as will, we hope, appear from their descriptions and figures.

The characters of the genus consist in the presence on the preopercular of one spine only, which is situated at the posterior angle of that bone, and is curved upwards and backwards. Sometimes a much smaller spine is to be found beneath, and in one instance there is a third one of the same size as the second, directed downwards. The inferior edge of the subopercular is also provided with a similar minute spine, having its point directed forwards, and generally completely concealed under the skin and muscles. The head consequently has a smooth appearance which contrasts singularly with the spiny head of Acanthocotti, or marine Cotti of authors. The mouth is but little cleft, and its angles seldom extend beyond the anterior rim of the orbit. The lips which line the jaws are capable of more or less expansion along the branches of the jaws, and at the angle of the mouth. The premaxillaries, the dentaries and the vomer, are the only bones provided with truly characterized, although very small, card-like teeth. In their immature state some species exhibit teeth-like asperities on the palatines. This occurs chiefly amongst those having four jointed rays to the ventrals: in *C. Wilsonii*, *C. Bairdii*, and *C. meridionalis*. *C. gracilis* is the only one of the division with three jointed rays, where similar asperities have been noticed. This character of palatine teeth, which is merely shadowed in the genus Cottus, acquires a full development in other genera, thus constituting a permanent feature and assuming an actual signification.

The eyes are situated near the summit of the head, more or less approximated on the frontal line. There are constantly two nasal openings; a tubular one, placed along the space comprised between the anterior border of the eye and the extremity of the snout; the other is even with the surface of the skin and situated backwards, behind and above the former and very close to the orbit. The latter opening has been but recently discovered, having generally been overlooked on

[1] Proc. Bost. Soc. Nat. History, iii. 1851, p. 183.

account of its minuteness. In Acanthocotti, however, it is quite large and easily distinguishable.

The body is smooth and deprived of scales; it is more or less viscous or slimy, as all fishes generally are. It diminishes gradually in thickness and in height from the head towards the tail. The back is almost straight or slightly arched. The lateral line exhibits in its structure a peculiarity which seems to belong chiefly, if not exclusively, to all the American species. The subcutaneous cartilages disappear on the last fourth of the line, whence it is continued to the base of the caudal fin by a series of minute pores, subjected to a sudden fall on the peduncle of the tail. This character had already struck Mr. Heckel, who makes of it the distinguishing mark of his *C. gracilis*, the only American species of which he saw specimens.

Another character, more or less general, making a distinction between the species of the two hemispheres, is the fact that the rays of the fins have a tendency to be more bifurcated in the species of the old hemisphere than in those of the new. As far as the rays of the pectoral fins are concerned, we know only one American species, the *C. Wilsonii*, in which the upper ones are subdivided. Except in *C. Richardsonii*, where we have noticed some rays of the centre of the second dorsal as showing a slight bifurcation at their summit, we are not aware of any other fin where that character of the bifurcation of the rays exists, except in the rays of the caudal fin generally, although in a less degree than among the European species.

The first dorsal fin is always lower than the second; sometimes continuous with the latter by a membrane, sometimes completely separated by a short interval. The length of the pectorals varies according to the species; their inferior rays are shorter and thicker than the upper ones, and their tips extend beyond the membrane which unites them, giving to the lower edge of the fin a scalloped appearance.

There is, in the structure of the ventral fins, a peculiarity worthy of notice, and which will undoubtedly have a great weight upon the question of the validity of the species in this genus. In some there are four soft and articulated rays, whilst others have but three, all of them possessing the anterior short and spiny ray, closely connected with the first soft one and hidden in the thickness of the skin. Now the European species, mentioned by Mr. Heckel, are all provided with four soft rays to the ventrals, and this also must have struck him as an interesting fact, since the presence of three soft rays constitutes the second character by which he distinguishes his *C. gracilis* from all others. The study of the American species has taught us that this character had more than a specific value; and, in consulting the various documents respecting the history of European species, we became satisfied that the same was the case with regard to these latter. Some may suppose this character to be sexual, but we are convinced that it is not the case, having had this question before us from the very commencement of our investigations. Having had series of individuals, young and adult, of most of the species, we always found it constant. Six species have four soft rays: *C. cognatus*, of Great Bear Lake; *C. Richardsonii*, of the northern shore of Lake Superior; *C. Alvordii*, of Lake Huron; *C. Bairdii*, of the north-western tributaries of the Ohio; *C. Wilsonii*, of the south-eastern tributaries of the same river; and *C. meridionalis*, from James River (Va.). Now, if we have to deal with a sexual character, we ought at least to find both sexes in the same hydrographical basin. But, along the southern and eastern shores of Lake Superior, we find the *C. Franklinii*, which inhabits the same basin as *C. Richardsonii*, and, even if both of these species were provided with the same number of rays to the ventrals, nobody would ever think of uniting them in one, so much do they differ in other respects.

If we take up the species with three soft rays only to the ventrals, we witness similar phenomena. Without speaking of *C. Fabricii*, which we have not had under actual examination, we find, in the same latitude, *C. gobioides* in the waters running west of the Green Mountains, and *C. boleoides* east of the same orographic range. Should the streams in which they live have a direct communication, a zoologist could not reasonably identify them. Finally, *C. viscosus* which inhabits eastern Pennsylvania, and *C. gracilis*, Connecticut, New York and Massachusetts, are widely distinct. The two species which resemble each other most, *C. viscosus* and *C. Franklinii*, are geographically the most remote.

It is not improbable that some one may hereafter propose to unite in a separate genus the species provided with four soft rays to the ventrals. Our impression, however, is, that such a generic subdivision would be useless, inasmuch as it would interrupt the philosophic idea to which we have been led by our investigations. Indeed, a genus, in our mind, is a group varying, it is true, as to the number of species which it may contain, but having, at the same time, a physical and a metaphysical signification. A genus involves a progressive idea whose realization is materially carried out in the species. Now we are at loss to find what progress is involved in the fact that some species have one ray more or less to the ventral fins. These two facts are cotemporaneous, and their value is entirely in the discrimination of the species, and, indeed, in this respect they have an actual signification in the manner in which they are distributed among them.

The same peculiarity is observed amongst Acanthocotti, and those also would have to be likewise subdivided. If the characters of three or four soft ventral rays were of a generic value, either the species with three or those with four should have appeared first in geological times.

The color in Cotti has not yet afforded any safe distinctive mark between the various species. The ground is generally brownish-yellow, sometimes blackish-brown, maculated and dotted with a deeper black or brown. The upper edge of the anterior dorsal in *C. viscosus* is orange, whilst in *C. gracilis* it is red. Whether that hue is specific needs still to be investigated, as well as its particular appearance in the other species of the genus.

The following synoptical table will exhibit the most prominent differences between the species of the genus Cottus :

COTTI	With five rays to ventral fins.	Body fusiform, elongated.	Origin of anal fin opposite to third ray of second dorsal. Pectorals shorter than the head. Vent placed midway between snout and tip of caudal fin.	C. RICHARDSONII.
COTTI	With five rays to ventral fins.	Body fusiform, elongated.	Origin of anal fin opposite to sixth ray of second dorsal. Pectorals of same length as head. Vent nearer to snout than to base of caudal fin.	C. COGNATUS.
COTTI	With five rays to ventral fins.	Body fusiform, elongated.	Upper rays of pectorals branched; their tip extending to anterior margin of second dorsal. Insertion of ventrals in advance of first dorsal.	C. WILSONII.
COTTI	With five rays to ventral fins.	Body fusiform, elongated.	First dorsal very low. Tip of pectorals extending beyond the anterior margin of anal. Insertion of ventrals opposite to the first ray of anterior dorsal.	C. BAIRDII.
COTTI	With five rays to ventral fins.	Body stout and short.	A second very minute preopercular spine. Origin of anal opposite to third ray of second dorsal. Tip of pectorals extending beyond the anterior margin of the second dorsal and anal. Insertion of ventrals near the lower edge of pectorals in advance of anterior dorsal fin.	C. ALVORDII.
COTTI	With five rays to ventral fins.	Body stout and short.	A second and third, exceedingly minute, preopercular spines. Origin of anal opposite to fourth ray of second dorsal. Tip of pectorals not reaching the anal fin. Insertion of ventrals even with the lower edge of pectorals in advance of the first dorsal fin.	C. MERIDIONALIS.
COTTI	With four rays only to ventral fins.	Body fusiform and slender.	Base of pectorals crescentic; their tip extending beyond the fifth ray of second dorsal and third of anal fins. Insertion of ventrals in advance of the anterior dorsal, near the lower edge of pectorals.	C. BOLEOIDES.
COTTI	With four rays only to ventral fins.	Body fusiform and slender.	A second minute preopercular spine. Tip of pectorals not reaching the anterior margin of second dorsal. Base of pectorals crescentic. Dorsal fins separated by a free space.	C. FORMOSUS.
COTTI	With four rays only to ventral fins.	Body fusiform and slender.	Base of pectorals crescentic; their tip extending beyond the fourth ray of second dorsal and first of anal fin. Insertion of ventrals under the pectorals and in advance of anterior dorsal.	C. GRACILIS.
COTTI	With four rays only to ventral fins.	Body cylindrical, or subcylindrical and stout.	Base of pectorals slightly curved; their tip not reaching the anterior margin of second dorsal. Insertion of ventrals in advance of anterior dorsal and under the middle of pectorals.	C. FRANKLINII.
COTTI	With four rays only to ventral fins.	Body cylindrical, or subcylindrical and stout.	Base of pectorals crescentic; their tip not reaching the anal fin. Insertion of ventrals under the upper edge of pectorals.	C. GOBIOIDES.
COTTI	With four rays only to ventral fins.	Body cylindrical, or subcylindrical and stout.	Base of pectorals straight; their tip not reaching the anterior margin of anal. Insertion of ventrals behind the base of pectorals, and in advance of the anterior dorsal.	C. VISCOSUS.
COTTI	With four rays only to ventral fins.	. . . .	Head subtuberculous; region behind the eyes and lateral line, rough.	C. FABRICII.

§ 2. Chronological Summary of the History of American Cotti.

Before entering into the descriptions of the species of this continent, a rapid glance at their chronological history is deemed here in place.

The most ancient document which exists relating to this subject, as far as we know, goes as far back as the first half of the eighteenth century.[1]

"The *Barbuts*, or *Miller's Thumbs*," says the writer, "are the very same here as those in England and other parts of Europe. They are about three or four inches long, have no scales, and the back is yellowish, with a few little black spots. The head is large, and the mouth wide and round. Out of the fins grow several sharp prickles or thorns, especially in those near the head. These fishes are very plenty in rivers and creeks, near the sea shore, where they feed on watery insects (p. 242)." The figure given of the fish is insignificant, and can be of no use in determining its characters. We cannot help thinking that the individuals mentioned as occurring in creeks near the sea shore are the young of *Acanthocottus virginianus*, which when three or four inches long, have a striking superficial resemblance with Cottus proper. For, the Cotti or *Miller's Thumbs*, keep off the sea shore and salt waters generally. As to the individuals found in rivers, we believe that they belong to the genus Cottus. But the species to which they must be referred we are not prepared to decide, as we have had no specimen on hand for direct comparisons. That they are different from the English ones, cannot be doubted for a moment, judging the question *à priori*, and comparatively with the facts with which the study of those fishes has made us acquainted. They will have to be carefully compared first with *C. meridionalis* from the tributaries of James River, especially if the ventrals should be composed of four jointed and soft rays.

Then a century elapses, during which nothing is done towards the natural history of the American Cotti, when in 1836, an English naturalist and traveler, Dr. Richardson, gave to the scientific world the descriptions of two species, his *C. cognatus* and *C. asper*. The latter constitutes now our genus Cottopsis after various unsuccessful attempts to refer it to a proper genus. (See Chap. IV.)

In 1837, Mr. Heckel, Professor at Vienna (Austria), made us acquainted with a species which the Museum of Vienna possessed in its galleries, labeled "New York," by calling it *Cottus gracilis*.

In 1840, Prof. S. S. Haldeman had distinguished another species, under the name of *C. viscosus*, inhabiting eastern Pennsylvania.

In 1842, Dr. James E. Dekay described and figured under the name of *Uranidea quiescens*, the *C. gracilis* of Heckel, not knowing that a description of this species had already been published.

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[1] Brickwell (John). The natural history of North Carolina with an account of the trade, manners and customs of the Christians and Indians, inhabitants. Illustrated with copper plates, whereon are curiously engraved the map of the country, several strange beasts, birds, fishes, snakes, insects, trees, and plants, &c. Dublin, 1737, small 8vo.

In 1845, Mr. W. O. Ayres wrote a somewhat extensive Memoir[1] with a view of demonstrating the identity between *C. cognatus* of Richardson, *C. viscosus* of Haldeman, and *Uranidea quiescens* of Dekay. The individuals under examination, taken as a standard, were all secured in the State of Connecticut, and are indeed identical with the species described by Dr. Dekay. *C. viscosus* and *C. cognatus* on the contrary, are two other perfectly distinct species.

After having referred to one and a single species, all the American Cotti, Mr. Ayres proceeds to establish the identity of this one and unique species, with the European *C. gobio*. But we would ask, why should it be identical with *C. gobio*, rather than with any one of the others found in Europe or Asia? Mr. Heckel's investigations being not known in this country in 1845, Mr. Ayres was still under the impression that *C. gobio* was the only species of the genus in the old world; whence the idea of identifying with it those of North America.

Without recapitulating here what we have said in the introduction, respecting the European Cotti, we may recall to mind that the *C. gobio* is not yet determined with accuracy, and that under such circumstances the comparisons lose somewhat of their value. Some have taken for terms of comparison the *C. gobio* of England; others, that of the Seine; still others, that of the Rhine, of the Danube, &c. &c., and now, if these are, as we believe, types of several species, which can we call at present *C. gobio?* Had Mr. Ayres been aware of this state of things, he would have himself admitted, that it was more than premature to bring under this appellation, the American Cotti.

It is evident that after *C. viscosus* and *C. cognatus* are identified with *C. gracilis* it is no longer possible to discern between *specific characters;* the idea of the genus alone is left to the mind. After this is done, you may read Artedi's description, and nothing will be more natural than to find it agreeing perfectly with all existing Cotti. There is a generic identity and not a specific one.

Thus, we shall consider *C. cognatus* and *C. viscosus* as two distinct species, as they were previous to 1845. We erase the name of *Cottus gobio* from the catalogue of fishes of the United States, into which it was too hastily introduced, recalling here to mind that wherever a complete study of the species of fish reputed identical in both continents within the limits of the Temperate Zone has been made, the results have been that species differ from one continent to the other. Yet we would not allow any one to conclude them distinct *à priori*, on this ground. We cannot, on the contrary, too much insist upon the necessity of direct observations and immediate comparisons.

In 1850, appeared the descriptions of two new species brought from Lake Superior, by Prof. Agassiz.

Our own researches have made us acquainted with eight others, besides a ninth, which constitutes a new genus; so that the whole number of the Cottoid group included in the present work amounts to fifteen.

There are a few more species which will be made known to science in the Ichthy-

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[1] Boston Journal of Natural History, v., p. 116.

ology of the United States Exploring Expedition. There will also appear the figure of our Cottopsis, the greatest iconographic desideratum of this Monograph.

§ 3. Species with Four Soft Rays to the Ventrals.

I. COTTUS RICHARDSONII, Agass.

Plate I. Figs. 1 and 2.

Syn. *Cottus Richardsonii*, Agass. Lake Sup., 1850, p. 300.—Girard, Proc. Am. Ass. Adv. Sc., 1850, p. 410; and, Proc. Bost. Soc. Nat. Hist. III., 1850, p. 189.

The largest specimens of Cottus which we have seen, belong to this species; they are four inches and three-quarters in total length, the caudal fin included.

The general form of the body is elongated, quite regular. Its greatest depth taken behind the pectorals is contained nearly six times in the length; and its least depth, in advance of the caudal, a little more than seventeen times. The decrease is uniform and gradual from the head backwards. The thickness is a little less than the depth. The free space between the second dorsal and the caudal is equal to two-thirds of the depth on the peduncle of the tail.

The head is very much depressed, subconcave above, and forming about the third of the length of the fish, the caudal fin excluded. Its width is equal to the three-fourths of its length, whilst its depth is a little more than the half of the latter. The mouth is large and wide, its amplitude measuring three-quarters of an inch; its angles reach a vertical which would pass through the pupil. The jaws are of equal length, beset with a band of very minute teeth, the summit of which is curved inwards. The lips which line the jaws are capable of great extension, from the branch of the dentary and premaxillaries unto the angles of the mouth; whilst on the symphysis of these bones they are reduced to a mere cutaneous ridge. The eyes are of medium size, circular, and nearer to the end of the snout than to the posterior edge of the opercular by one of their diameters, which is contained five times and a half in the length of the head. The interorbital space above is equal to one of the said diameter, the distance being measured from the visual rims; for the bony arcade is much narrower, as seen in Fig. 18, Plate III., which represents an upper view of the skull of this species. The anterior nostrils, situated nearly midway between the anterior rim of the eyes and the end of the snout, opens exteriorly through a membranous tube which rises above the surface of the skin. The posterior one is nearer to the eye, and situated on a line below the anterior one. The preopercular spine is very stout at its base, very acute at its extremity, and suddenly curved upwards. The subopercular spine is quite conspicuous, although generally concealed under the skin. The posterior and upper extremity of the opercular terminates in a flat and sharp process concealed within the thickness of the membrane which lines the edge of that bone, whence it passes also along the inferior edge of the subopercular. The branchiostegals, six on each side, are slender and cylindrical. The isthmus, under the throat, is three-eighths of an inch wide.

The fins in general are well developed. The first dorsal is composed of eight rays inserted on a basis of six-eighths of an inch; its anterior edge is at a distance of an inch and a half from the extremity of the snout. Its upper edge is subconvex; the fourth, fifth, and sixth rays being the highest. The second dorsal, twice as extended as the first and one-third more elevated than the latter, is composed of eighteen rays, the highest being situated in the middle of the fin and slightly dichotomized at their extremities. The membrane of the first dorsal reaches the first ray of the second, so that these two fins may be said to be continuous, although a very deep notch still exists between them. The caudal fin, six-eighths of an inch in length, is truncated posteriorly; its upper and lower edge are slightly convex. It contains thirteen full-developed rays with some rudimentary ones; the four middle ones, bifurcated from their very base, dichotomize again on the last fourth of their length, together with the two adjoining rays, on either side. The anal fin commences under the third ray of the second dorsal and terminates a little before the last, although the posterior extremity of the rays of the first extends a little more backwards. In shape, it differs from the second dorsal in being more convex, in having a lower membrane, and, consequently, the tips of the rays extending free beyond it to a greater length. There are fourteen undivided rays. The ventral fins are composed of five rays, a spiny one situated at the outer edge and closely connected to the second (the first soft one) but much shorter. The remaining four are soft and articulated but undivided, the two middle ones being the longest, as shown by the enlarged figure of the left fin beneath Fig. 1. The pectorals are comparatively moderate in size. The rays are fifteen in number, and all undivided. The longest occupy the upper third of that fin and are more slender. Their length is only six-eighths of an inch, consequently much below the length of the head. The base of insertion, seen exteriorly, is crescent shaped. The formula of the fins is as follows:—

Br. 6. D VIII.—18. A 14. C 3. I. 5. 6. I. V I. 4. P 15.

The vent being exactly situated on the middle of the total length, the caudal fin included, is consequently nearer the base of insertion of the caudal than the extremity of the snout. It is bordered posteriorly by a small, lanceolated, tongue-like membrane which lies against the anterior ray of the anal.

The lateral line is very conspicuous; it bends itself slightly down on the abdomen to follow afterwards a straight course to the fifth ray of the second dorsal, where the cartilaginous subcutaneous plates cease and minute pores alone exist to continue it inconspicuously to the base of the caudal fin.

The color, so far as we can judge from dead specimens, is of a dark olivaceous brown on the back and sides, blackish on the head, cheeks, and lower jaw. The lower part of the sides is lighter; the belly and lower part of the head reflect rather a yellowish hue with scattered small black spots. The general color of the fins is the same as the region to which they belong; they are maculated and dotted with black or brown. In the young, the spots are spread all over the body, which give to it a marbled or maculated appearance.

The characters by which this species is distinguished from *C. cognatus,* as far, at least, as those of the latter can be deduced from the description of Sir John Richardson, are as follow: 1st. A more backwards position of the vent. 2d. The lateral line which does not reach the caudal fin. 3d. The more advanced position of the anal relatively to the second dorsal; and, 4th, the shorter pectorals compared to the head.

This species inhabits the northern shore of Lake Superior, where specimens have been collected by Dr. C. T. Jackson and Professor Agassiz, and are now preserved at Cambridge (Mass.). A small individual of the same species may also be seen at the Smithsonian Institution.

II. COTTUS COGNATUS, Rich.

Syn. *Cottus cognatus*, Rich. Faun. Bor. Amer. III. 1836, p. 40.—Heck. Ann. Wien. Mus. II. 1837, p. 149.—Girard, Proc. Amer. Assoc. Adv. Sc. II. 1850, p. 410; and, Proc. Bost. Soc. Nat. Hist. III. 1850, p. 189.

This species we only know by the description of Sir John Richardson. This author compares it carefully with *C. gobio* of England, which we are told it resembles in numerous points. But this comparison will be valuable only after the *C. gobio* of all regions shall have been submitted to a severe criticism, and after we shall be satisfied of the identity or the difference of specimens collected in all the countries in Europe where that fish has been noticed. We have already mentioned the important fact observed by Mr. Heckel, that the *C. gobio* from Scandinavia belongs to a distinct species.

The *C. cognatus* appears to have nearly the same dimensions as the *C. gobio* of England; the shape and size of the head are similar, but the mouth is larger. The head forms one-third of the length, the caudal fin excluded; its width is equal to its length; its height is two-thirds of its breadth. The jaws are of equal length. The premaxillaries, the dentaries, and the vomer, are armed with short, velvet-like teeth. The tongue is smooth, broad, and short. The spine on the preopercular is small, curved upwards, and hidden under the skin. The branchiostegal rays are slender and cylindrical, as in *C. Richardsonii*, whilst they are stout and flattened in the *C. gobio* of England. The isthmus measures half an inch.

The greatest depth of the body, taken at the origin of the first dorsal, corresponds nearly to the transverse diameter of the same region, whilst towards the insertion of the caudal, the thickness of the body is reduced to the half of its depth. The posterior part of the body is rather acute than rounded. The vent is a little nearer the end of the snout than the insertion of the caudal. The lateral line runs parallel with the back, to which it is nearer than to the belly.

The origin of the first dorsal takes place a little behind that of the ventrals, at the same distance from the end of the snout as in *C. gobio* of England; but it extends more backwards, having two rays more,[1] the largest of which measure

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[1] Cuvier gives from six to nine rays to the first dorsal of *C. gobio*; Sir John Richardson informs us that, as far as his observations go, he constantly found six spiny rays to the first dorsal, and sixteen articulated,

one-third of the depth of the body. The second dorsal, twice as long as the first, is separated from the latter by a space less than a line. It contains eighteen articulated and simple rays, with the exception of two central ones which are very slightly forked. The anal is composed of fourteen articulated, but simple, rays; its origin is opposite to the sixth ray of the second dorsal and terminates, as usual, before the latter. The caudal, one-sixth of the total length, unites with the tail in a straight line; its rays, fifteen in number, are more or less subdivided or else dichotomized. The ventrals, arising a little behind the pectorals, contain five rays, of which four are soft and articulated, and one spiny, slender, and half the length of the others, close to the anterior or outer edge of the fin, and concealed by the skin. The pectorals are large and fan shaped; the rays of which they are composed are all articulated but not branched, the longest equalling the head in length.

Br. 6. D VIII. — 18. A 14. C 15. V I. 4. P 15.

"The under surface is silvery-gray minutely spotted with dark brown: on the sides, the dots are intermingled with crowded, irregular blotches of the same color, and on the back and top of the head the color is dark brown, nearly uniform, few spots of the light color appearing."—(Rich.)

Sir John Richardson gives four inches as the total length of this species; we regret not having had the opportunity of studying it in nature; but there exist no specimens to our knowledge in any public or private collection of fishes in the United States. We regret likewise that the author of the *Fauna Boreali-Americana* has not had it figured; the more so that it resembles so much its congener of both continents.

III. COTTUS WILSONII, Girard.

Plate I. Figs. 3 and 4.

In visiting the collection of fishes at the Academy of Natural Sciences of Philadelphia, in November 1850, we saw a Cottus labelled "Pittsburgh (Pa.)," presented by Mr. Jacob Green. After a careful examination of the unique specimen preserved in that cabinet, we satisfied ourselves that it belonged to a species distinct from any one hitherto known, and took pleasure in dedicating it to Dr. Thomas B. Wilson. Indeed, before that time, we had seen immature specimens of the same species, but we were unable to characterize it until we met with the one just mentioned.

The size of the individual figured and described is four inches and a quarter. The head forms exactly the fourth of that length. With regard to the general form it is amongst all the species the one whose depth diminishes least rapidly backwards. The greatest depth is comprised nearly six times in the length, and the least depth, on the peduncle of the tail, only twelve times. The thickness is a

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but simple, to the second, whilst Cuvier found in the latter seventeen to eighteen rays, the last of which is branched, and some of the middle ones forked. These facts must be taken into consideration in making a critical revision of the European Cotti.

little less than the depth. The head is much flattened above, gradually sloping towards the end of the snout. Its width is equal to the space comprised between the end of the snout and the base of the preopercular spine. The mouth is very broad; its angles, however, do not extend beyond the pupil. The palatine asperities are more conspicuous than in any of the other species which exhibit traces of them. They occupy an oblong and elongated area on the surface of their bones. The eyes are proportionally small; their diameter is contained nearly six times in the length of the head. The interorbito-frontal space measures a quarter of an inch, and accordingly, is broader than in any other species. The anterior and posterior nostrils are both tubular. The posterior one, the largest, is situated above in advance of the orbit; the anterior one is nearer the orbit than the end of the snout. The preopercular spine, directed obliquely upwards, is short, stout at its base and very acute at the tip. Underneath, and directed downwards, there exists a second very minute, blunt spine. The isthmus is five-sixteenths of an inch wide.

The surface of the head exhibits numerous holes all along the tracks of the cephalic channels of the lateral line, by means of which a direct communication is established with the surrounding medium. Several of these holes exist on the snout in the vicinity of the nostrils. They appear more distinct on the specimen figured, on account of the decomposed state of the epidermis which is deprived of all its pigmentum.

The origin of the first dorsal is one inch and a quarter from the extremity of the snout. Its rays, seven in number, occupy a longitudinal space of five-eighths of an inch, the last ray sending its membrane to the very base of the first ray of the second dorsal. The latter is composed of sixteen rays, the central ones exhibiting a slight bifurcation on their summit, without, however, solution of continuity. It extends on a basis of one inch and a quarter, that is, exactly twice the length of the first dorsal. Its anterior edge is nearly of the same height with the middle, and its decrease takes place gradually towards the posterior edge, distant from the caudal three-sixteenths of an inch. The origin of the anal fin is opposite the third ray of the second dorsal. It contains thirteen unbranched rays. The exterior margin of this fin is convex, the middle rays being a little longer than those of the second dorsal. The central rays of the caudal are twice subdivided; the posterior margin of this fin is subtruncated; differing in this respect from that of *C. Bairdii.* The insertion of the ventral fins takes place, as usual, under the pectorals; but in this species it is considerably more in advance of the first dorsal fin, whilst in *C. Bairdii,* it is situated immediately under the first ray of the anterior dorsal. They are composed of four soft, jointed, but unbranched rays, the second and third being the longest. The spiny ray is very slender. When bent backwards, the tip of these fins is far from reaching the vent, thus proportionally shorter than those of *C. Bairdii.* Their more advanced position is not sufficient to account for the difference. The pectorals are broad, with a crescentic base of insertion; they are composed of fourteen rays, the four uppermost but two, are bifurcated, a character quite peculiar to this species amongst the American ones.

Their tip will reach backwards, the origin of the second dorsal only, thus proportionally shorter than those of *C. Bairdii.*

Br. 6. D VII.—16. A 13. C 2. I. 4. 4. I. 2. V I. 4. P 14.

The vent is situated under the second ray of the second dorsal.

The lateral line is nearly straight, and can be traced to the base of the caudal. The cartilaginous capsules, however, disappear under the fourteenth ray of the second dorsal, whilst the fall takes place under the last ray. Its peculiar appearance in the specimen figured, is owing, as already observed, to the decomposed state of the epidermis, rendering the holes of the dermic layer more conspicuous.

The accompanying figure is the only one which was not drawn by Mr. Sonrel, from nature. Our sketch was made originally with a mere view of giving the striking character of the bifurcation of the pectoral fins.

Specimens of this species, the largest measuring only three inches and five-eighths, were sent to the Smithsonian Institution, by Prof. L. D. Williams of Meadville, and collected by that gentleman in French Creek (Pa.).

The ground color of these is yellowish-green, intermingled with cloudy patches of brownish-black. The base of the caudal is black. All the fins, the ventrals excepted, are banded with black. The latter have the uniform palish-yellow of the belly.

Prof. Baird's specimens were collected by himself in a tributary of the Alleghany River, at Foxburg (Pa.).

IV. COTTUS BAIRDII, Girard.

Plate I. Figs. 5 and 6.

Syn. *Cottus Bairdii,* Girard, Proc. Amer. Assoc. Adv. Sc. II. 1850, p. 410; and, Proc. Bost. Soc. Nat. Hist. III. 1850, p. 189.
Cottus gobio, Kirtl. Bost. Journ. Nat. Hist. V. 1847, p. 342.

This, amongst all the species represented on our plates, is the one which has the most elegant shape. The uniform declivity of the snout, passing gradually over the eyes, and backwards to the tail, without the slightest deviation from a slightly concave or almost straight course, contributes to that elegance, rendered more perfect by a similar outline of the belly. Now, as the body tapers very gradually away towards the tail, together with the thickness, the general form is still improved by these proportions of height and breadth. So we might call the general form, elongated, although at first sight it will strike us as being rather short, especially when compared to *C. viscosus.*

The greatest depth of the body, taken at the origin of the first dorsal and ventral fins, enters only six times and a half in the total length, and the least depth, in advance of the caudal, is contained in it nearly fourteen times and a half. The greatest thickness is equal to the depth; but it diminishes more rapidly backwards, so that, on the peduncle of the tail, the thickness is reduced to one-half of the depth.

The head forms the third of the length of the fish, the caudal fin excluded; it is one-third longer than broad, and less obtuse on the snout than in *C. viscosus.*

The mouth is proportionally great; its angles reach posteriorly a vertical which would pass in advance of the pupil. The jaws and teeth, as far as external investigations go, do not exhibit any peculiarity which is not to be found in other species. On the other hand, the palatine bones are in some cases provided with minute asperities or rudimentary teeth. The eyes are subcircular in form, proportionally large, and their longitudinal diameter contained only four times in the length of the head. The anterior nostrils are nearer the end of the snout than the orbit. The posterior ones are above and nearer the orbit, resembling a similar opening below and corresponding to the anterior extremity of the anterior suborbital. The preopercular spine is quite small, very acute, and bent obliquely upwards, assuming, on the figured specimen, a hook-like appearance. The spine on the subopercular is more conspicuous than in *C. viscosus.* The gill openings are also greater, and the isthmus smaller, than in the latter.

The first dorsal is very low; its origin is exactly opposite to the base of the ventrals, and distant from the end of the snout by fifteen-sixteenths of an inch. Its upper edge is almost straight, and parallel to the back, the rays having nearly all the same height. The latter are six in number, occupying a space of three-eighths of an inch, the last ray sending its membrane to the second dorsal.

The origin of the second dorsal is in advance of the vent, extending backwards till quite near the caudal, being two times and a half as long as the first dorsal. It contains sixteen unbranched rays, the last of which is often double. The anterior edge of the anal corresponds to the space between the fifth and sixth rays of the second dorsal, and terminates before the latter. The tip of its rays, however, extend nearly as far back. The rays, thirteen in number, are as long as those of the second dorsal, but, their membrane being shorter, the anal appears not quite as high. The caudal is elongated, posteriorly rounded off, and quite convex; its length is contained four times in that of the body and head inclusive, thus constituting the fifth part of the total length. The middle rays show a double bifurcation. The insertion of the ventrals takes place back of that of the pectorals, and, when bent backwards, their tip nearly reaches the vent. There are four soft, articulated, but unbranched rays, of which the two middle ones are the longest.

The pectorals are proportionally longer than in *C. viscosus;* the rays are slender, all undivided, and their tip reaches the origin of the anal, and, consequently, the fifth of the second dorsal. The base of insertion of these fins, seen exteriorly, is almost vertical. The formula of the fins is nearly identical with that of *C. Wilsonii.*

Br. 6. D VI.—16. A 13. C 2. I. 4. 4. I. 3. V I. 4. P 14.

The anus is nearer the snout than the extremity of the caudal fin, and under the first ray of the second dorsal.

The lateral line is conspicuous from head to tail. It takes a straight course until the fourteenth ray of the second dorsal, where it sinks gradually down to reach the medial line of the peduncle of the tail, just at the termination of the second dorsal, whence it takes again a straight course to the base of the caudal fin.

The general ground of the color is grayish, maculated, and dotted with black.

The top of the head and back are very dark, the sides and belly lighter, yellowish without the large spots. The dorsals, pectorals, and caudal fin are banded; the ventrals and anal, unicolor and only dotted.

This species may be readily distinguished from *C. Richardsonii* by the shape of the first dorsal, the length of the pectorals, their vertical base of insertion, and the convexity of the posterior margin of the caudal.

Caught by Prof. Baird in the Mahoning River at Poland (Ohio). Specimens are preserved at the Smithsonian Institution and in Prof. Agassiz's cabinet.

V. COTTUS ALVORDII, Girard.

Plate I. Figs. 7 and 8.

We have before us the smallest species hitherto described of the genus, measuring not quite two inches and a half. Whether it does not attain a larger size, we are not prepared to decide, as the specimen figured is the only one which we have hitherto seen. But that it belongs to a distinct species is readily apparent. The general form of the body resembles that of *C. meridionalis*, tapering suddenly away towards the tail, but the fins differ widely. The head forms a little more than the fourth of the entire length. The greatest depth of the body is contained about five times in the length, whilst the least depth enters in it nearly thirteen times. It is deeper than thick. The anterior region of the body is arched. The neck is depressed and the snout short and obtuse. The mouth is small; its angle extending not quite as far back as the pupil. The preopercular spine is short and stout, very much curved upwards, and slightly inwards. Below the convexity of the preopercular, there exists another very minute spine, the point of which is directed obliquely downwards. The gill openings are separated below by an isthmus of two-twelfths of an inch. The eyes are proportionally large, subcircular; their longitudinal diameter is contained four times in the length of the head. The anterior nostrils are nearer the orbit than the end of the snout.

The origin of the first dorsal is situated six-eighths of an inch from the extremity of the snout. It is composed of seven rays extending on a longitudinal basis of five-sixteenths of an inch. Its upper margin is regularly convex; the third and fourth rays are the longest; the first and second have the size of the fifth and sixth; the seventh is the shortest. The membrane runs from its tip to the anterior margin of the second dorsal, meeting the first ray on the middle of its height. How different this fin is from the similar one in *C. meridionalis*, an inspection of both figures will show at once.

The second dorsal is very close to the first, composed of sixteen undivided rays, the last of which is double. Its upper margin is likewise convex. The origin of the anal is under the third ray of the second dorsal; its outer margin is much more convex than that of the latter, and contains thirteen rays, the last one double. The caudal fin is rounded posteriorly. It is contained six times in the entire length. There are ten fully developed rays, eight of them bifurcated to a considerable length. The ventrals are very short and broad, inserted immediately under the middle of the pectorals, in advance of the first dorsal. The pectorals are broad and proportionally much developed, for their tip reaches backwards, the fourth ray of the second dorsal, and the first ray of the anal fin. The base of insertion of these fins is crescent-shaped and close to the gill opening. In this respect *C. Alvordii* differs considerably from *C. meridionalis*. The rays are fifteen in number, all undivided, the eight lowermost alone overrunning the membrane of the fin.

Br. 16. D VII. — 16. A 13. C 3. I. 4. 4. I. 2. V I. 4. P 15.

The lateral line, nearly straight, vanishes already under the seventh ray of the second dorsal, whence the series of minute pores cannot be followed to the tail without an eye-glass, when it is seen along the back as far as the posterior ray of the second dorsal, and there disappears entirely.

The anal opening is a little nearer the extremity of the jaws than the base of the caudal fin. It is provided posteriorly with a tongue-shaped membrane, broad at its origin, and very acute on its extremity, so that when seen in a profile view, it has the appearance of an ordinary ray. Our figure, however, gives a clear idea of it, as a solution of continuity exists between it and the first ray of the anal. A close examination will likewise show a structural difference.

The head and back are yellowish-brown, clouded on the sides. The belly and fins are yellowish; the first dorsal alone having two black spots on its posterior half.

This species inhabits the streams emptying into Lake Huron, in the vicinity of Fort Gratiot, where it was collected in 1850, by Major B. Alvord, and presented by this officer to the Smithsonian Institution, where the original specimen is preserved.

VI. COTTUS MERIDIONALIS, Girard.

Plate I. Figs. 9 and 10.

Syn. *Cottus meridionalis,* Girard, Proc. Amer. Assoc. Adv. Sc. II., 1850, p. 410; and, Proc. Bost. Soc. Nat. Hist. III., 1850, p. 189.

Nothing is more dissimilar than the general outline of this species and that of *C. Bairdii,* and yet the absolute length of both species is exactly the same on the specimens figured. Indeed, the species which *C. meridionalis* resembles most in shape, is *C. Alvordii,* and still there are differences which could not for a moment be overlooked; besides the fact of their remote habitat, which would likewise cause doubts as to their identical relationship. It is not without a certain resemblance with *C. viscosus,* and did it not belong to a different division of the genus by a hidden character, its stout and contracted body would scarcely suffice to distinguish it from the latter.

The greatest depth is contained but five times in the total length; four times only when we exclude the caudal fin, the length of which is equal to the depth. The body tapers very rapidly away; its least depth, on the peduncle of the tail, enters fifteen times in the total length. The greatest thickness is considerably less than the depth. The peduncle of the tail appears more elongated than in any other species.

The head forms nearly the fourth of the total length; it being contained a little more than twice in the length of the body, the caudal fin excluded. Its width is equal to the length of its upper surface. The eyes are a little smaller than in *C. Bairdii*, their form is circular, and their diameter enters five times in the length of the head. The interorbito-frontal space is equal to one diameter. The anterior nostril is situated nearly on the middle of the space between the end of the snout and anterior rim of the eye. The posterior one is above, close to the orbit. The mouth is larger than in *C. Bairdii*, and the palatine bones are likewise provided with teeth-like asperities, forming a more elongated patch.

The preopercular spine is very conspicuous, stout, directed obliquely upwards and backwards. Under it we observe a second preopercular spine, much smaller, of the size of that of the subopercular, the point of which is directed vertically downwards, and below, a third, still smaller, directed obliquely forwards. The gill openings are smaller, and consequently the isthmus is larger than in *C. Bairdii.*

The first dorsal commences a little behind the insertion of the ventrals and is a little more distant from the end of the snout than in *C. Bairdii.* Its shape is very different from that of the latter species; its upper edge is very convex. There are seven rays, the second and third the highest, the first is equal to the fourth, the fifth, sixth, and seventh are gradually diminishing. The second dorsal, contiguous to the first, commences in advance of the vent, and is composed of seventeen undivided rays, the last of which is branched. The upper edge of this fin is also more convex than in any other species. The origin of the anal corresponds to the space between the fourth and fifth rays of the second dorsal. Its last ray is double. The caudal fin is shorter than the head; it is convex posteriorly as in *C. Bairdii.* The seven middle rays are bifurcated only once.

The insertion of the ventrals takes place immediately under the pectorals; amongst the four soft rays the two middle ones are the longest and equal in length. The two outer ones are likewise equal in size. The pectorals are shorter and broader than in *C. Bairdii;* they scarcely reach the fourth ray of the second dorsal, but leave the anal behind. Their base of insertion is oblique but nearly straight. The tip of all the rays extend beyond their membrane.

Br. 6. D VII. — 17. A 12. C 4. I. 4. 3. I. 4. V I. 4. P 14.

The vent is nearer the snout than the tip of the caudal.

The lateral line runs parallel to the back; it is conspicuous until the thirteenth ray of the second dorsal, where it vanishes into a series of pores so minute as not to be distinguished without the aid of a lens.

We cannot give anything positive on the color of this species, the specimens collected by Prof. Baird having lost their general hue. The body, however, shows still some faint blotches of darker appearance than the ground color; and the fins appear to have been banded.

This species inhabits the tributaries of James River (Va.). Specimens are preserved in the Museum of the Smithsonian Institution.

§ 4. Species with Three Soft Rays to the Ventrals.

VII. COTTUS GRACILIS, Heck.

Plate I. Figs. 11 and 12.

Syn. *Cottus gracilis*, Heck. Ann. d. Wien. Mus. II., 1837, p. 148.—Girard, Proc. Amer. Ass. Adv. Sc. II., 1850, p. 411; and, Proc. Bost. Soc. Nat. Hist., III., 1850, p. 189.
Uranidea quiescens, Dekay, New York Fauna, 1842, p. 61, Pl. V. Fig. 14.
Cottus gobio, Ayres, Bost. Journ. Nat. Hist., V., 1845, p. 121, Pl. XI.

The history of this species is quite interesting: described abroad for the first time as the second species of Cottus, peculiar to this country, its description remained unknown for years on this side of the Atlantic, and when Dr. Dekay published the Fauna of the State of New York, he even lost sight of the fresh-water Cotti, and proposed for it a new genus. Next we find Mr. Ayres restoring this species to its true genus, and yet misled on the question of the species, an error which he would not have committed if the paper of Mr. Heckel had been at his command.

This is one of the small species of the genus, scarcely exceeding three inches in length. The specimens which we have had under examination had not quite that size. The general appearance is fusiform, slender, less so, however, than *C. boleoides;* but on the other hand, it is shorter than the latter, resembling more in shape *C. Bairdii.* The greatest depth of the body is contained a little more than six times in the total length; a little less thick than deep anteriorly, it diminishes gradually towards the tail, though more rapidly in thickness than in depth. The latter, on the peduncle of the tail is reduced to the proportions of one-thirteenth of the total length.

The head forms about the fourth of the total length. The occipital region is slightly sloping backwards, thus giving to the neck a depressed appearance. From the orbits to the end of the snout, the head is rather rounded, although not abruptly truncated. The eyes, circular in form, are one-sixteenth of an inch in diameter, which is comprised nearly four times in the length of the head. Their frontal distance is only the half of their diameter. The anterior nostrils are situated midway between the orbits and the snout; the posterior ones are higher up, and close to the eyes. The mouth is proportionally great; its angles nearly reach the pupil. The lips are well developed, but the teeth are not very conspicuous. Palatine teeth have been assigned to this species, but are not to be found in the specimen figured. There is nothing which resembles teeth on the tongue as ascribed to *Uranidea quiescens.* The preopercular spine is but little prominent; that of the subopercular is constantly concealed under the skin. The gill openings are oblique; the isthmus is a quarter of an inch wide. There are constantly six branchiostegal rays, even in the specimens in which Dr. Dekay signalizes seven.

The origin of the first dorsal is six-eighths of an inch distant from the extremity of the snout; it is not quite half an inch long, and its height is less than the half of its length. Its upper edge is rounded and convex; the first and second rays being a little shorter than the third and fourth; there are eight rays in all; the longest of which are one-third the depth of the body. The second dorsal is contiguous to the first, which sends to it the membrane of its last ray. Commencing above the vent, it is more than twice as long, and at least twice as high as the first, and composed of sixteen undivided rays, the middle ones being the longest and as high as the body itself on the region to which they correspond. The origin of the anal is under the third ray of the second dorsal, and terminates under the thirteenth. It has most generally twelve, sometimes eleven rays, which equal in height, if they do not surpass, the corresponding rays of the second dorsal. The caudal is sub-truncated; its length enters five times and a half in the total length of the fish. It is composed of sixteen rays, of which the five middle ones are subdivided twice; the two next on each side subdivide only once; finally, the others, four to the upper lobe, and three to the lower one, remain undivided, and are simply articulated. The ventrals are situated exactly under the pectorals, and when bent backwards, they reach the vent, and even sometimes go beyond it. They are composed of a short spiny ray, and three soft articulated and unbranched ones, of which the first is the shortest, and the middle one the longest. The insertion of the pectorals is oblique, or rather crescent-shaped, and takes place immediately behind the gill opening. Their tip reaches the third or fourth ray of the second dorsal. They are composed each of thirteen soft and undivided rays, of which the seven lowermost are a little thicker, and extend beyond the membrane which unites them.

Br. 6. D VIII.—16. A 12. C 3. I. 5. 4. I. 2. V I. 3. P 13.

The lateral line, slightly bent downwards on the abdominal region, re-ascends gradually nearer the back, and vanishes on the last third of the length of the second dorsal, that is, under the eleventh ray, sometimes even already on the middle of that fin, whence it follows its course towards the tail by means of minute pores after having made a sudden fall near the termination of the second dorsal in order to reach the centre of the peduncle of the tail, and then run directly to the base of the caudal fin.

The color, according to Mr. Ayres, seems to vary within considerable limits: "The prevailing color of the sides is light yellowish-brown, with numerous blotches of darker brown, sometimes, but not always, amounting to irregular bands, which occasionally cover the greater part of the side. The head is in general darker than the body. The under side of the body, from the lower jaw to the caudal fin, is yellowish-white. The first dorsal fin is of a light brown, with dark spots, and occasionally with bands; the upper margin of the fin is red. The second dorsal, pectorals, and caudal, are colored like the first dorsal, except that they are destitute of the red margin. The ventrals are nearly transparent. The anal is like the second dorsal, but not quite so dark," (pp. 123 and 124.)

This species is found in the States of Massachusetts, Connecticut, and New York. Dr. Dekay found it in Lake Pleasant, and previously, Dr. Emmons had it from Round Lake (N. Y.). Mr. Ayres caught his at Manchester (Ct.). Prof. Baird procured several of them from the northern tributaries of the Hudson, in Schroon township, Essex county (N. Y.), near Root's tavern.

Preserved specimens exist in the cabinet of the Boston Society of Natural History; in the State Museum, at Albany; and at the Smithsonian Institution.

VIII. COTTUS VISCOSUS, Hald.

Plate II. Figs. 1 and 2.

Syn. *Cottus viscosus*, Hald. Suppl. to a Monogr. of Limn., &c., 1840, p. 3.—Girard, Proc. Amer. Assoc. Adv. Sc. II., 1850, p. 411; and, Proc. Bost. Soc. Nat. Hist. III., 1850, p. 189.

In 1840, this species was announced to the scientific world rather than described. The author having no means of establishing direct comparisons, could not draw an accurate distinctive diagnosis. He knew not Mr. Heckel's *C. gracilis*, and had only before him an incomplete description of *C. gobio*, from Europe.

The specimen figured, is not quite four inches long. Since the latter has been drawn, we have seen another, measuring nearly four inches and a half.

The general form is sub-cylindrical, of rather stout appearance. The width, near the head, is greater than the depth, and sometimes both of these dimensions are equal. The greatest depth under the first dorsal, is comprised five times and a half in the entire length, and the least depth a little more than fifteen times. The head forms the two-ninths of the length of the fish. The occipital region is depressed, but flat; the nose convex, and the snout obtuse. The mouth is very little cleft, and its angles do not extend farther back than the anterior rim of the eye. The lips are very fleshy. The eyes themselves are of medium size, and circular in form; their diameter is contained five times in the length of the head. The tubular nostrils are nearer the eyes than the extremity of the jaws. The preopercular spine is stout and prominent, acute, directed obliquely upwards. In some cases there exists a second, very small, slender, acute spine, immediately under the base of the first, having its point directed vertically downwards. That on the inferior angle of the subopercular is very conspicuous, acute, directed as usual downwards and forwards. The gill openings are separated, below, by an isthmus of three-eighths of an inch.

The anterior margin of the first dorsal is distant one inch and a quarter from the extremity of the snout. It is rather low, uniformly arched, and composed of eight rays, the third, fourth, and fifth, nearly equal, and longest. The membrane between that fin and the second dorsal is quite low. The second dorsal is convex like the first, containing seventeen undivided rays on a base of one and an eighth of an inch, twice and a half as long as the base of the anterior fin. The origin of the anal is under the fourth ray of the second dorsal and is more convex than the latter. It is composed of twelve undivided rays, the last, as in many instances, double, opposite to the fourteenth of the second dorsal. The longest rays of both second dorsal and anal, are of equal length, but the membrane of the latter fin is more deeply notched, so as to make it appear shorter. The caudal is rounded posteriorly, and forms two-elevenths of the entire length. It is composed of eleven well developed rays, with four short ones above and three below. The nine middle ones are bifurcated on the last two-thirds of their length, and each branch again subdivided near the tip without solution of continuity; this latter feature not being exhibited in the figure. The insertion of the ventrals takes place in advance of the anterior dorsal, and behind the base of the pectorals. The two inner rays are the longest, as seen in the enlarged figure of these fins beneath Fig. 1. They do not reach the anus when bent backwards. The pectorals are of medium size, shorter than the head, composed of twelve unbranched rays. The membrane is deeply notched on the outer edge of the seven lowermost rays. Their base of insertion is nearly straight. When bent backwards they scarcely reach the anterior margin of the second dorsal, and leave the anal behind.

Br. 6. D VIII.—17. A 12. C 4. I. 5. 4. I. 3. V I. 3. P 12.

The lateral line is slightly inflexed on the abdomen, but runs straight along the back until the posterior extremity of the second dorsal, when the fall takes place obliquely towards the centre of the peduncle of the tail, and straight again to the base of the caudal. The series of pores commences under the tenth ray of the second dorsal.

The anus is situated a little nearer the end of the snout than the extremity of the caudal fin, consequently nearer the base of that fin than the snout.

The color is thus described by Prof. Haldeman: "yellowish, clouded with black, the first dorsal fin edged with a narrow line of orange."

The following information respecting the habits of this species, is from the notes of Professor Baird:—

These fish usually inhabit clear, spring waters, especially the spring runs which flow through rich meadows, bordered by turf, and having a shallow pebbly bottom. They lie concealed under projecting clods, flat stones, boards, or whatever may serve their purposes of concealment. On being disturbed, they usually hasten off to fresh cover, but sometimes remain motionless. Occasionally they occur in larger bodies of water, of less purity; but we have never seen them in creeks or rivers. Sometimes they are seen lying close to the edge of rivulets formed by leaking embankments, and where the water is far from clear. They always lie close to the bottom, and are never seen poised in the water.

The eggs are laid from the middle of April to the end of May, and are deposited in round packets about the size of an ounce bullet, under boards, stones, and in shallow, springy water. It is possible that they are watched by the parent, as we have frequently found individuals under the same cover as the eggs. The ova are of a rose color, and about the size of No. 3 shot, conveying the impression of disproportionate size. Occasionally, we have found the eggs with embryos moving freely within the envelope. A set examined April 22d, 1848, had the eye very distinct, and of large size. The fœtal fin extended from the head, by the tail, to the anus. In the course of the day, many became liberated, and swam about with the yolk bag attached. This was sessile, and filled with a transparent, reddish liquid, excepting opposite to the embryo, where was a hard, yellowish cake. All our attempts at raising the young, or of development of the egg, failed for want of fresh spring water.

The body is the most slimy amongst the known species, whence its name *viscosus,* which we think is well appropriated. Specimens have been collected by Prof

Baird, about Carlisle (Pa.), in Mountain and Yellow Breeches Creeks, and Letart Spring, the largest of which were three and six-eighths of an inch. They all agree with the above description, excepting the color of an individual from Mountain Creek, which we found of a dark and uniform black.

We owe to the kindness of Prof. S. S. Haldeman, an authentical specimen, three inches long, so that there can be no doubts left with regard to the species which is here described.

The specimen figured was caught in the vicinity of Carlisle, and is preserved at the Smithsonian Institution, together with several others of the same vicinities. Specimens were also obtained from the Schuylkill at Reading (Pa.), and from the tributaries of the Potomac, at Rohrersville (Md.), and in Rock Creek, Washington (D. C.). So that the range of *C. viscosus* is Eastern Pennsylvania and Maryland.

IX. COTTUS FRANKLINII, Agass.

Plate II. Figs. 5 and 6.

Syn. *Cottus Franklinii*, Agass. Lake Sup. 1850, p. 303.—Girard, Proc. Amer. Assoc. Adv. Sc. II., 1850, p. 411; and, Proc. Bost. Soc. Nat. Hist. III., 1850, p. 189.

Here is a species which we might easily have identified with the preceding, so much it resembles it by its general appearance, had we not looked into the anatomical as well as zoological peculiarities of both species.

Before we were prepared to formulate distinctively the characters by which this species differs from its congeners, the form of the skull had already satisfied us that it was distinct. In the first place, and to speak only here of this species and of *C. viscosus*, which appear so much alike, the conformation of the skull has something so peculiar that, when once well understood, it will be easy to tell at first sight to which of these two species such and such skulls may belong (Compare Figs. 8 and 12 of Plate III.).

If the differences exhibited in those profiles are not specific, comparative osteology can no longer be a sure guide in the study of species, nor can anatomy be of any help to zoology. But to this conclusion we have not yet arrived; we know what comparative osteology of the skull is worth, and, confident in the future of that science, we should have established the two species as distinct on those characters alone.

Zoologically speaking, the general form is short and stout. The greatest depth is contained five times and a half in the total length, and is proportionally greater than in *C. viscosus*. The least depth is one-nineteenth of the length. The body tapers rapidly away, as in *C. meridionalis* and *C. Alvordii*. The peduncle of the tail is more slender, and the back more arched than in *C. viscosus*. The thickness is greater than the depth for a considerable length; towards the tail, however, the depth becomes greater. The body, as a whole, has rather a cylindrico-conical shape.

The head, proportionally shorter than that of *C. viscosus*, is contained two times and a half in the length of the body, the caudal fin excluded. The snout, also, is much less obtuse, and the mouth more deeply cleft. The eyes are subcircular; their longitudinal diameter is contained four times in the length of the head. The interorbito-frontal space is equal to the half of that diameter. The anterior nostrils are situated midway between the orbit and the extremity of the jaws; the posterior ones are nearer the orbits.

The preopercular spine is hook-like, very acute, and different in all respects from that of *C. viscosus*. It resembles more that of *C. Bairdii* than any other species. The subopercular spine is slender and very acute.

In spite of the great resemblance between the fins of this species and the preceding one, a careful comparison shows that the paired fins are proportionally shorter. The base of the pectorals is slightly crescent shape; the tip of its rays scarcely reach the anterior edge of the second dorsal fin. The five uppermost rays do not overrun their membrane quite as much as exhibited in the figure. The ventrals are nearer the isthmus than in *C. viscosus*, and when bent backwards, they leave a greater space between their tip and the vent. Their insertion takes place immediately under the base of the pectorals instead of being situated behind.

The first dorsal is nearly of the same height with the second; it is longer than in *C. viscosus;* its upper edge is also more convex. There are eight slender rays, the first and last being of equal size. The second dorsal is contiguous to the first, and terminates at a greater distance from the base of the caudal than in *C. viscosus.* It contains seventeen rays, or only sixteen, the last one, double. The caudal fin is posteriorly truncated, whilst it is rounded in *C. viscosus.* It forms nearly the sixth part of the total length. The origin of the anal is under the fourth ray of the second dorsal, and terminates under the thirteenth. When bent backwards the tips of the rays do not reach as far as those of the second dorsal.

Br. 6. D VIII.—17. A 12. C 1. I. 5. 4. I. 1. V I. 3. P 14.

All the rays are unbranched with the exception of two in the centre of the caudal, which, however, bifurcate only once beyond the middle of their length.

The vent is situated nearer the base of the caudal fin than the tip of the snout.

The lateral line follows the curve of the back; it vanishes already under the sixth ray of the second dorsal, whence the series of minute pores is very little conspicuous. Its fall near the tail takes place less abruptly than in *C. viscosus.*

This species inhabits the southern and eastern shores of Lake Superior, where it has been collected first by Prof. James Hall of Albany, and afterwards by Prof. Agassiz, in whose cabinet specimens are still preserved. It is also to be seen in the collection of fishes at the Smithsonian Institution.

The specimen figured is the largest we have seen. Its total length is three inches and one-sixteenth.

X. COTTUS GOBIOIDES, Girard.

Plate II. Figs. 3 and 4.

Syn. *Cottus gobioides,* Girard, Proc. Amer. Assoc. Adv. Sc. II., 1850, p. 411; and, Proc. Bost. Soc. Nat. Hist. III., 1850, p. 189.

The first impression which strikes the observer after a superficial glance at this species, is a general resemblance with *C. Richardsonii,* from which it differs, however, much more than from several others, by several peculiarities of its structure. What leads to this impression is its large mouth, its large head, and undoubtedly its profile, as well as the general outline of the body. But as these species belong to two different sections, their intimate affinities are found more remote than might be anticipated.

Its large mouth distinguishes it readily from all the species, which possess, like it, three soft rays only to the ventral fins, with the exception, perhaps, of the following species, to which it has much affinity.

The greatest depth of the body is contained five times and a half in the entire length from the snout to the tip of the caudal fin; whilst the least depth enters in it nearly fifteen times. These dimensions, when compared to those in *C. boleoides,* are very striking, when we bear in mind the absolute size of the individuals which we here describe. In *C. boleoides,* three-quarters of an inch shorter than *C. gobioides,* we find both the greatest and least depth comprised a greater number of times in the length. The greatest thickness is a little less than the depth on the anterior region.

The head forms three-eighths of the entire length, proportionally a little shorter than in *C. boleoides.* Besides, it is much broader than deep, and its frontal length is sensibly equal to its width. The flattening of the head above the eyes and the convexity of the neck, make the frontal line appear as if more depressed than in other species. The snout is obtuse, differing greatly in this respect from *C. Richardsonii.* The angles of the mouth reach a vertical, which would pass beyond the pupil. The eyes themselves are circular and proportionally small; and their diameter is contained a little more than four times in the length of the head. The interorbito-frontal space is greater than in *C. boleoides.* The preopercular spine is much developed and stout, suddenly curved upwards. The spine of the subopercular is small and acute. The gill openings are large and oblique, and separated under the throat by an isthmus of four-eighths of an inch.

The first dorsal commences one inch and one-sixteenth from the extremity of the snout, and extends on a basis of half an inch, leaving a considerable space to be filled by the membrane. The origin of the second dorsal is opposite to the vent, and composed of seventeen undivided rays. Its upper edge is more convex than in *C. boleoides,* the first and last rays being sensibly shorter than the middle ones. The commencement of the anal takes place between the third and fourth rays of the second dorsal; it is higher than the latter, and composed of twelve undivided rays. The caudal is rather rounded than truncated posteriorly, and is contained but a little less than six times in the entire length. Its eight middle rays are bifurcated on their posterior half, and at their tip there seems to be a slight indication of a second bifurcation. The ventrals are inserted immediately under the first ray of the anterior dorsal, and when bent backwards do not reach the anus. The base of the pectorals is oblique, but not crescent-shaped; if directed backwards their tip will reach the third ray of the second dorsal, and leave the anal behind them. Their rays, fourteen in number, are undivided, and the six lower ones, shorter and thicker, extend beyond the membrane of that fin.

Br. 6. D VII.—17. A 12. C 3. I. 4. 4. I. 2. V I. 3. P 14.

The vent is situated nearly midway between the extremity of the snout and the insertion of the caudal fin.

The lateral line is quite conspicuous even on the tail, where it is reduced to cutaneous pores. Its fall on the peduncle of the tail is convex upwards, and rather near the caudal fin.

The ground color appears to have been olivaceous yellow, marbled with black, the marblings extending likewise to the fins.

For a specimen of four inches, that which we have had figured, we are indebted to the kindness of Rev. Z. Thompson, of Burlington, to whom it was presented by Mr. Ransom Colberth, who caught it in June, 1844, while fishing for the Brook Trout in a branch of Lamoille River, in the town of Johnson, Lamoille County (Vt.). The Lamoille River empties into Lake Champlain, about ten miles north of Burlington. This species, therefore, ranges west of the Green Mountains.

XI. COTTUS BOLEOIDES, Girard.

Plate II. Figs. 7 and 8.

Syn. *Cottus boleoides*, Girard, Proc. Amer. Assoc. Adv. of Sc. II., 1850, p. 411; and, Proc. Bost. Soc. Nat. Hist. III., 1850, p. 189.

Had the name of *gracilis* not been preoccupied to designate another species of this genus, the one here referred to would have deserved it with great propriety.

Indeed, although of medium size, it is slender and elongated. The outline of the head and back is regular and slightly arched; that of the lower part of the head and belly is nearly straight. The sides are full and rounded. The body is consequently subfusiform. Its greatest depth is contained six times and a half in the total length, while the least depth, in advance of the caudal, enters in it nearly twenty times. The thickness is one-fifth less than the depth.

The head forms a little less than the fourth of the total length; it is nearly as deep as broad, but its length is much greater than its width. Its upper surface back of the eyes is slightly flattened; the anterior part slopes quite rapidly, rendering the snout very obtuse; the jaws are rounded and of equal length. The mouth is proportionally broad; when it is shut, the posterior extremities of the maxillaries extend to a line passing through the pupil. The eyes are very large and subcircular; their longitudinal diameter is contained only four times in the length of the head. They come very near each other on the frontal line, and are separated by a very narrow space, narrower than in any other species. The anterior nostrils are a little nearer the orbit than the end of the snout. The preopercular spine is very acute, although stout at its base, and directed obliquely upwards; the spine on the subopercular is very minute. The gill openings are large and oblique; the isthmus is only three-sixteenths of an inch wide.

The fins in this species are proportionally much more developed than in any other within our knowledge. The pectorals, especially, would soon recall to mind the different kinds of flying fish. The origin of the first dorsal is placed seven-eighths of an inch from the end of the snout. It is very convex; there are eight or nine rays on a base of half an inch, the first one being the shortest. The greatest height of that fin is not quite a quarter of an inch. The second dorsal is considerably higher than the first, and twice as long, and is composed of seventeen rays, all undivided. The anal commences under the second ray of the second dorsal, and terminates under the thirteenth; it is much higher than the latter, and also more convex. It contains sometimes eleven, and sometimes twelve undivided rays. The caudal is much elongated, posteriorly subtruncated, forming the fifth of the entire length. The eight middle rays bifurcate from the middle of their length, and it can scarcely be said that two of them exhibit a tendency to subdivide again near their extremity. The ventrals are inserted under the base of the pectorals, and in advance of the first dorsal; they reach, and even extend beyond the vent when bent backwards. Amongst the three soft rays, the middle one is the longest, and the internal one, the shortest. The insertion of the pectorals is very oblique, and crescentic; their form is elliptic or oval, quite regular, and their tip, when directed backwards, reaches the fourth ray of the anal, and the sixth of the second dorsal. All the rays are undivided; the seven inferior ones are much stouter, and extend beyond their membrane.

Br. 6. D VIII or IX.—17. A 11 or 12. C 2. I. 4. 4. I. 2. V I. 3. P 14.

The vent is placed midway between the extremity of the snout and the base of the caudal fin, as in the preceding species.

The lateral line is rectilinear, disappearing already under the tenth ray of the second dorsal; but the minute pores, which mark its continuation to the caudal, become very indistinct, running in a straight line, always nearer the back, when a gradual fall brings it on the middle of the peduncle of the tail; five or six very large pores are seen on each side underneath along the lower jaw. These, as we have seen above, belong to that cephalic channel of the lateral line, which, from the occipital region, passes down into the preopercular and lower jaw. The same pores exist in the other species, but nowhere did we find them so conspicuous.

The remains of coloration left on such specimens as have been preserved in alcohol, indicate a grayish ground above, turning to yellowish underneath. The top of the head, and upper part of the body, are scattered all over with small, well-defined dots of black, of the size of a pin's head; the sides and tail exhibit large and irregular brown patches, surrounded by an orange tint, which becomes the predominant color of the lower part of the body. The pectorals, dorsals, and caudal, are slightly banded and dotted with black like the body itself.

A series of individuals of this species, the largest of which had three inches and a quarter, was first collected at Windsor (Vt.), by Ed. Cabot, Esq., of Boston. Dr. D. H. Storer had in his possession two small ones from the same vicinities.

Specimens are preserved in Prof. Agassiz's Cabinet, and at the Smithsonian Institution.

XII. COTTUS FORMOSUS, Girard.

Amongst the macerated remains of *Triglopsis Thompsonii*, described further on, we detected the body of a Cottus, in a similarly mutilated state. After instituting all the comparisons which could possibly be made, we became fully satisfied that we had to deal with a distinct and undescribed species, although not quite prepared to give a full and satisfactory description of it. Its most striking peculiarities are a small head, a slender and graceful body, with the two dorsals widely separated. The entire length, from the snout to the extremity of the caudal fin, is three inches and a quarter, in which length the head enters for about the fifth part. The upper surface of the head is very flat, and the eyes of medium size, circular, and very proportionate. The anterior and inferior part of the head are destroyed in the specimen under examination, so that we are at a loss to describe the nostrils, the shape of the mouth, the isthmus, as well as to state how many times the diameter of the eye is contained in the length of the head. The preopercular spine is stout and rather short, acute, and curved. There exists on the same bone a small spine, situated under the first, and directed obliquely downwards and backwards. The subopercular spine is well developed, acute, and curved upwards, being as usual directed forwards. The greatest thickness, and depth of the body cannot be given under the existing circumstances; but the least depth, taken on the peduncle of the tail, is contained nearly eighteen times in the total length, being about three-sixteenths of an inch. The body itself seems to have been regularly fusiform.

The anterior edge of the first dorsal is situated at thirteen-sixteenths of an inch from the snout. It is composed of eight rays, extending on a basis of half an inch. Its upper edge is regularly arched. The second dorsal is separated from the first by a space of nearly a quarter of an inch, filled by a membrane which extends between both fins. The rays, sixteen in number, are very slender and unbranched, the two anterior ones shorter than the third. There is a free space of a quarter of an inch between the posterior end of the second dorsal and the base of the caudal fin. The caudal itself is rounded posteriorly, convex, composed of eleven rays, and a few rudimentary ones; those of the middle of the fin, are branched towards their extremity; its length is contained six times and a half in the total length. The origin of the anal takes place under the third ray of the second dorsal, and leaves a space of nearly half an inch between its posterior end and the beginning of the caudal. The ventrals are situated under the pectorals, in advance of the anterior dorsal; when bent backwards, they are very far from reaching the vent. The base of the pectorals is crescent-shaped and very close to the gill openings. These fins are rather short, composed of twelve or thirteen unbranched rays, and when bent backwards, their tips do not reach the posterior margin of the first dorsal, and consequently not the anterior margin of the anal.

Br. 6. D VIII.—16. A 11. C 2. I. 5. 4. I. 1. V I. 3. P 12.

The lateral line runs straight, and near the back. It passes into the series of minute pores before it reaches the end of the second dorsal, and its fall on the peduncle of the tail is indicated by a slight undulation. The cephalic channels appear to be very much developed, perhaps more so than in any other species of the genus, if we judge of them by the wide duct which passes through the preopercular.

The vent is nearer the base of the caudal than the end of the snout.

Nothing can be said about the color, on account of the circumstances under which the specimen was found.

The species inhabits Lake Ontario, in the vicinity of Oswego (N. Y.), in company with *Triglopsis Thompsonii*, constituting a part of the food of *Lota maculosa*.

The only specimen hitherto known of this species was collected by Prof. Baird, and is now preserved at the Smithsonian Institution.

XIII. COTTUS FABRICII, Girard.

Syn. *Cottus Fabricii*, Girard, Proc. Amer. Assoc. Adv. Sc. II., 1850, p. 411; and, Proc. Bost. Soc. Nat. Hist. III., 1850, p. 189.
Cottus gobio, Fabr. Faun. Grœnl. 1780, p. 159.
Cottus tricuspis (Mus. Reg.). Graah, Reise Östk. Grönl. 1832, p. 194.

In the Fauna of Greenland, we find one species of true Cottus, identified by O. Fabricius with *C. gobio* of the authors of Northern Europe. But there would be a very remarkable peculiarity in the habits of this species, if it be true that it lives in company with *Acanthocottus scorpius* and *scorpioides*, and consequently in salt water. We are not prepared to tell how far fresh water Cotti may be accommodated in a saline medium, but it seems to us much more probable that the Greenland Acanthocotti themselves, like those of New England, leave the sea at a certain season, ascend the fresh water inlets, and then may be found in company with the Greenland Miller's Thumb. On the other hand, if we take into account the reduced saltness of the Arctic Sea, we can easily conceive how a fresh water fish may occur at the entrance of streams or rivulets emptying into the bays. If in the Temperate Zone, the Miller's Thumbs keep far away from the sea-shore, in the Arctic Zone, they may reach the sea without extending into its depth.

At any rate we have here a true Cottus, since Fabricius, who could not be mistaken respecting *C. gobio*, identifies it with the latter. Besides, his diagnosis leaves no doubts on the subject, "smooth with two spines on the head." Now this may be said of all the species of the genus without exception. Then, without giving its size, he tells us that it is much smaller than the *Cottus* (Acanthocottus) *scorpius* and *scorpioides*. Although very similar to *C. gobio*, we consider it as a distinct species. And if Fabricius be correct in the formula of the fins, we notice a fact which excludes at once the idea of identity with either *C. cognatus* or *C. Richardsonii*;

it is the presence of three soft rays to the ventral fins. It cannot be identified with *C. Franklinii*, although the ventrals of the latter possess only three soft rays; nor is it the *C. affinis* of Scandinavia which has again one soft ray more to its ventrals. Although the absolute number of the rays of the other fins does not constitute a specific character of unvariable constancy, that number is so peculiar in this case that it can be provisionally taken into account until the study of this species can be completed hereafter.

Br. 6 D X.—17. A 18. C 12. V I. 3. P 19.

Oth. Fabricius adds nothing special on the structure of the fins. He says that both dorsals are contiguous by a low membrane. This is the case with nearly all the Cotti and many Acanthocotti. We quote from his description the following details respecting the coloration. "The iris is silvery. The skin smooth, with a somewhat rough lateral line; sometimes the region behind the eyes and beneath the pectoral fins is also rough. Color of the back blackish, the sides white spotted. The belly paler, with white spots, which are silvery behind the anus. The breast and under part of the tail are white. Pectoral fins blackish, sinuated by a paler coloration, with their lower margin red. Second dorsal of the same color, but not bordered with red. First dorsal blackish. Ventrals white, with reddish spots. Anal reddish. Caudal palish. The female differs by its belly being not spotted, below whiter, and yellow dark-spotted ventrals."

This coloration strikes us as much more similar to that of Acanthocotti than to anything we know amongst Cottus proper.

The same author says that this species frequents sandy and argillaceous bottoms, and that its food consists of fishes (Ammodytes), holothuria (*H. priapus*), marine worms, and others living in the sand and clay.

The female deposits her white eggs amongst the Ulva, where they are watched by the male, as is the case with the lump fish and *A. scorpioides*.

That the lump fish (*Lumpus anglorum*) on the coasts of New England watches its eggs we have been often told by fishermen. We never heard whether sculpins (Acanthocotti) did the same.

At any rate nothing of the kind has, as yet, been observed amongst Cottus proper, and thus there would be in the history of this species a peculiarity unknown in the others, and which recalls to mind analogous facts observed amongst European sticklebacks.

CHAPTER IV.

ON THE GENUS COTTOPSIS, Girard.

We have proposed this genus[1] for the reception of one species placed by its author in the genus Cottus, at the time when the latter still included the marine species. It differs both from Cottus and Acanthocottus. By its large size it recalls to mind the marine species, and by its smooth head, the species of the fresh water. Its physiognomy, as a whole, partakes of both of these groups. Yet as it belongs to the fluviatile fauna, it is more nearly related to the fresh water species by its first dorsal lower than the second, by the structure of the other fins, the opercular apparatus, and the shape of the mouth.

The characters of the genus Cottopsis may thus be expressed: General form regular, fusiform, or subcylindrical. Body covered with a skin beset with prickles, instead of being smooth and scaleless. Head deeper than broad; shape of the head and cleft of mouth like those of Cottus. A preopercular spine only on each side; card-like teeth on the palatine bones.

The obtuse head, the cleft of the mouth, which does not extend beyond the eyes, the first dorsal lower than the second, and the prickly skin, are the essential characters by which this genus is distinguished from Acanthocottus, whilst the palatine teeth and the dermic prickles constitute its difference from Cottus proper. We have mentioned that in some Cotti teeth began to be perceived on the palatines, which character we consider as an approximation towards the Cottopsis, in which those teeth are fully developed, and perhaps more so in the adult than in the immature state.

Sir John Richardson foresaw the necessity of withdrawing one day the species here referred to from the genus Cottus, and suggested[2] that it would very likely be brought into the genus Hemilepidotus, on the ground perhaps of the presence in the latter of palatine teeth. But, as he remarks himself, Hemilepidoti have the body partly covered with scales, whilst in this case the skin is provided with prickles of a peculiar character. The spiny head of Hemilepidotus, as well as the fact that it is an inhabitant of the sea, bring that genus nearer the Acanthocotti, and is to the latter what Cottopsis is to Cotti. On the other hand, the unique dorsal of Hemilepidoti and their palatine teeth, indicate a closer relationship with *Scorpæna*, also a marine genus.

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[1] Proc. Bost. Soc. Nat. Hist., iii., 1851, p. 303.

[2] Fauna Boreali-Americana, iii., 1836, p. 313.

Mr. Heckel has placed the *C. asper* in his genus *Trachidermis*, to which it bears only analogies and no true affinities. The genera Trachidermis and Cottopsis have both a rough or prickly skin, and teeth on the palatine bones; but Trachidermis has the first dorsal, the mouth, the opercular spines, and the general shape of head and body, of Acanthocotti. Cottopsis has the first dorsal, the mouth, the opercular spine, the general shape of the head and body, of Cotti. The genus Trachidermis is the diminutive of Acanthocotti, provided with a rough skin and teeth on the palatines. The genus Cottopsis, on the other hand, is the amplification of Cotti, provided with a rough skin, and teeth on the palatine bones.

Besides all this, Trachidermis belongs to the marine tribe. Its relationships are complete.

Some time since, Sir John Richardson made the genus *Centridermichthys*[1] to include two cottoids of the seas of China and Japan, with which he proposed to associate his *C. asper*. But Centridermichthys we have shown to be identical with Trachidermis, in which the marine species must be placed.

COTTOPSIS ASPER, GIRARD.

Syn. *Cottopsis asper*, GIRARD, Proc. Bost. Soc. Nat. Hist. III., 1850, p. 303.
Cottus asper, RICH. Faun. Bor. Amer. III., 1836, pp. 295, 313. Pl. 95, Fig. 1.
Trachidermis Richardsonii, HECK. Ann. d. Wien. Mus. II., 1837, p. 162.
Centridermichthys asper, RICH. Ichth. of the Voy. of the Sulphur, 1844, p. 76.

This fish we know only through the description and figures given by Sir John Richardson. Its ordinary size is from nine to ten inches, surpassing thus in size all the fresh water species of the genus Cottus. To judge of the general form from the profile view, the body would appear quite regular, diminishing gradually in depth from before backwards. The back and belly are nearly straight and very regular, until the termination of the dorsal and anal fins.

The head forms the third of the length, the caudal fin excluded. Its upper surface is flattened or rather widely concave, without the least trace of ridges, tubercles, or spines. The inferior lip projects a little beyond the superior one when both jaws are brought close together. The mouth is broad, but not deeply cleft. The palatine bones are furnished with teeth similar to those on the vomer, premaxillaries, and dentaries.

The eyes are of medium size, and placed near the summit of the head; yet the distance which separates them above is more than one of their diameter. The nostrils, situated on the same horizontal line with the eyes, are small and a little nearer the snout than the orbit.

The opercular apparatus, as far at least as we could understand it, does not appear to differ much from that of Cotti. None of its constituent pieces are serrated or provided with spines on their edge. The convexity of the preopercular is armed with an acute spine, slightly curved upwards and covered by the skin so

[1] Ichthyology of the Voyage of the "Sulphur," 1844, p. 74.

as scarcely to be seen exteriorly. The inferior edge of the preopercular terminates in two distinct angular points. Finally the scapular is terminated by an acute point which is concealed under the skin, and perceptible only to the touch.

"There are no scales; the skin on the head is smooth to the touch, but dotted on the crown with minute soft warts. The belly, a stripe adjoining the anal on each side, a small space around the base of the caudal, and the interscapular space anterior to the first dorsal, are also smooth; but the rest of the skin of the body is thickly studded with very small subulate, acute spines directed backwards. These spines are too minute to be seen distinctly with the naked eye; but a little fold of skin, raised by each of them, produces a roughness which is very visible; they resist the finger only when it is drawn against their points."

"The lateral line, formed by a furrow, interrupted by about forty-four contractions, is very conspicuous."—RICHARDSON.

The origin of the first dorsal is opposite the base of the upper ray of the pectorals; it is much lower than the second, to which it is connected by means of a membrane. The sixth and seventh rays are the longest. The second dorsal commences opposite the anus, and extends a little farther back than the anal, as is usually the case in Cotti. The anal is proportionally lower than in Cotti, and, therefore, much lower than the second dorsal, if we judge of it by the figure given in the *Fauna Boreali-Americana.* The caudal is slightly rounded posteriorly, whilst its base of insertion is somewhat dilated or spread out. The peduncle of the tail is quite narrow. The ventrals are situated under the pectorals as in Cotti. There exists an anterior bony ray, and four soft but unbranched ones. The pectorals are obliquely suboval, and their rays unbranched.

Br. 6. D IX.—21. A 18. C 6. I. 4. 3. I. 6. V I. 4. P 16.

This species, according to Dr. Gairdner, is quite common in the Columbia River. To him Dr. Richardson was indebted for the specimens from which his description was drawn and the figures made. Specimens were collected by the United States Exploring Expedition.

For our description of this species, as well as of *C. cognatus,* we are indebted to the Fauna Boreali-Americana.

CHAPTER V.

ON THE GENUS TRIGLOPSIS,[1] Girard.

THERE are animals whose organization is specially adapted for the depths, and which are never or but seldom seen or met with at the edges of the water, on the sea beaches, or else on the shores of the lakes. The iron dredge has brought to light many such.

There is another way of securing the inhabitants of the deep bottoms, which consists in opening the stomachs of the large wandering kinds, as they generally feed upon the small and inoffensive ones. The sole difficulty in this case is the digestive power of that organ, which in a short time has destroyed all the soft and delicate parts, the ornament of the solid frame, either bony or calcareous.

The generic feature of Triglopsis does not consist in the possession of characters peculiar to itself alone, but rather in the association of characters which may individually be found to exist in other genera, and from whose combination results its peculiar physiognomy.

The general form of the head and body reminds us of the genus *Trigla;* by its smooth head, the structure of the mouth, and the first dorsal lower than the second it approaches Cotti; the elongated snout and head, and the presence of several spines on the preopercular, is an approximation towards Acanthocotti. The genus differs—from Trigla, by a smooth head and body, the first not being cuirassed, and the second not scaled, and by the first dorsal fin which is lower than the second;—from Acanthocottus, by the want of spines on the head, which, as stated, is smooth; also by the first dorsal lower than the second, and by the shape of the mouth, the angles of which do not extend back of the eyes; and if it appear more deeply cleft than in Cottus, it is owing to the fact that the snout is pointed instead of being truncated;—from Cottus it differs by its elongated snout and the presence of several spines on the preopercular, on the one hand, and by its more slender head and body, on the other. It is still more widely distinct from Cottopsis, with which it has no other affinities except those which entitle it to a place in the same family.

Although our genus Triglopsis has no generic character belonging exclusively to it, it is important that we should recapitulate all those which we have just enumerated, in connection with the genera which partake of some of them. Body and

[1] Proc. Bost. Soc. Nat. Hist. iv., 1851, p. 18.

head slender and elongated, the former tapering quite rapidly away towards the tail; both covered with a smooth skin; no teeth on the palatine bones; cleft of the mouth not extending beyond the eye; preopercular exhibiting four equal, needle-like, and very delicate spines. The first dorsal fin is separated from the second by a considerable space, and is much the lower. The great development of the second dorsal and the very large eyes might become a specific feature if other species were to be discovered hereafter, for which reason we would not mention them as of generic value. The lateral line, the perfectly smooth skin, and the absence of an isthmus may become as many generic characters.

The structure of the skull of Triglopsis exhibits the remarkable character of having hollow channels, hitherto only known to exist in Sciænoids, and considered as a characteristic of this group. We now find amongst Cottoids a similar structure, but much less developed in Cotti and Acanthocotti, in which we had overlooked it, before we knew the genus Triglopsis.

This anatomical peculiarity indicates quite a near relationship between Cottoids and Sciænoids. The representatives of the latter family in this country are all marine, but one.

TRIGLOPSIS THOMPSONII, Girard.

Plate II. Figs. 9 and 10.

Syn. *Triglopsis Thompsonii*, Girard, Proc. Bost. Soc. Nat. Hist. IV., 1851, p. 19.

It will be easy to form a correct idea of the general form of this species by the accompanying figures, which, although a restoration from several incomplete individuals, we are confident represent its specific features.

The head is elongated, tapering towards the snout, as the body tapers towards the tail. It forms more than the third, and not quite the fourth of the entire length. Its upper surface is smooth, gradually sloping towards the snout. Its greatest depth is contained twice in its length; whilst its greatest width forms only the two-thirds of the latter dimension. The snout is elongated, and thus the mouth, which does not extend beyond the entire pupil, is more deeply cleft than in Cotti. The lower jaw is slightly longer than the upper. The teeth are very minute, proportionally more so than in Cotti. They do not exist on the palatines, but the vomer, besides the crescentic band in front, is provided with a narrow strip of similar teeth along the middle line of the posterior branch of that bone. The eyes are very large and elliptical; their longitudinal diameter is contained four times in the length of the head, the same proportion as in many Cotti, but here the head is much more elongated, and accounts for the proportionally greater size of these organs in Triglopsis. The anterior nostrils are nearer the orbit than the snout; the posterior one is higher up on the frontal line, and still nearer the eye. Both pairs of these openings appear to be tubuliform, but the decomposed state of the specimens did not permit entire satisfaction on that point. The sides of the head are as smooth as the upper surface. The preopercular is the only bone of this region provided with spines, and the latter are comparatively smaller and more slender than amongst Cotti. There exist usually four of these spines, the uppermost, the strongest, directed obliquely upwards. The second is directed backwards; the third and fourth, the smallest, downwards. The branchiostegals are six in number, as in Cotti and Acanthocotti. The gill openings extend from the head obliquely down, each meeting its fellow from the opposite side under the medial line of the head, so that there exists no isthmus at all.

The greatest depth of the body is a little more than that of the head, and contained nearly seven times in the entire length of the fish. The least depth on the peduncle of the tail enters in the same length nearly twenty-three times, six times in the length of the head, fourteen times in that of the body, and nearly three in that of the caudal fin. The thickness is less than the depth, and diminishes very rapidly backwards.

The origin of the anterior dorsal is one inch and three-eighths distant from the end of the snout. It is composed of seven rays with a basis of half an inch. The first and last rays are the smallest, and nearly equal the one to the other. The second, third, and fourth are much higher, and of nearly equal length also. The second dorsal, much higher, is separated from the first by a space of three-sixteenths of an inch. Its anterior ray is not higher than the last of the anterior dorsal; its greatest height is three times that of the latter. Its shape is angular. It is composed of eighteen slender and undivided rays. The anal commences slightly in advance of the second dorsal; is about half the height of the latter, uniformly convex on its outer margin, and composed of fifteen rays, all undivided, the last one opposed to the fifteenth of the second dorsal. The caudal is rounded posteriorly, with ten well developed rays, eight of which are bifurcated. The ventrals are inserted under the pectorals, and in advance of the anterior dorsal, as in Cotti. They are composed of three soft rays and a spiny one, and when bent backwards, do not reach the anus. The insertion of the pectorals is crescentic and close to the gill openings. These fins are not quite as long as the head, and contain sixteen rays all undivided, the tip of the longest reaching nearly to the second ray of second dorsal and of the anal.

Br. 6. D VII.—18. A 15. C 1. I. 4. 4. I. 1. V I. 3. P 16.

The anus is at a distance of three-sixteenths of an inch from the first ray of the anal and situated almost midway between the tip of the snout and the base of the caudal fin, though a little more distant from the former. The lateral line is very much developed and very conspicuous until the eighth ray of the second dorsal, where it becomes less distinct, although running to the base of the caudal fin. The skin is perfectly smooth.

The ground color is uniform pale greenish-yellow, dotted and maculated with black or brown on the head, back, and sides. The caudal, pectoral, and dorsal fins are banded; the anal and ventrals, unicolor.

This species inhabits somewhere in the depths of Lake Ontario, but has not yet been seen or caught alive, either by fishermen, or by naturalists. The manner in which its discovery took place we have already related.[1] In opening the stomach of the Ling (*Lota maculosa*), the fishermen of Oswego finding it almost constantly filled with that fish, had entertained the erroneous opinion that the Ling swallowed its progeny. Professor Baird, who visited that place in 1850, and heard the story, secured specimens, which at once enabled him to recognize in them a fish new to science although half digested, the skin and the fins in most cases destroyed. In that state, when the head and body alone have preserved their shape, the elongation of the former, and the tapering away of the latter, may remind superficial observers of the elongated head and the tapering body of *Lota maculosa*.

It is hoped that persons living in the vicinity of Oswego, will feel interested enough in the subject to secure to science complete specimens, and gather some information respecting its habits and home at large.

Its food consists chiefly of shrimps, of a species yet undescribed, as far as we have been enabled to ascertain by the examination of the remains in a very soft condition.

Attention should be directed on all the fishing-grounds of the Ling, to the contents of the stomachs of this fish, as at present the only way known of procuring Triglopsis. By this means, at least, we should become acquainted with its geographic distribution; for mere remains, when they cannot be mistaken, are always sufficient to establish its occurrence at any given place, should complete and fresh specimens escape all researches.

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[1] Proc. Bost. Soc. Nat. History, iv., 1851, p. 18.

NOTE.

Since the foregoing pages have been put to press, a new fact touching the geographical distribution of *Cottus meridionalis*, has come to our knowledge, which is deemed of sufficient interest to be placed on immediate record here. This species has been found in one of the lower tributaries of the Potomac, in Rock Creek, Washington (D. C.). Consequently *C. meridionalis* occurs in the same hydrographical basin as *C. viscosus*.

It is well known that the aquatic fauna of the Southern States is very different, both from that of the Middle and that of the Northern. There are comparatively few species which occur throughout the Atlantic States of the Union. Still, faunas and floras, although circumscribed within particular provinces or districts, cannot be defined in their boundaries by mathematical lines, and we frequently find districts whose lines of demarkation overlap or interdigitate.

Now the State of Maryland seems to be placed on the limit, between the faunas of the Southern and Middle States, a fact which will make the study of its natural productions much more difficult, but at the same time of more than ordinary interest.

The locality, Rock Creek, Washington (D. C.), given at page 53 to *C. viscosus*, does not belong to the latter species, to which it was temporarily attributed before an examination of the specimens could be made critically. After this was effected, an oversight has allowed it to remain there.

DIAGNOSIS

OF THE

GENERA AND SPECIES

CONTAINED IN THIS

MONOGRAPH.

COTTUS, Artedi.—Upper surface of head, smooth. One small spine on the side of the head; sometimes a second still smaller below, and occasionally a third of the size of the second. First dorsal fin lower than the second. Palatine teeth none, or rudimentary. Cleft of mouth not extending beyond the orbits. Six branchiostegal rays.

I. Rays of ventral fins, five in number.

Cottus cognatus, Rich.—Body fusiform. Origin of anal fin opposite to sixth ray of second dorsal. Pectorals equalling the head in length. Anus situated nearer the snout than the base of caudal fin.

Cottus Richardsonii, Agass.—Body fusiform. Origin of anal fin opposite to third ray of second dorsal. Pectoral fins shorter than the head. Anus situated midway between the snout and tip of caudal fin. Insertion of ventrals in advance of the anterior dorsal, and near the lower edge of pectorals.

Cottus Wilsonii, Grd.—Body fusiform. Upper rays of pectoral fins, branched; their tip reaching the anterior margin of second dorsal fin. Insertion of ventral fins under the middle of pectorals, and in advance of the anterior dorsal.

Cottus Bairdii, Grd.—Body fusiform. First dorsal fin very low. Tip of pectorals extending be-

DIAGNOSIS

GENERUM ET SPECIERUM

IN HOC

MONOGRAPHO

DESCRIPTORUM.

COTTUS, Artedi.—Capitis superficie levi; spinâ parvâ ex capitis latere utroque, interdum alterâ aliquanto minore, infra positâ, et nonnunquam tertia magnitudine æquali secundæ. Pinna dorsali prima breviore secundâ. Dentibus palatinis nullis, vel eorum rudimentis tantum. Oris fissura ultra orbitas non porrectâ. Radiis branchiostegis sex.

I. Pinnarum ventralium radiis, quinque.

Cottus cognatus, Rich.—Corpore fusiforme. Origine pinnæ analis ex adverso sexto secundæ pinnæ dorsalis radio. Pinnis ventralibus capite longitudine æqualibus. Ano propius rostrum quam pinnæ caudalis basim posito.

Cottus Richardsonii, Agass.—Corpore fusiforme. Origine pinnæ analis ex adverso tertio secundæ pinnæ dorsalis radio. Pinnis pectoralibus capite brevioribus. Ano medio inter rostrum et pinnæ caudalis extremitatem. Pinnis ventralibus ante dorsalem anteriorem et prope inferiorem pectoralium marginem, insertis.

Cottus Wilsonii, Grd.—Corpore fusiforme. Superioribus pinnarum pectoralium radiis divisis, eorumque extremitate ad anteriorem pinnæ dorsalis secundæ marginem porrectâ. Pinnis ventralibus sub pectoralium medio et ante dorsalem anteriorem, insertis.

Cottus Bairdii, Grd.—Corpore fusiforme. Pinnâ dorsali primâ admodum brevi. Extremitatiyond the anterior margin of the anal. Insertion of ventrals under the anterior margin of first dorsal, and behind the pectorals.

Cottus Alvordii, Grd.—Body stout and short, tapering rapidly away. A second preopercular spine, very minute. Origin of anal fin opposite the third ray of second dorsal. Tip of pectorals extending beyond the anterior margin of the second dorsal and anal fins. Insertion of ventrals near the lower edge of pectorals, in advance of the anterior dorsal.

Cottus meridionalis, Grd.—Body stout and short. A second and third, very minute spines on the preopercular. Origin of anal fin opposite to fourth ray of second dorsal. Tip of pectorals not reaching the anal. Insertion of ventrals even with the lower edge of the pectorals, in advance of the anterior dorsal.

II. Rays of ventral fins, four in number.

Cottus gracilis, Heck.—Body fusiform. Tip of pectoral fins extending beyond the fourth ray of second dorsal, and first of anal fin. Occasional palatine teeth. Insertion of ventrals under the pectorals, and in advance of anterior dorsal.

Cottus viscosus, Hald.—Body subcylindrical, stout. Tip of pectorals not reaching the anterior margin of the anal. Insertion of ventrals behind the pectorals, and in advance of the anterior dorsal.

Cottus Franklinii, Agass.—Body nearly cylindrical. Tip of pectoral fins not reaching the anterior margin of second dorsal. Insertion of ventrals in advance of the anterior dorsal, and under the middle of pectorals.

Cottus gobioides, Grd.—Body subcylindrical. Tip of pectoral fins not reaching the anal. Insertion of ventrals under the upper edge of the pectorals.

Cottus boleoides, Grd.—Body fusiform, slender. Tip of pectoral fins extending beyond the fifth ray of second dorsal, and third of anal, fins.

bus pinnarum pectoralium ultra anteriorem pinnæ analis marginem prolatis. Pinnis ventralibus sub anteriorem marginem pinnæ dorsalis primæ et post pectorales, insertis.

Cottus Alvordii, Grd. — Corpore crasso brevique citò decrescente. Altera spina præopercu-lari, admodum parva. Origine pinnæ analis posita ex adverso tertio pinnæ dorsalis secundæ radio. Extremitatibus pinnarum pectoralium ultra anteriorem pinnarum dorsalis secundæ et analis marginem porrectîs. Pinnis ventralibus prope inferiorem pectoralium marginem et ante dorsalem anteriorem, insertis.

Cottus meridionalis, Grd. — Corpore crasso brevique. Spina minima secunda atque tertia supra præopercularem. Origine pinnæ analis ex adverso quarto dorsalis secundæ radio. Extremitatibus pinnarum pectoralium non porrectîs ad pinnam analem. Pinnis ventralibus in eadem lineâ quâ pectorales, et ante dorsalem anteriorem, insertis.

II. Pinnarum pectoralium radiis, quatuor.

Cottus gracilis, Heck.—Corpore fusiforme. Extremitatibus pinnarum pectoralium ultra quartum pinnæ dorsalis secundæ et primum analis radium porrectîs. Dentibus palatinis aliquando occurentibus. Pinnis ventralibus sub pectorales et ante dorsalem anteriorem, insertis.

Cottus viscosus, Hald.—Corpore subcylindrico, crasso. Extremitatibus pinnarum pectoralium non porrectîs ad anteriorem pinnæ analis marginem. Pinnis ventralibus post pectorales et ante dorsalem anteriorem, insertis.

Cottus Franklinii, Agass.—Corpore cylindrico. Extremitatibus pinnarum pectoralium non productis ad anteriorem pinnæ dorsalis secundæ marginem. Pinnis ventralibus ante dorsalem anteriorem et sub pectoralium medio, insertis.

Cottus gobioides, Grd.—Corpore subcylindrico. Extremitatibus pinnarum pectoralium non productis ad pinnam analem. Pinnis ventralibus sub superiorem pectoralium marginem, insertis.

Cottus boleoides, Grd.—Corpore fusiforme, gracile. Extremitatibus pinnarum pectoralium ultra quintum pinnæ dorsalis secundæ, et tertium analis

Insertion of ventrals in advance of the anterior dorsal, near the lower edge of pectorals.

Cottus formosus, Grd.—Body fusiform. Tip of pectoral fins not reaching the anterior margin of second dorsal. A second minute preopercular spine, directed downwards.

Cottus Fabricii, Grd.—Head having a tendency to become tuberculous. First dorsal and pectoral fins composed of several rays more than in any other species of the genus.

COTTOPSIS, Grd.—Head smooth. One spine on the preopercular, bent backwards and upwards as in Cotti. First dorsal fin lower than the second. Teeth on the palatine bones. Skin beset with minute prickles.

Cottopsis asper, Grd.—Tip of pectoral fins reaching scarcely the anterior margin of the second dorsal. Anal fin low. Lateral line extending uninterruptedly from head to base of caudal fin.

TRIGLOPSIS, Grd.—Head smooth. First dorsal fin lower than the second. No teeth on the palatine bones. Several radiating spines on the edge of the preopercular. Skin smooth.

Triglopsis Thompsonii, Grd.—First dorsal fin separated from the second by a considerable space. Second dorsal very elevated. Lateral line extending from head to the base of caudal fin.

radium porrectîs. Pinnis ventralibus ante anteriorem dorsalem et prope inferiorem pectoralium marginem, insertis.

Cottus formosus, Grd.—Corpore fusiforme. Extremitatibus pinnarum pectoralium non productîs ad anteriorem dorsalis secundæ marginem. Secundâ spina præoperculari minutâ deorsum directa.

Cottus Fabricii, Grd.—Capite ad tubercula habenda proclivi. Radii pinnarum dorsalium et pectoralium pluribus quàm ullâ specie hujus generis.

COTTOPSIS, Grd.—Capite levi. Unâ spinâ e præoperculari, flexa retrorsum et sursum, ut in Cottis. Pinna dorsali primâ breviore secunda. Dentibus in ossibus palatinis. Cute minutis aculeis hirsuta.

Cottopsis asper, Grd.—Extremitatibus pinnarum pectoralium vix productîs ad anteriorem secundæ pinnæ dorsalis marginem. Pinna anali brevi. Lineâ laterali non interruptâ a capite ad pinnæ caudalis basim.

TRIGLOPSIS, Grd.—Capite levi. Primâ dorsali pinnâ breviore secundâ. Dentibus ex ossibus palatinis nullis. Spinis compluribus radiantibus ex margine præopercularis. Cute levi.

Triglopsis Thompsonii, Grd.—Pinnâ dorsali primâ a secunda spatio aliquanto sejuncta. Pinna dorsali secundâ altissimâ. Lineâ laterali a capite ad basim pinnæ caudalis porrectâ.

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EXPLANATION OF THE PLATES.

Plate I, and Figs. 1—10 of Plate II, need no further explanation beyond what is written at the bottom of those plates.

Plate II, Fig. 11, represents the skeleton of *Triglopsis Thompsonii.* At pages 21, 22, we have alluded to some deficiencies in the general figure. The numbers appended to the bones of the face, as well as the initials, are those adopted by Prof. Owen. The numbers 1—12, which accompany the vertebræ, do not indicate their number in the series; we have allowed these numbers to be affixed in order to be more precise in alluding to any one of them. All these pieces have been homologized with those of *Cottus viscosus* on Plate III, of which a table is given immediately below.

Plate III, Figs. 1—3, represent the muscular masses of *C. viscosus,* and the peculiar bendings of the myocomma, seen in profile in Fig. 1, from the belly in Fig. 2, and from above in Fig. 3.—Fig. 4 represents the muscles which move the branchiostegal apparatus.—Fig. 5 is a general view of the skeleton of *C. viscosus.*—In Fig. 5^a, the bones of the face and scapular arch are exhibited; in Fig. 5^b, the hyoidean apparatus; in Fig. 5^c, the branchial apparatus; in Fig. 5^d, the ventral fins; and in Fig. 5^e, some of the pieces constituting the trunk.

8′. Supramastoids.
13. Vomer.
19. Turbinal.
20. Palatine.
21. Maxillary.
22. Premaxillary.
23. Entopterygoid.
24. Pterygoid.
25. Epitympanic.
26. Mesotympanic.
27. Pretympanic.
28. Hypotympanic.
29. Articular.
30. Angular.
31. Splenial.
32. Dentary.
34. Preopercular.
35. Opercular.
36. Subopercular.
37. Interopercular.
38. Stylohyal.
39. Epihyal.
40. Ceratohyal.
41. Basihyal.
42. Glossohyal.
43. Urohyal.
44. Branchiostegals.
45. Basibranchials.
46. Hypobranchials.
47. Ceratobranchials.
48. Epibranchials.
49. Pharyngobranchial.
49′. Inferior Pharyngobranchial.
50. Suprascapular.
51. Scapular.
52. Coracoid.
54. Ulna.
55. Radius.
56. Carpals.
57. Metacarpo-phalangeals.
58. Epicoracoid.
63. Pubic.
70. Metatarso-phalangeals.
71. Supraorbital.
72. Supratympanic.
73. Lachrymal.
73^a., 73^b. } Supralachrymals.
73′. Suborbitals.

The numbers 8′, 73^a and 73^b we have added to the series; 72 is called supratemporal by Professor Owen.

n s—neural spines.
i n—interneural spines.
dn—dermo-neural spines.
h s—hæmal spines.
i h—interhæmal spines.
d h—dermo-hæmal spines.
n′—neuro-caudal plate.
h′—hæma-caudal plate.
d n′—caudo-dermo-neural spines.
pl—pleurapophysis.

α represents the tenth vertebra, with its pleurapophyses and pelvic appendages below.
β is an anterior thoracic vertebra.
δ is a group of five vertebræ, two pelvic and three caudal.
ε, γ } belong likewise to the caudal region.

Fig. 6—9. Skull of *Cottus viscosus;* Fig. 6 from above; Fig. 7 from below; Fig. 8 in profile; and Fig. 9 from behind.

Fig. 10—13. Skull of *Cottus Franklinii;* Fig. 10 from above; Fig. 11 from below; Fig. 12 in profile; and Fig. 13 from behind.

Fig. 14—17. Skull of *Cottus Wilsonii;* Fig. 14 from above; Fig. 15 from below; Fig. 16 in profile; and Fig. 17 from behind.

Fig. 18—21. Skull of *C. Richardsonii;* Fig. 18 from above; Fig. 19 from below; Fig. 20 in profile; and Fig. 21 from behind.

Fig. 22—25. Skull of *Triglopsis Thompsonii;* Fig. 22 from above; Fig. 23 from below; Fig. 24 in profile; and Fig. 25 from behind.

Fig. 26—29. Skull of *Acanthocottus virginianus;* Fig. 26 from above; Fig. 27 from below; Fig. 28 in profile; and Fig. 29 from behind.

Fig. 30—32. Vertebræ of *Acanthocottus virginianus;* Fig. 30, thoracic, with its pair of pleurapophyses or ribs; Fig. 31, pelvic, with its pair of pelvic appendages; Fig. 32, caudal.

Fig. 33—35. Encephalon of *Acanthocottus virginianus;* Fig. 33 from above; Fig. 34 from below; and Fig. 35 in profile.

Fig. 36—38. Encephalon of *Triglopsis Thompsonii,* twice the natural size; Fig. 36 from above; Fig. 37 from below; and Fig. 38 in profile.

Fig. 39—41. Encephalon of *Cottus gracilis,* twice the natural size; Fig. 39 from above; Fig. 40 from below; and Fig. 41 in profile (under the name of *C. gobioides* on the plate).

Fig. 42. An imperfect sketch of the encephalon of *C. gobioides,* twice the natural size, seen from above (under the name of *C. gracilis* on the plate).

Fig. 43—45. Encephalon of *C. viscosus,* twice the natural size; Fig. 43 from above; Fig. 44 from below; and Fig. 45 in profile.

Fig. 46—48. Encephalon of *Acanthocottus variabilis;* Fig. 46 from above; Fig. 47 from below; and Fig. 48 in profile.

ALPHABETIC REGISTER

OF

SYSTEMATIC NAMES ALLUDED TO IN THIS MONOGRAPH.(1)

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(1) The names in capitals are those now adopted. The names in italics indicate their synonyms.

CONTENTS.

CHAPTER IV.

ON THE GENUS COTTOPSIS, Girard.

CHAPTER V.

ON THE GENUS TRIGLOPSIS, Girard.

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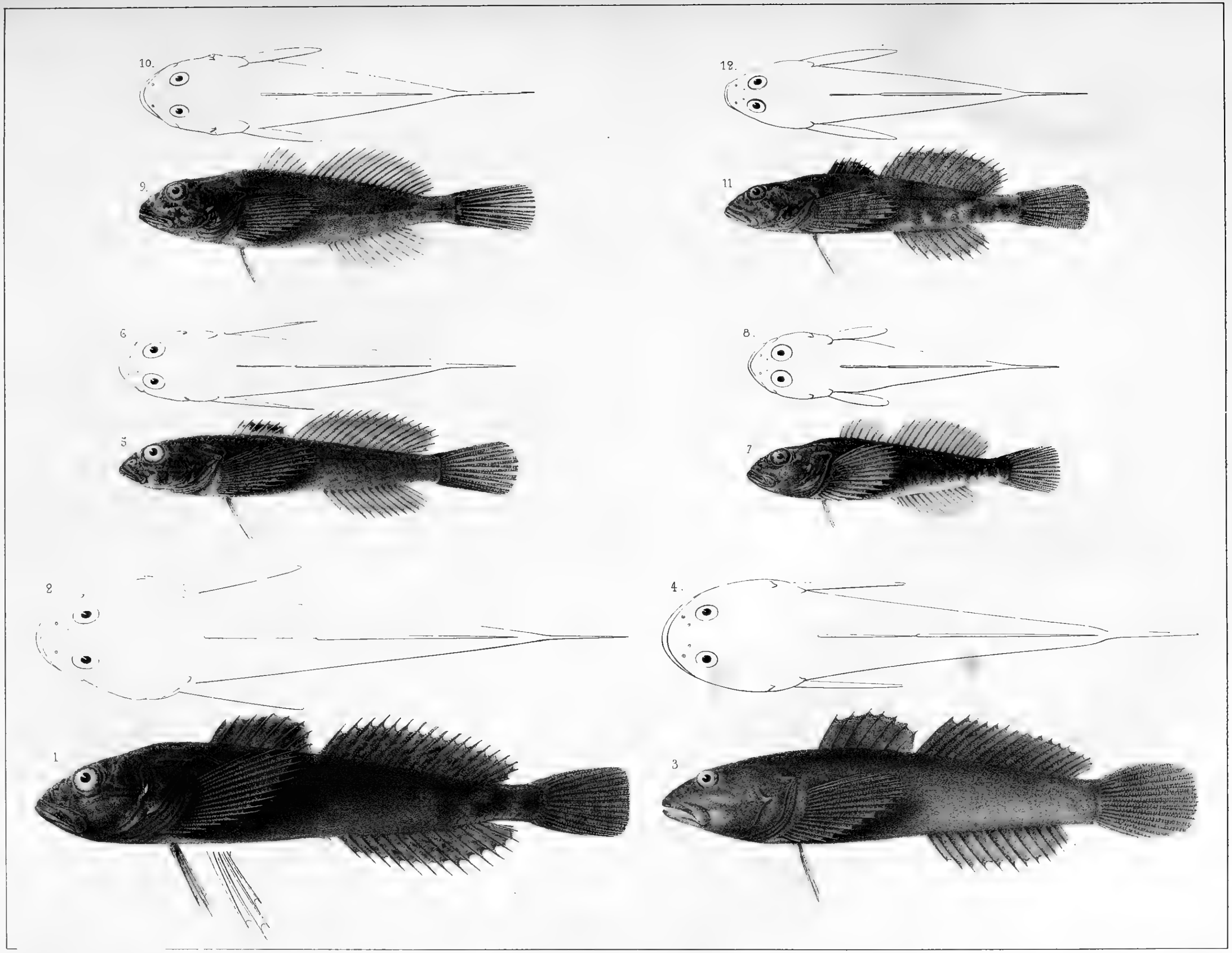

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Fig. 1 & 2. COTTUS RICHARDSONII Agass.—Fig. 3 & 4. COTTUS WILSONII Girard.—Fig. 5 & 6. COTTUS BAIRDII Girard.
Fig. 7 & 8. COTTUS ALVORDII Girard.—Fig. 9 & 10. COTTUS MERIDIONALIS Girard.—Fig. 11 & 12. COTTUS GRACILIS Heck

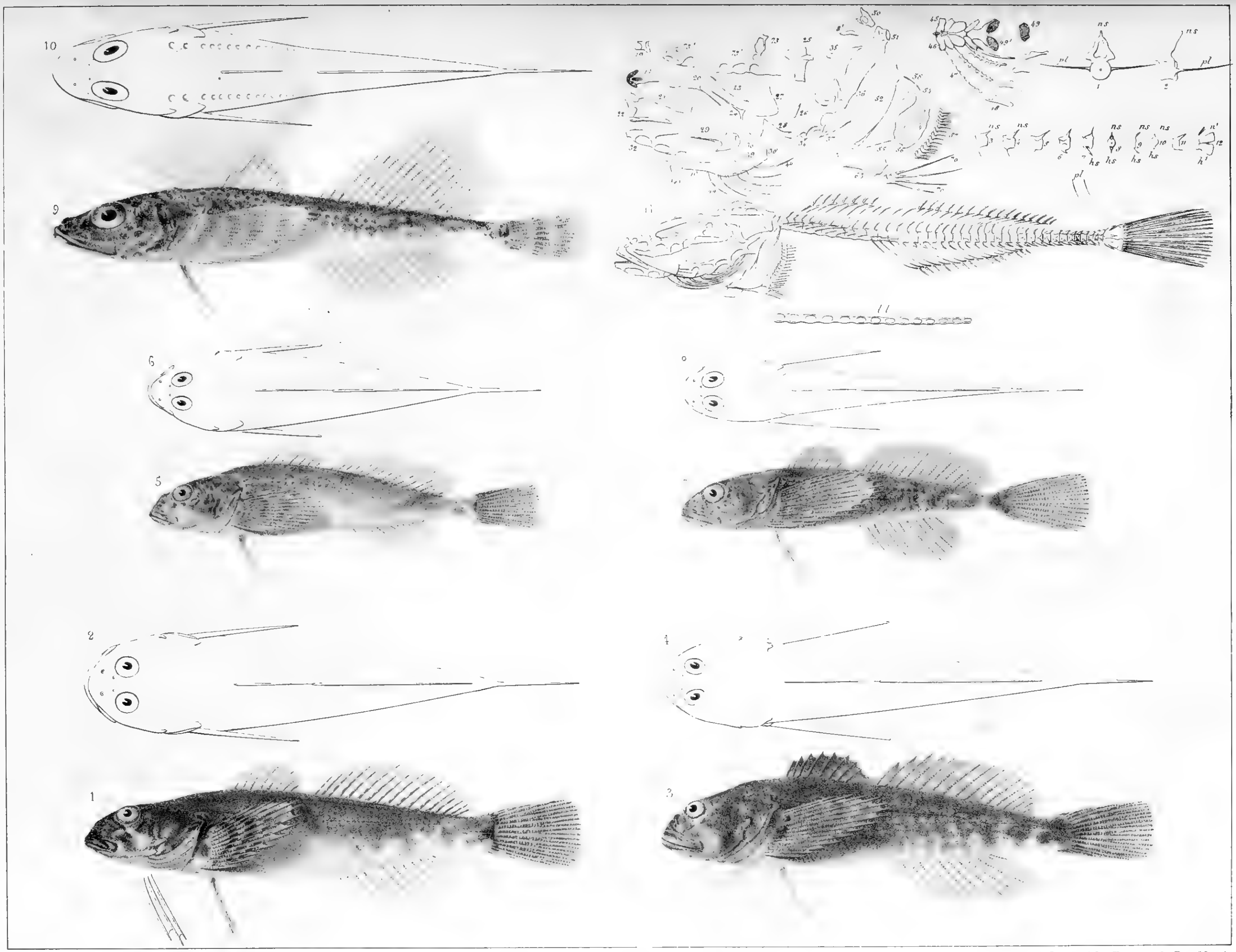

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Fig. 1 & 2. COTTUS VISCOSUS Hald. – Fig. 3 & 4. COTTUS GOBIOIDES Girard – Fig. 5 & 6. COTTUS FRANKLINII Agass.
Fig. 7 & 8. COTTUS BOLEOIDES Girard. – Fig. 9-11. TRIGLOPSIS THOMPSONII Girard

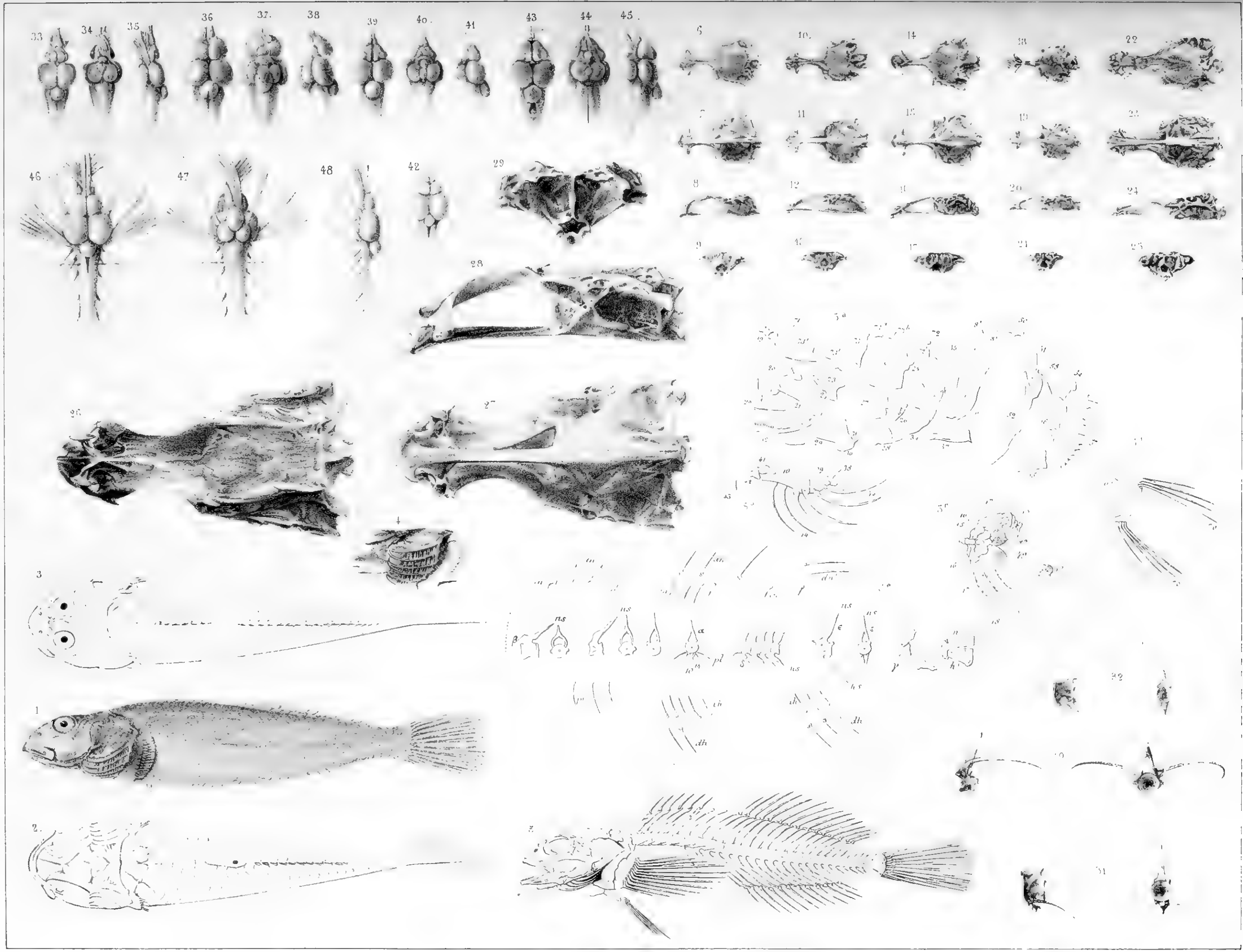

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Fig. 1-9 & 43-45 COTTUS VISCOSUS.—Fig. 10-13 C. FRANKLINII —Fig. 14-17 C. WILSONII — Fig. 18-21. C. RICHARDSONII.—Fig. 26-35 ACANTHOCOTTUS VIRGINIANUS
Fig. 46-48. ACANTHOCOTTUS VARIABILIS.— Fig. 39-41. COTTUS GOBIOIDES.— Fig. 42. C. GRACILIS.— Fig. 22-25 & 36-38. TRIGLOPSIS THOMPSONII

SMITHSONIAN CONTRIBUTIONS TO KNOWLEDGE.

NEREIS

BOREALI-AMERICANA:

OR,

CONTRIBUTIONS TO A HISTORY OF THE MARINE ALGÆ
OF NORTH AMERICA.

BY

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PART I.—MELANOSPERMEÆ.

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INTRODUCTION.

Among the plants which constitute the ordinary covering of the ground, whether that covering be one of forests, peopled by vegetable giants, or of the herbage and small herbaceous plants that clothe the open country, we observe that the greater number—at least of those which ordinarily force themselves on our notice—have certain obvious organs or parts: namely, a *root* by which they are fixed in the ground, and through which they derive their nourishment from the fluids of the soil; a *stem* or axis developed, in ordinary cases, above ground; *leaves* which clothe that stem, and in which the crude food absorbed by the roots and transmitted through the stem is exposed to the influence of solar light and of the air; and, finally, special modifications of leaf buds called *flowers*, in which seeds are originated and brought to maturity. These seeds, falling from the parent plant, endowed with an independent life under whose influence they germinate, attract food from surrounding mineral matter; digest it; *organize* it, that is, convert it from dead substance into living substance; form new parts or organs from this prepared matter; and, finally, grow into vegetables, having parts similar to those of the parent plant, and similarly arranged.

This is the usual course of vegetation: seeds develope roots, stems, and leafy branches; the latter at maturity bear flowers, producing similar seeds, destined to go through a like course; and so on, from one vegetable generation to another. But, with a perfect agreement among seed-bearing plants in the end proposed and attained, there is an endless variety of minor modifications through which the end is compassed. All degrees of modification exist between the simplest and most complicated digestive organs; in some, the root, stem, and leaves are so blended together, that we lose the notion of distinct organs, and in others the leaves are reduced to scales or spines, while the stem and branches are expanded and become not merely leaf-like, but actually discharge the functions of leaves. In the reproductive organs or flowers, too, we find equal variety; from the most elaborate and often gorgeous structures to the simplest and plainest, till at last we arrive at flowers, whose organization is so low that not only have calyx and corolla disappeared, but the very seed-vessel itself is reduced to an open scale or is wholly absent. Yet in all these modifications it is merely the means that are varied; the end proposed is as efficiently attained by the simplest agency as by the most complex; as if the Creator had designed to show us plainly how it is the same to Him to act by many or by few, by the most elaborate arrangement when He wills it, and by the simplest when that is His pleasure.

In all the cases of which we have as yet spoken, *seeds* are the result of the vegetable cycle; a seed being a compound body, containing an *embryo* or miniature plant, having stem, root, and leaf already organized, and enclosed with proper coverings or seed coats. But some plants do not produce such seeds. At least one-sixth of the vegetable kingdom, perhaps more, are propagated by isolated cells (or *spores*) cast loose from the structure of which they had formed a portion, and endowed thenceforth with independent powers of growth and development. Such are the reproductive bodies of the Ferns, the Mosses, and all plants below them in the vegetable scale, concluding with the large class to which our attention will now be confined—the Algæ—which of all are the lowest and simplest in organization.

The framework of every vegetable is built up of *cells*, little membranous sacs of various forms, with walls of varying tenacity, empty, or containing fluid or granular, organized matter, from which new cells may be developed. Among more perfect plants there is, in different parts of the same individual, considerable variety in the form and substance of the cells; those of the wood and of the veins of the leaves being different from those of the soft part of the leaves, and these again different from those of the skin which is spread over the whole. But as we descend in the scale of organization, greater and greater uniformity is found. Below the *Ferns,* no vascular tissue and no proper wood-cells occur; and at last in the Algæ, no cells exist differing from those of ordinary parenchyma or soft cells, such as compose the pulp of a leaf. Algæ, then, together with Mosses, Lichens and Fungi, are termed *cellular* plants, in contradistinction to Ferns and Flowering plants, which are denominated *vascular*. Among the most perfect of the Algæ, however, though the cells are all of the same substance and nature, all *parenchymatic*, they are of various forms and arrangement in different portions of the vegetable, often keeping up a very perfect analogy with the double system of arrangement—the vertical and horizontal, or woody and cellular systems—of higher plants. Thus the cells of the axis of the compound cylindrical Algæ are arranged longitudinally, like the wood-cells of stems, while those of the periphery or outer coating of the same Algæ have a horizontal direction.

In the most perfect of such Algæ the frame still consists of *root, stem,* and *leaves,* developed in an order analogous to that of higher plants. Passing from such, we meet with others gradually less and less perfect, until the whole vegetable is reduced either to a root-like body, or a branching naked stem, or an expanded leaf; as if Nature had first formed the types of the compound vegetable organs so named and exhibited them as separate vegetables; and then, by combining them in a single framework, had built up her perfect idea of a fully organized plant. But among the Algæ, we may go still lower in vegetable organization, and arrive at plants where the whole body is composed of a few cells strung together; and finally at others—the simplest of known vegetables—whose whole framework is a single *cell.* These are the true vegetable *monads:* with these we commence the great series of the Algæ at its lowest point, and proceeding upwards we find, within the limits of this same series, all degrees of complication of framework short of the development of proper flowers. It is this progressive organization of the Algæ, which renders the study of this portion of the vegetable world especially interesting to the philosophical botanist, because it displays to him, as in a mirror, something of that general plan of development which nature has followed in constructing other and more compound plants, in which her steps are less easily traced. From its first conception within the ovule to its full development, one of the higher plants goes through transformations strictly analogous to stages of advancement that can be traced among the Algæ from species to species, and from genus to genus, from the least perfect to the most perfect of the group. Each Alga-species has its own peculiar phase of development, which it reaches, and there stops; another species, passing this condition, carries the ideal plan a step further; and thus successive species exhibit successive stages of advancement.

While their gradually advancing scale of development renders the study of these plants more interesting, it also increases the difficulty of constructing a short and yet definite character, or *diagnosis*, which will include every member of the group, and exclude species more properly referable to the kindred groups of LICHENS and FUNGI. I shall not here attempt any such critical definition, but proceed to trace the gradual evolution of the frond and of the organs of fructification in the Algæ, assuming that with the ALGÆ are to be classed all Thallophytes (or Cryptogamic plants destitute of proper axes, in the more restricted view of that term) which are developed in water, or nourished wholly through the medium of fluids, while all Thallophytes that are ærial and not parasitic are LICHENS, and all that are ærial and parasitic are FUNGI.

Commencing then with Algæ of the simplest structure, a large part of them, belonging to the orders *Diatomaceæ* and *Desmidiaceæ*, consist almost entirely of individual isolated cells. Each plant, or frond, is formed of a single living cell; destitute therefore of any special organs, and performing every function of life in that one universal organ of which its frame consists. The growth of these simple plants is like that of the ordinary cells of which the compound frame of higher plants is composed. Nourishment is absorbed through the membraneous coating of the young plant (or cell), digested within its simple cavity, and the assimilated matter applied to the extension of the cell-wall, until that has reached the size proper to the species. Then the matter contained within the cavity gradually separates into two portions, and at the same time a cell-wall is formed between each portion, and thus the original simple cell becomes two cells. These no longer cohere together, as cells do in a compound plant, but each half-cell separates from its fellow, and commencing an independent career, digests food, increases in size, divides at maturity, &c., going again and again through a similar round of changes. In this way, by the process of self-division, and without any fructification, a large surface of water may soon be covered with these vegetable monads, from the mere multiplication of a single individual.

These minute plants, (*Diatomaceæ* and *Desmidiaceæ*) from their microscopic size and uniform and simple structure, are justly regarded as at the base of the vegetable kingdom. Notwithstanding which lowly position in the scale of being, they display an infinite variety of the most exquisite forms and finely sculptured surfaces; so that their study affords as much scope for the powers of observation as does that of the creation which is patent to our ordinary senses. These tribes are however omitted from this essay, because they have been made the objects of special enquiry by Professor Bailey of West Point, whose memoir in the second volume of the Smithsonian Contributions is referred to for further information.

But *Desmidiaceæ* and *Diatomaceæ* are not the only Algæ of this simple structure. The lowest forms of the order *Palmellaceæ*, such as the *Protococcus* or *Red snow plant*, have an equally simple organization. The blood-red colour of Alpine or Arctic snow which has been so often observed by voyagers, and which was seen to spread over so vast an extent of ground by Captain Ross, in his first arctic journey, is due to more than one species of microscopic plant, and to some minute infusorial animals which perhaps acquire the red colour from feeding on the *Protococcus* among which they are found. The best known and most abundant plant of this snow vegetation is the *Protococcus nivalis*, which is a spherical cell, containing a carmine-red globe of granulated, semi-fluid substance, surrounded by a hyaline limbus or thick cell-wall. At maturity the contained red matter separates into several spherical portions, each of which becomes clothed with a membranous coat; and thus forming as many small cells. The walls of the parent whose whole living substance has thus been appropriated to the offspring, now burst asunder, and the progeny escape. These rapidly increase in size until each acquires the dimensions of the parent, when the contained matter is again separated into new spheres; giving rise to new cells, to undergo in their turn the same changes. And as, under favourable circumstances, but a few hours are required for this simple growth and developement, the production of the red snow plant is often very rapid: hence the accounts frequently given of the sudden appearance of a red colour in the snow, over a wide space, which appearance is ascribed by common report to the falling of bloody rain or snow. In many such cases it is probable that the Protococcus may have existed on the portion of soil over which the snow fell, and its developement may have merely kept pace with the gradually deepening sheet of snow. That this plant is not confined to the surface of snow is well known; and Captain Ross mentions that in many places where he had an opportunity of examining it, he found that it extended several feet in depth. It has been found both in Sweden and Scotland on rocks, in places remote from snow deposits; and it probably lies dormant, or slowly vegetates in such cases, waiting for a supply of snow in which it grows with greater rapidity.

The structure and developement which I have described as characterizing *Protococcus*, are strikingly similar to those of what are commonly considered minute infusorial animals, called *Volvox*; the chief difference between *Protococcus* and *Volvox* being that the latter is clothed with vibratile hairs, by the rapid motion of which the little spheres are driven in varying directions through the water. Many naturalists, and some of high note, are now of opinion that *Volvox* and its kindred should be classed with the Algæ, and certainly (as we shall afterwards see) their peculiar ciliary motion is no bar to this association. I do not pronounce on this question, because it does not immediately concern our present subject, and because, in all its collateral bearings, it requires more attentive examination than it has yet undergone.

In *Protococcus* the cell of which the plant consists is spherical or oval; in other equally elementary Algæ the cell is cylindrical, and sometimes lengthened considerably into a thread-like body. Such is the formation of *Oscillatoriæ*. In *Vaucheriæ* there is a further advance, the filiform cell becoming branched without any interruption to its cavity; and such branching cells frequently attain some inches in length, and a diameter of half a line, constituting some of the largest cells known among plants.

In all these cases each cell is a separate individual: such plants are therefore the simplest expression of the vegetable idea. But even in this extremest simplicity we find the first indication of the structure which is to be afterward evolved. Thus in the spherical cell we have the earliest type of the cellular system of a compound plant developing equally in all directions; and in the cylindrical cell, the illustration of the vertical system developing longitudinally. These tendencies, here scarcely manifest, become at once obvious when the framework begins to be composed of more cells than one.

Thus in the genera nearest allied to *Protococcus*, the frond is a roundish mass of cells cohering irregularly by their sides. From these through *Palmella* and *Tetraspora* we arrive at *Ulva*, where a more or less compact membranous expansion is formed by the lateral cohesion of a multitude of roundish (or, by mutual pressure, polygonal) cells originating in the quadri-partition of older cells; that is, by the original cells dividing longitudinally as well as transversely, thus forming four new cells from the matter of the old cell, and causing the cell-growth to proceed nearly equally in both directions. Starting, therefore, from *Protococcus*, and tracing the developement through various stages, we arrive in *Ulva* at the earliest type of an expanded leaf.

In like manner the earliest type of a stem may be found by tracing the Algæ which originate in cylindrical cells. Here the new cells are formed in a longitudinal direction only, by the bipartition of the old cells. Thus, in *Conferva*, where the body consists of a number of cylindrical cells, strung end to end, these have originated by the continual transverse division of an original cylindrical cell. Such a frond will continually lengthen, but will make no lateral growth; and consisting of a series of joints and interspaces, it correctly symbolizes the stem of one of the higher plants, formed of a succession of nodes and internodes. And the analogy is still further preserved when such confervoid threads branch; for the branches constantly originate at the joints or *nodes*, just as do the leaves and branches of the higher compound plants.

We have then two tendencies exhibited among Algæ—the first, a tendency to form membranous expansions, the symbols or types of leaves; the second a tendency to form cylindrical bodies or stems. Among the less perfect Algæ the whole plant will consist either of one of these foliations, or of a simple or branched stem. But gradually both ideas or forms will be associated in the same individual, and exhibited in greater or less perfection. We shall find stems becoming flattened at their summits into leaves, and leaves, by the loss of their lateral membranes, and the acquisition of thicker midribs, changing into stems ; and among the most highly organized Algæ we shall find leaf-like lateral branches assuming the form, and to a good degree the arrangement of the leaves of higher plants. Not that we find among Algæ proper leaves, like those of phænogamous plants, constantly developing buds in their axils ; for even where leaf-like bodies are most obvious (as in the genus *Sargassum*), they are merely *phyllocladia* or expanded branches ; as may readily be seen by observing a *Sargassum* in a young state, and watching the gradual changes that take place as the frond lengthens. These changes will be explained in the systematic portion of this work.

I shall now notice more particularly the varieties of habit observed among the compound Algæ, and first,

OF THE ROOT.

The *root* among the Algæ is rarely much developed. Among higher plants which derive their nourishment from the soil in which they grow, and in Fungi which feed on the juices of organized bodies, root-fibres, through which nourishment is absorbed, are essential to the development of the vegetable. But the Algæ do not, in a general way, derive nourishment from the soil on which they grow. We find them growing indifferently on rocks of various mineralogical character, on floating timber, on shells, on iron or other metal, on each other,—in fine, on any substance which is long submerged, and which affords a foothold. Into none of those substances do they emit roots, nor do we find that they cause the decay, or appropriate to themselves the constituents, of those substances. They are nourished by the water that surrounds them and the various substances which are dissolved in it. On those substances they frequently exert a very remarkable power, effecting chemical changes which the chemist can imitate only by the agency of the most powerful apparatus. They actually sometimes reverse the order of chemical affinity, driving out the stronger acid from the salts which they imbibe, and causing a weaker acid to unite with the base. Thus they decompose the muriate of soda which they absorb from sea-water, partly freeing and partly appropriating the chlorine and hydrogen ; and the soda is found combined in their tissues with carbonic acid.

A remarkable instance of the action of a minute Alga on a chemical solution was pointed out to me by Prof. Bache, as occurring in the vessels of sulphate of copper kept in the electrotyping department of the Coast Survey office at Washington. A slender confervoid Alga infests the vats containing sulphate of copper, and proves very destructive. It decomposes the salt, and assimilates the sulphuric acid, rejecting (as indigestible !) the copper, which is deposited round its threads in a metallic form. It sometimes appears in great quantities, and is very troublesome ; but the vats had been cleaned a few days before I visited them, so that I lost the opportunity of examining more minutely this curious little plant. Most probably it is a species of *Hygrocrocis*,* a group of Algæ of low organization but strong diges-

* Perhaps the *Hygrocrocis cuprica*, Kütz, or some allied species ; but I had no opportunity of examining a recent specimen, and the characters cannot be made out from a dried one.

tive powers, developed in various chemical solutions or in the waters of mineral springs. All the Algæ however which are found in such localities are not species of *Hygrocrocis*, for several *Oscillatoriæ* and *Calothrices* occur in thermal waters. Species of the former genus are found even in the boiling waters of the Icelandic Geysers. Of the latter, one species at least, *Calothrix nivea*, is very common in hot sulphur springs, and I observed it in great plenty in the streams running from the inflammable springs at Niagara.

But on whatever substance the Alga may feed, it is rarely obtained through the intervention of a root. Dissolved in the water that bathes the whole frond, the food is imbibed equally through all the cells of the surface, and passes from cell to cell toward those parts that are more actively assimilating, or growing more rapidly. The *root,* where such an organ exists, is a mere holdfast, intended to keep the plant fixed to a base, and prevent its being driven about by the action of the waves. It is ordinarily a simple disc, or conical expansion of the base of the stem, strongly applied and firmly adhering to the substance on which the Alga grows. This is the usual form among all the smaller growing kinds. Where, however, as in the gigantic Oar-weeds or *Laminariæ*, the frond attains a large size, offering a proportionate resistance to the waves, the central disc is strengthened by lateral holdfasts or discs formed at the bases of side roots emitted by the lower part of the stem ; just as the tropical Screw-pine *(Pandanus)* puts out cables and shrouds to enable its slender stem to support the weight of the growing head of branches. The branching roots of the *Laminaria*, then, are merely *Fucus*-discs become compound : instead of the conical base of a *Fucus*, formed of a single disc, there is a conical base formed of a number of such discs disposed in a circle. In some few instances, as in *Macrocystis*, the grasping fibres of the root develope more extensively, and form a matted stratum of considerable extent, from which many stems spring up. This is a further modification of the same idea, a further extension of the base of the cone.

In all these cases the roots extend over flat surfaces, to which they adhere by a series of discs. They show no tendency to penetrate like the branching roots of perfect plants. The only instances of such penetrating roots among the Algæ with which I am acquainted, occur in certain genera of *Siphoneæ* and in the *Caulerpeæ*, tropical and sub-tropical forms, of which there are numerous examples on the shores of the Florida Keys. These plants grow either on sandy shores or among coral, into which their widely extended fibrous roots often penetrate for a considerable distance, branching in all directions, and forming a compact cushion in the sand, reminding one strongly of the much divided roots of sea-shore grasses that bind together the loose sands of our dunes. But neither in these cases do the roots appear to differ from the nature of holdfasts, and their ramification and extension through the sand is probably owing to the unstable nature of such a soil. It is not in search of nourishment, but in search of stability, that the fibres of their roots are put forth, like so many tendrils. We shall have more to speak of these roots in the proper place, and shall now proceed to notice some of the forms exhibited by

THE FROND.

The *frond* or vegetable body of the compound Algæ puts on a great variety of shapes in different families, as it gradually rises from simpler to more complex structures. In the less organized it consists of a string of cells arranged like the beads of a necklace; and the cells of which such strings are composed may be either globose or cylindrical. In the former case we have a *moniliform* string or *filament*, and in the latter a filiform or cylindrical one. The term *filament* (in Latin, *filum*) is commonly applied to such simple strings of cells, but has occasionally a wider acceptation, signifying any very slender, threadlike body, though formed of more than one series of cells. This is a loose application of the term, and ought to be avoided. By Kützing the term *trichoma* is substituted for the older word *filum* or filament. Where the *filament* (or *trichoma*) consists of a single series of consecutive cells, it appears like a jointed thread ; each individual cell constituting an *articulation*, and the walls between the cells forming *dissepiments* or *nodes*, terms which are frequently employed in describing plants of this structure. Where the filament is composed of more series of cells than one, it may be either *articulated* or *inarticulate*. In the former case, the cells or articulations of the minor filaments which compose the common filament are all of equal length ; their dissepiments are therefore all on a level, and divide the compound body into a series of nodes and internodes, or dissepiments and articulations. In the latter, the cells of the minor filaments are of unequal length, so that no articulations are obvious in the compound body. In *Polysiphonia* and *Rhodomela* may be seen examples of such articulate and inarticulate filaments.

By Kützing the term *phycoma* is applied to such compound stems; and when the phycoma becomes flattened or leaf-like, a new term, *phylloma*, is given to it by the same author. These terms are sometimes convenient in describing particular structures, though not yet generally adopted. The cells of which compound stems (or *phycomata*), are composed are very variously arranged, and on this cellular arrangement, or internal structure of the stem, depends frequently the place in the system to which the plant is to be referred. A close examination, therefore, of the interior of the frond, by means of thin slices under high powers of the microscope, is often necessary, before we can ascertain the position of an individual plant whose relations we wish to learn. Sometimes all the cells have a longitudinal direction, their longer axes being vertical. Very frequently, this longitudinal arrangement is found only toward the centre of the stem, while toward the circumference the cells stand at right angles to those of the centre, or have a horizontal direction. In such stems we distinguish a proper *axis*, running through the frond, and a *periphery*, or *peripheric stratum*, forming the outside layer or circumference. Sometimes the axis is the densest portion of the frond, the filaments of which it is composed being very strongly and closely glued together ; in other cases it is very lax, each individual filament lying apart from its fellow, the interspaces being filled up with vegetable mucus or gelatine. This gelatine differs greatly in consistence ; in some Algæ it is very thin and watery, in others it is slimy, and in others it has nearly the firmness of cartilage. On the degree of its compactness and abundance depends the relative *substance* of the plant; which is membranaceous where the gelatine is in small quantity; gelatinous where it is very abundant and somewhat fluid; or cartilaginous where it is firm.

The frond may be either cylindrical or stem-like, or more or less compressed and flattened. Often a cylindrical stem bears branches which widen upwards, and terminate in leaf-like expansions, which are of various degrees of perfection in different kinds. Thus sometimes the leaf, or *phylloma*, is a mere dilatation; in other cases it is traversed by a midrib, and in the most perfect kinds lateral nervelets issue from the midrib and extend to the margin. These leaves are either vertical, which is their normal condition, or else they are inclined at various angles to the stem or axis, chiefly from a twisting in their lamina, the insertion of the leaf preserving its vertical position. They are variously lobed or cloven, and in a few cases (as in the *Sea Colander* of the American coast) they are regularly pierced, at all ages, with a series of holes which seem to originate in some portions of the lamina developing new cells with greater rapidity than other parts, thus causing an unequal tension in various parts of the frond, and consequently the production of holes in those places where the growth is defective. Such plants, though they form lace-like fronds, are scarcely to be considered as net works. Net-like fronds are, however, formed by several Algæ where the branches regularly anastomose one with another, and form meshes like those of a net. Most species with this structure are peculiar to the Southern Ocean, but in the waters of the Caribbean Sea are found two or three which may perhaps yet be detected on the shores of the Florida Keys. In one of the Australian genera of this structure (*Claudea*) the net-work is formed by the continual anastomosis of minute leaflets, each of which is furnished with a midrib and lamina. The apices of the midribs of one series of these leaves grow into the dorsal portion of leaves that issue at right angles to them, and as the leaves having longitudinal and horizontal directions, or those that form the warp and weft of the frond, are of minute size and closely and regularly disposed, the net-work that results is lace-like and delicately beautiful.

In the *Hydrodictyon*, a fresh water Alga, found in ponds in Europe and in the United States, where it was first detected by Professor Bailey near Westpoint, a net-like frond is formed in a different manner. This plant when fully grown resembles an ordinary fishing-net of fairy size, each pentagonal mesh being formed of five cells, and one cell making a side of the pentagon. As the plant grows larger, the meshes become wider by the lengthening of the cells of which each mesh is composed. When at maturity, the matter contained within each cell of the mesh is gradually organised into granules, or germs of future cells, and these become connected together in fives while yet contained in the parent cell. Thus meshes first, and at length little microscopic networks, are formed within each cell of the meshes of the old net; and this takes place before the old net breaks up. At length the cells of the old net burst, and from each issues forth the little network, perfectly formed, but of very minute size, which by an expansion of its several parts will become a net like that from which its parent cell was derived. Thus, supposing each cell of a single net of the Hydrodictyon were to be equally fertile, some myriads of new nets would be produced from every single net, as it broke up and dissolved. In this way a large surface of water might be filled with the plant in a single generation.

The manner of growth of the frond is very various in the different families. In some, the body lengthens by continual additions to its apex, every branch being younger the further removed it is from the base; that is, the tips of the branches are the youngest parts. This is the usual mode of growth in the Confervoid genera, and also obtains in many of those higher in the series, as in the Fucaceæ and many other Melanosperms. In the Laminariæ, on the contrary, the apex when once formed does not materially lengthen, but the new growth takes place at the base of the lamina, or in the part where the cylindrical stipe passes into the expanded or leaflike portion of the frond. In such plants the apex is rarely found entire in old specimens, but is either torn by the action of the waves, or thrown off altogether, and its place supplied by a new growth from below. In several species this throwing off of the old frond takes place regularly at the close of each season; the old lamina being gradually pushed off by a young lamina growing under it. There are others, among the filiform kinds, in which the smaller branches are suddenly deciduous, falling off from the larger and permanent portions of the trunk, as leaves do in autumn from deciduous trees. Hence specimens of these plants collected in winter are so unlike the summer state of the species, that to a person unacquainted with their habits they would appear to be altogether different in kind. The summer and winter states of *Rhodomela subfusca* are thus different. In *Desmarestia aculeata* the young plants, or the younger branches of old plants, are clothed with soft pencils of delicate jointed filaments, which fall off when the frond attains maturity, and leave naked, thorny branches behind. Similar delicate hairs are found in many other Algæ of very different families, generally clothing the younger and growing parts of the frond; and they seem to be essential organs, probably engaged in elaborating the crude sap of these plants, and consequently analogous to the leaves of perfect plants. This is as yet chiefly conjectural. The conjecture, however, is founded on the observed position of these hair-like bodies, which are always found on growing points, the new growth taking place immediately beneath their insertion. In most cases these hairs are deciduous, but in some, as in the genus *Dasya*, they are persistent, clothing all parts of the frond so long as they continue in vigour. They vary much in form, in some being long, filiform, single cells; in others, unbranched strings of shorter cells, and in others dichotomous, or, rarely, pinnated filaments.

Three principal varieties of

COLOUR

are generally noticed among the Algæ, namely, *Grass-green* or *Herbaceous*, *Olive-green*, and *Red*; and as these classes of colour are pretty constant among otherwise allied species, they afford a ready character by which, at a glance, these plants may be separated into natural divisions; and hence *colour* is here employed in classification with more success than among any other vegetables. In the subdivision of Algæ into the three groups of *Chlorosperms*, *Melanosperms*, and *Rhodosperms*, the colour of the frond is, as we shall afterwards see, employed as a convenient diagnostic character. It is a character, however, which must be cautiously applied in practice by the student, because, though sufficiently constant on the whole and under ordinary circumstances, exceptions occur now and then ; and under special circumstances Algæ of one series assume in some degree the colour of either of the other series.

The *green* colour is characteristic of those that grow either in fresh water or in the shallower parts of the sea, where they are exposed to full sunshine but seldom quite uncovered by water. Almost all the fresh water species are green, and perhaps three fourths of those that grow in sunlit parts of the sea ; but some of those of deep water are of as vivid a green as any found near the surface, so that we cannot assert that the *green* colour is owing here, as it is among land plants, to a perfect exposure to sunlight. Several species of *Caulerpa*, *Anadyomene*, *Codium*, *Bryopsis* and others of the Siphoneæ, which are not less herbaceous or vivid in their green colours than other Chlorosperms, frequently occur at considerable depths, to which the light must be very imperfectly transmitted.

Algæ of an *olivaceous* colour are most abundant between tide marks, in places where they are exposed to the air, at the recess of the tide, and thus alternately subjected to be left to parch in the sun, and to be flooded by the cool waves of the returning tide. They extend however to low water mark, and form a broad belt of vegetation about that level, and a few straggle into deeper water, sometimes into very deep water. The gigantic deep-water Algæ, *Macrocystis*, *Nereocystis*, *Lessonia*, and *Durvillœa*, are olive coloured.

Red-coloured Algæ are most abundant in the deeper and darker parts of the sea, rarely growing in tide pools, except where they are shaded from the direct beams of the sun either by a projecting rock, or by over-lying olivaceous Algæ. The red colour is always purest and most intense when the plant grows in deep water, as may be seen by tracing any particular species from the greatest to the least depth at which it is found. Thus, the common *Ceramium rubrum* in deep pools or near low-water mark is of a deep, full red, its cells abundantly filled with bright carmine endochrome, which will be discharged in fresh water so as to form a rose-coloured infusion ; but the same plant, growing in open, shallow pools, near high water mark, where it is exposed to the sun, becomes very pale, the colour fading through all shades of pink down to dull orange or straw-colour. It is observable that this plant, which is properly one of the *red* series (or Rhodosperms) does not become grass-green (or like a Chlorosperm) by being developed in the shallower water, but merely loses its capacity for forming the red-coloured matter peculiar to itself. So also, *Laurencia pinnatifida*, and other species of that genus, which are normally dark purple, are so only when they grow near low water mark. And as many of them extend into shallower parts, and some even nearly to high water limit, we find specimens of these plants of every shade of colour from dull purple to dilute yellow or dirty white. Similar changes of colour, and from a similar cause, are seen in *Chondrus crispus*, the *Carrigeen* or *Irish Moss*, which is properly of a fine deep purplish red, but becomes greenish or whitish when growing in shallow pools. The *white* colour, therefore, which is preferred in carrigeen by the purchaser of the prepared article, is entirely due to bleaching and repeated rinsing in fresh water.

Many Algæ, both of the *olive* and *red* series, and in a less perfect manner a few of the *grass-green* also, reflect prismatic colours when growing under water. In some species of *Cystoseiræ*, particularly in the European *C. ericoides* and its allies, these colours are so vivid that the dull olive-brown branches appear, as they wave to and fro in the water, to be clothed with the richest metallic greens and blues, changing with every movement, as the beams of light fall in new directions on them. Similar colours, but in a less degree, are seen on *Chondrus crispus* when growing in deep water; but here the prismatic colouring is often confined to the mere tips of the branches, which glitter like sapphires or emeralds among the dark purple leaves. The cause of these changeable colours has not been particularly sought after. The surface may be finely striated, but it does not seem to be more so than in other allied species, where no such iridescence has been observed. In the *Chondrus* the changeable tints appear to characterize those specimens only which grow in deep water, and which are stronger and more cartilaginous than those which grow in shallow pools.

Fresh water has generally a very strong action on the colours as well as on the substance of marine Algæ which are plunged into it. To many it is a strong poison, rapidly dissolving the gelatine which connects the cells, and dissolving also the walls of the cells themselves ; and that so quickly that in a few minutes one of these delicate plants will be dissolved into a shapeless mass of broken cells and slime. Many species which, when fresh from the sea, resist the action of fresh water, and may be steeped in it without injury for several hours, if again moistened after having once been dried, will almost instantly dissolve and decompose. This is remarkably the case with several species of *Gigartina* and *Iridæa*. The first effect of fresh water on the red colours of Algæ is to render them brighter and more clear. Thus *Dasya coccinea*, *Gelidium cartilagineum*, *Plocamium coccineum*, and others, are when recent of a very dark and somewhat dull red colour ; but when exposed either to showers and sunshine on the beach, or to fresh water baths in the studio of the botanist, become of various tints of crimson or scarlet, according as the process is continued for a less or greater length of time. At length the colouring matter would be expelled and the fronds bleached white, as occurs among the specimens cast up and exposed to the long continued action of the air ; but if stopped in time and duly regulated, the colours may be greatly heightened by fresh water. Some plants which are dull brown when going into the press, come out a fine crimson ; this is the case with *Delesseria sanguinea*, though that plant is not always of a dull colour when recent. Others, which are of the most delicate rosy hues when recent, become brown or even black when dried. This is especially the case in the order *Rhodomelaceæ*, so named from this tendency of their reds to change to black in drying. The tendency to become black, though it cannot be altogether overcome in these plants, may often be lessened by steeping them in fresh water for some time previous to drying. Hot water generally changes the colours of all Algæ to green, and if heat be applied during the drying process, an artificial green may be imparted to the specimens ; but such a mode of preparation of specimens ought never to be practised by botanical collectors, though it may sometimes serve the purpose of makers of seaweed pictures.

THE FRUCTIFICATION

of the Algæ may be more conveniently described in the systematic portion of this work, when speaking of the various forms it assumes in the different families. I shall at present, therefore, limit myself to a very few general observations. The *spore* or reproductive gemmule of the Algæ is in all cases a simple cell, filled with denser and darker coloured endochrome (or colouring matter) than that found in other cells of the frond. In the simplest Algæ, where the whole body consists of a single cell, some gradually change and are converted into spores, without any obvious contact with others: but far more frequently, as in the *Desmidiaceæ* and *Diatomaceæ*, a spore is formed only by the conjugation of two cells or individual plants. When these simple vegetable atoms are mature, and about to form their fructification, two individuals are observed to approach ; a portion of the cell-wall of each is then extended into a tubercle at opposite points; these tubercles come into contact and at length become confluent ; the dissepiment between them vanishes, and a tube is thus formed connecting the two cavities together. Through this tube the matter contained in both the old cells is transmitted and becomes mixed ; changes take place in its organization, and at length a *sporangium* or new cell filled with spores is formed from it, either in one of the old cells, or commonly at the point of the connecting tube, where the two are soldered together. Then the old empty cells or plants die, and the species is represented by its *sporangium*, which may remain dormant, retaining vitality for a considerable time, as from one year to another, or probably for several years. These sporangia, which are abundantly formed at the close of the season of active growth, become buried in the mud at the bottoms of pools, where they are encased on the drying up of the water in summer, and are ready to develop into new fronds on the return of moisture in spring.

Many of the lower Algæ form fruit in this manner, to which the name *conjugation* is technically given. The thread-like Silk-weeds of ponds and ditches (*Zygnemata* and *Mougeotiæ*, &c.) are good examples of such a mode of fruiting. In these almost every cell is fertile, and when two threads are yoked together, a series of *sporangia* will be formed in one thread, while the other will be converted into a string of dead, empty cells. Before conjugation there was, seemingly, no difference between the contents of one set of cells and of the other ; so that there is no clear proof of the existence of distinct sexes in these plants, however much the process of fruiting observed among them may indicate an approach to it.

The process of fruiting in the higher Algæ appears to be very similar: namely, *spores* or *sporangia* appear to be formed by certain cells attracting to themselves the contents of adjacent cells; and in the compound kinds empty cells are almost always found in the neighbourhood of the fruit cells ; but with the complication of the parts of the frond, the exact mode in which spores are formed becomes more difficult of observation. At length, among the highest Algæ we encounter what appear to be really two sexes, one analogous to the anther and the other to the pistil of flowering plants. It would seem, however, that it is not each individual spore which is fertilized, as is the case in seed-bearing plants; but that the fertilizing influence is imparted to the pistil or sporangium itself, when that body is in its most elementary form, long before any spore is produced in its substance, and even when it is itself scarcely to be distinguished from an ordinary cell. *Antheridia*, as the supposed fertilizing organs are called, are most readily seen among the *Fucaceæ*, and will be described under that family.

Besides the reproduction by means of proper spores, many Algæ have a second mode of continuing the species, and some even a third. Among the simpler kinds, where the whole body consists of a single cell, a fissiparous division, exactly similar to the fissiparous multiplication of cells among higher plants, takes place. This cell, as has been already mentioned, divides at maturity into two parts, which, falling asunder, become separate individuals. Similar self-division has been noticed among the lower *Palmellaceæ*, and in other imperfectly organized families. Such a mode of multiplying individuals is analogous to the propagation of larger plants by the process of gemmation, where buds are formed and thrown off to become new individuals. When, as in the *Lemna* or *Duckweed*, the whole vegetable body is as simple as a phanerogamous plant can well be, the new frondlets or buds are produced in a manner very strikingly analogous to the production of new fronds in *Desmidiaceæ*.

The third mode of continuing the species has been observed in many Algæ of the *green* series, in some of which sporangia are also formed, but in others no fructification other than what I am about to describe has been detected. This mode is as follows. In an early stage, the green matter, or *endochrome*, contained within the cells of these Algæ, is of a nearly homogeneous consistence throughout, and semi-fluid; but at an advanced period it becomes more and more granulated. The granules when formed in the cells at first adhere to the inner surface of the membranous wall, but soon detach themselves and float freely in the cell. At first they are of irregular shapes, but they gradually become spheroidal. They then congregate into a dense mass in the centre of the cell, and a movement aptly compared to that of the swarming of bees round their queen begins to take place. One by one these active granules detach themselves from the swarm, and move about in the vacant space of the cell with great vivacity. Continually pushing against the sides of the cell wall, they at length pierce it, and issue from their prison into the surrounding fluid, where their seemingly spontaneous movements are continued for some time. These vivacious granules, or *zoospores* as they have been called, at length become fixed to some submerged object, where they soon begin to develop cells, and at length grow into Algæ similar to those from whose cells they issued.

Their spontaneous movements before and immediately subsequent to emission lead me to speak of the

MOVEMENTS OF ALGÆ

in general. These are of various kinds, and of greater or less degrees of vivacity

In some Algæ a movement from place to place continues through the life of the individual, while in others, as in the zoospores of which I have just spoken, it is confined to a short period, often to a few hours, in the transition state of the spore, after it escapes from the parent filament and until it fixes itself and germinates. Many observers have recorded these observations, which are to be found detailed in various periodicals.* I shall here notice only a few cases illustrative of the various kinds of movement. The most ordinary of these movements is effected by means of vibratile *cilia* or hairs, produced by the membrane of the spore, and which by rapid backward and forward motion, like that of so many microscopic oars, propel the body through the water in different directions, according as the movement is most directed to one side or the other. Sometimes the little spores, under the influence of these cilia, are seen to spin round and round in widening circles ; but at other times change of direction, pauses, accelerations, &c. take place during the voyage, which look almost like *voluntary* alterations, or as if the spore were guided by a principle of the nature of animal will. Hence many observers do not hesitate to call these moving spores *animalcules*, and to consider them of the same nature as the simpler infusorial animals.

This, as it appears to me, is a conclusion which ought not to be hastily assumed, not merely taking into consideration the extremely minute size of the little bodies to be examined, and the consequent danger of our being deceived as to the cause of movement, and of its interruption and resumption, but also remembering the facts ascertained by Mr. Brown, of the movement of small particles of all mineral substances which he examined. Many of the spores in question are sufficiently small to come under the Brownian law, though others are of larger size. Besides, if we regard the moving spores as animalcules, we must either adopt the paradox that a vegetable produces an animal, which is then changed into a vegetable, and the process repeated through successive generations, every one of these *vegetables* having been *animal* in its infancy ; or else, notwithstanding their strongly marked vegetable characteristics, we must remove to the animal kingdom all Algæ with moving spores.

Neither of these violent measures is necessary, if we admit that mere motion, apart from other characters, is no *proof* of animality. Though motion under the control of a will be indeed one of the charter privileges of the higher animals, we see it gradually reduced as we descend in the animal scale, until at last it is nearly lost altogether. Long before we reach the lowest circles in the animal world, we meet with animals which are fixed through the greater part of their lives to the rocks on which they grow, and some of them have scarcely any obvious movement on their point of attachment. In some the surface, like that of the Algæ-spores, is clothed with cilia which drive floating particles of food within reach of the mouth; in others even these rudimentary prehensile organs are dispensed with, and the animal exists as a scarcely irritable flesh expanded on a framework. This would seem to be the case in the corals of the genus *Fungia*, if the accounts given of those animals be correct ; while in the sponges the animal structure and organization are still further reduced, so as almost to contravene our preconceived notions of animal-will and

* See *Annales des Sciences Naturelles ; Taylor's Ann. Nat. Hist. ;* the *Linnæa, &c.* various volumes.

movement. But the sponges can scarcely be far removed from Fungia, nor can that be separated from other corals: so that, though I am aware some naturalists of eminence regard the sponges as vegetables, I cannot subscribe to that opinion, but rather view them as exhibiting to us animal organization in its lowest conceivable type, and parallel to vegetable organization, as that exists in the lowest members of the class of Algæ.

This hasty glance at the animal kingdom teaches us that voluntary motion is a character variable in degree, and at length reduced almost to zero within the animal circle. On the other hand, we know that movements of a very extraordinary character exist among the higher vegetables. Not merely the movement of the fluids of plants within their cells, which has at least some analogy with the motion of animal fluids; but in such plants as the Sensitive-plant, the Venus's Flytrap *(Dionæa)*, and many others, movements of the *limbs* (shall I call them ?) as singular as those of the Algæ-spores, are sufficiently well known. And these movements are affected by narcotics in a manner strikingly similar to the operation of similar agents on the nervous system of animals. The common sensitive-plant, indeed, only shrinks from the touch, but in the *Desmodium gyrans* a movement of the leaves on their petioles is habitually kept up, as if the plant were fanning itself continually. Such vegetable movements as these strike us by their rapidity, but others of a like nature only escape us by their slowness. Thus the opening of the leaves of many plants in sunlight and their closing regularly in the evening in sleep; the constant turning of the growing points towards the strongest light, and other changes in position of various organs, are all vegetable movements which would appear as *voluntary* as those of the Algæ spores if they were equally rapid. Their extreme slowness alone conceals their true nature.

So then we find animals in which *motion* is reduced almost to a nullity; and vegetables as high in the scale as the *Leguminosæ* exhibiting well marked movements, facts which sufficiently establish the truth of our position that *mere motion* is no proof of animality. But subtracting their movements from the Algæ-spores, what other proof remains of their being animalcules ? None whatever. They do not resemble animalcules either in their internal structure, their chemical composition, or their manner of feeding; and their vegetable nature is sufficiently marked by their decomposing carbonic acid, giving out oxygen in sunlight, and containing starch.

In the *Vaucheria clavata*, one of the species in which spores moved by cilia were first observed, the spore is formed at the apices of the branches. The frond in this plant is a cylindrical, branching cell, filled with a dense, green endochrome. A portion of the contained endochrome immediately at the tips separates from that which fills the remainder of the branch; a dissepiment is formed, and that portion cut off from the rest gradually consolidates into a spore, while the membranous tube enlarges to admit of its growth. The young spore soon becomes elliptical, and at length, being clothed with a skin and ready for emission, it escapes through an opening then formed at the summit of the branch. The whole surface of the spore, when emitted, is seen to be clothed with vibratile cilia whose vibrations propel it through the water until it reaches a place suitable for germination.

The cilia then disappear, and the spore becoming quiescent, at length developes into a branching cell like its parent. The history of other moving spores is very similar, the cilia, however, varying much in number in different species; commonly they are only two, which are sometimes inserted as a pair, at one end of the spore, but in other cases placed one at each end.

There are other Algæ in which vibratile cilia have not been observed, but which yet have very agile movements. Among these the most remarkable are the *Oscillatoriæ* and their allies, which suddenly appear and disappear in the waters of lakes and ponds, and sometimes rise to the surface in such prodigious numbers as to colour it for many square miles. In *Oscillatoria* each individual is a slender, rigid, needle-shaped thread, formed of a single cell, filled with a dense endochrome which is annulated at short intervals, and which eventually separates into lenticular spores. Myriads of such threads congregate in masses, connected together by slimy matter, in which they lie, and from the borders of which, as it floats like a scum on the water, they radiate. Each thread, loosely fixed at one end in the slimy matrix, moves slowly from side to side, describing short arcs in the water, with a motion resembling that of a pendulum; and, gradually becoming detached from the matrix, it is propelled forward. These threads are continually emitted by the stratum, and diffused in the water, thus rapidly colouring large surfaces. When a small portion of the matrix is placed over-night in a vessel of water, it will frequently be found in the morning that filaments emitted from the mass have formed a pellicle over the whole surface of the water, and that the outer ones have pushed themselves up the sides, as far as the moisture reaches.

The Oscillatoriæ, though most common in fresh water, are not peculiar to it. Some are found in the sea, and others in boiling springs, impregnated with mineral substances. It has been ascertained that the red colour which gives name to the Arabian Gulf is due to the presence of a microscopic Alga *(Trichodesmium erythræum)*, allied to Oscillatoria, and endowed with similar motive powers, which occasionally permeates the surface-strata of the water in such multitudes as completely to redden the sea for many miles. The same or a similar species has been noticed in the Pacific Ocean in various places, by almost every circumnavigator since the time of Cook, who tells us his sailors gave the little plant the name of "sea sawdust." Mr. Darwin compares it to minute fragments of chopped hay, each fragment consisting of a bundle of threads adhering together by their sides.

These minute plants move freely through the water, rising or sinking at intervals, and when closely examined they exhibit motions very similar to those of *Oscillatoriæ.* There are several of such quasi-animal-plants now known to botanists, and almost all belong to the *green* series of the Algæ, which are placed in our system at the extreme base of the vegetable scale of being.

HABITAT.

The *habitat* or place of growth of the Algæ is extremely various. Wherever moisture of any kind lies long exposed to the air, Algæ of one group or other are found in it. I have already alluded to the *Hygrocrocis*, so troublesome in vats of sulphate of copper, and many, perhaps almost all other chemical solutions, become filled in time, and under favorable circumstances, with a similar vegetation. The waters of mineral springs, both hot and cold, have species peculiar to them. Some, like the Red snow plant, diffuse life through the otherwise barren snows of high mountain peaks and of the polar regions; and on the surface of the polar ice an unfrozen vegetation of minute Algæ finds an appropriate soil. There are species thus fitted to endure all observed varieties of temperature. Moisture and air are the only essentials to the development of Algæ. It has even been supposed that the minute *Diatomaceæ* whose bodies float through the higher regions of the atmosphere, and fall as an impalpable dust on the rigging of ships far out at sea, have been actually developed in the air; fed on the moisture semicondensed in clouds; and carried about with these "lonely" wanderers.

When this atmospheric dust was first noticed, naturalists conjectured that the fragments of minute Algæ of which the microscope showed it to be composed, had been carried up by ascending currents of air either from the surface of pools, or from the dried bottoms of what had been shallow lakes. But a different origin has recently been attributed to this precipitate of the atmosphere by Dr. F. Cohn, Professor Ehrenberg, and others, who now regard it as evidence of the existence of organic life in the air itself! This opinion is founded on the alleged fact, that atmospheric dust, collected in all latitudes, from the equator to the circumpolar regions, consists of remains of the same species, and that certain characteristic forms are always found in it, and are rarely seen in any other place. Hence it is inferred that the dust has a common origin, and its universal diffusion round the earth points to the air itself as the proper abode of this singular fauna and flora,—for minute animals would seem to accompany and doubtless to feed upon the vegetable atoms. If this be correct, and not an erroneous inference from a misunderstood phenomenon, it is one of the most extraordinary facts connected with the distribution and maintenance of organic life.

If Algæ thus people the finely divided vapour that floats above our heads, we shall be prepared to find them in all water condensed on the earth. The species found on damp ground are numerous. These are usually of the families *Palmellaceæ* and *Nostochaceæ*. To the latter belong the masses of semi-transparent green jelly so often seen among fallen leaves on damp garden walks, after continued rains in autumn and early winter. These jellies are popularly believed to fall from the atmosphere, and by our forefathers were called *fallen stars*.* If such be their origin, we are tempted to address them, with Cornwall in King Lear,

> "Out vile jelly! where is thy lustre now?"

for certainly nothing can well be less star-like than a Nostoc, as it lies on the ground.

An appeal to the microscope reveals beauty indeed in this humble plant, but gives no countenance to the popular belief of its meteoric descent. It is closely related in structure to other species found under dripping rocks and in lakes and ponds,

* Other substances besides Nostocs occasionally get this name. Masses of undeveloped frog-spawn, for instance, dropped by buzzards and herons, pass for meteoric deposits.

and the only reason for regarding it as an aerial visitant is the suddenness of its appearance after rain.

In certain moist states of the atmosphere, accompanied by a warm temperature, the Nostoc grows very rapidly; but what seems a *sudden* production of the plant has possibly been long in preparation unobserved. When the air is dry the growth is intermitted, and the plant shrivels up to a thin skin, but on the return of moisture this skin expands, becomes gelatinous, and continues its active life. And as this process is repeated from time to time, it may be that the large jelly which is found after a few days rain is of no very recent growth. A friend of mine who happened to land in a warm dry day on the coast of Australia, and immediately ascended a hill for the purpose of obtaining a view of the country, was overtaken by heavy rains; and was much surprised to find that the whole face of the hill quickly became covered with a gelatinous Alga, of which no traces had been seen on his ascent. In descending the hill in the afternoon, on his return to the ship, he was obliged to slide down through the slimy coating of jelly, where it was impossible to proceed in any other way. No doubt, in this case, a species of *Nostoc* which had been unnoticed when shrivelled up had merely expanded with the morning's rain.

Where water lies long on the surface of the ground, as happens in cases of floods, it quickly becomes filled with *Confervæ* or *Silk-weeds,* which rise to the surface in vast green strata. These simple plants grow with great rapidity, using up the materials of the decaying vegetation which is rotting under the inundation, and thus they in great measure counteract the ill effects to the atmosphere of such decay. When the water evaporates, their filaments, which consist of delicate membranous cells, shrivel up and become dry, and the stratum of threads, now no longer green, but bleached into a dull white, forms a coarsely interwoven film of varying thickness, spread like great sheets of paper over the decaying herbage. This *natural paper*, which has also been described under the name of *water flannel*, sometimes covers immense tracts, limited only by the extent of the flood in whose waters it originated.

But though Algæ abound in all reservoirs of fresh water, the waters of the sea are their peculiar home; whence the common name "Seaweeds," by which the whole class is frequently designated. Very few other plants vegetate in the sea, seawater being fatal to the life of most seeds; yet some notable exceptions to this law (in the case of the cocoa nut, mangrove, and a few other plants) serve a useful purpose in the economy of nature.

The sea in all explored latitudes has a vegetation of Algæ. Towards the poles, this is restricted to microscopic kinds, but almost as soon as the coast rock ceases to be coated with ice, it begins to be clothed with *Fuci:* and this without reference to the mineral constituents of the rock, the Fucus requiring merely a resting place. Seaweeds rarely grow on sand, unless when it is very compact and firm. There are, therefore, submerged sandy deserts, as barren as the most cheerless of the African wastes. And when such barrens interpose, along a considerable extent of coast, between one rocky shore and another, they oppose a strong barrier to the dispersion of species, though certainly not so strong as the aerial deserts; because the waters which flow over submarine sands will carry the spores of the Algæ with less injury than the winds of the desert will convey the seeds of plants from one oasis to another. It cannot, however, be doubted that submerged sands do exercise a very material influence on the dispersion of Algæ, or their

GEOGRAPHICAL DISTRIBUTION.

Climate has an effect on the Algæ as upon all other organic bodies, though its influence is less perceptible in them than in terrestrial plants, because the temperature of the sea is much less variable than that of the air. Still, as the temperature of the ocean varies with the latitude, we find in the marine vegetation a corresponding change, certain groups, as the *Laminariæ*, being confined to the colder regions of the sea ; and others, as the *Sargassa*, only vegetating where the mean temperature is considerable.

These differences of temperature and corresponding changes of marine vegetation, which are mainly dependent on actual distance from the equatorial regions, are considerably varied by the action of the great currents which traverse the ocean, carrying the waters of the polar zone toward the equator, and again conveying those of the torrid zone into the higher latitudes. Thus, under the influence of the warm waters of the Gulf Stream, Sargassum is found along the east coast of America as far as Long Island Sound (Lat. 44°). And again, the cold south-polar current which strikes on the western shores of South America, and runs along the coasts of Chili and Peru, has a marked influence on the marine vegetation of that coast, where *Lessonia*, *Macrocystis*, *Durvillæa*, and *Iridæa*, characteristic forms of the marine flora of Antarctic lands, approach the equator more nearly than in any other part of the world.

The influence of currents of warmer water is also observable in the submarine flora of the west coast of Ireland, where we find many Algæ abounding in lat. 53°, which elsewhere in the British Islands are found only in the extreme south points of Devon and Cornwall. These, and other instances which might be given, are sufficient to show that average temperature has a marked influence in determining the marine vegetation of any particular coast.

Seasons of greater cold or heat than ordinary have, as might be inferred, a corresponding action. This is particularly noticeable among the smaller and more delicate kinds which grow within tide marks, and are found in greater luxuriance or in more abundant fruit in a warm than in a cold season. And the difference becomes more strongly marked when the particular species is growing near the northern limit of its vegetation. Thus in warm summers, *Padina Pavonia* attains, on the south coast of England, a size as large as it does in sub-tropical latitudes ; while in a cold season it is dwarf and stunted.

In speaking of the difference in colour of Algæ, I have already noticed the prevalence of particular colours at different depths of water. A corresponding change of specific form takes place from high to low water mark ; and as the depth increases, the change is strikingly analogous to what occurs among land plants at different elevations above the sea. Depth in the one case has a correspondent effect to height in the other ; and the Algæ of deep parts of the sea are to those of tidal rocks, as alpine plants are to littoral ones. In both cases there is a limit to the growth of species; each ærial species having a line above which it does not vegetate, and each marine one, a line beyond which it does not descend. And as, at last, we find none but the least perfect lichens clothing the rocks of high mountains, so in the sea beyond a moderate depth are found no Algæ of higher organization than the *Diatomaceæ.*

These latter atomic plants would appear to exist in countless numbers at very extraordinary depths, having been constantly brought up by the lead in the deep sea soundings recorded in Sir James Ross's Antarctic voyage. But ordinary sea plants cease to vegetate in comparatively shallow water, long before animal life ceases. The limits have not been accurately ascertained, and are probably much exaggerated as commonly given in books.

Lamouroux speaks of ordinary Algæ growing at 100 to 200 fathoms, but we have no exact evidence of the existence of these plants at this great depth. The *Macrocystis*, the largest Alga known, has sometimes been seen vegetating in 40 fathoms *(Hook. Fl. Ant. vol.* 2, *p.* 464*)* water, while its stems not merely reached the surface, but rose at an angle of 45° from the bottom, and streamed along the waves for a distance certainly equal to several times the length of the "Erebus ;" data which, if correct, give the total length of stem at about 700 feet. Dr. Hooker, however, considers this an exceptional case, and gives from eight to ten fathoms as the utmost depth at which submerged seaweed vegetates in the southern temperate and Antarctic ocean ; a depth which is probably much exceeded in the tropics, and which is at least equalled by Algæ of the north temperate zone.

Humboldt, in his "Personal Narrative" mentions having dredged a plant to which he gave the name *Fucus vitifolius*, (probably a *Codium* or *Flabellaria*) in water 32 fathoms deep, and remarks that, notwithstanding the weakening of the light at that depth, the colour was of as vivid a green as in Algæ growing near the surface. I possess a specimen of *Anadyomene stellata* dredged at the depth of 20 fathoms, in the Gulph of Mexico, by my venerable friend the late Mr. Archibald Menzies, and it is as green as specimens of the same plant collected by me between tide marks at Key West, and is much more luxuriant.

Professor Edward Forbes, whose admirable report on the Ægean Sea should be consulted by all persons interested in the distribution of life at various depths, dredged *Constantinea reniformis*, Post. and Rupr. in 50 fathoms, the greatest depth perhaps on record, as accurately observed, at which ordinary Algæ vegetate. I say, ordinary Algæ, for it will be remembered that Diatomaceæ exist in the profound abysses of the ocean, as far as we are acquainted with them.

And besides these microscopic vegetables, Algæ of a group called *Nullipores* or *Corallines (Corollinaceæ)*, long confounded with the Zoophytes, become more numerous as other Algæ diminish, until they characterize a zone of depth where they form the whole obvious vegetation. These remarkable plants assimilate the muriate of lime of seawater and form a carbonate in their tissues, which from the great abundance of this deposit become stony. The less perfect Nullipores are scarcely distinguishable, by the naked eye, from any ordinary calcareous incrustation, and strongly resemble the efflorescent forms, like cauliflowers, seen so frequently in the sparry concretions of limestone caverns. Others, more perfect, become branched like corals; and the most organised of the group, or the true corallines, have symmetrical, articulated fronds. This stony vegetation affords suitable food to hosts of zoophytes and mollusca, which require lime for the construction of their skeletons or shells, and it probably extends to a depth as great as such animals inhabit.

When the same species is found at different depths, there is generally a marked difference between the specimens. Thus, when an individual plant grows either in shallower or in deeper water than that natural to the species, it becomes stunted or otherwise distorted. I have noticed in many species (as in *Plocamium coccineum*, *Dasya coccinea*, *Laurencia dasyphylla*, various *Hypneæ*, and many others) that the specimens from deep water have divaricated branches and ramuli, and a tendency to form both hooks and discs or supplementary roots, from various points of the stem and branches. Sometimes the outward habit is so completely changed by the production of hooked processes and discs, that it is difficult to discover the affinity of these distorted forms; and such specimens have occasionally been unduly elevated to the rank of species.

When water of great depth intervenes, on a coast between two shallower parts of the sea, it frequently limits the distribution of species, acting as a high mountain range would in the distribution of land plants; but in a far less degree; as it is obviously easier for the spores of the Algæ to be floated across the deep gulf, than for the seeds of land plants to pass the snowy peaks of a mountain.

The intervention of sand, already alluded to, is a far greater barrier, because sandy tracts are usually of much greater extent than submarine obstacles of any other kind. To the prevalence of a sandy coast, in a great measure probably, is owing the very limited distribution of the *Fucaceæ* on the eastern shores of North America, where plants of this family are scarcely found from New York to Florida. Since the erection of a breakwater at Sullivan's Island, S. C., many Algæ not before known in those waters have, according to Professor L. R. Gibbes's authority, made their appearance, but none of the Fucaceæ are yet among them. In due time *Sargassum vulgare* will probably arrive from the south.

Some attempt has been made to divide the marine flora into separate regions, the particulars of which I have detailed elsewhere.* In the descriptive portion of this work I shall notice the distribution of the several families, where it offers any marked peculiarity, and I shall at present confine myself to some remarks on the distribution of Algæ along the eastern and southern shores of the United States; here recording the substance of some verbal observations which I made at the Meeting of the American Association, held in Charleston, in March, 1850.

EASTERN SHORES OF NORTH AMERICA.

In comparing the marine vegetation of the opposite shores of the northern Atlantic,

* *Manual of British Marine Algæ*, *Introd.*, p. xxxvi. et seq. ed. 2.

a great resemblance is observed between the ordinary seaweeds that clothe the rocks on the eastern and western sides ; with this difference, that the species do not reach so high a latitude on the American shore as on the European. The reason of this will be readily understood by inspecting a physical map of the Atlantic, on which Humboldt's Isothermal lines, or lines of mean annual temperature, are laid down. For then it will at once be seen that there is a very considerable bending of the Isothermal lines in favour of the continent of Europe. Thus the same line that runs through New York, in lat. 41°, strikes the shores of Europe in the North of Ireland, lat. 54°. And though there is less difference in mean temperature in the southern parts of the continents than in the northern, still there is a marked difference throughout.

With respect to vegetation, *Laminaria longicruris* is common on the American shore—at least as far south as Cape Cod (lat. 42°) ; while on the European it has not been found south of Norway, save some stray, waterworn stems occasionally cast on the north of Ireland or Scotland.

Rhodymenia cristata, so very abundant in Boston harbour, (42° 30′), where it enters largely into the composition of *seaweed pictures*, is rarely found in Europe south of Iceland and the northern parts of Norway ; its most southern limit being in the Frith of Forth, (56°), where it has been found but once or twice.

Delesseria hypoglossum has not been observed in America north of Charleston, (lat. 33°), while in Europe it occurs in Orkney, (lat. 59°), and is in great profusion and luxuriance on the north coast of Ireland in lat. 55°. The distribution of this species on the American shore is very anomalous if Charleston be its northern limit, for it certainly extends southward at least to Anastasia Island, (lat. 29° 50′). In the British seas it is most luxuriant on the Antrim shore, (55°), where its fronds are sometimes three feet in length ; southern specimens are generally much smaller, and in Devonshire it rarely measures more than three or four inches, which is the average size of specimens from the south of Europe, as well as of those found in Charleston harbour. If we are correct in limiting the American distribution of this species northward by Charleston, we have the remarkable fact that the greatest latitude attained by *Del. hypoglossum* in the north-western Atlantic is less by about 5° or 6° than the *southern* limit of the same species on the north-eastern, and by about 27° than the northern boundary of its distribution. This indicates a range which the isothermal lines can scarcely explain ; for the line which runs through Charleston strikes the coast of Spain. It is the more remarkable in this species, because the genus *Delesseria* is most numerous in the colder parts of the sea, its finest species being natives of Northern Europe and of Cape Horn and the Falkland Islands ; and, as we have seen, this very *D. hypoglossum* is no where of greater size or in greater plenty than in latitude 55° on the Irish coast.

It is different with *Padina Pavonia*, itself a tropical form, and belonging to a group peculiarly lovers of the sun. We are not surprised that in America this plant should not grow further north than the Keys of Florida, although, under some peculiarly favourable circumstances, it attains a limit 27° further north, on the south coast of England ; for in the land-vegetation of the two coasts there is something like an approach to similar circumstances, *oranges* and *citrons* being occasionally ripened in the open air in Devonshire, and *Magnolia grandiflora* attaining an arborescent size. The remaining marine vegetation of the Florida Keys, as we shall presently see, has a greater resemblance to that of the Mediterranean than to that of the British coasts; and this is more in accordance with the land floras, in which palm trees are a feature in both countries.

Probably one half of the species of Algæ of the east coast of North America are identical with those of Europe—a very large portion when we contrast it with the strongly marked difference between the marine animals of the two shores; the testacea, and to a great extent even the fishes of the two continents, being dissimilar. The European species, on the same length of coast, are greatly the more numerous, which appears to be owing to the prevalence of sands, nearly destitute of Algæ, along so great a length of the American shore, and particularly along that portion which, from its latitude, ought to produce the greatest variety of Algæ, were the local circumstances favourable to their growth.

As Algæ are little indebted for nourishment to the soil on which they grow, merely requiring a secure resting place and a sheltered situation, their number generally bears a proportion to the amount of indented rocks that border the coast. Stratified rocks are more favourable to their growth than loose boulders or stones; but if the upper surface be smooth without cavities, it is either swept by the waves too rapidly to allow the growth of a vigorous vegetation; or, in quiet places, it becomes uniformly clothed with some of the Fuci, or other *social* species, which cover the exposed surface with a large number of individuals, to the destruction of more delicate species. The rocks, then, most adapted for Algæ are those in which, here and there, occur deep cavities affording shelter from the too boisterous waves. In these, on the recess of the tide, a *tide pool* or rock basin preserves the delicate fronds from the action of the sun. The rare occurrence of such situations on the American coast is doubtless a reason of the comparative poverty of the marine flora.

This comparative poverty is observable even in the common littoral Fuci or Rock Kelp. In Northern Europe, besides several rarer kinds, six species (namely *Fucus serratus*, *vesiculosus*, *nodosus*, *canaliculatus*; *Halidrys siliquosa*; and *Himanthalia lorea*) are extremely common, four of them at least being found on every coast. In America, *Fucus vesiculosus* and *nodosus* alone are commonly dispersed; *F. serratus* and *canaliculatus* have not yet been detected; and the *Halidrys* and *Himanthalia* rest on very uncertain evidence: so that of the *six* common European kinds, only *two* are certainly found in America. This deficiency in *Fucaceæ* is, in degree, made up for in *Laminariaceæ*, of which family several are peculiar to the American shore, the most remarkable of which is the *Agarum* or Sea Colander.

Among the red Algæ (or *Rhodosperms*), species with expanded, leaf-like fronds are proportionably less numerous than on the European side. *Delesseria sanguinea* is absent on the American shore, where its place is supplied by *D. Americana*, a species of equally brilliant colouring, but lower in organization, connecting *Delesseria* with *Nitophyllum*. This latter genus, of which there are so many fine European species, is scarcely known in North America. A few scraps of *Nitophylla* (almost too imperfect to describe), picked up at the mouth of the Wilmington

River, N. C., and at Key West, are all the evidence we at present possess of the existence of that type of form on the North American shore. *Plocamium coccineum*, so abundant in Europe, and which is also widely dispersed in the Southern Ocean, extending from Cape Horn eastwards to New Zealand, has not that I am aware of been found on the American Atlantic coast, where its place seems taken by the equally brilliant *Rhodymenia cristata*. *Ceramium rubrum* is as common on the American as on the European coast, and many of the other common American *Rhodosperms* are natives of both continents.

The Green Algæ (*Chlorosperms*) are still more alike; but several of the American Cladophoræ (not yet fully explored) seem to be peculiar. *Codium tomentosum*, which is common to the shores of Europe from Gibraltar, in lat. 36°, to Orkney in lat. 60°, and perhaps further north, has yet been found only on the Florida Keys, (lat. 24°). Judging from its distribution in other parts of the world, particularly in the Pacific and Southern Oceans, one would have expected to find it all along the East coast of North America.

Perhaps it would be premature to indicate regions of Algæ into which the Eastern and Southern shores of the North American states may be divided, a few points only having as yet been carefully explored. Halifax Harbour, Massachussetts Bay, Long Island Sound at several points from Greenport to New York, New York Harbour, and the neighbourhood of Charleston, S. C., are the chief points at which the materials for this essay have been collected on the East coast. Our knowledge of southern Algæ is at present derived chiefly from a partial examination of the Florida Keys, by Dr. Wurdemann, Professor Tuomey, Dr. Blodgett and myself. I think it probable, however, that future researches will indicate four regions of distribution, as follows:—

1st. Coast north of Cape Cod, extending probably to Greenland. Among the characteristic forms of this region are the great Laminariæ, particularly *L. Longicruris*, one of the largest Algæ on the coast, and *Agarum Turneri* and *pertusum*. Several of the rarer Fucaceæ seem also to be confined to this district. One of the most abundant and characteristic species of this tract is *Rhodymenia cristata*, which has not to my knowledge been found farther south than Cape Cod. Specimens said to have come from Staten Island have been shown to me, but the evidence on which the habitat of these rests is not satisfactory, and none of the Brooklyn and New York Algologists (a numerous and indefatigable band) have yet detected the plant in their harbour. *Ptilota plumosa* is also a plant of this region, the only species (as far as I know) that is met with in Long Island Sound being *P. sericea*, Gm. *Rhodomelæ* are more abundant here than in the Sound, but are not limited to this division; *Odonthalia* (a peculiarly northern form) has been seen only at Halifax. *Dumontia ramentacea*, so abundant at Iceland, is found also at Newfoundland, and near Halifax, where I gathered it plentifully. Of this plant I possess a single specimen, picked up by Miss Frothingham on Rye Beach, New Hampshire. All the species I have mentioned are Arctic forms confined in the European waters to very high latitudes, and all appear to vegetate nearly as far south as Cape Cod, to which limits they are almost all confined. The Marine flora of this region as a whole bears a resemblance to that of the shores of Iceland, Norway, Scotland, and the North and North West of Ireland.

2nd. Long Island Sound, including under this head New York Harbour and the sands of New Jersey.

The natural limit of this region on the south is probably Cape Hatteras, but after passing New York the almost unbroken line of sand is nearly destitute of Algæ. I have not received any collection of sea plants made between Long Branch and Wilmington. In comparing the plants of the sound with those of our 1st region, a very marked difference is at once seen. We lose the Arctic forms, *Agarum*, *Rhod. cristata*, *Odonthalia*, *Dumontia ramentacea* and *Ptilota plumosa*, whose place is supplied by *Sargassum*, of which genus two species are found at Greenport and at other points in the Sound ; by various beautiful *Callithamnia* and *Polysiphoniæ ;* and by abundance of *Delesseria Americana* and *Dasya elegans.* Those two latter plants are not limited to this region, but are greatly more abundant here than north of Cape Cod. *Del. Americana* seems almost to carpet the harbour of Greenport, and is equally abundant in various points in the Sound, and *Dasya elegans* grows to an enormous size in New York Harbour, and is plentiful throughout the region. *Seirospora Griffithsiana* is not uncommon; it grows luxuriantly at New Bedford, whence Dr. Roche has sent me many beautiful specimens of it, and of other *Ceramieæ*. *Rhabdonia Baileyi*, *Gracilaria multipartita*, (narrow varieties) *Chrysymenia divaricata* and *C. Rosea* are also characteristic forms. *Delesseria Leprieurii*, found in the Hudson at West Point, scarcely belongs to this region, but is a tropical form at its utmost limit of northern distribution.

3rd. Cape Hatteras to Cape Florida. Of the Algæ characterizing this region we know little except those found in the neighbourhood of Charleston, and a few specimens collected at Wilmington, N. C. and at Anastasia Island. Many species found within these limits are common to the second region ; others are here met with for the first time. Of these the most remarkable are *Arthrocladia villosa* and a *Nitophyllum*, found at Wilmington ; a noble *Grateloupia*, probably new *(G. Gibbesii*, MS.*)* found at Sullivan's Island, and *Delesseria hypoglossum*, already mentioned as occurring at Charleston and Anastasia Island. I have seen no Fucoid plant from this region ; but if there were a suitable locality, we ought here to have *Sargassa*. None grow at Sullivan's Island, where *Grateloupia Gibbesii* is the largest sea plant, and the one most resembling a Fucus. All the æstuaries of this district produce *Delesseria Leprieurii*, and a *Bostrychia*, either *B. radicans*, Mont. or a closely allied species. These last are tropical forms first noticed on the shores of Cayenne, where the former was found both on maritime rocks, and on the culms of grasses in the æstuary of the Sinnamar river. With us these plants grow on the palmetto logs in Charleston Harbour, and on *Spartina glabra* as far up the river as the water continues sensibly salt. *Del. Leprieurii* was collected by Dr. Hooker at New Zealand, accompanied by a *Bostrychia*. No other habitats for it are known.

4th. Florida Keys, and Shores of the Mexican Gulf. Here we have a very strongly marked province, strikingly contrasting in vegetation with the East Coast, comprised in the three regions already noticed. As yet the Keys have been very imperfectly explored, and we are almost unacquainted with the marine vegetation of the main land of Florida, Alabama, Louisiana, and Texas. Of 130 species which I collected at Key West in February, 1850, scarcely one eighth are common to the east coast, seven-eighths being unknown on the American shore to the north of Cape Florida. With this remarkable difference between the Algæ of the Keys and those of the East Coast, there is a marked affinity between the former and those of the South of Europe. The marine vegetation of the Gulf of Mexico has a very strong resemblance to that of the Mediterranean Sea. Nearly one third of the species which I collected are common to the Mediterranean. Several of them straggle northwards along the coast of Spain and France, and even reach the south of England; but scarcely any of these are seen on the East coast of America. We may hence infer that they are not conveyed by the gulf-stream. My collection at Key West included 10 Melanosperms, 5 of which are common to the Mediterranean; 82 Rhodosperms, 25 of which are Mediterranean; and 38 Chlorosperms, of which 10 are Mediterranean. Besides these identical species, there are many *representative* species closely allied to Mediterranean types. This resemblance is clearly shown in the genus *Dasya*, of which *seven* out of *eleven* European species are found in the Mediterranean. At Key West I collected eight species of this beautiful genus. Among these, seven were new, and the eighth (*D. elegans*) is found along the whole eastern coast of North America. Three-fourths perhaps of the masses of seaweed cast ashore at Key West belong to *Laurencia*, of which genus several species and innumerable puzzling varieties are profusely common. A fine *Hypnea (H. Wurdemanni*, MS.) one of the most striking species of the genus, is also abundant. *Alsidium triangulare*, *Digenia simplex*, *Acanthophora*, *Amansia multifida* and other common West Indian Rhodosperms are abundantly cast ashore. *Sargassum vulgare* and *bacciferum; Padina Pavonia; Zonaria lobata;* and sundry *Dictyotæ* are characteristic melanosperms. But this region is chiefly remarkable for the abundance and beauty of its *Chlorosperms* of the groups *Siphonaceæ* and *Caulerpaceæ*. Ten species of *Caulerpa* were collected, some of which are of common occurrence, and serve for food to the turtles, which, in their turn are the staple article of diet of the islanders. *Penicillus* (at least three species); *Udotea; Halimeda; Acetabularia; Anadyomene; Dictyosphæria; Chamædoris; Dasycladus; Cymopolia*, and others, some of which are West Indian, some Mediterranean, are evidence of the high temperature of the sea round the Keys. Many of the plants obtained by me at Key West were cast up from deeper water when the south wind blew strongly, and were not seen at any other time. A visitor, therefore, in the *hurricane months*, would probably obtain many which escaped me. Among the new species two *Delesseriæ*, (D. *involvens*, and *D. tenuifolia*) both belonging to the hypophyllous section, are specially worth notice. These were very plentiful in the beginning of February, but soon disappeared. Two *Bostrychiæ (B. Montagnei*, and *B. filicula*, MS.) and a *Catenella* were found on the stems of mangroves near high water mark ; but it would extend this notice to too great a length, were I to enumerate all the forms which occur in this prolific region.

COLLECTING AND PRESERVING SPECIMENS.

I shall here reprint, for the convenience of the student, the substance of some directions for collecting and preserving specimens, issued by the Director of the Dublin University Museum.

Marine Algæ, as has already been stated, are found from the extreme of high water mark to the depth of from thirty to fifty fathoms ; which latter depth is perhaps the limit in temperate latitudes ; the majority of *deep water* species growing at five to ten fathoms. Those within the limits of the tidal influence are to be sought at low water, especially the lowest water of spring tides ; for many of the rarer and more interesting kinds are found only at the verge of low water mark, either along the margin of rocks partially laid bare, or, more frequently, fringing the deep tide-pools left at low water on a flattish rocky shore. The northern or shaded face of the tide-pool will be found richest in *red* algæ, and the most sunny side in those of an *olive* or *green* colour. Algæ which grow at a depth greater than the tide exposes, are to be sought either by dredging ; or by dragging after a boat an iron cross armed with hooks, on all shores where those contrivances can be applied ; but where the nature of the bottom, or the difficulty of procuring boats, renders dredging impossible, the collector must seek for deep-water species among the heaps of sea-wrack thrown up by the waves. After storms seaweed sometimes forms enormous banks along the coast ; but even in ordinary tides many delicate species, dislodged by the waves, float ashore, and may be picked up on the beach in a perfect state. The rocky portions of a coast should, therefore, be inspected at low water ; and the sandy or shingly beach visited on the return of the tide. In selecting from heaps we should take those specimens only that have suffered least in colour or texture by exposure to the air ; rejecting all bleached or half melted pieces.

Collectors should carry with them one or two strong glass bottles with wide mouths, or a handbasket lined with japanned tin or gutta percha, for the purpose of bringing home in *sea water* the smaller and more delicate kinds. This precaution is often absolutely necessary, for many of the *red* algæ rapidly decompose if exposed, even for a short time, to the air, or if allowed to become massed together with plants of coarser texture. The cooler such delicate species are kept the better; and too many ought not to be crowded together in the same bottle, as crowding encourages decomposition; and when this has begun, it spreads with fearful rapidity. These Algæ should be kept in sea water until they can be arranged for drying, and the more rapidly they are prepared the better. Many will not keep, even in vessels of sea water, from one day to another.

A common botanist's-vasculum, or an indian rubber cloth bag, will serve to bring home the larger and less membranous or gelatinous kinds ; but even these, if left long unsorted, become clotted together, and suffer proportionably.

In gathering Algæ from their native places, the *whole* plant should be plucked from the very base, and if there be an obvious root, it should be left attached. Young collectors are apt to pluck branches or mere scraps of the larger Algæ, which often afford no just notion of the mode of growth or natural habit of the plant from which they have been snatched, and are often insufficient for the first purpose of a *specimen*, that of ascertaining the plant to which it belongs. In many of the leafy Fucoid plants, (*Sargassa*, &c.) the leaves that grow on the lower and on the upper branches are quite different, and were a lower and an upper branch plucked from the same root, they might be so dissimilar as to pass for portions of different species. It is very necessary, therefore, to gather, when it can be done, *the whole plant, including the root.* It is quite true that the large kinds may be judiciously divided; but the young collector had better aim at selecting moderately sized specimens of the entire plant, than attempt the division of large specimens, unless he keep in view this maxim: every botanical specimen should be an epitome of the essential marks of a species.

Several duplicate specimens of every kind should always be preserved, and particularly where the species is a variable one. Very many Algæ vary in the comparative breadth of the leaves, and in the degree of branching of the stems; and when such varieties are noticed, a considerable series of specimens is often requisite to connect a broad and a narrow form of the same species. A neglect of this care leads to endless mistakes in the after work of identification of species, and has been the cause of burdening our systems with a troublesome number of synonymes.

Where it is the collector's object to preserve Algæ in the least troublesome manner, and in a rough state, to be afterwards laid out and prepared for pressing at leisure, the specimens fresh from the sea are to be spread out and left to dry in an airy, but not too sunny, situation. They are not to be washed or rinsed in fresh water, nor is their natural moisture to be squeezed from them. The more loosely and thinly they are spread out the better, and in dry weather they will be sufficiently dry after a few hours' exposure to allow of packing. In a damp state of the atmosphere the drying process will occupy some days. No other preparation is needed, and they may be *loosely* packed in paper bags or boxes, a ticket of the exact locality being affixed to each parcel. Such specimens will shrink very considerably in drying, and most will have changed colour more or less, and the bundle will have become very unsightly; nevertheless, if thoroughly dried, to prevent mouldiness or heating, and packed *loosely*, such specimens will continue for a long time in a perfectly sound state; and on being re-moistened and properly pressed, will make excellent cabinet specimens.

It is very much better, when drying Algæ in this rough manner, *not* to wash them in fresh water, because the salt they contain serves to keep them in a pliable state, and causes them to imbibe water more readily on re-immersion. All large and coarse growing Algæ may be put up in this manner, and afterwards, at leisure, prepared for the herbarium by washing, steeping, pressing, and drying between folds of soft paper, in the same way that land plants are pressed and dried. But with the membranous and gelatinous kinds, a different method must be adopted.

The smaller and more delicate Algæ must be prepared for the herbarium as soon as practicable after being brought from the shore. The mode of preparation is as follows, and, after a few trials and with a little care, will soon be learned.

The collector should be provided with three flat dishes or large deep plates, and one or two shallower plates. One of the deep plates is to be filled with sea-water, and the other two with fresh water. In the dish of sea-water the stock of specimens to be laid out may be kept. A specimen taken from the stock is then introduced into one of the plates of fresh water, washed to get rid of dirt or parasites that may infest it, and pruned or divided into several pieces, if the branches be too dense, or the plant too tufted, to allow the branches to lie apart when the specimen is displayed on paper. The washed and pruned specimens are then floated in the second dish until a considerable number are ready for laying down. They are then removed separately into one of the shallower plates, that must be kept filled with *clean* water; in which they are floated and made to expand fully. Next a piece of white paper of suitable size is carefully introduced under the expanded specimen. The paper then, with the specimen remaining displayed upon it, is cautiously brought to the surface of the water, and gently and carefully drawn out, so as not to disarrange the branches. A forceps, a porcupine's quill, a knitting needle, or an etching tool, or any finely pointed instrument will assist the operator in displaying the branches and keeping them separate while the plant is lifted from the water; and should any branch become matted in the removal, a little water dropped from a spoon over the tangled portion, and the help of the finely pointed tool, will restore it.

The piece of wet paper with the specimen upon it is to be laid on a sheet of soft soaking paper, and others laid by its side until the sheet is covered. A piece of thin calico or muslin, as large as the sheet of soaking paper, is then spread over the wet specimens. More soaking paper, and another set of specimens covered with cotton, are laid on these; and so a bundle is gradually raised. This bundle, consisting of sheets of specimens, is then placed between flat boards, under moderate pressure, and left for some hours. It must then be examined, the specimens on their white papers must be placed on dry sheets of soaking paper, covered with fresh cloths, and again placed under pressure. And this process must be repeated every day until the specimens are fully dry.

In drying, most specimens will be found to adhere to the papers on which they have been displayed, and care must be taken to prevent their sticking to the pieces of cotton cloth laid over them. Should it be found difficult to remove them from the muslin, it is better to allow them to dry, trusting to after-removal, than to tear them away in a half-dried state, which would probably destroy the specimens. A few dozen pieces of unglazed thin cotton cloth of proper size should always be at hand, (white muslin, that costs six or eight cents per yard, answers very well). These cloths will be required only in the first two or three changes, for when the specimen has begun to dry on the white paper it will not adhere to the soaking paper laid over it. In warm weather the smaller kinds will often be found perfectly dry after forty-eight hours' pressure, and one or two changes of papers.

USES OF THE ALGÆ.

The uses of the Algæ may be considered under two points of view, namely, the general office which this great class of plants, as a class, discharges in the economy of nature; and those minor useful applications of separate species which man selects on discovering that they can yield materials to supply his various wants.

The part committed to the Algæ in the household of nature, though humble when we regard them as the lowest organic members in that great family, is not only highly important to the general welfare of the organic world, but, indeed, indispensable. This we shall at once admit, when we reflect on the vast preponderance of the ocean over the land on the surface of the earth, and bear in mind that almost the whole submarine vegetation consists of Algæ. The number of species of marine plants which are not Algæ proper is extremely small. These on the American coast are limited to less than half a dozen, only one of which, the common *Eel Grass (Zostera marina)*, is extensively dispersed.

All other marine plants are referable to Algæ; the wide spread sea would therefore be nearly destitute of vegetable life were it not for their existence. Almost every shore—where shifting sands do not forbid their growth—is now clothed with a varied band of Algæ of the larger kinds; and microscopic species of these vegetables *(Diatomaceæ)* teem in countless myriads at depths of the ocean as great as the plummet has yet sounded, and where no other vegetable life exists. It is not, therefore, speaking too broadly to say that the sea, in every climate and at all known depths, is tenanted by these vegetables under one phase or other.

The sea, too, teems with animal life,—that "great and wide sea, wherein are things creeping innumerable, both small and great beasts," affords scope to hordes of animals, from the "Leviathan" whale to the microscopic polype, transparent as the water in which he swims, and only seen by the light of the phosphoric gleam which he emits. Now this exuberant animal creation could not be maintained without a vegetable substructure. It is one of the laws of nature that animals shall feed on organized matter, and vegetables on unorganised. For the support of animal life, therefore, we require vegetables to change the mineral constituents of the surrounding media into suitable nutriment.

In the sea this office of vegetation is almost exclusively committed to the Algæ, and we may judge of the completeness with which they execute their mission by the fecundity of the animal world which depends upon them. Not that I would assert that all, or nearly all, the marine animals are directly dependant on the Algæ for their food; for the reverse is notoriously the case. But in every class we find species which derive the whole or a part of their nourishment from the Algæ, and there are myriads of the lower in organization which do depend upon them altogether.

Among the higher orders of Algæ feeders I may mention the Turtles, whose *green fat*, so prized by aldermanic palate, may possibly be coloured by the unctuous green juices of the *Caulerpæ* on which they browse. But without further notice of those that directly depend on the Algæ, it is manifest that all must ultimately, though indirectly, depend on whatever agency in the first instance seizes on inorganic matter, and converts it into living substance suitable to enter into the composition of animal nerve and muscle. And this agency is assuredly the office of the vegetable kingdom, here confined in the main to Algæ ; we thus sufficiently establish our position that the Algæ are indispensable to the continuance of organic life in the sea.

As being the first vegetables that prey upon dead matter, and as affording directly or indirectly a pasture to all water animals, the Algæ are entitled to notice. Yet this is but one-half of the task committed to them. Equally important is the influence which their growth exerts on the water and on the air. The well-known fact that plants, whilst they fix carbon in an organized form in extending their bodies by the growth of cells, exhale oxygen gas in a free state, is true of the Algæ as of other vegetables. By this action they tend to keep pure the water in which they vegetate, and yield also a considerable portion of oxygen gas to the atmosphere. I have already stated that whenever land becomes flooded, or whereever an extensive surface of shallow water—whether fresh or salt—is exposed to the air, *Confervæ* and allied Algæ quickly multiply. Every pool, every stagnant ditch is soon filled with their green silken threads. These threads cannot grow without emitting oxygen. If you examine such a pool on a sunny day, you may trace the beads of oxygen on the submerged threads, or see the gas collect in bubbles where the threads present a dense mass. It is continually passing off into the air while the Confervæ vegetate, and this vegetation usually continues vigorous, one species succeeding another as it dies out, as long as the pool remains. And when, on the drying up of the land, the Confervæ die, their bodies, which are scarcely more than membranous skins filled with fluid, shrivel up, and are either carried away by the wind or form a papery film over the exposed surface of the ground. In neither case do they breed noxious airs by their decomposition. All their life long they have conferred a positive benefit on the atmosphere, and at their death they at least do no injury. The amount of benefit derived from each individual is indeed minute, but the aggregate is vast when we take into account the many extensive surfaces of water dispersed over the world, which are thus kept pure and made subservient to a healthy state of the atmosphere. It is not only vast, but it is worthy of Him who has appointed to even the meanest of His creatures something to do for the good of His creation.

These general uses of the Algæ, apparent as they are on a slight reflection, are apt to be overlooked by the utilitarian querist, who will see no use in anything which does not directly minister to his own wants, and who often judges of the use of a material by the dollars and cents which it brings to his pocket.

It would be in vain to adduce to him the indirect benefit derived to the rest of creation through the lower animals which the Algæ supply with food ; for probably he would turn round with the further demand, "what is the *use* of feeding all these animals ?" And he might think, too, that the amount of oxygen in the air was quite enough to last out at least his time, without such constant renovation as the Algæ afford, or that sufficient renovation would come from other sources had the Algæ never been created. "Show me," he would say, "how I can make money of them, and then I will admit the *uses* of these vegetables." This I shall therefore now endeavour to do, by summing up a few of the uses to which Algæ have been applied by man.

Man, in his least cultivated state, seeks from the vegetable kingdom in the first place a supply for the cravings of hunger, and afterwards medicine or articles of clothing. As *food*, several species of Algæ are used both by savage and civilized man, but more frequently as condiments than as staple articles of consumption. Many kinds commonly found on the shores of Europe are eaten by the peasantry. The midrib of *Alaria esculenta*, stripped of the membranous wings, is eaten by the coast population of the north of Ireland and Scotland ; but to less extent than the dried fronds of *Rhodymenia palmata*, the *Dulse* of the Scotch and *Dillisk* of the Irish. This latter species varies considerably in texture and taste according to the situation in which it grows. When it grows parasitically on the stems of the larger *Laminariæ* it is much tougher and less sweet, and therefore less esteemed than when it grows among mussels and Balani near low water mark. It is this latter variety, which, under the name of " shell dillisk," is most prized. In some places on the west of Ireland, this plant forms the chief relish to his potatoes that the coast peasant enjoys ; but its use is by no means confined to the extreme poor. It is eaten occasionally, either from pleasure or from an opinion of its wholesomeness, by individuals of all ranks, but, except among the poor, the taste for it is chiefly confined to children. It is commonly exposed for sale at fruit stalls, in the towns of Ireland, and may be seen in similar places in the Irish quarters of New York. In the Mediterranean it forms a common ingredient in soups, but notwithstanding M. Soyer's attempt in the famine years to teach this use of it to the Irish, they have not yet learned to prefer it cooked. Occasionally, however, it is fried.

Chondrus crispus, the *Carrageen* or *Irish Moss* of the shops, is dissolved, after long boiling, into a nearly colourless insipid jelly, which may then be seasoned and rendered tolerably palatable. It is considered a nourishing article of diet, especially for invalids, and has been recommended in consumptive cases. At one time, before it was generally known to be a very common plant on rocky coasts, it fetched a considerable price in the market. Though called " Irish moss," it is abundant on all the shores of Europe and of the Northern States of America. It is, perhaps, most palatable when prepared as a blanc-mange with milk, but it should be eaten on the day it is made, being liable, when kept, to run to water. Its nourishing qualities have been tested, I am informed, in the successful rearing of calves and pigs partly upon it.

Many other species, particularly various kinds of *Gigartina* and *Gracilaria*, yield similar jellies when boiled, some of which are excellent.

Gracilaria lichenoides, the *Ceylon Moss* of the East, where it is largely used in soups and jellies ; and *G. Spinosa*, the *Agar-Agar* (or Agal-Agal) of the Chinese, are among the most valuable of these. They are extensively used and form important articles of traffic in the East. Another species of excellent quality, the *Gigartina speciosa* of Sonder, is collected for similar purposes by the colonists of Swan River.

It was at one time supposed that the famous edible birds' nests of China, the finest of which sell for their weight in gold, and enter into the composition of the most luxurious Chinese dishes, were constructed of the semi-decomposed branches of some Alga of one or other of the above named genera; but it has since been ascertained that these nests consist of an animal substance, which is supposed to be disgorged by the swallows that build them.

Nearly all the cartilaginous kinds of Rhodospermeæ will boil down to an edible jelly. One kind is preferred to another, not from being more wholesome, but from yielding a stronger and more tasteless gelatine. The latter quality is essential; for though the skill of the cook can readily impart an agreable flavour to a tasteless substance, it is more difficult to overcome the smack of an unsavoury one. And the main quality which gives a disrelish to most of our Algæ-jellies and blanc-manges, is a certain bitterish and sub-saline taste which can rarely be altogether removed.

Very few Algæ have been found agreeably tasted when cooked, though *Dillisk* and others are pleasantly sweet when eaten raw. Many which, when moistened after having been dried, exhale a strong perfume of violets, are altogether disappointing to the palate.

Perhaps, after all, the most valuable as articles of food are the varieties of *Porphyra vulgaris* and *P. laciniata*, which in winter are collected on the rocky shores of Europe, and by boiling for many hours are reduced to a dark brown, semi-fluid mass, which is brought to table under the name of *marine sauce*, *sloke*, *slouk*, or *sloucawn*. It is eaten with lemon juice or vinegar, and its flavour is liked by most persons who can overcome the disgust caused by its very unpleasant aspect. At some of the British establishments for preserving fresh vegetables, it is put up in hermetically sealed cases for exportation and use at sea, or for use at seasons when it cannot be obtained from the rocks. It is collected only in winter, at which season the membranous fronds, which are found in a less perfect state in summer, are in full growth. Both species of *Porphyra* grow abundantly on the rocky shores of North America. They not only furnish an agreeable vegetable sauce, but are regarded as antiscorbutic, and said to be useful in glandular swellings, perhaps from the minute quantity of iodine which they contain.

As articles of food for man, other seaweeds might be mentioned, but I admit that none among them furnish us directly with valuable esculents; though many less nauseous than the hunter's "*Tripe de Roche*," are sufficiently nourishing to prolong existence to the shipwrecked seaman; and others, like the *Porphyræ* just mentioned, are useful condiments to counteract the effects of continued subsistence on salt-junk.

But if not directly *edible*, there are many ways in which they indirectly supply the table. As winter provender for cattle, some are in high esteem on the northern shores of Europe. In Norway and Scotland the herds regularly visit the shores, on the recess of the tide, to feed on *Fucus vesiculosus* and *F. serratus*, which are both also collected and boiled by the Norwegian and Lapland peasants, and when mixed with coarse meal given to pigs, horses, and cattle. These Fuci are both grateful and nourishing to the animals, which become very partial to such food. Yet, perhaps, they are only the resources of half-fed beasts, and would possibly be blown on by a stall-fed "short-horn" that looks for vegetables of a higher order.

To obtain such food for the high bred cow, the Algæ must be applied in another way—namely, as manure. For this purpose they are very largely used in the British Islands, where "sea-wrack" is carried many miles inland, and successfully applied in the raising of green crops. On the west coast of Ireland the refuse of the sea furnishes the poor man with the greater part of the manure on which he depends for raising his potatoes. All kinds of seaweed are indiscriminately applied; but the larger kinds of *Laminariæ* are preferred. As these rapidly decompose and melt into the ground, they should, in common with other kinds, be used fresh, and not suffered to lie long in the pit, where they soon lose their fertilizing properties. The crops of potatoes thus raised being generally abundant, but the quality rarely good, sea-wrack is more suitable to the coarser than to the finer varieties of the potato. It is, however, considered excellent for various green crops, and a good top dressing for grass land, and its use is by no means confined to the poorer districts. The employment of sea-wrack is limited only by the expense of conveying so bulky a material to a distance from the sea or a navigable river.

Though the agricultural profits derived from the Algæ are considerable, a still larger revenue was once obtained by burning the *Fuci*, and collecting their ashes as a source of carbonate of soda, a salt which exists abundantly in most of them. *Fucus vesiculosus*, *nodosus* and *serratus*, the three commonest European kinds, yielded, up to a recent period, a very considerable rental to the owners of tidal rocks on the bleakest and most barren islands of the north of Scotland, and on all similar rocky shores on the English and Irish coasts. A single proprietor (Lord Macdonald) is said to have derived £10,000 per annum, for several successive years, from the rent of his *kelp* shores; and the collecting and preparation of the *kelp* afforded a profitable employment to many thousands of the inhabitants of Orkney, Shetland, and the Hebrides.

During the last European war, when England was shut out from the markets from which a supply of soda was previously obtained, almost the whole of the alkali used by soap-boilers was derived from the *kelp* or sea-weed ashes collected in Scotland. The quantity annually made in favourable years, between 1790 and 1800, amounted on the authority of Dr. Barry* to 3,000 tons, which then fetched from £8 to £10 sterling per ton; but at a later period of the war rose from £18 to £20. It is also stated by the same author that within the 80 years, from 1720 to 1800, which succeeded the first introduction of the kelp trade, the enormous sum of £595,000 was realized by the proprietors of kelp shores and their tenants and labourers.

Yet so great was the prejudice of the islanders against this lucrative trade, when first proposed to them, "and," to quote Dr. Greville, "so violent and unanimous was the resistance, that officers of justice were found necessary to protect the individuals employed in the work. Several trials were the consequences of these outrages. It was gravely pleaded in a court of law, 'that the suffocating smoke that issued from the kelp kilns would sicken or kill every species of fish on the

* History of the Orkney Islands, p. 383 (as quoted by Greville, see Alg. Brit. Introd. p. xxi. et seq.)

coast, or drive them into the ocean far beyond the reach of the fishermen ; blast the corn and grass on their farms ; introduce diseases of various kinds ; and smite with barrenness their sheep, horses and cattle, and even their own families.'" We smile at the ignorant bigotry of these poor people ; but have we never heard as great misfortunes predicted of almost every new improvement of the age we live in, and that not by unlettered peasantry, but by persons calling themselves wise, learned, and refined? As sad stories have been told against temperance, free trade, or even against the exhibition in the Crystal Palace.

The Orkney islanders were not long in finding the golden harvest which had thus in the first instance been forced upon them, and within a few years "Prosperity to the kelp trade!" was given as the leading toast on all their festive occasions. This state of prosperity lasted until the general peace, when the foreign markets being thrown open, *barilla* came into competition with the home produce. The manufacture of kelp gradually declined as the price fell, and now it has nearly ceased altogether, for besides the competition with *barilla*, the modern process by which soda is readily procured from rock-salt has brought another rival into the field, and one against which it seems in vain to contend.

Kelp is still made on a small scale for local consumption, and is sometimes exported as manure, but at a very low price. It is not likely ever to rise again into importance, except as a source of *Iodine*, which singular substance was first discovered in a soap-ley made with kelp ashes. Iodine has now become almost indispensable, from its medicinal value, as well as from its use in the arts and manufactures, and has been found in greater quantity in the fronds of certain littoral Algæ than in any other substances. It is therefore possible that for producing this substance these kelp-weeds may again become of mercantile importance. As a remedy in cases of glandular swellings, the use of Iodine is now well established, and it is a singular fact that several littoral Fuci have been from early times considered popular remedies in similar affections. *Fucus vesiculosus* has long been used by the hedge-doctors to reduce such swellings ; and Dr. Greville mentions, on the authority of the late Dr. Gillies, that the "stems of a seaweed are sold in the shops, and chewed by the inhabitants of South America wherever goitre is prevalent, for the same purpose. This remedy is termed by them Palo Coto (literally Goitre-stick)," and Dr. Greville supposes, from the fragments which he had seen, that it is a species of Laminaria.

Iodine however, though the most important, is not the only medicinal substance obtained from the Algæ. *Gracilaria helminthochorton*, or *Corsican Moss*, has long held a place in the pharmacopœia as a vermifuge. What is sold under this name in the shops is commonly adulterated with many other kinds. In samples which I have seen, the greater part consisted of *Laurencia obtusa*, through which a few threads of the true *Corsican Moss* were dispersed. Possibly, however, the *Laurencia* may be of equal value.

Mannite also has been detected by Dr. Stenhouse in several Algæ, to which it imparts a sweetish taste. The richest in this substance appears to be *Laminaria saccharina*, from a thousand grains of which 121.5 grains or 12.15 per cent. of mannite were obtained. The method of extracting is very simple. The dried weed is repeatedly digested with hot water, when it yields a mucilage of a brownish red colour and of a sweetish but very disagreeable taste. When evaporated to dryness, this mucilage leaves a saline semicrystaline mass. This being repeatedly treated with boiling alcohol, yields the mannite in "large hard prisms of a fine silky lustre." *Halidrys siliquosa*, *Laminaria digitata*, *Fucus serratus*, *Alaria esculenta*, *Rhodymenia palmata*, &c. are stated by Dr. Stenhouse, from whose memoir this account is condensed, to contain from 1 to 5 or 6 per cent. of mannite.

In summing up the economic uses to which Algæ have been applied, I must not omit to mention their application in the arts. The most valuable species, in this point of view, with which we are acquainted, is the *Gracilaria tenax* of China, under which name probably more than one species may be confounded. Of this plant, on the authority of Mr. Turner, (Hist. Fuc. vol. 2, p. 142,) "the quantity annually imported at Canton is about 27,000 lbs., and it is sold in that city at about 6d. or 8d. per lb. In preparing it, nothing more is done than simply drying it in the sun ; after which it may be preserved, like other Fuci, for any length of time, and improves by age, when not exceeding four or five years, if strongly compressed and kept moist. The Chinese, when they have occasion to use it, merely wash off the saline particles and other impurities, and then steep it in warm water, in which, in a short time, it entirely dissolves, stiffening as it cools into a perfect gelatine, which, like glue, again liquefies on exposure to heat, and makes an extremely powerful cement. It is employed among them for all those purposes to which gum or glue is here deemed applicable, but chiefly in the manufacture of lanthorns, to strengthen or varnish the paper, and sometimes to thicken or give a gloss to gauze or silks." Mr. Turner derived the above information respecting *G. tenax* from Sir Joseph Banks ; but recent travellers tell us that *Gracilaria spinosa*, known colloquially as *Agal-agal*,* yields the strongest cement used by the Chinese, and that it is brought in large quantities from Sincapore and neighbouring shores to the China markets. Probably both species are esteemed for similar qualities.

Several Algæ are used in the arts in a minor way. Thus, according to Dr. Patrick Neill, knife-handles are made in Scotland of the stems of *Laminaria digitata*. "A pretty thick stem is selected, and cut into pieces about four inches long. Into these, when fresh, are stuck blades of knives, such as gardeners use for pruning or grafting. As the stem dries, it contracts and hardens, closely and firmly embracing the hilt of the blade. In the course of some months the handles become quite firm, and very hard and shrivelled, so that when tipped with metal they are hardly to be distinguished from hartshorn."

On the authority of Lightfoot,† the stems of *Chorda filum*, which often attain the length of thirty or forty feet, and which are popularly known in Scotland as "Lucky Minny's lines," "skinned, when half dry, and twisted, acquire so considerable a degree of strength and toughness," that the Highlanders sometimes use them as fishing lines. The slender stems of *Nereocystis* are similarly used by the fishermen in Russian America. In parts of England bunches of *Fucus vesiculosus* or *F.*

* See, the Voyage of H.M.S. *Samarang*.
† Fl. Scot. vol. 2, p. 964.

Serratus are frequently hung in the cottages of the poor as rude barometers, their hygrometric qualities, which arise from the salt they contain, indicating a change of weather.

In our account of the artistic value of Algæ, we ought not to pass unnoticed the ornamental works which the manufacturers of " sea-weed pictures," and baskets of " ocean-flowers," construct from the various beautiful species of our coasts, and which are so well known at charity bazaars, accompanied by a much-hackneyed legend, commencing,

" Call us not weeds, we are flowers of the sea," &c.

Some of these "works of art" display considerable taste in the arrangement, and the objects themselves are so intrinsically beautiful that they can rarely be otherwise than attractive. During the recent pressure of Irish famine, many ladies in various parts of the country employed a portion of their leisure in the manufacture of these ornamental works, and no despicable sum was raised by the sale.

Other sums, for charitable purposes, have been realized in a way which a botanist would deem more legitimate, by the sale of books of prepared and named specimens; and my friend, the Rev. Dr. Landsborough,* I am told, has in this manner collected money which has gone a considerable way towards building a church. There seems no good reason why missionaries in distant countries might not, either personally or through their pupils or families, collect these and other natural objects, and sell them for the benefit of their mission ; by which means they would not only obtain funds for pursuing the work more immediately committed to them, but would have the satisfaction of knowing that in doing so they were unfolding to the admiration of mankind new pages of the wide-spread volume of nature.

Unfortunately, it happens that in the educational course prescribed to our divines, natural history has no place, for which reason many are ignorant of the important bearings which the book of Nature has upon the book of Revelation. They do not consider, apparently, that both are from God—both are His faithful witnesses to mankind. And if this be so, is it reasonable to suppose that either, without the other, can be fully understood ? It is only necessary to glance at the absurd commentaries in reference to natural objects which are to be found in too many annotators of the Holy Scriptures, to be convinced of the benefit which the clergy would themselves derive from a more extended study of the works of creation. And to missionaries, especially, a minute familiarity with natural objects must be a powerful assistance in awakening the attention of the savage, who, after his manner, is a close observer, and likely to detect a fallacy in his teacher, should the latter attempt a practical illustration of his discourse without sufficient knowledge.† This subject is too important for casual discussion, and deserves the careful consideration of those in whose hands the education of the clergy rests. These are not days in which persons who ought to be our guides in matters of doctrine can afford to be behind the rest of the world in knowledge ; nor can they safely

* Author of " A Popular History of British Seaweeds."

† See some excellent observations on this subject in " Foot-prints of the Creator: or, the Asterolepis of Stromness," by Hugh Miller. London, 1849.

sneer at the "knowledge that puffeth up," until, like the Apostle, they have sounded its depths and proved its shallowness.

Why should the study of the physical sciences be supposed to have an evil influence on the mind—a tendency to lead men to doubt every truth which cannot be made the direct subject of analysis or experiment? I can conceive a one-sided scientific education having this tendency. If the mind be propelled altogether in one direction, and that direction lead exclusively to analytical research, it is possible that the other faculties of the individual may become clouded or enfeebled—and then he is the unresisting slave of analysis—not more a rational being than any other monomaniac. And yet, paradoxical though the assertion seem, he may be all his life a reasoner, forming deductions and inductions with the most rigid accuracy, in his beaten track.

I can conceive too the astronomer, conversant with the immensity of space and its innumerable systems of worlds, so prostrated before the majesty of the material creation, as not only to lose sight of himself and of the whole race to which he belongs, but of the world or even of the solar system, and be led to doubt whether things so poor, and mean, and small can have any value in the sight of the Lord of so wide a dominion. I can conceive him, too, observing the uniformity and the harmony of the laws that govern the whole system of the heavens; the undeviating course of all events among the stars coming round as regularly as the shadow on the dial; and the little evidence there is that this uniformity has ever suffered any disturbance that cannot be accounted for by the law of gravitation, and made the subject of calculation by the mathematician, who, working an equation in his closet, shall come forth and declare the cause of irregularity, though that cause may be acting at thousands of millions of miles distance—I can conceive him inferring from a uniformity like this the absence of a superintending Providence in human affairs. If the Creator, he will say, have given up the very heaven of heavens to the immutable laws of gravitation, can I believe that he interferes by his Providence to superintend the puny matters of this lower world?

His reasons seem plausible while the mind is pointed in that one direction. But they lose all their force when, laying aside for a moment the telescope, the philosopher investigates with his microscope the structure of any *living* thing, no matter how small and how seemingly simple the organism may be. Let the object examined but have *life*, and it will soon lead him to understand a little of the meaning of God's glorious title, *Maximus in minimis.* And the further he carries his researches, the more the field of research opens, until, extending from the speck beneath his lens, it spreads wider and wider, and at length blends with infinity at the "horizon's limit." Here his boasted analysis can afford him no help. He has laid bare the "mechanism of the heavens;" he has weighed the sun and the planets; he has foretold with unerring certainty events which shall happen a thousand years after he shall be laid in the dust;—and yet he cannot unravel the mystery that shrouds the seat of life, even as it exists in the meanest thing that crawls. And if the life of this poor worm be thus wonderful, what is that spirit which animates the human frame? What is that humanity which, but a moment ago, seemed like the small dust in the balance compared with the multitude and the masses of the stars? His conceptions of his own true position in the scale of being become more rational. For a moment he views from a new position the distant stars, as the peasant views them in a clear night:—points of light spangling the blue vault above. And he reflects, "How do I *know* that those shining ones are other than they seem; how do I *know* their size, their distance, the laws by which they are governed; the reins by which the "coursers of the sun" are held in their appointed track? How?—but by the intellectual powers of that human spirit which but now I deemed so poor and mean:—so unworthy of the very thought of the Almighty—much more, so unworthy of the price which He has paid for it."

Thus the mind, turned back upon itself, begins to discover that, after all, it is not "of the earth, earthy," but derived from a higher source and reserved for a higher destiny. And strange to say, this altered and bettered opinion of itself is traceable to the first check which it feels—the first baffling of its analytical powers. So long as the mind was extending the sphere of its researches into the material universe, weighing, and numbering, and tabulating all nature seemed to move in blind obedience to a force whose influence might be calculated; every world being found to act upon its fellow in exact proportion to its position and its weight, and *our* world to be but a part, and a small part of one vast machine. And with such a view of the relation of the earth to the universe, might not unnaturally come a lower estimate of man, the dweller on the earth. "Is he too but a part in the house in which he dwells? Is his course also subject to those immutable laws which bind the universe together? And if so, where is his individuality? Where the reflex of that image in which he is said to have been created?" But the moment that the mind apprehends the action of the inexplicable laws of life, and is certified of the *individuality* of every living thing however small;—and compares these microscopic "wholes" with the "whole" that it feels itself to be, that moment it begins to see that the human soul is a something apart from the world in and over which it is placed.

Galileo in his cell was bound in fetters, but his spirit could not be bound. His thoughts were as free and his mind had as wide a range as if he could have flown through all space on the wings of light. And thus it is with man: prisoned for a short time in this lower world, he belongs to an order of being that no world can confine. He cannot continue stationary, nor plod for ever a dull round in the treadmill here. He must either rise above all height into communion with the Deity; or fall, bereft of hope, for ever. We must not estimate such a being by the narrow bounds of the cell which he now inhabits. We must judge of him by his intellectual powers, his aspirations, his intuitive conceptions of his own nature; and, as a spirit, all these place him, in his *individuality*, far above any plurality of mere material worlds.

I may seem to be wandering from my proper theme, but my object is to vindicate the teaching of the Book of Nature from the aspersions of the ignorant and the prejudiced. Whilst I admit that half views of natural science may lead men astray; and whilst I deplore the infidelity of scientific men, whose minds are absorbed in the material on which they work;—I deny that the study of nature has, in itself, an evil tendency. On the contrary, the study of organic nature, at least, ought to be one of the purest sources of intellectual pleasure. It places before us structures the most exquisite in form and delicate in material; the perfect works of Him who is Himself the sum of all perfections :—and if our minds are properly balanced, we shall not rest satisfied with a mere knowledge and admiration of these wonderful and manifold works ; but, reading in them the evidence of *their* relation to their Maker, we shall be led on to investigate *our own.*

I do not assert that this study is, of itself, sufficient to make men religious. But as the contemplation of any great work of art generally excites in us a two-fold admiration—admiration of the work itself, and of the genius of its author—so a true perception of the wonders of nature includes a certain worship of the author of those wonders. Yet we may study natural objects, and admire them, and devote our whole life to elucidate their structure ; and after all may fail to recognize the being of Him who has fashioned them. Such blindness is scarcely conceivable to some minds ; yet to others, the opposite appears but the effect of a warm imagination. So inexplicable is the human mind ! The moral evidence which stirs one man to his centre brings no conviction to another. Physical truths, indeed, cannot be rationally denied ; but there is no metaphysical truth which may not be plausibly obscured or explained away by self-satisfied prejudice. Hence the inconclusiveness of all reasoning against infidelity. The failure is not in the reasons set before the mind, but in the non-acknowledgment of the imperative force of moral reasons. No man can be convinced of any *moral* truth against his will ; and if the will be corrupt, it is possessed by a blind and deaf spirit, which none can cast out until a " stronger than he " shall come.

Here I pause ; but I cannot conclude this Introduction without expressing my warm thanks to the kind friends who have aided me in my researches, both with specimens and with sympathy. To some of them I am personally unknown, and with others I became acquainted casually, during my recent tour along the shores of the United States. From all I have received unmixed kindness, and every aid that it was in their power to render. Indebted to all therefore, I am more especially bound by gratitude to my friend, Professor J. W. BAILEY, of West Point, the earliest American worker in the field of Algology. Well known in his own peculiar branch of science, he has found a relaxation from more wearing thought, in exploring the microscopic world, and his various papers on what may be called "vegetable atoms" *(Diatomaceæ)* are widely known and highly appreciated. From him I received the first specimens of United States Algæ which I possessed, and, though residing at a distance from the coast, he has been of essential service in infusing a taste for this peculiar department of botany among persons favourably situated for research ; so that either from him or through him I have obtained specimens from many localities from which I should otherwise have been shut out. To him I am indebted for an introduction to a knot of Algologists who have zealously explored the south-western portions of Long Island and New York Sounds, Messrs. HOOPER, CONGDON, PIKE, and WALTERS of Brooklyn, from all of whom I have received liberal supplies of specimens ; and through him Professor LEWIS R. GIBBES, of Charleston, whose personal acquaintance I had afterwards the happiness of making, first communicated to me the result of his explorations of

Charleston harbour, as well as the first collection of Florida Algæ which I received, and which Dr. Gibbes obtained from their collector, the late Dr. Wurdemann. Through Professor Asa Gray, of Cambridge, Mass., long before it was my good fortune to know him personally and intimately, I received collections of the Algæ of Boston Harbour made by Mr. G. B. Emerson, Miss Morris, and Miss Loring, (now Mrs. Gray) ; also of the Algæ of Rhode Island, made by Mr. S. T. Olney, who has done so much to illustrate the botany of that State, and by Mr. George Hunt. My gatherings from the same coasts have since been much enriched by specimens from Dr. Silas Durkee, of Boston, Dr. M. B. Roche, of New Bedford, and Mrs. P. P. Mudge, of Lynn.

To Professor Tuomey, of the University of Alabama, I feel especially indebted for the care and kindness with which he formed for me an interesting collection of the Algæ of the Florida Keys, and the more so because this collection was made purposely to aid me in my present work. My friend Dr. Blodgett, of Key West, also, since my return to Europe, has communicated several additional species, and is continuing his researches on that fertile shore. To the Rev. W. S. Hore, now of Oxford, England, (a name well known to the readers of the Phycologia Britannica) I am indebted for a considerable bundle of well preserved specimens, gathered at Prince Edward's Island, by Dr. T. E. Jeans ; and to the kindness of my old friend and chum, Alexander Eliott, of the Dockyard, Halifax, I owe the opportunity of a fortnight's dredging in Halifax harbour, and many a pleasant ramble in the vicinity.

My personal collections of North American Algæ have been made at Halifax ; Nahant beach ; New York Sound ; Green Port, Long Island ; Charleston harbour ; and Key West ; and are pretty full, especially at the last named place, where I remained a month.

The few Mexican species which find a place in this work have been presented to me by Prof. J. Agardh of Lund, and were collected by M. Liebman. Those from California are derived partly from the naturalists of Capt. Beechey's voyage ; a few from the late David Douglas ; and a considerable number brought by my predecessor, Dr. Coulter, from Monterey Bay. I have received from Dr. F. J. Ruprecht of St. Petersburgh several Algæ from Russian America ; from Sir John Richardson a few Algæ of the polar sea ; and various specimens of these plants, which have found their way from the North West Coast to the herbarium of Sir W. J. Hooker, have, with the well-known liberality of that illustrious botanist, been freely placed at my disposal.

But I should not, in speaking of the North West Coast, omit to mention a name which will ever be associated in my mind with that interesting botanical region, the venerable Archibald Menzies, who accompanied Vancouver, and whom I remember as one of the finest specimens of a green old age that it has been my lot to meet. He was the first naturalist to explore the cryptogamic treasures of the North West, and to the last could recal with vividness the scenes he had witnessed, and loved to speak of the plants he had discovered. His plants, the companions of his early hardships, seemed to stir up recollections of every circumstance that had attended their collection, at a distance of more than half a century back from the time I speak of. He it was who first possessed me with a desire to explore the American shores, a desire which has followed me through life, though as yet it has been but very imperfectly gratified. With this small tribute to his memory, I may appropriately close this general expression of my thanks to those who have aided me in the present undertaking.

W. H. H.

TRINITY COLLEGE, DUBLIN,
August 6th, 1851.

DIVISION INTO GROUPS OR SERIES.

For purposes of classification the Algæ may be conveniently grouped under three principal heads or sub-classes, which are, for the most part, readily distinguishable by the colour of the frond. They are named and defined as follows, viz.

1. Melanospermeæ. *Plants* of an olive-green or olive-brown colour. *Fructification* monœcious or diœcious. *Spores* olive-coloured, either external, or contained, singly, or in groups, in proper conceptacles ; each spore enveloped in a pellucid skin (*perispore*), simple, or finally separating into two, four, or eight *sporules*. *Antheridia*, or transparent cells filled with orange-coloured, vivacious corpuscles, moving by means of vibratile cilia. *Marine.*

2. Rhodospermeæ. *Plants* rosy-red or purple, rarely brown-red, or greenish-red. *Fructification* of two kinds, diœcious :—1, *Spores* (*gemmules*, Ag.) contained either in external or immersed conceptacles, or densely aggregated together and dispersed in masses throughout the substance of the frond : 2, *Spores*, commonly called *tetraspores* (*gemmules*, Thw.), red or purple, either external or immersed in the frond, rarely contained in proper conceptacles ; each spore enveloped in a pellucid skin (*perispore*), and at maturity separating into four *sporules*. *Antheridia* (not observed in all) filled with yellow corpuscles. *Marine, with one or two exceptions.*

3. Chlorospermeæ. *Plants* grass-green, rarely a livid purple. *Fructification* dispersed through all parts of the frond ; every cell being capable of having its contents converted into spores. *Spores* (*Sporidia*, Ag.) green or purple, formed within the cells, often (always ?) at maturity vivacious, moving by means of vibratile cilia. *Gemmules* (*Coniocystæ*, Ag.) or external vesicular cells, containing a dense, dark-coloured, granular mass, and finally separating from the frond. *Marine, or, more frequently, living in fresh-water streams, ponds, and ditches, or in damp situations.*

MELANOSPERMEÆ, OR OLIVE-COLOURED ALGÆ.

SYNOPSIS OF THE ORDERS OF MELANOSPERMEÆ.

* *Frond leathery or membranaceous, forming a compact cellular substance.*

1. Fucaceæ. *Spores* contained in spherical cavities of the frond.
2. Sporochnaceæ. *Spores* attached to external, jointed filaments, which are either free, or compacted into knob-like masses.
3. Laminariaceæ. *Spores* forming indefinite, cloudlike patches, or covering the whole surface of the frond.
4. Dictyotaceæ. *Spores* forming definite groups (*sori*) on the surface of the frond.

** *Frond formed of jointed filaments, which are either free, or united into a compound body.*

5. Chordariaceæ. *Frond* cartilaginous or gelatinous, composed of vertical and horizontal filaments interlaced together. *Spores* immersed.
6. Ectocarpaceæ. *Frond* filiform, jointed. *Spores* external.

ORDER I.—FUCACEÆ.

J. Ag. Sp. Alg., vol. 1, *p.* 180 ; *C. Ag. Syst. Alg. p.* xxxvii, *(in part) ; Endl. Gen. Pl., Suppl.* 3, *page* 29 *(excl. gen.). Harv. Man. Br. Alg., ed.* 2, *p.* 11. FUCOIDEÆ, *Grev. Alg. Brit. p.* 1 ; *Harv. Man., ed.* 1, *p.* 1. FUCEÆ, CYSTOSEIREÆ, SARGASSEÆ, *and* HALOCHLOÆ, *Kütz. Phyc. Gen., p.* 349, *et seq.* FUCIDÆ and CYSTOSEIRIDÆ, *Lindl. Veg. King., p.* 22.

DIAGNOSIS. Olive-coloured, inarticulate seaweeds, whose *spores* are contained in spherical cavities of the frond. *(Plants of large size, tough, of leathery texture, becoming dark-coloured in drying.)*

NATURAL CHARACTER. *Root* almost always a conical holdfast, adhering by its base to rocks and stones, usually simple and undivided ; in a few instances sending off lateral creeping branches, and forming a mat, from which many upright fronds arise.

Fronds of large size, inarticulate, leathery or rarely in parts thin and membranaceous ; tough, tearing with facility in a longtitudinal direction ; of an olive-brown or olive-green colour, becoming foxy in age, and changing to a dark brown or black in drying ; composed of minute, coloured, or colourless cells arranged in filaments, and closely united together by a very firm intercellular substance.

The *habit* is very various. In the least perfect genera (as *Splachnidium)* there is no distinction of stem, leaves, and organs of fructification, but the frond consists of a leathery bag, filled with loose jelly, through which a few longitudinal filaments pass. The spore-cavities are dispersed beneath the pores of the whole surface, and the frond is thus reduced to a root, and a universal receptacle of fructification.

In others *(Durvillæa, Sarcophycus)* there is a stem which gradually expands at the summit into a leaf-like, cloven lamina, through which the spore-cavities are scattered ; these genera have the habit of *Laminariæ*, but the fructification of Fucaceæ.

In the next stage of development *(Myriodesma, Carpoglossum,)* the frond becomes more leaf-like, but the spore-cavities are still dispersed equally through all its divisions.

To such forms succeeds *Himanthalia*, in which there is a clear distinction between the frond and the receptacle of fructification, but wherein the former is reduced to a cup-like air-vessel, while the latter is much branched and constitutes the bulk of the plant. In this case the true relations of the parts are determined by the development; the cup-like frond being wholly formed and perfected before the branching fructification begins to be evolved.

Rising to still higher types of the Order we find (in *Fucus*, *Halidrys*, *Cystoseira*, &c.,) plants with branching, pinnate, or more commonly, dichotomous stems, either filiform or imperfectly leafy, having usually their leaf-like portions strongly midribbed, and forming their fructification in portions of the branches; generally in the extremities, which at first resemble ordinary parts of the frond, but afterwards swell, become succulent, and are converted into more or less distinct *receptacles*.

Lastly, (in *Sargassum*, and its allies,) there is a branching stem; distinct midribbed, rarely ribless, leaves, which are, in a few instances, decurrent, developed in a distichous or subspiral order; and receptacles which are, from their origin, set apart as organs of fructification (not formed by swellings of the branches,) and placed, either in the axils or along the edges of the leaves or branches.

In a large number of the plants of this Order, *air vessels (vesiculæ)* or floats designed to give buoyancy to the stem and branches, are present. In the least perfect, (as in *Himanthalia*, *Fucus*, and *Cystoseira)* the air vessels are formed by simple swellings of portions of the branches, the swollen portion becoming hollow and filled with air. In *Halidrys* several of these hollow swellings placed close together in the ramuli become confluent into a compound moniliform vesicle, which is evidently only an extreme development of the chained vesicles of *Cystoseira*. In *Phyllospora* the air vessel is formed in the leaf-stalk, the lamina being a crest to its summit. Such is likewise the case in *Sargassum*, the highest type in the order, but in this genus the lamina of these vesicular leaves is either wholly abortive or reduced to a slender mucro; so that here the air vessel appears like a distinct organ. It usually accompanies the receptacles of fructification, and is, in fact, properly a floral leaf or bract, interposing between the ordinary leaves and those appropriated to the fructification.

On most parts of the frond, but especially on the expanded portions of the stem in the less organized types, and on the leaves in the more fully developed ones, will be found minute dot-like *pores*, from which, while the plant is under water and in a growing state, a pencil of delicate, colourless, jointed hairs is seen to protrude. These pores, called the *muciferous pores* by early writers, are found in all the *Fucaceæ*, and are one of their most definite characters. Under each pore is placed a minute hollow chamber, of a spherical form, from the inside of whose walls the colourless fibres originate. It is possible that these hairs may exercise an important physiological office, acting on the aerated water as the stomates of aerial leaves do upon the air; nothing, however, has been ascertained on this point. But whatever be the use of these hollow chambers and their contents in the vegetating parts of the frond, in those appropriated to fructification they are enlarged, and transformed into the *spherical cavities* within which the *spores* and *antheridia* are lodged.

In the less organised genera, as has been already mentioned, the *spore-cavities (scaphidia*, Ag.—*conceptacula*, Mont.—Endl.—*angiocarpia*, Kütz,) are dispersed over the whole frond; in the more perfect, they are confined to limited portions of the branches or leaves, which then become succulent and full of slimy mucus; and in the highest types, small metamorphosed branchlets are from the beginning set apart as organs of fructification. These metamorphosed branchlets, or the swollen parts of ordinary branches which are filled with spore-cavities, are called *receptacles*; (*receptacula*, Ag.—Endl. —*carpomata*, Kütz.)

Each *spore cavity*, placed immediately beneath the outer wall of the frond, and communicating freely with the water through its pore, is a hollow, spherical, membranous, bag-like chamber, whose inner surface is clothed with pellucid hairs *(paranemata)*, among which organs of fructification of two kinds (male? and female) are placed. Sometimes both kinds or sexes are found in the same cavity; sometimes all the cavities of one plant produce one kind only, and all those of another plant the other kind. (A vertical section of one of the female spore-cavities of *Fucus furcatus*, figured at our Plate III. A, fig. 4, will show the general appearance of the fructification.)

The *spores* are lodged within colourless, glassy *perispores*, or large, swollen, membranous, closed cells, attached to the walls of the cavity; each perispore containing from one to eight, and most commonly four *spores*. The *perispore* originates, like the hairs or paranemata, from the wall of the cavity, and appears to be formed from one of these hairs, which, having been fertilized at an early period of its development, instead of continuing to grow by the production of new cells at its apex, like an ordinary hair, has been arrested at the first or second cell; and this cell, becoming enlarged, has an endochrome gradually elaborated within it, and finally either condensed into a single spore or divided into several. In an early stage the colouring matter, or endochrome, is of a very fluid substance, and pale olive hue. Gradually it becomes darker and more opaque, its particles lying closer together, and at length is partially solidified and invested with a delicate membranous envelope, which constitutes the testa of the spore. In *Halidrys*, *Cystoseira*, and several other genera, each perispore contains at maturity but a single spore; in *Fucus* and others, the number of spores varies from two to eight, or perhaps a larger number.

The paranemata are either simple or branched. Those which produce *Antheridia* are always branched, and the antheridia are formed from the terminal cell of each branchlet, which is enlarged and ovate, obovate, or club-shaped. This *Antheridium*, or supposed male, is a pellucid, enlarged, closed cell, containing a multitude of minute *corpuscles (sporidia*, Ag.), which are supposed to represent the pollen, if not to fulfil its office in fertilizing the spore. They are oval, somewhat pointed at one end, and contain a reddish-orange granule; and they are furnished with two extremely slender vibratile hairs or *cilia*, one of which issues from the narrow extremity of the corpuscle; the other, which is of greater length, from the coloured granule. The corpuscles, at first contained within the antheridium, at length issue from it, escaping into the surrounding water, and immediately commence a succession of rapid movements to and fro, and in circles and curved lines, strikingly similar to the ciliary movements of some of the Infusoria, or of the spores of some of the fresh water Algæ of the *Green* series. These movements depend on the rapid vibrations of the cilia. During progression, the narrow end of the corpuscle is always in front; while the cilium, rising from the coloured granule, trails behind like a tail.

Messrs. Decaisne and Thuret, from whose memoir *(in Ann. des Sc. Nat.* 1845, *p.* 5 *et seq.)* this description is mostly taken, point out the strong analogy between these vivacious corpuscles of the *Fucaceæ* and the so-called spermatozoa of the Characeæ, Mosses, and Hepaticæ, and argue from this similarity of structure a similarity of function. They are, therefore, of opinion that the corpuscle-bearing cells are properly organs of a similar nature to the antheridia of other cryptogamic plants; and not, as is supposed by Agardh, analogues of the sporidia of the lower Algæ, and like them capable of germination. From my own investigations, I am disposed to agree with the opinion which regards them as male organs. They may readily be seen with the higher powers of the compound achromatic microscope; and are easily found in the ordinary shore Fuci, *(Fucus vesiculosus* and *F. nodosus)*, in winter or early spring, on specimens bearing bright yellow or orange coloured receptacles. Some of the most deeply coloured should be selected and placed in the air till partially dry. As the frond dries, little drops of a slimy, bright orange fluid will ooze out from the pores of the receptacle; and if one of these drops be removed, and placed in a little sea water on the stage of the microscope, it will be found to consist of multitudes of detached antheridia. If these be watched for a short time, the vivacious corpuscles may be seen to issue from them and perform their singular dances.

The *Fucaceæ* are readily known from all other orders of Melanosperms, by having their *spores* contained in those little spore-cavities, which we have already described. In no other order do such cavities exist.

The group of plants defined by this character is a very extensive one, comprising, perhaps, one-half of the known MELANOSPERMS. If we view it as also composed of an aggregate of individuals of each species, its relative importance will appear very much greater, for most of the plants of which it consists are *social* ones, and clothe very large portions of the submarine soil. About 230 species are described by Agardh in his last work, while Kützing, (who has introduced many species which are not admitted by other writers) enumerates upwards of 300. Of this large number, however, I am only able to claim 20 as inhabiting the American shores, and six of these are known only on the Pacific coasts.

The deficiency of *Fucaceæ* is a very remarkable feature of the American marine flora, the *common* fuci of the eastern coasts being only *two*, (*Fucus vesiculosus* and *nodosus*) and these two scarcely growing south of New Jersey. No doubt the long line of sandy shore which extends from New York Bay southward forbids the production of plants whose natural habitat is on tidal rocks and boulders; but it is remarkable that on the rock-bound coasts of the North Eastern States, there is no trace of the *Fucus serratus* or *F. canaliculatus* which are so widely dispersed on the European side of the Atlantic. We should not consider this absence of common European forms remarkable, if the Fuci found on the American coasts were *peculiar* to them. It is because the two species so abundant in America are also common in Europe, that we wonder at the absence, in the western waters of the Atlantic, of the equally common forms with which they are associated in the eastern.

The *Fucaceæ* are rarely deep-water plants. One species *(F. canaliculatus)*, common in Europe, begins to grow at the extremity of high water mark, in places where it is exposed to the atmosphere during the greater part of the twenty-four hours, and only submerged by the highest tide waves. In such places, though its growth is dwarfish, it frequently produces fruit. As it descends in depth toward mid-tide level, the frond becomes larger and more luxuriant, and in the space between this limit and that of quarter-tide, the greater number of individual plants occur. Few straggle into deeper water. This species, of all others, is best fitted to resist drought, its fronds being peculiarly dense and leathery; and in a warm day it frequently becomes crisp and dry, and to all appearance baked to death, during the recess of the water; and yet, on the return of the tide, the withered fronds expand and become flexible and juicy. Perhaps the non-occurrence of this plant on the American coasts may be owing to the fiercer heats which it would be subjected to, in the exposed places that it would naturally occupy.

With the slight exception of this semi-aerial species, all the ordinary Fucaceæ are characteristic of the space strictly defined by the tide marks, extending through the whole range of exposed rock; over which in temperate latitudes they usually spread so densely, that the colour of the sea-shore is as clearly characterised by them, as is the colour of the ground by the species of grasses which constitute its green mantle.

A few of the most highly developed genera *(Cystoseira, Sargassum, &c.)* are productions of deeper water, commencing to grow at depths at which the *Fuci* cease, and extending into a zone of depth where they are constantly submerged. I am not aware that any species has been traced into a deeper zone than that occupied by *Laminariæ*.

One remarkable species of the genus *Sargassum* has long been famous by the name of *Gulfweed* or *Sargazo (sea-lentils)*, under which most voyagers since the days of Columbus have spoken of it. That great discoverer was the first to encounter it in modern times, (16th September, 1492) and with his account we are therefore most familiar; but possibly the weedy sea which Aristotle speaks of as having been met with by the Phœnicians, at the termination of their voyage, may have been an early discovery of the same bank. It is curious that the great bank which extends between the 20th and 45th parallels of north latitude, and in 40° W. from Greenwich, appears to occupy the same position at the present day as it did in the days of Columbus. Between this bank and the American shores, various smaller strata and detached masses of seaweed occur, being thrown into this portion of the ocean by the eddy caused by the sub-circular motion of the great oceanic currents. The whole of this immense space of ocean, which is reported to be thickly covered with seaweed, is computed by Humboldt at upwards of 260,000 square miles, an area almost six times as large as Germany;* but it is not to be supposed that all this space is *equally* clothed with floating verdure. In many places the weed occurs in distant and narrow ridges, leaving spaces of clear water between. This portion of the Atlantic seems to be the chief *settlement* of the

* Johnst. Phys. Atlas. *Atlantic*, p. 5.

Sar. bacciferum, but straggling specimens occur in the Pacific and Indian Oceans, and on the shores of Australia and New Zealand ; and some few, carried northward by the Gulf stream, reach the northern shores of Europe in safety.

Naturalists have been puzzled to account for the origin of the Gulfweed, and formerly it was supposed to be altogether derived from the Gulf of Mexico ; being torn off the shores of the Florida reefs and keys, and carried to sea with the great current. It is possible (and indeed probable) that the *origin* of the present floating banks may have been partly of this nature, but it is most certain that the great masses of the weed that are at present found floating have had no such immediate parentage, but are produced on the surface of the ocean on which they float. Whoever has picked up the plant at sea, on any genuine portion of the bank, must have seen that it was in a perfectly fresh and growing state, and if he have looked at his specimen carefully, he will probably have observed, that different parts of the same specimen were of very different ages ; that though there was no apparent root, yet that toward the centre of the mass a small portion of stem was of a much darker colour than the rest, and possibly covered by parasitic incrustations ; and that all the branches springing from this central piece were successively more and more delicate and of paler colour, and evidently in a young and sprouting state. Such a specimen is clearly in vigorous life, yet it has no *root*. But the absence of root is a matter of very trivial moment in a seaweed ; for we must bear in mind that the roots of Algæ are merely holdfasts, intended to keep them from being washed off the rocks on which they grow. And in a plant capable of enduring extensive change of place, like this *Sargassum*, the root is the part which may be most readily dispensed with. No doubt the specimen under examination originated in a little branch accidentally broken from a neighbouring mass, and which being thus cast adrift, continued to push out new branches and leaves. In this manner, by the continual breaking up of old fronds and the continued growth of their broken parts, the floating masses spread over the surface of the sea.

In this floating state the species never forms proper fructification. There is, therefore, no growth from spores. The supply of plants is consequently kept up and extended by the constant development of buds or *gemmæ*, originating in broken fragments of branches. I have taken some pains to examine numerous specimens, picked up on various parts of the bank, while fresh from the sea, and have in general been able to convince myself that the tuft under examination had originated in a fragment of an older tuft.

This process of growth by breakage must have gone on for ages ; from that early time when the first individuals were brought from some unknown rocks by the currents of the ocean. Humboldt indeed conjectures that between the parallels of 20° and 45° there is an immense bank from which the supply of *Sargassum* is constantly derived ; but such a bank, if covered by only as much water as the *greatest* depth at which any Fucaceous plant is known to grow, could scarcely have escaped the notice of voyagers. And the aspect of this *Sargassum*, with its innumerable floating-bladders, shews that it was not intended to vegetate at any great depth ; for we invariably find the air-vessels most numerous in species which rise to the surface, and altogether absent in those which are deeply submerged.

The geographical range of the Order *Fucaceæ* is very extensive. The great bulk of the species occur within 35° of the equator on either side, within which limits also the generic types are most varied. To the north of 35° *Sargassa* become rare, and on the American shore the highest limit attained by any of this genus is in Long Island Sound, about 44°. Beyond this limit the genus *Fucus* becomes the prevalent form, and in the extreme north *Himanthalia* appears. *Cystoseira*, which has many representatives in the south of Europe, four of which extend as far as Great Britain, is not found on the eastern shores of America, and but slightly, represented on the north western. It forms an intermediate link, in structure and distribution, between the tropical and arctic forms of the order. Very few species have been traced into the Antarctic Ocean, where the most remarkable form is the gigantic *Durvillœa*, which has a stipe and habit resembling a *Laminaria* ; or it may be likened to a great Palm-leaf. The shores of Australia are peculiarly prolific in plants of this order, and the species of that sea are remarkable as well for their beauty, as for the large number of generic types which they exhibit. It is on those shores that the most fully organised types of the olive-coloured Algæ are met with.

In an economic point of view, the *Fucaceæ* take a high place among sea-plants. Their ashes contain a large quantity of carbonate of soda, for which the Fuci were formerly very much sought after, and even *cultivated* on some parts of the coasts of Scotland where they did not grow naturally ;—rocks being deposited to attract them to pebbly or sandy shores. At one time the proprietors of sea-shores on the most barren islands of Scotland drew a very large revenue from the sale of the *wrack* (varec) or sea-ware, which was then burned and its ashes sold under the name of Kelp:* but improvements in chemistry, by which carbonate of soda is now cheaply obtained from other sources, have almost destroyed the kelp trade. These seaweeds are now collected chiefly for manure, for which purpose they are often very valuable.

Iodine is their most remarkable constituent, and is found in their tissues in greater quantity than in any other of its known sources. The increasing demand for this valuable substance may, therefore, be expected to cause a partial revival of the kelp trade.

The ordinary species, *F. vesiculosus*, is eagerly eaten in winter by Scotch and Norwegian cattle, which regularly come down to the shore to browse on it at the recess of the tide ; and Linnæus tells us that in Gothland the peasantry boil it, and adding some coarse flour, give it to their hogs.

SYNOPSIS OF THE NORTH AMERICAN GENERA.

* *Frond branched, leafy. Air-vessels stalked, separate.*

I. SARGASSUM. *Receptacles* racemose, in the axils of the upper leaves.

* See Introduction, supra, p. 35.

** *Frond branched, imperfectly leafy or pinnatifid. Air-vessels formed in certain parts of the leaves or branchlets.*

II. PHYLLOSPORA. *Leaves* distichous, nerveless. *Air-vessels* formed in the petioles of the leaves.

III. HALIDRYS. *Frond* pinnatifid, leafy below, filiform above. *Air-vessels* formed in the ultimate branchlets, podlike, of several air-cells.

*** *Frond branched, imperfectly leafy or filiform. Air-vessels either absent, or formed irregularly by the occasional swelling of the branches.*

IV. CYSTOSEIRA. *Frond* much branched, bushy; the branches filiform. *Receptacles* filiform, slender, terminal; their substance formed of small cells.

V. FUCUS. *Frond* dichotomous, flat or compressed. *Receptacles* filled with mucus, which is traversed by a net-work of jointed filaments.

**** *Frond reduced to a top-shaped, or cup-shaped vesicle.*

VI. HIMANTHALIA. *Receptacles* strap-shaped, dichotomously branched.

I. SARGASSUM, *Ag.*

Root a conical disc. *Frond* much divided; having a distinct stem, branches, leaves, air-vessels, and receptacles. *Branches* filiform or flat, alternate, lateral, more or less distinctly pinnate. *Leaves* horizontal, or very rarely vertical and decurrent, mostly furnished with a midrib, and muciferous pores. *Air-vessels* stalked, axillary, formed from transformed leaves, pointless or tipped with a slender process. *Receptacles* small, linear, tuberculated, axillary, racemose or dichotomous, composed of a densely cellular substance; having numerous pores, beneath which are placed the spherical conceptacles (or spore cavities.) *Spore-cavities* mostly diœcious. *Spores* one or more in each conceptacle, to whose walls they are attached, obovoid, subsessile, having a hyaline perispore. *Antheridia* roundish, on branched filaments, racemose. *Paranemata* simple or forked, clothing the walls of the conceptacle.

The frond originates in a single leaf, having a lamina and midrib. This first leaf lengthens, and either continues undivided or becomes forked at the extremity. Afterwards the lamina gradually disappears from the lower portion, while the midrib thickens and becomes the commencement of the future stem; and the upper portion, still extending, is again divided and each of its divisions forms the starting point of a branch. All the young stems and branches, which in this manner are formed out of the midrib of the first formed leaves, are in their early growth winged with the remains of the lamina of the transformed leaf; but as this soon decays away and is not renewed, the branches as they extend upwards become quite filiform, and their upper divisions are, in the majority of species, never winged. In a few species, the wing-like border is continued through all portions of the frond. The *leaves* which clothe the branches, the only leaves generally seen on full grown plants, are formed by dilatations of ultimate barren branchlets, and therefore arise in a manner the reverse of the primary leaves which spring from the root. The root-leaves, by losing their lamina, form the commencement of the filiform stem and branches ; and again, the barren apices of the stem and branches, by acquiring a lamina, become ordinary leaves. The branching throughout the frond, which at a hasty inspection seems to be alternate, or repeatedly pinnate, is in truth but a concealed form of dichotomous division, in which every alternate prong of the fork is stopped, while the twin prong is lengthened and again forked at its extremity. It is easy to see how an alternately pinnate frond, with a zigzag rachis, would result from the continual repetition of such a system of branching. In some species with zigzag stems and branches this mode of division is very evident throughout ; but in ordinary forms, as in our *S. Montagnei* (Plate I. f. A. 1.) the truly dichotomous division of the frond is only to be clearly perceived in the lesser fertile branches. If, however, these be carefully traced back to older portions, or the development of a young plant from its first leaf watched, the alternate suppression of parts will be very evident. From the same figure it may be seen, that the air-vessels are nothing but *leaves* in which the lamina has become inflated, while the apex of the midrib is prolonged into a mucro. In other species the transformation of the vesicated leaf is less complete, and then a wing-like border surrounds the inflated portion. These vesicles are usually placed between the ordinary leaves and the receptacles of fruit, and are, therefore, to be regarded as a form of bracts, or appendages to the inflorescence. They are most numerous in species which grow in shallow water, and serve to buoy up the branches. The *receptacles* of the fructification are, in like manner, but altered leaves ; and, as in flowering plants, they are the *ultimate* leaves. The frond which originated in a *spore* has passed through the various stages of its development, and at the end of its upward growth it again forms *spores* from which new plants may germinate.

The number of species of the genus Sargassum is very considerable ; upwards of 120 have been described, and probably many more remain uncharacterised in various herbaria. They are chiefly tropical and sub-tropical, and are found in the oceans of both the eastern and western hemispheres, but seem to be most numerous in the former. The following are all that I have been able to ascertain as natives of North America :—

1. SARGASSUM *vulgare*, Ag. ; stem filiform, smooth or nearly so ; leaves linear or oblong-lanceolate, serrated, ribbed, brownish-olive, with evident glands ; air-vessels pointless, spherical, on compressed stalks which are as long as the air-vessel ; receptacles axillary, repeatedly forked, filiform, tuberculated, twice as short as the subtending leaf.—*J. Ag. Sp. Alg. vol.* 1, *p.* 342 ; *Grev. Alg. Brit. t.* 1 ; *Harv. Phyc. Brit.* t. 343. Fucus natans, Turn. Hist. Fuc. t. 46 (excl. vars.) *Eng. Bot. t.* 2114.

Hab. On rocks and stones near low-water mark. Perennial. Summer. Common on the Florida Keys; thrown up from deep water abundantly at Key West; growing within tide marks at Sand Key. At Green Port, Long Island, *Prof. Bailey*. Also at Seaconnot, Bristol Ferry and Stone Bridge, Rhode Island, *Prof. Bailey, and Mr. Thurber*. Narragansett Pier, Newport, and Seaconnot Point, Rhode Island, *Mr. S. T. Olney* (v. v.).

Stem from one to two feet long or more, generally undivided, but densely clothed throughout its length with lateral branches, the lowermost of which are longest, the upper gradually shorter, and those near the summit but rudimentary; terete, from a quarter to half a line in diameter, unarmed, and usually quite smooth. *Branches* similar to the main stem, either leafy, or furnished with a set of alternate secondary branches, similar to the primary. *Leaves* of a thickish substance and coriaceous texture, having many evident glandular pores, sharply serrate, or rarely repando-dentate or subentire: slightly narrowed at the base, and usually tapering to the point, but very variable in size, and in proportionate length and breadth; sometimes oblong, sometimes linear-lanceolate, and sometimes broadly lanceolate: furnished with a strong, percurrent mid-rib, which becomes less evident just below the apex. *Air-vessels* numerous, particularly on the upper branches, and beneath the fructification, spherical, pointless, (or rarely with a small mucro), from two to three lines in diameter, raised on compressed or flattened, sometimes winged petioles of their own length. *Receptacles* axillary, linear, repeatedly forked, shorter than the subtending leaf, tuberculated. *Colour* varying from a dark, brownish olive to a foxy or tawny bay. *Substance* tough and leathery.

2. Sargassum *Montagnei*, Bailey MSS.; stem filiform, slender, smooth; leaves very narrow, linear-lanceolate, attenuate, repando-dentate or subentire, ribbed, pale-greenish olive, membranaceous, glandular-dotted; air-vessels spherical, furnished with long, filiform or foliaceous points, raised on square petioles of their own length; receptacles axillary, tuberculated, more or less forked, and generally shorter than the subtending leaf.—(Tab. I. Fig. A.)

Hab. On rocks and stones, near low-water mark. Perennial. Summer. At Greenport, Long Island, growing with *S. vulgare*, *Prof. Bailey and W. H. H.*; Little Compton, Rhode Island, *Mr. Olney* (v. v.).

Root a conical disk. *Radical* and primary leaves oblong or lanceolate, 2-3 inches long and 3-4 lines in diameter, sharply serrate or unequally dentate, membranaceous. *Stems* from two to three feet long, filiform, smooth, very slender, undivided, set throughout with lateral branches, the lowest of which are twelve or fourteen inches in length, and the upper gradually shorter and less compound. The longer branches give off alternate branchlets, at intervals of half an inch to an inch. *Leaves* of the branches very narrow, usually two inches or more in length, and only a line or two in breadth, linear-lanceolate, attenuate, sometimes nearly entire, sometimes remotely dentate or merely repand, delicately membranaceous, of a very pale greenish olive colour, minutely glandular, furnished with a percurrent midrib. *Air-vessels* globose or slightly oval, on slender, square stalks, tipped either with a long filiform point or with a linear-lanceolate leaf, either of which is often deciduous. *Receptacles* axillary, filiform, tubercular, more or less forked, sometimes attenuate. *Colour* pale. *Substance* delicate.

My specimens, from which the plate has been drawn, were gathered in August, when many of them had formed receptacles. The fruit figured is scarcely mature. The receptacles eventually become more filiform, and repeatedly forked. I have received from Professor Bailey a fragment of a fertile branch of a Sargassum, destitute of leaves and therefore doubtful, but which probably belongs to this species. In it the receptacles are very much lengthened, slender, tassel-like, an inch and half long and repeatedly forked, and have something the aspect of the fructification of *Lycopodium Phlegmaria.* Should future observations on the spot, made later in the season, show that these very long receptacles are the ordinary state of the ripe fruit, it will materially strengthen the specific character. Professor J. Agardh mentions a var. of *S. vulgare,* which he calls *trichocarpum,* distinguished by similar tassel-like fruit. This species is dedicated by Professor Bailey to our mutual friend and fellow student, Dr. Montagne, of Paris. The *S. vulgare var. tenuifolium* of Mr. Olney's list ought, at least in part, to be referred to *S. Montagnei.*

3. SARGASSUM *affine,* J. Ag.; "stem filiform, smooth, leaves lanceolate-linear, acutely serrate, with a single row of glandular pores at each side of the midrib; air-vessels spherical, pointless, on subterete stalks of their own length; receptacles axillary, forked, racemose, cylindraceo-lanceolate, warted, unarmed." *J. Ag. Sp. Alg. vol.* 1. *p.* 343.

HAB. In the West Indian Sea. *J. Agardh.* (v. s. in Herb. Trin. Coll. Dublin.)

I introduce this, as it may probably be found on some of the Florida Keys. It seems to be intermediate in character between *S. vulgare* and *S. bacciferum.*

4. SARGASSUM *bacciferum,* Ag.; stem filiform, smooth; leaves linear-lanceolate, attenuate, sharply serrate, ribbed, usually destitute of glandular pores; air-vessels on subterete stalks, spherical, tipped with a filiform point; receptacles axillary, forked, cylindrical, warted, unarmed. *J. Ag. Sp. Alg. vol.* 1. *p.* 344; *Kütz. Sp. Alg. p.* 609; *Harv. Phyc. Brit. t.* 104. *Fucus bacciferus, Turn. Hist. Fuc. t.* 47.

HAB. Floating in the Gulf-stream, and thrown up abundantly on the Florida Keys, and on other parts of the coast. (v. v.)

The floating fronds generally grow from a central point, from which branches extend in all directions. In such specimens the base appears to be a fragment of broken branch, rather than a true disciform root. *Branches* smooth, zigzag, or angularly bent, once or twice divided in an alternate manner, the lesser branches set with distichous leaves, having a vesicle in the axil of each. *Leaves* from two to three inches in length and from one to three lines in width, coriaceous, sharply serrate, tapering to each end, furnished with a strong midrib, but usually destitute of glandular pores. The serratures are often duplicate. *Air-vessels* very numerous, about as big as peas, spherical, mostly mucronate, tipped with a longish bristle; their stalks about as long as the inflated part, and roundish. *Receptacles* rarely found. *Colour* when quite fresh a pale and beautifully clear olive; but soon changing and becoming foxy in age and very dark in drying. *Substance*, when living, brittle.

This is the common *Tropical Sea-grape*, whose air-vessels, resembling berries, are popularly taken for fruit. It has already been spoken of as the famous *gulfweed* of navigators.*

5. SARGASSUM *Liebmanni*, J. Ag.; "stem filiform, subterete, branched on all sides; leaves lanceolate, acuminate, ribbed, without glands, spinuloso-dentate, waved and twisted; air-vessels spherical, somewhat margined, pointed, on filiform stalks shorter than themselves; receptacles two-edged or triquetrous, serrato-dentate, forked, their branches at length subpedicellate, agglomerated in the axil." *J. Ag. Sp. Alg. vol.* 1. *p.* 326.

HAB. On the Pacific coast of the Mexican Republic, *Leibman.* (v. s. in Herb. T.C.D.)

Stems or primary branches numerous, from a short stipe, a foot or more in length, filiform, slightly flexuous, smooth, closely set with short, alternate, spirally disposed, spreading branchlets. These branchlets in my specimen are an inch or two in length, the lowest not longer than the upper, and issue at intervals of half to three-quarters of an inch. *Leaves* an inch to an inch and half long, three or four lines in breadth, somewhat lanceolate, obtuse, thick, leathery, waved and curled, midribbed, almost destitute of glandular pores, sharply spinuloso-dentate, the teeth deltoid-acuminate, patent, with rounded sinuses between. *Air-vessels* few, and only on the uppermost branchlets, on very short stalks, spherical, with a narrow leafy border, and a small point or leafy mucro. *Receptacles* axillary, densely tufted, repeatedly forked, three-sided, sharply spinoso-dentate, much shorter than the subtending leaf. *Colour* dark brownish olive. *Substance* leathery, dense.

6. SARGASSUM *hystrix*, J. Ag.; "Stem filiform, subterete, branched on all sides;

* Page 53.

leaves oblong-elliptical, acuminate, ribbed, obsoletely glandular, serrate or subentire; air-vessels spherical, pointless, on very short stalks; receptacles warted, two-edged, twisted, spinous-toothed, forked, their branches at length pedicellate, crowded in the axils." *J. Ag. Sp. Alg. vol.* 1, *p.* 322.

HAB. In the Atlantic, from the shores of Mexico to those of Newfoundland. *J. Agardh.*

I am not acquainted with this species.

7. SARGASSUM *filipendula*, Ag; "stem filiform, very smooth; leaves narrow-linear, ribbed, with a single row of glands at each side the rib, serrated, the uppermost very narrow and nearly entire; air-vessels spherical, pointless, nearly without glands, on compressed stalks longer than themselves; receptacles cylindrical, warted, unarmed, paniculate on a long axillary ramulus, the lowermost stalked, the upper confluent." *J. Ag. Sp. Alg. vol.* 1, *p.* 314.

HAB. The Gulf of Mexico, *J. Agardh.*

Unknown to me.

II. PHYLLOSPORA. *Ag.*

Root branching. *Frond* distichous. *Branches* flat or compressed, fringed with marginal leaves. *Leaves* nerveless, undivided, tapering at base into sub-distinct petioles, marginal, distichous, vertical. *Air-vessels* formed by transformation of a portion of the leaf into a bladdery vesicle. *Receptacles* leaf-like, having numerous pores beneath which are placed the spherical conceptacles (or spore cavities). *Spore-cavities* diclinous. *Spores* several in each conceptacle, to whose walls they are attached, obovoid, subsessile, having a hyaline perispore. *Antheridia* ellipsoidal, racemose. *Paranemata* long, simple, clothing the walls of the conceptacle.

A genus consisting of two species formerly placed in *Macrocystis*, of which they have in some respects the habit, but from which they essentially differ in fructification. The type of structure is in many respects lower than that of *Sargassum*; the fruit-leaves or receptacles scarcely differing from the ordinary leaves, except in being of somewhat smaller size, and thicker substance. The disposition of the branches and leaves is so unlike that of any other N. American Alga, that there can be no difficulty in recognising our only species. Its congener *(Ph. comosa)* is a native of the shores of New Holland and New Zealand, and is distinguished by having serrated leaves.

1. PHYLLOSPORA *Menziesii*, Ag.; stem flat, rough, especially below, with prominent points; the margin at each side densely fringed with spathulate or obovate, obtuse, entire, nerveless leaves; air-vessels large, ellipsoid, pyriform or spindle-shaped, tipped with a leafy crest. *J. Ag. Sp. Alg. vol.* 1, *p.* 254. *Harv. in Bot. Beechey Voy. p.* 163. *Kütz. Sp. Alg. p.* 592. *Phyllospora Chamissoi, J. Ag. l. c. Macrocystis obtusa, Harv. in Bot. Beech. Voy. p.* 163. *Fucus Menziesii, Turn. Hist. t.* 27. (TAB. III. FIG. B.)

HAB. In deep water on the shores of California at Monterey (*Dr. Coulter, Capt. Beechey*, and *Capt. Wilkes*); and on the coasts to the northward as far, at least, as Nootka Sound, where it was first gathered by *Mr. Menzies* when sailing with Vancouver. (v. s. in Herb. T.C.D.)

Root branching. *Stems* (according to Turner, who cites Mr. Menzies' MS. notes) "twenty fathoms and more long, rising with a short rounded stipes, divided into several long simple branches, of almost equal height." These branches, portions of which, and the base of a young frond, are now before me, vary from a quarter inch to more than an inch in breadth, are strap-shaped, and roughened with minute spinelike or tubercular prominences, and preserve their breadth pretty evenly, except toward the tips, where they become gradually narrower, and pass off into a long slender point. The roughness varies considerably; some specimens are densely erinaceous throughout; others are so only in the lower part, with a few scattered spinular or subfoliaceous prominences above; and others are quite smooth in the upper part. In all, the margins of the branch are set with distichous, vertical leaves, sometimes issuing at intervals of an inch apart, but much more frequently densely crowded, and forming a leafy fringe. They are of various sizes; some reduced almost to bristles, and others being from two to three inches in length. The shape is also subject to great irregularity, the wide portion being sometimes three-fourths of an inch in width, in others scarcely two lines; so that the leaf in some cases is narrowly spathulate, at others obovate: in all it tapers greatly to the base, and generally ends in a blunt point. The margin is more or less waved and curled, but destitute of any indentations. The *air-vessels* are formed by an inflation of the lower half, or imperfect petiole of the leaf, or else of a greater portion; sometimes, therefore, they are tipped by a long leafy crest, at others by a short and narrow point. They vary much in shape; being globose, ellipsoid, ovoid, pyriform, or spindle-shaped, and from half an inch to an inch and half in length. I have not seen fertile specimens.

AGARDH'S *P. Chamissoi* is said to be characterised by its *pyriform* air-vessels; but on numerous specimens of the ordinary *P. Menziesii*, now before me, there are scarcely two in which the vesicles are of the same size and shape. On a specimen from Mr. Menzies, they are very small and spindle-shaped; on Dr. Coulter's, some are globose and some ellipsoid and ovoid; and on Captain Beechey's, some are pyriform and others spindle-shaped, and of large size. The only valid reason for regarding *P. Chamissoi* as a species, is its habitat, should it really be, as is said, a native of the Atlantic.

In the Botany of Beechey's Voyage I distinguished a variety with leaves much broader than usual, under the name of *Macrocystis obtusa*, but I have long ceased to regard it as anything more than a form of *P. Menziesii.* At that time I had seen but few and imperfect specimens of this plant, and was not aware how greatly it varied in the shape and size of its leaves.

III.—HALIDRYS. *Lyngb.*

Root, a conical disc. *Frond* much divided, distichous, pinnatifid below, pinnated above, without distinct leaves; and forming its air-vessels and receptacles from transformed portions of the upper branchlets. *Branches* alternate, the lowest flattish or somewhat leaf-like, the upper narrow, repeatedly compound and sub-filiform. *Air-vessels* petiolate, siliquæform, acuminate, articulated, divided by transverse septa into numerous loculi. *Receptacles* formed by transformation of the terminal ramuli, pedicellate, lanceolate or pod-like, tuberculated, unarmed, of a densely cellular substance; having numerous pores, beneath which are placed the spherical conceptacles (or spore-cavities). *Spore-cavities* containing both spores and antheridia in the same loculus. *Spores* numerous, oblong, sub-sessile, having a hyaline perispore. *Antheridia* on branching filaments, densely racemose. *Paranemata* simple or forked, clothing the walls of the conceptacle.

The frond originates in an oblong, alternately-toothed root-leaf. As this increases in size, the marginal dentations lengthen out into lateral lobes, and the leaf becomes pinnatifid. Soon the uppermost lobes are found to elongate and become again pinnatifid. Some of the laciniæ are afterwards changed into articulated air-vessels, and of course rendered abortive; others become branches, margined with similar air-vessels and ramuli; and the apex of the developing lacinia is eventually drawn out into a sub-filiform or compressed branch, which is repeatedly divided in a pinnate manner. The fruit is formed by a change of the ultimate divisions of the upper branches, and the receptacle, which is distinctly pedicellate, sometimes springs from the rachis of the branch, and sometimes crowns a vesicular ramulus or air-vessel.

The genus contains but two known species, both of which come within the limits of the North American flora, and one of them is peculiar to our shores. Both are handsome shore-plants, and readily known by their articulated, many-celled air-vessels.

1. Halidrys *siliquosa*, Lyngb., frond compressed, narrow, repeatedly pinnate; air-vessels compressed, oblong or linear-lanceolate, mucronate, slightly constricted at the septa; receptacles lanceolate. *J. Ag. Sp. Alg., vol.* 1, *p.* 236; *Kütz, Sp. Alg., p.* 604; *Grev. Alg. Brit. t.* 1.; *Harv. Phyc. Brit. t.* 66; *Cystoseira siliquosa, Ag. Syst.*, p. 287; *Fucus siliquosus, L.—Turn. Hist. Fuc. t.* 159.; *E. Bot. t.* 474.

Habitat. On rocks near low-water mark. Shores of Newfoundland, *Herb. Banks (fide Turner).* (v. v.)

Fronds from one to four feet long or more, linear, compressed, two edged, from one to two lines broad, distichous, repeatedly pinnate. *Pinnæ* alternate, the lower ones much lengthened, and either naked below or furnished with a few small branchlets and air-vessels, pinnate or bi-tripinnate above, each successive division becoming narrower. *Air-vessels* linear-oblong, or lanceolate, supported on slender stalks, and tipped by a slender acumination of various lengths, which sometimes ends in a receptacle. The air-vessels are internally divided by transverse membranes into numerous compartments or chambers, and externally marked at each partition by slight constrictions, most visible after the plant has been dried. *Receptacles* usually forming racemes, which terminate the branches, pedicellate, lanceolate, compressed. *Colour*, when young a greenish olive; becoming a rich, glossy brown in age. *Substance* tough and leathery.

This plant is very common on the Atlantic shores of Europe, and is said, by Turner, to extend south as far as the Canary Islands. On the same authority we claim it as a native of Newfoundland, but I have never seen any American specimens. The above description is taken from British ones.

2. Halidrys *osmundacea*, Harv. frond simply pinnatifid below, with broadly linear, subacute midribbed laciniæ; decompound above, the pinnæ and pinnulæ slender, sub-filiform; air-vessels moniliform, deeply constricted at the septa; receptacles small, forked, crowning the air vessels. *Harv. in Bot. Beechey's Voy., p.* 407. *J. Ag. Sp. Alg., vol.* 1, *p.* 237. *Kütz. Sp. Alg., p.* 604. *Cystoseira osmundacea, Ag. Syst., p.* 287. *Fucus osmundaceus, Menz. in Turn. Hist. Fuc. t.* 105. (Tab. II.)

Hab. Rocks near low-water mark. At Port Trinidad, on the N. W. coast, *Archibald Menzies, Esq.* California, *Mr. D. Douglas.* Monterey, *Dr. Coulter*, (v. s. in Herb. T.C.D.)

Root discoid. *Frond* of unknown length, but probably many feet long when

when full grown. It originates in a pinnatifid, midribbed, flat leaf, six or eight inches in length, whose lowest laciniæ are short and deltoid; the upper gradually longer, broadly linear, from three lines to half an inch in breadth, and from one to three inches in length. As the plant grows older, the midrib of the first leaf becomes slightly bordered with a thick lamina, and thus forming a two-edged stem, is developed upwards; and new laciniæ, which are successively more compound as they are more distant from the root, are formed along it. The lowest of these divided laciniæ are simply pinnatifid; the next more deeply cut, and their laciniæ changed into vesicles. Those next in order are longer, more slender and more compound; and finally the upper branches of the fronds are slender and filiform, from one to two feet in length, and twice or thrice pinnate. The *air-vessels* begin to be formed on the first divided laciniæ of the young plant, and are produced in great abundance on all the upper branches, sometimes every ramulus, and always several of those nearest the base of the branch being changed into air-cells. On old plants, when the upper branches have reached their excessively divided condition, the apices of the air-vessels frequently are extended into ramuli, which become again branched, and even develop small air-vessels along their branches. The *receptacles* are of small size, short, thickish, simple or forked, tuberculated, and spring from the tips of the uppermost air-cells on fully developed plants. The colour when dry is a dark rich brown, and the substance is thick and leathery.

Turner's figure is taken from a young, undeveloped specimen. In our plate we have shown the appearance of a young stem, and the base of an older one, which would have extended nearly thrice as high as the portion admitted into the figure; the upper secondary branches becoming longer and more compound. Some of these upper branches are indeed so much divided, that, apart from their bases, they may be mistaken for parts of a *Cystoseira*, and have much resemblance to *C. expansa*, but are more robust.

IV. CYSTOSEIRA. *Ag.*

Root a conical disc. *Frond* much divided, either in a pinnate or dichotomous manner, the upper branches and ramuli filiform; forming receptacles by transformations of the ultimate ramuli, and air-vessels by swellings of the branches or ramuli. *Branches* alternate, naked or clothed with spine-like ramuli (or leaves). *Air-vessels* usually several together, forming a moniliform chain in some part of the branch. *Receptacles* formed by the transformation of the terminal ramuli, terete, tuberculated, smooth or thorny, of a densely cellular substance; having numerous pores, beneath which are placed the spherical conceptacles (or spore-cavities). *Spore-cavities* containing both spores and antheridia in the same loculus. *Spores* numerous, oblong or obovoid, subsessile, having a hyaline perispore. *Antheridia* on branching filaments, racemose. *Paranemata* simple, clothing the walls of the conceptacle.

Nearly related to the preceding genus, from which it differs in the air-vessels, which do not here run together into a compound vessel of many cells, though they form little chains, one inflation of the branches succeeding another but remaining separate. Upwards of twenty species are described, of which thirteen or fourteen are found in the Mediterranean, and four occur on the Atlantic shores of Europe as far north as Great Britain, reaching their highest latitude on the western coast of Ireland. The group is scarcely represented in the New World. One or two of the European species are stated, on doubtful authority, to occur on the shores of Guiana and Brazil, where probably something else has been mistaken for them ; but there is no record of any having been detected on the eastern shores of America, where European forms might, more naturally, have been anticipated. The only North American species with which I am acquainted is the following from California.

1. CYSTOSEIRA *expansa*, Ag. ; frond (its base unknown) very long, filiform, slender, smooth, repeatedly pinnate, distichous, the ultimate ramuli simple or forked ; air-vessels ellipsoidal, chained, several together in the lower half of the penultimate and ultimate branchlets ; receptacles " cylindrical, warted, paniculate, subconfluent with the tops of the branches." *J. Ag. Sp. Alg., vol.* 1, *p.* 226. *Cystoseira Douglasii, Harv. in Bot. Beechey, p.* 407. *Sirophysalis Douglasii, and S. expansa, Kütz. Sp. Alg., p.* 603. (TAB. I. B.)

HAB. Probably in deep water. At Monterey, California, *Mr. Douglas ; Dr. Coulter*. (v. s. in Herb. T.C.D.)

The root and lower part of the stem are unknown. Our specimens consist of portions of stems (or branches) from two to three feet in length, and about half a line in breadth, compressed, becoming narrower and more filiform toward the extremities ; and thrice or four times divided in an alternately pinnate manner. The ultimate ramuli show a disposition to become dichotomous. *Air-vessels* from one to two lines long, ellipsoidal, in strings of four to eight, forming swellings in the smaller branches and ramuli ; the string of swellings generally commencing near the base of the ramulus, and extending at least through its lower half. In the ultimate and smaller divisions the inflations are proportionally fewer and are sometimes solitary. I have not seen the receptacles which J. Agardh describes as being " 6—8 lines long, everywhere of equal thickness, warted, and nearly all pedicellate."

This is probably a species of very great length, the portions of branches which are alone known to us being evidently only the upper divisions. There is a striking resemblance in habit between these and the most branching forms of *Halidrys osmundacea*, but in the present species each vesicle stands perfectly apart from its neighbour, however closely they may approximate.

DOUBTFUL SPECIES.

2. Cystoseira *(Phyllacantha) oligacantha*, Kütz. "Of large size; branches filiform, bipinnate, slender; pinnæ very patent, alternate, sometimes opposite; pinnules erecto-patent, sparingly spinous; air-vessels chained, elliptic oblong; receptacles nodoso-tuberculate, cuspidate." *Kütz. Sp. Alg. p.* 596.

Hab. Newfoundland, *Lenormand (fide Kützing).*

Possibly this may be a form of *C. fibrosa*; but without seeing specimens it would be rash to decide.

V. FUCUS. *L. (in part.) Grev.*

Root a conical disc. *Frond* linear, compressed or flat, in the latter case traversed by a midrib, dichotomous, rarely pinnated: forming receptacles by transformations of the tips of the branches; and vesicles (when present) by inflations in the substance of the stem or branch. *Branches* mostly fastigiate, in some species winged with lamina, in none having separate leaves. *Air-vessels* often absent, simple, innate in the branches. *Receptacles* terminal or lateral, oblong or ovate, filled with mucus through which a net-work of jointed filaments extends; having numerous pores beneath which are placed the spherical conceptacles (or spore cavities). *Spore-cavities* generally diclinous, monœcious or mostly diœcious. *Spores* from two to eight in the same hyaline perispore, several such perispores rising from the walls of the cavity. *Antheridia* on branching filaments, ovoid, racemose or tufted. *Paranemata* simple, lining the cell.

A genus of *social* plants occupying the space between tide-marks, and contributing, on the shores where they grow, fully three-fourths of the vegetable clothing of the tidal rocks. Almost all the species are natives of the Northern Hemisphere, and chiefly of the Atlantic basin, where there are seven species on the European and five on the American shore; one of the latter being peculiar to America, and two of the former to Europe; the rest common to both. One species, allied to *F. nodosus*, is found at the Cape of Good Hope.

As already noticed in our Introduction, (p. 36), these common shore-plants yield, on incineration, a considerable per centage of carbonate of soda, to obtain which salt they were formerly largely collected and burnt. Iodine and mannite are also among their secretions.

By J. Agardh, in his recent work, this genus is divided into two, *Fucodium* and *Fucus*, the first of which, excluding some species, is identical with our first section.

Sect. 1. Fucodium, J. Ag. *Frond compressed or subterete, without a midrib.*

1. Fucus *fastigiatus*, J. Ag.; frond terete below, compressed above, linear, very narrow, many times dichotomous, fastigiate; the angles rounded and branches widely spreading; air-vessels none; receptacles terminal, simple or forked, oblong. *J. Ag. Sp. Alg. vol.* 1, *Sp.* 203. *Kütz. Sp. Alg. p.* 591. *Fucus furcatus, Harv. in Bot. Beechey, p.* 163 *(not of Ag.)* (Tab. III. A.).

Hab. On rocks within tide marks (probably above half tide level). Monterey, *Douglas! Coulter!* St. Francisco, *Capt. Wilkes!* (v. s. in Herb. T.C.D.)

Root a conical disc. *Frond* rising with a short terete stem, which becomes forked at about half an inch from the base. The two primary divisions are generally much divaricated, making a very wide angle, and the frond is repeatedly forked at intervals of from half an inch to an inch, till it attains the length of six or eight inches. There are frequently as many as twelve furcations in plants of this size. The lower parts of the stem are from one to two lines in diameter; the upper are gradually more and more slender, and at length the extreme forkings are often not a quarter line in breadth. The branches spread widely, so that the general outline of a frond is much broader than its length. There are no air-vessels. The branches are of nearly equal height, and in full grown specimens their tips are almost all enlarged into oblong or fusiform, simple or forked, tuberculated receptacles. *Spores* two in each perispore, a great number of which are attached to the walls of the spore-cavity.

My description and figure are made from Dr. Coulter's specimens; those brought by Douglas and Wilkes (that I have seen) being of smaller size, and apparently gathered in shallower water. This species is, in many respects, allied to the European *F. canaliculatus*, and probably occupies similar ground, near high-water mark. My specimen from Douglas has altogether the dwarfed appearance which indicates such a locality.

2. Fucus *nodosus*, Linn.; frond compressed, coriaceous, subdichotomous; the branches linear, somewhat pinnated, attenuated at the base, remotely toothed, here and there swelling into oblong air-vessels; receptacles lateral, globose, stalked, springing from the axis of the marginal teeth. *J. Ag. Sp. Alg. vol.* 1, *p.* 206. *Har. Phyc. Brit. t.* 158. *E. Bot. t.* 570. *Turn. Hist. t.* 91. *Ozothallia vulgaris, Dne.—Kütz. Sp. Alg. p.* 591. *Physocaulon nodosum, Kütz. Phyc. Gen. p.* 352.

Hab. On submarine rocks, between tide-marks. Abundant on the Atlantic shores of North America from Halifax to New York. Newfoundland, *De la Pylaie.* (v. v.)

Fronds densely tufted, from one to three or four feet long or more, compressed, linear, much branched, more or less pinnate; the branches long and subsimple, tapering to the base and here and there toothed, secondary branches and receptacles springing from the axil of the tooth. *Air-vessels* elliptical, from half an inch to two inches in length, occurring at irregular intervals in the substance of the stem or branches, and much wider than the parts around them. *Receptacles* lateral, pedicellate, ovate or globose, yellow when ripe. *Spores* four in each perispore. *Colour* varying from a greenish to a fulvous olive. *Substance* tough and leathery.

This species varies much in size, and in the comparative robustness of the branches. When growing on the open sea shore, far removed from the influence of fresh water, it attains the length of several feet, and a breadth of nearly half an inch, the colour being of a dark bottle green. In deep bays or arms of the sea, it is much less luxuriant, and more tawny. When growing in æstuaries it becomes of still smaller and feebler growth. I am indebted to Mr. Nicholas Pike of New York for specimens gathered in Chelsea River, Boston Bay, in which the whole frond, though bipinnate and in fruit, is not more than six inches long, and scarcely a line in diameter at the widest part. These specimens are without air-vessels, but have all the other characters of the species.

Another singular form, the *Fucus scorpioides* of Flora Danica, t. 1479, has been sent to me by Mr. Hooper from Fort Hamilton, New York Bay. This is nearly as slender as that just mentioned, but is much more irregularly branched, having a tendency to dichotomous division, with many irregularly placed, divaricating lateral branches. I have compared it with a Norwegian specimen of *F. scorpioides*, with which it agrees very nearly. I was at first disposed to consider it identical with the *F. Mackaii* of British authors, but it is less regular in its branching than that (supposed) species. Both are regarded by J. Agardh, and perhaps justly, as varieties of *F. nodosus*.

Sect. 2. FUCUS, J. Ag. *Frond flat, with a midrib.*

3. FUCUS *distichus*, Linn.; stipes filiform, expanding into a very narrow, linear, dichotomous ribbed frond; the margin very entire; air-vessels none; receptacles terminal, subsimple, in pairs, elongate-linear, compressed. *J. Ag. Sp. Alg. vol.* 1, *p.* 209. *Kütz. Sp. Alg. p.* 590. *Turn. Hist. t.* 4. *Fl. Dan. t.* 351. *Lyngb. Hyd. Dan. t.* 1.

HAB. Rocks between tide-marks. Shores of Greenland and Newfoundland, *De la Pylaie.*

Frond 3—6 inches long, rising from a filiform stipe, which gradually expands into an obsoletely ribbed, thickish lamina about a line in breadth and repeatedly forked. Axils acute. *Receptacles* scarcely wider than the segments which they terminate, linear, tapering to each end, from half an inch to an inch in length. *J. Ag. l. c.*

I am not acquainted with this species.

4. Fucus *furcatus*, Ag.; stipes compressed, expanding into a linear, dichotomous, ribbed frond; the margin very entire; air-vessels none; receptacles elongate, linear, flattish, repeatedly forked. *J. Ag. Sp. Alg. vol.* 1, *p.* 209. *Ag. Ic. Ined. t.* 14. *Kütz. Sp. Alg. p.* 591.

Hab. Newfoundland, *De la Pylaie.*

Frond a foot or more in length, and nearly four lines wide, with a less evident midrib than allied species, and which is altogether obsolete below the receptacle, dichotomous and fastigiate. *Vesicles* none. *Receptacles* three inches long, scarcely thicker than the frond and nearly flat, linear, tapering towards the apices, obtuse, rarely simple, generally once or twice forked. *J. Ag. l. c.*

I am unacquainted with this species.

5. Fucus *ceranoides*, Linn.; frond plane, coriaceo-membranaceous, linear, dichotomous, midribbed, without vesicles; the margin very entire; lateral branches narrower than the principal divisions, repeatedly forked, level-topped, bearing fruit at their apices; receptacles spindle-shaped or bifid, acute. *J. Ag. Sp. Alg. vol.* 1, *p.* 209. *Kütz. Sp. Alg. p.* 591. *Turn. Hist. t.* 89. *E. Bot. t.* 2115. *Harv. Phyc. Brit. t.* 271.

Hab. On rocks and stones between tide-marks, chiefly where fresh water mixes with the sea. Rare on the American coast. New York, *J. Agardh.* (v. v.)

Frond resembling *F. vesiculosus* in aspect, but of thinner and more transparent substance, destitute of air-vessels, though portions of the frond occasionally puff out into irregular distensions; and having numerous lateral, many-forked, narrow segments, whose tips are at length transformed into fruit. *Receptacles* commonly in pairs, sometimes confluent, bright yellow, or greenish, pointed.

I have not seen any American specimen of this species, which has been sent to Professor Agardh from New York.

6. Fucus *Harveyanus*, *Dne.* ined. (*cum Icone eximia*).

Hab. Monterey, California, *Herb. Paris*, (v. s. in Herb. T.C.D.)

I forbear to describe this species, named and figured by my friend M. Decaisne, some years ago, but of which no specific character has, I believe, yet appeared. It is very closely related to *F. ceranoides*, and I am not certain by what characters it is proposed to be distinguished from that species.

7. Fucus *vesiculosus*, Linn., frond flat, leathery, thick, linear, dichotomous, quite entire at the margin, midribbed ; air-vessels globose or elliptical, mostly in pairs, (often absent) ; receptacles terminal, turgid, ellipsoid, ovoid, or spindle-shaped. *J. Ag. Sp. Alg., vol.* 1, *p.* 210. *Kütz. Sp. Alg. p.* 589. *Turn. Hist. t.* 88. *E. Bot. t.* 1066. *Harv. Phyc. Brit. t.* 204. *Fucus divaricatus, F. inflatus, F. spiralis, F. volubilis, F. Sherardi, Auct. F. bicornis, and F. microphyllus, De la Pylaie, &c.*

Hab. On rocks and stones between tide-marks. Very common on all rocky shores from Greenland to New York. Also on the N. W. coast ; in California, and northward. (The southern limit on the east coast not ascertained.) (v. v.)

Fronds from two inches to two feet long, or more ; varying from a line to nearly an inch in breadth, flat, midribbed, many times forked ; often spirally twisted. *Air-vessels* generally in pairs, one at each side of the midrib, spherical or oval, their size varying with the breadth of the frond. *Receptacles* very turgid, and filled with a lax, watery jelly, through which a network of delicate filaments extends. *Colour* olive or brown. *Substance* coarse and thick.

Very variable in size and degree of ramification, according to the locality in which it grows. When destitute of air-vessels, it may be mistaken by the student for *F. ceranoides*, but the frond is much thicker and more opaque than in that species, and contains a far greater proportion of alkaline matter. The earlier writers on marine plants made a great number of species out of this ; but its varieties only appear different when isolated specimens are examined in the cabinet. On the sea shore all the various forms may be seen passing into one another at different tidal levels. *F. vesiculosus* is distributed in the northern Atlantic from the Arctic coasts to the Canary Islands ; and in the Pacific, from Kamtschatka to California. It is reported to have been brought from the Cape of Good Hope and from Australia, but these localities want confirmation. On the east coast of America it and *F. nodosus* constitute at least three fourths of the covering of tidal rocks.

VI.—HIMANTHALIA. *Lyngb.*

Root a disc. *Frond* at first top-shaped, then cup-shaped, vesicular, unbranched. *Receptacles* very long, strap-shaped, repeatedly forked, springing from the centre of the cup-shaped frond, filled with mucus, traversed by jointed fibres, and pierced by numerous pores, beneath which are placed the spherical conceptacles (or spore-cavities). *Spore cavities* diclinous. *Spores* four within the same hyaline perispore, several perispores attached to the walls of the cavity. *Antheridia* on branching filaments, racemose. *Paranemata* simple, lining the cavity.

A remarkable plant, common on the coasts of Northern Europe, where, in England, it has the popular name "Sea-thongs," which is nearly a literal translation of the sounding Greek imposed by Lyngbye. The view here taken of the frond and receptacles is that first given by Greville and Wahlenberg, and more recently adopted by Agardh; and I have no doubt but that it is the correct view. Dr. Greville has well observed that the pezizæ-form or cup-shaped base, here called the *frond,* attains its full size before any portion of the strap-shaped branches containing fruit, and here called *receptacle,* makes its appearance. The branching receptacle then grows with rapidity, and after it has ripened spores, falls away. The plant is biennial, and, like all biennials, the first year is wholly occupied with the formation of the top-shaped *frond* ; the receptacle is rapidly produced in the second season. Late in the autumn, when the old ripe receptacles are thrown off and drifted ashore in large banks, the young fronds for the next season may be seen sprouting in myriads round the dying ones of the last year. Carmichael says that the old fronds sprout again the second season, but I have never observed them do so, though I have repeatedly sought for such second growth.

1. HIMANTHALIA *lorea,* Lyngb.; frond top-shaped, at length collapsing, plano-convex, stipitate; receptacles repeatedly dichotomous, linear, tapering to the extremity. *J. Ag. Sp. Alg., vol.* 1, *p.* 196. *Harv. Phyc. Brit. t.* 78. *Fucus loreus, Turn. Hist. t.* 196. *E. Bot. t.* 569. *Fl. Dan. t.* 710.

HAB. Rocks near low-water mark. Biennial. "Coast of North America," *fide J. Agardh.* (v. v.)

Fronds an inch in height, top-shaped, the centre of the disc becoming depressed, and at maturity throwing out a strap-shaped receptacle from two to ten or even twenty feet in length, from a quarter to half an inch in width, tapering to the apices, and many times forked. *Conceptacles* scattered in myriads through the whole length of this gigantic receptacle.

I have seen no American specimen of this plant, and am not aware on what part of the shore it has been gathered, or by whom communicated to Professor Agardh. Judging from probabilities, I should suppose that it may have been found at Newfoundland, or to the north of that island. It is much more abundant in Europe, on the northern coasts, though said to extend southward as far as Spain.

ORDER II.—SPOROCHNACEÆ.

Harv. Man. Br. Alg. Ed. 2, *p.* 21. *Sporochnoideæ, Grev. Alg. Brit. p.* 36. *J. Ag. Sp. Alg. vol.* 1, *p.* 160. *Kütz. Phyc. Gen. p.* 342. *Kütz. Sp. Alg. p.* 567. *Endl. 3rd. Suppl. p.* 28. *Chordarieæ, in part Ag. Syst. p.* xxxvi. *Sporochnideæ and part of Dictyotidæ, Lindl. Veg. Kingd. p.* 22.

DIAGNOSIS. Olive-coloured, inarticulate seaweeds, whose spores are attached to external, jointed filaments, which are either free or compacted together into knob-like masses. (*Plants of mediocre size, soon becoming flaccid in the air, and then changing to a verdigris-green colour*).

NATURAL CHARACTER. *Root* usually a small, naked disc or point of attachment; in *Carpomitra,* bulbous and coated with woolly threads. *Fronds* of mediocre size, and much branched, frequently bushy, having, whilst living, a clear and rather bright brownish olive or chestnut colour, and a cartilaginous, firm, crisp substance; but rapidly becoming flaccid and changing to a verdigris green colour on exposure to the air, and possessing, after this change, the faculty of rapidly decomposing any small Algæ with which they may come in contact. *Stems* and *branches* uniform, destitute of any separate, leaf-like expansions, inarticulate; sometimes cylindrical and filiform, often exceedingly slender; sometimes compressed; and sometimes flattened, leaf-like, and furnished with a distinct midrib, occasionally throwing off lateral nervelets. The branching is frequently opposite, and almost always distichous. *Air-vessels* none. Almost all bear, at some period of their growth, pencils of delicate, jointed, confervoid filaments. In some, as in *Desmarestia* and *Arthrocladia,* these filaments are found on the growing apices, and on all the younger portions of the frond, and appear to be intimately connected with the process of cell-division then going on; and they gradually fall away after the part has attained its full size. In *Arthrocladia* a portion of them remains, and eventually supports the fructification. In others, as in *Sporochnus* and *Carpomitra,* similar filaments spring from and crown the receptacles of the fructification, and fall away when the spores have arrived at maturity.

The outward appearance of the fructification varies in the different genera of this Order, but the differences are of a minor character. In all, the spores are attached to branching, articulated filaments which issue from some part of the branches, and are, therefore, external to the substance. But in some, as in all the American genera, these filaments are free, either clothing the branches or forming pencil-like tufts along them; while, in others (*Sporochnus* and *Carpomitra*) the fertile filaments are closely packed together and combined into knob-like receptacles, in whose substance the spores are hidden. On dissection these receptacles are seen to be made up of branching filaments, of some of whose branches the spores are formed; and they are either borne on minute, lateral ramuli (or peduncles), or terminate the larger branches of the frond.

A small group of plants, of which five or six genera, comprising about 24 species, are at present known to botanists. They are all plants of deep water, none growing in places where they are left dry at the recess of the tide, and very few being found much above low-water mark, and then only in deep and shady tide-pools. They increase in numbers and in luxuriance of development at three or four fathoms depth, and extend to fifteen or twenty fathoms, often constituting at the bottom of the sea submarine fields of considerable extent. This is the case on the North American coast with respect to *Desmarestia aculeata*, which, in deep enclosed bays, like that of Halifax, is often the only plant that comes up in the dredge after five fathoms of depth, and in many places it seems to choke all other vegetation. A similar prevalence of two other species of this genus (*D. chordalis* and *D. Rossii*) in the deeper parts of the Laminarian zone, has been noticed by Dr. Hooker in the Antarctic Ocean.

Several of the plants of this Order are widely distributed. All the American species of *Desmarestia* have a range almost as wide as that of the ocean; being found in the temperate and colder regions at both sides of the torrid zone, and extending almost to the limit of marine vegetation towards either pole. Their reputed absence in the tropical waters is perhaps owing to a failure of observation. *Arthrocladia villosa*, recently discovered in North Carolina, had been until then supposed to be confined to the shores of Europe, where it almost always accompanies *Sporochnus pedunculatus*, a species not yet added to the American Flora. The genus *Chnoospora* is entirely tropical, but is found both in the eastern and the western hemisphere.

Although the different aspect of the fruit in this Order forces us to group the genera under two families, yet there is such a peculiar habit common to all the individuals of the group, that authors scarcely differ in the limits they assign to it. Agardh and Kützing coincide with the original view of Greville, which is that here adopted; but Endlicher and following him, Lindley, reject *Arthrocladia* and refer it to the neighbourhood of *Cutleria* in Dictyotaceæ. A comparison of the respective structure and development of *Arthrocladia* and *Desmarestia viridis* will I think show that these plants cannot well be far separated. There is something so distinctive in the colour of the Sporachnaceæ when fresh, and the very remarkable change which they undergo on exposure to the air, that these peculiarities alone seem to point, as Mr. Dawson Turner has long since noticed, to a natural affinity among them.

All the following genera belong to the sub-order ARTHROCLADIEÆ.

SYNOPSIS OF THE NORTH AMERICAN GENERA.

I. ARTHROCLADIA. *Frond* pinnate, filiform, nodose, hollow; the tube articulated within. *Nodes* whorled with delicate filaments.
II. DESMARESTIA. *Frond* pinnate, either filiform, compressed, or flat, solid.
III. CHNOOSPORA. *Frond* dichotomous, flat.

I. ARTHROCLADIA, *Duby.*

Frond cylindrical, pinnated, traversed by a wide, empty tube which is interrupted at short intervals by transverse, membranous septa that divide it into a number of vertically seriated air-cells. *Walls* of the frond composed of several rows of cells, arranged in longitudinal series, and diminishing in size from the central tube outwards. Externally the surface is marked at short intervals by nodose swellings, which are clothed with a whorl of numerous confervoid repeatedly pinnate articulated filaments. *Spores* formed from the cells of moniliform, podlike filaments borne along the inner faces of the lower divisions of the whorled filaments, oblate-spheroidal, minute.

A genus consisting of but one species, a native also of the shores of Europe, where it is found from Italy to Scotland, generally in deep water. It is a slender, filiform, distantly branched plant, delicately beautiful when its branches are young, and the pencils of filaments that whorl them uninjured.

1. ARTHROCLADIA *villosa, Duby. J. Ag. Sp. Alg., vol.* 1, *p.* 162. *Kütz. Sp. Alg., p.* 573 (*A. septentrionalis and A. australis, Kg.) Harv. Phyc. Brit. t.* 64. *Conferva villosa, Huds.—E. Bot. t.* 546. *Dillw. Conf. t.* 37. (PLATE IV. A.)

HAB. On submarine substances, in five (or more?) fathoms; very rare. Cast ashore at Smithville, near Wilmington, N. C., *Mr. Charles Congdon.* (v. v.)

Root a small disc. *Fronds* generally tufted, from six inches to nearly three feet in length, very slender, once, twice, or thrice pinnated, filiform; the pinnæ distant, opposite, or rarely alternate, patent, simple or again pinnulated with similar, simple pinnules; all the divisions furnished at intervals of from half a line to a line, with minute knoblike swellings which produce whorls of very delicate, byssoid, repeatedly pinnate jointed filaments of a pale green colour. The frond is traversed by a wide tube, divided by transverse membranes at short intervals into joints or chambers, four or five of which intervene between every whorl of filaments. This tube is surrounded by several series of cylindrical cells, placed end to end vertically, the innermost of which are of largest size, and the cells of each row to the circumference of less and less dimensions. The substance of the frond when quite fresh is cartilaginous, but it soon becomes flaccid in the air; and the colour, which at first is a bright bay, rapidly changes to verdigris green. The *fructification* is borne on the lowermost divisions of the whorled filaments, and forms moniliform strings of spores springing from the inner faces of the branch. These are developed by the metamorphosis of secund ramuli, and consist of a large number of very minute, oblate spores, which fall asunder when mature. In drying, the plant adheres firmly to paper.

I am indebted to Mr. Congdon for one of the few specimens of this rare plant, which he succeeded in saving during a very hasty visit to the shore near the mouth of the Cape Fear River. It is roughly dried, and I have, therefore, been obliged to use more carefully preserved (British) specimens to give an idea of the natural appearance of the species *(at Pl. IV. fig. A 1.)*, but I have drawn the magnified figures (2, 3, 4, 5, 6) from Mr. Congdon's specimen, so that there can be no doubt of their identity. The description of the species given above is mostly copied from the Phycologia Britannica. The magnified figures in Pl. 64 of that work, especially figs. 2 and 4, are much less correct than the corresponding one (2 and 5) now given.

II. DESMARESTIA, *Lamouroux.*

Frond linear, either cylindrical, compressed or flat, pinnated, solid, traversed by a slender articulated filament (or axis); the solid parts composed of several rows of small cells. *Branches* when young producing along the margin, and from the tips, tufts of byssoid, articulated, repeatedly pinnate filaments. *Fructification* unknown.

This genus, of which the fruit is at present unknown, is readily distinguished from *Arthrocladia*, by the structure of the frond. Here there are not the knots along the stem and branches, whorled with delicate filaments, which mark that genus; and moreover the frond, in the present group, is destitute of a tubular axis of large calibre. It is true that the articulated filament which traverses the stem and branches in *Desmarestia* may be compared with the articulated tube of *Arthrocladia*, but the former consists of a string of single cells, placed end to end; the latter is a compound structure, whose walls and septa are both made up of a great number of cells.

The manner in which the frond is developed may be readily seen by examining, under the microscope, any tip of a young branch in process of formation; particularly in the young points of *D. viridis* and *D. ligulata*, in which species the frond is more transparent than in *D. aculeata*. In *D. viridis* the young branch is prolonged, at its apex, into a confervoid filament, formed of a row of cylindrical cells, lengthening by division of the terminal cell, and becoming branched at intervals by the development of opposite budding cells from the shoulders of the older ones. Thus we have in its simplest form the type of the growth of the species; namely, a repeatedly pinnate division, with opposite pinnules. These pinnated confervoid apices become gradually clothed with a stratum of minute cellules, which may be observed commencing to be formed on the lowermost cells (those nearest the compound portion of the branch), and gradually extending upwards. Thus at length the confervoid filament is completely enclosed in a cellular coating; new coats are continually added to this;—until the frond becomes a cylindrical, compound-cellular body, through the centre of which runs an articulated filament; which filament was the earliest part formed, and the axial nucleus round which the other parts grew.

The manner of growth in *D. ligulata* is precisely similar, except that in that species the new cellular integument to the primary filament is not developed equally on all sides, but extends chiefly laterally, so as to form at first a two-edged and then a flat or even leaf-like stem. In this process of lateral extension, or widening of the stem, the lower portions of the pinnæ of the primary filament being enclosed within the cellular wings of the flattened branch, become the lateral nerves of the frond. Some of these merely reach the margin of the flat stem, or extend slightly beyond it, as a tooth, tipped with a pencil of fibres; others, continuing to vegetate, become the nuclei of the young lateral branches. In the broad forms of *D. ligulata*, constituting *D. herbacea* of authors, the nervation and its origin are both very clearly seen.

1. DESMARESTIA *viridis*, Lamour. frond cylindrical, filiform, repeatedly pinnate; pinnæ and pinnulæ capillary, exactly opposite, patent. *Kütz. Sp. Alg. p.* 570. *Harv. Phyc. Brit. t.* 312. *Dichloria viridis, Grev. Alg. Brit. t.* 6. *J. Ag. Sp. Alg. vol.* 1, *p.* 164. *Fucus viridis, Fl. Dan. t.* 886. *Turn. Hist. t.* 97. *E. Bot. t.* 1669.

HAB. On rocks, stones, and the larger Algæ in tide-pools, near low-water mark, and extending into deep water. Annual. Abundant on the shores of British America, and extending south to Boston Bay; Cape Anne, Connecticut; and Hell-gate, New York, *Mr. J. Hooper*. Unalaschka, *Chamisso*. (v. v.)

Fronds from one to three feet in length, cylindrical, from a quarter line to half a line, or sometimes a line in diameter below, gradually attenuated upwards to a hairlike fineness, excessively branched, having an ovate outline when the branches are freely displayed. All the branches, and every one of the lesser divisions, down to the most minute ramulus, are exactly opposite and distichous; the larger divisions are patent, or nearly horizontal, the lesser more erect. In a vegetating state the branches and ramuli terminate in extremely slender, articulated, byssoid filaments, which gradually become coated with cellules; and then the imbedded filament becomes the axis of the compound frond. *Structure* densely cellular, with numerous large air-cavities dispersed through the cellular substance. *Colour*, when growing, a fine chesnut-olive, quickly changing to verdigris green when removed from the water. *Substance* tender, soon decomposing.

2. DESMARESTIA *aculeata*, Lamour.; stipes short, cylindrical; stems (or primary branches) elongate, flattish, bi-tripinnate; pinnæ and pinnulæ alternate, very narrow, tapering to the base, either fringed with opposite tufts of bright green filaments or margined with awl-shaped, alternate spines. *J. Ag. Sp. Alg. vol.* 1, *p.* 167. *Kütz. Sp. Alg. p.* 571. *Harv. Phyc. Brit. t.* 49. *Grev. Alg. Brit. t.* 5, *f.* 2, 3. *Fucus aculeatus*, *Linn. Turn. Hist. Fuc. t.* 187. *Eng. Bot. t.* 2445. (TAB. IV. B.)

HAB. On submerged rocks and stones at low-water mark and at a greater depth. Very abundant on the east shores, from our northern limits to Long Island Sound (at least). Probably also on the N.W. coast (being found at Kamtschatka). (v. v.)

Fronds from one to six feet in length, about half a line in width, compressed or flattish, excessively branched and bushy; the branches usually alternate, rarely opposite, erect, tapering to their base and apex, as do also all the lesser divisions. When young the branches are of a tender substance, soft to the touch, and clothed at intervals of about a line with opposite pencils of finely divided byssoid filaments of a beautiful yellow green colour. In older fronds these delicate filaments fall away, and the branches become rigid and tough, while subulate spinelike alternate teeth are developed from the margin at every three or four lines apart. In transition specimens both spines and filaments are found together, the former being comparatively soft. *Colour* pale olive when young, foxy brown or sometimes very dark when old.

At different ages this plant may readily be taken by a student for two species, as indeed it was by Linnæus himself.

3. DESMARESTIA *ligulata*, Lamour.; frond flat, with a slender, more or less evident midrib, repeatedly pinnate; pinnæ and pinnulæ opposite, oblong or lanceolate, tapering to both ends. *J. Ag. Sp. Alg. vol.* 1, *p.* 169. *Kütz. Sp. Alg. p.* 572. *Harv. Phyc. Brit. t.* 115. *Fucus ligulatus*, *Turn. Hist. t.* 98. *E. Bot. t.* 1636. *Fucus herbaceus*, *Turn. Hist. t.* 99. *Desmarestia herbacea*, *Auct.*

HAB. North West Coast, *Mr. Menzies*. (v. v.)

The ordinary European form of this species, figured in *Phyc. Brit. t.* 115, has not yet been noticed on the American coast, except at Cape Horn (!), but may be expected to occur on the shores of some part of British America. The plant recorded above as having been found by Mr. Menzies on the N. W. coast has broader leaves, but, to judge by Mr. Turner's figure, is scarcely otherwise to be distinguished. The following is his description of Mr. Menzies' specimens :—

"*Frond* flat, two feet or more long, rising with a single, undivided *stem*, at its base nearly cylindrical, and as thick as a crow's quill, but almost immediately becoming flat, and gradually widening to the height of a few inches, where it acquires a width of half an inch, or three quarters of an inch, after which it becomes linear, till, on approaching the extremity, it is again slightly narrowed and terminates in a rounded apex; the margins are throughout the whole length serrated with small, spiniform, rather remote teeth; the stem, from root to summit, is pinnate with opposite, distichous branches, of the same substance as itself, between horizontal and patent, separated by intervals of about half an inch, a foot or a foot and half long, and the middle ones, apparently, longest, their greatest width nearly an inch, attenuated at their bases into very short, subcylindrical petioli, rounded at their apices, toothed at their margins, and in their turns pinnated with a series of others, similar to them in every particular, except their small size:—throughout the whole frond runs a midrib, thick and rather wide in the stem, but in the branches thin and faint, so as scarcely to be visible, unless the plant is held to the light, and appearing only like a dark line. *Colour* grass-green, with a faint tinge of brown, transparent. *Substance* membranaceous, extremely thin and tender, but somewhat thickened in the stem, near the root."

I have not seen any American individuals of this variety, but have gathered an equally broad-leaved form at the Cape of Good Hope, having, however, acute pinnæ, and a firmer and more coriaceous substance than Turner describes. On the whole I agree with Prof. J. Agardh in uniting, as one species, the broad leaved and narrow leaved forms.

III. CHNOOSPORA, *J. Ag.*

Frond compressed, repeatedly dichotomous, ribless; its substance composed of elongate prismatic cellules, scarcely denser in the centre. *Fructification*, densely tufted, clavato-moniliform, articulated, spore-bearing filaments, surrounded by sterile, branching filaments (*paranemata*), both aggregated together in wartlike excrescences near the middle of the frond. *Spores* (?) formed in the articulations of the sporiferous filaments, rounded.—(*J. Ag.*)

A small genus of tropical Algæ, readily known by its dichotomous branching. It seems to connect together, naturally, the two sub-orders of which the Order consists. In the structure of its masses of fructification there is an evident passage between those genera with dispersed spore-filaments and those in which these organs cohere together into definite receptacles.

1. CHNOOSPORA *fastigiata*, J. Ag.; "fronds tufted, several rising from the same

callus, erect, many times forked, fastigiate; segments compressed above, patent, with acute axils." *J. Ag. Sp. Alg. vol.* 1, *p.* 171. *Kütz. Sp. Alg. p.* 569. *Ch. Pacifica* and *Ch. Atlantica*, *J. Ag. Liebm. p.* 7. (Tab. IV. C.)

Hab. On the Pacific coast of the Mexican Republic, *Liebman.* (v. s. in Herb. T. C. D.)

Fronds many, from the same scutate base, 2-3 inches long, stipitate, soon forked, and then repeatedly divided dichotomously, the forks being closer and closer upwards; equal in diameter throughout, subcylindrical below, compressed above, with acute apices. The *axils* of the forks are narrow and acute. *Colour* in a dried state very dark, brownish. I have not seen perfect fructification.

I have not been able on the specimens which I have had an opportunity of examining, to make out the structure of the fructification with sufficient accuracy to authorize my introducing the cushions of spore-filaments into the plate. The above description is therefore chiefly translated from Prof. J. Agardh's account of the genus. In aspect the plant resembles a very narrow *Dictyota*, but its substance is very much thicker, and a section under the microscope shows it to be composed of a much greater number of rows of cells. The surface cellules are very minute, and the cells increase in length and breadth as they lie more towards the centre of the flesh.

Order III.—LAMINARIACEÆ.

Laminarieæ, Grev. Alg. Brit., p. 24. *J. Ag. Symb. p.* 4. *Sp. Alg. p.* 121. *Endl.* 3*rd, Suppl. p.* 26. *Kütz. Phyc. Gen. p.* 344, *and part of Chordeæ, p.* 333. *Sp. Alg. p.* 573. *Laminaridæ, Lindl. Veg. Kingd. p.* 22.

Diagnosis.—Olive-coloured, inarticulate seaweeds, whose spores are superficial, either forming indefinite, cloudlike patches, or covering the whole surface of the frond. *(Plants of large size, not much divided, usually stipitate, foliaceous.)*

Natural character.—*Root* rarely a simple, undivided disc; commonly much branched, or only simple and disc-like when young. As the plant advances in growth, new accessory holdfasts are formed toward the base of the stipe round the primary one, and these, lengthening and branching, unite into a conical mass of rootlets (or cables), which together make up the compound root. *Fronds* of an olive-brown or an olive-green colour, mostly becoming darker on exposure to the air, in some cases turning green in drying; usually tough and leathery in substance, but in some delicately membranaceous; the internal structure fibroso-cellular, the flesh being chiefly composed of interlacing threads, formed of strings of cylindrical cells, placed end to end. The plants of this Order are almost all of large, frequently of gigantic size, either tubular or furnished with a *stipe* which expands at the summit into a leafy frond. In the least developed genus *(Adenocystis)* the frond consists of a hollow, membranous bag, contracted at the base into a little stalk, and gradually tapering to the apex into a simple point. At the next stage (*Chorda)* the form is still tubular, but the tube becomes cylindrical, or filiform, and is divided internally into several compartments, by transverse membranes stretched across its cavity. In the more perfect genera we clearly recognise a cylindrical solid stem or *stipe*, occasionally vesicular in its upper portion, and bearing at its summit an expanded leaf. This stem is in most cases simple; in the most perfect genera alone it becomes branched, its divisions being repetitions of the primary idea. The leafy expansion crowning the stem or branches is sometimes ribbon-shaped, quite simple and tapering to its extremity; sometimes it is cloven vertically into many narrow laciniæ, by a process of natural splitting which takes place in a very irregular manner; sometimes it is regularly pinnatifid (as in *Ecklonia*) and lastly (in *Agarum* and *Thalassiophyllum*) the whole expansion is perforated with holes, like a sieve. In the majority of cases the leaf is ribless; but in the more fully organized a midrib, formed of a prolongation of the apex of the stipe, traverses its substance. *Air-vessels* are very often wanting; where they are found, they are formed either by distensions of the upper portion of the stipe, or (in *Macrocystis*) by vesications of the petioles of the leaves.

In those species that are perennial the stipe lasts for several years, but the leaf is changed at the end of each season. The process for effecting a change of leaf is gradual, and commences long before the fall of the previous leaf. The new leaf is not formed, however, in the axil of the old one, but begins at the apex of the stipe, or in that portion where the stipe, or common petiole, passes into the leaf. At that point, new and vigorous tissue is always found; there a new lamina begins to expand, and as it elongates it gradually pushes before it the older part of the leaf, which for a long time adheres to the apex of this new part, and falls away only when the new leaf has reached the normal size.

The fructification of this Order is on a very simple type of development. Innumerable minute *spores*, each contained within a hyaline perispore, are formed out of the surface cells either of the whole frond, or of some large and imperfectly defined portions of it. In the highest types only (as in *Alaria*) are spores found in spaces definitely limited, or in proper leaflets. In the lowest (*Chorda*) they clothe the whole surface, and in most other cases (*Laminaria*, *Agarum*, *&c.*) they form cloud-like, dark-coloured patches of considerable extent and uncertain limits. Usually but one spore is found in each perispore, but in some each perispore contains four sporules. Barren filaments, or *paranemata*, occasionally accompany the spores, and in some cases *Antheridia* are found attached to them. These last are oval cells, filled with minute corpuscles.

The *Laminariaceæ*, though formed on a much less fully organised type than the

Fucaceæ, are of much larger dimensions. The number of species under twelve inches in length is very small; almost all, when mature, exceed twelve feet in length, and when we light upon the real giants of the Order, the frond is measured by fathoms and not by feet. The ordinary *Oarweeds*, *Tangle*, *Devil's-apron* and *Sea-colander* of the American shores, which are familiar examples of these plants, are frequently seen ten, twelve, or even twenty feet in length, with immense fronds or aprons terminating their stems; but these are mediocre indeed, compared to some of their co-ordinals in the Pacific. The *Nereocystis* of the North West Coast is said, when fully grown, to have a stem measuring 300 feet in length, which bears at its summit a huge air-vessel, six or seven feet long, shaped like a great cask, and ending in a tuft of upwards of fifty forked leaves, each of which is from thirty to forty feet in length. The cask-like air-vessel buoys up this immense frond, which, like Milton's hero, lies

> Prone on the flood, extended long and large,
> (And) floating many a rood.—

Here the Sea Otter (*Lutra marina*) has his favourite lair, resting himself on the vesicle, or hiding among the leaves while he pursues his fishing. The stem which anchors this floating mass of fronds, though no thicker than whip-cord, must be of considerable strength and flexibility; and accordingly we find it employed as a fishing line by the rude natives of the coast. But great as is the length of this seaweed, it is exceeded by the *Macrocystis*, whose stems are calculated by Dr. Hooker* occasionally to reach 700 feet, while Bory St. Vincent attributes to them a length of 1500 feet. These are the longest fronded of the Order, and indeed the longest vegetables that are known. Others, as the *Lessoniæ* of the Pacific and Southern Oceans, though of less height have stems of much greater bole, and a habit that reminds us of some large endogenous arborescent plants, as the *Aloe dichotoma* or as the *Dracæna Draco*. These gigantic Algæ have trunks of considerable diameter and height, branched dichotomously, each branch bearing at its summit bunches of long ribbon-like leaves. Torn from the submerged rocks on which they grow, these marine trees are driven ashore on the rocky coasts of the Falkland Islands in great numbers, and lie, as Dr. Hooker well describes, rotting for many a mile, in banks several yards in breadth and three or four feet in depth. The trunks, from which the leaves have been washed, resemble drift-wood, and "on one occasion" (as related by Dr. Hooker) "no persuasion could prevent the captain of a brig from employing his boat's crew, during two bitterly cold days, in collecting this incombustible weed for fuel." Another noble genus of the Southern Ocean *(Ecklonia)* may be compared to the Palm in habit, having pinnated fronds of large size. One of the best known species, the *Trumpet-weed (Ecklonia buccinalis)* of the Cape of Good Hope, has a stem often more than twenty feet in height, crowned with a fan-shaped cluster of leaves, each twelve feet long or more. The stem of this seaweed which is hollow in the upper portion is, when dried, often used in the colony as a siphon; and by the native herdsmen is formed into a trumpet for collecting the cattle at evening. But perhaps the most curious plants of the Order

* Fl. Antarct. vol. 3, p. 464.

are the Arctic genera *Agarum* and *Thalassiophyllum*, both found within our limits and described below.

The Order contains some fifty species, about half of which are natives of the western world, and the largest portion of these of the northern continent. They are plants of deep water, rarely vegetating within tide-marks, or barely reaching a few inches above low water mark, and characterise a broad zone of depth extending from low water to four or five fathoms below it; while the larger species straggle into deeper water, to an unknown distance from the surface. Many of these probably first vegetate on detached masses of rock at a moderate depth, and are afterwards drifted, carrying their rocky anchors with them, into the deeper sea. They are mostly plants of high latitudes, to which the greater number are confined. *Macrocystis* and *Ecklonia* are characteristic of warmer climates, and extend, as well as some species of *Laminaria*, into the tropical zone.

SYNOPSIS OF THE NORTH AMERICAN GENERA.

1. *Frond having a stem, furnished with definite leaves.*

I. Macrocystis. Stem filiform, branched. *Leaves* simple, secund along the stem, each leaf rising from a stalked air-vessel.

II. Nereocystis. *Stem* filiform, unbranched, bearing at its summit an air-vessel, from which many forked leaves spring.

III. Lessonia. Stem dichotomous (or simple?). *Leaves* terminating the branches. *Air-vessels* none.

2. *Frond stipitate, the stipes expanding at the summit into a simple or cloven lamina.*

* *Lamina midribbed.*

IV. Alaria. *Lamina* traversed by a single rib.

V. Costaria. *Lamina* traversed by several parallel ribs.

** *Lamina without midrib.*

VI. Laminaria. *Lamina* either simple or cloven.

3. *Frond flat, pierced, like a colander, with holes.*

VII. Agarum. *Lamina* midribbed.

VIII. Thalassiophyllum. *Lamina* without midrib, spirally developed round a (branching) stipe.

4. *Frond cylindrical, tubular or bag-shaped.*

IX. Chorda. *Frond* filiform, septate within.

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1. MACROCYSTIS, *Ag.*

Root branching extensively. *Stem* filiform. *Leaves* simple, formed by the continual splitting of a primary terminal leaf; developed in secund order along the lengthening stem, petiolate, having an *air-vessel* in the petiole. *Spores* forming irregular, superficial, cloudlike patches on small radical leaves, ellipsoidal, with hyaline perispore, surrounded by densely packed, inarticulate, clavate paranemata.

When fully grown the frond in this genus consists of a much branched root, from which rise many filiform, simple or branched stems, naked below; but furnished above with numerous, unilateral, lanceolate, petiolate leaves, having their petioles enlarged into pear-shaped or oblong air-cells. The lateral leaves have their edges directed toward the stem and are so far vertically disposed; and the stem itself, when unbroken, always terminates in an oblique leaf, broader than the rest, and having one or more slits in its base. This terminal leaf is the growing apex, and from the development of the slits in its base new lateral leaves are gradually separated. The whole frond, indeed, much divided as it eventually becomes, has been developed from the continual splitting of such a leaf. The young stem as it first rises from the root bears at its summit a single vertical leaf, destitute of vesicle, serrated, except at a short distance above the base, and having the apex generally a little hooked in: its outline is therefore somewhat scymetar-shaped. In this leaf, commencing within the margin of its lowest edge, are gradually formed a series of splits, proceeding from the base and extending upwards towards the apex. As each split increases in length, it widens by the onward growth of the common base; and air-vessels begin to be formed in the lower and slender part of the segments, which are gradually separated. The splitting process continues until the split reaches the margin, at which time the air-vessel is completely formed, and the margin of the young segment furnished with ciliæform teeth; and its apex being at length free, it becomes a leaf, only differing in size from those lower down on the stem, and which have had a similar origin.

The fructification is found only on root-leaves which never rise to the surface and are destitute of air-vessels. It forms cloudy patches, and contains myriads of extremely minute spores.

The student will find an interesting history of this genus, illustrated by an excellent figure showing the development of the leaves, in Dr. Hooker's *Flora Antarctica, vol.* 2, *p.* 461—466, *tab.* 169, 170, 171.

1. MACROCYSTIS *pyrifera;* Ag. *Hook. and Harv. in Hook. Fl. Antarct. vol.* 2, *p.* 461. *Macrocystis Humboldtii, planicaulis, angustifolia, tenuifolia, pyrifera, pelagica, luxurians, latifolia, Orbigniana, Auct.—J. Ag. Sp. Alg. p.* 155—158. *Kütz. Sp. Alg. p.* 582—583 *(also M. Dubenii, Aresch., latifrons, Bory, &c.). Lessonia ciliata, Post. and Rupr. Illust. p.* 9, *t.* 38, *f.* 9.

Hab. Shores of California, *Beechey*, *Coulter*, *Wilkes*, *&c.* Unalaschka and Sitcha, *Postels and Ruprecht.* (v. v. ad C. B. S.)

Root much branched. *Stems* from five feet to several hundred feet long, filiform or flattish, eventually subdichotomously branched. *Leaves* lateral, secund along the branches, lanceolate, varying much in length and breadth, membranaceous or coriaceous, smooth or wrinkled, bordered with slender cilia or subulate teeth; each leaf rising from an air-vessel. *Air-vessels* as variable in form and size as the leaves, globose, ellipsoidal, pear-shaped or fusiform, or long and narrow-club-shaped.

I fully concur with my friend Dr. Hooker in the view of this species which we have jointly taken in another place. (*Fl. Ant. vol.* 2, *p.* 461.) We have together carefully examined specimens representing most of the forms distinguished as species by authors, and still retained by Prof. J. Agardh ; and each of us,—Dr. Hooker very extensively,—has had an opportunity of verifying opinions arrived at in the study by observations made from the living plants on the sea-shore ; and we have both, independently, arrived at the conclusion that all the forms separated by authors are referable to a single, and not *very* variable species. Many of these reputed species may indeed be found growing together on different parts of the same stem ; the differences observed being either the result of age, or of a different degree of submersion, or other modifying cause.

II. NEREOCYSTIS, *Post. and Rupr.*

Stem filiform, simple, terminating in a club shaped air-vessel, from which springs a tuft of dichotomously divided leaves, formed by the continual splitting, from the base upwards, of an original, simple, terminal leaf. *Root* branching. *Fructification* unknown.

Nereocystis *Lütkeana*, *Post. and Rupr. Illustr. p.* 9. *t.* 8. 9. *Endl. Gen. Pl.* 3*rd Suppl. p.* 27. *J. Ag. Sp. Alg., vol.* 1, *p.* 148. *Kütz. Sp. Alg. p.* 584. *Fucus Lütkeanus, H. Mert. in Linn.* 1829. *p.* 48. *Hook. Bot. Misc. vol.* 3, *p.* 3.

Hab. North West Coast, at Norfolk Sound, *Dr. Henry Mertens.* (v. s. in Herb. T. C. D.)

I copy the following account of this remarkable plant from the paper of Dr. Henry Mertens, its discoverer :—

" A root, ramified in the manner of the *Laminarias* produces a stipes like pack-thread, and everywhere of uniform thickness, about two or three feet long, and suddenly swelling at the end into a perfectly round, large, bladder-nut. The upper portion of this hemispherical body bears a tuft of geminate leaves, mostly rising on five petioles: but in the division of these petioles, there never exists such a symmetry as that the fifth is found exactly in the centre and opposite to the point of insertion of the stipes at the vesicle; rather, there are three on one side, and two only on the other. In some rare instances I noticed but four leaf-stems, two on either side. The summit of the vesicle always presented an open space: the leaves are lanceolate, sharply attenuated at both extremities, their substance like the frond of *Laminaria Phyllitis*, about one and a half to two feet long, and measuring two inches in their greatest breadth; some longitudinal nerves appear, of uncertain number, running from the base of the leaf to the middle, where they are lost in the substance. Such is the configuration of this fucus in a young state; when older it alters so as to be scarcely recognisable, and then only acquires that remarkable appendage, which I shall now proceed to explain. In advanced age, the stipes becomes immensely long, without however increasing proportionably in thickness; for whilst it remains at the base of the stoutness of packthread, its diameter, at ten or fifteen fathoms' distance, scarcely measures two and a half lines. Gradually the vesicle changes into a turnip-shaped or retort-like cylinder, more than a fathom long, measuring at its broadest dimension that supports the leaf near the end, 4—6 inches or even more in diameter, while the lower end gradually, and quite imperceptibly, loses itself in the stipes. The formation of the frond keeps an equally gradual advance: the leaves described above are numerously divided in their length, the nerves of the young leaves indicating their future points of separation. Entangled at their bases by matting together, these attain a very great length and an equal increase of breadth; the tuft now covering an immense surface with its crowded masses. In one specimen, by no means the largest, which I examined, I calculated that there were upwards of fifty leaves, each twenty-seven feet long. The Russians call this fucus (to which I had previously given the name of *Lutkeanus*, in honour of our worthy commander, who daily shows himself more zealous in favouring our natural history labours) *See Otter Kohl*, or the Sea Otter's Cabbage. The valuable animal, *Lutra marina*, makes particular choice of this seaweed as its favourite refuge and residence; delighting to rock and sleep on the long cylindrical bladders, which, like enormous sea-serpents, float on the surface of the water, and individually sweep between the little islands, rendering the channels impassible, even for boats. From the information that I collected from various Russians and Aleutians concerning its duration, this fucus is annual. In autumn it is cast in great quantities on shore by the then prevalent storms, where it soon decays, and in spring not the least trace of it is to be seen. The Aleutians employ the stipes, which are said sometimes to be forty-five fathoms long, for fishing lines: I purchased one of them. I once saw the Kadiakensers, in Sitcha, make use of the cylinder as a siphon, for pumping the water out of their Beidarkas; a use to which it is well known that the *F. buccinalis* is often applied at the Cape of Good Hope. Owing to the moist climate of Sitcha, the drying of this sea-weed is attended with considerable difficulty. I hardly ever succeeded in preserving a tolerable specimen of the cylinder or bladder, though I bestowed much pains and labour on the operation, for this part generally dissolves completely, or if dried, the leaves then become brittle as glass, and fall to pieces with the slightest touch. The opening of the bladder and discharging the water which it uniformly contains, only hastens the process of decomposition."—*H. Mert.* (*translated*) *in Hook. Bot. Misc.* 3, *p.* 3-5.

Little is known of this singular Alga beyond the above graphic description, and the figure of Postells and Ruprecht. I earnestly recommend it to the notice of all collectors of plants on the North West Coast; though it would appear to be confined to Russian America.

III. LESSONIA, *Bory.*

Stem cylindrical, solid, dichotomously branched, each branch terminating in a pair of lanceolate leaves. *Air-vessels* none. *Spores* collected in a thickened portion of the lamina of the leaves, and there forming a subdefined, dark-coloured patch, ellipsoidal, with hyaline perispore, and lying among densely packed, inarticulate paranemata.

Species of this genus probably exist on the North West Coast, but as yet I have received no certain information on this subject. The *Lessonia Sinclairii* from California, mentioned by Dr. Hooker, *Fl. Antarct. vol.* 2, *p.* 460, must for the present remain undescribed. The name was given in MSS. to a specimen existing in Sir William J. Hooker's herbarium, having the habit of *Laminaria saccharina*, but a central patch or *sorus* of fructification, like that of the ordinary Lessoniæ. I have no means, at present, of referring to the original specimen, and neglected to make an accurate examination of it when it was named. It was gathered by Dr. Sinclair at San Francisco, and is the *Lam. saccharina* of *Harv. in Hook. and Arn. Bot. Beechey, p.* 407.

IV. ALARIA, *Grev.*

Root branching. *Frond* stipitate, membranaceous, with a percurrent cartilaginous midrib (a continuation of the stipes); the lower part of the stipe pinnated with ribless leaflets. *Spores* collected in a thickened, central portion of the leaflets, forming a definite, dark coloured patch, four spores contained within each pear-shaped perispore, myriads of which are vertically packed together among inarticulate paranemata.

A small genus inhabiting the colder regions of the Northern Atlantic and Pacific. The *lamina* which forms the wing, at either side of the midrib, or prolonged apex of the stipes, is of a delicately membranaceous substance, and tears easily in an oblique direction from the margin to the midrib, and it is rare to find specimens of large size in which the upper half of the leaf is not reduced to tatters. During the growing season new ribbed membrane is, however, constantly developed at the base of the old winged portion, and by its upward growth supplies the place of the apex which is destroyed by the waves. In the young plant the stipes is very short and has no pinnæ. As the growth proceeds, it gradually lengthens and becomes much thicker and stronger, throwing out along its margin in the upper half, and immediately below the base of the leafy portion, narrow spathulate ribless leaflets. These are destined to contain the fructification, and are the nearest approach to a proper *receptacle* of fruit that is found within the limits of the Order. The barren leaflets are membranaceous, and not very different in substance from the ribbed leaf, except in being a little thicker; but those in which fruit is formed have their lower half, at least, incrassated, and gradually changed to a dark brown. The thickening is sometimes confined to the lower half of the leaflet, and sometimes extends to the whole surface. A vertical section through this mass of fructification shows it to be composed of innumerable *perispores*, formed out of the enlarged surface-cellules of the frond. Each perispore, at maturity, contains four spores. Numerous barren filaments or *paranemata* accompany the fertile perispores.

The midrib of *Alaria esculenta*, when stripped of the membrane, is eaten by the peasantry on the shores of Scotland and Ireland under the various names *Badderlocks*, *Henware*, *Honeyware*, and *Murlins*. If the first of these names signify that this esculent is *far from good*, it is perhaps the most appropriate of the whole; but I do not vouch for the authenticity of this derivation.

1. ALARIA *esculenta*, Grev.; midrib solid, scarcely wider than the stipes; lamina ovate at the base, decurrent along the stipe; pinnæ linear or cuneate. *J. Ag. Sp. Alg.* 1, *p.* 143. *Kütz. Sp. Alg. p.* 579. *Harv. Phyc. Brit., t.* 79. *Fucus esculentus, Turn. Hist., t.* 117. *E. Bot. t.* 1759. *Fl. Dan. t.* 417. *Laminaria musæfolia, and L. linearis, De la Pyl. Fl. Terr. Neuv. p.* 31 *and* 37.

HAB. On rocks about low water mark. On the eastern coast, as far south as Cape Cod. Newfoundland. Also on the N.W. Coast, at least in Russian America. (v. v.)

Root of many grasping branches. *Stipe* naked at the base, cylindrical, from two to eight or ten inches long, and from two to four lines in diameter, pinnated in its upper half with numerous ribless, linear-spathulate leaflets, which at length become crowded together; above these leaflets the stipe is winged at each side with membrane, and passes gradually into the cartilaginous midrib of the foliaceous frond, which is from three to twenty feet long or more, and from two inches to eight or ten inches or more in width. This leafy portion is very thin and easily torn, of a clear olive when growing, becoming greener and more transparent when dried.

The masses of fructification are reddish brown, much thicker than the leaves in which they lie.

2. ALARIA *Pylaii*, Grev.; midrib solid, scarcely wider than the stipes, lamina cuneate at the base, decurrent along the stipes for a considerable space; pinnæ obovato-spathulate. *J. Ag. Sp. Alg. vol.* 1, *p.* 143. *Kütz. Sp. Alg. p.* 579. *Laminaria Pylaii, Bory. De la Pyl. Fl. Ter. Neuv. p.* 29.

HAB. On rocks near low-water mark. Newfoundland, *De la Pylaie.* (v. s. in Herb. T.C.D.)

Scarcely differing from the preceding, with which it has probably been sometimes confounded. It is chiefly marked by the broader and more obovate pinnæ; the cuneate base of the frond is a very indefinite character.

3. ALARIA *fistulosa*, Post. and Rupr.; "Midrib fistular, inflated, at intervals constricted and septigerous; lamina delicately membranaceous; pinnæ linear, rounded at the apex, attenuated at base, sessile."—*Post. and Rupr. Illustr. p.* 11, *t.* 16.

HAB. Illuluk Bay, Unalaschka, *Postells and Ruprecht, l. c.*

4. ALARIA *marginata, Post. and Rupr.*; "Midrib solid, rather broad; lamina thin but leathery," (chartaceo-coriacea); "pinnæ linear, rounded at the base and apex, stipitate, coriaceous, entire at the margin, plane, bordered by a shining stripe (fascia nitida cinctis)."—*Post. and Rupr. Illust. p.* 11.

HAB. At Unalaschka, *Postells and Ruprecht, l. c.*

V.—COSTARIA, *Grev.*

Frond stipitate, undivided, flat, three to five ribbed, the ribs sub-parallel, radiating from the apex of the stipe. *Fruit* . . . ?

The stipe is simple, solid, flattened, and marked with numerous elevated longitudinal striæ, and so continued through a simple, linear, or ovate lamina, that the striæ of the stipe are produced in ribs. These ribs are three or five; they are united in the stipe; separated, they run through the lamina sub-parallelly, and approach again at the apex. The lamina is mostly wrinkled and bullated, often perforated between the ribs, the perforations irregular. *J. Ag. l. c.*

1. COSTARIA *Turneri*, Grev.; stipes flat, expanding into a linear-lanceolate five-ribbed lamina. *J. Ag. Sp. Alg. vol.* 1, *p.* 139. *Kütz. Sp. Alg.* 580. *Fucus costatus*, *Turn. Hist. t.* 226.

HAB. On the North West Coast, *Mr. Menzies.*

"*Frond* solitary, rising with a stipe about an inch in length, marked from top to bottom with prominent, nearly parallel striæ, cylindrical, and of the size of a crow's quill at its origin, but almost immediately becoming compressed, and soon after flat, gradually expanding, too, as it rises, but so slowly that at the top it is scarcely above a line in diameter; it here suddenly expands into a single, flat, undivided leaf, a foot and a half or more long, nearly linear, about two inches wide, quite entire, and slightly waved at the margin, at the base attenuated; the surface marked all over with irregular transverse wrinkles, and having five parallel ribs running through it from top to bottom. *Colour* a pale, dirty yellow in the stipe, in the leaf olive-brown, and semi-transparent. *Substance* of the stem woody, of the leaf membranaceous."—*Turn. Hist.* 4, *p.* 72.

2. COSTARIA *Mertensii*, J. Ag.; "stipes flat, expanding into a cordato-ovate five-ribbed lamina."—*J. Ag. Sp. Alg.* 1, *p.* 142. *Costaria Turneri*, *Post. and Rupr. t.* 24.

HAB. North West Coast, *Dr. H. Mertens.*

I think this must be merely a broad leaved form of the last.

VI. LAMINARIA, *Lamour.*

Frond stipitate, coriaceous or membranaceous, flat, ribless, undivided or irregularly cleft. *Fructification*, cloud-like patches of *spores*, imbedded in the thickened surface of some part of the leafy expansion.

The plants commonly known as *Oarweed, Tangle, Devil's Apron, Riband-weed, Sole-leather-kelp, &c.* belong to this genus, which is more numerous in species, and possessed of a wider geographical range than any other of the Order. With the exception of *L. Fascia*, which is only a few inches long, they are all plants of a large size, varying from three to twelve, or twenty feet in length. They commence to grow about low-water mark, and descend, beyond that limit, to the depth of five to ten fathoms.

Many are perennial; the stipe remaining from year to year and the frond falling away. The new frond is developed between the apex of the stipe and the base of the old frond, and at first appears like a flattening and widening of the apex of the stipe. This flattened portion gradually lengthens, assuming the normal form of the species, and carries at its apex the old leaf, which is about to be changed. The point of cohesion of this leaf becomes less firm, and gradually the now decayed lamina falls off, leaving the young frond to crown the stipe in its place.

1. LAMINARIA *Fascia*, Ag.; stipe very short, slender, flattened, expanding gradually into a membranaceous, broadly oblong, wedge-shaped, lanceolate, or linear frond. *Harv. Phyc. Brit. t.* 45. *Lam. Fascia, cæspitosa et debilis, J. Ag. Sp. Alg. vol.* 1, *p.* 129-130. *Phyllitis Fascia et debilis, Kütz. Sp. Alg. p.* 566.

HAB. On rocks and stones, near low-water mark. Fort Hamilton, N. Y. *Capt. Pike and Mr. Hooper.* Halifax, *W. H. H.* (v. v.)

Root, a small disc. *Stipe* as thick as hog's bristle, half an inch long, filiform at base, compressed upwards and gradually widening into the cuneate base of the frond. *Lamina* very variable in form, 2—12 inches long, from a quarter inch to two inches broad, sometimes abruptly cuneate at the base, sometimes much attenuated, either lanceolate, oblong, or linear, or oblong-ovate; in some specimens remarkably obtuse, in others tapering more or less to the point. Margin waved or flat. *Colour* when growing a clear chestnut brown, changing to greenish olive in drying. I can by no means distinguish from one another the three species of Prof. Agardh, above referred to this. The form of the frond is most variable, even in the same tuft, and the gradations between the several forms so complete, that if you examine a sufficient number of specimens not specially selected as typical, there can be no difficulty in tracing the narrowest and most cuneate into the widest and most ovate. *L. Fascia* is widely distributed, being found also on the Atlantic and Mediterranean shores of Europe; and at the Falkland Islands in the Southern Atlantic.

2. LAMINARIA *lorea*, Bory; stipes rising from a branching root, flat, winged above, dilating into a linear-ensiform, membranaceous, very long frond, entire or cleft at the apex. *J. Ag. Sp. Alg. vol.* 1, *p.* 130. *L. tæniata, Post. and Rupr. t.* 38, *f. (fide Ag.). L. saccharina, var. Kütz. Sp. Alg. p.* 574.

HAB. Shores of Newfoundland, *Despreaux.*

Stipe 3—4 inches long, flat from its origin, dilated above, and winged with a thinner margin. The wing of the stipe is expanded into the lamina of the frond, the stipe itself (or its thickened portion) being continued in furrows through the lower part of the lamina. *Lamina* several feet long, an inch and a half wide, at each end much attenuated. *J. Ag. l. c.*

I am not acquainted with this plant, said to be a very distinct species by Agardh, from whom I copy the above description.

3. LAMINARIA *dermatodea*, De la Pyl.; stipes rising from a branching root, terete below, compressed or flattened above, dilating into a cuneate-oblong simple frond afterwards becoming cordate at base, and palmately cleft from the apex. *J. Ag. Sp. Alg.* 1, *p.* 131. *Phyllitis dermatodea, Kütz. Sp. Alg. p.* 567.

HAB. On rocks, at and below low-water mark. Newfoundland, *De la Pylæie.* (v. s. in Herb. T.C.D.)

Stipe 3-4 inches long, in the young plant compressed, in the full-grown altogether flat, passing into the base of an oblong or lanceolate frond, which in the young plant is entire, but which at last, becoming more dilated and with a more cordate base, is cloven into several segments and assumes the habit of *L. digitata.*

I have seen only young specimens of this species, and in them the apex is imperfect. They were collected by Despreaux and communicated to me by *M. Lenormand.*

4. LAMINARIA *saccharina*, Lamour.; stem cylindrical, solid, short, expanding into a cartilaginous or submembranaceous, lanceolate or oblong, undivided frond. *J. Ag. Sp. Alg. vol.* 1, *p.* 132. *Kütz. Sp. Alg. p.* 574. *Harv. Phyc. Brit. t.* 289. *Fucus saccharinus, L. E. Bot. t.* 1376. *Turn. Hist. t.* 163. *Lam. Lamourouxii? Bory, Dict. Cl. Hist. Nat.* 9, *p.* 189.

HAB. On rocks in the sea, from low-water mark to four or five fathoms. Common on rocky shores, from Greenland to New York; and cast up from deeper water on the New Jersey coast. (Its southern limit not ascertained beyond Long-branch, N. J.). (v. v.).

Root of several branching fibres, forming a conical holdfast. *Stem* from a few inches to a foot or more in length, from a quarter to half an inch in diameter, terete, compressed at its upper end, and gradually dilating into the base of the terminal, undivided lamina. Lamina very variable in its proportionate length and breadth, sometimes linear-lanceolate, sometimes ovato-lanceolate, sometimes elliptical, acute, or obtuse, or drawn out at the apex into a long caudate prolongation, from one to six or ten feet in length, and from one to twelve inches in breadth, flat, or very much curled at the margin, and at length over the whole surface; sometimes regularly transversely wrinkled through the middle of the lamina, sometimes irregularly bullated. *Substance* in some varieties membranous, in others cartilaginous or leathery, or even horny in some. *Colour* of the leaf when young a greenish olive, browner as it grows old.

Numerous varieties, which perhaps demand future study, occur on the American coast. The *Laminaria Lamourouxii* of Bory, which has been sent me from Boston Harbour by Prof. Asa Gray, and of which I also possess an authentic specimen from Newfoundland, looks almost like a species, with its thickish, broadly elliptical, scarcely waved frond, and its slightly branching root; but I am not sufficiently acquainted with it to say whether it has claims to be regarded as anything more than a form. Prof. J. Agardh refers it unhesitatingly to *L. saccharina*, and it must be confessed, that if we separate it on the mere characters assigned it by M. Bory, we must be prepared to admit to specific rank many other forms now referred to *L. saccharina.*

5. Laminaria *longicruris*, De la Pyl. ; Stipes very long, slender at the base, hollow and inflated in the middle, and gradually tapering to the apex ; frond undivided, ovato-lanceolate, membranaceous, obtuse. *J. Ag. Sp. Alg. vol.* 1, *p.* 135. *Kütz. Sp. Alg. p.* 576. *Harv. Phyc. Brit. t.* 339. (TAB. VI.)

HAB. In deep water, from five to ten fathoms (or more?). Very abundant on the American shores, from Greenland to Cape Cod. Newfoundland, *De la Pylæie.* Bahama Islands, *Chauvin.* (v. v.)

Root of many slender and much branched, clasping fibres, which issue at irregular intervals from the lower part of the stipe. *Stipe* from eight to twelve feet in length, very slender at the base, and there solid, gradually widening upwards, and soon becoming hollow ; at length, towards the middle, widened to upwards of an inch in diameter, and thence tapering to the apex, and terminating in the broadly cuneate base of the lamina. *Lamina,* when full grown, 6 to 8 feet in length, and from two to three feet in width, oblong-lanceolate or oval, very much waved at the margins, and obtuse at the apex, of a thinner substance than in *L. saccharina. Colour* of the stem yellowish brown, pale ; of the lamina a beautiful pale greenish olive.

This noble species, though having much general resemblance to the preceding, is at once distinguished from every form of it by the very long, hollow stem, tapering to both extremities. It is by far the most abundant species on the northern coasts, and gradually diminishes, in the number of individuals, and in the size and luxuriance of growth, as it extends southward. In Boston Bay it is still plentiful, though of much smaller dimensions than at Halifax, where it is the chief ornament of the sub-marine flora. I have seen no specimen from a more southern locality that Cape Cod ; but M. Chauvin is said to have received it from the Bahamas. In Europe it is scarcely known to grow beyond the limits of the Arctic Sea, whence water-worn specimens occasionally reach the coasts of Scotland, and of the north of Ireland.

PLATE VI. *Fig.* 1. A young frond of LAMINARIA *longicruris* ; one third of the natural size ; *fig.* 2. part of the hollow stipes of a full grown plant, the *natural* size.

6. LAMINARIA *trilaminata*, Harv. MSS.—Olney, in proceedings of Providence Franklin Society, vol. 1. p. 39.

HAB. Floating near Narragansett Pier, R. I. *Mr. Olney*. (v. s.)

I introduce this undescribed and scarcely known plant, because it has already obtained publicity in Mr. Olney's list of Rhode Island plants, quoted above ; but I am unable to give a satisfactory description from the few fragments that have reached me ; and probably, after all, these may belong to some strangely anomalous form of *L. saccharina*. The fragments sent me by Mr. Olney and Professor Bailey are labelled as part of a large Alga resembling *L. saccharina* in appearance, but having a trilaminate frond ; that is, from the centre of the lamina, along its whole (?) length, there projects a wing or additional lamina, making, with the two halves of the true leaf, a third lamina. Nothing is known of the stipes.

7. LAMINARIA *digitata*, Lam. ; stem robust, woody, terete below, compressed above, expanding into a leathery, oblong, or ovate frond, which is deeply cleft into many linear segments of irregular breadth. *J. Ag. Sp. Alg. vol.* 1, *p.* 134. *Harv. Phyc. Brit. t.* 223, *and t.* 338. *Hafgygia digitata, Kütz. Sp. Alg. p.* 577. *Phyc. Gen. t.* 30, 31. *Fucus digitatus, L. Turn. Hist. t.* 162. *E. Bot. t.* 2274.

HAB. On rocks, at and below low-water mark. Common as far south as Cape Cod. Narragansett Pier, R. I., *Mr. Olney. (floating only).* (v. v.)

Root formed of many stout branching holdfasts united together in a conical mass. *Stipe* from two to six feet long, cylindrical below, from a quarter inch to an inch in diameter at base, solid, tapering, and becoming compressed upwards, and terminating in the base of a standard-like broad lamina. *Lamina* from one to five feet long, or more, from one to three feet wide, deeply cleft from the apex to near the base into many linear strap-shaped segments of uncertain breadth. *Substance* of the stem woody, but flexible, horny when dry ; of the lamina leathery. *Colour* olive, becoming dark in age.

Possibly more than one species is here confounded. Some varieties, like that figured in *Phyc. Brit. t.* 338, are very narrow, with very much compressed, or even flattened stipes, and of a dark blackish-brown colour and glossy surface. Others, which I have from Boston Bay, have dried extremely pale, and though I have not seen perfect specimens of these, I remember to have noticed on the beach near Nahant some forms of pale colour and with very flat stems, which may belong to a peculiar species. The limits of species among these gigantic Algæ can rarely be determined from Herbarium specimens alone, and should be fixed by persons familiar with the plants in their places of growth, and who have watched the development of the frond through all its stages.

VII. AGARUM, *Bory.*

Frond stipitate, coriaceous, flat, pierced in all parts with roundish holes, and traversed by a cartilaginous midrib which is a prolongation of the stipes. *Fructification*, cloudlike patches of *spores*, imbedded in the thickened surface of some part of the perforated expansion.

A remarkable genus peculiar to the northern parts of the Atlantic and Pacific Oceans, on the American and Asiatic shores. The common American species *(A. Turneri)* is well known in the north eastern states as the *Sea Colander*, a name aptly expressive of the perforated frond. The holes in the membrane exist at all ages, but increase in size and circularity, as well as in numbers, as the growth proceeds. They are at first merely narrow slits, and commence to be formed near the midrib, where the active cell-division seems to take place. As in Laminaria, the newest portion of the leaf is at the base, where the stipes enters ; and the apex is continually worn out and thrown off. The *fructification* is found on old fronds late in the autumn, or early in winter, and forms very dark coloured patches of uncertain extent on the pierced membranes.

1. AGARUM *Turneri*, Post. and Rupr. ; stipes compressed, coriaceous, continued as a flattened midrib through the frond ; lamina membranaceous, its nearly circular holes with flat margins, and of various sizes intermixed. *J. Ag. Sp. Alg. vol.* 1, *p.* 141. *Kütz. Sp. Alg. p.* 580. *Fucus Agarum, Turn. Hist. t.* 75. *Fl. Dan. t.* 1542. (TAB. V.)

HAB. On rocks and stones, &c., from low-water mark to a depth of 5—10 fathoms. Very abundant on the Eastern Coasts, from Greenland to Cape Cod. North West Coast, at least in Russian America. (v. v.)

Root much branched, formed of many clasping, dichotomous fibres, interwoven together. *Stipe* from one to four lines wide, and from two inches to a foot in height, compressed, coriaceous, becoming flattened and sensibly widened where it meets the lamina, through which it is then continued as a midrib. The width of this midrib varies much in different specimens of the same age ; in some being scarcely wider than the stipe, and in others three or four times that width. *Lamina* oblong, at first elliptical, then becoming ovate, and at length deeply cordate at the base, the margin at the same time being changed from nearly flat to be very much waved and curled, this portion of the frond continuing to be developed after growth has nearly ceased within it. The whole lamina is pierced, at short distances, with roundish holes, which commence of small size and gradually widen ; these are irregularly mixed together, large and small, in all parts of the leaf, the smaller holes being of later formation than the larger. The new growth of membrane chiefly takes place where the stipe enters at the base, but also for a considerable time near the margin of the lower half of the leaf. The substance of the leaf is membranaceous, soon drying ; that of the stipe and midrib more coriaceous, or cartilaginous. The colour is a darkish olive-green, becoming brown in age. The leaves, when full grown, are often ten or twelve feet in length, and two or three feet wide.

PLATE V. *Fig*, 1. A young frond of AGARUM *Turneri*, the *natural* size ; *fig.* 2, part of a thin vertical slice, through a *sorus* and the outer coats of the frond ; *fig.* 3, *spores*, in their *perispores*, from the sorus ; *fig.* 4, a *spore* isolated:—all the latter figures more or less highly *magnified.*

2. AGARUM *pertusum*, Mert. ; "stipes compressed, coriaceous, continued as a scarcely widened midrib ; lamina membranaceous, its holes when young furnished with a margin raised at one side, and formed by openings in the bullated membrane." *J. Ag. Sp. Alg. l. p.* 142. *Kütz. Sp. Alg. p.* 580. *Post. and Rupr. t.* 23.

HAB. Newfoundland, *De la Pylæie* (fide J. Ag.)

I am not acquainted with this species, which is said to have the holes much more irregular in shape and fewer in number than those of the preceding species ; also of more equal size, and smaller, rarely two lines in width ; and that they arise from the bursting of a bullated membrane.

A third species (*A. Gmelini*, *Post. and Rupr. p.* 11. *t.* 20, 21,) is described from the Northern Pacific, characterised chiefly, as it would seem, by having a midrib twice as wide as the stipes, and holes with undulated margins ; but I fear these characters can hardly be considered as alone sufficient to distinguish a species, for I find among a number of specimens picked up on Nahant Beach, great diversity in the comparative breadth of the midrib, and form of the holes. In some of my specimens, where the leaf measures 26 inches in length, the midrib is but two lines wide ; and in others of somewhat inferior superficies, it is at least five lines, the stipe being in the same specimens but two lines wide. I find similar variations in specimens collected at Halifax, and that it is impossible to fix limits between those with narrow, and those with wide stipes. It will remain to be seen whether observers on the shore can detect characters, existing at all ages, between those specimens with wide midribs and those with narrow. In many that I possess, the apex of the frond, both midrib and lamina, is strongly curved or hooked to one side, and this seems generally to occur in those with wide ribs.

VIII. THALASSIOPHYLLUM. *Post and Rupr.*

Frond with subdistinct leaves ; the leafy expansions formed by the evolution of a lamina, spirally developed round a branching stipe ; each leafy-lobe ribless, reniform, undivided, pierced in all parts with roundish holes. *Fructification*, cloud-like patches of *spores*, imbedded in the thickened surface of some part of the perforated leaf-lobes.

This genus is very nearly related to the preceding, from which it differs in having a branching stipe, round which a perforated lamina, partially divided into definite leaves, is spirally coiled. There is but one species yet known, viz:—

THALASSIOPHYLLUM *Clathrus*, Post. and Rupr. Illustr. t. 18, and t. 19. *J. Ag. Sp. Alg.* 1, *p.* 139. *Kütz. Sp. Alg. p.* 581. *Fucus clathrus*, *Grev. Hist. Fuc. t.* 33.

HAB. On the shores of Russian America. (v. s. in Herb. T. C. D.)

My specimens of this are so imperfect, that I prefer copying the following account given by Dr. H. Mertens of its appearance in a living state :—

" The ocean hardly boasts a more beautiful production than this ; it is generally about the height of a man, very bushy and branched, each branch bearing a broad leaf at its extremity, which unfolds spirally, and by this gradual development produces the stipes with its branches and lateral divisions. A spiral border, wound round the stipes, indicates the growth of the frond. The frond presents a large, convex, bent lamina, without nerves ; or to a certain degree a leaf, of which one half is wanting, for the stipes may be considered as an excentric nerve. A number of rather long, narrow perforations, arranged in a radiate form, give the frond the appearance of a cut fan ; these foramina being coeval with the formation of the frond, and apparently not owing to inequalities of substance. At first, these foramina, which are situated near the stipes, and where the frond is bent in, are round, and have their margins turned outwards ; but by the subsequent growth of the frond they become longer, and their margins disappear ; in the middle of the frond they are like true clefts, but nearer the margins, from the greater development of the leafy substance, they are more contracted in their breadth and therefore seem round. The frond has a complete and entire margin, but is frequently torn ; its substance is coriaceous. I have never detected any fructification. The root resembles that of the larger *Laminarias*, but is more woody. This fucus is very plentiful in the bay of Illuluk, and round the whole island of Amaknak. It clothes the rocky shore, like a thick hedge, for a space of 60 or 80 feet, forming, at a little distance, a very pleasing feature in the scenery." *H. Mert. in Hook. Bot. Misc.* 3, *p.* 5, 6.

IX. CHORDA, *Stack.*

Root scutate. *Frond* simple, cylindrical, tubular; its cavity divided by transverse membranes into separate chambers. *Fructification* a stratum of obconical spores, covering the whole external surface of the frond.

1. CHORDA *filum*, Stack.; frond cartilaginous, lubricous, clothed with pellucid hairs, filiform, very long, tapering to each extremity, not constricted at the dissepiments. *Grev. Alg. Brit. t.* 7. *Harv. Phyc. Brit. t.* 107. *Kütz. Sp. Alg. p.* 548. *Scytosiphon filum, Ag.—J. Ag. Sp. Alg.* 1, *p.* 126.

HAB. On rocks, etc. in the sea, between tide-marks, and extending to 4—10 fathoms depth, especially in deep, quiet bays. Common on the northern shores. (v. v.)

Root a minute disc. *Fronds* from one to ten, twenty, or even forty feet in length, according to depth of water, scarcely twice as thick as hog's-bristle at the base, gradually increasing in thickness to the middle and there from a quarter inch to nearly half an inch in diameter, and again gradually diminishing toward the apex, which is of equal tenuity with the base. This threadlike frond is cylindrical, hollow, divided at short intervals by very thin membranes, into chambers or joints, which are not visible externally; it is slimy to the touch, and clothed, at an early stage, with very dense, slender, gelatinous filaments, which generally disappear as the plant advances to maturity, but may sometimes be found on old plants, especially on such as grow in quiet, deep bays where they are little exposed to the action of waves. The *substance* is cartilaginous and firm, and very tough when recent. The *fructification* covers the whole external surface of old plants, and consists of obconical, vertical spores, supported on long pedicels, by which they are attached to the outer row of cellular tissue. Mixed with these are found numerous, narrow, elliptical, transversely striated cells, which may be antheridia. The walls of the tubular frond are formed of several rows of hexagonal, elongate cells, placed end to end, and forming longitudinal threads, glued together by the sides. Of these the inner ones are of large size; the outer, minute and more densely packed together.

2. CHORDA *lomentaria*, Lyngb.; frond membranaceous, constricted at distant intervals; the interstices inflated. *Lyngb. Hyd. Dan. p.* 74, *t.* 18. *Harv. Phyc. Brit. t.* 285. *Chorda filum, ζ. lomentaria, Kütz. Sp. Alg. p.* 548. *Scytosiphon lomentarium, J. Ag. Sp. Alg. vol.* 1, *p.* 126.

HAB. On rocks and stones, &c. in tide pools. On the eastern coast, from British America to Charleston, S. C. (v. v.)

Root a small disc. *Fronds* from eight to twelve or eighteen inches in length, tapering at the base to the diameter of horse hair, attenuated upwards, either to a bluntish or a very fine point, from two to four lines in diameter at the greatest breadth, cylindrical, constricted at irregular intervals and furnished with a transverse septum at each constriction. The walls of the tube are composed of a thick layer of large, polygonal cells, of which the outer ones are gradually smaller; on the outside of which, forming the periphery, is a stratum of radiating, close-packed, moniliform filaments. These are only found in their full development on mature specimens. *Colour* a brownish or greenish olive. *Substance* membranaceous and soft.

In habit this plant has more resemblance to *Asperococcus echinatus* than to the preceding species, but the structure of the walls is more in accordance with *Chorda*. There is also considerable affinity with the Antarctic *Adenocystis*, a little group that scarcely differs essentially from *Chorda*, with which Kützing unites it. I cannot agree so well with that author in making *C. lomentaria* merely a variety of *C. filum*, from which it has latterly been kept separate by most authors, and from which it differs in many essential characters.

Order IV.—DICTYOTACEÆ.

Dictyoteæ, Grev. Alg. Brit. p. 46. *J. Ag. Sp. Alg*, *vol.* 1, *p.* 68. *Endl.* 3*d. Suppl.*, *p.* 24. *Dictyoteæ, Encœlieæ, and part of Chordeæ and Phycoserideæ, Kütz., Phyc. Gen. pp.* 337, 336, 333, 296. *Dictyotidæ, Lindl. Veg. Kingd. p.* 22.

Diagnosis. Olive-coloured, inarticulate seaweeds, whose *spores* are superficial, and disposed in definite spots or lines (*sori*). (*Frondose, or rarely filiform plants of small or mediocre size, and membranaceous texture ; their surface reticulated with large cells.*)

Natural Character. *Root* usually a minute membranous disc or holdfast ; sometimes a conical fleshy mass of large size, densely clothed with curled, wool-like jointed hairs. *Fronds* of an olive-green or olive-brown colour, mostly becoming paler on exposure to the air ; of a membranaceous, flexible substance, rarely leathery or cartilaginous, and scarcely at all juicy : composed of two or more strata of cells, of which the inner ones are largest, usually empty, and either quadrate or appear so in profile. These large cells, seen through the smaller superficial and coloured cells which form the actual coating of the frond, give to its surface, when examined under a lens of moderate power, a netted appearance which is highly characteristic, and has suggested the name by which the Order is distinguished. In some, these internal cells form a regular honey-combed tissue of twelve-sided cells ; but in others they are cylindrical, arranged in longitudinal series or filaments which, however, cohere closely throughout their length, forming a membrane, and are not separable without laceration.

In external habit the plants of this Order exhibit considerable variety. In some of the humblest, the frond is an unbranched thread formed of numerous cells concentrically disposed round an imperfectly hollow axis. Then we have bag-like, simple fronds, as in *Asperococcus*, formed as it were by the inflation of such a thread, accompanied by the expansion of the walls into thin membranes. Next, in *Punctaria*, the bag becomes flattened into a nerveless leaf. In higher groups the tubular or flattened frond is divided into a branching stem, which, however, does not develope any separate leafy organs. In one case *(Haliseris)* this stem is winged throughout with membrane, or may be described as a midribbed branching frond. Among the most highly developed genera *(Zonaria* and *Padina)* the frond shows a tendency to assume a fan-shaped outline, having a definite, subcircular margin at the summit, and gradually widening from the base upwards. Such fronds are usually marked at regular intervals with concentric lines, and are formed of longitudinal rows of cells collaterally united in membranes ; the rows diverging as they grow, and new rows of cells being introduced in the interspaces. In many, and perhaps in all, the growing frond is clothed with exceedingly slender, jointed, and often colourless hairs, which sometimes, whilst expanded under water, decompose the rays of light, and cause the frond to display brilliant prismatic colours. These hairs are prolongations of the surface-cells, or issue from their sides, and are probably organs of the same kind as the pencilled fibres already noticed in the *Sporochnaceæ.*

The fructification exhibits considerable diversity of aspect in the various genera, but the characters are of minor value, chiefly relating to the form and position of the masses of fruit. In all, the *spores* are developed externally, either being formed from the surface-cells, which, when fertilized, stand out prominently from the ordinary cells; or from those cells immediately beneath the epidermis, in which case the spore-cell bursts through the external coat, carrying it outwards as a separated membrane. Usually each perispore contains but a single sporular mass, but in *Padina*, four spores are found at maturity in each perispore ; and in *Cutleria*, eight spores. In some genera the spores are scattered singly over the surface of the frond ; but in by far the greater number they are collected into definite spots, or *sori*, which are round, oblong, or linear, and are either dispersed irregularly over the whole surface, or confined to a certain part of it ; or else ranged in transverse, horizontal, or concentric bands. In some, both scattered and aggregated spores are found on the same individual, or on different individuals of the same species. In such cases, the scattered spores are usually of larger size and paler colour than the aggregated ones, and their contents appear to be different. They have sometimes been supposed to be *antheridia*, but have not, as yet, been examined with sufficient care. The spores in most cases are accompanied by barren, jointed hairs, or *paranemata*, which appear to be formed from the same parts as the fertile spores, but to have developed into numerous cells. In *Stilophora* these paranemata compose the greater part of the warts of fructification. In some of the more perfect forms, as in *Cutleria* and *Padina*, *antheridia* have been noticed ; these are sometimes found on the same individuals as the spores, and sometimes on different individuals.

This Order is of decidedly rare occurrence on the American coast, and scarcely attracts much notice, from the amount of individuals representing the species, until we proceed as far south as Florida, where, on the Keys, several kinds occur in such abundance as to be conspicuous among the ordinary shore plants. This increase in numbers to the southward is characteristic of the Dictyotaceæ in general. Very few are found in high latitudes, and they gradually become more numerous, and of higher type of structure, the nearer we approach the torrid zone. Those which occur in temperate waters show their propensity for warmth by growing in shallow tide-pools near high-water mark, where they can enjoy a warm bath for many hours of a summer's day. Thus *Padina Pavonia*, which, on the American shore, is not found farther north than the Florida Keys, in lat. 25°, where it inhabits a region extending below low-water mark, reaches the latitude of 51° on the south coast of England, its farthest observed northern limit; but there it is found only in warm pools near high-water mark, and in sheltered situations. This plant has a very wide distribution, being a native of all the warmer parts of the Atlantic, Pacific, and Indian Oceans, as well as one of the most abundant shore-plants in the Mediterranean. It is possible that more than one species may be confounded under this name, but no satisfactory diagnostic characters have yet been pointed out. *Dictyota dichotoma* is equally cosmopolitan, and has been noticed in the cold waters of the Antarctic Ocean, as well as on the shores of New Zealand, the Cape of Good Hope, and on the western coast of South America. Of the genus *Haliseris*, which is scarcely represented on the North American coasts, ten species are known, all of them tropical or sub-tropical; although one (*H. polypodioides*) extends far to the north, and has been traced from the Canary Islands (lat. 28°) along the Atlantic shores of Europe, as far as lat. 53° 45′ on the west of Ireland: and if the Tasmanian specimens and those reported from the Brazilian shores really belong to the same species, it has a nearly equal dispersion in the Southern Ocean.

None of the Dictyotaceæ are used in the arts.

SYNOPSIS OF THE NORTH AMERICAN GENERA.

* *Frond flat, dichotomous, traversed by a midrib.*

I. HALISERIS.

** *Frond flat, without midrib.*

† *Frond fan-shaped, vertically cleft.*

II. PADINA. *Sori* linear, concentric, bursting through the epidermis.

III. ZONARIA. *Sori* roundish, scattered.

IV. TAONIA. *Sori* linear, concentric, superficial, alternating with scattered solitary spores.

†† *Frond linear, dichotomous.*

V. DICTYOTA.

†† *Frond undivided.*

VIII. PUNCTARIA.

IX. SORANTHERA, Post. and Rupr. *(I do not see how this differs from Punctaria.)*

*** *Frond cylindrical, or bag-like.*
† *Branched.*

VI. STILOPHORA. *Sori* wart-like, composed of spores and moniliform threads.

VII. DICTYOSIPHON. *Spores* either solitary and scattered, or collected into dot-like sori.

† † *Unbranched, bag-like.*

X. ASPEROCOCCUS.

**** *Frond pierced with round holes, lace-like.*

XI. HYDROCLATHRUS.

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1. HALISERIS. *Tozzetti.*

Root coated with woolly hairs. *Frond* flat, linear, membranaceous, traversed by a cartilaginous midrib. *Spores* collected in naked *sori*, disposed in longitudinal lines at either side of the midrib, and rising from both surfaces of the membranous frond. *Paranemata* forming groups separate from the sporiferous sori.

This is the only genus in the Order in which the frond is traversed by a midrib; and one species (*H. Areschougia*, J. Ag.) is described as being nerveless. In most species the membranous border of the frond tears with ease in an oblique direction toward the midrib; so that it is rare to find specimens of full size in which the lower part of the fronds is not much jagged. The margin is either entire, or minutely denticulate, and is sometimes thicker than the rest of the membrane. In two species the midrib throws off lateral secondary nerves which traverse the frond toward the margin, ascending obliquely. Of the ten species known, four are American, four South African, one Australian and Indian, and one a native of the tropical and temperate regions of the Eastern Hemisphere. The name, derived ἁλς and σερις, is spelled *Halyseris* by Agardh, &c.

1. HALISERIS *delicatula*, Lamour.; frond delicately membranaceous, winged from the base, dichotomous; with very patent linear segments and rounded angles; the margin very entire, somewhat thickened. *J. Ag. Sp. Alg.* 1, *p.* 116. *Kütz. Sp. Alg. p.* 562. (TAB. VII. A.)

HAB. On the shores of Mexico, *J. Agardh.* (v. s. in Herb. T.C.D.)

Fronds densely tufted, three or four inches long, and from one to two lines in breadth, thrice or four times forked, the forkings an inch or more apart, widely spreading or divaricate, and somewhat flexuous. *Segments* linear, obtuse, with an entire, slightly thickened margin, distinctly marked by a depressed line, and formed of smaller and more vertical cells than the interior portion of the membrane. *Sori* minute, oblong, forming a line at each side of the midrib. *Substance* very thin and delicate, composed of oblong cells, ranged in series proceeding obliquely from the midrib to the margin. *Colour* very pale, greenish-olive. I have not seen Mexican specimens, and have taken this description and prepared the figure given, from specimens collected at Pernambuco, and presented by Dr. Areschoug, to the Herbarium of the University of Dublin.

PLATE VII. A. *Fig.* 1. Plant of HALISERIS *delicatula;* the *natural* size; *fig.* 2, a segment, slightly *magnified; fig.* 3, a small portion of the same, with a *sorus; fig.* 4, *spores:* both more or less highly *magnified.*

II. PADINA. *Adans.*

Root coated with woolly hairs. *Frond* flat, ribless, fan-shaped, marked at regular distances with concentric lines, and fringed with articulated hairs; the apex involute. *Fructification*, linear, concentric *sori*, formed beneath the cuticle of the upper surface of the frond, and bursting through it; and containing at maturity, numerous obovate, hyaline perispores fixed by their bases, each perispore enclosing four spores. *Paranemata* club-shaped, articulate, disposed in concentric lines alternating between the sori.

Four species of this genus are retained by Agardh, who admits the difficulty of distinguishing them by exact characters. All have very similar fronds, all inhabit the warmer parts of the sea, and *P. Pavonia* at least is subject, even in the same locality, to variations almost as great as those which have been fixed on by authors, as characteristics of the several supposed species. But if there be a difficulty in distinguishing these plants, supposing them to be really different in specific character one from another, there is none in recognising our common species among all other Algæ; for its form and substance are strikingly peculiar. Its fan-like shape, and its property of reflecting prismatic colours whilst growing under water, have won it the popular name of *Peacock's-tail.*

1. PADINA *Pavonia*, Lamour.; frond between membranaceous and coriaceous, broadly fan-shaped, entire or deeply and variously cleft, each lacinia being then fan-shaped, powdery on its outer surface; concentric lines numerous. *Harv. Phyc. Brit. t.* 91. *J. Ag. Sp. Alg.* 1, *p.* 113. *Zonaria Pavonia*, *Kütz. Phyc. Gen. t.* 22. *f.* 1. *Sp. Alg. p.* 565. *Ulva Pavonia*, *Linn. E. Bot. t.* 1276. (TAB. VII. B.)

HAB. On stones, &c. about low-water mark. Annual. Spring and early summer. Abundant on some of the Keys at Florida, as at Sand Key in February, *W. H. H.* Later in the season it appears at Key West, *Dr. Blodgett*, &c. Conch Key, *Prof. M. Tuomey*. (v. v.)

Root densely coated and cushioned with woolly hairs. *Fronds* tufted, from two to five or six inches in height, cuneate at the base, rapidly expanding into a broadly fan-shaped lamina, whose upper margin forms constantly a circular arc. This lamina, which is at first simple, is at length, as the plant advances in growth, cloven into numerous lobes, by splits arising in some point of the margin and proceeding downward toward the base: each lobe, at first cuneate, soon becomes, by the rapid lateral development of its arched margin, fan-shaped like the primary frond. The whole fronds of young plants, and the several laciniæ of older, are, when the plant is growing, rolled up in little conical or funnel-shaped cups. At distances of one or two lines, the frond is marked with concentric bands, more or less evident, according to age, along each of which is developed a fringe of extremely slender, orange coloured, jointed hairs. These hairs, which in young plants are found on every band, are limited on older specimens to the last formed bands, and at length disappear. The *margin* at the summit of the frond is always strongly rolled inwards; the outer or lower surface of the lamina is whitened with a variable quantity of chalky powder; the inner surface, except for the fringes of hairs, is smooth, olive-coloured, greenish towards the summit. The *sori* of fructification form concentric bands, alternating between the fringed bands. They are at first concealed beneath the surface-cells, but burst through in lines, raising the membranous skin of the frond, which then folds over them like the indusium of a fern. At maturity, the sorus consists of numerous obovate, hyaline perispores, fixed to a linear receptacle, each containing four sporules. *Paranemata*, club-shaped, articulated filaments, are found also in concentric bands, parallel to those which produce spores, and placed at short distances from them.

PLATE VII. B. *Fig.* 1. Plant of PADINA *Pavonia;* the *natural* size; *fig.* 2, part of the surface, showing portions of the band-like *sori* of *spores*, and of *paranemata* respectively; *fig.* 3, vertical section of the frond, showing *spores* in situ; *fig.* 4, *spores*, each containing four sporules in the *perispore ; fig.* 5, section through one of the concentric bands of paranemata ; *fig.* 6, *paranemata :* the latter figures more or less highly *magnified.*

III. ZONARIA, *Ag.*

Root coated with woolly hairs. *Frond* flat, ribless, coriaceo-membranaceous, flabelliform, entire or vertically cleft, the segments radiating ; the surface cellules disposed in distinct longitudinal lines flabellately radiating from the base. Concentric lines indistinct. *Fructification* roundish or linear *sori*, formed beneath the cuticle of the frond, and bursting through at either surface ; and composed at maturity, of *spores* furnished with hyaline perispores, and of *paranemata* which are mixed with the perispores. *Paranemata* club-shaped, articulated, numerous.

In the more or less fan-shaped frond this genus approaches *Padina*, but differs in the more opaque substance, only obscurely marked with concentric zones ; and in the fructification, which is not disposed in regular, concentric lines. Here, too, the spores and paranemata occupy the same sorus, while in *Padina* they are separated. Under a pocket lens the surface appears to be finely striated longitudinally, an appearance caused by the disposition of the superficial cellules, which are ranged in lines proceeding from the base, slightly diverging one from another, and admitting the introduction of new series of cells between each original row, as the frond advances in growth. From this peculiarity results the fan-like form of the mature frond.

Ten or twelve species of this genus, from various parts of the world, are known to botanists. All are natives of the warmer parts of the sea, with the exception of *Z. parvula*, which by some authors is rejected from the genus.

1. ZONARIA *lobata*, Ag. ; frond erect, coated with woolly hairs at the base only, membranaceo-coriaceous, broadly flabelliform, at first with a nearly entire margin, then palmately cloven, or divided nearly to the base ; laciniæ eventually elongate, wedge-shaped, simple or again divided, concentrically zoned ; sori linear, formed along the concentric lines. *J. Ag. Sp. Alg. vol.* 1, *p.* 109. *Stypopodium fuliginosum, Kütz. Sp. Alg. p.* 663. (TAB. VII. C.)

HAB. On stones about low-water mark. Annual ? Keys of Florida : abundant at Sand Key in February ; and sparingly, at the same season, at Key West, *W. H. H.* Sand Key, *Prof. M. Tuomey.* (v. v.).

Root clothed with entangled and curled woolly hairs, which extend a short way from the base, covering from half an inch to an inch square of the lower part of the frond. The frond, which eventually becomes a foot or more in length and divided nearly to the base into many narrow lobes, originates in a sessile or nearly sessile, broadly reniform, membranaceo-coriaceous lamina. This lamina has at first a circumscribed margin, forming a somewhat cycloidal curve, and is nearly undivided. When it attains an inch or two in height, vertical slits, commencing in the margin, extend downwards, dividing it in a pedate or palmate manner, into a great number of narrow, wedge-shaped laciniæ, placed side by side in digitate order. These, as they grow, become flabellate above, from the divergence of the rows of cells of which they are composed, and are again cleft and re-cleft, until often the originally reniform leaf becomes a bunch of narrow ribbons growing from a central point. In all these changes the apical margin remains truncate, and circumscribed by a curved line. It is perfectly flat, not inrolled. Radiating striæ, or inequalities in texture, proceeding from the base upwards towards each lobe, are more or less obvious in various specimens; and faint concentric lines, paler than the rest of the frond, are seen here and there crossing the lobes, at distances of a quarter to half an inch. These are more evident on older and more divided specimens, though they occur on the upper or newer portions of their fronds. The radiating longitudinal bands or striæ are sometimes very faint, and sometimes strongly marked. I have not seen *fructification* on any specimen collected at Sand Key.* The colour when growing is a dark olive, reflecting prismatic colours, chiefly vivid greens and blues, from the striated surface. In fresh water a good deal of dark colouring matter is given out; yet in drying the frond becomes exceedingly dark. In this state it adheres, but not very strongly, to paper, and shrinks very considerably.

Not having seen authentically named specimens of *Zonaria variegata*, Ag., it would be rash to say that that species may be only an undeveloped or small state of the present. Some of my Sand Key specimens are so remarkably striated, or marked with darker and paler longitudinal bands, and others so obscurely banded, and there are such insensible gradations between the banded and unbanded individuals, that I fear a character derived from these bands will not stand good. If *Z. variegata*, then, be distinguishable from our *Z. lobata*, it will probably be by a character taken from the different form of the sori, which are said to be "elliptical and scattered" in that species.

PLATE VII. C. *Fig.* 1, plant of ZONARIA *lobata*; the *natural* size: *fig.* 2, small portion of the summit of a segment, *magnified*, to show the surface cellules.

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* The *sori*, on West Indian specimens, form dark lines at both sides of the pale, concentric band; but, besides these linear sori, others of irregular form are scattered between the bands.

IV. TAONIA, *J. Ag.*

Root coated with woolly hairs. *Frond* flat, ribless, vaguely cleft, reticulated ; the surface-cellules equally distant, in the apices of the laciniæ in parallel or subdivergent series. Concentric lines more or less evident. *Fructification* : linear, wavy, concentric, superficial *sori*, on both surfaces of the frond, destitute of indusium, and consisting of *spores*, furnished with hyaline perispores, and unaccompanied by paranemata.

This genus is formed for the reception of the old *Ulva atomaria*, Good. and Woodw., which has been variously referred to *Zonaria*, *Dictyota*, and *Padina*. To this typical species, whose character is chiefly embodied in the above generic diagnosis, Prof. Agardh has added, doubtfully, two other species, one of which falls within our limits. Perhaps it would have been better to have retained Kützing's genus, *Spatoglossum*, for these two, whose relation to *T. Atomaria* is rather doubtful.

1. Taonia? *Schrœderi*, J. Ag. ; frond decompoundly cleft, irregularly dichotomous ; laciniæ broadly linear, toothed above, and bordered with marginal processes or lobules ; "antheridia ? scattered over the whole surface," (fructification unknown). *J. Ag. Sp. Alg. vol.* 1, *p.* 102. *Dictyota Schroederi, Kütz. Sp. Alg. p.* 566. *Aresch. Ic. t.* 9. *Ulva Schroederi, Mart. Fl. Braz. p.* 21, *Ic. Select.* 1, *t.* 2, *f.* 3.

Hab. At Vera Cruz, Mexico, *Liebman!* (v. s. in Herb. T.C.D.)

Frond rising from a shaggy base, ten to twelve inches in length, somewhat fan-shaped in the general outline of its laciniæ, irregularly dichotomous ; the principal laciniæ from half to three-quarters inch in breadth, the upper ones gradually narrower. In the lower part of the principal laciniæ the margin is either entire or obscurely denticulate ; in the upper half it is either strongly toothed, or the teeth lengthen out into linear or subulate, simple or slightly compound lobules. Sometimes the margin is flat, sometimes undulated or even curled. The apices are often irregularly jagged. The sinuses between the laciniæ are rounded, and the laciniæ themselves diverge at wide angles. The substance is thin and membranous, shrinking much in drying ; and the colour is a brownish or a greenish olive. No fructification has yet been observed, but the frond is commonly dotted over with minute, dark, prominent cells, which Agardh supposes may contain antheridia.

V. DICTYOTA. *Lamour.*

Root coated with woolly hairs. *Frond* flat, ribless, membranaceous, dichotomous or sub-pinnatifid, reticulated; the surface cellules minute, equidistant, converging at the ends of the laciniæ and ending in a single cellule. Concentric lines none. *Fructification*; roundish, scattered *sori*, bursting through the cuticle of both surfaces of the frond, consisting at maturity of numerous obovate, tufted *spores*, with hyaline perispores. *Paranemata* in sori distinct from those containing spores, clavate, articulate, filled with grumous matter.

This genus, as recently reformed by Prof. J. Agardh, is easily known from any of the preceding by the mode of development of the frond, each of whose laciniæ is seen to terminate in a single cellule, by the constant division of which at its lower side the other cells of the frond are formed, the terminal cell being thus continually pushed onwards. From this mode of growth it results that the longitudinal lines of superficial cells, which in the flabellate genera already described diverge from one another, in this converge: thus affording a ready method of ascertaining the genus in default of fructification.

1. Dictyota *Fasciola*, Lamour. (?); fronds densely tufted, very narrow, membranaceous, linear, many times dichotomous; axils obtuse; laciniæ patent, very entire; apices acute; sori forming a medial line, and often accompanied by filiform processes. *J. Ag. Sp. Alg.* 1, *p.* 89. *Kütz. Sp. Alg. p.* 555. *Roth. Cat. Bot. vol.* 1, *p.* 7, *f.* 1. *Esp. Fuc. t.* 44. (?). (Tab. VIII. B.)

Hab. On rocks and stones, and corals near low-water mark. Annual. Abundant on the Florida Keys. Key West, Feb., *W. H. H.* (v. v.)

Fronds forming large and dense tufts, matted together at the base, six to ten inches in length, scarcely a line in breadth, of nearly equal breadth from the base to the apex, many times dichotomous. The axils are conspicuously rounded and the laciniæ thus diverge one from another, particularly the upper ones. Sometimes the forking proceeds with equal arms throughout the tuft, and then the plant forms round, fastigiate masses, the individual fronds not having any leading stem. In other specimens one arm of the fork, at alternate sides of the growing branch, is constantly shorter than the other; thus a frond with leading stems, bordered with short, simple or forked laciniæ, is formed. The substance of the frond is membranaceous, thickish and subopaque below; the surface cells are about four times as long as broad; and the largish, hexagonal cells of the interior of the frond may be seen through the exterior cells in the younger parts at least. The apices are more or less acute, but not acuminate. The sori are disposed in a line through the centre of the lamina. Those formed of *paranemata* are most abundant in my specimens, between which scattered spores are often found. In very many specimens the position of the sori is occupied by a line of proliferous papillæ or cilia of greater or less length.

I have some doubts whether I am correct in referring the Florida plant to *D. Fasciola*, Lam., to which, if it be different, it approaches very closely. I have compared it with Mediterranean specimens, but not with very well preserved or sufficiently developed ones ; and the agreement in most respects is very great. But there is considerable difference in aspect among the Key West specimens, so much that at first I referred them to two species, in one of which the frond is fastigiate, and regularly dichotomous ; in the other, having more virgate branches, pinnatifido-dichotomous. On comparison of a great number of specimens, I do not find this difference in branching sufficiently constant. The figures of Roth and Esper, quoted above, are very rude. The present species is what was formerly doubtfully referred, on my authority, to *D. linearis*, *Ag.*, and published by Prof. J. W. Bailey, as such, in his list of North American Algæ.

PLATE VIII. B. *Fig.* 1, Plant of DICTYOTA *Fasciola* ; the *natural* size ; *fig.* 2, portion of a segment, with *spores*, and tufts of *antheridia ; fig.* 3, portion of a similar segment with papillæ ; both *magnified ; fig.* 4, small portion of a segment, with scattered *spores* and tufts of *paranemata ;* showing also the surface cellules, and the lines defining the large internal cells ; highly *magnified.*

2. DICTYOTA *dichotoma*, Lamour.; frond repeatedly dichotomous, broadly-linear, (1—4 lines broad) membranaceous ; the axils narrow and subacute ; laciniæ erecto-patent, gradually narrower towards the extremities ; the margin entire ; the apices obtuse or emarginato-crenate ; sori and scattered spores dispersed over the medial region of the segments, leaving an unoccupied space within each margin. *J. Ag. Sp. Alg. vol.* 1, *p.* 92. *Harv. Phyc. Brit. t.* 103. *Ulva dichotoma, Huds.—E. Bot. t.* 774. *Dictyota vulgaris, and D. dichotoma, Kütz. Sp. Alg. p.* 553, 554. *Dichophyllum, Kütz. Phyc. Gen. p.* 337.

HAB. On stones and sea plants in tide pools. Rare. At Charleston, growing on old submerged wood-work at Sullivan's Island, *Prof. Lewis R. Gibbes,* Key West, *W. H. H.* (v. v.)

Fronds tufted, but not very densely clustered, from three to six inches long or more, varying much in breadth ; ordinarily three or four lines in breadth, but sometimes much narrower and occasionally wider, several times dichotomous ; the segments at each successive forking becoming narrower. In some varieties, the ultimate segments are very narrow and constantly spirally twisted ; in the ordinary forms they are flat, and not much narrower than the lower ones. The axils are narrower than in the preceding species and the segments less widely spreading ; and the apices are decidedly obtuse. The substance is thin and membranous, semi-transparent, and the areolations visible with a moderately powerful pocket lens; they vary in shape and in size in different parts of the membrane, and I fear scarcely afford a satisfactory specific character. I have not seen *fruit* on American specimens. On the European plant two sorts of fruit have been noticed, on different individuals: first, oval clusters of spores, covered at first by a common vesicular membrane; each spore when ripe containing four sporules in a hyaline perispore; second, solitary, roundish, simple spores scattered over the surface. The colour is olivaceous, sometimes greenish and sometimes brownish.

3. Dictyota *ciliata*, J. Ag.; frond woolly at the base, repeatedly dichotomous, broadly linear, membranaceous; the axils rounded; laciniæ patent, linear, gradually narrower towards the extremities; the margin ciliate, with distant, awl-shaped, slender teeth; the apices obtuse; spores forming minute sori scattered over the middle region of the lamina, leaving an unoccupied space within each margin. *J. Ag. Symb.* 1. *p.* 5. *Sp. Alg. vol.* 1. *p.* 93. *Kütz. Sp. Alg. p.* 556. (Tab. VIII. A.)

Hab. On Algæ and corals near low-water mark. Florida Keys, abundant at Key West, *Dr. Wurdemann*, *Dr. Blodgett*, *W. H. H.*, *&c.* (v. v.).

Root and lower part of the frond coated with curled, woolly hairs. *Fronds* densely tufted, six to eight or ten inches in length, from an eighth to a quarter-inch in breadth, many times dichotomous; the laciniæ gradually narrower in the upper dichotomies, ciliated at intervals of a few lines with slender, subulate, tooth-like processes. These are more abundant in some specimens than in others. The axils are rounded; the lower ones spread widely and the upper are gradually narrower. The apices are subacute, or blunted. The *sori* consist of a few spores, irregularly grouped together, and scattered over three-fourths of the surface of the laciniæ, leaving a narrow unoccupied portion down each margin. Sometimes the frond is pitted, (as shown at fig. 4,) the pits apparently caused by the falling off of the sori, carrying with them the surface cells. The colour is a clear brown olive, greener toward the tops; and the substance is membranaceous, shrinking in drying. Readily known, in most cases, by the ciliate margins; but sometimes nearly entire, in which case it may be mistaken for *D. dichotoma.*

Plate VIII. A. *Fig.* 1. Plant of Dictyota *ciliata;* the *natural* size; *fig.* 2, part of a segment, with sori, and *fig.* 3, part of a segment from which the *spores* have fallen, leaving pits; both *magnified; fig.* 4, small portion of the surface, with *sorus*, showing the small surface cellules, and the lines defining the large internal cells: highly *magnified.*

4. Dictyota *Bartayresiana*, Lamour.; frond scarcely woolly at the base, repeatedly dichotomous, linear, coriaceo-membranaceous, very entire; the axils rounded;

laciniæ spreading, especially the upper ones; apices divaricate, the younger ones sharply bifid, each lobe acuminate; spores forming minute sori scattered over the whole surface of the lamina.—*J. Ag. Sp. Alg. vol.* 1, *p.* 94. *Kütz. Sp. Alg. p.* 554. (TAB. VIII. C.)

HAB. Tropical. Coast of Mexico, at Vera Cruz, *Liebman!* (v. s. in Herb. T.C.D.).

Frond three or four inches long, one or two lines in diameter, of nearly equal breadth throughout, many times dichotomously divided, with rounded axils and spreading segments. The uppermost divisions are more or less divaricated. The margin is entire and flat. The young apices are sharply notched or bifid; each notch deltoid-acuminate, ending in a sharp point. The *sori* are minute and densely dotted over the whole surface. In our specimen they have fallen away, leaving cavities in their place. The substance of the frond is thickish, somewhat coriaceous, and the structure is denser than in some other species. The surface cellules are minute; the areolations beneath them not much longer than their breadth. In drying, this plant does not adhere to paper. Known by its sharply bifid apices from any state of *D. fasciola* or *D. dichotoma.* Distinguished from *D. acutiloba* by the widely scattered fructification.

PLATE VIII. C. *Fig.* 1, Plant of DICTYOTA *Bartayresiana;* the *natural* size; *fig.* 2, apex of a segment, *magnified; fig.* 3, extremity of the same, with depressions from which *sori* have fallen, and showing the surface cellules and internal cells; highly *magnified.*

5. DICTYOTA *crenulata*, J. Ag.; frond woolly at the base, repeatedly dichotomous, coriaceo-membranaceous, with patent, but not very blunt axils; laciniæ linear, undulate; the margin eroso-dentate, the toothlets close together and of unequal size; apices very blunt, lingulate; sori at length occupying the whole surface. *J. Ag. Sp. Alg. vol.* 1, *p.* 94. *Kütz. Sp. Alg. p.* 558.

HAB. Tropical. At St. Augustin, on the Pacific coast of the Mexican Republic, *Liebman!* (v. s. in Herb. T. C. D.).

Fronds tufted, 2—4 inches high, about one and half or two lines in breadth, gradually wider from the base upwards, many times closely dichotomous; the segments spreading, the whole frond having a fan-like outline. The sinuses betwen the laciniæ are rounded, though not conspicuously so, and the upper ones are rather narrow. The margin is undulated, and closely eroso-denticulate, or jagged with unequal, deltoid, or subulate, tooth-like processes. The apices are rather wider than the portions below them, and so blunt as to be almost truncate. The young ones are obtusely emarginate. The sori are small, at first forming patches here and there, but eventually occupying the whole superficies. The dentation of the margin is of the same nature as that of *D. ciliata*, but the teeth are very much closer and more irregular in form than in that species.

VI. STILOPHORA. *J. Ag.*

Root a small, naked disc. *Frond* cylindrical, branched, solid, or imperfectly tubular; composed of two strata of cells, the inner stratum of many rows of colourless cells, of which those nearest the centre become ruptured in age, leaving a cavity traversing the frond; the outer stratum of one or two rows of minute, coloured cells. *Fructification*, convex, wart-like *sori*, scattered over the branches, composed of obovate *spores*, nestling among moniliform, simple, densely packed *paranemata*.

The frond is described by Agardh as being at first tubular, but gradually becoming solid with advancing age. The contrary of this structure has always appeared to me to be the case, the older parts being more empty than the younger.

1. STILOPHORA *rhizodes*, J. Ag.; frond subsolid, much and irregularly branched, subdichotomous; the apices scarcely attenuate, acute; ramuli scattered, forked; sori densely covering the branches and ramuli. *J. Ag. Sp. Alg. vol.* 1, *p.* 85. *Harv. Phyc. Brit. t.* 70. *Spermatochnus rhizodes*, *Kütz. Sp. Alg. p.* 549. (TAB. IX. B.).

HAB. Near low-water mark, on other Algæ in tide pools. Rare. Newhaven, *Dr. Durkee.* Greenport, Long Island, *W. H. H.* Oyster Bay, N. Y. *Mr. Walters.* (v. v.)

Frond, in the American specimens, from four to five inches long, as thick as hog's bristle, much branched, irregularly dichotomous, with rounded axils. Branches flexuous, variously divided, furnished with a few lateral ramuli which are either simple or forked above their middle. The apices are acute, but not much tapered. The whole frond, in fertile specimens, is densely covered with the prominent, wart-like fructification; each wart composed of a great many moniliform vertical filaments, packed together. Among these the obovate spores are found lying, being attached to the bases of the filaments. The colour is a greenish olive; and the substance cartilaginous and elastic when fresh, but soon becoming soft and gelatinous, and in drying the branches shrink considerably and adhere strongly to paper.

Plate IX. B. *Fig.* 1. Frond of Stilophora *rhizodes*, the *natural* size ; *fig.* 2, a small portion of a branch, with its wart-like sori, *magnified ; fig.* 3, section of a sorus, and of a portion of the frond ; *fig.* 4, a *spore* and *paranema ;* the latter figures highly *magnified.*

2. Stilophora *papillosa*, J. Ag. (?) ; frond cylindrical, many times dichotomous, with very patent angles and divaricating, attenuated apices ; the dichotomous branches and their lesser divisions clothed with very many slender horizontal, hair-like ramuli. *J. Ag. Sp. Alg. vol.* 1, *p.* 84. (?)

Hab. Chesapeake Bay, *Prof. J. W. Bailey.* (v. s.).

I am not satisfied that the plant from the Chesapeake, which I introduce more on my friend Prof. Bailey's authority than my own, is the same as the Mediterranean species described by Agardh; nor, indeed, am I quite certain that it belongs to this genus. I have examined one of the original specimens, presented to me by Prof. Bailey, and had intended figuring it, but have not been able to make out the microscopical characters to my satisfaction. The above specific diagnosis applies very well to the specimen. But Meneghini's figure, (*Alg. Ital. t.* 3, *f.* 2,) quoted by Agardh for his species, is very unlike our plant. I have seen no authentic example of the Mediterranean *S. papillosa*, and thus am unable fully to decide on the identity of the American ; and, in this uncertainty, think it better to place the species on record, in the hope that future observation may clear the subject in one way or other. My specimen is about four inches square in the spread of the branches, and it scarcely adheres to the paper on which it has been dried.

VII. DICTYOSIPHON. *Grev.*

Root a small, naked disc. *Frond* filiform, tubular, much branched ; its walls composed of several rows of cells, of which the inner are elongated, and connected into longitudinal filamentous series ; the outer or superficial small, coloured, polygonal, forming a membrane. *Fructification :* solitary or aggregated, naked *spores*, scattered irregularly over the surface.

When young the frond is solid, but the cells forming the axis, which are of larger size than the rest, are also weaker and soon perish, leaving the stem and branches fistular. In a growing state every branch is clothed with long, slender, pellucid, jointed hairs, which give the plant, when seen under water, a beautifully feathery character. Similar hairs are seen on many others of the Order, and are doubtless connected with the development of the frond. The walls are composed of many rows of elongated cells, disposed longitudinally and firmly united into a compact cellular substance. The innermost of these are very long, the outer proportionably shorter. All, except those that compose the outermost row or circle, are colourless, and nearly empty.

1. DICTYOSIPHON *fœniculaceus*, Grev. ; frond setaceous, very much branched ; the branches capillary, decompound ; ramuli subulate, alternate or scattered, rarely opposite.—*J. Ag. Sp. Alg. vol.* 1, *p.* 82. *Kütz. Sp. Alg. p.* 485. *Harv. Phyc. Brit. t.* 326.

HAB. In rock pools, between tide-marks on stones and the smaller Algæ. Sea shores from New Brunswick to Long Island Sound. Prince Edward's Island, *Dr. Jeans.* Halifax, *W. H. H.* Boston Bay, *G. B. Emerson* and *Mrs. Asa Gray, &c.*, Rhode Island, *Mr. Geo. Hunt*, *Mr. Olney*, *&c.* Arctic Coast, *Mr. Seeman.* (v. v.)

Fronds from six inches to one or two feet long, about as thick, or sometimes twice as thick, as hog's-bristle, much branched and bushy ; usually having an undivided stem, set with many lateral branches, which are furnished with one or two series of lesser branches, also lateral, and very unequally and irregularly placed. *Primary* branches as long as the leading stem, or longer, very numerous. The spores are plentifully scattered over the branches, and are usually solitary. *Colour* a greenish or a brownish olive. *Substance* membranous, soft, but not gelatinous, adhering to paper in drying.

VIII. PUNCTARIA. *Grev.*

Root a small naked disc. *Frond* flat, ribless, membranaceous, undivided. *Fructification*, minute, dot-like *sori*, scattered over the whole surface, and containing roundish, sessile *spores*, accompanied by a few short, club-shaped, jointed *paranemata.*

The species comprising this group have the leaf-like habit of the smaller Laminariæ, such as *L. Fascia ;* or of the restricted genus *Ulva*, in which, by the older botanists, they would all have been placed. From Laminariæ they differ in being of a more reticulated structure, formed of larger cellules, and in the very different fructification ; and from the Ulvæ in colour as well as structure. To the genus *Asperococcus*, which immediately follows in order, *Punctaria* is very closely related, and only to be distinguished by the flattened, not tubular frond. But in *Asp. compressus* we find a strictly intermediate form, nearly as flat as a *Punctaria*, but evidently composed of two separable membranes.

1. PUNCTARIA *tenuissima*, Grev.; frond very thin, linear or linear-lanceolate, much attenuated to base and apex, flat or undulated. *Grev. Alg. Brit.* (1830) *p.* 54. *Harv. Phyc. Brit. t.* 248. *Punctaria undulata, J. Ag. Sp. Alg. vol.* 1, *p.* 72. *Diplostromium tenuissimum et D. undulatum, Kütz. Sp. Alg. p.* 483.

HAB. Parasitical on various Algæ near low-water mark; as *Zostera marina, Chorda filum, &c.* Annual. Spring and Summer.—Halifax, *W. H. H.* Boston Harbour, *G. B. Emerson.* Little Compton, R. I., *Mr. Olney, and Prof. J. W. Bailey.* Fort Hamilton, N. Y., *Mr. Hooper, &c., W. H. H.* (v. v.)

This forms dense tufts extending for several inches along the leaves of the *Zostera* or the fronds of the *Chorda* on which they grow. The *fronds* are from two to eight or ten inches in length, and from a line to four or five lines in width, broadest in the middle, and tapering to both extremities. Some specimens are nearly linear throughout, except at the base or apex where they fine off; but others are strictly lanceolate, very much attenuated from the middle towards the apex and the base. The margin in the young plant is quite flat; and often remotely, but irregularly denticulate. In older specimens the frond is undulated, or crisped and often twisted spirally. The membrane is very thin, semitransparent, and delicate; and the colour which is at first a pale greenish olive, becomes brownish or rather horn-colour in old plants. The fructification has not been observed.

I retain Dr. Greville's name for this plant, as being of earlier date than that assigned by Prof. J. Agardh; who rejects Dr. Greville's epithet from grounds which appear to me to be insufficient. The *Zonaria tenuissima* of the elder Agardh, which Dr. Greville takes as the type of his species, appears to have been founded (*Sp. Alg.* 1. *p.* 138, *and Syst. Alg. p.* 268) on *Ulva plantaginifolia var. tenuior, Lyngb. Hyd. Dan., p.* 31, *t. b.;* and from Lyngbye's figure and description there can be little doubt that Lyngbye's and Greville's plants were identical in species. Nay, this is admitted by Prof. J. Agardh, who quotes both these authors under his *P. undulata;* but for some cause which I do not understand, he at the same time refers the synonym, "*Zonaria tenuissima, Ag.*" to *Laminaria Fascia.* Yet, on referring to the Syst. Alg. where that name was first published, and from which Dr. Greville adopted it, we find the only synonym quoted is "*Ulva plantaginea var. tenuior, Lyngb. t. b.*" but with a mark of doubt. On referring back to Agardh's earlier work, the Sp. Alg. this same synonym is quoted without any doubt as the authority for Agardh's "*Zonaria plantaginea var. tenuior,*" which is evidently the type of the subsequent "*Z. tenuissima.*" Whether Agardh confounded young *Laminaria Fascia* also under this name is not to the point, as it is evident from his description and quotation that he intended by the name "*tenuissima,*" the "*U. plantaginifolia var. tenuior*" of Lyngbye; and that is also the plant intended by Dr. Greville, and here described. I see no reason therefore for changing the older and very appropriate specific name into "*undulata.*"

2. PUNCTARIA *plantaginea*, Grev.; frond dark brown, coriaceo-membranaceous,

obovate, much attenuated at the base. *Harv. Phyc. Brit. t.* 228. *J. Ag. Sp. Alg. vol.* 1, *p.* 73. *Phycolapathum plantagineum, Kütz. Sp. Alg. p.* 483.

HAB. On stones and Algæ between tide-marks. Annual. Summer. Prince Edward's Island, *Dr. Jeans.* Boston Harbour, *G. B. Emerson, Esq.* (v. v.)

Tufted. *Fronds* from 6 to 12 inches long, an inch to an inch and half in breadth in the widest part, generally blunt, obovate or cuneate, tapering considerably to the base from near the middle of the membrane. The substance is thicker and more coriaceous than in *P. latifolia* and the colour always darker. But specimens occur which are almost intermediate in character between the two. There is also danger of confounding *P. plantaginea* with *Laminaria Fascia*, which has a very similar appearance.

PUNCTARIA *latifolia*, Grev.; frond pale olive green, thickish, membranaceous, soft and tender, oblong or obovate, suddenly tapering at the base. *Harv. Phyc. Brit., t.* 8. *J. Ag. Sp. Alg. vol.* 1, *p.* 73. *Phycolapathum debile, Kütz. Sp. Alg.* 483.

HAB. On stones and Algæ between tide-marks. Annual. Summer. Halifax, *W. H. H.* Boston Harbour, *G. B. Emerson.* Flushing Bay, Long Island, *Prof. J. W. Bailey and Mr. Hooper.* Fort Hamilton, N. Y. *Mr. Hooper*, &c. (v. v.)

Tufted. *Fronds* eight to twelve inches long, and from one to three inches wide in the broadest part, oblong or obovate, or somewhat ovate, generally obtuse, and suddenly tapering at the base into a short cuneate stem, a line or two in length. The margin is undulate, sometimes much crisped and curled. The substance is thin, membranaceous, soft, and almost gelatinous to the touch when young, at which time it is clothed with pellucid hairs; afterwards it is more rigid, and at length so coarse that it will not adhere to paper when drying. The colour, when young, is an extremely pale olive, inclining to green, and specimens are often found that retain this colour at their full size, but now and then others accompany them in which the colour is much darker. These approach *P. plantaginea*, and are then only to be known by the less tapering base. I retain the three species as published by Greville, though I admit that it is sometimes difficult to distinguish between them in every case. There are *three* principal typical forms, and a number of intermediate links. The present is much the commonest on the American shore, and after it that called *P. tenuissima.* I shall not be surprised if future botanists, when the rage for species-making has exhausted itself, and the tide sets in an opposite direction, shall re-unite these three under the old name *plantaginea.*

IX. SORANTHERA, *Post. and Rupr.*

"*Frond* membranaceous, olive-green, simple, flat, dilated, entire. *Fructification : Antheridia* pear-shaped, vaginate, mixed with club-shaped jointed threads, and aggregated in roundish sori scattered over the whole frond."

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1. SORANTHERA *ulvoidea*, Post. and Rupr. Illustr. p. 19. *J. Ag. Sp. Alg. vol.* 1, *p.* 120. *Kütz. Sp. Alg. p.* 556.

HAB. Island of Sitcha, Russian America, parasitical on *Rhodomela larix. (Postells and Ruprecht).*

"Lamina membranaceous, olive-green, sub-rotund, plaited, in the two specimens seen not more than an inch in breadth ; the margin very entire, not thickened, nor distinctly revolute. The whole lamina so densely covered with roundish tubercles, a quarter of a line in diameter, and prominent on both surfaces, that scarcely any intersticial spaces of more than a line in breadth remain sterile. The tubercles are composed of an assemblage of heterogeneous antheridia, and considered as sori ; in the dry state they collapse and become harder and brown. The dried lamina is thinly membranous, scarcely loses colour, and does not adhere to paper."—*Post. and Rupr.* Of this plant I know nothing. It seems, to judge by the above description, to be related to *Punctaria*, if distinguishable from that genus.

X. ASPEROCOCCUS, *Lamour.*

Root a small, naked disc. *Frond* tubular, cylindrical or inflated, rarely compressed, membranaceous, unbranched and inarticulate. *Fructification* minute, dot-like *sori*, scattered over the whole surface, and containing roundish, sessile *spores*, accompanied by a few short, club-shaped, jointed paranemata.

This genus differs from *Punctaria* in having a tubular or inflated, instead of a flat frond. *Asperococcus sinuosus* departs in habit from the typical species, but seems to be identical in structure or nearly so. *A. clathratus* of authors is, in my opinion, sui generis.

1. ASPEROCOCCUS *echinatus*, Grev. ; frond cylindrical, club-shaped, obtuse, much attenuated at the base. *Harv. Phyc. Brit. t.* 194. *Grev. Crypt. Fl. t.* 290. *J. Ag. Sp. Alg. vol.* 1. *p.* 76. *Encœlium echinatum, Ag.—Kütz. Sp. Alg. p.* 552.

HAB. Rocks, &c. between tide-marks. Annual. Boston Bay, *G. B. Emerson* (fide Prof. J. W. Bailey.) (v. v.)

Very variable in size. *Fronds* from a few inches to two feet in length, and from the thickness of hog's-bristle to half an inch in diameter, linear-club-shaped, tapering to the base. The apex is either obtuse, or somewhat attenuated. The dots of fructification are crowded, and often entirely cover the surface.

I have not seen American specimens, but give this species on the authority of my friend Prof. Bailey, merely remarking that *Chorda lomentaria* is often mistaken for it, and has been sent to me from America for the Asperococcus. The true *A. echinatus* is however so common in the Northern Atlantic, that it is most probably to be found on many parts of the American coast. It may be known from *Ch. lomentaria* by being never constricted into joints.

2. ASPEROCOCCUS *sinuosus*, Bory ; fronds globose, or irregular, heaped together, sessile, inflated, at length irregularly distorted and torn. *J. Ag. Sp. Alg. vol.* 1. *p.* 75. *Encœlium sinuosum, Ag.—Kütz. Sp. Alg. p.* 552. (TAB. IX. C.)

HAB. On rocks, corals and Algæ between tide-marks. On the Florida Keys. Very abundant at Sand Key, and washed ashore at Key West, *W. H. H.* (v. v.)

Fronds growing in dense clusters which cover spaces of many inches or some feet square. Each individual frond is globose, one or two inches in diameter, or larger, becoming much inflated and irregular in outline as it advances in age, and is then often ruptured, and pierced here and there with holes of irregular shape and size. The frond is membranous, thin, soft, but not very tender, having a reticulated appearance, from the large interior cells composing the inner lining of the membrane ; and with a smooth uniform surface, from the minute cells which compose the superficial coating : it thus follows that with lenses of different powers the frond appears either areolated or of densely cellular structure. Such *fructification* (?) as I have seen consists in minute *sori*, dotting over the surface, and composed of linear, moniliform *paranemata*, formed at first under the membranous coating of the frond, and bursting through it :—but I have not detected any *spores*. *Colour* a brownish olive.

In habit this plant strongly resembles *Leathesia tuberiformis* (common on the shores of the Northern States) but is of a totally different structure, and can only be confounded with that plant through carelessness or inattention

PLATE IX. C. *Fig.* 1. Cluster of ASPEROCOCCUS *sinuosus* ; the *natural* size ; *fig.* 2, a minute portion of the surface ; *fig.* 3, vertical section of a sorus ; *fig.* 4, *paranemata* from the same ; the latter figures highly *magnified.*

SPECIES OF DOUBTFUL AFFINITY.

3. Asperococcus *intricatus*, J. Ag., "frond tubular, branched, sub-hemispherically expanded, subrepent; branches intricate, gradually attenuated, decompound-dichotomous; the apices forked." *J. Ag. Sp. Alg. vol.* 1, *p.* 77.

Hab. Tropical. At Vera Cruz, Mexico. (*Liebman*).

I am not acquainted with this plant, which scarcely seems to fall naturally under this genus.

XI. HYDROCLATHRUS, *Bory.*

Frond membranaceous, convex, hemispherical, bag-shaped, regularly pierced with orbicular holes, which gradually dilate more and more, until the plant becomes a clathrate net, eventually mishapen and ruptured. *Margin* of the apertures involute. "Spores minute, globose, collected into dot-like, scattered, innate *sori*, accompanied by club-shaped, jointed filaments." (*Mont.*)

This is a very remarkable plant, and of so peculiar a habit, as well as distinct structure, that I can hardly imagine any person who has had an opportunity of seeing it alive on its native rocks, placing it in the same genus with *Asperococcus sinuosus;* although my valued friend Prof. J. Agardh even doubts its specific diversity from that species. I must suppose that Prof. Agardh has formed his judgment from an examination of dried specimens, which are so wholly unlike the living plant in appearance, and can be so imperfectly examined when remoistened, that a satisfactory opinion can scarcely be formed from them. I regret that the microscope which I had with me at Key West was not of sufficient power to enable me to make out the anatomical structure perfectly, and the plant decomposed so rapidly that it was difficult to obtain good slices of the membrane sufficiently thin for examination. When fresh from the sea, the frond was quite crisp, and could readily have been cut, but my specimens (collected at Sand Key) had to be brought a long way in an open boat, under a hot sun; and although every care was taken to keep them cool, and though they were brought in buckets of water, decomposition had commenced long before they reached Key West, and then, in the attempt to save from destruction a large gathering of other Algæ, the fruit of the same excursion, only very imperfect notes could be made on the present curious plant. Such sections as I was able to make through the membrane showed me that it was composed of several rows of cells; the inner rows, occupying almost the whole thickness, being formed of large, colourless cells, filled with fluid, distended, and having thin walls. The outer stratum in which the colour resides is very thin, composed of exceedingly minute cells, with square ends, but whose exact shape I could not well determine. Dr. Montagne, in his splendid work on Algerian Algæ, says that they are parallelipipeds, placed, with their smaller ends to the circumference. With the views respecting this species entertained by Dr. Montagne and expressed in that work I fully concur, and now proceed to describe this curious vegetable in detail.

1. HYDROCLATHRUS *cancellatus*, Bory.—*Mont. Alg. Algier. p.* 36. *Asperococcus clathratus*, *J. Ag. Sp. Alg.*, *vol.* 1, *p.* 75. *Encœlium clathratum*, *Ag.*—*Kütz. Sp. Alg. p.* 552. *Halodictyon cancellatum*, *Kütz. Phyc. Gen. p.* 338. (TAB. IX. A.)

HAB. Subtropical. On rocks, etc., in tide pools near low-water mark. Annual. Sand Key, Florida, abundant in February. *W. H. H.* (v. v.)

Fronds of irregular form, oblong or sinuous, two to three inches in length and about an inch high, heaped together in wide-spreading patches, adhering to the rocks by the lower surface, and to each other by their sides. The young fronds, in the earliest stage at which they were found, are pierced by rounded holes, of small size and somewhat pressed together. As the membrane expands, the original holes expand also, and grow wider, and new holes are formed in the interspaces, until the whole membranous wall of the bag-like body is converted into a delicate, lace-like network. The *margin* round each hole is strongly involute, which gives the appearance of a thickened rim, when the membrane is viewed vertically. The substance is thick, crisp to the touch at first, but very fragile, and it soon changes colour and loses rigidity on exposure to the air. The surface-cells are exceedingly minute, filled with colouring matter; those that compose the thickness of the membrane are of large size, hexagonal, with thin walls and full of watery juice. No fructification was observed on my specimens. The colour when growing was a very pale, yellowish-olive, somewhat ochraceous. This rapidly changes, and the plant becomes dark brown in a dried state.

Our figure gives a tolerable idea of the Sand Key plant, as to size of individual fronds and mode of composition of the patches: but I have failed in making it sufficiently lace-like, and in giving the effect of depth to the holes which pierce it in every direction. I have some doubts whether all the plants known under the name *H. cancellatus* are identical. The beautiful figure in the great French work on Egypt, would not at all answer any specimen of the Sand Key plant which fell under my notice. But it must be borne in mind that my specimens were gathered early in the season, and were comparatively young; and, therefore, it is possible that later in the year they might have put on a very different aspect. If all the clathrate Algæ referred to this place by botanists belong to the present species, it has a wide range; being found through the warmer parts of the Atlantic at both sides; in the Mediterranean; the Red Sea; on the shores of the Mauritius, and of those of New Holland. It would be difficult to determine from dried specimens whether the specimens from these various places were identical or not. The living plant has the aspect of a very open sponge, and is so frail that it cannot be raised from the rocks without laceration, and so weak that it cannot support its own weight when lifted from the water.

PLATE IX. A. *Fig.* 1. Several fronds of HYDROCLATHRUS *cancellatus*, growing together, the *natural* size ; *fig.* 2, a portion of the perforated frond, *magnified ; fig.* 3, minute piece of the same, showing the surface-cellules, *highly magnified.*

ORDER V. CHORDARIACEÆ.

CHORDARIEÆ, *Harv. in Mack. Fl. Hib. part* 3, *p.* 183. *Harv. Man. Br. Alg. Ed.* 1, *p.* 45. *Ed.* 2, *p.* 44. *J. Ag. Sp. Alg. vol.* 1, *p.* 45. CHORDARIEÆ, *(excl. gen.) J. Ag. Alg. Medit. p.* 31. *Endl. 3rd, Suppl. p.* 23. *Dne. Ess. p.* 33. MESOGLOIACEÆ, *Kütz. Phyc. Gen. p.* 329. *Sp. Alg. p.* 539. CHORDARIDÆ (*excl. gen.) Lindl. Veg. Kingd. p.* 22.

DIAGNOSIS. Olive-coloured seaweeds, with a gelatinous or cartilaginous frond composed of vertical and horizontal filaments (or strings of cells) interlaced together. *Spores* attached to the filaments, and concealed within the substance of the frond.

NATURAL CHARACTER. *Root* rarely more than a disc of attachment ; in the more perfect kinds it forms a point of fixture, at the base of the stem ; in the less perfect, the whole under-surface of an expanded frond adheres to the object on which the plant grows. *Frond* very variable in form, but in all cases composed of articulated threads or cells strung together in vertical and horizontal series, variously combined among themselves, but easily separable under the microscope, and either accompanied by mucus or lying in a transparent gelatine. The gelatine varies both in quantity and in degree of tenacity. When little developed, it is also more tenacious, and then the fronds are firmly cartilaginous, or somewhat coriaceous, and highly elastic. But more generally the gelatine is abundant in quantity and very loose in substance, and then the threads composing the frond lie considerably apart one from another, and the common substance becomes soft and gelatinous. The least organised plant of the order (*Ralfsia*) has a crust-like frond spreading over the surface of rocks, like one of the *Lichens*, in circular or oblong patches, and bearing on its surface small prominences which eventually contain *spores*, mixed with paranemata. Next in development is *Leathesia*, whose frond is either a shapeless or lobed roundish mass, or a cluster of such growing together like so many small potatoes. This genus, lumpy as it is, is closely allied in structure to *Mesogloia*, from which it is chiefly distinguished by the shapeless frond. The frond in the latter group is branching, with a pinnate habit. A further advance in structure is made in *Chordaria*, where the axis becomes very compact; and in *Scytothamnus*, a genus found at New Zealand, the frond attains its maximum of structure. In that group the substance is as tough and leathery as it is among the *Fucaceæ*, yet an appeal to the microscope shows a filamentous structure not essentially differing from that found in *Chordaria* or *Mesogloia*. The genera *Elachista* and *Myrionema* are a little different in structure from the other genera of the order, and indicate a passage into *Ectocarpaceæ*. In them some of the filaments composing the frond are free, or not enclosed in gelatine; but as the spores are lodged among the filaments which are compacted together into the base of the fronds, I prefer retaining these genera in the present order. By Prof. J. Agardh, *Elachista* is referred to Ectocarpaceæ, and *Myrionema* retained in Chordariaceæ, but both are so closely allied to each other, and also to *Leathesia*, that I am unwilling to separate them.

The *spores* of the Chordariaceæ are very generally obovate, obtuse at the apex and narrowed to the base, and in many they taper so considerably as to become almost club-shaped. They are enclosed in pellucid perispores, and attached to some portion of the filamentous structure of the frond, generally to the filaments forming the *periphery* or outer stratum. They are usually accompanied by paranemata. In *Ralfsia* alone they form prominent, wart-like *sori*, not unlike those of *Stilophora* among Dictyotaceæ. The colour of the frond varies from a greenish to a brownish olive, and is sometimes very dark. It is not much altered in drying.

About forty-five species of this Order have been described from various parts of the world. The majority are natives of the colder portion of the temperate zone, both north and south; and some species, such as *Leathesia tuberiformis* and *Chordaria flagelliformis*, are equally common in the Northern and Southern Hemispheres.

I have found the gelatine of *Chordaria flagelliformis*, extracted by allowing the fronds to remain a day or two in fresh water, useful in causing small Algæ, which are not of themselves sufficiently gelatinous, to adhere to paper. It is however too weak for any except very slender kinds. With this exception, none of the species are used in the arts.

SYNOPSIS OF THE NORTH AMERICAN GENERA.

* *Frond cylindrical, branching.*

I. Chordaria. *Axis* cartilaginous, dense, solid (at length hollow in the centre) Filaments of the periphery unbranched.

II. MESOGLOIA. *Axis* gelatinous, laxer in the centre, composed of a network of filaments. *Filaments* of the periphery branched.

III. LIEBMANNIA. *Axis* gelatinous, denser in the centre, composed of longitudinal, approximated filaments. *Filaments* of the periphery forked.

** *Frond either tuber-shaped or crust-like.*

IV. LEATHESIA. *Frond* tuber-shaped, cartilagineo-gelatinous.

V. RALFSIA. *Frond* crust-like, spreading in round patches.

*** *Parasites, consisting of densely tufted filaments, connected at the base, and free above.*

VI. ELACHISTA. *Filaments* pencilled, rising from a common tubercle composed of vertical fibres.

VII. MYRIONEMA. *Filaments* pulvinate, rising from a flat base composed of decumbent fibres.

I. CHORDARIA. *Ag.*

Frond cylindrical, branched, cartilaginous, solid, at length hollow in the centre, coated with a pile of radiating, horizontal, peripheric filaments. *Axis* formed of oblong cells, connected by their ends into anastomosing, longitudinal filaments, forming a compact network. Filaments of the *periphery* at first deficient, gradually evolved, and at length coating the axis in a continuous pile, densely set, club-shaped, simple, moniliform, composed of spherical cells. *Spores* clavate or obovate, arising from the base of the radiating peripheric filaments, and concealed among them.

It is stated by Prof. J. Agardh that the axis of the frond is at first hollow, and that it gradually becomes solid in age, from the tube being filled up with cells. I find the reverse of this to be the case. In carefully made cross sections of the young frond of *Ch. flagelliformis* taken when the plant is an inch or two in height, and long before the evolution of the peripheric filaments, I find the axis quite as solid as at more advanced periods; and I also find in old plants, but more especially in *Ch. divaricata*, that the central cells of the axis disappear in old age, leaving the frond quite fistular. This also takes place in *Mesogloia*, particularly in *M. vermicularis*. In *Ch. divaricata* this hollowing of the frond of old specimens is very obvious.

1. CHORDARIA *flagelliformis*, Ag.; stem subsimple, densely set with long, lateral, filiform, simple branches, which are either naked or sparingly furnished with ramuli;

filaments of the periphery club-shaped. *J. Ag. Sp. Alg. vol.* 1, *p.* 66. *Kütz. Sp. Alg. p.* 546. *Harv. Phyc. Brit. t.* 111. *Fucus flagelliformis, Turn. Hist. t.* 85. *E. Bot. t.* 1222.

HAB. On rocks, stones, and the smaller Algæ between tide-marks. Common on the shores of the Northern States. Newfoundland, *Lenormand.* Halifax, *W. H. H.* Newport, R. I., *Prof. Bailey, Mr. Olney,* &c. Boston, *G. B. Emerson.* Staten Island, N. Y. (v. v.)

Fronds 1—2 feet long, as thick as bristle, mostly with an undivided leading stem, which is densely set throughout its whole length with crowded or fasciculate lateral branches. These branches are several inches long, of the same thickness as the stem, straight or nearly so, and usually unbranched and quite naked : sometimes they have each a few distant, spreading, straight ramuli ; and sometimes they are as densely beset as the stem with such ramuli. The substance is firmly cartilaginous and elastic, the surface lubricous, and if the plant be allowed to remain some hours in fresh water, a very considerable quantity of mucus and some colouring matter will be given off. The colour is always very dark olivaceous brown. In young specimens, the whole frond consists of the cellulo-fibrous axis, composed of a dense network of anastomosing threads ; there is then no *periphery,* or merely an outward coating of dark-coloured cells. As the plant enlarges, the surface-cells grow out, by repeated cell-division, into moniliform peripheric threads, which form a complete covering or pile to the frond. These peripheric filaments are club-shaped, the cells of which they are composed gradually increasing in size, from the base to the apex of the filament. *Spores,* concealed among the threads of the periphery, are abundantly produced by almost every full-sized individual. When growing, the whole frond is clothed with fine, colourless, jointed hairs, which give the branches, as seen through the water, a feathery appearance.

2. CHORDARIA *divaricata,* Ag. ; frond irregularly divided ; branches divaricating, subdichotomous, flexuous, furnished with scattered, short, very patent, mostly forked ramuli ; filaments of the periphery capitate. *J. Ag. Sp. Alg. vol.* 1, *p.* 65. *Harv. Phyc. Brit. t.* 17. *Mesogloia divaricata, Kütz. Sp. Alg. p.* 545. (TAB. XI. A.)

HAB. On the smaller Algæ, etc., at and below low-water mark. Shores of Long Island Sound, Stonington, *Prof. J. W. Bailey.* Newport, R. I., *Mr. S. T. Olney. Dr. Durkee.* Green Port, Long Island, *Prof. J. W. Bailey and W. H. H.* New Bedford, *Mr. Congdon.* (v. v.)

Fronds tufted, one or two feet long or more, not a line in diameter, very much, but irregularly branched. Sometimes there is a leading stem, with lateral branches, and sometimes the frond is broken up from the base into many principal divisions. The branches are of various lengths, subsimple or repeatedly forked. They spread at wide angles, and their divisions are equally patent, the intermediate spaces being curved or flexuous. In some specimens these forked branches are quite naked; in others furnished with patent simple or forked ramuli from half an inch to an inch in length; and in others beset with a multitude of such ramuli, or of more compound ones. In these last the frond becomes excessively branched, with all its divisions divaricated and beset with irregular branchlets. When young, the axis is solid, firmly cartilaginous and cellular, but with advancing age the central cells die out, and the stems and branches become fistular, or even somewhat inflated. Such specimens also lose much of their original lubricity, and may readily be mistaken for a different species—or even for a *Stilophora*, if care be not taken to observe the filaments of the periphery. These filaments afford a tolerably definite specific character in being slender, with a large terminal cell; but in individuals of different ages the size of the terminal cell varies considerably. The colour is a greenish olive, paler than in the former species, but becomes dark brown in old age and in drying, in which latter state the plant adheres to paper and shrinks very considerably.

PLATE XI. A. Frond of CHORDARIA *divaricata*, the *natural* size; *fig.* 2, cross section of a young branch; and *fig.* 3, the same of an older branch, both equally *magnified*; *fig.* 4, a spore and two peripheric filaments, *highly magnified.*

II. MESOGLOIA, *Ag.*

Frond cylindrical, branched, cartilagineo-gelatinous, solid, at length partially hollow in the centre, coated with a pile of radiating, horizontal, branched peripheric filaments. *Axis* composed of longitudinal, articulated, anastomosing filaments, connected together into a network, which is laxer toward the centre; the cells of the inner filaments long, those of the outer shorter. Filaments of the *periphery* rising from the outer layer of axial filaments, moniliform, composed of ellipsoidal cells, fasciculate, frequently dichotomous. *Spores* obovoid, attached to the base of the peripheric filaments, and concealed among them.

Plants with the habit and much of the structure of *Chordaria*, but of a more gelatinous substance and looser texture. In this group I propose to include *Myriocladia* of J. Agardh, the structure of which does not appear to me to be essentially different from that of ordinary *Mesogloiæ*, while the external habit is so similar that even the specific diversity of the species of *Myriocladia* from species referred by Agardh to *Mesogloia* is variously held by different authors. Careful analyses of recent specimens in various stages have still to be made; for though these plants can be tolerably well observed in a dried state, it is not easy in that state to isolate the filaments of the axis so as to show the structure perfectly. For this reason, among others, I prefer retaining *Mesogloia Zosteræ*, Aresch. and *M. Lovenii*, J. Ag. in the same genus as *M. virescens*.

1. MESOGLOIA *vermicularis*, Ag. ; frond clumsy ; branches irregularly pinnate, thick, worm-like, lineari-fusiform ; ramuli copious, long, flexuous, resembling the branches ; filaments of the periphery moniliform, clavate, with spheroidal cells. *J. Ag. Sp. Alg. vol.* 1, *p.* 58. *Kütz. Sp. Alg. p.* 544. *Harv. Phyc. Brit. t.* 31. *E. Bot. t.* 1818.

HAB. On stones and Algæ between tide-marks. Annual. Halifax, *W. H. H.* (v. v.)

Frond a foot or more in length, with a subsimple leading stem set with lateral branches, which are either simple and naked, or furnished with secondary, worm-like branchlets. The principal divisions are two or three lines in diameter, irregularly swollen here and there, often contracted at the base, curved or flexuous, and taper to a bluntish point. The filaments of the periphery are densely set, shorter than the diameter of the branches, and rise from the inflated, colourless, external cells of dichotomous intra-peripherial filaments, which branch off from the longitudinal filaments composing the axis. The peripheric filaments are coloured, tufted, clavate, and bear *spores* in the centre of the tuft. In old age the stem and branches become hollow, and the substance less gelatinous. This takes place most frequently when the plant grows in deep water, beyond the influence of the tide. The colour is a brownish olive.

I collected only a single specimen of this plant at Halifax.

2. MESOGLOIA *virescens*, Carm. ; frond filiform, gelatinous ; branches long, erecto-patent, slender, villous ; ramuli more or less numerous, very patent, short, obtuse ; filaments of the periphery as long as the diameter of the axis, dense, moniliform, with spheroidal cells rather longer than their breadth. *J. Ag. Sp. Alg. vol.* 1, *p.* 56. *Harv. Phyc. Brit. t.* 81. *Kütz. Sp. Alg. p.* 545. (TAB. X. B.).

HAB. On Zostera at Nahant, Massachussetts, *Miss E. H. Brewer.* On small Algæ at Sand Key, Florida, *W. H. H.*

Frond in the American specimens already seen, which are not of full size, two to three inches long, in full grown (European) specimens 8—12 inches or more, slender, branched in a pinnated or irregular manner, usually with a leading undivided stem, set with patent, lateral branches. *Branches* horizontal or widely spreading, short, or more generally elongated, filiform, of nearly equal diameter throughout, appearing villous to the naked eye from the length and projection of the peripheric filaments. Secondary branches resembling the primary, but shorter, increasing in number with the age of the specimen. The peripheric filaments are beautifully beaded; more slender and much longer than in *M. vermicularis;* but shorter, and with more globose joints than in *M. Zosteræ.* The colour is an olivaceous green, becoming rather greener after the specimen has been dried. The substance is very soft and gelatinous.

My figure is taken from one of the Sand Key specimens. These are less *villous*, owing to youth, than most specimens of the species, and have more the aspect of *M. Griffithsiana*, but on a close microscopic examination they appear to have all the characters proper to *M. virescens.* Miss Brewer's specimens are still younger, but, though growing on Zostera, appear to belong to *virescens* and not to the following.

PLATE X. B. *fig.* 1. Fronds of MESOGLOIA *virescens*, the *natural* size; *fig.* 2, small portion of a branch, *magnified*; *fig.* 3, peripheric filaments, attached to the axial; *fig.* 4, a peripheric filament removed, the latter figures *highly magnified.*

3. MESOGLOIA *Zosteræ*, Aresch. (?); frond filiform, gelatinous, flexuous, slightly branched; branches very short and subsimple, distant, villous, patent, with rounded angles; filaments of the periphery much longer than the diameter of the axis, lax, submoniliform, with ellipsoidal cells, twice as long as their diameter. *Mesogloia Zosteræ, ?; Aresch. Pug. t.* 8, *f.* 1, *a.* 6. *Myriocladia Zosteræ ? or M. Lovenii ? J. Ag. Sp. Alg. vol.* 1, *p.* 53. (TAB. X. A.).

HAB. On Zostera in deep water. Annual. Halifax, *W. H. H.*

Fronds 6–8 inches long, very slender, filiform, flexuous or angularly bent, either without lateral branches, or furnished at distant intervals with a few very short, patent, or divaricating, simple or forked ramuli, from a line to an inch in length, but seldom longer. These branchlets issue at very wide angles, and sometimes at the point where they arise the main stem takes a bend in the opposite direction, as if the proper mode of branching were dichotomous, but that one of the forks were perpetually aborted into a ramulus. The peripheric filaments are much longer than the diameter of the axis which they clothe, and are laxly set, surrounded by a loose jelly. They are dichotomous, and spring from slender longitudinal filaments coating the internal filaments of the axis, but which I have failed to detect anastamosing into a net work, as described by J. Agardh (if we are really speaking of the same plant). The articulations of the radiating filaments are fully twice as long as broad, and but slightly contracted at the dissepiments. The colour in my specimens is a yellowish olive.

Few plants have been more confused by authors than the *Linckia Zosteræ* of Lyngb., *Mesogloia Zosteræ*, Aresch.; and I hope I am not farther confusing synonyms by referring to this place the plant now described and figured. Lyngbye's figure is certainly very unlike my plant, and is referred by J. Agardh to the young of *Mesogloia virescens*, which it much more nearly resembles. But Areschoug, whose figure accords more nearly with that now given than with the previous figure of Lyngbye, has examined a specimen of Lyngbye's plant, and declares it the same as his own. J. Agardh, taking up Areschoug's *M. Zosteræ*, as identical with his own *Myriocladia Zosteræ*, states that the cells of the peripheric filaments are subspherical; and describes a new species, *M. Lovenii*, in which they are twice as long as broad. In my specimens now described I find the peripheric cells of the length attributed to those of *M. Lovenii*, and yet I hesitate whether to refer them to that species. I have not seen any authentic specimen of either Agardh's or Areschoug's plant, and must leave the final determination of the difficulty to those who have such specimens to compare.

PLATE X. A. *Fig.* 1. Fronds of MESOGLOIA *Zosteræ*, growing on *Zostera marina*, the *natural* size; *fig.* 2, small portion of a branch, *magnified; fig.* 3, some of the axial and peripheric filaments of the same; *fig.* 4, portion of one of the peripheric filaments; the latter figures highly *magnified.*

III. LIEBMANNIA. *J. Ag.*

" *Frond* cylindrical, branched, filamentous, solid, clothed with radiating peripheric filaments. *Axis* composed of oblong, approximated cells, cohering in longitudinal filaments; the filaments toward the centre narrower, and there collected into a peculiar dense stratum. Peripheric filaments arising from the outermost axial cells, mucous, moniliform, forked. *Spores* obovoid, seated in the axils of the radiant filaments, girt with a hyaline perispore. *Propagula* at the apex of the radiating fibres lancioid, one, two or four, sessile within a hyaline, inflated, obpyriform perispore, sub-articulate-constricted, and longitudinally divided."—*J. Ag.*

LIEBMANNIA *Leveillei, J. Ag. Alg. Medit. p.* 35. *Sp. Alg. vol.* 1, *p.* 61. *Mesogloia Leveillei, Menegh. Alg. Ital. p.* 283, *b.* 5, *t.* 2.

HAB. Parasitical on Zostera. At Vera Cruz., Mexico, *Liebman.* (v. s. in Herb. T.C.D.)

I give the characters of this genus as nearly as possible in Prof. J. Agardh's words. I have not seen an American specimen, but possess an Adriatic one from Prof. Meneghini. This has the outward characters of *Mesogloia vermicularis.*

IV. LEATHESIA. *S. F. Gray.*

Frond globose or lobed, solid or at length hollow, consisting of filaments radiating to all sides from a central point. *Axis* composed of oblong colourless cells, united in dichotomous threads which issue from a common base ; the uppermost cells half-moon shaped. *Peripheric* filaments issuing from the outermost axial cells, simple, moniliform, strongly glued together, with globose articulations. *Spores* obovoid or pyriform, affixed at the base of the peripheric filaments (with which they have a common origin) and concealed among them.

Very unlike the preceding genera in external characters, but closely allied in structure to *Mesogloia*, particularly to *M. vermicularis*. Leathesia indeed chiefly differs from Mesogloia in having the frond irregularly lumpy or tuberous, instead of cylindrical and branching. The following species has a very wide geographical range, being a common inhabitant of the shores of both hemispheres, East and West, and also of the Southern Ocean. It abounds at least at the Cape of Good Hope.

1. LEATHESIA *tuberiformis*, Gray ; fronds olivaceous, tuberous, when young stuffed with cottony fibres (the axis), at length hollow. *Harv. Phyc. Brit. t.* 324. *Leathesia marina, Endl.—J. Ag. Sp. Alg. vol.* 1, *p.* 52. *Kütz. Sp. Alg. p.* 543. *Corynephora marina, Ag.—Rivularia tuberiformis, E. Bot. t.* 1956. (TAB. X. C.)

HAB. On rocks and Algæ between tide marks. At Halifax, *W. H. H.*, (v. v.)

Fronds clustered together, varying in size from the bigness of a pea to that of a large walnut, irregularly lobed and bullated ; at first solid but becoming hollow from the perishing of the cottony axial filaments. The frond then consists merely of the peripheric filaments, which are strongly glued together and constitute the whole substance of the walls of the then hollow tuber. They can be separated only by using considerable pressure. The plant makes its first appearance in April or May, and in August or September attains its full size and produces fruit, decaying soon after.

PLATE X. C. *Fig.* 1. Cluster of fronds of LEATHESIA *tuberiformis*, on a piece of rock, the *natural* size ; *fig.* 2, vertical section of a frond, showing a small portion of the periphery, and some of the axial filaments, *magnified* ; *fig.* 3, peripheric filaments supported on the apical cells of the axial filaments ; *fig.* 4, a *spore* and two peripheric filaments, both the latter figures *highly magnified.*

V. RALFSIA. *Berk.*

Frond coriaceo-crustaceous, fixed by its inferior surface, orbicular, concentrically zoned, composed of densely packed, vertical, simple filaments, agglutinated together into a crust. *Fructification*, depressed warts, scattered over the upper surface, containing obovate *spores*, attached at the bases of vertical filaments or *paranemata*.

The plants included in this group resemble the crustaceous lichens in outward characters, and, like them, spread over the face of rocks in varying patches. In the character of the fructification there is an approach to *Dictyotaceæ*, but the genus is retained in *Chordariaceæ* on account of the structure of the frond, and a supposed affinity with *Leathesia*.

1. Ralfsia *expansa*, J. Ag.; frond orbicularly expanded into a crust, lobed at the margin, flattish (?) in the middle, here and there raised in tubercles. *J. Ag. Sp. Alg.* 1, *p.* 63.

On Madrepores in the Gulf of Mexico. Vera Cruz, *Liebman.*

I have not seen this plant, and am uncertain whether I have correctly translated Prof. J. Agardh's specific character, which is as follows:—"Fronde orbiculariter expansa in crustam margine lobatam, medio subcontinuam hic illic in pustulas elevatam."

2. Ralfsia *deusta*, Ag., (not Berk.); frond concentrically lobed, the lobes subreniform, imbricated, longitudinally striate, concentrically zoned. *J. Ag. Sp. Alg.*, 1, *p.* 63. *Fucus fungularis*, *Fl. Dan. t.* 420.

Hab. On the shores of Greenland, *Vahl.* Unalaschka, *Tilesius.*

Frond orbicular, 1—2 inches in diameter, adhering to the rocks, constituted of numerous lobes, one imbricating on the other. *Colour* chestnut brown.

I am not acquainted with this plant.

VI. ELACHISTA. *Duby.*

Fronds parasitical, penicillate, composed of axial and peripheric filaments. *Axial* filaments dichotomously branched, cohering together into a tubercular common base. *Peripheric* filaments, simple, free, penicillate, radiating from the base, coloured, articulate. *Fructification* : pear-shaped spores attached to the axial filaments, and hidden within the tubercular common basis.

ELACHISTA *fucicola*, Fries.; tufts pencilled ; filaments elongate, flaccid, membranaceous, attenuated upwards ; articulations once or twice as long as broad ; tubercle spherical. *J. Ag. Sp. Alg.* 1, *p.* 12. *Harv. Phyc. Brit.*, *t.* 240. *Phycophila fucorum*, *Kütz. Sp. Alg. p.* 541. (TAB. XI. B.)

HAB. Parasitical on the fronds of *Fucus nodosus* and *F. vesiculosus*. Narragansett Pier, *Mr. Olney*. Halifax, *W. H. H.* (v. v.)

A common parasite on littoral fuci, forming brown or foxy-coloured pencils of filaments. I am acquainted only with the two American stations recorded above, but most probably this parasite will be found all along the shores of the Northern States.

PLATE XI. B. *Fig.* 1. Tufts of ELACHISTA *fucicola*, growing on *Fucus nodosus*, the *natural* size ; *fig.* 2, a small portion of a tuft *magnified ; fig.* 3, a *spore* with paranemata ; *fig.* 4, 5, portions of the pencilled filaments, the latter figures *highly magnified.*

VII. MYRIONEMA. *Grev.*

Fronds minute, parasitical, cushion-like, composed of axial and peripheric filaments. *Axial* filaments decumbent, branched, spreading as a thin expansion on the surface to which the parasite adheres. *Peripheric* filaments short, erect, simple, springing from the decumbent expansion, and united by interposed gelatine into a cushion-like frond. *Spores* oblong, affixed either to the erect or to the decumbent filaments.

A genus of minute parasites which annually attack the smaller *red* and *green* Algæ in old age, and hasten their decay. The following is so common on old fronds of *Ulva latissima* and *Enteromorpha compressa*, both common American shore plants, that I venture to introduce it into this work, though I have not received it from any correspondent in America.

MYRIONEMA *strangulans*, Grev.; patches convex, confluent, brown; vertical filaments clavate, densely set; spores obovoid, on short stalks, attached to the decumbent filaments. *Grev. Crypt. Fl. t.* 300. *Harv. Phyc. Brit. t.* 280. *J. Ag. Sp. Alg.* 1, *p.* 48. *Kütz. Sp. Alg. p.* 540.

HAB. Parasitical on the fronds of *Ulvæ* and *Enteromorphæ;* common on the shores of Europe. (v. v.)

This parasite first appears like a dark brown stain, spotting the plant on which it grows, and at this stage consists of little more than an imperfect membranous expansion, composed of prostrate filaments. Afterwards, by the growth of the erect filaments, the spots become convex and gelatinous, and the plant is matured. The spores are of large size (for the plant), and arise, like the vertical filaments, from the upper face of the decumbent ones.

M. Leclancherii, and *M. punctiforme* are, with the preceding, *probably* to be found on the American shores.

ORDER VI. ECTOCARPACEÆ.

ECTOCARPEÆ, *C. Ag. Sp. Alg. vol.* 2, *p.* 9. *(excl. gen.) Harv. Man. Ed.* 1, *p.* 38. *Ed.* 2, *p.* 52. *Kütz. Sp. Alg. p.* 449. ECTOCARPEÆ *and* SPHACELARIEÆ, *J. Ag. Alg. Medit. p.* 26. *Sp. Alg. vol.* 1, *p.* 6, 27. *Dne. Ess. p.* 33, 42. *Kütz. Phyc. Gen. p.* 287, 291. ECTOCARPIDÆ, *(in part) and* SPHACELARIDÆ, *Lindl. Veg. Kingd. p.* 22.

DIAGNOSIS. Olive-coloured, articulated, filiform seaweeds, whose spores are (generally) external, attached to the jointed ramuli, or formed in a swelling of the ramulus.

NATURAL CHARACTER. *Root* commonly a small disc, or point of attachment, occasionally accompanied by woolly fibres. *Frond* filiform and slender, (or *filamentous*) often capillary, or of extreme tenuity, more or less conspicuously articulated, each articulation composed either of several cells of equal length disposed in a ring round an axis, or of a single cell. In the latter case the frond is said to be a *filament* (*filum*, Ag. *trichoma*, Kg.) and is formed of a series of cells, placed end to end, and strung together. In some of the higher forms, as in *Cladostephus* and *Chætopteris*, the main stem and the larger branches are inarticulate, formed of a multitude of minute cells, the central ones of which are frequently cubical, closely compacted together into a firm, somewhat horny, rigid substance. In a few cases the frond is unbranched (as in the genus *Myriotrichia*) ; very generally it is much divided, either pinnated, alternately branched, or more rarely subdichotomous. In *Cladostephus* the ramuli are short, subsimple, whorled round the branches, and deciduous at the close of each season. In *Sphacelaria* and *Chætopteris* the ramification is distichous, the lesser divisions being simply or doubly pinnated. In *Ectocarpus* the frond is occasionally subsimple, or but slightly branched ; but in by far the larger number it is much divided, either dichotomous or distichous, and alternately or oppositely branched, but the branches rarely approach so nearly together as to be *pinnated* ; this is however the case in *E. Mertensii.* In some few the thread-like fronds are bundled together into branching ropes, forming a sub-definite, sponge-like, compound frond.

The *fructification* appears under two forms, sometimes both found in the same or on different individuals of the same species ; in other cases but one kind of fruit has been noticed on all the individuals of a species, and hence has been employed as a specific character. The *spores* are less commonly formed than *propagula*, by which name the secondary fruit is known, and are oval or spheroidal, dark coloured, dense, furnished with a hyaline perispore, and attached to the sides of the ramuli, scattered and without paranemata. The *propagula*, which are chiefly characteristic of *Ectocarpus*, where their modifications often afford the best specific characters, are lanceolate, linear or conical, sessile or pedicellate, or immersed in the substance of the branches, transversely striate and filled with dense endochrome. In *Sphacelaria* they are lodged in the distended tops of the branches.

In *substance*, the plants of this Order are rarely gelatinous ; those of the first sub-order are rigid, in some almost horny ; of the latter sub-order soft, and soon decomposing after removal from the water. The colour varies from dark brown to pale greenish-olive, and is subject to little change in drying except on the application of artificial heat, when the olive tints are brightened into more or less vivid greens.

This Order is closely connected with the last, from which it is known by the absence of a gelatinous matrix connecting the filaments into a compound frond, and by the *spores* being external, scattered, and unaccompanied by paranemata. The genus *Elachista* is in some respects intermediate, and has been referred by Prof. J. Agardh to the present Order; but appears to me to be too intimately connected with *Myrionema* and *Leathesia*, both clearly belonging to Chordariaceæ, to be separated from them.

By Agardh, Endlicher, and formerly by Kützing, the two sub-orders defined below are separated as distinct Orders ; and by Endlicher they are placed widely apart one from the other. To me their connection appears to be close, and their difference chiefly technical,—one being a rather simpler expression of the other—and therefore I am unwilling to multiply needlessly the number of Orders ; particularly when I find, in such plants as *Ectocarpus Mertensii*, an obvious passage from one sub-order into the other.

These plants are most numerous in the temperate waters of the ocean, diminishing toward the warmer and the colder zones. On the American coast they are more frequent on the shores of the northern and midland States; and in Europe on the coasts of Britain and France. Several are, however, found in the Mediterranean and Adriatic. They are all plants of small size, though few come within the limits of strictly microscopic objects. The genera are widely dispersed, all nearly cosmopolitan.

SYNOPSIS OF THE NORTH AMERICAN GENERA.

Suborder 1. SPHACELARIEÆ. *Frond* rigid; each articulation composed of numerous cells.

I. CLADOSTEPHUS. *Stems* inarticulate. *Ramuli* whorled.

II. CHÆTOPTERIS. *Stems* inarticulate. *Ramuli* pinnated.

III. SPHACELARIA. Whole *frond* articulate, pinnately branched.

Sub-order 2. ECTOCARPEÆ. *Frond* flaccid; each articulation composed of a single cell.

IV. ECTOCARPUS. Capillary, soft, much branched.

I. CLADOSTEPHUS, *Ag.*

Frond cylindrical, inarticulate, densely clothed with whorled, articulate, short, subsimple ramuli. *Stem* cellular, composed of a triple stratification of cellules; the central portion of longitudinal prismatical cells horizontally connected; the intermediate of roundish cells; the outer of minute cellules. *Fructification*, ellipsoidal *spores*, having a hyaline perispore, and borne on little stalks on accessory ramuli. The sphacelate tips of the whorled ramuli also contain a sporaceous mass or *propagulum* (?).

Readily known from the rest of the order by the densely-set, quadrifarious, whorled and imbricated ramuli. The two following species are very closely allied to each other, and perhaps not permanently distinct, the differences indicated arising from difference of locality.

1. CLADOSTEPHUS *verticillatus*, Ag.; branches slender, ramuli mostly forked, regularly whorled; the whorls at short intervals. *J. Ag. Sp. Alg.* 1, *p.* 43. *Harv. Phyc. Br. t.* 33. *Cl. Myriophyllum, Ag. Kütz. Sp. Alg. p.* 468. *Conferva verticillata, E. Bot. t.* 1718, *and t.* 2427, *f.* 2. (TAB. XI. C.)

HAB. On tidal rocks, in pools near low water mark. Perennial. Newport, R. I., *Mr. Olney* and *Prof. Bailey.* Lynn, Mass., *Mr. Hooper.* (v. v.)

Fronds 3—6 or 8 inches high, irregularly dichotomous, innovations springing here and there along the principal divisions. Occasionally a large tuft of such irregular branches issues from a single incrassated portion of the main stem, and is either simple or forked. The whorls of ramuli are about a line asunder, the apices of the lower whorl lying over the bases of that next above; each ramulus is incurved, tapering to the base, and acute at the extremity, and bears above its middle one or two subulate processes on the outer margin. The articulations are shorter than their diameter, and longitudinally striate, each stria composed of numerous seriated cellules. The fructification is formed in winter, at which season most of the verticillate ramuli fall away, and their place is supplied by short, densely set, accessory ramuli which bear the *spores.* These have been described by authors as a parasitical *Sphacelaria,* and the name *S. Bertiana* bestowed on them.

PLATE XI. C. *Fig.* 1, a frond of CLADOSTEPHUS *verticillatus*, the *natural* size; *fig.* 2, small portion of a branch, *magnified; fig.* 3, two of the whorled ramuli, *highly magnified.*

2. CLADOSTEPHUS *spongiosus*, Ag.; branches thick and clumsy; ramuli mostly simple, irregularly whorled, densely imbricated. *J. Ag. Sp. Alg.* 1, *p.* 43. *Kütz. Sp. Alg. p.* 469. *Harv. Phyc. Brit. t.* 138. *Conferva spongiosa, E. Bot. t.* 2427. *f.* 1.

HAB. On tidal rocks, at about half tide level. Perennial. With the preceding, *Mr. Olney.* (v. v.).

Smaller than the preceding, with thicker and more clumsy branches, and longer and denser ramuli. I am not certain that the American specimens above quoted have been rightly named, or are anything more than a variety of *C. verticillatus.* The British plant looks something different; but the technical characters by which it is known are not always constant.

II. CHÆTOPTERIS. *Kütz.*

Frond filiform, compressed, inarticulate, distichously pinnate. *Stem* cellular, omposed of a triple stratification of cellules; the central portion of longitudinal, prismatic cells, horizontally connected; the intermediate of roundish cells; the outer of minute cellules. *Fructification:—spores* (unknown). The sphacelate tips of the pinnated ramuli contain a sporaceous mass or propagulum.

This genus has the habit of *Sphacelaria*, with which it has until recently been associated by authors, and a structure of stem similar to that of *Cladostephus*. It is therefore exactly intermediate between these genera.

1. CHÆTOPTERIS *plumosa*, Kütz.; stems naked at the base, elongated, irregularly branched; branches pectinato-pinnate; pinnæ opposite, simple, very long, closely set. *Kütz. Sp. Alg. p.* 468. *J. Ag. Sp. Alg.* 1. *p.* 41. *Sphacelaria plumosa*, *Ag. Harv. Phyc. Brit. t.* 87. *Conferva pinnata*, *E. Bot. t.* 2330, (*left hand fig.*)

HAB. On the shores of Greenland, *J. Agardh.* Arctic Coast, *Mr. Seeman.* (v. v.)

Fronds from two to four or six inches long, setaceous, naked below, irregularly and much branched above. *Branches* alternate or secund, or frequently tufted, one or two inches long, simple, closely pectinated along their whole length with slender, articulated, distichous ramuli. These ramuli are from one to three lines long, opposite, a pair growing from every joint of the branch.

This beautiful plant is peculiarly a northern form, and though it reaches the south of England, is there of much smaller size than on the shores of Scotland. The branches resemble delicate feathers.

III. SPHACELARIA. *Lyngb.*

Frond filiform, articulated, distichously branched, rigid, pinnated, rarely subdichotomous. *Articulations* of the stem and larger branches composed of several cells radiating from a central point. *Apices* of the branches distended, membranous, containing a sporaceous mass or *propagulum*. *Spores* ovoid, having a pellucid *perispore*, affixed to the branches.

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1. SPHACELARIA *cirrhosa*, Ag. ; stems naked at the base, short, densely tufted, simple or branched, pinnate or bipinnate ; pinnæ opposite, alternate or irregular, simple ; spores globose, scattered, sessile or shortly stalked. *J. Ag. Sp. Alg.* 1, *p.* 34. *Kütz. Sp. Alg. p.* 464. *Harv. Phyc. Brit. t.* 178. *Conf. pinnata, E. Bot. t.* 2330. *(right hand fig.)*

HAB. On the small Algæ between tide-marks. Long Island Sound, *Captain Pike.* Ship Ann Point, Con. *Messrs. Walters, Hooper, and Congdon.* New Bedford, Mass. *Mr. Congdon.*

Fronds forming globose, fastigiate tufts, an inch or rather more in diameter ; more or less densely tufted, scarcely fastigiate, and only a quarter inch in height. *Filaments* capillary, of equal diameter throughout, straight, once or twice pinnated, the pinnæ very irregular ; in some specimens closely set, opposite and plume-like, in others distant, alternate, variable in length on the same branch ; either erecto-patent or spreading horizontally, simple, naked, blunt. The *spores* are not uncommon, and are found scattered along the pinnæ. *Colour* a foxy brown or olive. *Substance* rigid, scarcely adhering to paper in drying.

Probably common on the shores of the Northern and Midland States. Numerous specimens that I have received are very similar to European forms of this variable plant.

2. SPHACELARIA *radicans*, Dillw. ; filaments decumbent, sending out fibrous radicles in the lower part, with a few irregular, simple, straight, naked branches ; spores clustered, sessile. *Harv. Phyc. Brit. t.* 189. *S. olivacea, J. Ag. Sp. Alg. vol.* 1, *p.* 30. *S. radicans and S. olivacea, Kütz. Sp. Alg. pp.* 463, 466. *Conf. olivacea, E. Bot. t.* 2172 ; *and C. radicans, t.* 2138.

HAB. On sand-covered rocks, between tide-marks. (I gathered on rocks at Beverley, on Boston Bay, what I supposed to be this species ; but have mislaid my specimens. *W. H. H.*).

A small plant, forming spreading patches half an inch in height, and two inches or more in diameter. The specific name *radicans,* though not adopted by Prof. Agardh in his recent work, has evidently the claim of priority, having appeared in English Botany 34 plates earlier than the rival name *olivacea*—a name moreover, equally applicable to any other species of the genus, all being *olive-coloured.*

IV. ECTOCARPUS. *Lyngb.*

Frond capillary, articulated, variously much-branched, flaccid. *Articulations* composed of a single cell, short, rarely twice or thrice as long as broad. *Apices* attenuated. *Spores* spherical or ellipsoidal, scattered (rarely produced.) *Propagula*, or pod-like bodies, oblong, conical, linear or lanceolate, transversely striate, and celluloso-granulated, formed either of transformed ramuli, or of some portion of a ramulus, or of portions of the main and secondary branches.

A large genus of confervoid Algæ, usually much branched, and forming fine, feathery tufts of slender, soft, brownish or olive green filaments. The articulations are always very short, and nearly of equal size in all parts of the plant. They are usually filled with endochrome, which is sometimes pellucid, sometimes granulated, and sometimes condensed into a dark spot in the middle of the cell. The species are difficult to determine or fix limits to, owing to the uncertain nature of the ramification, which it is by no means easy to characterise, and which appears to vary in different specimens collected together and seemingly of one species. The best characters are derived from the *propagula*, or " silicules," as they have been called ; podlike bodies regarded as fructification. These are either formed in the substance of the branches, or of the whole substance of a shortened branchlet. They contain a darker endochrome than the unchanged branches, and are divided at minute intervals by transverse lines. The spaces between the lines are broken up into granular cells disposed in transverse bands, and supposed to be reproductive.

The American species are not yet fully worked out, and though I have proposed some new ones below, I am by no means certain that they ought all to be retained. Some are but partially known, and all require a careful investigation on the sea shore. Solitary specimens of these plants are by no means sufficient, and when any seemingly *new* form is observed among them, numerous specimens ought not only to be collected, but the collector should notice what other seemingly different Ectocarpus was growing with the supposed novelty ; and should carefully compare one form with the other before assuming that he has a new species to describe. This cannot be done at a distance, and in many cases I have had to decide from very insufficient materials.

* *Propagula short or elongated, formed in some portion of the larger or lesser branches, (not in the ultimate ramuli).*

1. ECTOCARPUS *brachiatus*, Harv. ; finely tufted, feathery, much branched ; the branches free, opposite or quaternate ; ramuli opposite, very patent ; propagula forming oblong or elliptical swellings in the smaller branches, or at the point where two opposite ramuli issue. *Harv. Phyc. Brit. t.* 4. *J. Ag. Sp. Alg.* 1, *p.* 20.

HAB. Parasitical on the smaller Algæ. Prince Edward's Island, *Dr. Jeans.* South Boston, *Dr. Durkee.* Lynn, *Mrs. Estes.* (v. v.).

Tufts feathery, 2—4 inches high, the main stems slightly entangled at the base, the lesser branches quite free, spreading. *Filaments* much branched, all the branches and their divisions either opposite or in fours, widely spreading, almost horizontal, the larger divisions subdistant, the lesser gradually nearer. *Ramuli* filiform, patent, mostly opposite. *Propagula* (or perhaps *spores ?)* immersed in the lesser branches, often bipartite. *Colour* a pale olive green.

2. ECTOCARPUS *littoralis*, Lyngb.; tufts dense, interwoven, olive-brown, or olive-green; filaments capillary, much and irregularly branched, the ultimate divisions erecto-patent, alternate or opposite; angles acute; propagula forming elongated, linear swellings in the substance of the greater and lesser branches. *Harv. Phyc. Brit. t.* 197. *J. Ag. Sp. Alg.* 1, *p.* 18 (?) *and E. firmus, p.* 23.

HAB. Very abundant on littoral *Fuci;* also attached to various substances between tide-marks. Shores of the Northern and Midland States. (v. v.)

Tufts 6—12 inches long, dense and bushy, sometimes bundled together in ropes, sometimes untangled and feathery. *Branches* mostly alternate, repeatedly divided, the divisions issuing at acute angles, the upper ones opposite. *Articulations* of the branches almost as long as broad. *Propagula* elongated, many times longer than their breadth, at first transversely striate, (like an *Oscillatoria),* afterwards moniliform. *Substance* soft, but not glutinous, closely adhering to paper. The colour varies from olive-green to brown; and if dried by artificial heat, the tints may be much vivified and made more green.

This is the commonest form on the American coasts.

* * *Propagula linear or lanceolate, formed of or in the ultimate ramuli.*

3. ECTOCARPUS *siliculosus*, Lyngb.; tufts yellowish or pale olive-green, gelatinous, soft; filaments very slender, excessively branched; ultimate branchlets alternate or secund, attenuated; propagula pedicellate, subulato-lanceolate, attenuated to a fine point. *Harv. Phyc. Brit. t.* 162. *J. Ag. Sp. Alg. vol.* 1, *p.* 22.

HAB. On various substances between tide-marks. Shores of Long Island Sound, and Hudson River at West Point, *Prof. Bailey.* Prince Edward's Island, *Dr. Jeans.* Charleston, S. C., *W. H. H.* (v. v.)

Tufts 3—6 inches long or more, not entangled. *Filaments* excessively branched, and very slender, all the divisions usually alternate and erecto-patent, with acute axils. The *propagula* are generally formed of the upper half of the ramuli, leaving an unchanged portion or pedicel at the base of the propagulum : they taper to a fine point, and are sometimes prolonged into ramuli, or tipped with an unchanged mucro. *Colour* mostly yellowish olive, but variable.

4. ECTOCARPUS *viridis ;* tufts feathery, loose, expanding, olive-green ; filaments slender, much branched, very flexuous, dichotomous, the lower forkings distant, the upper approximated, having a few lateral ramuli ; axils rounded ; apices alternate, articulations of the branches once and half as long as broad ; propagula sessile or pedicellate, elongate, tipped with a long mucro or unchanged portion of ramulus. (TAB. XII. B. C., *two varieties.)*

HAB. On Algæ between tide-marks. Charleston, *Prof. L. W. Gibbes.* Providence, R. I., *Mr. Olney.* Bergen Island, *Mr. Walters* and *Mr. Hooper.* Hellgate, *Mr. C. Congdon.* (v. s.)

I fear this is too nearly related to the preceding, notwithstanding the apparently different mode of branching. Dried specimens have the ramuli at the tips of the divisions of the tufts dense, or slightly fastigiate or corymbose, and are of a very green olive. The propagula are more frequently formed in the basal half of the ramulus, and are therefore sessile ; but sometimes are found in the middle portion also. The very patent, rounded axils I once thought a good mark, but fear that it is hardly constant enough.

PLATE XII. B. *Fig.* 1, Part of a filament of ECTOCARPUS *viridis, magnified ; fig.* 2, minute portion, with *propagula, highly magnified.*

PLATE XII. C. *Fig.* 1, Portion of a filament of ECTOCARPUS *viridis, var., magnified ; fig.* 2, minute portion, with *propagula, highly magnified.*

5. ETOCARPUS *lutosus ;* tufts somewhat entangled and rope-like ; filaments intricately branched, decompound, the branches spreading, opposite or alternate, with few, distant, scattered ramuli ; angles very wide ; articulations of the branches once and half as long as broad ; propagula very long, linear, formed in the middle of short, spreading or reflexed ramuli whose base forms a pedicel, and whose apex a long excurrent mucro. (TAB. XII. A.)

HAB. Greenport, Long Island, *Mr. J. Hooper.* (v. s.)

This has the habit of *E. tomentosus*, but branching more like *E. littoralis.* I have seen but a solitary specimen, and though I give it a *name,* not knowing how to dispose of it otherwise, I must consider it for the present as a doubtful species ;—*muddy* in more respects than one. Its colour in the dry state is brownish.

PLATE XII. A. *Fig.* 1, Part of a filament of ECTOCARPUS *lutosus*, *magnified ; fig.* 2, minute portion, with *propagula, highly magnified.*

*** *Propagula oval, ellipsoidal or conical, sessile or pedicellate, scattered.*

6. ECTOCARPUS *tomentosus ;* Lyngb. ; filaments very slender, flexuous, irregularly branched, interwoven into a dense, sponge-like, branching tuft ; propagula ellipsoidal, obtuse, pedicellate. *Harv. Phyc. Brit. t.* 182. *J. Ag. Sp. Alg.* 1, *p.* 23.

HAB. On various substances between tide-marks. Prince Edward's Island, *Dr. Jeans.* Boston Bay, *Mrs. Asa Gray.* (v. v.)

The sponge-like tufts of this plant, composed of innumerable densely matted, flexuous, branching filaments, are from two to six inches long or more, and divided into several branches, which are either simple or furnished with lesser divisions. The filaments are very slender, and most irregularly branched, the branches flexuous, secund or alternate, and of various lengths. *Articulations* twice or thrice as long as broad, pellucid. *Propagula* pedicellate, linear-oblong or ellipsoidal, very obtuse. *Colour* varying from yellowish olive to dark brown.

The densely interwoven, rope-like, branching tufts at once mark this species from most others.

7. ECTOCARPUS *fasciculatus*, Harv. ; tufts olivaceous, dense ; main filaments not much divided ; the branches distant, set throughout with alternate or secund fascicles of subulate ramuli, the ramuli secund in each fascicle ; propagula sessile, secund, several together, ovato-acuminate or subulate. *Harv. Phyc. Brit. t.* 273. *J. Ag. Sp. Alg.* 1, *p.* 22.

HAB. On the larger Algæ between tidemarks, generally on the Laminariæ. Rhode Island, *Mr. Olney*, *Prof. Bailey*, and *Mr. G. Hunt.* Also in *Herb. J. Hooper.* (v. v.)

Tufts dense, 3—6 inches long, entangled and rope-like at the base, free and feathery above ; the ultimate ramuli densely aggregated ; appearing under a pocket-lens to be fasciculate, but not strictly so, being only placed in secund series close together. *Articulations* once-and-half to twice as long as broad. *Colour* varying from olive green to dull brown or rusty. *Substance* soft, adhering to paper.

8. ECTOCARPUS *granulosus*, Ag. ; tufts olivaceous, lax, feathery ; filaments capillary, elongate, much branched : branches free, opposite, spreading ; ramuli opposite

or rarely alternate ; propagula (spores?) elliptical, dark coloured, sessile. *Harv. Phyc. Brit. t.* 200. *J. Ag. Sp. Alg.* 1, *p.* 21.

HAB. On Algæ, etc. between tide-marks, in rock pools. Boston, *Dr. Silas Durkee.* (v. v.)

Filaments capillary, not very densely tufted, from four to eight inches long much branched, with a principal stem and lateral decompound branches. All the divisions mostly opposite and spreading. *Propagula* ellipsoidal, dark-coloured, plentifully scattered on the ramuli.

9. ECTOCARPUS *Durkeei* ; tufts not very dense ; filaments robust, decompound, much branched, the branches and the lesser divisions alternate ; the angles acute and ramuli erecto-patent, attenuated, alternate or secund ; articulations of the branches shorter than their breadth ; propagula elliptic-oblong, obtuse, subsessile, constricted at the base, transversely striate. (TAB. XII. F.)

Portsmouth, New Hampshire, *Dr. Durkee* (No. 35). (v. s. in Herb. T. C. D.)

Tufts two inches long, hair-like, spreading. *Filaments* much branched, with an evident leading stem, and decompound, alternately divided branches ; the main stem and larger branches much more robust than the branches of second or third order, and remarkable for the shortness of their articulations, whose dissepiments are somewhat constricted. The angles are all acute, and the branches and ramuli consequently erect. The propagula are borne toward the base of the smaller branches, and several are generally found together on the same branch. *Colour* olive-green.

The ramification of this plant is most like that of *E. Littoralis*, but the fruit is nearer in form to that of *E. granulosus*. It seems a distinct species, so far as I can judge from the examination of a single specimen.

PLATE XII. F. *Fig.* 1, Portion of a filament of ECTOCARPUS *Durkeei, magnified* ; *fig.* 2, minute portions with propagula ; *fig.* 3, a propagulum ; the latter figures *highly magnified.*

10. ECTOCARPUS *Mitchellæ ;* tufts feathery ; filaments very slender, decompoundly much branched, the branches and their lesser divisions alternate ; the ultimate ramuli approximated ; angles wide, and branches and ramuli patent ; ramuli attenuate, articulations of the branches twice or thrice as long as broad, of the ramuli once and half as long, propagula elliptic-oblong or linear, quite sessile and very obtuse, transversely striate, several together. (TAB. XII. G.)

Nantucket, Mass., *Miss A. Mitchell.* (v. s. in Herb. T. C. D.)

Tufts 2—3 inches long, loose, plumy, the ultimate divisions subcorymbose or fastigiate. *Filaments* very slender and much divided, the divisions alternate and patent. *Propagula* abundant on the lesser branches, several together in secund order near the base of the branch, at first ellipsoidal, then linear-oblong, then elongating and linear, always very obtuse and quite sessile, scarcely narrower at the base than above it, sometimes slightly obovoid. *Colour* a yellowish green. To the naked eye this pretty species looks like *E. siliculosus* or *E. viridis*, but the difference in fructification at once separates it from those species. It comes nearer in character to *E. Durkeei*, but is a much more delicate plant, with longer articulations, more patent branching and differently shaped fruit.

PLATE XII. G. *Fig.* 1, Portion of a filament of ECTOCARPUS *Mitchellæ, magnified* ; *fig.* 2, minute portion, with propagula ; *fig.* 3, a propagulum ; the latter figures *highly magnified.*

**** *Propagula unknown (probably of the same form as in last section.)*

11. ECTOCARPUS *Landsburgii*, Harv. ; filaments dark brown, tenacious, intricate, much branched ; branches irregularly forked, divaricated, zig-zag, bristling with numerous, short, spine-like, horizontal ramuli ; articulations short, the endochrome filling the cell, and recovering shape on being moistened, after having been dried. *Harv. Phyc. Brit. t.* 233. (TAB. XII. D.)

HAB. Dredged in deep water. Halifax bay, *W. H. H.* (v. v.)

Filaments 1—2 inches long, capillary, forming small, intricate tufts, tangled round the branches and roots of various Algæ, and on other submerged substances. *Branches* very widely spreading, often at right angles, variously curved, bent, and divided, almost every articulation emitting a minute spine-like, horizontally patent ramulus. *Colour* dark brown. *Substance* firm, and rather rigid. *Propagula* unknown.

PLATE XII. D. *Fig.* 1, Portion of a filament of *Ectocarpus Landsburgii, magnified ; fig.* 2, minute portion, *highly magnified.*

12. ECTOCARPUS *Hooperi* ; tufts rope-like ; filaments entangled, flexuous, sparingly and irregularly branched ; branches distant, elongate, subsimple, set at subdistant intervals, with short, horizontal, spine-like ramuli ; articulations of the branches twice or thrice as long as broad. (TAB. XII. E.)

In *Mr. Hooper's* Herbarium, without habitat (probably Greenport ?). (v. s.)

This forms dark brown, rope-like tufts, not unlike some states of *E. tomentosus*, but the filaments are much more robust than in that species. The numerous spine-like ramuli resemble those of *E. Landsburgii*, but are less abundant; and the articulations are much longer than those of that species. It appears to me to be sufficiently characterized, and I hope its discoverer may be able to ascertain the place where his specimen was obtained, and may find it again. At present I have seen but one specimen; Mr. Hooper informs me that he has no duplicate.

Plate XII. E., *Fig.* 1. Portion of a filament of *Ectocarpus Hooperi*, *magnified*; *fig.* 2, minute portion, *more highly magnified.*

13. Ectocarpus *Dietziæ;* tufts entangled, floccose; filaments robust, very flaccid, elongate, slightly and distantly branched, subdichotomous (?), flexuous, here and there emitting dichotomous branches; ramuli few, subulate; articulations of the branches once and half as long as broad.

Greenport, *Herb. J. Hooper.* (v. s.)

Forming a pale green, entangled, very flaccid tuft, 4—5 inches long, with the habit of *E. pusillus* or of *E. crinitus*. It seems different from any species of North America with which I am acquainted, but is not sufficiently defined by the above diagnosis. I have seen but one specimen, which adheres so closely to the paper, that it is difficult to remove fragments for examination, and I have found it impossible to display the portion examined, so as to enable me clearly to trace the order of branching. This imperfect examination, and the absence of fructification, compel me to place the species, at present, among the doubtful ones, but I trust more perfect specimens may eventually be obtained. Meantime, the specific name is bestowed in honour of Mrs. Dietz, of New York; a lady whose diligent researches in marine botany entitle her to this token of respect from fellow-labourers.

ALPHABETIC INDEX OF NAMES.

[The systematic names in capitals are those which are adopted. The names in italic indicate synonyms, whilst the vulgar names are in roman. The asterisks refer to the page of description.]

REFERENCES TO THE PLATES.

PLATE I. A.—*Sargassum Montagnei*, Bailey, p. 58.
B.—*Cystoseira expansa*, Ag. p. 66.
—— II. *Halidrys osmundacea*, Harv. p. 64.
—— III. A.—*Fucus fastigiatus*, J. Ag. p. 68.
B.—*Phyllospora Menziesii*, Ag. p. 62.
—— IV. A.—*Arthrocladia villosa*, Duby, p. 75.
B.—*Desmarestia aculeata*, Lamour. p. 78.
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E.—*Ectocarpus Hooperi*, Harv. p. 144.
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G.—*Ectocarpus Mitchillæ*, Harv. p. 143.

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Plate I

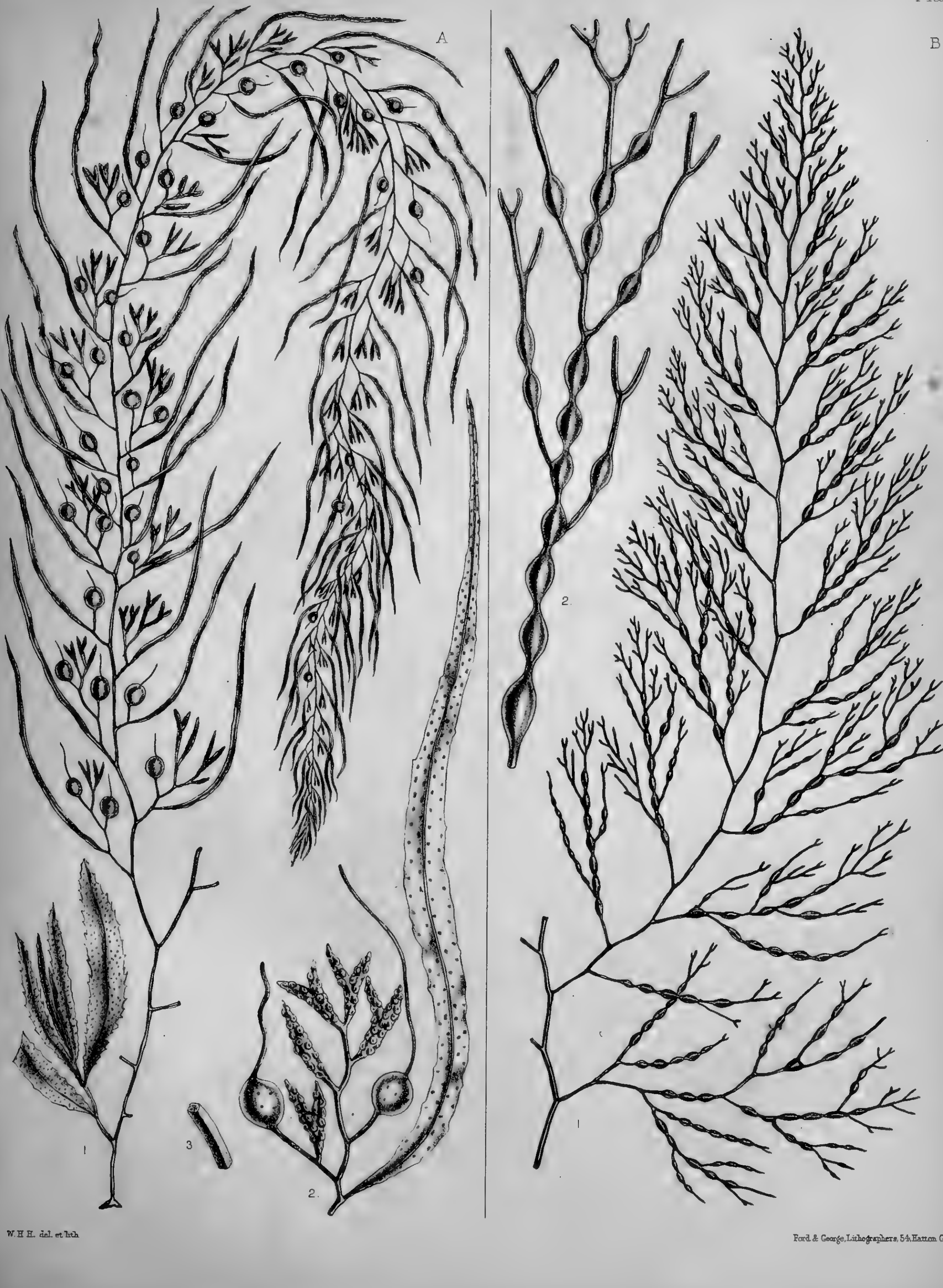

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Plate II

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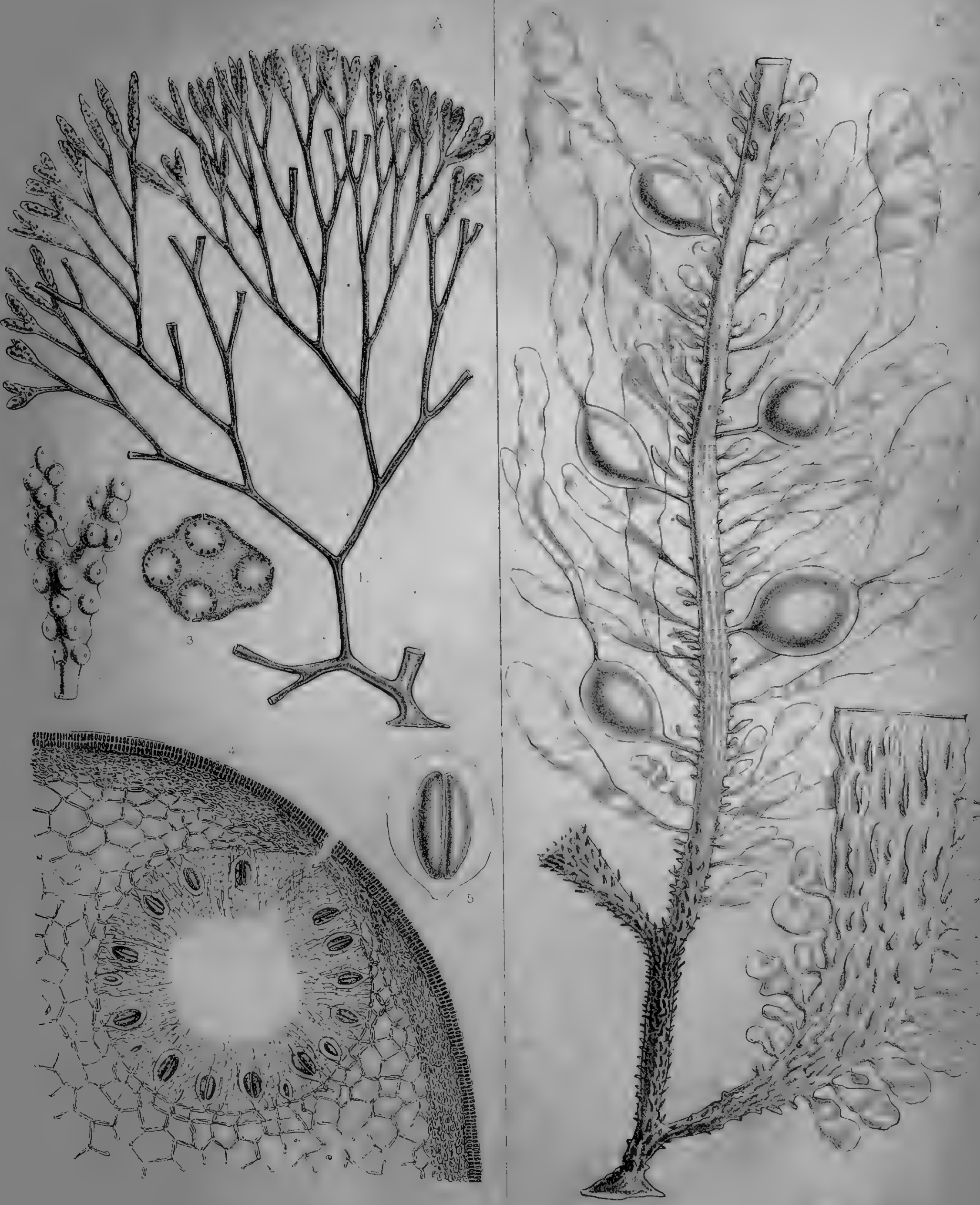

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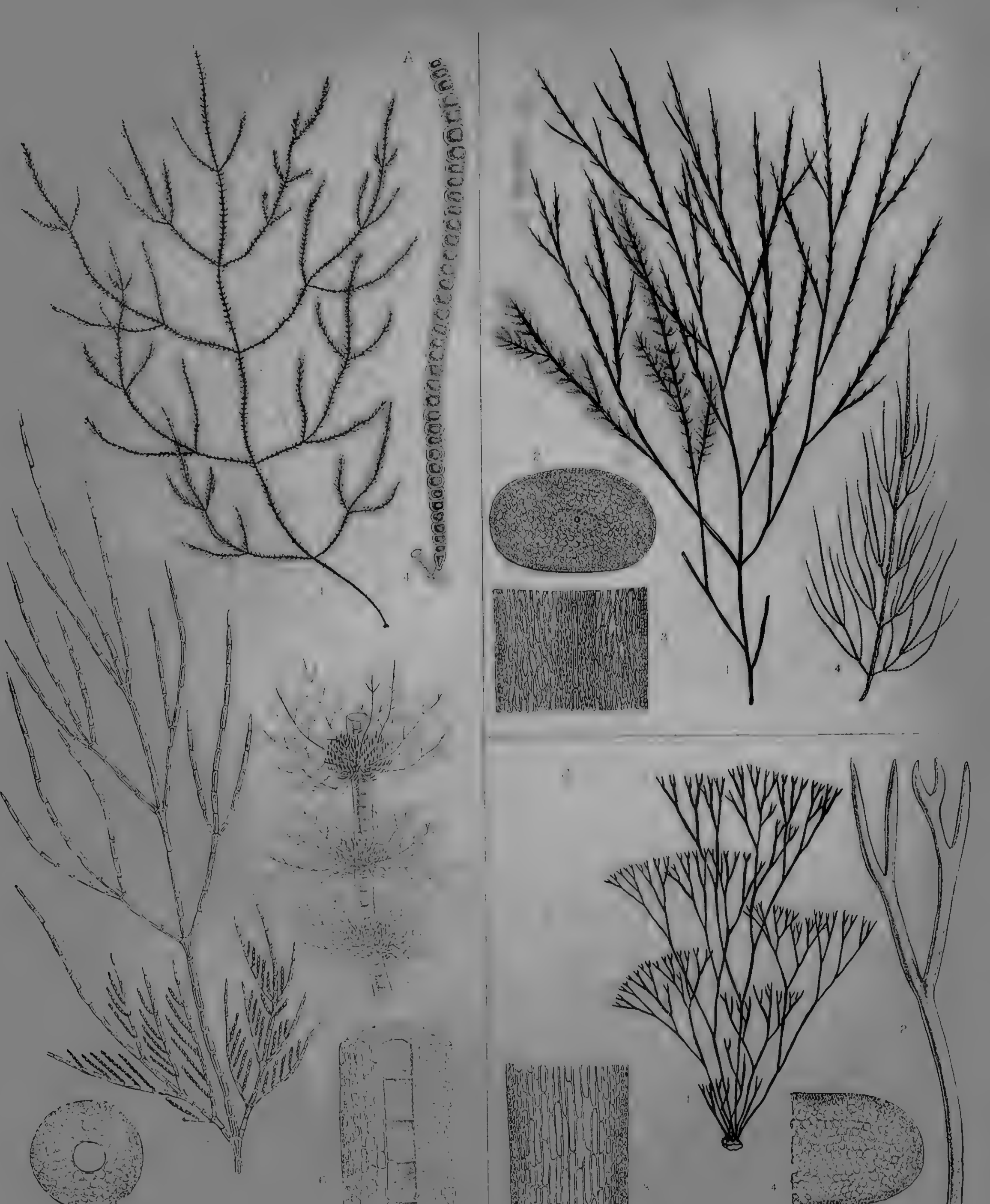

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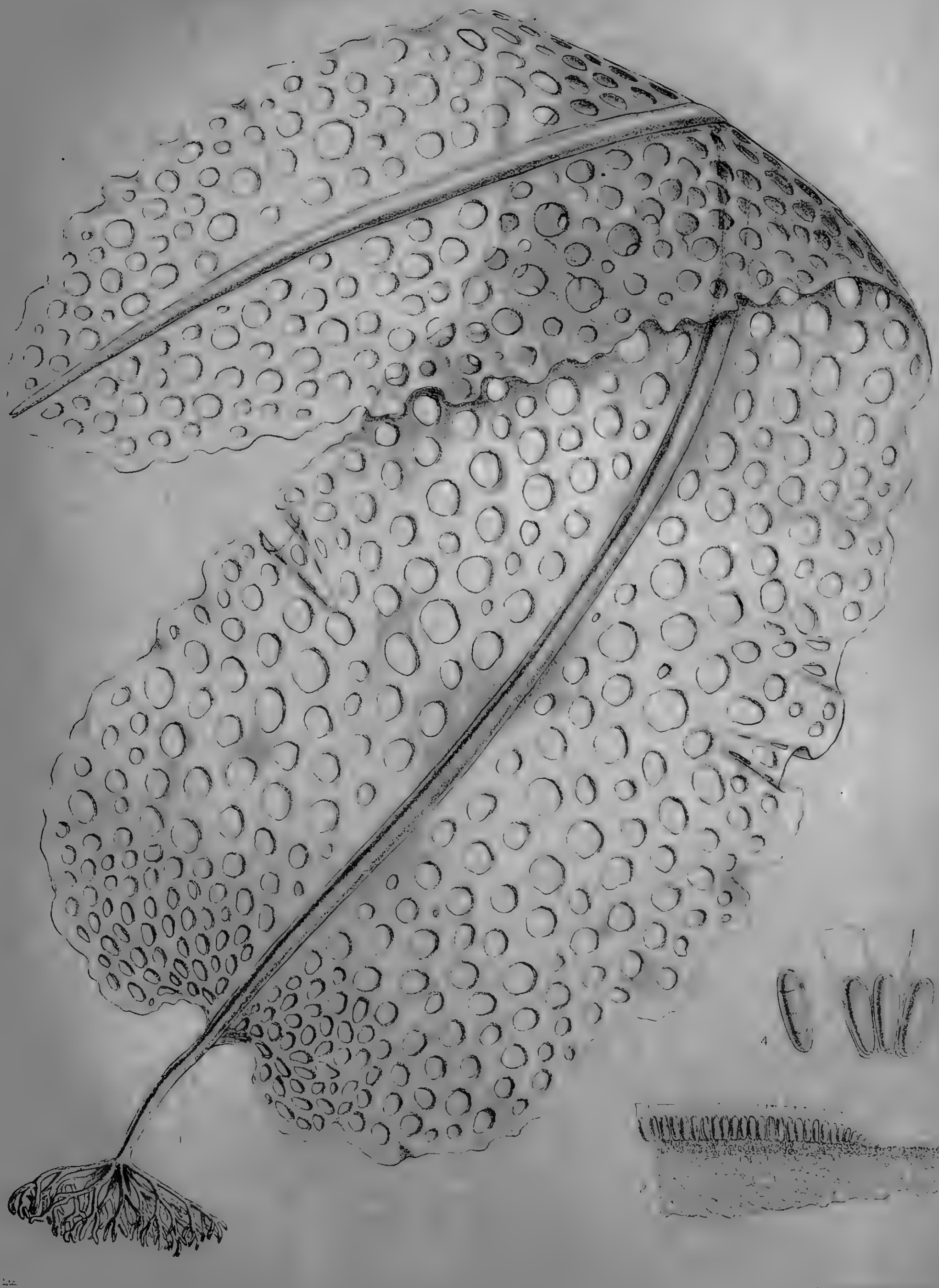

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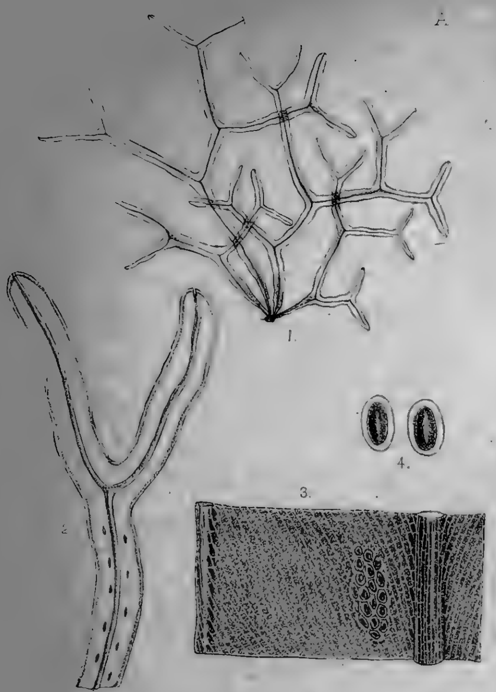
Plate VII



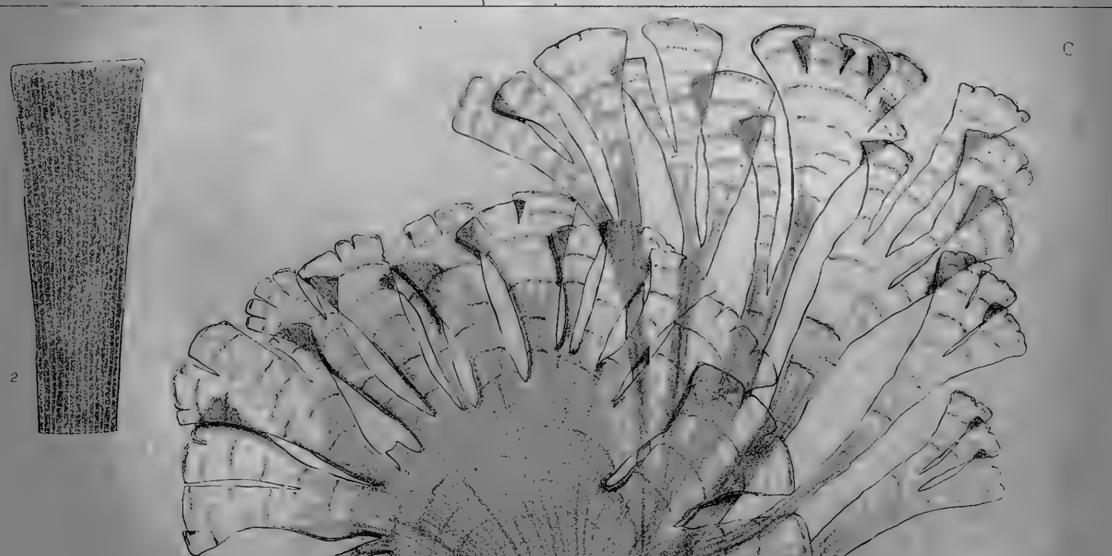


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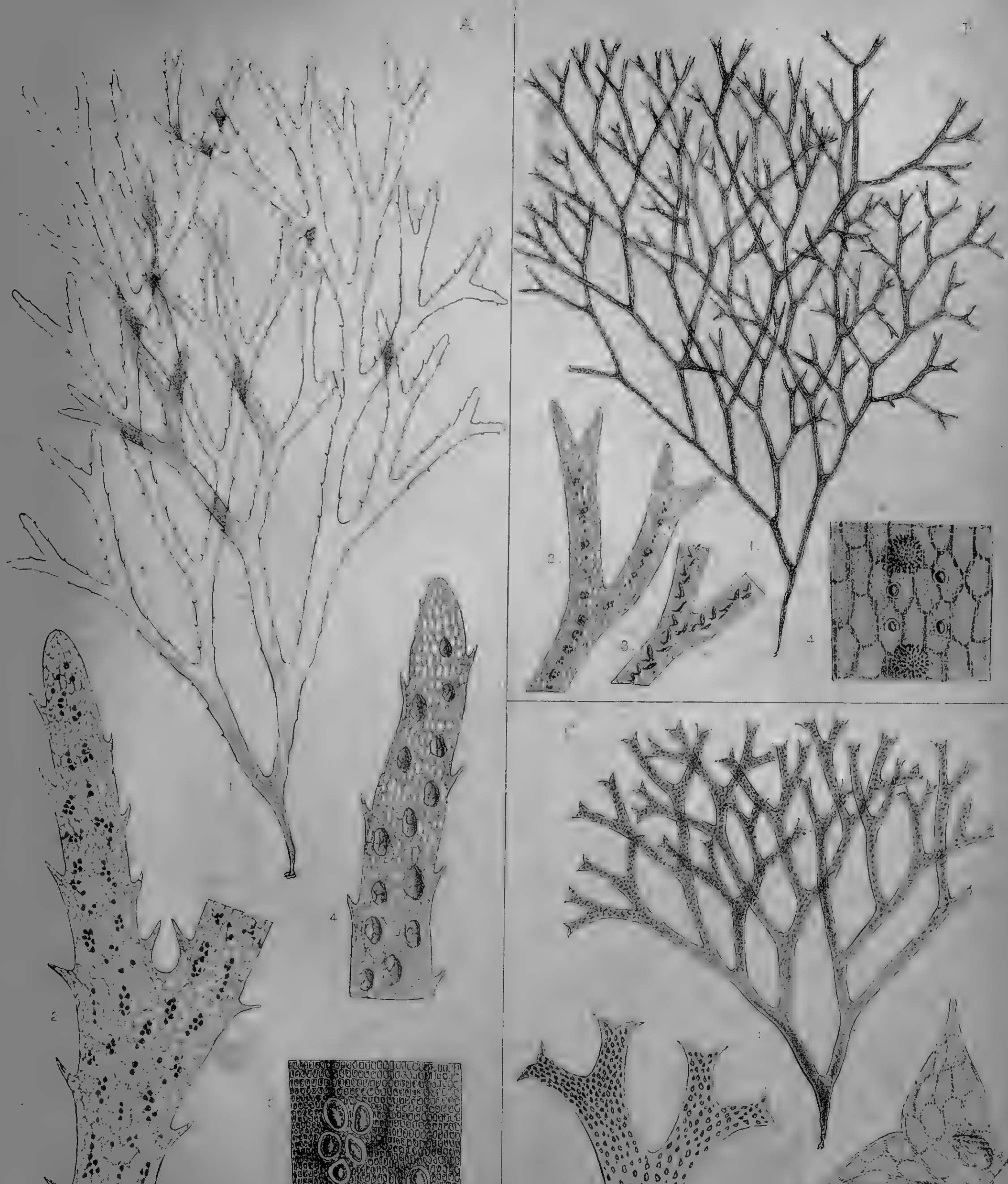
Plate VIII



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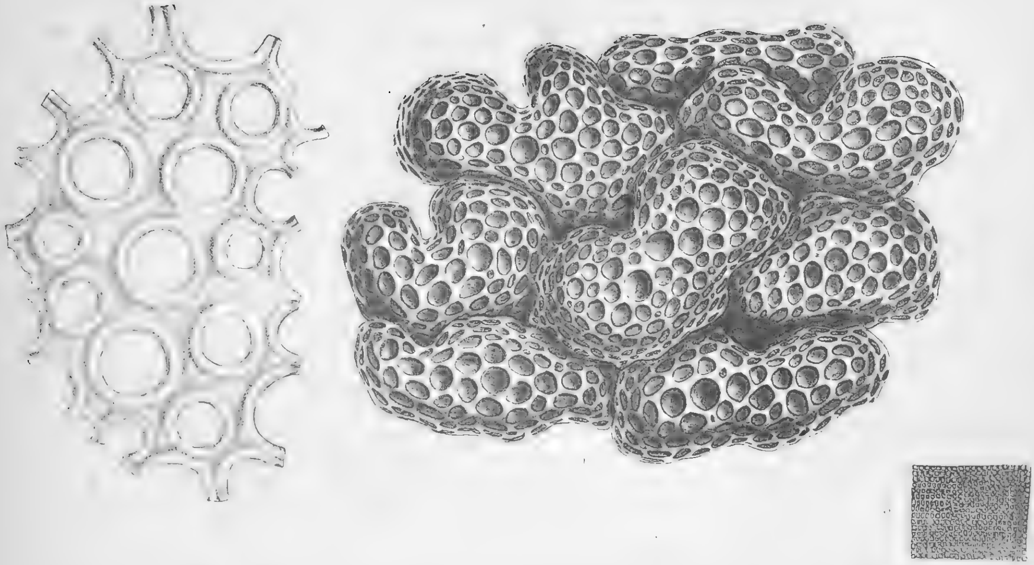

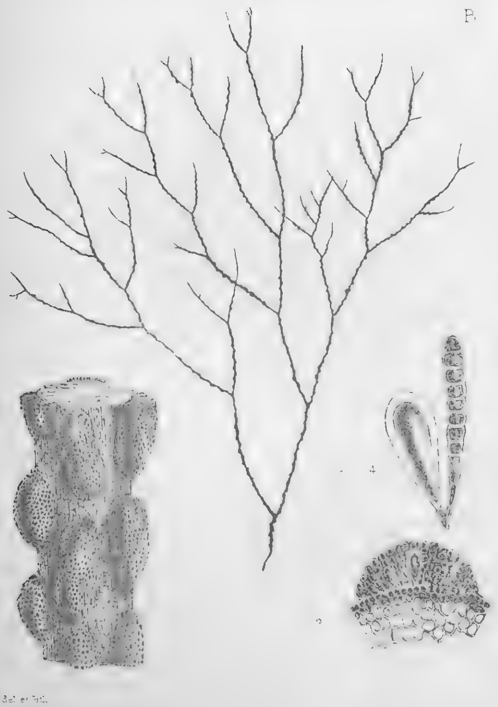

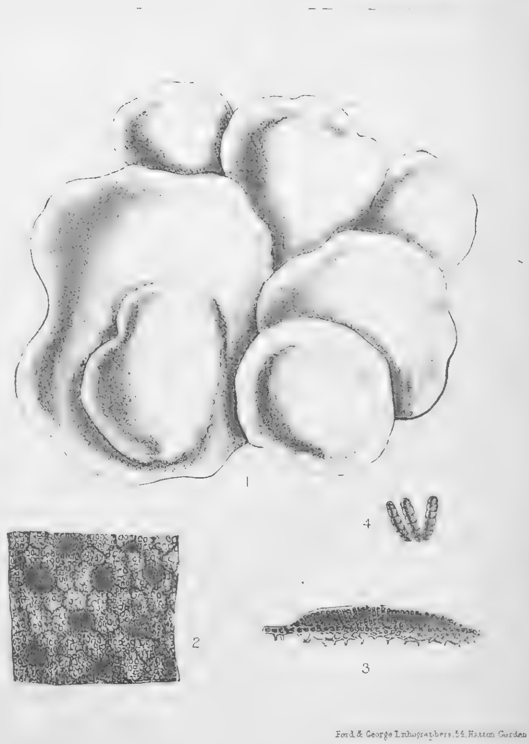

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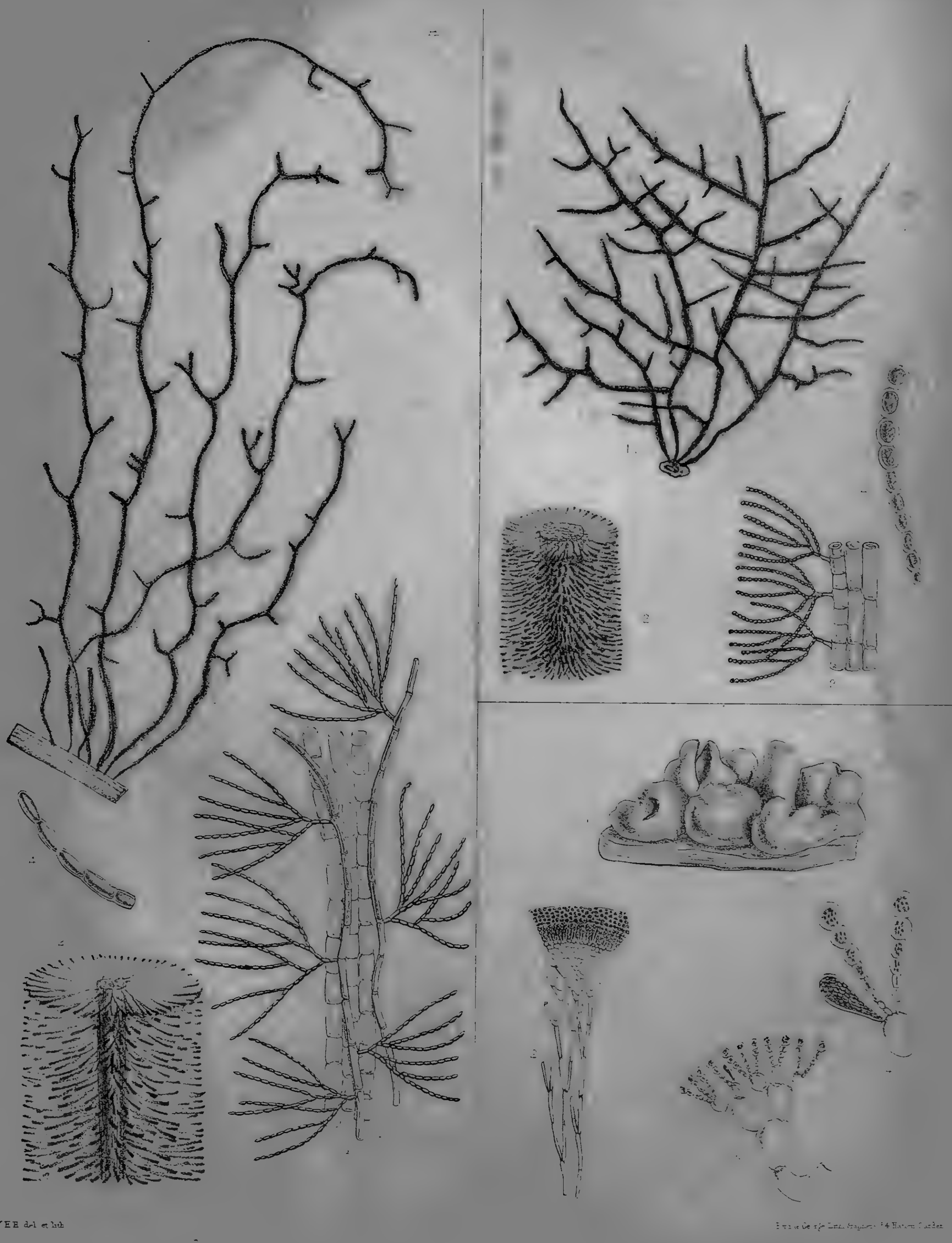

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Plate X!

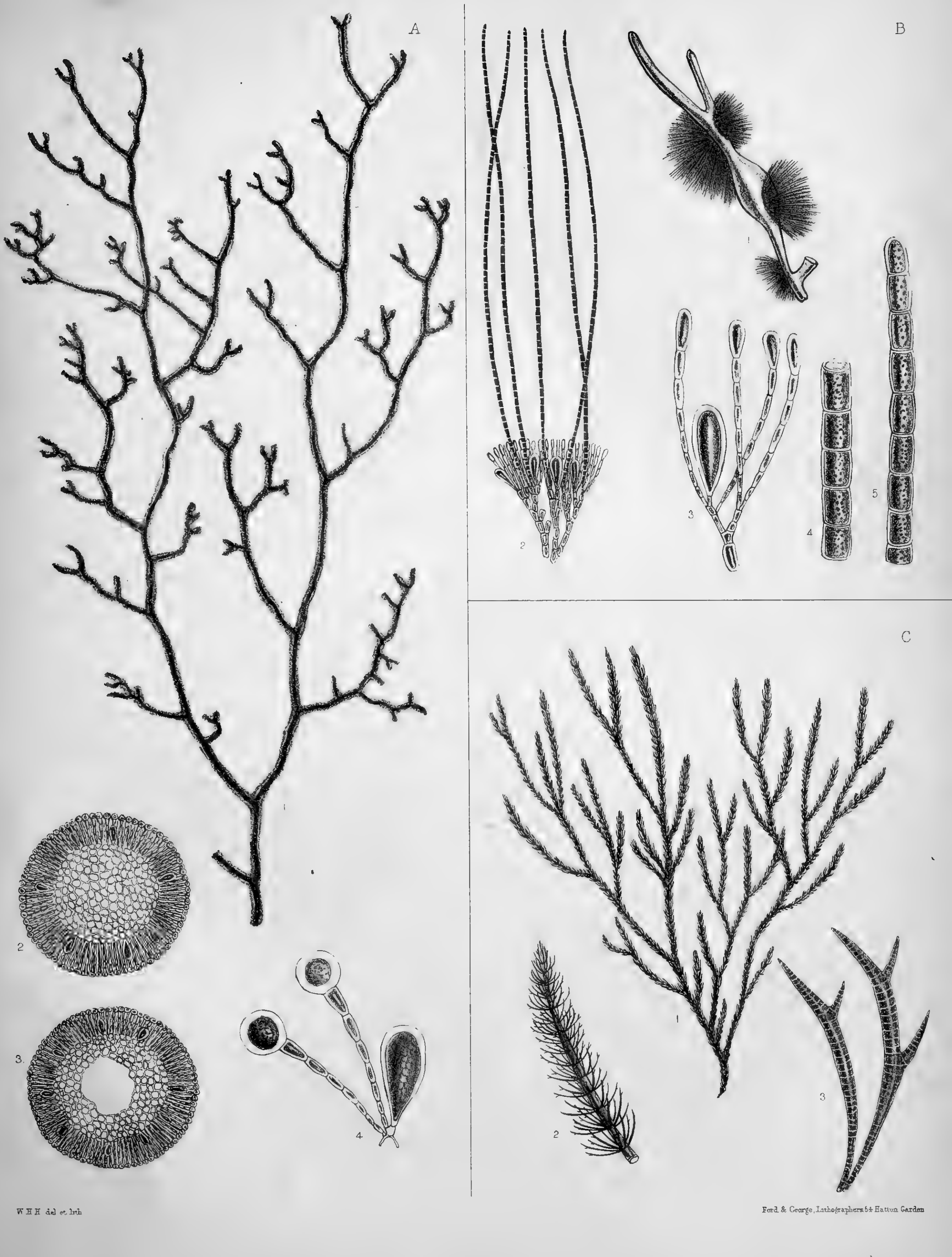

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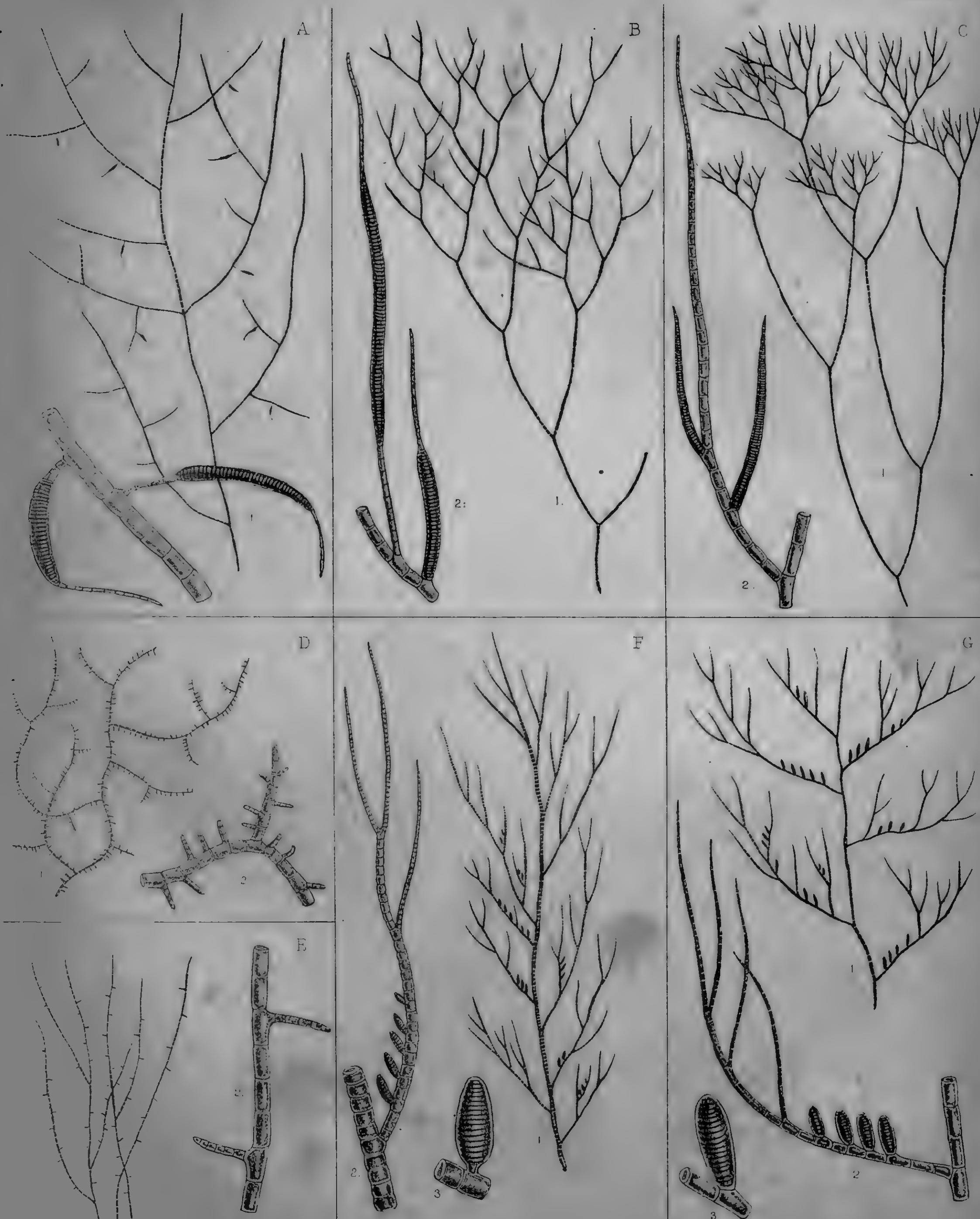
Plate XII



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PLANTÆ WRIGHTIANÆ

TEXANO–NEO-MEXICANÆ,

BY

ASA GRAY, M. D.,

FISHER PROFESSOR OF NATURAL HISTORY IN HARVARD UNIVERSITY.

PART I.

ACCEPTED FOR PUBLICATION

BY THE SMITHSONIAN INSTITUTION,

MARCH, 1850.

COMMISSION

TO WHICH THIS PAPER HAS BEEN REFERRED.

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JOSEPH HENRY, *Secretary.*

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PLANTÆ TEXANO-MEXICANÆ.

PART I.

PLANTÆ WRIGHTIANÆ TEXANO-NEO-MEXICANÆ:

AN ACCOUNT

OF

A COLLECTION OF PLANTS MADE BY CHARLES WRIGHT, A. M.,

IN AN EXPEDITION FROM TEXAS TO EL PASO, NEW MEXICO, IN THE SUMMER AND AUTUMN OF 1849.

Mr. Charles Wright, who has for several years past devoted much attention to the botany of Texas, returned to Galveston from the North in the spring of 1849, and proceeded to San Antonio, purposing to avail himself of the opportunity afforded by the movement of a body of United States troops from this place across the country to El Paso, in Southern New Mexico, to investigate the natural history, and especially the botany, of this hitherto untrodden region. A recommendation from the War Department, that all proper facilities should be furnished to Mr. Wright, in furtherance of his arduous and entirely scientific undertaking, procured for him only the free transportation of his paper for preserving specimens, and of the collections he was enabled to make. This favor he owes to the kindness of Captain French, the quartermaster of the expedition, to whom and to Major Henry and Major Van Horn, Mr. Wright desires to express his thanks. The train left the frontier settlement of Castroville about the first of June, and reached El Paso early in September. The remainder of that month was devoted to making collections in the vicinity of that interesting station. Finding that much time would necessarily be lost in passing the long winter in New Mexico, Mr. Wright retraced his steps, and accompanied his rich collections back to Texas by the return train, leaving El Paso in October, and reaching San Antonio late in November. In returning he was enabled to add to his collection some species which had escaped notice during the outward journey, or which were not then in season, as well as largely to increase his collection of seeds, and of living Cactaceous plants. Specimens of the latter have been placed in the hands of Dr. Engelmann, of St. Louis, for examination. The seeds have been divided between the Botanic Garden of Harvard University, under my charge, and the Royal Botanic Gardens at Kew, under the direction of Sir Wm. Hooker.

A full set of the plants here enumerated or described is retained in my own herbarium; another becomes the property of the Smithsonian Institution, which has efficiently patronized this exploration. It will there form, with similar sets of the collections of Fendler and Lindheimer, made in New Mexico and Texas, the nucleus of an important and authentic North American herbarium, destined to be enriched, I trust, by continued accessions, especially from our newly-acquired territories, until it shall comprise representatives of our whole flora, and specimens of all the vegetable products of our wide country.

Another set of these plants will be found in the herbarium of John A. Lowell, Esq., of Boston, who has liberally patronized Mr. Wright's scientific explorations. The others, eight or nine in number, are about to be issued to the subscribers who have applied for them.

The numbers prefixed to the names are those under which the specimens are distributed. Those marked with a †, in place of a number, were collected in single specimens, or at least not in sufficient quantity for distribution.

The whole will give a good idea of the vegetation, and consequently of the climate, general character, and capabilities, of the region traversed. I append, from time to time, notices or characters of plants gathered by other collectors in adjacent regions, especially by Dr. Wislizenus in the valley of the Rio Grande and in Chihuahua, and by the indefatigable Dr. Gregg * in the same district and in the northern provinces of Mexico, — chiefly from materials obligingly furnished by Dr. Engelmann.

Orders or genera elaborated by Dr. Engelmann, Dr. Torrey, Mr. Bentham, or others, have the name of the author prefixed.

A proper account of the topography and physical character of the region traversed by the United States troops in their march from Texas to New Mexico will doubtless be officially published, before the printing of this memoir is completed. It is therefore unnecessary for me to attempt to compile any such account from Mr. Wright's disjoined and necessarily imperfect memoranda.

A. GRAY.

HARVARD UNIVERSITY, CAMBRIDGE, May, 1850.

* Tidings of the lamented death of this most assiduous collector, in California, have just been received.

Part I.

RANUNCULACEÆ.

1. Clematis Drummondii, *Torr. & Gray, Fl.* 1. *p.* 9; *Gray, Pl. Lindh.* 2. *no.* 319; var. foliis parvulis ramulisque magis sericeis. Bluffs of the Rio San Felipe, July; also in the pass of the Limpia, in valleys between the mountains, Aug.; in fruit. Apparently the same as No. 634 and 637 of Coulter's Mexican collection, named by Dr. Harvey "C. caudata, *Hook.*," — a species which I have not found described. A few specimens of the normal form were gathered in Western Texas.

† Ranunculus repens, *Linn.;* var. caulibus elongatis; floribus pleiopetalis. Margin of the Limpia, August.

MENISPERMACEÆ.

2. Cocculus Carolinus, *DC.; Gray, Gen. Ill.* 1. *t.* 28. High prairies, between the San Felipe and San Pedro Rivers, July.

NYMPHÆACEÆ.

3. Nymphæa Mexicana, *Zuccarini, Abhand. Math.-Phys. Bayersch. Acad.* 1. *p.* 365? ex char. in *Walp. Repert.* 1. *p.* 108. In a pond near the head of the Leona; June. (In flower and fruit.) — A slender species, with a short rhizoma. Leaves three or four inches long, obscurely crenate or mostly entire. Petals an inch and a half long, tinged with blue in the dried specimens; the color of the recent flowers not recorded. Seeds smaller than in N. odorata, globular, smooth.

† N. ampla, *DC. Syst.* 2. *p.* 54; *Hook. Bot. Mag., t.* 4469. A specimen of this plant was gathered by Mr. Wright in 1848 on the Rio Grande, above Presidio de Rio Grande. The anthers are terminated by a slender tip.

CRUCIFERÆ.

4. Streptanthus linearifolius, *Gray, Pl. Fendl. in Mem. Amer. Acad. n. ser.* 4. *p.* 7. Valley of the Limpia or Wild Rose Creek; Aug. — The root is plainly perennial. I was doubtless mistaken in attributing to Fendler's specimens an annual or biennial root.

5. S. petiolaris, *Gray, Pl. Fendl. l. c. in not.* San Marcos Spring, Texas.

6. S. bracteatus, *Gray, Gen. Ill.* 1. *p.* 146, *t.* 60, & *Pl. Lindh.* 2. *p.* 143. Sand-bars of the Colorado; April. — With entire and with lyrately parted or divided leaves.

7. Thelypodium Wrightii (sp. nov.): foliis lanceolatis repando-dentatis vel denticulatis omnibus in petiolum brevem angustatis; petalis calycem vix superantibus; racemo fructifero denso modice elongato; siliquis patentissimis elongatis brevissime stipitatis. — Pass of the Limpia, on the mountains of New Mexico; Aug. (in flower and with immature fruit). — Stem two or three feet high, from a biennial or annual root. Leaves broadly lanceolate, or lanceolate-oblong, from two to four inches in

length, all repand-toothed or denticulate. Flowering racemes short and dense; the flowers, &c., much as in T. integrifolium, *Endl.* (Pachypodium integrifolium, *Nutt. in Torr. & Gray*, *Fl.* 1. *p.* 96), except that the petals are by no means so long; the fruiting raceme becoming four or five inches in length. Pedicels divaricate in flower and fruit, six lines long. Siliques (immature) slender, two inches long, or nearly, widely spreading. Ripe seeds not seen. In T. integrifolium the pods are only an inch long, and erect or ascending.

8. Erysimum asperum, *DC.*; *Hook. Fl. Bor.-Am.* 1. *p.* 64, *t.* 22; var. siliculis breviusculis adscendentibus. Plains at the western base of the Guadaloupe Mountains, El Paso; Oct.

9. Sisymbrium auriculatum (sp. nov.): annuum seu bienne, parce pilosulum; caule erecto ramoso; foliis lyrato-pinnatifidis subruncinatis petiolatis, caulinis basi auriculis duobus rotundatis stipuliformibus amplexicaulibus instructis, lobis dentatis triangulatis oblongisve; racemo virgato fructifero prælongo; floribus albis majusculis; siliquis patentibus teretibus gracilibus stylo brevi manifesto superatis pedicello divaricato quadruplo longioribus; seminibus ovalibus. — Valley of a stream, about ten miles from the Rio Grande, below El Paso; Sept. — Plant two or three feet high, with somewhat the aspect of S. Irio; but with less deeply cut leaves, and larger, white flowers. It is especially characterized by the stipuliform auricles at the base of the leaf, remote from the lower of the proper lobes. Flowers three lines long, on spreading pedicels of about the same length; the spatulate petals conspicuous. Raceme in fruit attaining eighteen inches or more in length. Siliques an inch and a half long, slender, widely spreading, or somewhat ascending on the divaricate pedicels: valves 3-nerved, the midnerve more prominent. — Dr. Gregg has the same species from San Antonio de las Alanzanes, Mexico (No. 428 and No. 367), but with less membranaceous leaves and shorter pods.

10. S. diffusum (sp. nov.): perenne, pube 3–4-fida minuta canescens; caulibus ramosissimis diffusis; ramis usque ad apicem foliosis; foliis oblongis obtusis basi attenuatis sinuato-dentatis imisve pinnatifidis; floribus parvis; petalis calyce brevioribus; siliquis patentibus teretibus fere subulatis brevibus (4–5 lin. longis) canescentibus stylo manifesto superatis; seminibus (immaturis) oblongis. — Pass of the Limpia, in crevices of rocks on the mountains; Aug. — Stems about a foot high, from an elongated and rather ligneous root, much branched, bushy; the branches and branchlets diverging. Cauline leaves about an inch long, the lower somewhat petioled. Racemes short, branching, often bracteate at the base. Flowers minute in all the specimens, with the petals barely discernible; perhaps they are sometimes more manifest. Siliques scarcely thicker than their pedicels, tipped with a style fully half a line in length. — This species is apparently allied to S. humile of C. A. Meyer, but it certainly is not the plant figured by Ledebour.

GREGGIA, *Nov. Gen.*

Calyx basi æqualis, sepalis lineari-oblongis patentiusculis. Petala obovato-rotundata, ungue angusto. Discus hypogynus inter petala et stamina annularis, contorto-lobatus, lobis ante stamina. Filamenta edentula, filiformia. Ovarium oblongum a latere compressum, stylo æquilongum: stigma cordatum, bilobum, lobis ad placentas respondentibus. Siliqua breviter linearis, septo angusto subenervi contrarie plano-compressa, utrinque retusa, stylo conspicuo superata; valvis naviculari-conduplicatis, dorso tenuissime uninerviis. Semina in loculis plurima (20 – 40), uniserialia, e funiculo libero pendula, ovalia, turgida, immarginata. Cotyledones lineari-oblongæ, planæ, septo (ut videtur) parallelæ, radiculæ adscendenti incumbentes. — Suffrutex humilis, pube molli stellata canescens; caulibus a basi ramosis diffusis; foliis spathulatis sæpius repandis vel sinuato-dentatis in petiolum angustatis; racemis laxis; floribus majusculis albis; siliquis cano-puberulis (6 – 8 lin. longis) pedicello æqualibus vel sublongioribus.

11. Greggia camporum. (Tab. I.) High prairies and calcareous hills, at the head of the San Felipe; July (in flower and fruit). Also gathered, some years since, "west of Parras" in Cohahuila, and later at Cerros Bravos, by Dr. Josiah Gregg, the author of the "Commerce of the Prairies," and other writings on the physical character, productions, and resources of New Mexico, and who has for several years past been a most diligent explorer and collector of the botanical treasures of New and Northern Mexico. Intelligence of his lamented decease, in California, (from over-exertion in scientific investigation in the interior,) having reached me while engaged in the study of this interesting plant, — one of his own discoveries, — I dedicate the genus to his memory, and give to the species a name that associates it with the plains of the Southwest, which this enterprising discoverer has so largely explored and so ably illustrated. The genus formerly dedicated to Dr. Gregg by my friend and colleague, Dr. Engelmann, proves to be the Cowania purpurea of Zuccarini, and is, without doubt, a true Cowania. — It will be seen that the Cruciferous plant here described and illustrated, from Mr. Wright's excellent specimens, is the same as that which is briefly noticed in *Plantæ Fendlerianæ*, p. 116, in a note, under Synthlipsis. It proves to have, as I suspected, *incumbent* cotyledons, as well as other characters which abundantly distinguish it from the last-named genus, notwithstanding the similarity in aspect and in the lateral compression of the pods. If the pod be deemed a silicle, the genus would fall into the tribe Lepidineæ of De Candolle's arrangement, where it would appear to be out of place. If it be called a silique, the strong compression contrary to the septum would seem to exclude it from the Sisymbrieæ. The flowers are apparently somewhat handsome; the broad and rounded petals are nearly four lines long, including the abrupt claw. — The mucilaginous mass which envelopes the seeds of most Cruciferæ when moistened is here pretty evidently seen to arise from the disruption of delicate cells on the surface of the testa, and the uncoiling and softening of a contained gelatinous coil, as in Collomia, &c.

12. Hymenolobus pubens (sp. nov.): caule erecto ramoso racemisque prælongis densifloris pube stellata subcinereis; foliis caulinis glabratis lanceolatis oblongisve parce dentatis (imis ignotis); silicula ovali cinereo-pubescente stylo brevi apiculata. — Margins of a pond, in a valley about eighty miles beyond the Pecos; August. — Annual or biennial, from twelve to twenty inches high, including the fully-developed fruiting racemes, which are from six to ten inches long, rather

stout and strict, and loaded with pods. All the lower leaves have fallen; the upper are half an inch or more in length. Silicles about three lines long, a little shorter than the pedicels, oval, inflated, moderately compressed contrary to the partition, cinerous, like the pedicels, &c., with a close stellular pubescence, not emarginate, tipped with a short but distinct style; the boat-shaped valves not keeled, obscurely 1-nerved; the septum linear-oblong. Seeds very numerous in two series in each cell, oblong-oval, marginless, compressed contrary to the incumbent cotyledons. — A much stouter plant than any of the species of Hymenolobus enumerated by Nuttall, but, except in the distinct style, the characters accord with those of that genus, and with no other known to me.

13. Dithyrea Wislizeni, *Engelm. in Wisliz. Mem. N. Mex., p.* 11. Iberis, n. sp.? *Torr. in Ann. Lyc. Nat. Hist. New York,* 2. *p.* 166. Valley of the Rio Grande, sixty or seventy miles below El Paso; Sept. (in flower and with ripe fruit). — A striking plant, apparently common in the valley of the Rio Grande del Norte, and well characterized by Dr. Engelmann.

14. Vesicaria Engelmannii, *Gray, Gen. Ill.* 1. *p.* 162, *t.* 70, *& Pl. Lindh.* 2. *p.* 144. Banks of the Rio Blanco, Western Texas; May.

15. V. argyræa, *Gray, Pl. Lindh.* 2. *p.* 146; var. foliis minus argenteis. Hills of the Leona, and prairies of Live Oak Creek; June.

15[a]. V. densiflora, *Gray, Pl. Lindh.* 2. *p.* 145. Near Austin, Texas; May.

16. V. stenophylla, *Gray, Pl. Lindh. l. c. p.* 149, *in not.* Gravelly bars of the Rio Frio, Western Texas; June. Calcareous hills of the Rio San Felipe, and of the San Pedro; July. Mountain valleys beyond the Limpia pass; Aug. Also gathered, the previous year, on the Texan side of the Rio Grande, near Presidio. The collection embraces various forms of the species. In some of them the radical leaves are rather broadly spatulate.

17. Lepidium alyssoides, *Gray, Pl. Fendl., p.* 10. Valley of the Pecos; Aug. Mountain valleys farther towards the Rio Grande, and in the valley of that river sixty or seventy miles below El Paso; Sept.; in flower and fruit. — Cotyledons incumbent. — Dr. Gregg gathered the same species near Buena Vista, and in the valley of Conchos, below St. Rosalia.

18. L. sordidum (sp. nov.): humile, bienne; caulibus diffusis a basi ramosissimis ramulisque tenuiter granuloso-viscosis; foliis (imis ignotis) caulinis parvis spathulatis inciso-pinnatifidis glabris; racemis multis, fructiferis elongatis densis; floribus minimis fere apetalis tetrandris; siliculis ovatis emarginatis apteris glabris pedicellis erectiusculis confertis æquilongis; cotyledonibus incumbentibus. — In mountain valleys east of the Rio Grande del Norte; Aug. — A depressed, insignificant species; the specimens loaded with fruiting racemes, on which the pedicels are densely crowded. Silicles barely half as large as those of L. Virginicum.

CAPPARIDACEÆ.

19. Polanisia uniglandulosa, *DC. Prodr.* 1. *p.* 242. Cleome uniglandulosa, *Cav. Ic.* 4. *t.* 306. Hills near El Paso, and on the San Pedro; Aug.-Sept. — The specimens have more or less stipitate pods, as has the similar plant in Coulter's

Mexican collection from Zimapan, and other New Mexican specimens from Dr. Gregg. But Dr. Engelmann has remarked the same thing in some of Lindheimer's Texan specimens of P. trachysperma, which, as already remarked, can hardly be more than a Northern, smaller-flowered form of P. uniglandulosa.

20. Wislizenia refracta, *Engelm. in Wisliz. Mem. N. Mex., p.* 15. (Tab. II.) Along the Rio Grande, five miles below El Paso; Sept., in flower and with abundant ripe fruit. — This very remarkable and quite handsome Capparidaceous plant, abundantly gathered by Mr. Wright in the region where it was discovered by the enterprising scientific traveller whose name it bears, is so well characterized by Dr. Engelmann, as to leave nothing of any importance to add, except to give a figure, with analyses, made by Mr. Sprague from his own dissections. From Oxystylis, *Torr. & Frem.*, which I have barely seen in Dr. Torrey's herbarium, it seems to be well distinguished by the characters adduced by Dr. Engelmann, by the filiform (not gladiate and spinous) style, and by a marked difference in habit. — The subjoined note on the species of the allied genus *Cleomella*, drawn up some time since, has been recently communicated by Professor Torrey.*

* *Notes on* CLEOMELLA; by John Torrey.

This genus was founded by De Candolle, on an unpublished drawing of a Mexican plant, of which specimens seem to be almost unknown in European herbaria. The description of De Candolle is brief and unsatisfactory. It was with doubt that I referred to his *Cleomella Mexicana* a plant found in Western Arkansas by Dr. James, in Long's first expedition. The latter plant was afterwards detected by Mr. Drummond, in Texas, and by Mr. Beyrich, on the Upper Platte. It was described and figured by Sir William Hooker, in the first volume of his *Icones*, as C. Mexicana, and described under the same name in the *Flora of North America*, as well as in the recent *Genera Illustrata* of Dr. Gray. Another species of the genus was discovered by Colonel Fremont, in California, and published in his second report. About three years ago I received from Dr. Halsted excellent specimens of a Cleomella, which he collected on the march of our army from Vera Cruz to the city of Mexico. This is probably the original species of De Candolle, as it seems to be exclusively Mexican, while the Cleomella of Texas and Arkansas has not been found beyond those States, except in their immediate borders. I have, therefore, changed the name of the latter plant. A fourth species of the genus was discovered by Dr. Gregg in Chihuahua and San Luis Potosi, in 1847 and 1848. The following synopsis will exhibit the leading characters of all the species.

1. Cleomella Mexicana (DC.): foliolis spathulato-obovatis obtusis vel retusis glabris; bracteis plerumque trifoliolatis; ovario stylum brevissimum multoties superante stipitem subæquante; capsula retusa subbicorni stipitem superante; seminibus lævibus. — C. Mexicana, *DC. Prodr.* 1. *p.* 237; *D. Don. in Edinb. New Phil. Jour., Jan.* 1831. — *Hab.* Mexico, *Moçino & Sesse*, ex *De Candolle.* Between Vera Cruz and the city of Mexico, *Dr. Halsted.* — This species is about a foot high, much branched, and apparently diffuse. The leaflets are about one third of an inch long, quite glabrous, somewhat fleshy, and mucronate with a short bristle. The petiole is about as long as the leaflets. Stipules minute, subulate and entire. The golden-yellow flowers are in terminal racemes, which are finally much elongated. Petals about three times the length of the sepals. Pod 6 – 8-seeded, almost two-horned by the projecting upper angles of the valves, the breadth (about 3½ lines) nearly twice as great as the length. Fructiferous pedicels 4 – 5 lines long.

2. C. longipes (sp. nov.): foliolis spathulato-obovatis obtusis vel retusis integerrimis vel margine serrulato-scabris; bracteis superioribus simplicibus; ovario stylum bis superante stipite pluries breviore; capsula retusa subbicorni stipite subduplo breviore. — *Hab.* Valley near San Pablo, Chihuahua, and near San Francisco, San Luis Potosi, Mexico, *Dr. Gregg.* Collected in flower only, April 29th, and in both flower and fruit, Dec. 28th. — Differs from the preceding in the considerably larger and less conspicuously

VIOLACEÆ.

21. Ionidium lineare, *Torr. in Ann. Lyc. Nat. Hist. New York*, 2. *p.* 168; *Torr. & Gray, Fl.* 1. *p.* 145; *Gray, Gen. Ill.* 1. *t.* 82, & *Pl. Lindh.* 2. *p.* 151. Forma normalis Torreyi, multiceps, humilis; foliis omnibus angustis acutis, majoribus etiam linearibus vel lanceolatis 2–3-pollicaribus; stipulis plerisque parvulis, inferioribus minutis. — Declivities along the San Pedro or Devil's River; July: in flower and fruit. — The numerous specimens are only a span high, from a ligneous root, with quite narrow and slender leaves, scarcely longer, however, than the upper ones of Lindheimer's No. 344. They are principally alternate. Marked as this form is, it is too clearly connected with the next to admit of a specific separation.

22. I. lineare, *Torr.*; var. stipulis majusculis; foliis plerisque linearibus, imis obovatis. — I. stipulaceum, *Nutt.* Western Texas; May.

23. I. lineare, *Torr.*; var. platyphyllum: magis puberulum; caulibus erectis sesquipedalibus; foliis oblongo-lanceolatis 4–6 lin. latis rariter serratis. — Valley of the Limpia or Wild Rose Creek; Aug. — This appears to be widely different from No. 21, but I cannot regard it as other than the opposite extreme of the same species, which varies greatly as to the foliage.

ELATINACEÆ.

24. Elatine Texana, *Hook. Ic. Pl. t.* 278 (sub "Merimea seu Burgia"); *Gray*,

mucronate leaves, the remarkably long stipe, and the conspicuous style; while the upper bracts seem to be uniformly simple. Seeds the same as in C. Mexicana.

3. C. obtusifolia (Torr. & Frem.): foliolis cuneato-obovatis obtusissimis integerrimis supra glabris subtus pubescentibus; bracteis unifoliolatis; sepalis lacerato-3–5-dentatis; ovario stipite 4–5-ties breviore stylo bis breviore; capsula . . . . — *Torr. & Frem. in Frem. Second Report, p.* 311. — *Hab.* On the American Fork of the Sacramento River, California; flowering in March, *Colonel Fremont.* — My only specimen of this species is that of an annual, about a span high, but doubtless much larger when mature. The stem is branched from the base, and glabrous. The leaflets are about half an inch long, and are tipped with a deciduous bristle. Stipules laciniately fimbriate. Calyx much shorter than the corolla. Petals yellow, oblong-lanceolate. Stipe much exserted. Ovary obovate, with apparently but few (about 6) ovules. Capsule unknown. — This species in its fimbriate stipules and long style resembles *Wislizenia* of Engelmann (in Wislizenus's *Report on New Mexico*, p. 99, 1848). It was named when the only Cleomella known to our botanists was the narrow-leaved one described below. Were it not possible that it may prove to be a distinct genus (which can be told only when the fruit is known), I should propose to call it *C. Fremontii.*

4. C. angustifolia: foliolis oblongo-linearibus acutiusculis integerrimis; bracteis superioribus simplicibus; ovario stylum multoties superante stipite bis terve breviore; capsula dilatato-rhomboidea acuta; seminibus transverse rugulosis. — C. Mexicana, *Torr. in Ann. Lyc. Nat. Hist. New York*, 2. *p.* 167; *Hook. Ic.* 1. *t.* 28; *Torr. & Gr. Fl. N. Am.* 1. *p.* 121; *Gray, Gen. Ill.* 1. *p.* 174, *t.* 75, & *Pl. Lindh. no.* 10 (*in Bost. Jour. Nat. Hist.* 5, 1845), non *DC.* — *Hab.* Western Arkansas, *Dr. James.* On the Upper Platte, *Mr. Beyrich.* San Felipe, Texas, *Drummond.* High prairies west of Houston, *Lindheimer.*

[Don's account of *Cleomella Mexicana*, from *original specimens*, in the journal above cited, suffices to identify the Candollean species with the Mexican plant gathered by Dr. Halsted. Had not this account been overlooked, the mistake in respect to the Arkansan and Texan plant would have been long since corrected. I have also the true C. Mexicana from Coulter's Mexican collection. A second species, which I do not possess, recorded in Professor Harvey's list as *Cleomella Coulteri*, n. sp., is probably the C. longipes, characterized above. A. G.]

Gen. Ill. 1. *p.* 218, *t.* 96, *& Pl. Lindh.* 2. *p.* 187. Valley of the Rio Grande, sixty or seventy miles below El Paso; Sept.

CARYOPHYLLACEÆ.

25. LŒFLINGIA SQUARROSA, *Nutt. in Torr. & Gray, Fl.* 1. *p.* 174; *Hook. Ic. Pl. t.* 285; *Gray, Gen. Ill.* 2. *t.* 106. Sandy road-sides, Austin, Texas; May.

26. PARONYCHIA LINDHEIMERI, *Engelm. in Pl. Lindh.* 2. *p.* 152. Mountains between the Limpia or Wild Rose Creek and the Rio Grande; Aug. — The specimens well accord with Lindheimer's and with Wright's Texan specimens.

27. P. JAMESII, *Torr. & Gray, Fl.* 1. *p.* 170; *Gray, Pl. Fendl. p.* 14. Hills of the San Pedro River; July. — Resembles the larger form among Fendler's specimens, No. 69; but with the calyx rather more hairy: in both, the sepals are tipped with a cusp or awn as long as that of P. dichotoma.

28. P. JAMESII, var. canescenti-puberula, cymis confertis multifloris. — Crevices of rocks on a creek beyond the Pecos, growing in strong tufts; Aug.

PORTULACACEÆ.

29. SESUVIUM PORTULACCASTRUM, *Linn. Sp. ed.* 2. *p.* 684; *DC. Prodr.* 3. *p.* 453: var. floribus subsessilibus. (S. sessile, *Pers.; DC. Pl. Grass. t.* 9.) Low bottoms of the Rio Grande below El Paso; Sept. — The specimens, as well as those gathered by Gregg and Wislizenus in Northern Mexico, all belong to the form with subsessile flowers.*

30. "PORTULACA RETUSA, *Engelm. Pl. Lindh.* 2. *p.* 154. Valley of the Rio Grande below El Paso, in sandy soil. The long style and the broadly winged sepals are decisive as to the identity of this species. The seeds are of the same size and roughness as those of Lindheimer's specimens, but opaque and black, not grayish. The only specimen before me is a small erect plant, without any flowers. [In Mr. Wright's notes the flowers are said to be "yellow and minute."] — To the character of the *Spathulatæ* in *Pl. Lindh. l. c.* add: *Operculo capsulæ acuto sub apice constricto semina unum plurave includente.* I had overlooked this remarkable fact; but it constantly occurs in all the species of this section, both European and American." *Engelmann.*

31, 32. "P. PILOSA, Linn. W. Texas to New Mexico. I have before me specimens from six different localities, from the Brazos westward, collected by Lindheimer and Wright, differing from one another in the size and appearance of the seeds, and in the shape of the capsule; but these differences vary so much, that even varieties can hardly be characterized. In some the capsule is small with a long stipe, the operculum conic, the seeds very minute, and more or less shining with metallic lustre. In others the capsule is more than twice as large, the operculum semiglobose, the stipe very short, and the much larger seeds black and opaque." *Engelmann.*

* Sesuvium pentandrum, *Ell. Sk.* 1. *p.* 556 (figured in *Gen. Illustr. t.* 100), has been republished under the same name by Fenzl, in *Ann. Wien. Mus.* 2. *p.* 347, from Drummond's New Orleans specimens.

† Talinum aurantiacum, *Engelm. Pl. Lindh. l. c.* Common throughout South-western Texas. Also found by Dr. Wislizenus in the Jornada del Muerto.

33. "T. aurantiacum, β. angustissimum: foliis anguste linearibus; pedunculis ad basin vel vix supra basin articulatis; sepalis magis membranaceis quam petala brevioribus; stylo stamina æquante ovario vix longiore." *Engelmann.* — Bottoms of Live Oak Creek, and on the San Felipe; July. — The flowers, according to Mr. Wright, expand in the afternoon and last till the next mid-day. No. 92 of Drummond's 3d Texan collection, from San Felipe, is the same form. The earlier flowers in one of Wright's specimens show peduncles nearly as long below the articulation as in the ordinary T. aurantiacum, the later flowers of which have it abbreviated: so that it is not a distinct species, as Dr. Engelmann suspected it might be. To T. aurantiacum I must also refer Nos. 41, 714, and 715 of Coulter's Mexican collection, from Zimapan, &c., as well as (from the character) one from Wislizenus's North Mexican collection, which Engelmann had characterized as a new species. The peduncles in vigorous specimens are sometimes 2 – 3-flowered.

34. T. sarmentosum, *Engelm. Pl. Lindh. l. c.* On the Leona; June. — "Root thick, tuberous." To char. add, "bracteolis subulatis." *Engelm.* — Very near T. patens, which is cultivated in the gardens under the name of T. purpureum, and perhaps a prostrate variety of it.

35. "T. spathulatum (sp. nov.): caule erecto gracili folioso; foliis carnosis oblanceolato-spathulatis breviter cuspidatis in petiolum sensim attenuatis; cymulis axillaribus bracteatis laxe trifloris versus caulis apicem in paniculam dispositis; bracteis ovatis cuspidatis minutis deciduis; floribus longe pedicellatis [corolla ex cl. Wright flava]; seminibus nigris nitentibus tuberculatis." *Engelmann.* — Mountains of New Mexico east of the Rio Grande; August. — "Well distinguished from the nearly related T. sarmentosum by the narrower, spatulate leaves (2 – 3 inches long, and half an inch or more wide), by the short ovate bracts, the larger capsule, and the very much larger seeds, which are much more distinctly tuberculate." *Engelm.* To which I may add that the flowers are yellow, according to Mr. Wright's note. I believe it is in Coulter's Mexican collection, and have scarcely a doubt that it is T. reflexum, *Cav.*

TALINOPSIS, *Nov. Gen.*

Calyx ebracteatus, diphyllus; sepalis æqualibus, ovatis, muticis, membranaceis, persistentibus. Petala 5, hypogyna, libera, ovalia, exunguiculata, æstivatione imbricata, cito gelatinoso-marcescentia. Stamina circ. 20, in phalanges 5 petalis oppositas iisque adhærentes disposita: filamenta subulata: antheræ biloculares, loculis oblongis discretis. Ovarium fusiforme uniloculare: stylus columnaris, brevis, apice trifidus, lobis oblongis intus stigmatosis. Ovula numerosissima, subamphitropa, columellæ gracili centrali funiculis gracillimis inserta. Capsula fusiformis, subtrigona, calyce semiinclusa, ab apice trivalvis; epicarpio coriaceo valvarum ab endocarpio chartaceo 6-valvi dissiliente. Semina indefinita, uncinata, inappendiculata; testa laxa granulata; tegmine membranacea embryoni hamosi-arcuato conformi. Albumen fere nullum. — Fruticulus glaber, ramis gracilibus nodosis; foliis carnosis linearibus plerisque oppositis, axillis obsolete barbatis; inflorescentia terminali cymosa, internodiis articulatis, floribus in dichotomiis sessilibus; "corolla purpurea."

36. Talinopsis frutescens. (Tab. III.) Mountain valleys, seventeen miles east of the Rio Grande, New Mexico; Sept. — Plant apparently two feet high; the slender stems and branches entirely woody below, glabrous, except the minute hairs in the axils. Leaves 6 to 12 lines long, scarcely a line wide, probably nearly terete in the living state. Cyme few-flowered; the branches short, angled, articulated. Flowers closely sessile in the forks, disarticulating and readily falling away in the dried specimens. Sepals thin, very obtuse, several-nerved, with narrow scarious margins. Petals not unguiculate, in anthesis longer than the calyx. Filaments apparently all somewhat connate at the base, and further adnate, usually in fours, to the base of each petal. Anthers of two oblong and discrete cells, without any connective, as in Talinum teretifolium, Portulaca, &c. Style shorter than the ovary, rather longer than the somewhat dilated lobes or stigmas, which become gelatinous-confluent after anthesis. The free central placenta reaches quite to the narrowed apex of the cell, but is very slender, and not ovuliferous towards the summit: below the middle it is crowded with ovules, in shape like those of Portulaca oleracea. Capsule nearly half an inch long, covered, except the tapering summit, by the persistent, and, in the dried state, at length subscarious calyx, one-celled, three-valved from the apex: valves rather coriaceous, separating from a thin and white papery endocarp, each of the three valves of which splits into two; and the sutural nerves also incline to separate. Seeds crowded on the central placenta, uncinate or arcuate; the granulated testa rather loose and soft, but conformed to the thin internal integument, which is exactly conformed to the uncinate-arcuate, slender embryo; the albumen being reduced to a mere vestige, or to a few loose starch-grains, within the curvature. Radicle straight, when the seed is uncinate, or a little curved; the cotyledons incumbently incurved, as in Talinum teretifolium, &c., but sometimes, if I mistake not, accumbent. — A genus closely allied to Anacampseros of South Africa, and Grahamia, *Gillies*, of Chili, with much the habit of the latter; from which it is distinguished by the ebracteate flowers, the dissilient endocarp, and the wingless seeds.* From Anacampseros it differs in habit, in the persistent equal sepals, the short style, the coriaceous valves of the capsule, which do not separate from the base and fall away, &c.

37. Trianthema monogyna, *Linn. Mant. p.* 69; *Lam. Ill. t.* 375. Road-sides and banks of the Rio Grande, New Mexico; Sept.

MALVACEÆ.

38. Callirrhoë pedata, *Gray, Pl. Fendl., & Gen. Ill.* 2. *p.* 53. *t.* 118, excl. syn. Edges of thickets, near San Marcos; May. — The specimens sent by Nuttall to De Candolle and to Hooker, under the name of "Nuttallia pedata," are both the form of his Callirrhoë (demum Nuttallia) digitata, with shorter lobes to the leaves, and I

* The mature seeds of Gillies's specimens in the Hookerian herbarium furnish the means of completing the generic character of Grahamia, as follows: — Semina late membranaceo-alata, testa lævi. Embryo curvatus (radicula gracilis recta, cotyledonibus accumbenti-incurvis) albumen parcum semicingens.

now can hardly doubt that the drawing sent to Sir Wm. Hooker, from which the figure in the *Exotic Flora* was made, represents the same plant. *Nuttallia pedata* therefore merging in the earlier Callirrhoë digitata (of which it is merely a state, not a distinct variety), my name of *Callirrhoë pedata* may be allowed to stand for the present plant, excluding the Nuttallian synonymy, rather than that a new specific name should be introduced.

39. SIDALCEA MALVÆFLORA. Sida malvæflora, *Moç. & Sesse, Fl. Ic. Mex. ined.; DC. Prodr.* 1. *p.* 194. Sidalcea Neo-Mexicana, *Gray, Pl. Fendl. p.* 23. Margins of the Limpia River; Aug. "Plant 2–8 feet high: flowers purple." — That this is the original Sida malvæflora, I am convinced by inspection of the drawing in the collection of Prof. De Candolle, and of a specimen in Pavon's herbarium (now belonging to M. Boissier), ticketed "Sida palmata, Nueva Espagna." The drawing represents the stems, petioles, &c., as beset with spreading bristly hairs. The specimen above mentioned is much less so, and the plant is said in the Prodromus to be "glabriuscula." I am now of opinion, that the Sidalcea Oregana, which is the plant in cultivation under the name of Sida malvæflora, is not specifically distinct; and that here also belongs the Sida delphinifolia, *Nutt.*, which, from an original specimen in the Hookerian herbarium, I find has a perennial root. It is therefore distinct from the plant of Hartweg's Californian collection, No. 1667, which is characterized in *Pl. Fendl. l. c.*, and in *Plantæ Hartwegianæ*, as Sidalcea delphinifolia, and its stamineal column and fruit figured in the *Genera Illustrata*, 2. *t.* 120. The latter may be named S. hirsuta.*

40. MALVASTRUM TRICUSPIDATUM. M. carpinifolium, *Gray, Pl. Fendl. p.* 22 (excl. syn. Sida carpinifolia & S. planicaulis), *& Pl. Lindh.* 2. *p.* 161. Malva tricuspidata, *Ait. Kew. ed.* 2, 4. *p.* 210. M. Lindheimeriana, *Scheele in Linnæa*, 21. *p.* 470. W. Texas, &c. — Sida carpinifolia, *Linn. f. Suppl. p.* 307, is a true Sida, and is well distinguished in the original description by its short petioles, bifarious leaves, suffruticose stem, and biaristate carpels. It was merely a cultivated plant in Madeira. ("*Hab.* in Madera in horto monasterio Sti Francisci, *F. Masson.*") Having no specimen of it (and indeed I have as yet seen none from the Canaries), but having, under that name, a Madeira specimen of the Malva tricuspidata, *Ait.* (Sida carpinoides, *DC.*), I incorrectly referred all to one species, and adopted for it the oldest name. Both are doubtless natives of the warmer parts of America, but are now widely diffused over the world. In the Hookerian herbarium I find only M. tricuspidatum from the Canary Islands; but Mr. Webb has well described the Sida carpinifolia.†

41. M. COCCINEUM, *Gray, Pl. Fendl., p.* 24: a variety with remarkably broad and

* SIDALCEA HIRSUTA: annua; caule stricto simplici superne cum racemo denso hirsutissimo; foliis radicalibus rotundo-cordatis sublobatis, caulinis 7–9-partitis sectisve, segmentis linearibus angustis simplicibus; calycis hirsutissimi laciniis lineari-lanceolatis acuminatis tubo pluries longioribus; coccis reticulatis glabriusculis rostello molli erecto hispido apiculatis. — S. delphinifolia, *Gray, Pl. Fendl. p.* 19, *& Gen. Ill.* 2. *t.* 120, *fig.* 10–12, *& in Benth. Pl. Hartw. p.* 300, non Sida delphinifolia, *Nutt.*

† A plant of Rugel's Southern Florida collection (No. 90), distributed by Mr. Shuttleworth under the name of Malva Americana, Linn. var., differs from Malvastrum tricuspidatum merely in its apparently suffruticose stems, and its muticous carpels, the three cusps being slightly indicated, but obsolete.

large divisions of the leaves, to which belongs the plant mentioned in *Pl. Fendl. p.* 23, under the name of Sphæralcea pedata, *Torr. ined.*, and which makes an evident transition into Malvastrum grossulariæfolium (Sida grossulariæfolia, *Hook. & Arn.*). Bed of the Limpia River; Aug.

† M. COCCINEUM, a more canescent variety, with narrow divisions to the leaves, approaching the var. dissectum. Valley of the Limpia; Aug.

42. M. PEDATIFIDUM: suffruticosum; caulibus diffusis gracilibus ramosis; foliis tripartitis profunde trifidisve pilis stellatis parce hirsutis, segmentis lateralibus bifidis, terminali subtrilobo, omnibus subpinnatifido-incisis, lobulis dentibusve patentibus; stipulis subulatis; floribus sparsis axillaribus et secus ramulos laxe racemosis; bracteolis 3 setaceis; laciniis calycis triangulato-lanceolatis acuminatis tubo longioribus; carpellis muticis, rostro brevi complanato membranaceo inflexis. *Gray, Pl. Lindh. 2. p.* 160 (adnot.). — Dry soil along the Rio Grande near Presidio; also on hills near El Paso. — The New Mexican specimens are decidedly suffruticose. Stems 6 – 12 inches high, much branched, much more slender than in M. coccineum; the flowers smaller and paler (between a buff and a brick-color). The leaves are not canescent, but green and sparsely stellate-hirsute, and their segments incised or almost pinnatifid; the lobes are tipped with a deciduous mucro or short seta.

‡ M. LEPTOPHYLLUM * (sp. nov.): pube tenui lepidoto-stellata incanum; caulibus e basi lignescente plurimis adscendentibus spithamæis gracilibus; foliis inferioribus petiolatis trisectis, segmentis et foliis superioribus sessilibus anguste linearibus siccate involutis nunc filiformibus integerrimis; stipulis minimis caducis; bracteolis 2 – 3 setaceis caducis; lobis calycis triangulatis tubo æquilongis; carpellis reniformibus muticis. — Between W. Texas and El Paso, New Mexico, 1851. — Whole plant silvery-canescent with a fine and close lepidote-stellate pubescence: a great number of slender stems arising from a thickened woody base, bearing at the summit a few racemose flowers, which are smaller than those of M. pedatifidum. Upper leaves, and lobes of the lower trisected leaves, from 6 to 9 lines long. Calyx 5-cleft to the middle, the lobes ovate-triangular, shorter and less acute than those of M. pedatifidum. Corolla brick-red, half an inch in diameter. Carpels 9 or 10, tomentulose, reniform, beakless and pointless, forming a depressed umbilicate capsule, shorter than the calyx.

43. SPHÆRALCEA HASTULATA (sp. nov.): humilis, hirtello-pubescens; caulibus herbaceis e basi suffrutescente erectis nunc decumbentibus; foliis oblongis lanceolatisve hastato-subtrilobis sinuato-dentatis heteromorphis, junioribus subtus canescentibus; floribus longiuscule pedunculatis axillaribus solitariis ad apicem ramorum subracemosis; lobis calycis triangulato-lanceolatis acutis tubo subduplo longioribus fructiferis capsulam superantibus; carpellis biovulatis sæpius dispermis dorso hirtis mucrone brevi apiculatis. — Prairies beyond the Pecos, Aug.; in flower. (Also found by Mr. Trecul on the Nueces and Rio Grande, Texas.) Again collected by Mr. Wright during the past season, with fine fruit. — Stems a span to a foot high,

* Under this mark (‡) I introduce some species collected by Mr. Wright during the past season (1851), in a second journey from Texas to New Mexico, while attached to the corps of Colonel Graham, then surveyor of the Mexican boundary.

rather leafy, bearing few flowers towards the summit. Leaves one or two inches in length, on rather long petioles, acute or obtuse, coarsely and irregularly toothed or sinuate, and nearly all of them with two hastate lobes near the base: both surfaces are greenish, or the lower somewhat canescent when young; the upper becomes almost glabrous. "Flowers orange-red," larger than those of S. incana and S. Fendleri (No. 59, 60), the fruit also larger and with shorter cusps than in the latter, the lobes of the calyx narrower and more prolonged.

44. SIDA HEDERACEA, *Torr. in Pl. Fendl. p.* 23. Malva hederacea, *Dougl. in Hook. Fl. Bor.-Am.* 1. *p.* 107. M. Californica, *Presl. Rel. Hænk.* 2. *p.* 121. M. plicata, *Nutt. in Torr. & Gray, Fl.* 1. *p.* 227. Sida obliqua, *Torr. & Gray, Fl. l. c.* New Mexico, the locality not recorded.

46. S. HEDERACEA, a variety with more toothed leaves; otherwise as the Oregon plant, but less downy. Sandy bottoms of the Rio Grande, below El Paso; Sept. "Flowers pale yellow." — Various forms of this species have just been received from Mr. Wright's New Mexican collection of 1851; among them one with much smaller, more oblique and plicate, and laciniately toothed leaves.

‡ S. LEPIDOTA (sp. nov.): undique furfuraceo-lepidota vel argentata; caulibus e radice perpendiculari lignescente procumbentibus diffusis; foliis triangulari-cordatis vel hastato-sublanceolatis acutis basi valde obliquis laciniato-dentatis seu apicem versus integriusculis; pedunculis axillaribus solitariis unifloris; calycis ebracteolati lobis ovato-triangulatis acuminatis tubo subduplo longioribus corolla (ut videtur rubella) paulo brevioribus; carpellis dorso puberulis læviusculis rostro brevissimo obtuso apiculatis. — New Mexico; from Mr. Wright's collection of 1851. — Root long and rather woody. Stems 4 to 10 inches long, silvery with close lepidote scurf. Leaves on rather long petioles, clothed, especially when young, with similar scurf (instead of the loose stellate pubescence of S. hederacea), which at length becomes more sparse, or is partly deciduous, especially from the upper surface: they are from half an inch to an inch and a half long, quite variable in shape, the lower inclining to cordate or reniform, the uppermost to hastate-lanceolate. Peduncles as long as the petioles, or the lower elongated. Flowers mostly smaller than those of S. hederacea. A well-marked, although somewhat polymorphous, species of the section *Pseudo-Malvastrum.*

45. S. LEPIDOTA, var. DEPAUPERATA: magis argentea, foliis floribusque minoribus. — Hill-sides between El Paso and the mountains, Aug.; in flower only, and insufficient specimens: — hence I have characterized the species as above, from the more normal and better developed specimens gathered during the past summer.

47. S. LEPIDOTA, var. SAGITTÆFOLIA: foliis lanceolatis hastatis vel sagittatis basim versus sæpe dentibus laciniisve 2–3 instructis, cæterum integerrimis (infimis desunt). Mountain valley, sixty miles west of the Pecos; Aug. — This is evidently no more than a variety of S. lepidota, with narrower, chiefly rameal leaves, some of the uppermost nearly linear and entire.

48. S. CUNEIFOLIA: cano-tomentosa, humilis; caulibus e basi fruticulosa assurgentibus ramosissimis; foliis parvulis rotundato-cuneiformibus flabellato 3–5-nerviis crenato-dentatis repandisve utrinque concoloribus; stipulis linearibus petiolum

subæquantibus; floribus (flavis) brevissime pedunculatis folio brevioribus; carpellis 5 pubescentibus membranaceis turgidis apice inter rostra brevia mollia demum bivalvibus; semine globoso. — In subsaline soil, Texas, about thirty-five miles northeast of Eagle Pass, on the Rio Grande; September. — A well-marked, low, procumbent species, in foliage and habit not unlike a Hermannia. The soft, downy leaves are only about half an inch in length and breadth, on petioles of three or four lines long; the flowers are solitary, or often clustered in the axils, and sometimes scarcely exceed the petioles. The yellow corolla is twice the length of the calyx, and is half an inch in diameter when expanded. The ovate carpels are membranaceous, slightly inflated; the seed is proportionally large and spherical, as in Abutilon, with the micropyle somewhat rostellate. — *Gray, Pl. Lindh. 2. p.* 165. *adnot.*

49. S. FILIPES: furfuraceo-canescens; caule erecto gracili herbaceo e radice perenni; foliis brevissime petiolatis lanceolatis basi cordatis dentato-serratis obtusiusculis supra velutino-pubescentibus subtus ramulisque cano-tomentosis nunc fulvis vel ferrugineis; stipulis setaceis petiolum excedentibus; pedunculis unifloris capillaribus (2 – 3-pollicaribus) foliis longioribus paulo sub flore pendulo articulatis; corolla purpurea calycem subduplo superante; carpellis 7 reticulato-rugosis muticis superne pubescentibus dorso canaliculatis bivalvibus. *Gray, Pl. Lindh. 2. p.* 164. *adnot.* — Hills of Turkey Creek, near Austin, Texas. Very near, I fear, to S. venusta, *Schlecht.*, from Mexico.

50. S. LONGIPES (sp. nov.): pubero-scabrella; caule gracili stricto e radice lignescente; tuberculis infrafoliaribus nullis; foliis linearibus imisve lanceolatis longiuscule petiolatis utrinque obtusis superioribus crebre serratis, serraturis juniorum glandulosis; stipulis setaceis petiolo multum brevioribus; pedunculis solitariis elongatis unifloris, fructiferis folia ter-quaterve superantibus; corolla aurantiaca calyce duplo longiore; carpellis 10 acutis erostratis omnino muticis. — Prairies of Live Oak Creek, June; mostly in fruit. — Stem 6 to 18 inches high. Leaves 1½ – 2 inches long, one or two lines wide, or the lower 6 or 8 lines wide, and only repand-serrate, canescently puberulent beneath; the petioles of the lower ones half the length of the blade. Fructiferous peduncles 3 – 6 inches long, erect. Flowers as large as those of S. Lindheimeri. Carpels nearly smooth on the back, obtusely somewhat pointed at the apex, but not at all rostrate, aristate, nor bimucronate, dorsally dehiscent at the apex. — This is probably the same as No. 830 of Coulter's Mexican collection, from Zimapan, and I think I have seen it in other collections from that region. I had supposed it might be S. linearis, *Cav.*; but the short peduncles, small flowers, and spinose tubercle under the leaves, which that species is represented to have, point to a plant like S. angustifolia, *Lam.*,* only with more numerous and

* S. heterocarpa, *Engelm. in Pl. Lindh.* 2. *p.* 163 (note), is this cosmopolite S. angustifolia, *Lam.* (S. minor, *McFadyen in herb. Hook.*), which Planchon, perhaps with good reason, considers only a variety of S. spinosa. The awns or cusps of the carpels vary much in length.

S. glabra, *Nutt.*, is the same as S. stipulata, *Cav.* (also S. Balbisiana, *DC.*), and not distinct from S. acuta, *Burm.*, *DC.*; a species now widely scattered over the warmer parts of the world. Varieties of it (S. glabra β. ? &c. *Torr. & Gray, Fl.*) from Key West and East Florida are distributed by Mr. Shuttleworth under the name of S. carpinifolia, *Linn. f.* var. ? The S. carpinifolia is a related but distinct species, with smooth and even, biaristate carpels.

muticous carpels. Our species is related to S. Elliottii and S. Lindheimeri, but is distinguished from both by its longer petioles, long peduncles, and entirely muticous carpels.

51. S. PHYSOCALYX, *Gray, Pl. Lindh.* 2. *p.* 163. Western Texas; May – June. — This species, S. hastata, *St. Hil.*, and S. physalodes, *Presl.*, form a section, remarkable for the bladdery inflated calyx, which may be distinguished by the name of *Physalodes.**

52. ANODA HASTATA, *Cav. Diss. t.* 11. *f.* 2; *Gray, Gen. Ill.* 2. *t.* 124. Presidio de San Elisario; Sept. "Probably introduced."

53. ABUTILON HOLOSERICEUM, *Scheele in Linnæa*, 21. *p.* 471. A. velutinum, *Gray, Gen. Ill.* 2. *t.* 125. Hills on the Rio Grande, and east to San Marcos, Texas.

† A. HOLOSERICEUM, var. foliis plerisque subtrilobis. Hills of the San Pedro or Devil's River; Aug.

54. A. WRIGHTII (*Gray, Pl. Lindh.* 2. *p.* 162. *adnot.*): caulibus decumbentibus vel suberectis ramosis; ramis viscoso-pubescentibus et pilis gracillimis patentibus villosis; foliis ovato-cordatis obtusiusculis argute dentatis supra viridulis scabrido-pubescentibus subtus mollissime niveo-tomentosis; stipulis subulatis caducis; pedunculis unifloris petiolum æquantibus vel superioribus folium minorem superantibus; calyce tomentoso 5-partito, laciniis sensim acuminatissimis corollam auream subæquantibus; capsula lanuginoso-pilosa calyci æquilonga e carpellis 7 apice subulato-aristatis 3-spermis. — Common from the Rio Seco, Texas, westward; June – July. — Stems herbaceous. Leaves thin, the larger ones only two inches long; the petioles, like the branches and peduncles, beset with soft spreading hairs. Corolla over an inch in diameter. Capsule half an inch long; the thin carpels not inflated, little spreading, the subulate beak about one third its length.†

* Sida Napæa, *Cav.* (Napæa lævis, *Linn.*), I have just received specimens of, through my friend, the Rev. J. F. Holton, gathered in Kanawha County, Virginia, by the Rev. James M. Brown, who states that the plant is truly indigenous there. It has not before been found since the days of Hermann, who more than a century ago received seeds of it from Virginia.

† A related species, possibly A. ellipticum, *Schlecht.*, is Gregg's No. 495, from Azufrora, and also, I believe, No. 840 of Coulter's Mexican collection. Another allied North Mexican, and also Texan, species is ABUTILON HYPOLEUCUM (sp. nov.): herbaceum, caule erecto ramoso albo-tomentoso; foliis e basi profunde cordata (sinu nunc clauso) elongato-ovatis sensim acuminatis seu cordato-lanceolatis eroso-serratis subtus mollissime candido-tomentosis supra scabrido-pubescentibus aut subvelutinis; pedunculis axillaribus sæpius unifloris petiolo longioribus; calycis candido-tomentosi 5-partiti angulati laciniis ovatis quasi cordatis acuminatis corollam flavam capsulamque subæquantibus; carpellis 12 et ultra villosis longe subulato-rostratis 3-spermis. — Monterey, *Berlandier* (v. s. in herb. Hook.), *Dr. Gregg*, &c. Zimapan, *Coulter* (No. 815). Near New Braunfels, *Lindheimer* (1850). — Stems 2 – 4 feet high: branchlets more or less pubescent, with soft spreading hairs, as well as a close and lanuginous covering. Leaves 2 or 3 inches long; the close tomentum of the under surface remarkably soft and white. Carpels over half an inch long, including the subulate beak, which is hardly as long as in A. Wrightii; their summits diverging at maturity. — In foliage and indumentum this species considerably resembles the Abutilon peraffine, *Shuttleworth, Pl. Rugel, no.* 95[b], from Key West (which is the species I had mentioned in *Gen. Ill.* 2. *p.* 67, *note*, and erroneously taken for the Caribbean Sida periplocifolia): but that has smaller flowers, a different calyx, and beakless, barely acute carpels, and in this latter character chiefly differs from A. permolle, *Shuttleworth, Pl. Rugel, no.* 95[a], from Southern Florida, which has acuminate-subulate carpels. This is very probably the Sida permollis, *Willd. Enum.*, and it is the same as a plant collected in Cuba by Drummond, named in Hooker's herbarium "Abutilon lignosum, *Richard*," — perhaps his A. confertiflorum.

55. A. Texense, *Torr. & Gray, Fl.* 1. *p.* 231; *Gray, Pl. Lindh.* 2. *p.* 161. A. Nuttallii, *Torr. & Gray ! l. c.* Western Texas, common. — From original specimens in the Hookerian herbarium it is abundantly evident that A. Nuttallii and A. Texense are founded upon the very same species; the former on cauline specimens; the latter on fully developed branches. The carpels are just alike in both.

56. A. parvulum (sp. nov.): pube minuta laxa cinereo-tomentosum; caulibus e radice perenni lignescente diffusis gracilibus superne paniculatis; ramulis patenti-pilosis; foliis parvis (6 – 12 lin. latis) cordatis dentatis nunc subtrilobis sæpius obtusis subtus canescenti-tomentosis; pedunculis axillaribus unifloris folio longioribus; floribus parvis luteis; capsula ovoidea tomentulosa apice breviter 5-loba calyce brevi multoties longiore; carpellis erectis obtusiusculis muticis 2 – 3-spermis. — Calcareous hills of the San Felipe and the San Pedro Rivers; July. — This species in some respects resembles A. Texense, but it is clothed with a lax tomentose pubescence, and the branchlets with slender, soft hairs; the slender stems are diffuse, one or two feet long, many arising from the same woody root; the leaves are remarkably small, the larger cauline barely an inch in diameter, and the numerous rameal ones very much smaller; the flowers are of lesser size; and the carpels are only five.

57. A. (Gayoides) crispum, *Don; Gray, Gen. Ill.* 2. *t.* 126. Beloere crispa, *Shuttleworth.** Mountains east of the Rio Grande, New Mexico.

58. Sphæralcea angustifolia, *β.* floribus fructibusque minoribus. S. stellata, *Torr. & Gray, Fl.* 1. *p.* 228. Low grounds, near Zacate Creek, July; and in Texas on the Rio Grande. The typical form of this species also occurs in Mr. Wright's collection of 1851.

59. S. incana (*Torr. in Pl. Fendl. p.* 23): suffruticosa, undique pube minuta appressissima cano-velutina; caule suffrutescente erecto; foliis ovatis subtrilobis obtusis obsolete crenulatis nunc subcordatis; floribus (parvulis) axillaribus confertis et racemoso-paniculatis; ovarii loculis 2 – 3-ovulatis. — Fields, at Presidio de San Elisario, New Mexico; Sept. (Also Jornada del Muerto, *Wislizenus*, with a var. ? *β.* dissecta: foliis tripartitis, segmentis lanceolatis plerumque lobatis. Ojo del Muerto.) — Nearly allied to No. 60: the flowers about the same size; the fruit not known. Stems 2 or 3 feet high. — Good specimens having come to hand of a second species indicated by Dr. Torrey, the characters are here appended.†

60. S. Fendleri: herbacea, minutum stellato-pubescens, subcinerea; foliis trilobis seu hastato-oblongis, infimis cordatis, lobis incisis dentatisve; floribus parvulis axil-

* Beloere, "Genus novum ab Abutilo, cujus typus mihi est A. Avicennæ, *Gærtn.*, distinctum, carpellis vesicariis inter se demum omnino solutis, sed ad columnam centralem nervo libero longe affixis et dependentibus, serius caducis." *Shuttleworth*, in sched. "Beloere cistiflora, n. sp." (Key West, *Rugel*), which, according to Mr. Shuttleworth, is the Abutilon hirtum, *Don.* It is apparently too near A. graveolens, which is naturalized in Jamaica.

† Sphæralcea Emoryi (*Torr. in Pl. Fendl. l. c.*): suffruticosa, humilis; foliis crassiusculis cordato-trilobis triangulatis vel subhastatis supra incanis subtus ramisque furfuraceo-tomentosis fulvis bullato-venosis; pedunculis unifloris; floribus majusculis; bracteolis involucelli 2 – 3-filiformibus; capsula depresso-globosa tomentosa 15-cocca calyce tomentissimo obtecta; coccis apice mucronatis dispermis. — Southern New Mexico? *Col. Emory. Mexico* at Rinconada and Saltillo, *Dr. Gregg.* — Flowers reddish: the petals fully an inch long. Capsule half an inch in diameter. Leaves small.

laribus, infimis solitariis, cæteris fasciculatis, superioribus spicato-racemosis; pedunculis unifloris brevissimis; capsula ovoidea lobis calycis ovato-triangulatis paulo longiore, coccis 15 mucronatis dispermis. — Sphæralcea miniata, *Gray, Pl. Fendl. p.* 19, *& Gen. Ill.* 2. *t.* 127, non Malva miniata, *Cav.* — Sides of mountains near El Paso; Sept. "Much branched and spreading from the root." — I had doubtfully referred this species to the Malva miniata, *Cav.;* but that has probably been correctly identified by Hooker and Arnott (*Bot. Misc.* 3. *p.* 151) with specimens from Mendoza, gathered by the late Dr. Gillies. At least, one of these specimens accords admirably with the figure of Cavanilles, which our plant does not. Wright's specimens are more dwarf, diffuse, and pubescent than those of Fendler, doubtless from having been gathered at a drier season or locality.

61. Pavonia Wrightii, *Gray, Gen. Ill.* 2. *p.* 76. *t.* 130, *& Pl. Lindh.* 2. *p.* 161. Rocky cliffs of the Nueces River, and hills of the Rio Frio, Texas. — A pretty plant in cultivation, producing an abundance of its fresh rose-colored flowers during the whole season.

62. Malvaviscus Drummondii, *Torr. & Gray, Fl.* 1. *p.* 230; *Gray, Gen. Ill.* 2. *t.* 131. Bottoms of the Leona River, W. Texas.*

63. Hibiscus cardiophyllus (sp. nov.): humilis, tomentosus; caule e radice perenni erecto; foliis cordatis subrotundis crenulato-dentatis obtusis vel acutiusculis supra velutinis subtus densissime cano-tomentosis; stipulis setaceis; pedunculis axillaribus solitariis unifloris folium æquantibus vel superantibus paulo sub apice articulatis; involucello 9–10-phyllo; phyllis spathulato-lanceolatis tomentosis laciniis calycis lato-lanceolatis 3–5-nerviis æquilongis vel demum brevioribus; corolla roseo-purpurea columnam stamineum superante; capsula glabella calyce breviore, valvis chartaceis; seminibus puberulis in loculis paucis. — Rocky hill-sides, Turkey Creek, W. Texas, June; and on the Rio Grande, in Southern Texas. Also Zimapan, Mexico, *Coulter* (No. 805). Near Monterey, *Gregg* (185, &c.), *Dr. Edwards & Major Eaton, Wislizenus* (370). — Mr. Wright's specimens are mostly in fruit; the others are finely in flower. The stems are rather stout, from 9 to 20 inches high, from a lignescent perennial root; the exactly cordate leaves are from one and a half to above two inches in diameter. Peduncles 3 or 4 inches long. Leaves of the involucre broad and conspicuous. Petals more than an inch long, spreading, deep rose-purple, considerably longer than the column. Ovules 10 or 12 in each cell. — I know of no species with which this may be particularly compared.

64. H. (Bombicella) denudatus, *Benth. Bot. Voy. Sulph. p.* 7. *t.* 3. *β.* involucellatus: ramis superne minus foliosis; corolla majore; involucello e bracteolis 5–7 modice evolutis setaceis. — Sides of hills near El Paso, New Mexico; Sept. Gathered in the same region by Wislizenus, and at Cerros Bravos, Northern Mexico, by Gregg (481). — Stems suffruticose, one or two feet high, much branched; the flowering branches more naked than in the poor specimens gathered in the voyage

* Malvaviscus Floridanus, *Nutt.*, is Hibiscus (Cremontia) Floridanus, *Shuttleworth, Coll. Rugel* (Key West) No. 104, and also, I believe, H. truncatus, *A. Rich. Fl. Cub.* 1. *p.* 144. *t.* 16, as well as H. Bancroftianus, *McFad. Fl. Jamaic.* 1. *p.* 70 (H. Mackleyanus, *Bancroft.*).

of the Sulphur; the (light purple) corolla larger, 2 inches in diameter, and the involucel (of which traces are visible in the South Californian plant) manifest, although inconspicuous, about the length of the tube of the calyx. I see no further difference on comparison of the specimens. The figure cited above is not a good one. — Specimens in Mr. Wright's collection of 1851, just received, are more branched and leafy than those here characterized, and well agreeing with the original Californian specimens, except that the setaceous involucre is manifest. The name of the species is not well chosen.

65. H. (Bombicella) Coulteri (*Harvey, ined.*): humilis, strigoso-hispidus; caulibus suffruticosis erectis 1–3-floris; foliis trilobis trisectisve dentatis vel infimis ovatis indivisis; stipulis setaceis; pedunculo folium multo superante; involucello 10-phyllo, phyllis lineari-setaceis lacinias calycis 5-partiti lanceolato-acuminatas trinerves subæquantibus corolla speciosa sulphurea dimidio brevioribus; capsula globosa demum glabrata, loculis pleiospermis. — High hills of the San Pedro River; July. Also Zimapan, Mexico, *Coulter* (809), and Paso de Caritas, *Gregg*. — Stems a span to a foot high, strigose with appressed stellate hairs. Leaves strigose, about an inch wide, variable in form and in division, mostly three-lobed; the lobes oblong or lanceolate, irregularly toothed. Peduncles 2 or 3 inches long, one-flowered, articulated near the flower. Calyx, involucel, and the young capsule strongly hispid. Petals spreading, broadly obovate-cuneiform, from an inch to an inch and a half in length. Column much shorter than the corolla. Style filiform, twice the length of the column, 5-cleft at the summit. Seeds clothed with long woolly hairs.*

* We have a new Kosteletzkya from Coulter's Mexican collection, viz.: —

Kosteletzkya Coulteri (sp. nov.): humilis, parce hispidula; caulibus ramisve gracilibus; foliis rotundis subcordatis dentatis vetustioribus glabratis, inferioribus sublobatis, superioribus 5-fidis vel pedatis; pedunculis axillaribus unifloris petiolo floreque parvo luteo sæpius brevioribus; antheris paucis; capsula puberula acute 5-carinata, carinis (suturalibus) ciliato-hispidis; seminibus glabris. — Sonora Alta, Northern Mexico, *Coulter* (No. 804). — The stems or branches are a foot long, simple, sparsely hispid, like the leaves, with simple or sparingly stellate spreading hairs. Leaves an inch or less in breadth, none of them approaching to hastate; the uppermost 5-parted. Involucel of few, setaceous bracteoles, shorter than the 5-cleft calyx. Petals light yellow, narrowly obovate, 4 or 5 lines long. Column rather shorter than the petals, bearing less than a dozen anthers. Styles little exserted. Capsule 3 lines wide, loculicidal, acutely carinate at the dehiscent sutures.

Two new United States species of Kosteletzkya, gathered by Rugel along the Manate River, in Southern Florida, are distributed, one, No. 103, under the name of "*Hibiscus* (*Pentaspermum*) *smilacifolius*, Shuttleworth, n. sp."; the other, No. 102, as "*Hibiscus* (*Pentaspermum*) *altheæfolius*, Shuttleworth, n. sp."

The Fugosia of Drummond's third Texan collection, No. 42 (not 44), mentioned by Bentham in *Hook. Jour. Bot.* 4. *p.* 120, may be thus characterized, from the complete specimens which exist in the Hookerian herbarium: —

Fugosia Drummondii (sp. nov.): glabrata; caulibus e radice perenni decumbentibus angulatis; foliis ovalibus e basi obtusa 5–7-nervatis grosse et inæqualiter dentatis, dentibus mucronatis; involucello 7–9-phyllo, phyllis linearibus calyce profunde 5-fido paulo breviore; stigmatibus 4–5 adglutinatis; capsula subglobosa calycem æquante glabra 4–5-loculari, loculis dispermis; seminibus breviter lanuginosis. — Gonzales, Texas, *Drummond*. — This has not been gathered, so far as I am aware, by any other collector in Texas. But in the Hookerian herbarium there is a fragment of the same or a closely allied species from South Brazil. The leaves are from one to two inches in length, on rather long petioles. The corolla is sulphur-color, or pale yellow, more than an inch in diameter.

BYTTNERIACEÆ.

66. MELOCHIA PYRAMIDATA, *Linn.; Gray, Gen. Ill.* 2. *t.* 134, & *Pl. Lindh.* 2. *p.* 165. Western Texas, in wet places.

67. HERMANNIA TEXANA, *Gray, Gen. Ill.* 2. *p.* 88. *t.* 135. On the Sabina and Rio Grande, Western Texas. — I have already remarked, in *Plantæ Lindheimerianæ*, 2. *p.* 165, that the corolla is wrongly represented as expanded in the figure above cited of this interesting plant; the drawing having been made from a dried specimen.

(644.) AYENIA PUSILLA, *Linn.; Cav. Diss.* 5. *p.* 289. *t.* 147; *DC. Prodr.* 1. *p.* 488: var. tenuiter pubescens; ramorum assurgentium foliis ovato-lanceolatis subcordatis acutatis. — Hill-sides from the San Pedro River to near the Rio Grande, New Mexico; July, Aug. — The seeds are coarsely rugose-corrugated, as in the West Indian A. pusilla; of which Mr. Rugel has gathered a small-leaved form at Key West.

(645.) A. PUSILLA, var. ramis erectis, foliis superioribus lanceolatis; cæt. præced. — Hills at the head of the San Felipe, Western Texas, July. Also in the collection of 1851. It has a thick, manifestly perennial root. — This and the preceding have so much the aspect of a Tragia as to have been passed as such in the distribution.

(77.) A. MICROPHYLLA (sp. nov.): fruticosa, humilis; caulibus ramosissimis; foliis parvis ovato-rotundis grosse dentatis pube stellata brevissima fructibusque cinereis in ramulos confertis; stipulis subulatis persistentibus; capsula non stipitata. — Mountain-sides, near El Paso; Sept. — Stems a span high, woody and rigid, as are also the spreading branches; the growth of the preceding year more or less squarrose with the short and the subulate persistent stipules. Leaves only 2 or 3 lines long, roundish, obtuse, coarsely toothed, often subcordate, marked with a few strong, straight veins, on short petioles. Fruit nearly a quarter of an inch in diameter, on a peduncle of less than that length, and not at all stipitate, 5-coccous, cinereous-pubescent, and verrucose-echinate with soft processes. Seed solitary in each cell, oblong. — Unfortunately, I find not a single flower upon the scanty specimens, and only a few capsules; but I doubt not it is an Ayenia, and a very distinct one.

TILIACEÆ.

68. CORCHORUS PILOLOBUS, *Link, Enum. hort. Berol.* 2. *p.* 72; *DC. Prodr.* 1. *p.* 504, ex *Shuttleworth in sched. Pl. Rugel. et. litt.* C. septentrionalis, *Planchon in herb. Hook.* C. siliquosus, *Torr. & Gray, Fl.* 1. *p.* 239; *Gray, Gen. Ill.* 2. *t.* 127, non *Linn.* Along streams, San Pedro River, &c.; Aug. Also on the Rio Grande, Texas. — This is perfectly distinguished from the West Indian C. siliquosus, *Linn.*, as pointed out by Mr. Shuttleworth, by the proportionally shorter pods, conspicuously acuminated by the undivided style (not obtuse and two-toothed at the apex). Link's name is not an appropriate one, as the pods are only minutely and inconspicuously hairy or pubescent. The true C. siliquosus has also been found in Key West, by Mr. Blodgett and Mr. Rugel.

LINACEÆ.*

69. Linum perenne, *Linn.; Torr. & Gray, Fl.* 1. *p.* 204. Hills of the San Pedro River; July.

70. L. Berlandieri, *Hook. Bot. Mag. t.* 3480; *Engelm. & Gray, Pl. Lindh. p.* 5. & 2. *p.* 156. With the foregoing.

71. L. rupestre, *Engelm. in Pl. Lindh.* 2. *p.* 232. Prairies of Turkey Creek,

* The following notes are contributed by Dr. Engelmann: —

LINUM, *L.* (Dehiscence of the capsule only, or at least most readily, through the secondary, or false, dissepiments!)

Sect. Adenolinum.

1. Linum perenne, *Linn.* Collected for the first time in Mexico by Dr. Gregg, in dry valleys near Saltillo, Sept. 1848. — Secondary dissepiments incomplete, with capillary fibres on their margins, much as in L. Boottii.

Sect. Linopsis.

§ 1. Capsules 5-valved; the secondary dissepiments more or less membranaceous, but entire; styles united to above the middle, mostly to near the apex.

2. L. multicaule, *Hook.* — L. hudsonioides, *Planch.*, is a mere variety. Styles mostly united almost to the tips. Capsule obtuse, as long as or a little shorter than the calyx; the secondary dissepiments entirely membranaceous, falling away to let the seed escape. Texas, from the coast (Houston and Victoria) to the West (N. Braunfels, Pierdenales, etc.). — Sepals persistent, even after the fall of the capsule, while in all other species they fall off when the fruit ripens.

3. L. aristatum, *Engelm. in Pl. Wisl. p.* 101. Leaves sometimes with stipular glands. False dissepiments for the greater part membranaceous, with a narrow falciform cartilagineous part exteriorly and inferiorly. — Between El Paso and Chihuahua. Wright's No. 72 is a smaller form of this species; the sepals rather less aristate; the flowers and capsules a little smaller, and with a large and perpendicular ligneous root.

4. L. rigidum, *Pursh.* Glaucous; stem simple below; leaves, at least the upper ones, glandular-serrate, without stipular glands; pedicels thickened at the end, forming a cup-shaped exterior caliculus; styles almost entirely united; filaments subulate from a triangular base; capsule not seen. (My specimens were collected by Geyer, on the Upper Missouri.)

Var. puberulum. Glaucous; stems very much branched from the base, puberulent, or rarely glabrate; leaves erect, linear, 1-nerved, mucronate, a pair of stipular glands at their base; pedicels equalling or exceeding the calyx; sepals glandulose-ciliate, the exterior 3-nerved; filaments with an ovate-triangular base, toothless; styles united to the summit; capsule rather shorter than the sepals, ovate, acutish, 5-valved, the secondary dissepiments almost entirely membranaceous. — Santa Fé to the Cimarron River, *Fendler*, No. 85. Prof. Gray in *Pl. Fendl.* considered it a variety of L. Berlandieri, and in *Pl. Lindh. p.* 157 as belonging to L. rigidum. From the former it is distinguished by the glaucous appearance, the linear leaves, and especially the small capsule with the almost entirely membranaceous secondary dissepiments. From the latter, the absence of the calyculate cup below the calyx, the smaller flowers, and the entire leaves appear to separate it. [Dr. Engelmann inclined to consider this a distinct species; but the capsules of true L. rigidum, in the Hookerian herbarium, show precisely the same structure, and others rightly named " L. rigidum " by Planchon have manifest stipular glands, although he has not noticed them; so that it would be wrong, I think, to separate the present plant specifically. It is evident that the stipular glands do not furnish reliable specific distinctions. A. G.]

5. L. Berlandieri, *Hook.* Green; leaves lanceolate or lanceolate-linear; stipular glands often present, but not always; filaments lanceolate-subulate at the base; capsules globose-ovate, subacute, 5-valved, the secondary dissepiments partly (the upper and inner half) membranaceous. — From Galveston to the Bra-

W. Texas; June. — This truly perennial species is nearly related to L. Boottii, *Planch.*, which includes all that has been called L. rigidum from New England, North Carolina, and Georgia. I have it also from Illinois. The distinctions of these species are indicated by Dr. Engelmann, in the subjoined note.

72. L. ARISTATUM, *Engelm. in Wisliz. Mem. N. Mex. p.* 101. Locality not recorded; probably from the valley of the Rio Grande, near El Paso, where it was detected by Dr. Wislizenus.

zos, N. Braunfels, and the Pierdenales, *Lindheimer, &c.* On the San Pedro River, *Wright.* — The latter approaches a slightly glaucous form, with narrower and more rigid leaves, which occurs on the Cimarron (*Wislizenus*, *Fendler*, mixed with No. 85), often only two or three inches high, but much branched, with manifest stipular glands; the capsule ovate and acute. It appears very near to L. [rigidum, var.] puberulum; but the structure of the false dissepiments is decisive.

§ 2. Capsules 10-valved.

* *Styles united at the base or below the middle.*

6. L. BOOTTII, *Planchon.* Annual; styles in northern (St. Louis) specimens united at or below the lower third only, in Texan specimens (*β. Planchon*) almost to the middle; capsules globose, acute, 10-valved; the secondary dissepiments incomplete, with numerous hair-like fibres on the margin. — No. 86, *Pl. Fendl.* belongs here, and not to L. rigidum. This is the only one of our species with a 10-valved capsule, where the styles are somewhat united.

** *Styles free to the base.*

† *Secondary dissepiments incomplete.*

7. L. RUPESTRE, *Engelm. in Pl. Lindh.* 2. *p.* 232. Capsule globose-ovate, acute or cuspidate, like that of the foregoing species, but smaller; secondary dissepiments exactly the same: distinguished principally by the perennial ligneous root, the subulate leaves, the smaller flowers and fruit, and the entirely free styles. — Found by Lindheimer about New Braunfels, and Camanche Spring; by Wright (No. 71) on Turkey Creek. Dr. Gregg collected it near Saltillo in June, and a variety, which may be named *β. cymulosum*, on the battle-field of Buena Vista in May; this latter may be distinguished by the small and crowded cymes at the end of the branches.

8. L. GREGGII (sp. nov.): viride, glabrum, caulibus pluribus e rhizomate ligneo adscendentibus a basi fruticulosa ramosis angulatis; foliis alternis inferioribus oblanceolatis superioribus lanceolatis patulis; glandulis stipularibus geminis rarius inconspicuis; cymis virgatis dissitifloris contractis; pedicellis calyce sæpius longioribus; sepalis lanceolatis acutis trinerviis margine glandulosis; filamentis basi brevi dilatatis 2-denticulatis; stylis liberis; stigmatibus cohærentibus; capsula depresso-globosa cuspidata calycem subæquante 10-valvi, dissepimentis secundariis incompletis. — Near Saltillo, Sept. 1st, 1848, *Dr. Gregg*, No. 387. — Stems about 10 inches high. Leaves similar to those of L. Virginianum, the capsule and seeds of the same size. Distinguished from L. rupestre by the broader leaves, much smaller flowers and fruit, the singular united stigmata, which I have found in all the flowers (and many of them) examined by me, and the hairless false dissepiments. Apparently near L. Mexicanum, but that species has opposite leaves, &c. [L. Mexicanum, at least the plant coll. Coult. 759, is a very different species, larger in all its parts, with broad ovate sepals, not glandular on their margins. A. G.]

†† *Secondary dissepiments complete and similar to the primary ones: capsule splitting into* 10 *closed cocci.*

9. LINUM VIRGINIANUM, *Linn.* Biennial (or perennial?) with a fibrous root (all the others have a tapering simple root).

Var. *β.* OPPOSITIFOLIUM: caule erecto; foliis plurimis oppositis obovatis seu oblongis obtusis; panicula patula; sepalis integerrimis late ovatis acutis; petalis flavis. — Little Rock, Arkansas, in springy morasses with Sphagnum. Flowers smaller than in the usual form.

Var. *γ.* ANGUSTIFOLIUM: caule stricto; foliis erectis; panicula contracta sparsiflora; sepalis lanceolatis capsulam superantibus, interioribus glandulosis; petalis sulphureis. — Western Arkansas, on sandy hills in open woods. Flowers and fruit larger than in the common form.

G. ENGELMANN.

73. L. MULTICAULE, *Hook. in Torr. & Gray, Fl.* 1. *p.* 678. L. multicaule & L. hudsonioides, *Planchon in Lond. Jour. Bot.* 7. *p.* 185; *Gray, Pl. Lindh.* 2. *p.* 156. Border of Post-Oak woods, on the Colorado, Texas; May. — I had endeavored, in *Plantæ Lindheimerianæ* above cited, to distinguish Planchon's L. hudsonioides; but now, with the original specimens before me, I am unable in any wise to do so. Berlandier's plant is at most a state of L. multicaule.

OXALIDACEÆ.

74. OXALIS DICHONDRÆFOLIA (sp. nov.): cinereo-pubescens; caulibus e basi crassa suffruticosa diffusis vel decumbentibus foliosis; foliis unifoliolatis longe petiolatis; foliolo rotundato cordato apice truncato-retuso sinu mucronati-cuspidato; stipulis setaceis; pedunculis axillaribus solitariis unifloris; sepalis e basi subcordata lanceolatis corolla flava dimidio brevioribus; filamentis glabris; stylis pilosis; ovarii loculis 2–3-ovulatis; seminibus tuberculatis. — Turkey Creek to the prairies of the San Felipe, and on the Rio Grande, Texas. Also gathered by Berlandier in Southern Texas, and by Dr. Edwards, Dr. Gregg, &c., in Northern Mexico. — Stems 4 to 10 inches long, often rather ligneous near the thickened, woody root, or with a woody creeping rhizoma. Leaves an inch or less in diameter, mostly shorter than the petiole, usually strongly apiculate at the emarginate apex: the setiform stipules 3 or 4 lines long. Peduncles as long as the petiole, bibracteolate near the flower; the bractlets like the stipules. Petals nearly half an inch long. Capsule subglobose, cinereous, with 2 or 3 strongly tuberculate-rugose seeds in each cell. — This very curious species does not resemble any other with which I am acquainted.

† O. VESPERTILIONIS, *Torr. & Gray, Fl.* 1. *p.* 679. Hills of San Pedro River. This is at once distinguished from O. violacea by the narrow and divaricate lobes of the deeply two-cleft leaflets. No. 91 of *Pl. Fendlerianæ*, which was so called, is only O. violacea.

‡ O. WRIGHTII (sp. nov.): caulescens, trifoliolata, exstipulata; caulibus e radice crassa perpendiculari assurgentibus petiolis pedunculisque hirsutis; foliolis glaucescentibus brevissime petiolulatis basi truncatis dilatatis profunde obcordato-bilobis hirto-ciliatis junioribus hirsutis, lobis late obovatis; pedunculis solitariis unifloris raro bifloris folio longioribus; staminibus glabris edentulis; stylis brevissimis hirtellis; capsula elongata canescente, loculis 9–12-spermis. — Between Texas and New Mexico: coll. of 1851. — Root simple and fusiform, perpendicular, 6 inches long or more, lignescent but rather fleshy, reddish. From its summit spring a number of slender, assurgent stems, wiry and slightly ligneous at the base, clothed, like all other parts of the plant when young, with appressed hirsute hairs. Leaves of a pale cinereous hue. Leaflets dilated, much broader than long, 3 or 4 lines wide, somewhat truncate at the base, the very broad notch reaching beyond the middle, so as to form two divergent, broadly obovate lobes. Fructiferous peduncle an inch long, and bearing a pedicel (or rarely a pair of pedicels) of nearly the same length. Sepals lanceolate-oblong, obtuse, not glandular, 2 lines long, about half the length of the (apparently purple) petals. Stamens conspicuously monadelphous. Styles much shorter than the ovary: stigmas truncate. Capsule from one half to two thirds of an inch in length. Seeds strongly rugose.

ZYGOPHYLLACEÆ.

75. Kallstrœmia grandiflora (*Torr. in herb. Hook.*): suberecta, setis patentibus hispida; foliis 3–5-jugis; pedunculis folio longioribus; petalis (aureis) sepala lanceolata longe acuminata duplo excedentibus; staminibus 10 conformibus subæqualibus; carpellis dorso rugoso-tuberculatis stylo persistente dimidio brevioribus. — Borders of the Gila, *Col. Emory.* Sonora Alta, Mexico, *Coulter*, No. 783.

Var. detonsa: multo minus hispida vel nuda, foliis minoribus. — New Mexico (near El Paso?), Sept. — Stems a span to a foot high, from an annual root. Leaflets oblong, slightly falcate. Petals an inch long. Style much longer than in K. maxima.

76. Larrea Mexicana, *Moricand. Pl. Nouv. Amer. t.* 48; *Torr. in Emory, Rep. p.* 137. *t.* 3; *Gray, Gen. Ill.* 2. *p.* 120. *t.* 147. L. glutinosa, *Engelm. App. Wisliz. Mem. N. Mex. p.* 93. Zygophyllum tridentatum, *DC.! Ic. Fl. Mex.* From the Rio Grande in Texas to New Mexico. Shrub 3 or 4 feet, in Northern Mexico from 5 to 8 feet high. — In Dr. Gregg's earlier North Mexican collection I find scanty specimens of a curious new genus of this order, the characters of which are here subjoined.*

77. Vide p. 24 (Byttneriaceæ).

78. Porliera angustifolia: ramulis foliisque glaberrimis; foliolis 8–16 reticulatis; stipulis espinosis; floribus sæpius 5-meris 10-andris; filamentis breviter squamulosis; stylo subulato apice bidentato; ovario biloculari; capsula obcordato-biloba. — Guaiacum angustifolium, *Engelm. in Wisliz. Mem. N. Mex. p.* 113; *Gray, Gen. Ill.* 2. *p.* 121. *t.* 149, & *Pl. Lindh.* 2. *p.* 158 (subgen. Guaiacidium). On the San Pedro River, Aug. — In the *Genera Illustrata* above cited, I did not refer this plant to Porliera, with which it accords well in habit and in the squamulate filaments (and sometimes even in having tetramerous flowers), chiefly because that genus is figured by Adr. de Jussieu as having a strongly arcuate embryo, with the cotyledons parallel to the axis of the fruit. And indeed so I find the not yet fully-grown embryo in a specimen of Porliera hygrometrica of Pavon's herbarium (now

* SERICODES, *Nov. Gen.*

Calyx 5-partitus, persistens; laciniis ovato-lanceolatis. Petala 5, rhombeo-ovata, subacuta, vix unguiculata, subperigyna, nempe imo calyci inserta, laciniis ejusdem æquilonga, tarde decidua. Stamina 10, æqualia, cum petalis inserta: filamenta filiformia, 5 petalis opposita nuda, 5 sepalis opposita basi intus squamula bifida pilosa persistente appendiculata: antheræ oblongo-lineares, introrsæ, medio affixæ. Discus nullus. Ovarium sericeo-villosissimum, arcte sessile, 5-loculare, 5-lobum, loculis sepalis oppositis: stylus superne 5-angulatis, clavatis, angulis deorsum longiuscule stigmatosis. Ovula in loculis solitaria, pendula. Fructus 5-coccus, siccus; coccis sericeo-villosissimis, coriaceis, indehiscentibus, ab axi centrali gracili secedentibus. Semen exalbuminosum, loculi conforme, apice ultra hilum rostellatum. Embryo rectum: cotyledones ovales, axi contrariæ: radicula conica supera. — Frutex humilis ramosissimus; foliis simplicibus! parvis oblongo-spathulatis integerrimis sericeis sessilibus fasciculatis, fasciculis alternis! stipulis minutis spinescentibus; floribus 1–3 ex eodem fasciculo foliorum breviter pedunculatis; corolla flava.

S. Greggii. — In a dry valley near San Lorenzo, in Northern Mexico, *Dr. Gregg.* — This is certainly a Zygophyllaceous plant, notwithstanding the obscurely perigynous petals and stamens, and the alternate simple leaves.

in that of M. Boissier). On the other hand, the ripe fruits of the specimens in the Hookerian herbarium (viz. that of Cumings, No. 274, from the Andes of Chili, and that of Bridges from Llayllay) show a nearly straight embryo, the radicle being slightly bent, and with the edges of the broad and flat cotyledons directed to the axis of the fruit. I therefore join our species to Porliera without hesitation. But the Guaiacum arboreum, *DC.*, judging from the detailed description of Kunth, cannot belong to the same genus. G. parvifolium, *Planchon in herb. Hook.* (*Andrieux Pl. Mexic.* No. 475), has similar narrow leaflets, but has esquamulate filaments, and appears to be, like G. Guatemalense, *Planchon in herb. Hook.*, a true Guaiacum. The plant figured as G. sanctum in *Gen. Ill.* 2. *t.* 148 (G. Sloanei, *Shuttleworth, Pl. Rugel*, no. 68, 69) is no doubt G. verticale of Ortega; but it has pubescent branchlets; and I know not whether it is distinct from the Linnean G. sanctum.

COCHLOSPERMEÆ.

79. Amoreuxia Scheidiana, *Planch. in Hook. Lond. Jour. Bot.* 6. *p.* 140. *t.* 1. Euryanthe Scheideana, *Cham. & Schlecht. in Linnæa*, 5. p. 225. (Tab. III. B.) Prairies near the San Pedro River, July; mostly in fruit. "Flowers yellow." Also near Monterey, Northern Mexico, *Dr. Gregg*, *Dr. Edwards.* — This beautiful and highly remarkable plant has a known geographical range from the western borders of Texas to New Granada. As the peduncles are often by abortion one-flowered, I should without hesitation refer it to the original Amoreuxia palmatifida of De Candolle, except that the flowers of the Moçinian plant are said to be "rubelli." The fruit having now for the first time come to hand, I am able to give a figure of it, and to complete Planchon's new character of the genus, which in all other respects leaves nothing to be desired.*

Capsula pendula, ovoidea (bipollicaria), trilocularis, 6-valvis; valvis coriaceis ab endocarpis et dissepimentis scariosis tenuissimis, axi centrali persistente adnatis, secedentibus; loculis polyspermis. Semina placentæ centrali incrassatæ affixa, obovoideo-rotundata, breviter anatropa: integumentum exterius tenue membranaceum, laxum, fragile, arilliforme, facie ventrali raphi brevi prominente percursum, hilo parvo notatum, ab integumento interiori osseo nitido leviter reniformi omnino solutum. Embryo in axi albuminis dense carnosi sigmoideo-biarcuatus, ejusdem fere longitudine; cotyledonibus foliaceis subflexuosis; radicula crassissima brevi, hilo proxima.

RUTACEÆ.

80. Rutosma Texanum, *Gray*, *Gen. Ill.* 2. *p.* 144, *t.* 155, & *Pl. Lindh.* 2. *p.* 158.

* Whether the A. Scheideana be different from A. palmatifida, *DC.*, or not, there can be no doubt that an incomplete specimen, characterized below, belongs to a species quite distinct from either.

Amoreuxia malvæfolia (sp. nov.): foliis orbiculatis sublobatis, lobis (7) truncatis, costis subtus cum pedunculis calycibusque tomentulosis; staminibus vix inæquilongis. — Northern Mexico, near Chihuahua. The imperfect specimen, in flower only, was gathered by an unknown, and apparently unscientific collector, and sent, with other plants, to Mr. Scheer of Kew, and by him presented to Sir William Hooker, who has kindly permitted me to characterize the species. The flowers are about as large as those of A. Scheideana, and accord with them in all essential particulars, except that the stamens are less unequal. The leaves may be compared with those of Malva rotundifolia, and are scarcely more deeply lobed than they.

Calcareous hills of the San Felipe River; July. It was likewise gathered by Berlandier, in the southern part of Texas. — To this solitary representative of the proper Rue Family in America hitherto known, the subjoined species of Peganum, from Dr. Gregg's collection, is to be added.*

† KŒBERLINIA SPINOSA, *Zucc. Pl. Hort. & Herb. Monac. fasc.* 1. *p.* 359 (*in Denkschrift. Münchn.* 1832); *Benth. Pl. Hartw. p.* 35. Along the Rio Grande, Texas. Also on the Mexican side of the river, at Bolson de Mapimi, &c., *Dr. Gregg.* — "A much-branched, leafless shrub, consisting of nothing but thorns, flowering in July and August. Flowers greenish-white. Berries oval." *Wright.* In Dr. Gregg's collection we have young fruit, and from Dr. Torrey I now have ripe fruit, gathered on our Southern frontiers by the U. S. Boundary Commission; which shows that the genus does not belong to Pittosporaceæ, where it was referred by Zuccarini, but tends to confirm the view suggested by Bentham, of its affinity with the American Diosmeæ. I append the characters.† The stamens are not of sensibly unequal length, nor are the anthers attached by the base, as stated by Bentham; nor do I find the style incurved or uncinate at the apex, at least until after flowering. The ovules are straight and anatropous; but the seeds, which are few, and large for the size of the fruit, are strongly circinate or cochleate.

ZANTHOXYLACEÆ.

81. ZANTHOXYLUM CAROLINIANUM, *Lam.; Torr. & Gray, Fl.* 1. *p.* 214: var. fruticosum; foliolis brevioribus ovatis oblongisve vix aut ne vix acuminatis magis cre-

* PEGANUM MEXICANUM (sp. nov.): caule humili pubescente; foliis multipartitis, laciniis anguste linearibus; calyce 4-sepalo corollam 4-petalam duplo superante; sepalis 3–5-partitis foliiformibus, laciniis subæqualibus; staminibus 12–13. — Saltillo and Monterey, Northern Mexico, abundant, *Dr. Gregg.* — Stems 8 or 9 inches high, very leafy. Peduncles axillary, shorter than the flower. Corolla pale yellow. Disk scarcely cupulæform. Style slender; the three-lobed stigma shorter than that of P. Harmala. Filaments scarcely dilated at the base. Except in this last respect, and in the (perhaps not uniformly) quaternary calyx and corolla, our plant wholly accords with the characters of Peganum. It is remarkable for the great length of the calyx, the divisions of which resemble those of the leaves. The plant is evidently well known to the Mexicans, who, according to Dr. Gregg, call it *Garbanzilla, Romero del Campo*, or *Limoncillo*, and use a decoction of it for gonorrhœa. It is said to be poisonous to cattle.

† KŒBERLINIA, *Zucc.*

Calyx tetrasepalus, parvus, liber; sepalis subcoloratis, obtusis, æstivatione imbricatis, deciduis. Petala 4, hypogyna, calyce 3–4-plo longiora, obovato-oblonga, subunguiculata, æstivatione convoluto-imbricata, decidua. Discus nullus. Stamina 8, hypogyna, libera, petalis subæquilonga: filamenta medio incrassata, utrinque subulato-attenuata: antheræ ovales, dorso supra basim insertæ, introrsæ, biloculares, loculis longitudinaliter dehiscentibus. Ovarium ovoideum biloculare, basi in stipitem brevem, apice in stylum simplicem subulatum, attenuatum: stigma terminale, obtusum, minutissime emarginatum. Ovula plurima, in placentis crassiusculis medio dissepimento utrinque adnatis multiseriata, horizontalia vel dependentia, anatropa. Bacca subglobosa, parvula, stylo persistente apiculata, bilocularis, sarcocarpio tenui; loculis abortu 1–2-spermis. Semina verticalia, circinato-cochleata: testa crustacea, levissime ruguloso-striata: albumen tenuissimum seu vix ullum. Embryo annularis, endopleurum tumidum replens; cotyledonibus semiteretibus; radicula adscendente. — Frutex aphyllus, ramosissimus, glaber; ramis viridibus rigidis; ramulis teretibus omnibus in spinas validas desinentibus; squamulis ad folia respondentibus alternis, minimis, caducis; floribus parvulis in racemis brevibus umbelliformibus sub apice ramulorum lateralibus, albidis.

natis nunc coriaceis supra lucidis; ovariis semper 2. — Z. coriaceum, *Wright in Herb.* Z. digynum, *Engelm. in litt. cum descr.* Near Austin; also on the Rio Grande, Texas; May. (Rocky soil, New Braunfels, April, *Lindheimer*, 1850.) — If I rightly remember, this is indicated as a new species by Nuttall, in the herbarium of the Academy of Natural Sciences, I have no record under what name. I have received it in the earliest collections of Mr. Wright, who always insisted it was quite distinct from Z. Carolinianum, and was uniformly a shrub of small height. And in Lindheimer's collection of 1849–50, Dr. Engelmann has likewise characterized it. I have just received it from Mr. Shuttleworth, under the name of Z. alveolatum, *n. sp.*, *Pl. Rugel.* No. 71, from Southern Florida, which name should be preferred, having been applied to it in a named, distributed collection. Still, I am unable to distinguish it as any thing more than a variety of the Southern Prickly Ash, into the ordinary state of which (viz. with ovate-lanceolate and acuminate leaflets) the foliage passes in a series of specimens before me; and the flowers appear to be quite the same. A specimen from Norfolk, Virginia, has equally small and short leaves. The apex of the connective of the anthers is thickened and glandular, as it is, perhaps less conspicuously, in the ordinary Z. Carolinianum.

82. Ptelea trifoliata, β. mollis, *Torr. & Gray*, *Fl.* 1. *p.* 680. P. mollis, *Curtis, in Sill. Jour.* Along Turkey Creek, W. Texas; June, in fruit.

ANACARDIACEÆ.

83. Rhus virens, *Lindh. in Pl. Lindh.* 2. *p.* 159. Pass of the Limpia, and hills along the San Pedro River, in flower and fruit. — Specimens of what appears to be the same species, from Galeotti's Mexican collection (No. 3,900) are in Hooker's herbarium, named Rhus Scheideana, *Schlecht.*, by Planchon, and perhaps correctly. But the leaflets are at most 9, instead of from 11 to 15, and scarcely if at all cordate. — This species is a pinnated Lobadium with panicled aments, according to Dr. Engelmann; the flowers being sessile and tribracteate, and developed in October, not in March, as said in *Pl. Lindh.*

84. R. microphylla (*Engelm. in litt.*): "fruticosa; ramulis verrucosis; foliis impari-pinnatis 3–4-jugis, rhachidi alata; foliolis sessilibus parvis ovalibus obtusis v. mucronatis basi acutis integerrimis seu levissime crenulatis pilosulis; floribus dioicis amentaceis præcocibus basi tribracteolatis; petalis ciliatis; drupa globosa subcompressa glandulari-pilosa, putamine lævi. — Margins of thickets, on the top of hills, in the large prairie between New Braunfels and San Antonio, 15 miles from the former place, 1850; also gathered, without developed flowers, in 1846. It blossoms in March, and shows ripe fruit in May. A large shrub: stems one or two inches in diameter, branching above, with numerous small branchlets. Leaflets 3 or 4 lines long. Disk 5-lobed, the lobes emarginate. A true Lobadium with pinnated leaves." *Engelm.* — Mr. Wright's specimens (barely in flower) were gathered between the Leona and Turkey Creek, in June.

‡ R. trilobata, *Nutt. in Torr. & Gray*, *Fl.* 1. *p.* 219; *Gray*, *Pl. Fendl. p.* 28. New Mexico; with ripe fruit. Drupes deep scarlet, sparsely hairy.

SIMARUBACEÆ.

85. Castela Nicholsoni, *Hook. Bot. Misc.* 1. *p.* 271. *t.* 56; *Planchon in Lond. Jour. Bot.* 5. *p.* 568; *Gray, Gen. Ill.* 2. *t.* 158. On the high prairies of the San Felipe, &c.; July, with forming fruit. Also on the Rio Grande, Texas. — In his revision of the Simarubaceæ, Planchon has united Castela to that family.

VITACEÆ.

86. Vitis æstivalis, *Michx. Fl.* 2. *p.* 230: var. foliis tenuioribus magis dentatis, tomento tenui deciduo. On the Blanco River, Texas. — What I had called V. vulpina in *Pl. Lindh.* 2. *p.* 166, is the same thing.*

† V. indivisa, *Willd.; Torr. & Gray, Fl.* 1. *p.* 243. San Marcos, Texas; May.

† V. incisa, *Nutt. in Torr. & Gray, Fl. l. c.* Austin, &c. — Some specimens, and all of those gathered by Lindheimer in 1850, have barely three-cleft or three-lobed leaves, none of them trifoliolate.

RHAMNACEÆ.

87. Zizyphus obtusifolia, *Gray, Gen. Ill.* 2. *p.* 170. *t.* 163, *& Pl. Lindh.* 2. *p.* 168. Paliurus Texanus, *Scheele in Linnæa*, 21. *p.* 580. Prairies, Western Texas.

‡ Z. lycioides, *Gray, Pl. Lindh.* 2. *p.* 168. *adnot.* Between Western Texas and El Paso, New Mexico, Coll. of 1851.

88. Condalia obovata, *Hook. Ic. Pl. t.* 287; *Torr. & Gray, Fl.* 1. *p.* 685; *Gray, Gen. Ill. t.* 164, *& Pl. Lindh. l. c.* Hills along the Rio Frio and Rio Grande.

88[a]. C. spathulata (sp. nov.): humilis; ramis divaricatis; foliis spathulatis obtusis retusisve muticis nunc obtuse mucronatis inferne longe attenuatis subpetiolatis, venis latissimis nerviformibus subtus prominulis; pedicellis quam folia dimidio brevioribus. — On the Rio Grande, Texas; and prairies on the San Felipe, July; in flower. — Shrub from one to six feet, very much branched; the rigid branches divaricate, often spinescent: some specimens bear small axillary spines, shorter than the leaves; others are unarmed. Leaves alternate, or on the flowering branches all fascicled, 3 to 6 lines long, including the attenuated base, broadest near the apex, thickish, entire, pinnately 5–7-veined; the veins very broad and prominent underneath, as in C. microphylla, but not so numerous nor contiguous, nor are the leaves so coriaceous. Pedicels solitary or fascicled from the centre of the tufts of leaves. Flowers much as in C. obovata, but smaller, apetalous, pentandrous. Ovary apparently one-celled and two-ovuled. Fruit not seen. — A congener of C. microphylla, *Cav.*, and with the same venation, which is very different from that of C. obovata.

89. Karwinskia Humboldtiana, *Zucc. Nov. Stirp. fasc.* 1. (*in Denkschrift. Baier. Akad. Wissensch.* 4.) *p.* 351. K. glandulosa, *Zucc. l. c. t.* 16. K. Humboldtiana, glandulosa, affinis, & biniflora ? *Schlecht. in Linnæa*, 15. *p.* 460. Rhamnus

* Vitis candicans, *Engelm. ined.* (which is also the V. coriacea of Shuttleworth, *Pl. Rugel. exsic.*, from Southern Florida) is not the same as Vitis Californica, *Benth.*, to which, in *Pl. Lindh.* 2. *p.* 166, I was disposed to refer it. Perhaps it may be V. Caribæa, *DC.*

Humboldtiana, *H. B. K. Nov. Gen. & Sp.* 7. *p.* 40. *t.* 618. R. biniflorus, *DC. Prodr.* 2. *p.* 26? R. umbellatus, *Cav.*? — Rocky hills, Turkey Creek, June; in flower. Also near Monterey, *Berlandier*, *Gregg*. North of Queretaro, *Gregg* (in fruit). Sonora Alta, Real del Monte, and Zimapan, *Coulter* (No. 1 – 3), and California, No. 113, *Coulter*. New Mexico, *Wislizenus*. — All the collectors agree in stating that this is a shrub, from 2 to 3, or sometimes, according to Gregg, from 4 to 12 feet in height. There is probably an error, therefore, in Kunth's statement that Humboldt's specimens were from an "arbor procerrima." For our plant seems to be the Rhamnus Humboldtiana, as well from Schlechtendal's account of original specimens, as from Kunth's character and figure, except that the latter, but not the description, represents the upper leaves as acute. The species varies much in the size of the leaves, &c., and in the number of flowers in the axillary clusters, just as do most Rhamni. Wright's and most of our specimens have them raised on a short common peduncle, as in K. Humboldtiana. I cannot think that K. glandulosa is distinct, nor is the name a good one. The leaves are only pellucid-punctate. The 2 – 3-celled ovary has two ovules in each cell. The mature drupe is ovoid, 4 or 5 lines long, ripening from one to three seeds. Rhamnus biniflorus, *Hook. & Arn.*, is another species of this genus.

90. Colubrina Texensis, *Gray*, *Pl. Lindh.* 2. *p.* 169. Rhamnus? Texensis, *Torr. & Gray*, *Fl.* 1. *p.* 263. On the Leona, June; in fruit. Common throughout Western Texas. — This is a low, divaricately much-branched and spreading, flexuose shrub, from 2 to 4 feet high, flowering from March to May. In Lindheimer's collection of 1850 are fine specimens of what I take for a larger-leaved variety of C. Texensis, but which Dr. Engelmann, under the name of *Colubrina stricta*, considers as specifically distinct. It is "erect, very little branched, only leafy at the end of the slender branchlets, from 5 to 10 feet high; the leaves pendulous (much as in a Cerasus), larger, and it flowers much later (June 15), than C. Texensis; the flowers and fruit are much the same." *Engelm.* The leaves on vigorous sterile branches are often fully 2 inches long, oval or ovate-oblong, with a rounded base, softly silky-tomentose underneath. These larger leaves on sterile branches are common to our Zizyphus, to Condalia obovata, and other Rhamnaceæ, as Dr. Engelmann remarks.

MICRORHAMNUS, *Nov. Gen.*

Calyx coloratus, 5-fidus; tubo expanso subplano; lobis patentissimis, ovatis, trinervatis, nervo medio intus carinatis. Discus carnosus, pateriformis, calycis tubo adnatus, margine subundulatus, ovarium superum cingens. Petala 5, obcordata, unguiculata, calyce breviora. Stamina 5, petalis æqualia, iisdem libera: antheræ didymæ, biloculares, bivalves. Ovarium liberum, ovoideum, biloculare, in stylum columnarem angustatum: stigma emarginatum. Ovula solitaria. Fructus subdrupaceus, siccus, ovoideus, osseus, calycis cupula parva suffultus, abortu subunilocularis monospermus. Cotyledones foliaceæ, oblongæ, planæ. — Fruticulus ericoideus, ramosissimus, glaber; ramis rigidis spinescentibus; foliis alternis et in axillis vel in ramulos brevissimos fasciculatis, persistentibus, parvis, linearibus vel spathulato-linearibus, marginibus arctissime revolutis, subtus bisulcatis, enervibus; stipulis squamæformibus subulatis deciduis; pedunculis foliis brevioribus; floribus minimis flavis.

91. MICRORHAMNUS ERICOIDES. — Valley of the Pecos, between Western Texas and El Paso, Oct.; in flower; likewise just received in Mr. Wright's collection of 1851, from the same region, in fine fruit. Also on dry plains near Parras, Northern Mexico, *Dr. Gregg.* — A rigid, intricately much-branched, small shrub, from 2 to 5 feet high, thickly clothed with the persistent coriaceous leaves. These are from 2 to 3 lines long, obtuse, their margins for the most part so strongly revolute that they meet the thickened midrib underneath, leaving merely a groove on each side of it. Ovary free, or nearly so, though its base is encircled by the thickened disk. The fruit, about 3 lines long, though dry, is doubtless subdrupaceous, with a thin sarcocarp, like that of Ceanothus: the thick and bony putamen has a single small cell, and often the vestige of the second cell or of the dissepiment. The seed, although I have found none quite mature, appears to be like that of Berchemia; and the foliaceous narrowly oblong cotyledons are similar. — When known only in flower, I was inclined to refer the plant to Ochetophila (although O. trinervis has *opposite* leaves, not alternate, as stated by Endlicher); but the fruit proves to be altogether different, and to approximate the plant to Berchemia and Zizyphus; but I am unable to refer it to any known genus.

91[a]. ADOLPHIA INFESTA, *Meisn. Gen. p.* 70 (50); *Benth. Pl. Hartw. p.* 286. Ceanothus infestus, *H. B. K.! Nov. Gen. & Sp.* 7. *p.* 61. *t.* 574. Colletia infesta, *Brongn. in Ann. Sci. Nat.* 10. *p.* 366. C.? multiflora, *DC. Prodr.* 2. *p.* 29. C.? disperma, *DC. l. c.?* Colubrina infesta, *Schlecht. in Linnæa*, 15. *p.* 468. Mountain-sides, in the pass of the Limpia; Aug. (mostly in fruit). Also Zacatecas, *Coulter*, No. 10. — Ours is plainly the plant figured by Kunth, who represents the flowers as mostly fascicled in the axils. But Brongniart characterizes his Colletia infesta as having solitary flowers and a longer peduncle. I add the characters of the fruit. — Capsula basi calyce persistente adnato cincta, triloba, tricocca; coccis chartaceis monospermis. Semina et embryo Ceanothi. — The genus is hardly sufficiently distinct from Colubrina.

CELASTRACEÆ.

MORTONIA, *Nov. Gen.*

Calyx quinquelobus, tubo obconico 10-costato, lobis margine scarioso-albidis. Petala 5, obovata, eroso-crenulata, sub margine disci perigyni carnosi 5-lobi (lobis emarginatis oppositipetalis) inserta. Stamina 5, sinubus disci inserta, petalis breviora: antheræ cordato-didymæ, mucronulatæ. Ovarium ovoideum, liberum vel basi calyce accretum, 5-loculare; loculis biovulatis; ovulis collateralibus erectis. Stylus columnaris, apice 5-dentatus; lobis intus stigmatosis. Fructus siccus, ovoideus vel oblongus, stylo apiculatus, calyce persistente stipatus, coriaceus, abortu unilocularis monospermus, indehiscens. Semen oblongum, pericarpio conforme; arillo nullo; testa tenui membranacea. Embryo intra albumen carnosum parcum rectus, longitudine seminis; cotyledonibus oblongis carnosis; radicula brevissima infera. — Frutices ramosissimi, conferte foliosi, sempervirentes; foliis plerisque alternis parvulis coriaceis enervibus vix petiolatis integerrimis, marginibus crassis pl. m. revolutis; stipulis glandulæformibus minimis caducis; floribus albis ad apicem ramorum thyrsoideo-paniculatis, bracteis sæpius oppositis persistentibus.

92. MORTONIA SEMPERVIRENS (sp. nov.): fruticulosa; foliis oblongis obtusis parvis (2 – 3 lin. longis); calyce fructu oblongo dimidio breviore, lobis obtusiusculis muticis; stylo longiusculo. (TAB. IV.) — Calcareous hills along the San Felipe River; July: also gathered in the collection of 1851. — Shrub a foot or two high, much branched from the root, very leafy throughout quite to the inflorescence, glabrous, except that the young branchlets are minutely hirsute-puberulent. The very coriaceous small leaves are obtuse at both ends, and with a distinct, but minute petiole. The flowers are about 3 lines in diameter, and the ripe fruit, including the persistent style, of barely the same length. The disk is expanded, lining the tube of the calyx, much like that of the staminate flowers of Celastrus scandens, only more deeply lobed, the five lobes opposite the petals, and so strongly emarginate that the disk should perhaps rather be called 10-lobed. The ovary is free, or with its very base only connate with the base of the calyx-tube, which closely invests it, as it does the base of the fruit, to which at first sight it appears to be adherent. The cells of the ovary are opposite the petals. The dissepiments in the young ovary do not quite meet in the axis, except at the base; and they are obliterated during the growth of the fruit. The dry, indehiscent fruit is slightly 5-grooved: the single seed that matures fills the cell. There is no trace of an arillus. The membranaceous testa is marked with a slender rhaphe; and the albumen is very sparing. — I know of no genus with which this remarkable one may be particularly compared. Deprived, by the preoccupation of the name, of the privilege of dedicating it to the enterprising discoverer of the present species, I had, in the Hookerian herbarium, applied to it the name of my estimable friend, Elias Durand, Esq., of Philadelphia, an excellent botanist and promoter of the science: but I find, just when consigning my manuscript to the printer, that Planchon has already established a Durandea (in Linaceæ). I wish, therefore, to dedicate it to the memory of that most eminent American naturalist, the late Dr. Samuel George Morton, author of the *Crania Americana*, &c., and President of the Academy of Natural Sciences, Philadelphia. — There is a second species in the late Dr. Gregg's collection.*

(635.) SCHÆFFERIA CUNEIFOLIA (sp. nov.): foliis fasciculatis parvulis obovato-cuneatis sessilibus sæpe retusis; floribus (fœmineis) sessilibus; stylo subnullo. — High prairies of the San Felipe, and on the Rio Frio; in flower and fruit. Also in the collection of 1851, in fine fruit. Dr. Gregg gathered it at Cerralvo, North-

* MORTONIA GREGGII (sp. nov.): foliis spathulatis mucronato-cuspidatis ($\frac{1}{2}$ – 1 poll. longis); ovario semiinfero; calyce fructu ovoideo vix breviore, lobis acutissimis; stylo brevi. — Near Rinconada, Monterey, and Encarnacion, Northern Mexico, *Dr. Gregg*. — "A large shrub, in low grounds." Tube of the calyx more adnate to the ovary than in M. sempervirens; its lobes triangular, with a thick and rigid midrib, tapering to a sharp, rigid point.

ern Mexico. — Shrub 3 or 4 feet high, much branched, rigid, glabrous. Leaves alternate, and mostly fascicled on short axillary spurs, persistent, coriaceous, shining, 3 – 5-nerved at the base, reticulate-veined, spathulate, obovate, or cuneiform, very obtuse, often retuse, 5 to 8 lines long. Male flowers not seen. Female flowers much smaller than those of S. frutescens, several together, closely sessile in the centre of the fascicle of leaves, greenish. Sepals 4, orbicular, scale-like, persistent, doubtless imbricated in æstivation. Corolla of 4 narrowly oblong and obtuse petals, hypogynous, deciduous. Disk none. Filaments of four abortive stamens small, hypogynous, alternate with the petals. Ovary sessile, free, ovate, two-celled, with a solitary anatropous ovule erect from near the base of each cell. Style nearly wanting: stigmas 2, oblong-linear, large, divergent, commonly 2-cleft; the lobes acute, often unequal, papillose. Drupe globular, scarcely two lines in diameter, deep scarlet, containing two separable crustaceous pyrenæ. Seed with a membranaceous testa. Embryo straight, surrounded by a sparing fleshy albumen, nearly of its length: cotyledons oval, foliaceous, plane, occupying nearly the whole breadth of the albumen: radicle very short, inferior. — Plainly a congener of Schæfferia frutescens, *Jacq.*, of which I have female specimens only, from Key West, both from Mr. Blodgett and Mr. Rugel's collections. It is uncertain to what family the genus belongs; — surely not to Rhamnaceæ, to which De Candolle and Endlicher append it; for the calyx is not valvate, nor are the rudimentary stamens of the female flowers (which alone I have seen) opposite the petals. S. frutescens has not a slender style, as described by De Candolle, but has two large stigmas, much like those of the present plant.

MALPIGHIACEÆ.

93. Galphimia linifolia, *Gray, Gen. Ill.* 2. *p.* 196, *t.* 173, *& Pl. Lindh.* 2. *p.* 166. Banks of the Medina River, Texas; June.

94. G. linifolia, *β.* oblongifolia: foliis fere omnibus oblongis; caulibus diffusis. — With the foregoing.

95. Aspicarpa hyssopifolia (*Gray, Pl. Lindh.* 2. *p.* 167): caulibus e radice lignescente plurimis erectis (5 – 12-pollic.); foliis concoloribus lineari-lanceolatis imisve oblongis basi rotundatis vel subcordatis arcte sessilibus; floribus axillaribus solitariis, petaliferis pedunculatis sparsis (pedunculo ebracteato folio breviore, petalis fimbriatis), apetalis præcocioribus in axillis inferioribus sessilibus; coccis reticulatis dorso acute cristatis, lateribus immarginatis. — On the Rio Grande and Rio Seco; also on the San Felipe, July; in flower and fruit; the fruit chiefly from the abnormal and more precocious apetalous flowers, which are closely sessile in the lower axils. In 1851, Mr. Wright gathered a dwarf or early state, barely a span high, exhibiting abundance of apetalous flowers and fruit, but none other. Stems strigose-sericeous. Leaves an inch or less in length, hispid-ciliate, otherwise mostly glabrous, veinless. The later petaliferous and pedunculate flowers are occasionally fruitful. — A. Hartwegiana, *Juss.*, has cordate-lanceolate, glabrate, inconspicuously veiny leaves, on very short petioles, the upper acute and mucronate; the apetalous fertile flowers subsessile in the lower axils, bibracteate; the sides of the rugose-

reticulated fruit are sharply carinate-margined; and the petaliferous flowers are umbellate at the summit of the stem. Between this and the original A. urens, *Lagasca*, should stand the following.

‡ A. LONGIPES (sp. nov.): caulibus gracillimis decumbentibus; foliis cordato-oblongis obtusis longiuscule petiolatis laxe penninerviis hirsutulis subtus pallidis; floribus apetalis axillaribus solitariis longe pedunculatis bracteis 2 foliiformibus fructum subsuperantibus suffultis, petaliferis 3–4 ramulos graciles terminantibus umbellatis; coccis læviusculis, lateribus submarginatis. — Between Texas and El Paso; in Mr. Wright's collection of 1851. — Stems numerous from a ligneous root, very hirsute with Malpighiaceous hairs, from one to three feet long, diffusely decumbent or procumbent. Leaves about three fourths of an inch in length, ovate or ovate-oblong with a cordate base, pubescent both sides, obtuse, or the lower retuse, minutely mucronate; the primary veins conspicuous underneath; the petioles nearly 2 lines long. Peduncles of the apetalous fertile flowers from half an inch to more than an inch in length, furnished with two small leaf-like subpetiolate bracts at the apex, which subtend a pedicel about as long as the flower or fruit. The petaliferous flowers, 3 or 4 together on slender pedicels, terminate similar, but longer and more foliaceous-bracteate peduncles, or axillary filiform branches. The flowers are rather larger than those of A. hyssopifolia, but smaller than in A. Hartwegiana. Petals broadly ovate, erose-crenulate, and minutely glandular-fimbriate towards the apex, on exserted claws. Filaments 5, slightly monadelphous at the base, three of them with perfect, the others with imperfect anthers. Gynæcium as in A. Hartwegiana. Fruit of a single carpel, of nearly the same form as in A. Hartwegiana, but more even, with rounded and only slightly margined sides. — A. urens, according to the figure in *Mém. du Mus.*, has larger and acute leaves, and subsessile fertile flowers.

96. JANUSIA GRACILIS (sp. nov.): suffruticosa, subvolubilis; foliis lanceolato-linearibus brevissime petiolatis utrinque cum caulibus gracillimis sericeis; pedunculis axillaribus dichotome bifloris. — Mountains east of El Paso, Aug.; in fruit. — Stems and branches very slender, twining or trailing. Leaves an inch long, one or two lines wide, mostly acute at both ends, the margin with two or three dentiform glands near the base, the two surfaces equally silky with close-pressed hairs. Bracts linear, as long as the pedicels, which are minutely bibracteolate in the middle. Fruit nearly as in J. Californica, *Benth.* I find only one or two late flowers, which are quite minute, with four of the sepals bearing either one or two glands at the base; the petals short and entire; only one or two of the five stamens antheriferous.*

* Hiræa septentrionalis, *Juss.*, was gathered on the northern borders of Mexico by Wislizenus, Gregg, Coulter, and others. The former also brought specimens of a remarkable new species, with the inflorescence of Jussieu's second section of the genus, the floral characters of the first, and the samaræ differing from both in the great development of the dorsal wing; viz.: —

HIRÆA SERICEA (*Engelm. ined.*): foliis linearibus vel lineari-oblongis obtusis sessilibus utrinque sericeis subtus cano-argenteis plurimis in axillis fasciculatis; umbellis 2–4-floris sessilibus; sepalis omnibus basi grosse biglandulosis; petalis glabris; ovariis 2; samaris æqualiter late trialatis, alis distinctis. — Near Cadena, Northern Mexico, *Wislizenus.* Plain west of Mapimi, *Gregg.* — "An erect shrub," apparently

SAPINDACEÆ.

97. Ungnadia speciosa, *Endl. Atakt. t.* 36; *Gray, Gen. Ill.* 2. *t.* 178, 179, *& Pl. Lindh.* 2. *p.* 167. Near Austin, in flower; on the Leona, Western Texas, in fruit.

† Sapindus marginatus, *Willd.; Gray, Gen. Ill.* 2. *t.* 180. Western Texas. — Sapindus Manatensis, *Shuttleworth, Pl. Rugel. No.* 115, from the Manate River, Southern Florida, is the form of this species with nearly marginless petioles: it also occurs in Gregg's collection from Northern Mexico.

98. Serjania? aff. S. racemosæ. Along the Rio Grande, Southern Texas. In flower, and with some barely forming fruit, which in one specimen has a short basal wing plainly indicated, while another appears as if it would have the pyriform fruit of a Paullinia. The foliage is much as in that named Serjania racemosa, in *Plantæ Hartwegianæ* (which Eaton and Edwards also gathered near Monterey along with a new Urvillæa*); but the leaflets are more obovate and blunter, less serrate, though sparingly incised. It cannot safely be described until the full-grown fruit is known.

POLYGALACEÆ.

99. Polygala alba, *Nutt.! Gen.* 2. *p.* 87; *Torr. in Nicollet, Rep. p.* 145. P. Beyrichii, *Torr. & Gray, Fl.* 1. *p.* 670. P. bicolor, *H.B.K.! Nov. Gen. & Sp.* 5. *p.* 394. *t.* 507 (1821). P. scoparia, *Benth. Pl.! Hartw. no.* 30, non *H.B.K.* Valleys in the mountains beyond the Limpia; Aug. — No. 371 of Gregg's collection, from San Antonio de las Alanzanes, with rather larger flowers that turn orange or reddish, is exactly Kunth's P. bicolor, according to his figure, &c., and is different from the more slender forms, gathered in Northern Mexico by Hartweg (No. 30), Coulter (No. 275), Seemann, and Gregg, which in all respects agree with Nuttall's prior P. alba.

100. P. scoparia, *H.B.K. Nov. Gen. & Sp.* 5. *p.* 399: var. multicaulis: caulibus e basi abbreviata vel e radice lignescente perplurimis fasciculatis; foliis lineari-subulatis. — Mountains near El Paso, New Mexico; also farther east; Aug., Sept. — This well agrees with an original specimen in the Paris Museum, with which I have compared it, as well as with Kunth's detailed description, except that the fasciculated slender stems, a span or more in height, divide at once next the ground from very short persistent bases, springing from the thickish, perpendicular root; and the stigma, which is the same as in the plant of Humboldt, is

of small height. Leaves half an inch long, many of them fascicled. Petals probably purplish. Fructiferous pedicels drooping. Wings of the fruit three lines wide, the dorsal one even rather larger than the lateral. (Hiræa sericea, *A. Juss. in St. Hil.* is Tetrapterys sericea, *A. Juss. Mém. Malpigh.*)

* Urvillæa Mexicana (sp. nov.): tomentulosa, trifoliolata; foliolis ovatis acutis duplicato-serratis subincisis subtus molliter tomentosis; petiolulis marginatis; racemis elongatis; squamulis petalorum longissime barbato-ciliatis apice cucullato-appendiculatis. — Near Monterey, *Dr. Edwards* and *Major Eaton*, *Dr. Gregg.* — A climbing vine, with larger flowers than U. ulmacea, as large as those of Cardiospermum Halicacabum. Squamulæ of the petals furnished with an apical appendage behind the inflexed tip, which in two of them is longer and acute. Fruit much as in the figure of U. ulmacea, very thin and membranaceous.

not in all respects well described by Kunth. The stigma is open and cucullate in the centre; the porrect lower lip terete, short, and with a capituliform papillose apex: the upper is very short and dentiform, and barbate with a penicillate tuft of hairs, which Kunth everlooked. The wings in our plant are a little more obovate. Flowers about as large as those of P. Austriaca, in equally lax spikes or racemes, greenish-white. Crest of four 2-parted thickish filiform processes, of which the lateral adhere to the galea, the divisions simple, or sometimes two-lobed at the apex. Stamens 8. Capsule oblong, slightly emarginate, glabrous, membranaceous, little longer than the persistent wings. Seed cylindrical, hairy, with a smooth and prominent papilliform chalaza. Caruncle unilateral, half the length of the seed, narrow, two-lobed, the lobes linear. The slender stems and branches are much angled: the leaves from 3 to 5 lines long, seldom half a line broad, thickish, rigid, pointed.

101. P. MACRADENIA (sp. nov.): fruticosa, humilis, pube velutina cinerea; ramis fasciculatis adscendentibus e caule crasso procumbente usque ad apicem conferte foliosis flexuosis; foliis alternis parvis oblongis vel oblongo-lanceolatis obtusis muticis subsessilibus enerviis glandulis magnis (more Tagetis) pellucido-punctatis; floribus solitariis extra-axillaribus breviter pedunculatis; pedunculo ebracteolato; carina imberbi nuda; semine sericeo-villosissimo caruncula mitriformi pubescente instructo. — Hills at the head of the San Felipe; July. Also on the Rio Grande, in Southern Texas. — This well-marked species is manifestly related to the P. glandulosa, *H.B.K.*, which has obovate, mucronate, and minutely pubescent leaves, dotted with much smaller pellucid glands than ours. The whole structure of the flower and fruit accords almost exactly with the figures of Kunth, except that the narrow lateral petals are not contracted below, the minute upper lobe of the stigma is emarginate, the seed is more villous, and its short caruncle pubescent. As in P. glandulosa, the calyx is deciduous. The capsule is ovate, emarginate, cinereous, and often dotted with glands. The branches are about a span long, from a woody procumbent stem, thickly beset with leaves which are but two or three lines in length: the glands are conspicuous on the lower surface, and appear blackish by reflected light. — It belongs to the same section as the following species.

102. P. LINDHEIMERI (*Gray, Pl. Lindh. 2. p.* 150): pubescens; caulibus e radice incrassata lignosa rubra plurimis foliosis diffusis; foliis alternis subsessilibus coriaceis reticulatis nitidulis cuspidatis, imis obovatis, cæteris gradatim ovatis oblongis et lanceolatis; racemis terminalibus demumve lateralibus laxifloris; rhachi geniculato-flexuosa bracteis 3 parvis ad nodos persistentibus squamosa; pedicellis brevissimis; sepalo superiore bracteiformi a flore subdistante alis spathulatis vix dimidio breviore; carina imberbi crista calcariformi aucta; capsula elliptica utrinque emarginata puberula sepalo superiore persistente (cæteris deciduis) stipata; caruncula bicalcarata semine sericeo dimidio breviore. — Rocky hills and cliffs, Western Texas to the San Felipe, and south to the Rio Grande. — I have completed the specific character from Mr. Wright's specimens, which have mature fruit.

103. P. OVATIFOLIA (sp. nov.): caulibus e basi suffrutescente diffusis velutino-pubescentibus; foliis late ovatis ovato-oblongisve plerisque obtusis 3–5-plinerviis mar-

gine revolutis breviter petiolatis molliter pubescentibus; racemis brevibus laxifloris; carina nuda ampla dilatata integra alis oblongis pubescentibus multo majore petalis lateralibus spathulato-cuneiformibus duplo longiore; capsula fere orbiculari emarginata tenui villoso-ciliata facie glabra. — Hills of the Rio Grande and Rio Frio, Texas, westward to the San Felipe. (Also Monterey, *Edwards & Eaton.*) — Stems 3 to 9 inches long, leafy to the raceme. Leaves 5 to 10 lines long, thickish, very obtuse, or the upper acutish; the petioles half a line long. Flowers greenish-yellow, about as large as those of P. grandiflora, *Walt.* The wings are small, and the lateral petals unusually short, compared with the carina, which forms the most conspicuous part of the flower. This is very broad and rounded above, not at all lobed or plicate at the sides, scarcely unguiculate, entirely naked. The whole calyx and corolla are deciduous, leaving the capsule naked, as in the allied P. Americana, *Mill.*, P. Caracasana and rivinæfolia, *H.B.K.*, P. ovalifolia, *DC.*, &c., and the stamens, stigma, and seeds are the same as in those species and the succeeding one: the caruncle short and bonnet-shaped. Capsules drooping, membranaceous, flat, 5 lines long, and nearly as broad, the sides perfectly glabrous, but the margins conspicuously ciliate. — I had (in *Pl. Lindh.* 2. *p.* 151) taken this plant for P. ovalifolia, *DC.*, which, judging from a recent inspection of the incomplete original specimen in the Delessertian herbarium, is the same as No. 732 of Coulter's Mexican collection. It has more oblong leaves, the upper ones acute, larger and broader wings, and especially a smaller and much narrower carina, which the linear lateral petals almost equal in length, and the whole surface of the deeply emarginate pod is pubescent, as stated by De Candolle. Still the two plants look very much alike. — P. buxifolia, *H. B. K.*, is allied to this and to P. Lindheimeri.

104. P. PUBERULA (sp. nov.): pube brevissima subcinerea; caulibus e radice suffrutescente erectis; foliis linearibus lanceolatisve (imis nunc oblongis) mucronatis brevissime petiolatis; racemis laxis elongatis; floribus pendulis; carina omnino nuda integra alis late obovatis ciliolatis æquilongi petala lateralia ovali-oblonga paulo superante; capsula ovali emarginata glabra marginibus tenuiter ciliata. — P. pubescens, *Schlecht. in Linnæa*, 14. *p.* 160. — Valley of the Limpia; Aug.: also in the collection of 1851. — This species so much resembles P. grandiflora, *Walt.*, in its foliage, pubescence, and whole habit, that it might readily be confounded with it, were it not for the deciduous floral envelopes, and the much larger and flat, naked pods. These are a quarter of an inch in length, when young sometimes minutely pubescent on the face, but when mature quite glabrous, except the thickish margin, which is much less ciliate than in the preceding species. The "purple" flowers are rather smaller than in P. grandiflora, and larger than in P. obscura, *Benth.*; the carina deep violet-purple. From P. obscura (also gathered at Misteca Alta by Galeotti, No. 883) our plant is abundantly distinguished by its more simple herbaceous stems, longer and narrower leaves, entirely crestless carina, and elongated fruiting racemes, the pods and the fertilized flowers all drooping. The floral envelopes fall almost as soon as the pod begins to grow. The seed, as in most species of this group, is retrorsely hairy, and capped at the summit with a short, bonnet-shaped, somewhat lacerate or lobed, scarious caruncle. The two lobes of the stigma

are similar, closely approximate, and papilliform. The flowers are as if intermediate between those of P. ovatifolia and P. ovalifolia. P. monticola, *H. B. K.*, has smaller flowers, narrower wings, &c.*

KRAMERIACEÆ.

‡ Krameria parvifolia (*Benth. Bot. Voy. Sulph. p.* 6. *t.* 1.): fruticosa, pube appressa canescens; caule erecto 1–2-pedali ramosissimo; ramis divaricatis; foliis linearibus sessilibus junioribus mucronatis; pedunculis sparsis sæpe bis bibractea-

* Polygala flabellata, *Shuttleworth, Pl. Rugel, exsicc. No.* 37, from Key West, appears like a smoother and very narrow-leaved, small-flowered variety of P. grandiflora (the var. β. *Torr. & Gray, Fl.* 1. *p.* 671), the opposite extreme from his variety canescens, No. 39.

P. leptostachys, *Shuttleworth*, from Aspalaga, Florida, is a good species, which I have from Dr. Torrey (E. Florida, *Leavenworth*) under the name of P. tenuis, *n. sp.;* and a less slender form is also sent by Dr. Chapman, who distinguished it as an undescribed species. It is well distinguished from P. verticillata and P. ambigua, by its glabrous, more slender and lageniform, somewhat curved seed. The calycine wings are oval and subsessile, and the slender spikes are long-peduncled, as in P. ambigua, but the narrowly linear leaves are nearly all verticillate. Mr. Shuttleworth's name, under which the plant has been distributed, should be preferred.

P. Rugelii, *Shuttleworth*, No. 26 of Rugel's Southern Florida collection, is only a form of P. lutea the flowers of which have turned green, as in P. nana, probably in drying. Besides the characters given in the *Flora of North America*, P. nana differs from P. lutea in having a prolonged cylindraceous rostellum at the hilar end of the seed: in P. lutea the rostellum is very small and incurved.

The corrections to the synonymy of Polygala cymosa and its allies in the *Flora of North America*, as made in the Supplement, p. 670, are stated in a manner that is liable to mislead, and several of the names are wrongly referred. It is true that to the P. cymosa of Walter must be referred the P. corymbosa of Michaux, the P. graminifolia of Poiret, and the P. acutifolia of *Torr. & Gray, Fl.* 1. *p.* 128: P. ramosa of Elliott, however, belongs not to this species, but to the P. corymbosa, *Torr. & Gray l. c.*, as is manifest from Elliott's whole description, and especially from the hairy seeds which he attributes to it; and this name of Elliott's must be adopted for the species, since the P. attenuata of Nuttall surely belongs to the other species, as also does the P. corymbosa of Elliott. The character and the synonymy should stand as follows: —

Polygala cymosa (Walt.): caule simplici elato superne attenuato subnudo; foliis radicalibus lanceolatis linearibusve acutis sæpius elongatis gramineis, caulinis sensim abbreviatis subulatis; cyma corymbosa simpliciuscula (e racemis simplicibus nunc parce ramosis); rhachi post lapsum florum squarrosa; alis calycinis ellipticis mucronatis; seminibus subglobosis glaberrimis ecarunculatis. — P. cymosa, *Walt. Car. p.* 179; *Torr. & Gray, Fl.* 1. *p.* 128, *& p.* 670 (excl. syn. P. ramosa, *Ell.*). P. corymbosa, *Michx. Fl.* 2. *p.* 54 (in partem); *Ell. Sk.* 2. *p.* 187, non *Nutt.*, nec *Torr. & Gray, Fl.* P. graminifolia, *Poir. Dict.* 5. *p.* 500; *DC. Prodr.* 1. *p.* 329. P. attenuata, *Nutt. Gen.* 2. *p.* 90. P. acutifolia, *Torr. & Gray, Fl.* 1. *p.* 128 (P. cymosa β. graminifolia, *Torr. & Gray, l. c. p.* 670); forma cyma composita.

Polygala ramosa (Ell.): caulibus e basi plurimis (8–10-uncialibus) usque ad apicem foliosis; foliis obtusis, radicalibus spathulato-obovatis, caulinis oblongo-linearibus; cyma decomposita fastigiata e racemis brevibus confertis; alis calycinis oblongis acuminato-cuspidatis; seminibus ovoideis hispidulis carunculo duplo longioribus. (Flores et semina iis P. cymosæ subdimidio minores.) — P. ramosa, *Ell. Sk.* 2. *p.* 186. P. cymosa, *Poir. Dict.* 5. *p.* 500, non *Walt.* P. corymbosa, *Nutt. Gen.* 2. *p.* 89; *Torr. & Gray, Fl.* 1. *p.* 128, non *Michx.*, nec *Ell.*

Walter's name must be kept for the first of these species, to which it certainly belongs, as the specimen in his herbarium, as well as the character, shows. Michaux's P. corymbosa consists principally of P. cymosa, *Walt.*, with which in his herbarium some P. Baldwinii, I believe, is intermixed. The two species are distinguished, and for the first time well characterized, by Elliott, whose name for the last should be retained. I am much indebted to Mr. Carey for the elucidation of these species.

tis; alabastro gibboso; petalis posticis æquilongis unguibus coalitis, lamina lateralium dilatata obliqua rhomboidei-ovata intermedia anguste oblonga multo majore; staminibus discretis ungui adnatis; fructu ovoideo-acuminato nunc subcordato. — Gathered in the western borders of Texas, 1851; in flower and with young fruit. — Stems rather stout, rigid; the divaricate branches more slender, and inclined to become spinescent. Leaves about 4 lines long, often subfalcate, obtuse, or the younger ones tipped with a slender mucro, canescent, like the branchlets, &c., with a fine but somewhat hirsute appressed pubescence. Peduncles mostly solitary, terminating short lateral branchlets, which more commonly bear two rather distant pairs of bracts, or opposite leaves like the ordinary alternate ones of the branches, but occasionally only a single such pair, from 3 to 6 lines below the flower, sparsely beset with small glandular setæ intermixed in the canescent pubescence. Flower-bud remarkably gibbous, a quarter of an inch long, about the length of the peduncle above the bract. Sepals petaloid (purple), but silky-pubescent externally, moderately unequal, ovate and oblong; the two exterior acutish; the others more or less obtuse. Claws of the three posterior petals short, united nearly to the tip; the lamina of the two lateral very obliquely dilated-ovate; the middle one very much narrower, narrowly oblong. Stamens 4, nearly equal, separate, inserted on the middle of the claw of the three united petals. The unripe fruit is ovate and pointed, marked with a medial ridge, especially on the lower side, canescently hairy, and beset with slender barbed prickles. It agrees with the ripe fruit of Bentham's Californian plant, except that it is not yet at all cordiform. (In one specimen I found an additional middle petal, and five stamens.) — This is the same as the South Californian species described by Mr. Bentham, from very imperfect specimens (though with good fruit); an original specimen of which, as well as another from Coulter's Californian collection (No. 71), I have examined in the Hookerian herbarium. The figure in the Botany of the Voyage of the Sulphur, is not a good one; for the plant has none of the spreading bristly hairs there delineated, but is canescent with appressed pubescence, as described in the text.

105. K. PARVIFOLIA, var. RAMOSISSIMA: minus canescens; foliis brevioribus sæpe in axillis fasiculatis; floribus minoribus magis coloratis ad apicem ramulorum solitariis vel subracemosis. — Prairies of Live Oak Creek, June; and banks of the Rio Grande, on the southern border of Texas. Dr. Gregg also gathered it on the Mexican side of the river, at Camargo. — Shrub 1 to 3 feet high, erect, excessively branched, the divaricate branches and branchlets slender; the leaves of the flowering ones gradually reduced to one or two lines in length. Peduncles short, destitute of glandular bristles. The structure of the flowers is just as in the foregoing, of which I think it can be no more than a variety. The ripe fruit not seen: but the young pod has shorter prickles.

106. K. CANESCENS (sp. nov.): fruticosa, pube brevi densa sericeo-incana; caulibus erectis ramosis; foliis brevibus oblongo-linearibus seu lanceolatis mucronatis sessilibus; pedunculis folio pluries longioribus medio bibracteatis demum recurvis; sepalis lanceolatis acuminatis; petalis posticis exiguis distinctis staminibus 4 discretis liberis brevioribus lamina fere destitutis; fructu ovoidei-globoso. — Prairies near

the Pecos; Aug. Also in the collection of 1851. — Shrub from one to three feet high, erect, much branched. Leaves simple, 3 to 4 or 5 lines long, silvery-canescent, like the branchlets, peduncles, and outside of the calyx, with a very fine matted pubescence. Sepals 5, purple inside; four of them nearly equal, lanceolate from a broad base, acuminate, about 3 lines long, the fifth smaller and linear. The three upper petals very small, linear-spatulate, appearing like sterile filaments. Stamens wholly distinct, the two intermediate rather shorter. Fruit beset with small and slender prickles, which are glochidiate at the apex only. — Except that the leaves are not villous, this species is scarcely at variance with the imperfect character of K. pauciflora, *DC.*; but the drawing upon which that species was founded represents a low or procumbent plant, much like the K. secundiflora. Specimens just received in Mr. Wright's collection of 1851 appear to show that K. secundiflora and K. lanceolata are hardly specifically distinct. — K. cinerea, *Schauer*, with trifoliolate leaves, is also in Coulter's Mexican collection (No. 735), from Zimapan.

LEGUMINOSÆ.

107. Phaseolus retusus, *Benth. Pl. Hartw. p.* 11; *Gray, Pl. Lindh.* 2. *p.* 170. P. maculatus, *Scheele in Linnæa*, 21. *p*. 465. On the Rio Grande, Texas; and in the bed of the Limpia; Aug. — "Stems trailing, 6 – 8 feet long: flowers purple."

108. P. Wrightii (sp. nov.): volubilis, puberulus; ramis gracilibus; foliolis hastato-trilobis, lobis obtusissimis, lateralibus nunc repando-angulatis terminali oblongo sæpius dimidio brevioribus; pedunculis folio longioribus perpaucifloris; bracteis bracteolisque lanceolatis minimis deciduis; pedicellis calyce brevi duplo longioribus; calycis labio superiore truncato emarginato, dentibus lateralibus triangulatis acutis infimo brevioribus; legumine pendulo compresso falcato (ultrapollicari) stylo gracili cuspidato tenuiter pubescente, valvis membranaceis; seminibus compressis rotundatis subquadratisve rugosis. — Declivity of a mountain, near El Paso; Sept. — This is nearly allied to the S. Californian Phaseolus (Drepanospron) filiformis, *Benth.*, *Voy. Sulph.*, and is perhaps a variety of it; but the foliage is coarser, the flowers are little smaller than those of P. paniculatus, and the legumes (over an inch long, 6 – 8-seeded) and seeds are fully twice as large. From P. pedicellatus, *Benth.*, a Mexican species (which Walpers wrongly says is from Brazil), it differs in its pubescence, in the form of the leaflets, in the minute and deciduous bracts, and in the shorter pedicels. The seeds are either suborbiculate with a truncate or excised base, or sometimes nearly quadrate, coarsely rugose.*

† P. acutifolius (sp. nov.): volubilis; ramis gracillimis puberulis; foliolis sub-

* P. sinuatus, *Nutt.*, of which I have fine specimens from Rugel's Florida collection, No. 132, is widely different from P. perennis; but is apparently closely allied to P. pedicellatus, *Benth.* The leaflets of some of the lower leaves are rounded, retuse, and entire.

Phaseolus bilobatus, *Engelm. in Wisliz. Mem. N. Mex. p.* 109, is evidently the same as P. heterophyllus, *Benth. Pl. Hartw. No.* 50, and apparently also of Willdenow, who describes the leaflets as linear-oblong, and the root as perennial (not annual, as De Candolle states): in Hartweg's specimens it is tuberous.

ovato-lanceolatis e basi ad apicem usque attenuatis acutis integerrimis scabrido-puberulis; pedunculis paucifloris folio brevioribus; bracteis bracteolisque subulatis minimis deciduis; pedicellis flore æquilongis; calyce profunde bilabiato, labio superiore vix emarginato, dentibus lateralibus et infimo ovato-oblongis subæqualibus tubo paulo brevioribus; legumine compresso lato-lineari falcato pubescente; seminibus complanatis leviter rugosis. — Mountain valley, thirty miles east of El Paso; Sept. — Plant in general aspect and foliage much resembling a slender narrow-leaved variety of P. helvolus: but the leaves are more tapering and pointed; the 2–3-flowered peduncles are shorter than the leaf, and seldom longer than the common petiole; and the pedicellate flowers are smaller than those of P. perennis. It belongs to the section *Drepanospron*, having a flat and falcate legume, not much curved, two inches long, a quarter of an inch wide, 8–9-seeded. Seeds oval, compressed, somewhat shining, lightly rugose. The leaflets are from one to two inches long, varying from ovate-lanceolate to lanceolate from a broad base.

† P. PAUCIFLORUS, *Benth. Comm. Legum. Gen. p.* 76. P. leiospermus, *Torr. & Gray, Fl.* 1. *p.* 280; *Gray, Pl. Fendl. p.* 30. Western Texas. — Without doubt the P. leiospermus is the same as the earlier P. pauciflorus of Bentham, which was overlooked in the *Flora of North America.* P. diversifolius and P. helvolus have not woolly nor pubescent seeds, but they are furfuraceous with a mealiness that rubs off, leaving a smooth and shining testa.

‡ RHYNCHOSIA TEXANA, *Torr. & Gray, Fl.* 1. *p.* 687; *Gray, Pl. Lindh.* 2. *p.* 171. Between Texas and New Mexico; coll. of 1851. — The small flowers are either solitary, in pairs, or in fascicles of three or four in the axils of the leaves. The subulate teeth of the calyx are considerably shorter than the corolla, in well-developed flowers.

109. R. TEXANA, var. ANGUSTIFOLIA: ramis elongatis subvolubilibus; foliis plerisque vel superioribus lanceolatis seu oblongo-linearibus; floribus sæpius majoribus 2–4-natis nunc subracemosis. — R. angustifolia, *Engelm. in litt.* Prairies of the Sabinal and Turkey Creek, Western Texas, June; climbing over low bushes, &c. (Prairies near New Braunfels; climbing over herbaceous plants and shrubs of from 5 to 7 feet in height, *Lindheimer*, July, 1850.) — Mr. Wright's collection of 1851 contains numerous intermediate specimens between this and the described R. Texana, showing that it is only a more luxuriant form. The leaflets of the lower leaves are mostly oval, rounded, or rhombic-ovate, varying from half an inch to more than an inch in length; while those of the branches, especially the voluble ones, become lanceolate, linear-oblong, or even linear-lanceolate, of about the same length, or some of them, in Lindheimer's specimens, even two inches long.

110. GALACTIA MARGINALIS, *Benth. Comm. Legum. Gen. p.* 62; *Torr. & Gray, Fl.* 1. *p.* 288. Western Texas.

111. G. WRIGHTII (sp. nov.): herbacea, suberecta, pube tenui appressissima cinerea; ramis subvolubilibus; foliis trifoliolatis; foliolis oblongis utrinque obtusis mucronulatis supra glabellis subtus argenteo-cinereis, lateralibus breviter petiolulatis; racemis folium superantibus multifloris; calycibus bracteisque canescentibus. — Hills near the Limpia; Aug. — Stems branched from the base, slender. Leaflets

an inch and a half long, 8 or 9 lines wide, green above, beneath veiny and silvery, with a very fine and close whitish pubescence. Racemes strict, not interrupted, many-flowered; the "purple" flowers smaller than in G. glabella, 5 to 6 lines long. Pedicels a line long, shorter than the lanceolate deciduous bracts. Calyx-teeth triangular-lanceolate, nearly twice the length of the tube. Fruit not seen.

112. GALACTIA TEXANA, *Gray, Pl. Lindh.* 2. *p.* 170. Lablab Texanus, *Scheele in Linnæa,* 21. *p.* 467. Banks of the Leona River, June; in fruit.

‡ COLOGANIA ANGUSTIFOLIA (*Kunth, Mimos. p.* 209. *t.* 58): "volubilis; foliis linearibus obtusis subconcoloribus utrinque strigulosis; calycibus hispido-pilosis" (*Kunth ex DC.*); legumine falcati-gladiato hirto. — New Mexico, near El Paso? coll. of 1851. — This appears to be Kunth's C. angustifolia; but I have not the work in which it is described and figured to refer to. Our plant has a strong and deep perennial root; from which proceed slender, branching, striate-angled, herbaceous stems, cinereous-hirsute, as is the foliage, &c., with copious short strigulose hairs. Petioles 6 to 9 lines long. Leaflets from one to nearly two inches in length, about two lines wide, of rather firm texture, exactly linear, very obtuse at both ends, mucronate. Flowers in pairs, or sometimes solitary in the axils, on peduncles half an inch long, which are bibracteate at the base and minutely bibracteolate next to the villose-hirsute calyx: bracts and bractlets subulate. Corolla apparently violet-purple. Vexillum biappendiculate at the base with narrow inflexed margins. Legume narrowly linear, an inch to an inch and a half long, compressed, sabre-shaped, 7 – 9-seeded. Seeds oval, with a small hilum, not strophiolate.

‡ C. PULCHELLA, *H.B.K. Nov. Gen. & Sp.* 6. *p.* 414; *DC. l. c.; Schlecht. in Linnæa,* 12. *p.* 287. New Mexico, near El Paso? coll. of 1851; in flower only. — The specimens are more pubescent and cinereous, the leaflets thicker and more veiny, the flowers rather smaller and the calyx more hairy than in No. 603 of Coulter's Mexican collection, which is named C. pulchella by Bentham, and they belong perhaps to a different species, but they accord well with Kunth's character.

113. INDIGOFERA LINDHEIMERIANA, *Scheele in Linnæa,* 21. *p.* 464. On the Honda and San Felipe; June. "Flowers red." — This is more cinereous than I. Anil (to which I had referred it in *Pl. Lindh.* 2. *p.* 172), and the pods are longer and somewhat flatter, not tetragonal, but rather compressed (as De Candolle characterizes I. Anil): I see no other essential difference.

‡ I. LEPTOSEPALA, *Nutt.*, var. undique cinereo-argentata. — Between Texas and El Paso; coll. of 1851.

114. PSORALEA CYPHOCALYX, *Gray, Pl. Lindh.* 2. *p.* 172. Banks of the Honda River, Western Texas; June.

115. P. HYPOGÆA, *Nutt.*, var. SCAPOSA, *Gray, Pl. Lindh.* 2. *p.* 173. Southern and Western Texas.*

115 (bis). EYSENHARDTIA AMORPHOIDES, *H.B.K. Nov. Gen. & Spec.* 6. *p.* 491, *t.* 592; *Gray, Pl. Lindh.* 2. *p.* 173. E. Texana, *Scheele in Linnæa,* 21. *p.* 462. Rocky hills, Austin, Texas.

* Psoralea Floridana, *Shuttleworth, Pl. Rugel.*, No. 163, appears to be just the same as P. Lupinellus; the legume of which should not have been called "small" in the *Flora of N. America.*

116. E. AMORPHOIDES, var. foliolis majoribus, fere semipollicaribus. — Margins of a creek, between the Pecos and the Limpia; Aug.

117. PETALOSTEMON VIOLACEUM, *Michx.*, var. PUBESCENS (*Gray, Pl. Fendl. p.* 33). P. virgatum, *Scheele in Linnæa*, 21. *p.* 461. Prairies, Austin, Texas. — From the Snake Country, in the interior of Oregon, Mr. Burke sent to Sir Wm. Hooker dwarf specimens of this variety, and from the Black Hills of the Platte both Burke and Gordon have sent others, with densely pubescent leaves and even tomentose stems, which I cannot otherwise distinguish from this species. Some specimens, having long acuminate bracts, approach too near to P. decumbens, which is further distinguished chiefly by its broader leaflets.

118. P. MULTIFLORUM, *Nutt. in Jour. Acad. Philad.* 7. *p.* 92; *Torr. & Gray, Fl.* 1. *p.* 309. Banks of the Medina River, Western Texas; June.

119. DALEA FRUTESCENS, *Gray, Pl. Lindh.* 2. *p.* 175; forma spicis brevibus capituliformibus.— Hill-sides in the Pass of the Limpia; Aug. Also near Austin, Texas.

120. D. FRUTESCENS; forma spicis pl. m. elongatis laxifloris. — Hills west of the Limpia; Aug. Also on the Rio Grande, Texas.

‡ D. FRUTESCENS; forma spicis mox elongatis densifloris. — Between Western Texas and New Mexico, coll. of 1851.

121. D. FORMOSA, *Torr. in Ann. Lyc. N. Y.* 2. *p.* 178, & *Emory, Rep. t.* 1; *Gray, Pl. Fendl. p.* 32. Hills along the San Pedro and Pecos; July. Shrub one or two feet high.

122. D. AUREA, *Nutt. Gen.* 2. *p.* 101; *Gray, Pl. Fendl. p.* 31. Prairies of the Nueces; June.

123. D. NANA, *Torr. in Pl. Fendl. p.* 31; *Gray, Pl. Lindh.* 2. *p.* 175. Dry soil, from Austin, Texas, to the mountains east of the Rio Grande, New Mexico. — Leaflets varying from oval to linear-oblong.

124. D. NANA, var. elatior (pedalis), foliolis sublinearibus. — Pass of the Limpia; Aug. — Plant nearly as tall as some states of D. aurea, but more slender.

125. D. LACHNOSTACHYS (sp. nov.); herbacea; caulibus ramosis petiolis pedunculisque glandulis conicis brunneis tuberculatis pubescentibus; foliolis 9 – 11 ovalibus obovatisve utrinque villosis juxta margines præcipue grosse glandulosis; spicis cylindraceis densissimis; bracteis ovatis scariosis pubescentibus in acumen longum viride florem subæquans productis caducis; calyce undique barbato-villosissimo, dentibus aristatis tubo corollaque purpurea æquilongis; carina petalis vix longiore; legumine villosissimo. — Hills about 80 miles west of the Pecos; Aug. — A species remarkable for its copious tuberculate (mostly conical) glands, and especially for the thick and densely barbate-woolly spikes. These are two inches or less in length, fully three fourths of an inch thick, on short peduncles; and the calyces are sessile, much crowded, 3 to 4 lines long, the campanulate tube sparsely glandular, the limb of 5 subulate-aristate teeth, which are as long as the expanded corolla, the whole exterior very thickly clothed with long and straight beard-like hairs, which nearly conceal the corolla. The ovary is similarly bearded. The root is perhaps perennial; the suberect and thickish stems much branched, rather diffuse, a foot or

more in height. Leaflets half an inch long, obtuse, beset underneath, close to the repand or subcrenulate margins, with a row of very large and flat glands, and often with a few others near the midrib, petiolulate.

127. D. MOLLIS, *Benth. Pl. Hartw. p.* 306; var.? NEO-MEXICANA: humilis, pube sericeo-villosa canescens; caulibus e radice perenni diffusis herbaceis parce glandulosis; foliolis 7 – 11 obovatis cuneatisve subretusis grosse glandulosis; spicis oblongis densifloris; rhachi squarrosa; bracteis lanceolatis subulato-acuminatis calycibusque sericeo-villosissimis, dentibus e basi lata aristatis tubum et corollam subsuperantibus; carina purpurea petalis vix longiore; legumine sericeo. — Hills beyond the Pecos and the Pass of the Limpia; Aug. — Stems much branched and diffuse, a span high, often decumbent, leafy, clothed like both surfaces of the leaves with a short and soft villous-silky cinereous pubescence. Leaflets an eighth of an inch long, approximate, petiolulate. Spikes on short peduncles, half an inch or more in length, thick and dense, very woolly with the silky-villous calyces. These and the rest of the flowers are much as in D. lachnostachys, except that they are only half the size or less, and the silky-villous covering is shorter in proportion and less abundant. Mr. Wright notes that the flowers are yellow, at least in one set of specimens; but the carina in the specimens is tinged with purple. — Coulter's Californian plant, to which I have joined the above, is smaller in all its parts, but, as the whole structure is essentially the same, I think it may be no more than a starved state of the same species. With more hesitation, on account of the larger size of all the parts, I am constrained to append to it No. 126 also.

126. D. MOLLIS, var.? villosior, minus canescens; foliolis spicisque majoribus; calycibus magis plumosis. — On a mound near the San Felipe; July. "Flowers purple." — The larger leaflets are a quarter of an inch long, and the spikes over half an inch in diameter, with perhaps a more copious villous-silky down; I notice no further difference between it and No. 127.

128. D. LANATA, *Spreng. Syst.* 3. *p.* 327; *Gray, Pl. Fendl. p.* 31. D. lanuginosa, *Nutt.* Bottoms of the Rio Grande, New Mexico, 60 miles below El Paso; Sept.

129. D. ALOPECUROIDES, *Willd.; DC. Prodr.* 2. *p.* 244; *Gray, Pl. Fendl. p.* 31. Valley of the Rio Grande, near Presidio de San Elisario, New Mexico; Sept.

130. D. SCOPARIA, *Gray, Pl. Fendl. p.* 32. Sandy bottom of the Rio Grande below El Paso; Sept. — The excessively branched stems of this remarkable species are woody at the base. The lower leaves are trifoliolate, with linear leaflets, the lateral ones shorter than the terminal; the uppermost are all unifoliolate as in the specimens of Wislizenus.

131. D. ARGYRÆA (sp. nov.): fruticosa, erecta; ramis canescentibus glanduloso-tuberculatis foliosis; foliolis 7 – 13 obovato-oblongis argenteo-sericeis supra nitentibus subtus glandulis nigris punctatis; spicis brevibus densifloris; bracteis ex ovato acuminatis calycibusque subæquilongis cinereo-pubescentibus; dentibus calycis subulatis tubo unguibusque petalorum brevioribus; vexillo flavo alis carinaque purpureis subduplo brevioribus; legumine cum stylo hirsuto. — High hills near the San Pedro River, abundant; July. (San Antonio de las Alanzanes, Mexico, *Gregg*, No. 357. Southern frontiers of Texas, *Dr. Bigelow.*) — Stems 1 to 2 feet high, stout, wholly

woody, corymbosely branched above; the branches leafy to the top. Petioles short: rhachis sparingly glandular, and usually with a pair of larger glands at the insertion of the leaflets. Leaflets commonly 11 or 13, thickish, 3 lines long, remarkably silvery and shining, especially above, with a close and fine silky pubescence. Peduncles short. Spikes 12–20-flowered, at first capitate. Calyx rather longer than the bract. Corolla showy, and large in proportion to the calyx; the wings and keel bright reddish-purple, on slender exserted claws, the lamina of the keel-petals a quarter of an inch long; the wings rather smaller: vexillum shorter, orbiculate, cucullate and infundibular at the base, yellow, becoming tinged with purple in fading. — A handsome species, very different from any other North American one, but apparently allied to the Mexican D. argentea of Martius.

132. D. POGONATHERA (*Gray, Pl. Fendl. p.* 31): pusilla, herbacea, glaberrima; caulibus e radice perenni plurimis adscendentibus; foliolis 5–7 oblongo-linearibus subtus rhachique grosse nigro-glandulosis; spicis oblongis densifloris; bracteis ovatis cymbiformibus acuminato-cuspidatis glabris dorso parce glanduliferis marginibus late scariosis tubo calycis sericeo-villosi æquilongis persistentibus; dentibus calycis setaceis plumosissimis tubo longioribus; petalis dilute purpureis; staminibus 10. — Pass of the Limpia; also along the Rio Grande, in Southern Texas; Aug. — The stems are slender, seldom more than a span high; the full developed spikes only an inch long, and densely flowered. The setaceous teeth of the calyx are always longer than the tube, and in fruit about twice its length (a quarter of an inch long). Wings longer than the vexillum, shorter than the keel. Legume and lower part of the style villous. — D. laxiflora (to which belongs D. penicillata, *Moricand*, as the inspection of Berlandieran specimens reassures me) is perfectly distinguished by its taller and upright growth and bushy habit, its elongated and lax spikes, its coriaceous, orbiculate-dilated, thickly black-glandular bracts with narrower scarious margins and a shorter mucro, its smaller and yellow corolla, and its uniformly nine stamens.

133. D. LASIATHERA (sp. nov.): humilis, glaberrima; caulibus e radice perenni assurgentibus herbaceis; foliolis 7–13 (sæpius 11) oblongo-linearibus retusis subtus rhachique grosse glandulosis; spicis cylindricis densifloris; bracteis orbiculari-ovatis cuspidato-acuminatis cymbæformibus glabris dorso grosse glanduliferis marginibus scariosis calyce sericeo-pubescente paulo brevioribus persistentibus; dentibus calycis subulatis tubo brevioribus confertim villosis; petalis puniceis; staminibus 10. — Prairies, west of San Antonio, Texas, and valley of the Limpia; Aug. Also in the coll. of 1851. (On the Liano, Western Texas, *Lindheimer, Pl. Lindh.* 2. *p.* 174, where the specimen was wrongly referred to D. pogonathera.) — This species in the smaller states resembles the foregoing; but it is stouter and larger in all its parts; the stems from a span to a foot high; the leaflets somewhat more numerous; the dense spikes become two or three inches long in fruit; the calyx-teeth are subulate, much shorter, and thickly villous with shorter and rather appressed hairs, so that they do not appear plumose; and the showy, purple-red corolla is considerably larger. The petals are nearly of the same relative proportion in these two species and D. laxiflora; and the ovary and lower part of the style are villous in all

three. The tube of the calyx, in all of them, is beset with 10 rows of glands, alternating with the 10 ribs.

134. D. Wrightii (sp. nov.): humilis, cano-sericea, eglandulosa; caulibus e radice lignescente perpendiculari plurimis (2 – 6-pollicaribus); stipulis setiformibus persistentibus; foliis pinnato-5-foliolatis; foliolis lanceolatis acutis; spicis sessilibus oblongis; bracteis tenuiter membranaceis lanceolatis acuminatis villoso-ciliatis flores æquantibus; calyce villosissimo, laciniis aristæformibus longe plumosissimis tubo plusduplo longioribus corollam flavam æquantibus. — Dry hills 80 miles west of the Pecos, and on mountains near El Paso; Aug., Sept. — This interesting plant so much resembles D. Jamesii that there is scarcely any thing besides the *pinnately* 5-foliolate and narrower leaflets to distinguish them. The leaflets are from 5 to 8 lines long; the setiform stipules are shorter, and the pappus-like calyx-segments perhaps longer, than in D. Jamesii. These exceed the short and rounded lamina of the vexillum, are fully as long as the wings, but scarcely equal the keel. The specimens are all far advanced; and are entirely destitute of glands.

‡ D. Jamesii (*Torr. & Gray, Fl.* 1. *p.* 308): nana, cano-sericea, eglandulosa; caulibus cæspitosis e caudice lignescente; stipulis setiformibus elongatis persistentibus; foliis palmato-trifoliolatis argenteo-nitentibus; foliolis obovatis vel oblongis obtusis vel acutis; spicis cylindraceis sessilibus; bracteis oblongis aristato-acuminatis villosis flores subæquantibus; calyce villosissimo, laciniis aristæformibus longe plumosissimis tubo duplo longioribus corollam flavam nunc purpuream subæquantibus. — Coll. of 1851, in fruit and flower. There is no appearance of glands.*

† Amorpha canescens, *Nutt.*, var. glabrata: foliolis parce pubescentibus mox glabratis! spicis incanis prælongis. — Eastern Texas, in an early collection made by Mr. Wright. — This shows that even A. canescens greatly varies, like the other species, as to pubescence. The leading spike is nearly a foot in length, much longer than in Engelmann's var. leptostachya, *Pl. Fendl.* No. 125. †

† A. paniculata, *Torr. & Gray, Fl.* 1. *p.* 306; *Engelm. & Gray, Pl. Lindh. p.* 7. Eastern Texas, in an early collection, made by Mr. Wright. — Remarkable for its very dense and long canescent spikes of small flowers, as well as for its large leaflets, which are prominently pinnately-veined underneath.

† A. lævigata, *Nutt. in Torr. & Gray, l. c.;* var. pubescens: foliolis retusis (9 – 15 lin. longis) supra glabellis subtus cum petiolulis ramulis spicisque majusculis molliter cinereo-pubescentibus. — Eastern Texas. — The leaflets are as softly pubes-

* No. 7013 of Galeotti's Mexican collection is Dalea leucostachys, *Gray, Pl. Fendl. p.* 32, or near it.

† No. 126 of Rugel's Florida collection, wrongly named "A. canescens, *Nutt.*," is A. herbacea, *Walt.*, and A. pumila, *Michx.*, the more pubescent form (A. pubescens, *Willd.*); and of this, the A. glabra, *Desf.*, and A. Caroliniana, *Croom*, are merely the glabrous variety, as Mr. Curtis and Dr. Chapman have well ascertained. A. Tennessensis, *Shuttleworth, Pl. Rugel.*, is either a form of this or of A. fruticosa, I am uncertain which. A. pumila and A. herbacea of *Schlecht. Hort. Halensis*, 1848, *Linnæa*, 24. *p.* 185, of which Prof. Schlechtendal has kindly sent me fine specimens, must belong to one species, notwithstanding a small difference in the fruit; and they agree with A. Lewisii, *Loddiges*, and A. nana, *Bot. Mag. t.* 2112; also with No. 595, *Pl. Lindh.* 2. *p.* 174. The fruit of all these is shorter, straighter, and usually thicker, and the leaflets are mostly attenuate at the base and firmer in texture, than in the true A. fruticosa: but whether they form a distinct species is not so clear.

cent, and many of them as large, as those of the A. paniculata; but they have not the prominent veins underneath, and the flowers are three times larger. It is plainly a pubescent variety of the "glabrous and very smooth" A. paniculata, *Nutt.*, excellent specimens of which have just come to hand in Lindheimer's collection of 1850. In these the leaflets are all deeply retuse, or almost obcordate, from 12 to 18 lines long; in one specimen they are elliptical or narrowly oblong; in another they are broad and rounded, the larger ones over an inch in width. The spikes and dark-purple flowers are much larger than in A. fruticosa: the fruit not seen. — To this species must belong the "† A. fruticosa, var. subglabra," from Fredericksburg, *Pl. Lindh.* 2. *p.* 174.

‡ Glycirrhiza lepidota, *Nutt. Gen.* 2. *p.* 106; *Torr. & Gray, Fl.* 1. *p.* 298; *Gray, Pl. Fendl. p.* 31. G. glutinosa, *Nutt. in Torr. & Gray, Fl. l. c.* New Mexico, coll. of 1851. — All the specimens I have seen, from whatever locality, have the spikes considerably shorter than the leaves, and accord with the character of G. glutinosa, *Nutt.*, which I suppose is not different from G. lepidota.

135. Medicago sativa, *Linn.* Old fields near El Paso: introduced.

136. Trifolium Bejariense, *Moricand, Pl. Nouv. Amer. p.* 2. *t.* 2. T. macrocalyx, *Hook. Ic. Pl. t.* 275; *Torr. & Gray, Fl.* 1. *p.* 691. Western Texas, near Austin, &c.

137. Hosackia puberula, *Benth. Pl. Hartw. p.* 305. — Valley of the Limpia; Aug. — The specimens accord with Coulter's, from Zacatecas.

PETERIA, *Nov. Gen.*

Calyx ebracteolatus, tubulosus, quinquelobus, lobis subulatis, duobus superioribus altius coalitis. Vexillum obovatum, emarginatum, recurvum, alis oblongis obtusis longe unguiculatis æquilongum: carina cuculliformis, obtusissima, alis brevior. Stamina 10, filamento vexillari libero diadelpha. Ovarium lineare, stipitatum, multiovulatum. Stylus filiformis, adscendens, apice dense aspergillo-barbatus: stigma terminale, barbatum. Legumen lineare, plano-compressum, breviter stipitatum, immarginatum, continuum, sæpius abortu oligospermum; valvis coriaceis. Semina ovalia, compressa. — Herba glabrata; caulibus e basi suffrutescente ramosissimis, ramis scopariis teretibus gracillimis; stipulis spinosis; petiolis filiformibus persistentibus, aliis aphyllis, aliis foliolis plurimis parvis oblongis gerentibus; racemis virgatis dissitifloris erectis ramulos terminantibus; floribus pendulis flavidis.

138. Peteria scoparia. — Mountain valleys beyond the pass of the Limpia, Aug.; in fruit. Also in the collection of 1851; in flower. Also near Lake Encinillas, north of Chihuahua, *Wislizenus*, No. 126. — Stems 2 or 3 feet high, terete, glaucescent, much branched and bushy. Stipules a pair of divaricate prickles, 2 or 3 lines long. The persistent petioles are from 2 to 4 inches long, filiform, slender, not indurated nor spinescent, all the upper ones on many specimens aphyllous; the others usually bearing from 9 to 15 small leaflets. These are elliptical or lanceolate, petiolulate, mucronate, from one to three lines long, when young more or less canescently pubescent, as are the young branches and calyces. Racemes terminal, slender, 8 to 12 inches long, very sparsely flowered. Pedicels 3 to 5 lines long,

spreading or drooping, each subtended by a small subulate bract. Bractlets none. Calyx 5 lines long, gibbous at the base; the lobes about half the length of the 5-nerved tube, triangular-subulate, the two upper united nearly to the middle. Vexillum with a broad claw: the wings and keel-petals with longer and slender claws, their lamina obliquely truncate at the base. Anthers uniform, oblong. Ovary slender, smooth, as well as the filiform style, up to the apex, where it is surrounded with a conspicuous, dense, and somewhat unequal, aspergilliform tuft of hairs; and the depressed terminal stigma is bearded with similar, but rather shorter hairs. The pendulous pods are two inches or more in length, a quarter of an inch wide, often narrowed where the seeds are abortive, but continuous, flat, usually ripening only 3 or 4 round and flat seeds. — Unable to refer this striking plant to any known genus of Galegeæ, I venture to characterize it as a new one, which I dedicate to the memory of the late Dr. Robert Peter, who was the worthy associate of Dr. Short in botanical researches, and in publications on the Botany of Kentucky. Very few specimens were obtained by Mr. Wright in 1849, and those only in fruit; but an abundance of complete and beautiful specimens occur in that portion of his collection of 1851 which has come to hand. The genus is nearest allied, perhaps, to Caragana. The aspergilliform style is something as in Lessertia.*

139. Astragalus Wrightii, *Gray, Pl. Lindh.* 2. *p.* 176: annuus, pumilus, hirsuto-canescens; caule subsimplici; stipulis subulatis liberis; foliolis 3–5-jugis oblongis acutiusculis; pedunculis folio longioribus paucifloris; floribus capitatis parvis; calyce hirsutissimo, lobis lineari-subulatis attenuatis corollam violaceam superantibus legumine oblongo hirsuto subtereti fere biloculari 6–4-spermo dimidio brevioribus. — Dry soil, near Austin, Texas. Also found in Western Texas, by Lindheimer. An inconspicuous, well-marked species.†

* In Dr. Wislizenus's collection is a Chætocalyx which shows none of the setose glands from which the name of the genus was taken: —

Chætocalyx Wislizeni (sp. nov.): prostratus, puberulus; foliolis 5 rotundatis venulosis concoloribus; calycibus non glanduloso-setosis, dentibus parvis; vexillo extus puberulo; carina alis subduplo breviore; staminibus diadelphis. — Battle-ground of Sacramento, near Chihuahua, Mexico. — Herbaceous, slender: leaflets half an inch long, stipules short. Corolla golden-yellow. Fruit not seen.

† I avail myself of the ample materials accumulated in Sir William Hooker's herbarium to arrive at a better understanding of Astragalus caryocarpus, and the species nearly allied to it, viz.: —

A. caryocarpus, *Ker. Bot. Reg. t.* 176; *Hook. Fl. Bor.-Am.* 1. *p.* 150; *Torr. & Gray, Fl.* 1. *p.* 331; *Engelm. & Gray, Pl. Lindh. p.* 34 (*no.* 230) & 2. *p.* 176 (*no.* 596). A. carnosus, *Nutt. Gen.* 2. *p.* 100 (non *Pursh*, nisi fructu). A. succulentus, *Richard. in Frankl. Jour.; Lindl. Bot. Reg. t.* 1324. — This has a violet-purple corolla, and *ovate, pointed* legumes, about two thirds of an inch in diameter. The two cells are quite small in proportion to the thickness of the walls. — The calyx is as figured in *Bot. Reg. t.* 176. & *t.* 1324. The pubescence of the foliage, &c., is fine and close, and the whole hue in the living plant (from Missouri) glaucescent, as in the original figure of A. caryocarpus (*t.* 176); but the more northern form of the plant is smoother and greener, as in the figure of A. succulentus, *Bot. Reg. t.* 1324, which accords very well with Richardson's, Douglas's, and Drummond's specimens. No fruit of this northern form is yet known. The hairiness of the calyx, as in the others, may be either white, gray, or blackish.

A. Mexicanus, *Alph. DC. Pl. H. Genev. not.* 5. *p.* 17. *t.* 3 (excl. fig. 6, 7), which is A. trichocalyx, *Nutt. in Torr. & Gray, l. c.* (though the villosity of the calyx is very variable, and furnishes no reliable

‡ A. Nuttallianus, *DC.; Torr. & Gray, Fl.* 1. *p.* 334; var. pumilus, canescenti-strigosus, et leguminibus breviusculis ut in β. trichocarpo sed glaberrimis. — New Mexico; coll. of 1851. — Plant 2 to 5 inches high, slender; the peduncles 2–3-flowered; the legumes varying from a quarter to half an inch long. No. 156, *Pl. Fendl.*, is nearly the same plant. Although the pods are smooth, it is nearer related to the var. trichocarpus than to the original A. Nuttallianus. — Allied to this species and to A. distortus, but with larger flowers than either, is an Astragalus, which I have formerly received from Mr. Wright, and recently from Lindheimer, under the name of

† A. Lindheimeri (*Engelm. ined.*): glabriusculus; caulibus e radice annua plurimis adsurgentibus; foliolis 7–8-jugis anguste oblongis emarginatis; stipulis e basi lata scariosa subulato-acuminatis; pedunculis folium paulo superantibus 6–12-floris; floribus approximatis; bracteis subulatis pedicello longioribus; calycis dentibus setaceis tubo companulato longioribus; vexillo amplo (violaceo) subemarginato; leguminibus immaturis oblongo-linearibus subfalcatis glabris 10-spermis. — Sandbar in the Colorado near Austin, Texas; April. (On rich, Muskit soil, near water, along the Santa Clara, 10 miles south of New Braunfels, April, 1850, *Lindheimer*. Vexillum beautifully purple-blue, as is the tip of the carina; the wings with sulphur-yellow tips.) — A span to a foot high, with the leaves much as in the American A. Hypsoglottis. Flowers half an inch long: the very slender calyx half the length of the corolla. Mature fruit not seen.

† A. distortus (*Torr. & Gray, Fl.* 1. *p.* 333): glabriusculus; caulibus e radice perenni plurimis adsurgentibus; foliolis 5–12-jugis oblongis obovatisve sæpe retusis; stipulis triangulari-subulatis; pedunculis folium superantibus; spica brevi 10–20-flora; floribus mox decurvis; calycis campanulati dentibus subulatis tubo subduplo brevioribus; vexillo apice emarginato-bilobo; leguminibus oblongis turgidis

character), is a larger plant, with more numerous and usually rounder leaflets, pale flowers (white or ochroleucous, tinged above with rose-color and violet), and very turgid, globose-ovoid, wholly obtuse and pointless legumes, which are over an inch in diameter. These, like the ovary, are perfectly glabrous. (I know not what is represented by fig. 6 and 7 in De Candolle's plate cited above, nor do I find any reference to them in the text.) *No.* 597, *Pl. Lindh.* 2. *p.* 176, I must now refer (at least as to the specimen before in the Hookerian herbarium) to

A. Plattensis, *Nutt. in Torr. & Gray, Fl. l. c.* This is a more hirsute plant than either of the preceding (the young leaves, &c., quite villous), from which it is well distinguished by its larger flowers (an inch long), the *longer subulate teeth of the calyx*, and the *pubescent* (ovate, acuminate) *legume.* To this species belongs Geyer's No. 128, from the Kanzas River, referred by Hooker (in *Lond. Jour. Bot.* 6. *p.* 210) to A. caryocarpus: also what I had referred to A. Mexicanus (No. 597) in *Pl. Lindheimerianæ*, as just mentioned. The specimens are not in fruit, but the ovary is pubescent (while in the preceding it is perfectly glabrous), and the large flowers, long and narrow calyx-teeth, hairy foliage, &c., exactly accord with Nuttall's original specimens.

A. diphysus, *Gray, Pl. Fendl.*, is a nearly glabrous plant, with adnate stipules, obovate and mostly retuse leaflets, and thin-walled pods.

A. humilis, *Geyer in Hook. Lond. Jour. Bot.* 6. *p.* 211 (non *Bieb.*), of which the fruit only is known, does not belong to this group, although it has a thick-walled pod. The pod is not two-celled, the dorsal suture being only moderately inflexed. It is an acaulescent species, allied to A. cyaneus, if it really belongs to this genus, and not to Oxytropis.

acutis arcuato-incurvis lunatisve coriaceis glabris (nunc lævibus nunc reticulatis) suturis utroque introflexis subbilocellatis. — Near Austin, Texas, in Mr. Wright's earlier collection. (Near Houston and Brazos, *Lindheimer*. Mason County, Illinois, *Dr. Mead.*) — Flowers 4 or 5 lines long, bluish or purplish: the keel tipped with violet; the vexillum conspicuously notched at the apex. Pod 7 to 9 lines long, following the curvature, not usually abruptly bent or twisted, but strongly arcuate or lunate-incurved, at least when fully ripe, broader transversely than through the sutures. — A. obcordatus has obcordate leaflets, an entire or barely retuse vexillum, and much broader and larger legumes, which are chartaceous, laterally compressed, straighter, slightly lunate, with the upper suture salient and acute, the lower introflexed, but so little that Mr. Shuttleworth referred the plant to Phaca.

‡ A. MOLLISSIMUS, *Torr. in Ann. Lyc. N. Y.* 2. *p.* 178; *Gray, Pl. Fendl. p.* 35. New Mexico; coll. of 1851, in fruit.

140. OXYTROPIS LAMBERTI, *Pursh; Bot. Mag. t.* 2147; *Bot. Reg. t.* 1054 (var.). Hills east of Austin, Texas, April; in flower. A remarkably large-flowered, loosely-racemed form of the species.

141. DESMODIUM NEO-MEXICANUM (sp. nov.): annuum, pubescens; caule gracili subpedali erecto ramoso; foliis omnibus trifoliolatis; foliolis linearibus reticulatis mucronulatis subtus præcipue ad margines pilosis; stipulis subulatis aristatis; lomento substipitato, articulis parvis puberulis rotundatis medio adnexis. — Mountain valley 30 miles east of El Paso; Oct. Specimens in fruit only. — Leaflets from half an inch to an inch and a quarter long, one to two lines wide, acutish, strongly and coarsely reticulated beneath. Flowers small. Fructiferous pedicels half an inch long or more. Joints of the loment little over a line in diameter.*

142. DESMODIUM WRIGHTII (*Gray, Pl. Lindh.* 2. *p.* 177): caulibus e radice perenni gracilibus ramosis puberulis; foliis omnibus unifoliolatis breviter petiolatis; foliolo membranaceo oblongi-ovato basi subcordato fere glabro subtus pallido; stipulis stipellisque subulatis minimis; racemis laxis; lomento 3–4-articulato breviter stipitato, articulis inæquilateris ovalibus. — Thickets near Austin, Texas. (In deep rocky ravines of the Guadaloupe above New Braunfels, *Lindheimer*, 1850.) — Stems one or two feet high. Leaves veiny, pale and minutely pubescent underneath, mucronulate; the larger two inches long, on petioles half an inch long; the upper sometimes acute. Legume less than an inch long; the stipe as long as the stamineal tube.

143. CROTALARIA LUPULINA, *DC. Prodr.* 2. *p.* 133. Fields, near Presidio de San Elisario and El Paso; introduced. Called "Frijolillo."

* Allied to this and to the succeeding is the subjoined from Northern Mexico: —

DESMODIUM WISLIZENI (*Engelm. ined.*): tenellum, puberulum; caulibus e radice perenni pluribus diffusis; foliis inferioribus unifoliolatis, summis sæpius trifoliolatis; foliolo terminali ovato vel oblongo obtuso sæpe subcordato reticulato scabrido, lateralibus dum adsunt minoribus oblongis; stipulis bracteisque subulato-setaceis conspicuis; racemo elongato; lomento breviter stipitato 3–6-articulato, articulis ovali-rhomboideis glaberrimis medio adnexis. — Cosiquiriachi, Northern Mexico, *Wislizenus*. — Stems a span or more in length. Leaflets thicker than those of D. Wrightii, conspicuously reticulated underneath, 6 to 10 lines long. Flowers very small. Loment 5 to 8 lines long when of 4 or 5 joints.

† LUPINUS SUBCARNOSUS, *Hook. Bot. Mag. t.* 3467; *Engelm. & Gray, Pl. Lindh. p.* 34. Near Austin, Texas. — L. Texensis, *Hook. Bot. Mag. t.* 3492, *Pl. Lindh.* 2. *p.* 177, is no more than a variety, and scarcely a permanent one, of L. subcarnosus; as an inspection of the original specimens shows. The leaflets of both forms are equally succulent, those of the upper leaves often acute, while the lower are obtuse or retuse.

144. SOPHORA (DERMATOPHYLLUM) SPECIOSA, *Benth. in Pl. Lindh.* 2. *p.* 178. Dermatophyllum speciosum, *Scheele in Linnæa*, 21. *p.* 459. Western Texas; common. — The specimens gathered by Dr. Gregg, near Monterey, Saltillo, and Parras, with the foliage densely silky-canescent when young, but glabrate or glabrous when old, belong, I suspect, to a mere variety of the Texan plant, and both are probably to be referred to S. secundiflora.

‡ S. (PSEUDOSOPHORA) SERICEA, *Nutt. Gen.* 1. *p.* 280; *Torr. & Gray, Fl.* 1. *p.* 390; *Gray, Pl. Fendl. p.* 38. New Mexico; coll. of 1851. — The specimens are in fruit, and are the first which have been obtained in this condition. The canescent pods ripen only one seed, either at the base or in the middle, forming an ovate and pointed articulation from 3 to 5 lines long.

145. HOFFMANSEGGIA JAMESII, *Torr. & Gray, Fl.* 1. *p.* 393; *Gray, Pl. Fendl. p.* 38, *& Pl. Lindh.* 2. *p.* 178. Prairies, east of El Paso, Oct.; in fruit. Also in the collection of 1851. — Some of the stipules show one or two setaceous teeth on each side. The vexillum is often dotted with black glands.*

146. H. CAUDATA (*Gray, Pl. Lindh.* 2. *p.* 179): frutescens, glaberrima; stipulis bracteisque cordato-ovatis integris scariosis brevibus deciduis; petiolis ramulisque glandulis parvis stipitatis rariter muricatis; pinnis 2–3-jugis 8–10-foliolatis cum impari elongata 24–30-foliolata; foliolis omnino eglandulosis glaberrimis crassiusculis rotundatis oblique subcordatis venosis; racemo sparsifloro; calycibus sparse glandulosis; legumine acinaciformi dilatato glabrato glandulis subsessilibus asperato. — Sandy soil, between the Rio Grande and Nueces, Texas, Sept.; principally in fruit. — A foot or more in height. This species is remarkable for its smoothness (some small tack-shaped glands only occurring on the calyx, or a few still minuter ones scattered on the upper part of the branches and the petioles), and for the elongation of the terminal pinna, which is two or three inches in length, and bears many pairs of leaflets; while the lateral ones are scarcely an inch long. The leaflets are about two lines in length, crowded, thickish, obscurely mucronulate, subsessile, oblique. Raceme sparsely 6–9-flowered. Legume not stipitate, nearly two inches long and two thirds of an inch wide, flat, reticulated, furfuraceous-glandular, and roughened with subsessile, blackish glands; the upper suture straight, except the incurved apex. There are no expanded flowers; the raceme of one specimen bears unopened flower-buds.

* Hoffmanseggia melanosticta (Pomaria melanosticta, *Schauer in Linnæa*, 20. *p.* 748) was gathered by Gregg at Buena Vista (No. 292), and in a valley near Azufrora (No. 497), Northern Mexico. Although allied to H. Jamesii, it is readily distinguished by its larger and fewer leaflets (only 6 or 8 to each pinna), and larger, more muricate, and straighter pods. In one specimen the pod is over an inch and a half long. There are a few sessile black glands on the petioles and branches (as is also the case in H. Jamesii); in all other respects it perfectly accords with Schauer's description.

‡ H. BRACHYCARPA (sp. nov.): glabriuscula, herbacea; stipulis obovatis sæpe dentatis caducis; petiolis ramisque glandulis minimis rariter conspersis; pinnis bijugis cum impari æquilongis; foliolis 4–5-jugis ellipticis nunc retusis enervibus subtus glandulis depressis nigro-punctatis; racemo paucifloro; calycis laciniis lanceolatis nigro-glandulosis; petalis subconformibus, unguibus eglandulosis; legumine ovali fere æquilatero stylo recto cuspidato glabrato ad suturas parce glanduloso et hispido-muricato dispermo. — New Mexico, coll. of 1851; the specimens nearly all in fruit. — A species remarkable for its short and broad, nearly equilateral pods, in this respect apparently much like Bentham's H. platycarpa (a species which is not before me); but that has from 4 to 6 pairs of pinnæ and no glands. Our species has many ascending stems from a lignescent root, slender, leafy to the top, angled, minutely pubescent or nearly glabrous, either glandless, or, like the petioles, with a few scattered and sessile black glands. Leaflets minutely pubescent or glabrate, 3–5-lines long, the lower surface sprinkled with rather large, flat, and sessile black glands. Flowers no larger than those of H. Drummondii. Petals yellow, with rather long (reddish) slightly pubescent inappendiculate and glandless claws, the vexillum with a few dark glands on the back. Legume 8 or 9 lines long and 4 or 5 broad, rounded at the base, not in the least stipitate, the flat sides puberulent or glabrate, sometimes with a few scattered glands like those of the leaves, the sutures beset with scattered stipitate black glands and with rigid setose-muricate projections.

† H. DRUMMONDII, *Torr. & Gray, Fl.* 1. *p.* 393. Between Austin and the Rio Grande, Texas. — Stems woody at the base. Stipules scarious, ovate, often denticulate. Legumes strongly lunate-incurved, minutely muricate when young.

147. "H. OXYCARPA (sp. nov.): stipulis ovato-acutis integris; pinnis 3–5-jugis cum impari; foliolis oblongis enervibus eglandulosis; calycis laciniis obtusiusculis parce glandulosis; petalis elliptico-oblongis subnudis brevissime stipitatis; legumine falcato acutissimo stipitato-glanduloso." *Benth. Mss.* — Calcareous hills and high prairies of the San Felipe and Live Oak Creeks; July. Also in the collection of 1851. (Near Monterey, Northern Mexico, *Gregg*, *Edwards*, and *Eaton.*) — "Foliage nearly that of H. falcaria; flowers of H. Drummondii, but with rather narrower petals. Pod an inch or more in length, and not above three lines broad." *Benth.* Stems and petioles villous-pubescent, often with some stipitate glands intermixed; low, slender, from a suffrutescent base. Ovules 7–9. Legume 4–6-seeded, in some specimens of Wright's recent collection larger (4 lines wide) and less acute, the young ones densely glandular-hispid.

148. "H. DENSIFLORA (sp. nov.): stipulis late ovatis; caule foliisque pubescentibus vix glandulosis; pinnis 3–6-jugis cum impari; racemo pedunculato per anthesin denso subcapitato calycibusque dense pubescentibus et parce glandulosis; vexillo dense stipitato-glanduloso ungue dilatato; legumine . . . . . — Caulis e basi perenni nunc humilis, nunc fere pedalis, simplex vel parce ramosus. Folia et stipulæ H. falcariæ. Pedunculus folio ultimo paullo brevior, floribus confertis magnitudine H. falcariæ. Stamina 10 omnia antherifera. Ovula circa 8." *Benth. Mss.* — Valley of the Pecos; Aug. — The fruiting specimens and all the loosely-flow-

ered ones, distributed under this number, belong to the next species, from which I am not sure if H. densiflora is sufficiently distinct.

148 (partim). H. STRICTA, *Benth.*, β. DEMISSA: humilis; racemo laxo breviter pedunculato; pedicellis floriferis patentibus fructiferis recurvis; legumine parum falcato. — Mountain valleys west of the pass of the Limpia; Aug. Also in the collection of 1851. Near Saltillo and Parras, Northern Mexico, *Gregg* (No. 268, &c.). — Mr. Bentham has distinguished this, under the name of H. demissa: but the copious flowering specimens since gathered by Mr. Wright, some of them dwarf, with the raceme much longer than the rest of the plant, others nearly a foot high, with stricter racemes, lead me to refer it to H. stricta, *Benth.* My Coulterian specimen is destitute of fruit, indeed; but the very obtuse legumes both of Wright's and Gregg's plants are minutely glandular, and often falcate, though more commonly straightish. They are from an inch to an inch and a half long, scarcely 3 lines wide, 6 – 12-seeded (ovules about 12). The stems and pedicels are more or less stipitate-glandular, as well as the calyx.

‡ "H. STRICTA (sp. nov.): stipulis late ovatis; ramis parce glandulosis foliisque puberulis glabratisve; pinnis 4 – 6-jugis cum impari; racemo stricto; pedicellis dissitis suberectis calycibusque pubescentibus et stipitato-glandulosis; vexillo dense stipitato-glanduloso ungue dilatato; legumine falcato glanduloso polyspermo." *Benth. Mss.* — Zacatecas, Mexico, *Coulter.* With this, specimens in Wright's collection of 1851 well accord, except that the flowers are perhaps rather larger and the pedicels more spreading. They are not in fruit. The tallest specimens are over a foot high. — Mr. Bentham contributes the following remarks. "The above species (H. stricta, demissa, and densiflora) agree with H. falcaria in their most important characters. The stipules are broadly ovate, membranaceous, blunt or scarcely pointed; the petioles long and slender, with usually 3 or 4, sometimes 5 or 6 pairs of pinnæ, each bearing from 6 to 10 pairs of obliquely oval-oblong blunt and nerveless crowded leaflets, without any odd one: the common petiole, however, is always terminated, in my specimens, by an odd pinna, usually rather longer than the lateral ones. In all these species, the divisions of the calyx are linear-oblong, rather blunt, equal, or the lower one rather shorter and broader, generally persistent, but sometimes falling off before the fruit is ripe. The four lower and outer petals are nearly equal, scarcely oblique, obovate, and narrowed into long claws, which bear copious stipitate glands on their inwardly turned edges. The upper and inner petal, or vexillum, is equal in length, but very differently shaped: it is concave or folded, the lamina rather smaller than in the others, the claw expanded in the middle, and the copious stipitate glands are on the back instead of the front, covering the claw and the lower part of the lamina. Stamens straight, nearly equal (the lower ones rather longer), the filaments more or less beset with rigid hairs and stipitate glands (the latter sometimes wanting), the five inner always less hairy than the five outer, and all ten antheriferous in all the flowers I have examined. Ovary glandular; the style smooth, clubshaped at the apex, with a contracted opening more or less ciliate; but these cilia and the thickening of the apex appear to vary according to the age of the flower. The pod is flat, the margins slight-

ly thickened, and the apex remains blunt after the falling of the style. — These species, with H. trifoliata, *Cav.* (Port Desire, *Middleton!*), differing in its foliage, also H. gracilis, *Hook. & Arn.* (Chili, *Cuming*, No. 880!) and H. prostrata, *Lag.* (Lima, *Cuming*, No. 1069!), in both of which the petals are scarcely glandular, and the claw of the vexillum long and narrow, would form the section *Hoffmanseggia* proper. H. viscosa, *Hook. & Arn.* (W. Colombia, *Cuming*, No. 1175! and Peyta, *Gaudichaud*), may also be referred to the same section, although the claws of the petals are shorter and the pod less marginate and more readily dehiscent. The H. glandulosa, *Vog.*, from South America, which I have not seen, must be very near H. viscosa, but with a very long glandular raceme. . . . . . If we consider the section *Pomaria* as characterized by the nearly sessile petals, only differing from each other in the vexillum being rather broader, all with few or no stipitate glands (where they exist they are generally dorsal on the vexillum), we may subdivide it into three or four distinct groups. The first (§ *Gladiatæ*), including H. gladiata* and H. platycarpa,† *Herb. Coll. Trin. Dubl.*, with the habit and foliage of H. stricta, without black dots on the leaves, has the flowers nearly as in H. Drummondii, and a straight or slightly curved pod, blunt at the apex, with the upper or seminal suture more or less convex, and usually broadest below the middle. The second group (§ *Lunatæ*) would include H. oxycarpa, Drummondii, and caudata, with a variable habit, the leaflets without black dots, and the pod broadly falcate, very sharp by the persistent base of the style, more readily dehiscent than in any of the preceding, with the seminal suture straight or concave. The third group (§ *Melanostictæ*), with the under side of the leaves sprinkled with black glandular dots, and the pod nearly that of the *Lunatæ*, is less known to me, as I have not myself examined any flowers. It would comprehend the H. melanosticta and H. Jamesii, if the two are not one species. Pomaria humilis, *Mart. & Gal.*, is probably allied to H. platycarpa, and P. glandulosa, *Cav.*, to H. melanosticta; but both are unknown to me. Of De Candolle's genus *Melanosticta* I have seen but a very imperfect specimen of M. Burchellii, with a pod shaped like that of a Cæsalpinia, and still worse specimens without flower or fruit of what appears to be a second African species. Until they can be examined from better specimens, it cannot be determined whether they are or are not generically distinct from Hoffmanseggia." *Benth. in litt.* — My H. brachycarpa, which, having just reached me from the discoverer, has not yet been seen by Mr. Bentham, would seem to be ambiguous between the sections *Gladiatæ* and *Melanostictæ*, approaching the former in the shape of the pod, but belonging rather to the latter on account of the persistent style and the black glands on the under surface of the leaves. I have still to add another species, entirely glandless, which, with the sessile petals of a Pomaria, has the thin, tardily dehiscent and many-seeded legume of Hoffmanseggia proper, viz.: —

* " H. GLADIATA: stipulis ovato-acutis; pinnis 3 – 6-jugis cum impari; foliolis oblongis enervibus eglandulosis; calycibus acutis hirsutis glandulosisque; petalis oblongis brevissime stipitatis; legumine lanceolato subincurvo hirtello et parce glanduloso. (Zimapan, Mexico, *Coulter.*)" *Benth. in litt.*

† " H. PLATYCARPA: stipulis ovato-acutis; pinnis 4 – 6-jugis cum impari; foliolis oblongis enervibus eglandulosis; calycibus acutis hirtis glandulosisque; petalis ovatis vix stipitatis; legumine late oblongo pubescente vix glanduloso. (Mexico, *Coulter.*)" *Benth. in litt.*

‡ H. DREPANOCARPA (sp. nov.): humilis, glabella, undique eglandulosa; stipulis bracteisque ovato-acutis; pinnis 3 – 5-jugis cum impari; foliolis 9 – 10-jugis oblongis subfalcatis enervibus; racemo elongato laxifloro; calycis laciniis oblongo-lanceolatis obtusiusculis; petalis subconformibus obovatis exunguiculatis; ovario glaberrimo; legumine lato-lineari utrinque obtusissimo eximie falcato 9 – 10-spermo, valvulis chartaceis reticulatis. — New Mexico, or between Texas and El Paso; coll. of 1851; in flower and fruit. — Root thick and ligneous, perpendicular, 6 or 8 inches deep; the crown bearing many abbreviated, slender stems, seldom more than an inch or two long before they terminate in the slender (often subradical) peduncle of the elongated and loosely-flowered raceme (the latter with the peduncle 6 inches in length). The stems, foliage, calyx, &c., are minutely cinereous-puberulent, but almost glabrous to the naked eye, especially the leaflets, and all are entirely destitute of any kind of glands. Leaflets about 3 lines long, crowded. Bracts and usually the stipules caducous. Calyx 3 lines long, persistent. Petals yellow, a little longer than the calyx, broadly obovate, very obtuse, nearly alike, except that the vexillum is broader at the base and truly exunguiculate, the other petals being contracted into a narrow insertion; all naked and glabrous. Filaments equal, all ten antheriferous and similarly villous-barbate below the middle. The filiform style and the stigma as described above by Mr. Bentham in Hoffmanseggia proper. Legume flat, an inch and a half long, following the strong curvature, 3 lines wide, of exactly the same width throughout from the rounded base (subtended by the persistent calyx) to the very blunt and naked apex, glabrous, or minutely puberulent under a lens, not in the least glandular, tardily dehiscent; the thin valves finely reticulated, and transversely impressed between the seeds.

149. CERCIDIUM TEXANUM (sp. nov.): pinnis unijugis bifoliolatis; foliolis oblongo-obovatis retusis; petalis late obovatis subrhombeis calyce duplo longioribus; ovario villosissimo; legumine pubero immarginato. — Prairies of Elm Creek and on the Rio Grande, Texas; July, in flower. Also in the collection of 1851; in flower and with some young fruit. — Shrub 2 to 5 feet high, much branched; the branches very rigid, divaricate, flexuose, and usually armed throughout with short and spreading axillary spines, green, when young cinereous, as are the leaves, with a fine close pubescence. Leaves sparse and soon deciduous. Leaflets one or rarely two pairs on each pinna, 2 to 3 lines long, about as long as the partial and general petiole together. Flowers solitary in the axil of a spine, or subracemose at the extremity of some of the branches. Lobes of the calyx oblong-lanceolate. Corolla golden-yellow; the dilated petals 4 or 5 lines long; the vexillar one with a longer claw and a little smaller and rounder lamina than the others, its margins auriculate-inflexed at the base. Immature legume about an inch long, pubescent, flat, about 2-seeded; the valves minutely reticulated, the reticulations narrow and longitudinal; both sutures entirely destitute of a winged margin. The pod is probably dehiscent in this species, as it certainly is in the nearly allied C. floridum.*

* CERCIDIUM FLORIDUM (*Benth. in Herb. Trin. Coll. Dubl.*): glabellum; pinnis 1 – 2-jugis; foliolis trijugis obovato-oblongis; petalis obovatis calyce subduplo longioribus; ovario glabro; legumine falcato

150. Cassia Lindheimeriana, *Scheele in Linnæa*, 21. *p.* 457; *Gray, Pl. Lindh.* 2. *p.* 179. Western Texas, common. Also Monterey, N. Leon, *Berlandier.* It is allied to C. apiculata, *Mart. & Galeotti*; but it is more silky-tomentose, larger in all its parts, with broader and caducous stipules, more numerous leaflets; the mature pods glabrate.

151. C. Rœmeriana, *Scheele, l. c.* Hills, from Austin, Texas, west to the San Pedro River. — Stems 8 to 15 inches high, herbaceous nearly or quite to the base, from a very thick ligneous root.

152. C. bauhinioides (*Gray, Pl. Lindh.* 2. *p.* 180, *adnot.*): humilis, suffruticosa, sericeo-canescens; foliolis unijugis rariusve bijugis, oblongis vel subovatis utrinque rotundatis inæquilateris; glandula interposita; stipulis setaceis persistentibus; pedunculis 2–3-floris folium æquantibus; legumine membranaceo turgido rectiusculo vel subfalcato hirsuto. — On the Rio Grande, Texas, and west to New Mexico: also in the collection of 1851. — Stems from a span to nearly a foot high, numerous from a thick and lignescent perpendicular root. Legume oblong or linear-oblong, 8–15-seeded.

153. C. pumilio (*Gray, Pl. Lindh.* 2. *p.* 180): nana, subcaulescens e radice longa perpendiculari lignosa, strigulosa; foliolis unijugis linearibus lanceolatisve cuspidatis subnervatis, glandula subulata interposita; petiolo in appendicem subulatam producto; stipulis setaceis elongatis basi petioli adnatis rigidis persistentibus; pedunculis unifloris folium superantibus infra apicem unibracteatis; sepalis scarioso-marginatis obtusissimis; staminibus 3 superioribus difformibus castratis; legumine inflato ovoideo vel oblongo obtusissimo membranaceo puberulo dehiscente calyce persistente subduplo longiore; seminibus plurimis (6–12) horizontalibus septis hyalinis incompletis parallelis. — Bottoms of the San Pedro River, in sandy soil; and on the Rio Grande in Southern Texas. Also in the collection of 1851, with ripe fruit. — This singular dwarf species, with a pod like that of a Crotalaria (inflated, and with the sides slightly compressed, half an inch or a little more in length, sometimes globose-ovoid), is scarcely referrible to any one of Vogel's sections, although it has the flowers of a Chamæsenna. The deep, often nodose-thickened, ligneous root is six or seven inches long. The caudex or stem, usually very short, sometimes rises two or three inches out of the ground, and is clothed with the subulate persistent stipules. Peduncle two or three inches long, articulated at the insertion of the subulate bractlet. Leaflets subcoriaceous, in some specimens nearly glabrous; the earlier ones lanceolate, or sometimes oblong.

154. C. nictitans, *Linn.; Torr. & Gray, Fl.* 1. *p.* 396. Mountain valley, thirty miles east of El Paso.*

vel rectiusculo sutura ventrali angustissime marginato. — Northern Mexico, *Coulter, Gregg* (who gathered it between Monterey and Matamoras). Cerralvo, *Wislizenus.* Also found by Col. Emory and Mr. Fremont on the Gila, where it is said to be abundant in an arid region. The flowers are rather smaller than in C. Texanum. The legumes two inches long, four or five lines wide, perfectly glabrous, as is the ovary, tardily dehiscent, the ventral suture narrowly, but distinctly and acutely margined.

* I have the following new Cassias from Northern Mexico: —

Cassia (Chamæcrista) Greggii (sp. nov.): fruticosa, ramosissima; ramis puberulis; stipulis subulatis

155. Algarobia glandulosa, *Torr. & Gray, Fl.* 1. *p.* 399. Plains of Western Texas. "A tree, from 20 to 30 feet high; the trunk 12 or 18 inches in diameter." — In foliage at least our plant seems unlike Prosopis dulcis; but quite like P. siliquastrum (or P. juliflora), which is thought to be a mere variety of P. dulcis. The structure of the pod is the same in all three, and all may be varieties of one widely distributed and polymorphous species, for which the name of juliflora should be adopted. What I had once examined as an *Algarobo* pod (*Pl. Lindh. p.* 35) was doubtless the legume of a Ceratonia. P. Limensis has the seeds inclosed in separate coriaceous investments, as in P. juliflora; so has P. fruticosa. It is the same in P. sericantha and P. humilis, only the *pips* are quadrate from mutual pressure. In the former they are very thick and cartilaginous: and the pod in both is liable to break up transversely into one-seeded articles. In P. torquata the seeds are inclosed in similar, well-defined pips: so also in P. abbreviata, except that they are thin, pointed at both ends, and elongated, so as to become spirally twisted with the pod. These *torquate* species are therefore inseparable from Algarobia, except as a mere section, while P. strombulifera, P. reptans, and the following species, having continuous, even, and closely spiral legumes, are true Strombocarpæ.

156. Strombocarpa pubescens. S. brevifolia, *Nutt. in Herb. Hook.* Prosopis (Strombocarpa) pubescens, *Benth. in Lond. Jour. Bot.* 5. *p.* 82. — High pebbly prairies west of Zacate Creek, July; in flower. Valley of the Rio Grande 40 or 50 miles below El Paso, Sept.; in fruit. Also gathered, in flower, in the collection of 1851. North of the Jornada del Muerto, N. Mexico, *Dr. Wislizenus.* — Shrub 6 – 12 feet high; the erect spikes an inch or an inch and a half long, on rather long peduncles; the rhachis nearly glabrous, but the flowers silky-pubescent, and the ovary very villous. The closely spiral cylindrical pods are from one to two inches long, and cinereous-pubescent when young. — The specific name of *pubescens* is not well chosen, as the leaflets scarcely appear pubescent to the naked eye. But it may prove to be only a small-leaved variety of Dr. Torrey's earlier-published Prosopis odorata. The oblong leaflets, however, are barely half as long, about three lines, and the pinnæ only an inch long.*

persistentibus; foliolis 3 – 4-jugis elliptico-oblongis glabellis nitidis coriaceis eximie reticulatis (3 – 4 lin. longis); glandula petiolari turbinata; pedunculo axillari vel supra-axillari pluribracteato 1 – 2-floris folio æquilongis; sepalis membranaceis (aurantiacis) obtusis glabellis petalis obovatis aureis dimidio brevioribus; legumine ignoto. — Northern Mexico, near Rinconada, Cerralvo, and Monterey, *Dr. Gregg;* North of Monterey, *Dr. Wislizenus.* — A shrub, one or two feet high, with small leaves, and proportionally large, deep-yellow flowers.

C. (Chamæfistula?) Wislizeni (sp. nov.): fruticosa, subglabra; foliis plerumque fasciculatis; foliolis bijugis obovatis retusis mucronatis recte-venosis (3 lin. longis); petiolo eglanduloso in appendicem setaceam producto; stipulis subulato-setaceis; pedunculis 3 – 5-floris ad apicem ramorum confertis corymboso-paniculatis; sepalis late ovalibus obtusissimis margine subscariosis undulatis petalis (flavis) obovato-rotundis ter quaterve brevioribus; legumine ignoto. — Carizal and Ojo Caliente, south of El Paso, *Dr. Wislizenus;* Aug. — Shrub 4 to 6 feet high; the branches puberulent, very leafy to the top, and bearing a corymb or panicle of copious and large flowers; the petals almost an inch long.

* Berlandier's No. 2013, mentioned under Prosopis reptans, in *Hook. Jour. Bot.* 4. *p.* 352, was most probably gathered in Northern Mexico, not in Texas. It is doubtless the same as No. 492 of Gregg's Mexican collection, which, I think, may be characterized as follows: —

157. Neptunia lutea, *Benth. in Hook. Jour. Bot.* 4. *p.* 356. Low and moist prairies, Zacate Creek; and on the Rio Grande, Texas. — From New Braunfels, Lindheimer has sent a variety with brighter yellow flowers, and with the ovary and young pod pubescent.

158. Desmanthus velutinus, *Scheele in Linnæa*, 21. *p.* 456; *Gray, Pl. Lindh.* 2. *p.* 183. Hills of the Rio Seco, Western Texas; June.

† D. reticulatus, *Benth. in Hook. Jour. Bot.* 4. *p.* 357. Near Austin, Texas.

‡ Mimosa fragrans, *Gray, Pl. Lindh.* 2. *p.* 182. Between Texas and New Mexico; coll. of 1851; with ripe fruit. — The leaflets are rather shorter than in Lindheimer's Texan plant. The ripe pods, of a thin, chartaceous texture, are mostly much constricted between the seeds, perfectly smooth, and unarmed, or very rarely with one or two minute and weak prickles on the margin; which, as well as the more numerous and usually narrower leaflets, distinguishes it from

‡ M. borealis, *Gray, Pl. Fendl. p.* 39. Between the frontiers of Texas and El Paso; coll. of 1851; with ripe fruit. — The specimens are exactly like those of Fendler; the branches armed with very strong prickles, and the leaves very small; the margins of the pod also armed with a few large, hooked prickles.*

159. M. borealis, var.? Texana: foliolis 5 – 6-jugis oblongis. — Hills near Austin, May, in flower; and on the western borders of Texas, in fruit. Also in the coll. of 1851. — In foliage this is between M. borealis and M. fragrans; but with the pods of the former. I believe the same plant was gathered by Gregg, near Buena Vista and Cadena; and it is the plant referred to under M. fragrans in *Pl. Lindh. l. c.* as formerly gathered by Mr. Wright in Texas.

160. M. biuncifera, *Benth. Pl. Hartw. p.* 12. *& in Hook. Jour. Bot.* 4. *p.* 409. Mountain valleys, 30 or 40 miles east of the Rio Grande, in Southern New Mexico, Sept.; in fruit. Dr. Gregg also found it near Ojito. — The legumes, which were before unknown, are narrowly linear, falcate-incurved or sickle-shaped, glabrous or nearly so, an inch to an inch and a half long, less than two lines wide, the margin beset with one or two hooked prickles, or more commonly naked. — Mr. Bentham

Strombocarpa cinerascens (sp. nov.): erecta, humilis; ramulis foliisque cinereo-pubescentibus; pinnis unijugis; foliolis oblongis 8 – 12-jugis; pedunculo folium æquante; spicis globosis; calyce superne tomentoso dimidium corollæ adæquante. — Valley near Azufrora, New Leon, *Dr. Gregg.* — "Shrub 6 – 12 inches high." The slender thorns longer than the leaves. Leaflets twice as large as those of S. reptans. Fruit not seen.

* A closely allied North Mexican species, but well distinguished by having the leaflets as well as the pinnæ reduced to a single pair, is characterized by Mr. Bentham as follows: —

"Mimosa zygophylla (sp. nov.): glabra; aculeis infrafoliaceis solitariis recurvis; pinnis foliolisque unijugis, his parvis oblique orbiculatis crassiusculis; pedunculis folio sublongioribus; capitulo globoso; floribus pentameris; legumine glabro subfalcato acutissimo margine nudo vel parce aculeato. — La Vaqueria towards San Juan, 30 miles from Saltillo, *Wislizenus.* Near Saltillo and Monterey, *Gregg.* — Allied to M. depauperata; but perfectly glabrous; the leaflets rather larger and thicker (from one to one and a quarter of a line long), never more than one pair on each pinna, of which also each leaf has but one pair. The pod, from an inch to an inch and a half long, is reddish and rather glaucous in the dry state, very smooth, ending in a very sharp point. The shrub is said to be two or three feet high. I have seen the flowers only in a withered state." *Benth. in litt.*

remarks that this species is perhaps too near M. acanthocarpa. M. Lindheimeri is also too like it.

161. "M. FLEXUOSA (sp. nov. Ameria Acanthocarpæ):* fruticosa, minute pruinoso-puberula; aculeis infrastipularibus geminis conicis rectis; pinnis 5–7-jugis; foliolis 7–10-jugis minimis oblongis obtusis crassiusculis puberulis; capitulis globosis; legumine lineari rectiusculo minute cano-puberulo margine tenui aculeato.— Ramuli rigidi, flexuosi, albidi. Aculei caulini cæsiæ, 2 lin. longi; petiolares minutissimi. Stipulæ minutæ, setaceæ. Petiolus communis vix semipollicaris. Pinnæ confertæ, 2–3 lin. longæ. Foliola fere imbricata, semilineam longa, rigidula, læte virentia, utrinque puberula, obtusa, vel rarius mucronulata. Pedunculi fructiferi 2–3 lin. longi. Legumen pollice paullo longius, vix 2 lin. latum, rectum vel leviter falcatum, crassiusculum, aculeis marginalibus irregularibus rectis. Aff. M. Lindheimeri." *Benth. in litt.*— Mountain valleys beyond the Limpia; Aug. "A much-branched shrub, 2 or 3 feet high."

162. = No. 180. q. v.

163. "M. DYSOCARPA (sp. nov. Habbasia): fruticosa; ramis petiolisque ferrugineo-villosis; aculeis sparsis validis subrecurvis; pinnis 6–10-jugis; foliolis 8–10-jugis oblongis acutis sericeo-villosis; spicis cylindricis; floribus pentameris sericeo-villosis; calyce corollæ dimidium æquante; legumine lineari-falcato dense tomentoso inermi aut margine aculeis validis sparsis armato.— Aculei ramulorum sæpius solitarii, rarius infrastipulares, petiolorum pauci parvi. Stipulæ subulatæ, rigidæ, villosæ, 2–3 lin. longæ. Petioli communes sesquipollicares, tomentosi. Foliola conferta, vix 2 lin. longa. Spica densa pollicaris. Calyx fere lineam longus, membranaceus, breviter 5-dentatus. Stamina 10: filamenta sursum complanata. Ovarium villosissimum. Legumen sesqui–bipollicare, 3 lin. latum, apice rigide acuminatum, fere pungens, tomento rufescente dense vestitum, valvulis ab margine crasso in articulos demum secedentibus." *Benth. in litt.*— Mountain valleys in the Pass of the Limpia and beyond, August; in fruit. Also in the collection of 1851, in flower. This species seems in some respects to connect the *Ameria Acanthocarpæ* with *Habbasia Batocaulon*, having the habit and small leaflets of the former; but the pods, although at first appearing continuous, at length separate into from five to seven articles.

164. M. MALACOPHYLLA (*Gray, Pl. Lindh. 2. p.* 182, *adn.*): suffrutescens, molliter sericeo-tomentulosa; caulibus procumbentibus angulatis petiolisque copiose aculeatis, aculeis brevibus uncinato-recurvis; pinnis 4–7-jugis; foliolis 5–8-jugis ovatis vel ovali-oblongis mucronatis venosis; panicula racemosa laxa; floribus 5-meris 10-andris; legumine lato-lineari longiuscule stipitato membranaceo glabro nitido inermi 6–8-spermo.— On the Rio Grande, in Southern Texas, August, September; in flower and fruit. Also gathered near Monterey, Northern Mexico, by *Dr. Gregg* and *Dr. Edwards*, without fruit; and east of Rinconada by *Dr. Gregg* in 1848.— Plant with the habit of a Schrankia, canescent with a fine and very soft down; the partial and general petioles, as well as the stem, beset with

* The characters of this and several other new Mimoseæ were obligingly communicated by Mr. Bentham.

numerous short, uncinate prickles. Leaflets 3 to 5 lines long. Flower swhite, according to Mr. Wright, yellowish, according to Dr. Gregg. Legume two inches or more in length, with a stipe-like base half an inch long, very smooth. — A well-marked species of the section Habbasia Rubicaules.

165. CALLIANDRA CHAMÆDRYS, *Engelm. in Pl. Fendl. p.* 39; var. foliolis oblongis (1 – 2 lin. longis). — Hills on the Rio Grande, Texas, in great abundance, July; in flower. — "Plant a foot high." The leaflets are pilose when young, with longer and looser hairs than those of C. Californica, soon glabrate, and they are coarsely reticulate-veined from a prominent midrib. The pinnæ are commonly two pairs, sometimes three. — C. Chamædrys must be critically compared with C. eriophylla of Bentham, who, I perceive, has referred one of Dr. Gregg's Chihuahuan specimens to that species. The leaflets are soon glabrate, and the pinnæ frequently unijugate.

166, 167. "C. CONFERTA (sp. nov.): humilis; ramulis petiolisque pubescentibus; pinnis unijugis; foliolis 8 – 12-jugis parvis oblique oblongis subcoriaceis nitidulis subtus sericeo-villosis; pedunculis petiolo brevissimo longioribus subcorymbosis; floribus paucis sessilibus pilosis; calyce corollæ dimidium æquante; legumine adpresse villoso, valvulis medio membranaceo-coriaceis crasse marginatis. — Fruticulus semipedalis. Stipulæ lanceolato-subulatæ, lineam longæ. Petiolus communis stipulis fere brevior. Pinnæ semipollicares; foliolis vix 2 lin. longis, confertis, villis longis paginæ inferioris obtectis, supra glabriusculis. Pedunculi subfasciculati, 2 – 4 lin. longi. Flores in capitulo 5 – 9, (staminibus neglectis) vix 2 lin. longi. Calyces breviter 5-dentati. Stamina (ex sicco) pallida, vix semipollicaria. Legumen sessile, basi longe angustatum, sesquipollicare, 3 lin. latum. — This species ranks with the *Nitidæ Unijugæ*, near C. brevipes, and is readily distinguished by its small stature, few leaflets and flowers, and very hairy leaves. In these respects it is nearer C. eriophylla; but it appears never to have more than one pair of pinnæ, and the form and proportion of the flowers are different." *Benth in litt.* — Hills at the head of the San Felipe, in flower; and on Zacate Creek, July, in fruit: also on the Rio Grande, Texas.

168. C. HERBACEA, *Engelm. in Pl. Fendl. p.* 39. Mountain valleys in the Pass of the Limpia, Aug.; in fruit. Also in the collection of 1851, from the same region, both in flower and fruit. — Stems numerous from a thick and lignescent caudex, three or four inches long, slender, spreading. Leaflets from one to two and a half lines long, subcoriaceous, when young villous beneath and on the margins with loose silky hairs, at length glabrate. Flowers apparently pale purple; the calyx and corolla pubescent, becoming glabrate; the stamens exserted for a quarter of an inch. Legumes 2 or 2½ inches long, 3 lines wide, minutely puberulent under a lens, the valves chartaceo-coriaceous, with very tumid narrow margins, bursting elastically in the manner of the genus. Seeds oval, mottled. — I suspect it is not specifically distinct from Calliandra humilis, *Benth. in Lond. Jour. Bot.* 5. *p.* 103, from Zacatecas, No. 511 of Coulter's Mexican collection.

169. DESMANTHUS JAMESII, *Torr. & Gray. Fl.* 1. *p.* 402? *Gray, Pl. Fendl. p.* 38; var. legumine breviore acutato. — Mountain valleys in the Pass of the Limpia; Aug. — This is the same as the plant of Fendler's collection, above cited, only the

legume is sharp-pointed. The leaflets are ciliolate, otherwise glabrous. The very rigid and thick pod is like that of D. velutinus (which is in Wright's collection of 1851 from the same region), of which it is most likely only a smooth variety.

170, 171. "LEUCÆNA RETUSA (sp. nov.): subglabra; pinnis 2–5-jugis; foliolis 6–8-jugis oblique obovatis vel late oblongis obtusis retusisve membranaceis venosis; pedunculis capitulo longioribus; legumine subcoriaceo, marginibus incrassatis. — Gemmæ et folia novella pube tenui flavescunt; ramuli et folia adulta glabra sunt. Stipulæ membranaceæ, puberulæ, basi obliquæ et latæ, in acumen subulatum 2–3 lin. longum desinentes. Petioli tenues, communis 3–4 poll. longi, partiales vix breviores. Glandulæ parvæ, elevatæ, fere stipitatæ. Foliola pleræque 8–10 lin. longa, 4–6 lin. lata, nonnulla fere dimidio minora, basi valde obliqua, læte-virentia, 3–5-nervia et reticulato-venosa. Pedunculi floriferi pollicares, fructiferi bipollicares. Capitulum fere L. glaucæ. Bracteæ stipitatæ; lamina peltata, ovata, subulato-acuminata, supra villosa. Calyx $1\frac{1}{4}$ lin. longus, tubulosus, membranaceus, apice breviter 5-dentatus. Petala anguste oblonga, calycem paulo superantia. Stamina 10; antheris glabris. Legumen 6–9 poll. longum, 6 lin. latum, rigidius et crassius marginatum quam in L. glauca. — The general appearance of the foliage of this species is that of some Albizziæ allied to A. Milleti." *Benth. in litt.* — Bottom of the Rio Nueces, June, in flower; and Pass of the Limpia, Aug., in fruit. Also in the collection of 1851.

172. "ACACIA MALACOPHYLLA (sp. nov. Vulgares Pennatæ): subscandens? molliter pubescens; aculeis subrecurvis sparsis raris; pinnis 2–3-jugis obliquis obovatis oblongisve obtusis utrinque molliter pubescentibus; capitulis globosis; legumine lato-lineari glabro. — Ramuli et folia pube molli undique canescentia. Petioli communes tenues, 2–3-pollicares; partiales breviores. Foliola 3–6 lin. longa, obscure venosa. Pedunculus fructifer sæpius pollicaris. Legumen 4 poll. longum, 9 lin. latum, falcatum, basi acutum et breviter stipitatum, planum, tenuiter subcoriaceum, margine leviter incrassato." *Benth in litt.* — Uplands of the Leona, Western Texas, June; in fruit. Near Cerralvo, Northern Mexico, May (in fruit), *Wislizenus* (No. 363), whose specimen is more aculeate, some of the rameal aculei geminate. Notwithstanding the specimens are in fruit only, Mr. Bentham remarks, that the remains of the flower at the base of the pod leave no doubt as to the genus and affinities of the plant, although it is so very distinct a species in the group to which it belongs.

173. "A. WRIGHTII (sp. nov. Vulgares Nudifloræ): glabra, inermis; stipulis minutis obsoletisve; pinnis 1–2-jugis; foliolis 2–4-jugis oblique obovatis oblongisve obtusis vel retusis; spicis elongatis laxis; floribus breviter pedicellatis; legumine lato-lineari obtuso plano membranaceo marginato glabro. — Ramuli albidi. Folia subfasciculati: petiolo communi 2–6 lin. longo, partialibus 4–6 lin. Glandulæ parvæ convexæ. Stipellæ minimæ ad basin pinnarum. Foliola rigidula, 2–3-nervia; ultima 3–5 lin. longa, 2–3 lin. lata, fere dimidiata; inferiora sæpius minora. Pedunculi sesqui–bipollicares, jam infra medium interrupte floriferi. Bracteæ minutæ. Pedicelli calyce breviores. Flores cum staminibus fere 3 lin. longi, absque staminibus linea vix breviores, pentameri. Calyx semi-5-fidus, membrana-

ceus, glaber. Petala spathulata, ima basi subconnata, margine tenuissime lanato-ciliolata, calyce duplo longiora. Legumen stipitatum, subfalcatum, 2–3 poll. longum, 8–9 lin. latum." *Benth. in litt.* — Prairies west of St. Antonio, and on the Rio Grande, Texas, June; in flower and fruit. Also in the collection of 1851, from Western Texas. (Near Ojito, Northern Mexico, *Gregg.*) — A small, much-branched tree; the flowering branches loaded with slender and graceful spikes. According to Mr. Bentham, the species much resembles A. hamulosa and other African species among the *Ataxacanthæ*, as well as A. rigidula and A. amentacea among the *Gummiferæ;* but there is no vestige of any thorns or prickles.

‡ A. Greggii (sp. nov. Vulgares Ataxacanthæ): glabella; ramis virgatis; aculeis paucis sparsis recurvis; stipulis minutis obsoletisve; pinnis 1–3-(sæpius 2-) jugis; foliolis parvis 3–7-jugis obovato-oblongis subobliquis crassiusculis subtrinervatis petiolisque minute pubescentibus mox glabratis; spicis cylindricis elongatis folia duplo superantibus; floribus subsessilibus; legumine lato-lineari subfalcato acuminato plano membranaceo glabro. — Western Texas; coll. of 1851; in flower and with young fruit. (Dry valley west of Patos, Northern Mexico, April, *Gregg.*) — A small tree, 10 or 20 feet high, with white [cream-colored ?] flowers, according to Dr. Gregg. It much resembles A. Wrightii, and has the same inflorescence; but the branches are sparingly armed with solitary and rather stout recurved prickles, the leaves are not half as large, and are minutely pubescent, at least in Wright's specimens, the spikes (12–18 lines long) are denser, and the young pods (2 or 3 inches long and 5 or 6 lines wide) taper to an acute point. Common petiole 3–5 lines long: pinnæ 3–6 lines long; a petiolar gland below the lower pair. Leaflets not more than a line and a half in length, pale, rather crowded.

174. A. rigidula, *Benth. in Lond. Jour. Bot.* 1. *p.* 504. Rocky hills near Turkey Creek, Western Texas, June; in flower only. — "Shrub 4 to 6 feet high." *

‡ A. Rœmeriana, *Scheele in Linnæa*, 21. *p.* 456; *Gray, Pl. Lindh.* 2. *p.* 185. Western Texas; coll. of 1851, in fruit.

175, 176. A. tephroloba (sp. nov. Vulgares Pennatæ): aculeis sparsis raris vel nullis; ramis petiolis pedunculisque cinereo-puberulis; pinnis 5–9-jugis, glandula depressa; foliolis 25–45-jugis oblongo-linearibus inæquilateris acutiusculis vel mucronulatis glabellis viridibus venulosis; stipulis semicordatis acuminatis; pedunculis axillaribus et subpaniculatis; capitulis dense multifloris; calyce corolla breviore; legumine plano lato-lineari rectiusculo obtuso basi in stipitem angustato pube brevissima mollissima velutino-canescente. — Hills of the San Pedro River, Nov., in flower; and on the Rio Seco, Western Texas, June, in fruit. Also in the collection of 1851. Mier, on the Mexican side of the Rio Grande, *Wislizenus*, No.

* Acacia flexicaulis, *Benth.*, occurs with full-grown pods in the collection of Dr. Wislizenus from Cerralvo and Monterey; and in Dr. Gregg's from Camargo and Monterey, both in flower and fruit. The pods are 3 or 4 inches long, an inch wide, falcate, exceedingly thick and convex, almost woody, and divided between the seeds by false partitions of thick dry pulp, as in A. Farnesiana. The seeds are globular-ovoid, and over half an inch in their longer diameter. When green they are cooked and eaten, and when dry they are used as a substitute for coffee, according to Dr. Gregg. It forms a tree, from 20 to 30 feet high.

365; and west of Patos, &c., *Gregg*. — A shrub, from 3 to 15 feet high. Pinnæ 1½ to 3 inches long: leaflets commonly 2 or 3 lines long. Stipules foliaceous, obliquely triangular-semicordate, or the upper subulate from a broad base, caducous. Heads half an inch in diameter. Legumes 4 – 6 inches long, three quarters of an inch broad, remarkably velvety-canescent; the valves perfectly flat, coriaceous, with somewhat thickened margins. Unripe seeds flat. — Allied to A. Berlandieri, *Benth.*, for which it was at first mistaken; but distinguished by its sparingly aculeate branches, glabrate foliage, and long, flat, stipitate pods.* — Between Monterey and Cerralvo, Wislizenus gathered a fruiting specimen (No. 343), with mature dehiscent pods, which is most likely a variety of A. tephroloba. These pods are broader and proportionally shorter (oblong, an inch wide, and 3 or 4 inches long), somewhat curved, the valves more indurated, and the large seeds flat.

177. A. CUSPIDATA, *Schlecht. in Linnæa*, 12. *p.* 573; *Benth. in Lond. Jour. Bot.* 5. *p.* 99. Hills of Turkey Creek, Western Texas, June; in flower and fruit. "Plant one to three feet high." — This is the same as Coulter's Mexican plant, referred by Bentham to A. cuspidata, except that the pods are mostly longer. But I fear it is much too near A. Texensis (of which I have no authentic specimen), and I am confident that it passes into A. hirta.

178. A. HIRTA, *Nutt. in Torr. & Gray*, *Fl.* 1. *p.* 404; *Benth. in Lond. Jour. Bot.* 1. *p.* 525. Low prairies of the Guadaloupe, Texas; May.

179. "A. COULTERI (sp. nov. Vulgares Nudifloræ): glabra vel minute puberula, inermis; stipulis minutis obsoletisve; petioli glandulis parvis oblongis; pinnis 3 – 5-jugis; foliolis 10 – 25-jugis oblongo-linearibus valde obliquis acutiusculis obtusisve; spicis elongatis axillaribus laxifloris; floribus subsessilibus puberulis; calyce corollæ dimidium æquante; ovario stipitato glabro; legumine lato-lineari plano marginato puberulo, valvulis rigidulis. — (Zimapan, Mexico, *Coulter*; without any number.) Uplands of the Leona River, Western Texas; June. — Allied to A. Acatlensis and A. Wrightii, but perfectly distinct from both. The leaflets are about three lines long, and scarcely a line broad. The spikes from 2 to 2½ inches long, on a very short peduncle; the flowers not crowded, and often distant from each other. They are, including the stamens, about 2½ inches long; the corolla itself about one line. Pod at least three inches long and nearly one inch broad, covered with a minute down, obscurely veined: it is of a much thicker and firmer consistence than that of A. Wrightii." *Benth. in litt.*

180. "A. CONSTRICTA (sp. nov. Gumiferæ Medibracteatæ): subglabra; spinis stipularibus subulatis divaricatis rectis vel subrecurvis; pinnis 2 – 7-jugis; foliolis parvis 6 – 10-jugis oblongis obtusis crassis enervibus, glandula parva scutelliformi; pedunculis medio bracteatis; legumine anguste lineari complanato toruloso glabro,

* A. BERLANDIERI (*Benth. in Lond. Jour. Bot.* 1. *p.* 522): adde char. legumine oblongo falcato (2½-pollicari) utrinque obtuso estipitato velutino-puberulo, valvulis coriaceis convexis; seminibus turgidis. — The character of the fruit is drawn from a pod which accompanies a flowering specimen in the collection of Wislizenus (No. 276), gathered about Cadena, half way between Chihuahua and Monterey, New Leon, where (not in Texas) Berlandier's plant, with the character of which this well accords, was collected. The pod, unfortunately, is not attached.

valvulis coriaceis. — Ramuli tenues rigidi, novelli vix minute puberuli, nunc visciduli. Folia ramorum sterilium vegetiora, petioli communi sæpe 1 – $1\frac{1}{2}$-pollicari puberulo, pinnis 4 – 6-jugis; ramorum florentium glabra, petiolo communi raro 4 lineas excedente, pinnis plerisque bijugis. Pinnæ 4 – 6 lin. longæ; foliola raro lineam excedunt. Pedunculi solitarii vel cum foliis fasciculati, 6 – 9 lin. longum. Capitulum parvum, florens cum staminibus 4 lin. diametro. Bracteæ alabastro breviores. Flores 5-meri, rarius 4-meri. Calyx membranaceus, truncatus, breviter dentatus. Petala calyce triplo longiora, alte connata. Legumen stipitatum, rectiusculum vel falcatum, 2 – 5 poll. longum, $1\frac{1}{2}$ – 2 lin. latum, inter semina constrictum, suturis leviter incrassatis. — This is the only American *Medibracteate* species known to me." *Benth. in litt.* — Prairies, near the source of the San Felipe, July; in flower and fruit. Pass of the Limpia, Aug.; in fruit (No. 162). Abundant in the collection of 1851. Sand-hills 50 miles below El Paso; Jornada del Muerto, and thence to Chihuahua, common, *Wislizenus* (flowers exhaling the fragrance of orange-blossoms). Near Mier, Castanuela, and Buena Vista, *Gregg.* — Shrub 5 to 8 feet high. Stipular spines on the flowering branches from 3 to 6 lines long. Most of the numerous flowering specimens gathered by Mr. Wright during the past year have not only the branchlets but the foliage glutinous, so that they adhere to the paper in which they were dried.

† A. Farnesiana, *Willd.* Common in Western Texas and Northern Mexico. One of Gregg's specimens is referred by Mr. Bentham to the nearly allied A. Cavenia, and Lindheimer has a flowering specimen, with very small leaflets, which might also be so referred.*

ROSACEÆ.

181. Prunus rivularis, *Scheele in Linnæa*, 21. *p.* 594; verging to P. Americana. Along the Leona River, June; in fruit. — Lindheimer remarks, that it more commonly grows on declivities than along the banks of streams.

* Leucæna glauca is in Gregg's North-Mexican collection, from near Rinconada, where, as well as in other localities, he also gathered the following remarkable Pithecolobium: —

" Pithecolobium brevifolium (sp. nov. Samanea stipulis spinescentibus!): ramulis inflorescentia foliisque junioribus puberulis; stipulis subulatis plerisque spinescentibus; pinnis 3 – 5-jugis; foliolis 10 – 20-jugis oblongo-linearibus subtus pallidis; panicula foliosa; floribus cano-puberulis; corolla calyce plus triplo longiore; ovario stipitato glabriusculo; legumine recto glabro, valvulis haud coalitis." *Benth in litt.* — Between Cerralvo and Monterey, more common in the low country, May, *Wislizenus* (No. 362, 355). East of Rinconada and Papagallo; also between Cerralvo and Maria, *Gregg.* — " This species in its straight pod, not curled or twisted as in most Pithecolobia, and general character, is allied to P. fragrans and P. Berterianum; but it appears to be a shrub, not a tree; the pinnæ and leaflets are very much fewer; the pod is thinner and drier, although the valves are of a reddish hue inside, and show signs of a dried-up thin pulp, as in all species of Pithecolobium; and, above all, the stipules are generally persistent in the form of straight spines from 2 to 4 [and even 6] lines long, which is not known to be the case in any other species of the section *Samanea.* The leaflets are from 2 to 3 lines long, very much like those of P. fragrans. The inflorescence is but imperfectly developed in the specimens gathered, but appears to be the same as that of P. fragrans." *Benth. in litt.*

Schrankia platycarpa, *Gray, Pl. Lindh.* 2. *p.* 183, in Lindheimer's collection of 1849, has the broadly linear and flat pods aculeate on the thickened margins, and along the middle of the valves, the rest of the face naked.

‡ CERASUS (MICROCERASUS) MINUTIFLORA, *Engelm. in Pl. Lindh.* 2. *p.* 185, sub Pruno. Western borders of Texas; coll. of 1851, in fruit. A few fruiting specimens were gathered on the former journey, along the prairies of Turkey Creek, June; but they were not distributed. The plant is a close congener of Amygdalus microphylla, *H.B.K.;* but the glaucescent leaves are entire, or nearly so, and very obtuse, or retuse: the larger ones are three quarters of an inch long, not including the slender petiole. The globular fruit is tomentulose, nearly half an inch in diameter, the thin flesh dry, narrowly grooved down the ventral suture, down which it inclines to split, as in the Almond, in dried specimens, and to separate from the globose, smooth and even putamen, the sutures of which are slightly and obtusely ridged and grooved, not carinate, and the sides not at all compressed.

182. SPIRÆA (PETROPHYTUM) CÆSPITOSA, *Nutt. in Torr. & Gray, Fl.* 1. *p.* 418; *Gray, Pl. Fendl. p.* 40. Crevices of rocks on the mountains east of El Paso; forming dense flat tufts, from one to three feet in diameter; Oct.*

183. CERCOCARPUS PARVIFOLIUS, *Nutt. in Torr. & Gray, Fl.* 1. *p.* 427; *Hook. Ic. Pl. t.* 323: var. foliis plerisque vix dentatis. Mountains of New Mexico, 40–60 miles east of the Rio Grande; Aug. (in fruit). The leaves are narrower and much less toothed than in No. 194 of Fendler's collection.†

184. FALLUGIA PARADOXA, *Torr. in Emory, Rep. t.* 2; *Gray, Pl. Fendl. p.* 41. Sieversia paradoxa, *Don.* Geum? cercocarpoides, *DC. Prodr.* 2. *p.* 554. (ex Icon.!) Banks of the Rio Grande and Nueces, Texas, and westward. — Geum dryadoides may be the Cowania plicata, *Don*, the C. purpurea, *Zucc.* (Greggia rupestris, *Engelm. in Wisliz. N. Mex.*), abundantly met with by Gregg and others in Northern Mexico; but its flowers are not white.

‡ POTENTILLA PARADOXA, *Nutt. in. Torr. & Gray, Fl.* 1. *p.* 437. Between Western Texas and New Mexico; coll. of 1851. — The root is annual or biennial.

185. ROSA BLANDA, *Ait.*, *β. Torr. & Gray, Fl.* 1. *p.* 460. Along the Limpia, Aug.; in fruit.

LYTHRACEÆ.

186. NESÆA LONGIPES (sp. nov.): herbacea, ramosissima; ramis elongatis gracilibus; foliis linearibus oppositis basi auriculata subsessilibus margine revolutis; pedunculis filiformibus in axillis solitariis unifloris sub flore bibracteolatis; petalis 6 purpureis; staminibus 12 subæquilongis. — Low grounds, along the Rio Grande and Medina, Texas, and west to Zacate Creek; July. (Near Parras, *Gregg.*) — Stems slender, from one to three feet long, diffuse or ascending, glabrous, as is the whole plant, slightly angled. Leaves one to two inches long, one to two lines wide, acute. Peduncles about as long as the leaves; with a pair of small bractlets very near the flower; from the axils of which there is rarely seen the pedicel of an

* Lindleya mespiloides, *H. B. K.*, or a species which I have not the means of clearly distinguishing from it, was abundantly gathered by Dr. Gregg, near Saltillo and Buena Vista. It is a "shrub, eight or ten feet high, growing on rocky cliffs."

† Cercocarpus fothergilloides, *H. B. K.*, was likewise gathered by Dr. Gregg, near Saltillo; where it forms "a large, evergreen shrub."

additional flower. Petals three lines long. Stamens almost equally inserted in the bottom of the calyx, scarcely unequal in length, not exceeding the petals. Style filiform, much exserted. — From the section *Heimia* this plant differs only in its purple flowers, elongated peduncles, and herbaceous habit; from *Decodon*, in its solitary hexamerous flowers, and its equal and equally inserted stamens; and from *Nesæa* proper, in the one-flowered peduncle with small bracts, in which respect, however, as in its foliage and tendency to bear three flowers on the peduncle, it agrees with N. Candollei, *Guill. & Perrotet.**

187. LYTHRUM ALATUM, var. LINEARIFOLIUM, *Gray, Pl. Lindh.* 2. *p.* 188. Low grounds, Western Texas; May. — The petals are smaller than in Lindheimer's plant (which occurs again in the collection of 1850). L. flexuosum, *Lagasca* (L. Græfferi, *Tenore*), perhaps belongs to the same species.

188. L. ALATUM, var. PUMILUM, *Gray, Pl. Lindh. l. c.* Rio Nueces, in shallow water. — L. flagellare, *Shuttleworth, Pl. Rugel, No.* 232, from Florida, is intermediate between this and the var. ovalifolium, *Pl. Lindh. l. c.*

ONAGRACEÆ.

† EPILOBIUM COLORATUM, *Muhl. in Willd. Enum.* 1. *p.* 411. Along the Limpia; August.

189. ŒNOTHERA JAMESII, *Torr. & Gray, Fl.* 1. *p.* 693; *Gray, Pl. Lindh.* 2. *p.* 189. Along the San Pedro River; also found eastward as far as to Austin. The wild plant is from four to six feet high, and with flowers as large as the cultivated, viz. five inches in diameter.

190. Œ. BIENNIS, *Linn.*, var. Along the Limpia. — This is the same strigose-hirsute variety as No. 218, *Pl. Fendl.*, a form which is common in Oregon and along the Rocky Mountains.

† Œ. BIFRONS, *Don, in Sweet, Brit. Fl. Gard.* 4. *t.* 386; *Hook. Bot. Mag. t.* 3764. Œ. heterophylla, *Spach, Onagr. p.* 28. Plains of Western Texas. — To this must needs belong No. 56, *Pl. Lindh.*, referred to Œ. rhombipetala, from which it differs in the broad and somewhat cordate bracteal leaves and more or less obtuse petals. It accords with No. 74 of Drummond's third Texan collection; but the lower leaves incline to be pinnatifid, as they strikingly are in No. 53 of Drummond's second collection, which is the Œ. heterophylla of Spach.

191. Œ. ALBICAULIS, *Nutt. in Fras. Cat., & Gen.* 1. *p.* 245. Var. subcinerea; foliis sinuato- seu pinnatifido-dentatis; caule lignescente ramosissimo. — Valley of the Rio Grande, 60 or 70 miles below El Paso, in sandy soil; Oct. — I employ the oldest name of a very polymorphous species, which also varies exceedingly in size and duration; flowering sometimes as a low annual, and again, becoming lignescent at the base and branching copiously, it apparently endures for a longer period. The same species, but with less toothed leaves, is Œ. pinnatifida, *Gray, Pl. Fendl. p.* 44 (No. 224), where some remarks are made upon the extent of the species, which

* Nesæa (Heimia) salicifolia was gathered by Dr. Gregg in Northern Mexico, from Camargo to Monterey and Queretaro.

the Hookerian herbarium fully confirms. No. 176 of Geyer's Oregon collection, referred by Hooker to Œ. pallida (in *Lond. Jour. Bot.* 6. *p.* 222), is exactly the same as No. 224 of Fendler. These forms run insensibly into those with longer, lanceolate or linear leaves, either repand-dentate or nearly entire, very minutely pubescent, and with very smooth and white stems, — the Œ. albicaulis, *Nutt.*, *Hook. Fl. Bor.-Am.*, *&c.* Sometimes the plant attains the height of four feet, according to Geyer, and is very bushy. Œ. pallida, *Dougl.*, judging from Douglas's own specimens, and the figure in the Botanical Register (*t.* 1142), differs from the narrow-leaved, true Œ. albicaulis, *Nutt.* only in its smoothness, losing nearly all trace of the fine pubescence; while Nuttall, Tolmie, and others, have under this name a bushy form of the plant, with broader and shorter leaves, the very smooth surface often beset with a few hairs. Œ. leptophylla, *Nutt.*, is the same as the last, very bushy, and with crowded, small leaves on the branches; in Burke's Oregon collection we have the same thing, but almost as cinereous-pubescent as the specimens of Wright with which this account began, and the leaves, though narrower, are as strongly toothed. This brings us round to the Œ. pinnatifida, *Nutt.*, the Œ. albicaulis, *Pursh* (of which the original specimens of Bradbury are the same as Nuttall's, and also Geyer's No. 37); which begins to flower when only three or four inches high, but usually continues through the season; sometimes bearing pinnatifid leaves, such as Fendler's No. 223, and sometimes with barely toothed or nearly entire leaves, as in Fendler's No. 224. Between these two, Wright's No. 191, characterized above, is exactly intermediate.

192. Œ. SPECIOSA, *Nutt.*; var. foliis lanceolatis subintegerrimis; flore minore. — Hills along the Leona; June. This species is exceedingly variable in foliage.

193. Œ. SPACHIANA, *Torr. & Gray, Fl.* 1. *p.* 498. Blennoderma Drummondii, *Spach, Monogr. Onagr. addend. p.* 87. Œnothera Drummondii, *Walp. Rep.* 2. *p.* 85, non *Hook.* Near Austin, Texas: also gathered on the Rio Brazos by Lindheimer.

194. Œ. (MEGAPTERIUM) MISSOURIENSIS, *Sims, Bot. Mag. t.* 1592; *Gray, Pl. Lindh.* 2. *p.* 188 (var. *a*, the narrow-leaved form). Gravelly banks of the Nueces; June.*

† Œ. (LAVAUXIA) TRILOBA, *Nutt.; Hook. Bot. Mag. t.* 2566; *Gray, Pl. Lindh.* 2. *p.* 189. Near Austin, Texas. — Biennial. The dehiscence is loculicidal, and I think never also septicidal, as I stated in the Flora of North America. — Although with a more crustaceous or lignescent pod, with small and even wings, and a truly perennial caudex, I consider the following to form a second species of this section.

† Œ. (LAVAUXIA) BRACHYCARPA (sp. nov.): acaulescens, pube brevi cinerea;

* Here belongs No. 268 of Geyer's Oregon collection, referred to Œ. Drummondii in *Lond. Jour. Bot.* 6. *p.* 221. The latter is only found in the low country of Texas. — Œ. guttulata, *Geyer*, *l. c.*, is the same as Œ. canescens, *Torr. in Fremont's 2d Rep.*, as referred in *Pl. Fendl. p.* 44. It was also gathered by Wislizenus, at Rock Creek, New Mexico. — The specimens of Œ. heterantha, *Nutt.*, collected in Oregon by Geyer (No. 406), and especially those of Burke, have many of the leaves *lyrate-pinnatifid*, so that it is not surprising that they should have been referred by Hooker to Œ. triloba. One of Burke's specimens in the Hookerian herbarium has ripe capsules: these are ovoid-oblong, barely acute, bearing the persistent remains of the whole calyx, smooth and even, the valves with a slightly prominent smooth medial rib. Seeds ovoid, reticulate-pitted under a lens, with a slender and inappendiculate rhaphe.

caudice incrassato; foliis primariis ovatis oblongisve subintegerrimis, sequentibus lyrato-pinnatifidis lobo terminali oblongo-lanceolato vel lineari-lanceolato; tubo calycis prælongo; capsulis sessilibus ovatis tetragono-alatis lignescentibus lævibus; seminibus angulatis testa suberosa incrassata. — Between Western Texas and El Paso; in fruit. Also in the collection of 1851, in flower, and with a few capsules of the preceding year. — The branching, creeping caudex is from one third to half an inch in diameter. Leaves crowded, cinereous or canescent with a fine and close pubescence, glabrate above with age, petioled; the earlier ones (as seen in the coll. of 1851) mostly entire or repand, with the lamina two inches or less in length and sometimes an inch wide; the succeeding ones narrower and mostly pinnatifid; the entire or toothed terminal lobe prolonged, 2–4 inches in length. Tube of the calyx 5 or 6 inches long, rather stout, much as in the section Pachylophis, as likewise, apparently, is the flower; except that the petals (18 lines long) seem to have been pale yellow, changing to rose-color in fading. Capsules closely sessile on the caudex, from half to three quarters of an inch in length, and nearly half an inch in diameter, of a thick, crustaceous texture, acute, but blunt at the apex, scarcely if at all reticulated, the sides broad and not at all ridged, the narrow wings or wing-like angles perfectly smooth and even, thickish, loculicidally 4-valved at the apex, the valves not pointed. Seeds numerous, large, closely packed in two rows in each cell, which they entirely fill, strongly angled by mutual pressure; the testa very thick and corky, especially toward the chalaza; where in the young seeds is seen a sort of thick double crest with a denticulate edge, which is nearly obliterated when mature.

195. Œ. (Meriolix) serrulata, δ. spinulosa, *Torr. & Gray, Fl.* 1. *p.* 502: — the same large-flowered form as No. 393, *Pl. Lindheimer.* Woods and prairies, Austin; May.

197. Œ. (Meriolix v. Salpingia) tubicula (sp. nov.): minutissime glanduloso-puberula, humilis; caulibus suffruticosis ramosis diffusis; foliis lanceolatis lineari-oblongisve planis glabellis sessilibus integerrimis; calycis tubo infundibulari laciniis ovarioque vix duplo longioribus; petalis orbiculato-obovatis; capsulis clavato-cylindraceis inferioribus subpedunculatis. — Prairies beyond the Pecos; Aug. Also gathered in larger and much better specimens in the collection of 1851. — Stems a span to a foot high, bushy, at first erect, at length diffuse, puberulent, as is the foliage, &c., with a very minute viscous glandulosity, nearly glabrous to the naked eye. Leaves from half an inch to an inch long, and one to three lines wide, bright green, thin. Tube of the calyx from one third to half an inch long, little longer than the broadly triangular-lanceolate lobes, which are not carinate nor marked with a salient midnerve. Petals 4 to 6 lines long, much dilated and roundish, yellow. Capsules half an inch long, not thicker than packthread. Seeds ovoid-oblong, with a thin and smooth inappendiculate testa. — This species may as well be referred to the section *Meriolix* as to *Salpingia*, and indicates the propriety, in a revision of the genus, of admitting the latter as a subdivision only of Meriolix.

197 (partim). Œ. tubicula, var. demissa: magis puberula, omnino minor; petalis (2–3 lin. longis) tubum calycis æquantibus. — On the Guadalupe Mountains;

Oct. — Stems 3 or 4 inches high. Leaves only 4 to 6 lines long; the flowers also proportionally small. Evidently, however, only a reduced form of the foregoing.

† Œ. (SALPINGIA) HARTWEGI, *Benth. Pl. Hartw. p.* 1. On the Rio Grande, Texas, and in mountain valleys east of El Paso; Aug. Abundant in the collection of 1851. — Flowers as large as those of Hartweg's plant (the petals from three fourths of an inch to an inch long; calyx-tube about an inch and a half long); the stems more elongated and suffruticose, from a span to a foot high, erect. The specimens pass into

198. Œ. HARTWEGI, var. caulibus elongatis diffusis; foliis lanceolato-linearibus, 1 – 3 lin. latis. (Prairies on the Sabinal; June.) And this in turn apparently passes into Œ. Fendleri, with oblong-lanceolate leaves, abundantly gathered in the collection of 1851, indicating a species of as diverse forms as Œ. serrulata.

‡ Œ. (SALPINGIA) LAVANDULÆFOLIA, *Torr. & Gray, Fl.* 1. *p.* 501; *Hook. Lond. Jour. Bot.* 6. *p.* 223. Between Western Texas and El Paso; coll. of 1851; in beautiful flowering specimens. — The fasciculate-clustered erect stems are from two or three inches to a span high; and the hoary leaves (of the hue of those of lavender) are much crowded, often fascicled, and with revolute margins. The petals are smaller than in Œ. Hartwegi, from 6 to 8 lines in length.

196. Œ. LAVANDULÆFOLIA, var. caulibus spithamæis et ultra; foliis glabratis. — Prairies of Live Oak Creek, Western Texas; June. "Plant from 6 to 12 inches high." Tends to connect Œ. lavandulæfolia with Œ. Hartwegi.

199. Œ. (SALPINGIA) GREGGII, *Gray, Pl. Fendl. p.* 46, *adnot.*; var. PUBESCENS: pilis mollibus patentibus villosa. — Dry hills beyond the Pecos; Aug. — Stems woody, rather stout, a span to a foot high. Leaves oblong, 2 – 4 lines long. Calyx-tube 9 – 15 lines long. Petals 4 – 6 lines long. Capsules hairy, 4 – 6 lines long, cylindraceous, thickish.

200. LUDWIGIA NATANS, *Ell. Sk.* 1. *p.* 581; *Gray, Pl. Lindh.* 2. *p.* 190. In the Leona and San Felipe; July, Aug.

201. PROSERPINACA PALUSTRIS, *Linn.* In the Rio Nueces; June.

202. MYRIOPHYLLUM HETEROPHYLLUM, *Michx.*; var. foliis emersis parvulis. — Turkey Creek, Texas; June.

203. GAURA SINUATA, *Nutt. in DC. Prodr.* 3. *p.* 44. Prairies of Live Oak Creek and the San Pedro River; June, July.

204. G. SUFFULTA, *Engelm. in Pl. Lindh.* 2. *p.* 190. Hills along the Rio Frio, Texas; June. — The fruit, as in Lindheimer's specimens, is either acute or obtuse, usually the latter when fully ripe, and the sides are mostly even. No. 82 of Drummond's third Texan collection (from San Felipe) is the same species. The flowers are tetramerous and the fruit tetraquetrous, in the specimens of the Hookerian herbarium; but in those of Mr. Webb's herbarium I observed both tetraquetrous and triquetrous fruit, even on the same specimen, and it is, as I suspected, the plant referred to G. tripetala by Spach; of which our plant is, I suppose, only a pretty constantly tetramerous variety. It has been raised in the Jardin des Plantes, from seeds gathered by M. Trécul.

205. G. TRIPETALA, *Cav. Ic.* 4. *p.* 66. *t.* 396. Prairies along the Rio Brazos;

May, June. — From Mr. Wright alone have I received specimens of this trimerous Gaura, gathered in successive years. They all look like depauperate specimens of the foregoing, with the fruit (being triquetrous) perhaps a little narrower and more pointed, and its sides more distinctly corrugated. It agrees very well with the G. tripetala of Mr. Webb's herbarium, both with indigenous specimens from Pavon, and with cultivated ones by Desfontaines from the Jardin des Plantes.

‡ G. VILLOSA, *Torr.; Gray, Pl. Fendl. p.* 46. Coll. of 1851. Stems somewhat woody at the base, from a thick and truly perennial root.

206. G. COCCINEA, *Nutt.*; var. caule villoso-pubescente, foliis subsericeis. — Valley of the Limpia; Aug. There is no ripe fruit. That of the ordinary G. coccinea is canescent-puberulent, pyramidal above, acute, or when ripe quite obtuse, contracted abruptly below into a narrow neck, which is shorter than that of G. Drummondii.

207. G. COCCINEA, *Nutt.; Torr. & Gray, Fl.* 1. *p.* 518, fere var. γ. Prairies of Zacate Creek, and near the valley of the Rio Grande, New Mexico. Also in the coll. of 1851. — The ripe fruit is remarkably broad and obtuse, with a very short narrowed base; but it is much the same in specimens from Saskatchawan; and the younger fruit on the same individuals is acute. Similar forms in Fendler's collection were referred to G. epilobioides, *H. B. K.*, and apparently with good reason, for I see no available characters to distinguish the two species.

208. G. COCCINEA, var. Same as the last, but with the stems hairy below. — Valleys between the Pecos and the Limpia; Aug. There are also some specimens with very small and narrowly linear leaves.

209. G. DRUMMONDII, *Spach; Torr. & Gray, Fl.* 1. *p.* 519. Prairies on the Sabinal, Texas; June.*

LOASACEÆ.

210. MENTZELIA OLIGOSPERMA, *Nutt.; Torr. & Gray, Fl.* 1. *p.* 533. M. aurea, *Nutt. Gen.* 1. *p.* 300. M. rhombifolia, *Nutt. in Torr. and Gray, l. c.* Dry hills and plains from Turkey Creek to the San Pedro River. "Flowers opening in the morning," as in other species with yellow blossoms. To this common and widely diffused species we may safely join the M. rhombifolia of Nuttall.

211. M. (BARTONIA) WRIGHTII, *Gray, Pl. Fendl. p.* 48. On sand-bars in the Colorado at Austin, and opposite Bastrop, Texas. — Flowers smaller than those of M. pumila, *Nutt.*, and ochroleucous.

212. M. (BARTONIA) NUDA, *Torr. & Gray, Fl.* 1. *p.* 535; *Gray, Pl. Fendl. p.* 47, *& Pl. Lindh.* 2. *p.* 191. Gravelly banks of the Rio Seco, Western Texas; June. A smaller-flowered state than usual; the petals only three fourths of an inch long. — No. 212[a], from the Guadalupe Mountains, is apparently a depauperate form of the same species, and not M. pumila, *Nutt.*, which has yellow, according to Geyer "bright golden-yellow," flowers of lesser size.†

* In 1848, Mr. Wright collected, on the Rio Grande, a Gaura with extremely silky-canescent ovate-lanceolate leaves and pedicellate flowers; but without fruit it cannot properly be characterized.

† Mentzelia (Bartonia) lævicaulis, raised during the last season in the Cambridge Botanic Garden, from Oregon seeds brought by Fremont, has bright, pure yellow blossoms, opening in the afternoon, at four or five o'clock, in bright sunshine. (See notes in *Pl. Fendl. p.* 47.)

† M. (Bartonia) multiflora, *Nutt. Pl. Gamb. p.* 180; *Gray, Pl. Fendl. p.* 48. Valley of the Rio Grande near El Paso; Sept. Also collected by Wislizenus. — Plant (with stems scarcely a foot high) wholly like Nuttall's specimens in the Hookerian herbarium; the petals in some specimens three fourths of an inch long, as Nuttall describes them (in one from Wislizenus even larger), in others barely half an inch long. The larger pods are from three fourths to half an inch in length, cylindraceous-clavate (as in Nuttall's specimens), while the smaller, even on the very same plant, are "urceolate" or turbinate, and only three or four lines long, like those of No. 214. Mr. Wright has both states in his collection of 1851; and Gregg gathered it at Buena Vista. The mere size of the flowers affords no good characters in this genus.

213. M. (Bartonia) multiflora, var. foliis angustis; floribus minoribus; capsulis plerisque cylindraceo-clavatis. — Mountain valleys, 30 or 40 miles east of the Rio Grande, New Mexico; Aug. "Flowers light yellow." The specimens are mostly in fruit.

214. M. (Bartonia) multiflora, var. humilis; foliis angustissimis (lobis rhachique lineam latis); capsulis brevibus urceolatis. — With the preceding? The specimens wholly in fruit.*

215. Cevallia sinuata, *Lagasca, Nov. Gen. & Sp. p.* 11. *t.* 1; *Torr. & Gray, Fl.* 1. *p.* 536, & 696; *Hook. Ic. Pl. t.* 252; *Fenzl, in Denkschr. Regensb.* 3. *p.* 188. *t.* 4. Hills near the head of the San Felipe, July, and along the Rio Grande, Texas. Also abundantly found by Gregg and Wislizenus in New Mexico and Northern Mexico.

PASSIFLORACEÆ.

216. Passiflora tenuiloba, *Engelm. in Pl. Lindh.* 2. *p.* 192. Calcareous hills between Zacate Creek and the San Felipe; also towards the Rio Grande in Texas; July. Abundant in the coll. of 1851. "Fruit dark purple, the size of a rifle-bullet." — The leaves are various in different individuals of this remarkable species, or on different parts of the same plant; but the lateral lobes are always long, narrow, and divaricate, and the middle one very short.

* No. 663 of Geyer's Oregon collection, which was inadvertently referred by Hooker (*Lond. Jour. Bot.* 6. *p.* 227) to Bartonia micrantha, *Hook. & Arn.*, and said exactly to accord with an original Californian plant, is not that species, but is only a more leafy form of Mentzelia albicaulis. The filaments are all filiform, the pods elongated-cylindrical and many-seeded. It is likewise in Spalding's Oregon collection, from the same part of the country. I notice that most of the flowers in Geyer's specimens have only ten stamens, while Spalding's has 20 or 30, as in the species generally. The same thing occurs in the nearly-related M. Hænkii (Acrolasia bartonioides, *Presl*) of Chili; at least Presl characterizes and figures his plant as decandrous, while I find 15 or 20 in specimens collected by C. Gay (though not so described in the *Flora Chilena*). The pods of my specimens of the Chilian plant have as many as twelve or fourteen seeds; and I find in M. albicaulis also distinct traces of the few small bristles at the apex of the petals from which Presl derived his generic name; — so that Acrolasia is not to be distinguished, even as a section. Still A. bartonioides is not the same species as M. albicaulis, its pods being oblong-turbinate and only 3 or 4 lines long; while those of the latter are slender, half or three quarters of an inch long, and 30 – 40-seeded.

217. P. affinis, *Engelm. in Pl. Lindh.* 2. *p.* 233. Banks of the Leona, June; in flower. — Flower nearly twice the size of that of P. lutea, an inch and a half in diameter. Bractlets minute.

218. P. affinis, *Engelm.;* in fruit. Hills of the San Pedro River; July.*

CUCURBITACEÆ.

219. Cyclanthera dissecta, *Arn. in Hook. Jour. Bot.* 3. *p.* 280; *Gray, Pl. Lindh.* 2. *p.* 193. Echinocystis pedata, *Scheele.* Low prairies, near San Antonio, Texas; May.

† Melothria pendula, *Linn.; Torr. & Gray, Fl.* 1. *p.* 540. Bottom of the Leona; June. — Although the leaves are thinner and with sharper lobes, this is probably the same as M. chlorocarpa, *Engelm. in Lindh. Tex. Coll.* 1850, which "differs from M. pendula by the habitat (dry sterile places), by the firmer and more hispid leaves, with blunter lobes and a narrower sinus, and by the larger and greenish fruit with smaller seeds. Root branching, annual: flowers monœcious, yellow: fruit green and whitish, striped, elliptical, 5 or 6 lines long, 3 lines or more in diameter." *Engelm.* But from the dried specimens I should not be able to characterize this on the one hand, or Mr. Shuttleworth's M. microcarpa on the other.

220. Sicydium Lindheimeri, *Gray, Pl. Lindh.* 2. *p.* 194. Thickets near Austin and San Antonio, Texas. Abundant also in the coll. of 1851. Dr. Wislizenus gathered it at Cerralvo, and Mr. Hinds obtained what appears to be the same species in Lower California. The pods are fully an inch in diameter, and ripen 10 or 12 seeds. These are rounded, nearly orbicular in outline, $2\frac{1}{2}$ to 3 lines in diameter, very turgid, and surrounded by a very narrow margin, which is a little produced each side of the hilum. The foliage varies exceedingly, some leaves being scarcely lobed, and others so much dissected as to effect a transition to

221. S. Lindheimeri, *β.* tenuisectum: foliis 5-partitis, segmentis laciniato-lobatis lobisque linearibus; bacca minore. — Dry sandy soil, near the Rio Grande, Texas, and New Mexico. (North of El Paso, *Wislizenus*, with almost filiformly dissected leaves.) Berry from half to three fourths of an inch in diameter. There are fine fruiting specimens in Mr. Wright's collection of 1851, in all of which the seeds are narrower than in the foregoing, obovate, and obliquely or obscurely bidentate at the base; so that I should regard this as a good species, were it not that Wright's No. 221 has seeds just like those of No. 220.

222. Cucurbita perennis, *Gray, Pl. Lindh.* 2. *p.* 193. Cucumis? perennis, *James.* Along the Rio Frio, Texas; June.

† C. Texana, *Gray, Pl. Lindh.* 2. *p.* 193. Banks of the San Pedro River; native.

*** Cactaceæ, No. 223–227. The determinations of these, and of the living plants of the family gathered by Mr. Wright, have not yet been received from Dr. Engelmann.

† Passiflora gossypiifolia, *Lam.* (P. fœtida, *Cav.*) was gathered in Eastern Texas by M. Trécul: also P. suberosa, *Linn.*, in Southern Florida, by Rugel.

FOUQUIERIACEÆ.

228. Fouquiera splendens, *Engelm. in Wisliz. Mem. N. Mex. p.* 98. F. spinosa, *Torr. in Emory, Rep. p.* 147. *t.* 8. excl. syn. "A shrub with very long branches from near the root, growing on hills, beyond the San Pedro River, without flower or fruit." — Dr. Engelmann and Dr. Torrey have well shown, by their observations on the ovary and fruit of this species, that Bronnia is not distinct from Fouquiera. The structure of the flowers of F. splendens is the same as in F. formosa, but they are more slender and on slender pedicels, while those of the latter are closely sessile. The (corymbose) flowers and fruit of F. (Bronnia) spinosa are in Coulter's Mexican collection (No. 919, from Sonora Alta). The former are as described by Bentham (in *Bot. Voy. Sulph.*), except that the expanded corollas are straight and nearly an inch in length: the capsules, seeds, &c. are as described and figured by Kunth. The broad wing of the seed is composed of long, spirally-marked cells, just as remarked by Torrey in Fouquiera splendens; and the filaments are glabrous throughout. — There are fruiting specimens in the collection of 1851.

CRASSULACEÆ.

228[a]. Echeveria strictiflora (sp. nov.): foliis radicalibus spathulato-lanceolatis, caulinis lanceolatis parvis, floralibus similibus flore dimidio brevioribus; floribus breviter pedicellatis arcte secundis appresso-erectis in spicam simplicem strictam confertis; petalis longe attenuato-acuminatis sepala oblonga duplo superantibus. — Mountains west of the pass of the Limpia; Aug. "Flowers scarlet," in a very strict and close secund raceme or spike, of six or eight inches in length: the flowers two thirds of an inch long; pedicels two or three lines long. — There is an allied species in the collection of Dr. Wislizenus, which I cannot identify with any described.*

229. Sedum Wrightii (sp. nov.): glabra, caulibus decumbentibus; foliis sparsis crasso-carnosis obovatis, ramorum floriferorum oblongis basi solutis; floribus brevissime pedicellatis in cymam densam 2–3-fidam digestis secundis; petalis 5 spathulatis obtusis mucrone apiculatis (albis roseo tinctis) sepalis oblongis obtusis duplo longioribus. — Hills near the San Pedro River, in crevices of rocks, and summit of mountains near El Paso, New Mexico; Aug.–Oct. — Perennial, with fibrous roots; the stems diffusely spreading, or at first erect, a span or more in length. Leaves 3 or 4 lines long. Cyme very compact. Flowers larger than in S. Moranense; the petals 3 or 4 lines long, and broadly spathulate or obovate. Carpels abruptly apiculate with a slender style.

* Echeveria paniculata (sp. nov.): foliis radicalibus obovato-lingulatis, caulinis sparsis parvulis lanceolatis canaliculatis, omnibus mucronato-acutis; floribus laxe paniculatis undequaque versis; petalis apice breviter recurvis sepala duplo superantibus. — Cosiquiriachi, Northern Mexico, *Wislizenus.* — Flowering stems a foot long above the rosulate and apparently radical tuft of leaves; the latter 2 or 3 inches long, the scattered or subopposite stem-leaves from half an inch to an inch in length. Flowers half an inch long, disposed in a loose, elongated panicle: the proper terminal flowers are on very short peduncles, the lateral ones mostly with rather long, bracteate peduncles. Bracts small, linear.

SAXIFRAGACEÆ.

229[a]. Lepuropetalon spathulatum, *Ell. Sk.* 1. *p.* 370; *Torr. & Gray, Fl.* 1. *p.* 590. In wet places, Western Texas; Feb., March.

‡ Philadelphus serpyllifolius (sp. nov.): ramosissimus, ramis confertis rigidis; foliis in ramulos breves confertis vel fasciculatis parvis ovalibus vel ovato-oblongis subpetiolatis trinervatis supra puberulis subtus cano-sericeis; floribus subsessilibus ochroleucis; stylo brevissimo; stigmate crasso 4-lobo; capsula globosa. — Between Western Texas and El Paso, New Mexico; coll. of 1851. — A most remarkable species, apparently forming a low, rigid, subspinescent bush; the leaves not half as large as those of P. microphyllus itself, three to five lines long and from one to two and a half wide, much crowded, obtuse, entire, green and pubescent or puberulent above, the under surface white with a dense covering of appressed villous hairs. Flowers much smaller than in any other species, very numerous, mostly solitary and subsessile at the apex of the spurs or short leafy branchlets. Calyx silky-pubescent; the lobes ovate, half as long as the corolla. Petals only three lines long, oval, inserted by a broad base, apparently cream-color. Capsule a line and a half in diameter, 4-celled. — The hairs which clothe the lower surface of the leaves, under the microscope, are studded all over with tubercles, as also in P. hirsutus, and, more or less evidently, in other species.

FENDLERA, *Engelm. & Gray, Nov. Gen.*

Calyx tubo turbinato 8-costato, cum ovarii basi connato; limbo 4-partito, lobis triangulatis æstivatione valvatis. Petala 4, ovato-deltoidea, unguiculata, erosa, decidua. Stamina 8 cum petalis inserta: filamenta linearia, plana, apice bifurcata, lobis lineari-attenuatis ultra antheram longe productis: antheræ introrsæ, mucronatæ, biloculares, longitudinaliter dehiscentes. Ovarium semisuperum, 4-loculare (loculis sepalis alternantibus): styli pilosuli conniventes, pl. m. coaliti: stigmata terminalia simplicia. Ovula in loculis plurima, e placentis centralibus imbricato-pendula, anatropa. Capsula crustacea, ovoideo-conica, stylis persistentibus acuminata, basi calyce accreta, 4-locularis, ex apice septicida. Semina in loculis pauca pendula, imbricata, oblonga, testa membranacea laxa reticulata deorsum alata. Embryo in albumine parco rectus, ejusdem fere longitudine; cotyledonibus oblongis radicula supera duplo longioribus. — Frutex 2–4-pedalis; foliis oppositis lanceolatis subsessilibus trinervatis integerrimis; floribus ramulos breves terminantibus solitariis vel ternis breviter pedunculatis, petalis albis.

† Fendlera rupicola. (Tab. V.) — Var. *α.* Lindheimeri: glabriuscula; foliis planis (pollicem longis 3 lin. latis) subtus parce strigosis; ramis sterilibus gracillimis. On perpendicular rocks of the Guadalupe, above New Braunfels, Texas, *Lindheimer;* coll. of 1850, flowering in April. — Var. *β.* Wrightii: foliis minoribus plerisque lineari-lanceolatis subcoriaceis margine revolutis subtus strigoso-canescentibus. Crevices of rocks on the San Pedro River, July, with old fruit; and a few flowering specimens were gathered on the return in November. (Sparingly distributed as No. 228[a].) Fine fruiting specimens have also come to hand since our

figure was made, in the collection of 1851. — This very remarkable new genus, which is more nearly related to Deutzia than to any other, fully confirms the view I took, in the *Flora of North America*, in uniting Philadelphus to the Saxifragaceæ. The few flowers I have seen being open, I know not whether the petals are convolute, but their form forbids their being valvate, in æstivation. The pods dehisce septicidally, splitting at the apex, first usually into two lobes, each of which soon divides in the same way. The surface of the hairs of the leaves is scabrous with minute tubercles, just as in Philadelphus. From the want of sufficient flowers I was obliged to use both Wright's and Lindheimer's specimens in the plate. I suppose the two are only varieties, but they may belong to distinct species; for the fruiting specimens in Mr. Wright's recent collection agree with his former ones in their more rigid habit, and in the smaller, more crowded, revolute leaves, canescent underneath; — a difference which may be owing to a more arid station. In the flower furnished by Lindheimer, the anthers are tipped with a longer cusp than in our figure. Be this as it may, Dr. Engelmann and myself rejoice in the opportunity of dedicating such an interesting and well-marked genus of our Texano-New-Mexican region to Mr. Augustus Fendler, who, next to Wislizenus, was the earliest botanical explorer in New Mexico, where he made with much hardship the excellent collection now so well known to botanists.

UMBELLIFERÆ.

230. ERYNGIUM WRIGHTII (sp. nov.): glauco-pallidum; caule erecto apice cymoso-polycephalo; foliis rigidis, radicalibus oblanceolatis pectinato-dentatis vel pinnatifidis dentibus triangulatis apice setiferis, caulinis sessilibus pinnatipartitis segmentis lineari-lanceolatis cuspidatis, superioribus sensim abbreviatis fere palmatiformibus, nempe segmentis confertis infimis subulatis parvis cæteris elongatis trifidis, involucralibus capitulo ovali duplo longioribus cuneato-lanceolatis trifidis cum 2–3 minoribus linearibus integerrimis; paleis subulatis corneis flores superantibus, summis 2–3 sæpius foliiformibus capitulum coronantibus; calycis lobis ovatis mucronulatis. — Bed of the Limpia or Wild Rose Creek; Aug. Also in the coll. of 1851. "Flowers light blue." Stem one or two feet high, from a long, apparently biennial root. Uppermost involucriform cauline leaves closely sessile, and almost palmately-parted. Heads 3 to 5 lines in diameter, shorter than the close and rigid involucre, pale, most of them inconspicuously coronate in the manner of E. Hookeri. It is more related to E. heterophyllum, *Engelm. in Wisl. Mem. N. Mex.*, from Cosiquiriachi.*

† E. HOOKERI (*Walp. Repert.* 2. *p.* 389): annuum; caule erecto paniculatim polycephalo; foliis inferioribus basi semivaginante subpetiolatis trisectis, segmentis lateralibus 3–5-partitis lobis lanceolatis pinnatifido-laciniatis spinulosis, terminali

* Eryngium Beecheyanum, *Hook. & Arn.*, is apparently a dwarf state of E. comosum, *Laroche.*

E. filiforme, *Shuttleworth*, *Pl. Rugel*, must be a mere variety of E. Baldwinii, *Spreng.*: his E. filiforme, var. latifolium (*Rugel*, *No.* 180, 181) is just the E. gracile, *Baldw.*, according to the specimens in the Hookerian herbarium.

E. prostratum, *Nutt.* is most likely a distinct species, and the E. Americanum of Walter.

longe petiolulato multo majore lanceolato laciniati-dentato, foliis summis sessilibus palmatipartitis lobo medio sessili cæteris conformi, involucralibus lineari-lanceolatis spinuloso-laciniatis capitulum globosum duplo superantibus; paleis lanceolatis lateribus late membranaceis apice subulato-spinescentibus calycis lobos acuminato-aristatos vix superantibus, summis foliaceis capitulum coronantibus. — E. coronatum, *Torr. & Gray*, *Fl.* 1. *p.* 604; *Engelm. & Gray*, *Pl. Lindh. p.* 10, non *Hook. & Arn.* On the Brazos, Texas, *Drummond*, *Lindheimer*, *Wright.* — The new character here given is requisite now that the lower leaves are known. It is taken from Drummond's specimens in the Hookerian herbarium.

231. E. Leavenworthii, *Torr. & Gray*, *Fl.* 1. *p.* 604; *Gray*, *Pl. Lindh.* 2. *p.* 209. On the San Pedro River.

232. Daucosma laciniatum, *Engelm. & Gray*, *Pl. Lindh.* 2. *p.* 210. Pebbly bars of the Rio Nueces (in flower and in fruit). — It occurs with perfectly ripe fruit in Lindheimer's collection of 1850. The genus should stand next to Cynosciadium.*

233. Cymopterus montanus, *Nutt. in Torr. & Gray*, *Fl.* 1. *p.* 624; *Gray*, *Pl. Fendl. p.* 56. Hills near Austin, Texas; March (in fruit). Accords with Nuttall's and also with Geyer's specimens in the Hookerian herbarium, except that the fructiferous peduncle is longer than the leaves, and the fruit is not quite so large. The carpophore persists when the mericarps fall, as in Fremont's specimens. Like Nuttall's and Geyer's specimens, moreover, the silvery-scarious involucre and involucels are smaller and less conspicuous than in Fendler's plant (No. 275), which also has larger wings to the fruit. Like Fendler's, but still larger, are the silvery involucres of specimens gathered by Burke at "Portneuf River," which are just coming into flower. Can they belong to C. albiflorus, *Nutt.?*

† Tauschia (Museniopsis) Texana (*Gray*, *Pl. Lindh.* 2. *p.* 211, *adnot.*): glaberrima; foliis omnibus radicalibus utrinque viridibus pinnato-decompositis, nempe pinnis 3–5 cum impari, inferioribus petiolulatis (petiolulis ac petiolo gracili apteris) pinnato-3–5-partitis, segmentis cuneiformibus 3–5-fidis, lobis oblongis obtusissimis; scapo simplicissimo nudo; involucro parvo 1–2-phyllo aut nullo; involucello dimidiato e phyllo unico palmati 3–5-fido; radiis umbellulæ fructu didymo brevioribus; mericarpiis lævigatis 18–20-vittatis, jugis obsoletis. — Western Texas, near Austin. Galveston Bay, *Drummond* (No. 109 of the third collection) *in herb. Hook.* — No. 2760 of Galeotti's Mexican collection is the same as No. 121 of Coulter's, viz. Tauschia Coulteri (*Pl. Lindh. l. c.*). †

* Thaspium Walteri, *Shuttleworth*, *Pl. Rugel*, *exsicc.* (Apium bipinnatum, Walt.?), from Macon County, North Carolina, is the same as Zizia pinnatifida, *Buckley*, *in Sill. Jour.* 45. *p.* 175 (1843), from the same region (also gathered in the barrens of Kentucky by Dr. Short). It is hard to say whether the plant should be referred to Zizia or Thaspium; — probably to the latter.

† Musenium divaricatum, *Nutt.* (which probably includes M. trachyspermum and M. angustifolium) has scabrous fruit, crowned with conspicuous and persistent calyx-teeth. Of M. (Daucophyllum) tenuifolium, *Nutt.*, the fruit is unknown. To it however does not belong No. 220 of Geyer's Oregon collection (referred to it by Hooker), which is a Peucedanum, allied to P. triternatum.

RUBIACEÆ.

234. Galium (Relbunium) microphyllum (sp. nov.): glaberrimum, humile; caule cæspitoso ramosissimo diffuso; foliis quaternis lineari-lanceolatis arcte sessilibus rigidulis mucronatis marginibus nervoque valido lævissimis pedunculos unifloros æquantibus; flore cum fructu glabro in involucro tetraphyllo sessili. — Mountains at the Pass of the Limpia, in crevices of rocks, and in the valley of the Limpia; Aug. — Root perennial, reddish. Stems a span long, herbaceous, slender, very leafy; the strong obtuse angles, like the whole plant, perfectly smooth. Leaves two or three lines long, their sessile bases almost connate, the lower lanceolate. Peduncles axillary, one-flowered, but the four-leaved involucre is sometimes proliferous. Involucre like the ordinary leaves, longer than the small, "yellow," tetramerous flower, and the glabrous, but minutely pruinose fruit. Lobes of the corolla ovate, obtuse. — This should be compared with Rubia lævigata, *DC.*, described from Hænke's collection, which has ovate-oblong or ovate-lanceolote leaves. — Younger specimens, barely in flower, are in the collection of 1851; their lower leaves oblong-lanceolate.*

‡ G. virgatum, *Nutt.*, var. diffusum: caulibus demum ramosis laxis; pedunculis vel ramis floriferis plerisque folia superantibus sæpe proliferis. — Western borders of Texas; coll. of 1851. — Each flower is subtended either by a pair of leaf-like bracts, as in the ordinary G. virgatum, or by a whorl of four leaves; from which the branch is sometimes proliferous.

235. G. (Trichogalium) Wrightii (sp. nov.): suffruticosum; caulibus ramosissimis diffusis ramisque hirsutis; foliis quaternis oblongis submembranaceis uninerviis utrinque pilis patentibus hirsutis; floribus pedicellatis in cymulis terminalibus laxis; corolla rubro-purpurea; fructu setis longis apice non uncinatis hispidissimo. — Crevices of rocks, on mountains, in the Pass of the Limpia; Aug. — Stems 6 to 12 inches high from a thick woody base; the branches slender. Leaves from two to four lines long, sessile, obtuse, often setose-apiculate. Corolla half a line in diameter, deep red-purple, the lobes acuminate. Bristles of the fruit white, straight, rather longer than its diameter.†

236. Bouvardia hirtella, *H.B.K. Nov. Gen. & Sp.* 3. *p.* 384. Hill-sides in the Pass of the Limpia; Aug. (Northern Mexico, *Wislizenus*, *Gregg;* and near the city of Mexico, *Gregg.*) It appears to pass into the pubescent form of what is called B. Jacquinii. Some specimens in the collection of 1851 have more herbaceous and strict stems, larger leaves, the upper in whorls of from four to seven, and larger flowers. ‡

* No. 186 of Coulter's Mexican collection (from Zimapan) is a nearly related species, perhaps a mere variety, with the margins of the leaves sparsely setose.

† Galium suffruticosum, *Nutt. in Torr. & Gray*, *Fl.* 2. *p.* 21, has a name which is preoccupied for a Chilian species by Hooker and Arnott. It may therefore be called G. Nuttallii.

‡ Bouvardia glaberrima, *Engelm. in Wisl. N. Mex. p.* 106, is B. splendens, *Graham in Bot. Mag.*, and also apparently the Houstonia coccinea, *Andr. Bot. Repos. t.* 106, and the Ixora coccinea, *Cav. Ic.* 4. *t.* 305.

237. Hedyotis (Ereicotis) acerosa (sp. nov.): fruticulosa; caulibus cæspitosis confertis foliosissimis; foliis acerosis scabro-hirtellis 3–4-natim verticillatis et in axillis fasciculatis persistentibus; floribus inter folia fasciculata sessilibus; corollæ tubo infundibulari calycis laciniis setaceis et limbo suo quadruplo longioribus. — High prairies, from Live Oak Creek to the Las Moras, Western Texas; June. Also near Buena Vista, &c., Northern Mexico, *Gregg.* — Stems about a span high, very many from the same thickened root, rigid, rather woody, erect or diffuse, leafy to the top, sparingly branched; the rigid setaceous leaves longer than the internodes. Flowers mostly solitary at the summit of the branches and in the axillary fascicles of leaves. Corolla five or six lines long, purplish or "bluish"; the lobes ovate, puberulent inside. Anthers linear. Stigmas linear-oblong. Capsule globose, crowned with the setaceous teeth of the calyx, coherent with its tube nearly to the summit, two-celled; the cells 12–20-seeded. — Hedyotis (Anotis, *DC.*) Cervantesii, *Kunth*, I have not seen, but from the character it can be neither the present species, so remarkable for its acicular leaves, nor H. rubra (Houstonia, *Cav.*). The latter, which I have seen also from Northern Mexico, and which was found by Fendler in New Mexico, is herbaceous, depressed, and I believe an annual, like H. humifusa.

238. H. (Amphiotis) stenophylla, *Torr. & Gray, Fl.* 2. *p.* 41: var. parviflora: tubo corollæ limbo vix longiore; capsula etiam parva; caulibus humilibus rigidulis diffuse ramosis; cymis apertis. — Crevices of rocks on the San Pedro River; July. — This accords with H. stenophylla, as characterized, in the shortness of the pedicels, &c.: as to the size of the corolla and the length of its tube, No. 55 of Drummond's (first?) Texan collection is intermediate between this and No. 116 of Drummond's third collection.

239. H. stenophylla, var. parviflora: strictior; cymis densifloris contractis. — Mountain valleys east of the Rio Grande, New Mexico; Aug. "Flowers white." — This has the dense fastigiate cymes and very short pedicels, especially those of the central flowers, of the typical H. stenophylla, namely, the plant common in Florida, and also in Arkansas and Texas (the H. lasiantha, *Nutt. in herb. Hook.*). That has, however, considerably larger flowers and a longer tube to the corolla: but there seems to be no more constancy in this than in other characters, apparently of equal or greater consequence, which prove so little reliable in this difficult group.*

240. H. stenophylla? passing into H. longifolia β. tenuifolia, *Torr. & Gray, l. c.* — Prairies of Turkey Creek, Western Texas, June. — Same as No. 620 of Lindheimer's collection, the fruiting specimens at least; wholly herbaceous, with the cymules paniculate and loosely flowered, and all the flowers distinctly pedicelled. But the pods are turbinate. The flowering specimen of Lindheimer's No. 620 (in

* At Buena Vista, Mexico, Dr. Gregg collected specimens of the variety of Hedyotis purpurea called by Nuttall Houstonia macrosepala. To this belongs Hedyotis calycosa, *Shuttleworth*, which he has determined to be Spermacoce lanceolata of Frank and Diodia Frankii of Hochstetter and Steudel.

No. 325 of Rugel's Florida collection, named Oldenlandia corymbosa by Shuttleworth (surely not of Linnæus), is Hedyotis Halei, *Torr. & Gray, Fl.* 2. *p.* 42.

herb. Hook.), with the flowering branches and the pedicels elongated and filiform, is surely the same as Nuttall's Houstonia tenuifolia.

241. HEDYOTIS (HOUSTONIA) HUMIFUSA, *Gray, Pl. Lindh.* 2. *p.* 216. Sandy soil near Austin, Texas; also west of the Pass of the Limpia; Aug. "Flowers white."

COMPOSITÆ.

242, 243. VERNONIA JAMESII, *Torr. & Gray, Fl.* 2. *p.* 58. Bottom of the San Pedro River; also beyond the Pecos, and on the Limpia; Aug. — Under these numbers are distributed several forms of one species, of which those with the larger and more turbinate heads agree well with V. Jamesii (although the leaves are often somewhat serrulate), while those with smaller heads approach V. fasciculata. The corymb is simple and small, and the stems only from ten to eighteen inches high. It is rightly placed between V. fasciculata and V. angustifolia.*

244. PECTIS (PECTIDOPSIS) ANGUSTIFOLIA, *Torr.; Gray, Pl. Fendl. p.* 61; var. SUBARISTATA: pappo in fl. exterioribus nonnullis sæpius 1 – 2-aristulato. — Pectis fastigiata, *Gray, Pl. Fendl. p.* 62. Valley between the Pecos and the Limpia; Aug. — The awns of the pappus, which are almost always single in these specimens, are found in only one or two of the exterior flowers of each capitulum, and in many they are altogether wanting; — showing not only that De Candolle's genus Pectidopsis is untenable, but that my Pectis fastigiata can be nothing else than a more or less aristate variety of P. angustifolia. — The whole of Pectis (meaning thereby the Eupectideæ of De Candolle) greatly needs a revision, from adequate materials, when it will be found that some of the characters used as specific are variable, especially the number of awns or paleæ, and the difference between the pappus of

* A synonym of this last is Liatris umbellata, *Bertoloni, Misc. Bot.* 5. *p.* 13. *t.* 4. *fig.* 1; from Alabama specimens.

Vernonia Rugeliana, *Shuttleworth* (N. Carolina, *Rugel*) appears to be only the ordinary form of V. Noveboracensis.

No. 238 of Coulter's Mexican collection appears to belong to a very distinct undescribed genus, remarkable among Vernoniaceæ for its paleaceous receptacle. The subjoined character is drawn from the specimen in the Hookerian herbarium: —

BOLANOSA, *Nov. Gen.*

Capitulum multiflorum, homogamum, æqualiflorum? Involucrum hemisphæricum, extus laxe lanatum; squamis oblongo-lanceolatis membranaceis appressis apice subcoloratis (purpureis) inappendiculatis, intimis disco subæqualibus. Receptaculum planiusculum paleaceum; paleis invol. squam. referentibus conduplicatis, singulis florem involventibus. Corollæ purpureæ, marginales (ampliatæ?) reflexæ. Styli etc. Vernoniacearum. Achenia turbinata, sericeo-hirsuta. Pappus duplex rigidus, exterior e paleolis squamellatis plurimis lineari-lanceolatis ovario æquilongis, interior e setis aristæformibus complanatis sursum incrassatis pluriserialibus corolla paullo brevioribus, utrisque crebre denticulatis. — Herba floccoso-lanata; caule (seu ramo) erecto apice capitula plura ($\frac{1}{2}$-poll. diametro) corymboso-congesta gerente; foliis alternis ovato-oblongis utrinque acutis subsessilibus penninerviis integris supra mox glabratis? subtus dense cano-lanatis.

B. COULTERI. — Bolanos, Northern Mexico, *Coulter.* — Differt a Vernonia receptaculo paleaceo, pappi setis seu paleis rigidis incrassatis, ab Heterocoma squamis involucri haud nervatis, pappo externo squamellato, etc.

the ray and disk. Such species as P. elongata have the pappus as truly biserial as any Lorentea.*

245. P. (Eupectis) prostrata, *Cav. Ic.* 4. *p.* 12. *t.* 324; *DC. Prodr.* 5. *p.* 100. Mountain valleys towards the Rio Grande; and at Presidio de San Elisario, New Mexico; Aug. – Sept. — The specimens belong to a depauperate state of the species, being only from one to three inches high. The involucral scales are not conduplicate, each embracing a flower, as in the foregoing and many other species. The paleæ of the pappus are broader than in the figure of Cavanilles.

246. Liatris punctata, *Hook. Fl. Bor.-Am.* 1. *p.* 306. *t.* 55; *Torr. & Gray, Fl.* 2. *p.* 69. Pass of the Limpia; Aug. — This is one of the slender, narrow-leaved forms, with the scales of the involucre very obtuse and abruptly mucronate. L. mucronata, *DC.* (founded on Berlandier's No. 1926) is a similar but more depauperate state of this same species: while L. resinosa, *DC.*, was described from a cultivated specimen of the variety (var. *β. Torr. & Gray, l. c.*) with lanceolate-pointed scales.†

† L. acidota, *Engelm. & Gray, Pl. Lindh. p.* 10. L. mucronata, *Torr. & Gray, Fl.* 2. *p.* 70. Western Texas. — L. mucronata, *Engelm. & Gray, Pl. Lindh. l. c.*, is only a variety of this, with more abruptly mucronate-pointed involucral scales.

247. Kuhnia eupatorioides, *Linn.; Torr. & Gray, Fl.* 2. *p.* 78: between var. γ. gracilis and δ. gracillima, *Gray, Pl. Lindh.* 2. *p.* 218 (K. leptophylla, *Scheele*). On the Las Moras and Zacate Creeks, Texas. Also on the Rio Grande. Some of the lower leaves are large and lanceolate; those of the branches very narrow and slender.

248. K. eupatorioides, var.; nearly the same as the last, but depauperate; from six to eight inches high. Mountain valleys between the Limpia and the Rio Grande, New Mexico; Aug.

248[a]. Brickellia Riddellii. Clavigera dentata, *DC.! Prodr.* 5. *p.* 128. C. Riddellii, *Torr. & Gray, Fl.* 2. *p.* 77; *Gray, Pl. Lindh.* 2. *p.* 218. On the Rio Grande, Texas. I find from De Candolle's herbarium that this is indeed his Clavigera dentata; but the leaves are so little toothed, and often entire, that I have preferred a later specific name while referring the plant to another genus. The pappus affords no available distinction between Brickellia and Clavigera, and the latter

* The species have to be arranged under a considerable number of sections, somewhat as follows: —

Pappus coroniformis, vel in disco vel in radio, et sæpius 1 – 4-aristatis:	
Aristis sursum scabris v. nullis. (P. angustifolia, filipes, uniaristata, et sp. nov. Am. Merid.)	Pectidopsis.
Aristis corneis retrorsum hispidis. (P. Coulteri, multiseta.)	Heteropectis.
Pappus uniformis, ex aristis paucis corneis lævissimis.	Pectidium.
Pappus uniserialis, e paleis vel aristis basi paleaceo-dilatatis paucis.	Eupectis.
Pappus biserialis paleaceus, in radio nunc dimidiato-ariculæformis, nunc nullus.	Lorentea.
Pappus setosus, 1 – 2-serialis, setis capillaribus basi vix aut ne vix dilatatis, in radio nunc dimidiato-auriculæformis.	Pectothrix.

† Liatris radians, *Bertoloni, Misc. Bot.* 5. *p.* 9. *t.* 1, is L. elegans. L. lanceolata, *Bertoloni, l. c. p.* 11. *t.* 3, is L. gracilis, *Pursh.* L. sessiliflora, *Bertoloni, l. c. p.* 10. *t.* 2, is L. spicata. L. umbellata *Bertoloni, l. c. t.* 4. *f.* 1, is Vernonia angustifolia, as already stated; and the same author's Eupatorium glastifolium (*t.* 4. *f.* 2) is Liatris odoratissima!

name can only be retained for the section with linear leaves. (Vide *Kew Jour. Bot.* 3. *p.* 225.) *

249. B. PARVULA (sp. nov.): scabrella; caulibus spithamæis gracilibus e basi suffruticosa plurimis adscendentibus; foliis plerisque oppositis oblongo-ovatis basi

* BRICKELLIA, *Ell. Sk.* 2. *p.* 290. (Clavigera & Bulbostylis, *DC.*)

Capitulum pluri-multiflorum. Involucrum imbricatum, squamis striatis. Receptaculum nudum planum. Corollæ cylindricæ (albidæ vel ochroleucæ), limbo haud ampliato, dentibus brevissimis. Stylus basi bulbosus. Achenia cylindrica 10-striata. Pappus capillaris, setis subplumosis barbellatis vel serrulatis. — Genus ab Eupatorio acheniis multistriatis nec pentagonis, a Kuhnia pappo non plumoso, præsertim distinctum.

The following species are more or less known to me: —

§ 1. CLAVIGERA, *DC.* — Involucrum 4-12-florum. Caules virgati foliosissimi, foliis linearibus alternis.

* *Folia integerrima, marginibus revolutis: involucri squamæ obtusæ.*

1. B. CORYMBOSA. — Clavigera corymbosa, *DC.* C. scabra, *Benth. Pl. Hartw. p.* 19. Mexico.
2. B. SCOPARIA. — Clavigera scoparia, *DC. Prodr.* 5. *p.* 128; *Deless. Ic. Sel.* 4. *t.* 12. Mexico.

* * *Folia acerosa, supra canaliculata, integerrima: involucri squamæ obtusæ, minus striatæ.*

3. B. PINIFOLIA. — Clavigera pinifolia, *Gardn. in Lond. Jour. Bot.* 5. *p.* 461. Brazil, *Gardner.*

* * * *Folia pungentia spinuloso-dentata: involucri squamæ acutæ.*

4. B. SPINULOSA. — Clavigera spinulosa, *Gray, Pl. Fendl. p.* 63, *adnot.* Mexico (Chihuahua), *Gregg.*

§ 2. BULBOSTYLIS, *DC.* — Involucrum pluri-multiflorum. Folia præsertim inferiora sæpius opposita.

* *Folia arcte sessilia vel amplexicaulia: capitula* 10-20-*flora, subracemosa: involucrum pauciseriale.*

5. B. WISLIZENI, *Gray, Pl. Fendl. p.* 64. Northern Mexico, *Wislizenus.* A variety apparently of this species was gathered by Seemann, at Cerro de Pinal, Western Mexico.

* * *Folia subsessilia seu brevissime petiolata, haud cordata.*

+ Folia rigido-coriacea, valde reticulata, fere omnia opposita: pedunculi axillares et terminales nudi.

6. B. LANATA, *DC.! Prodr.* 7. *p.* 268. B. rigida, *Hook. & Arn.! Bot. Beech. p.* 297. — Capitula magna, plusquam 30-flora: involucrum multiseriale. Mexico, *Mendez! Beechey! Coulter!* (No. 237, Bolanos.) — Coulter's plant agrees with the specimens described by De Candolle, having subpetioled leaves; but the plant gathered in Beechey's voyage has the leaves sessile by a subcordate base. There is no further difference. In all of them the white wool disappears from the upper surface.

7. B. RETICULATA, *DC.* Mexico, *Hænke.* — This I have barely seen in the herbarium of De Candolle. It is possibly the same as the next, which, however, has narrow serrated leaves, and naked inflorescence.

8. B. OLIGANTHES: cinereo-pubescens; caulibus gracilibus erectis; foliis ellipticis seu lineari-oblongis utrinque obtusis valde reticulatis brevissime petiolatis supra glabratis scabris a medio ad apicem rariter serratis; capitulis pauciusculis in ramos graciles subnudos virgato-paniculatis sæpius remotis; involucro turbinato 10-12-floro; squamis extimis ovatis lanoso-ciliatis, intimis linearibus acutis; acheniis sericeis; pappo scabro. — Eupatorium oliganthes, *Less.! in Linnæa,* 4. *p.* 137. Bulbostylis oliganthes, *DC. Prodr.* 5. *p.* 139. — Mexico, *Scheide* (v. sp. in herb. Par.), *Seemann:* and if I rightly recollect, No. 2306 and No. 1152 of Galeotti's collection also belong here. Heads 5 or 6 lines long.

++ Folia haud coriacea, alterna.

9. B. OBLONGIFOLIA, *Nutt.* Oregon.
10. B. RIDDELLII. Vide supra, p. 83. Texas.
11. B. BRACHYPHYLLA. — Clavigera brachyphylla, *Gray, Pl. Fendl. p.* 63. New Mexico.

+++ Folia haud coriacea, plerumque opposita.

12. B. PARVULA. Vide supra. New Mexico.
13. B. CYLINDRACEA, *Gray, Pl. Lindh.* 2. *p.* 218. Texas.

* * * *Folia petiolata: rami foliosi: capitula* 9-30-*flora, axillaria seu paniculato- vel racemoso-thyrsoidea: involucrum pluriseriale.*

+ Folia argute dentata seu laciniata, haud cordata.

14. B. LACINIATA. Vide p. 87. Northern and New Mexico.

truncatis grosse dentatis venosis ($\frac{1}{2}$ poll. longis) breviter petiolatis; pedunculis gracilibus subcorymbosis monocephalis; involucro sub-12-floro pubescente, squamis interioribus linearibus subobtusis, extimis brevibus ovatis mucronatis; acheniis hirsutis; pappo tantum barbellato. — Mountains beyond the Pass of the Limpia;

15. B. BACCHARIDEA. Vide p. 87. New Mexico.

+ + Folia sæpe cordata, crenato-serrata vel subintegerrima.

16. B. RENIFORMIS. Vide p. 86. New Mexico.

17. B. VERONICÆFOLIA. Eupatorium veronicæfolium, *H. B. K.! Nov. Gen. & Sp.* 4. *p.* 112. *t.* 441. Bulbostylis veronicæfolia, *DC. l. c.* Mexico. — Var. *α.* caule pulverulento-puberulo; foliis incanis vel canescentibus. Mexico, *Galeotti* (No. 2105), *Shepherd*, *Bates*, *Gregg* (89? 353, 613, 440), &c. — Var. *β.* ramis foliisque vix canescentibus subhirtellis. Real del Monte to Zacatecas, *Coulter* (No. 243). Guanaxuato, *Berlandier*. — The plant is unlike Bulbostylis pedunculosa, *DC.*, with which De Candolle compares it.

18. B. GALEOTTII (sp. nov.): suffruticosa? cinereo-puberula; caule erecto superne paniculato; foliis plerisque alternis petiolatis 3 – 5-nerviis supra glabratis subtus cinereis, caulinis rotundato-cordatis crenatis, ramealibus subcordato-ovatis subintegerrimis; capitulis longiuscule pedunculatis sæpius ternis terminalibus corymboso-paniculatis; involucro circiter 20-floro turbinato pluriseriali, squamis exterioribus orbiculatis, intimis lanceolato-linearibus acutiusculis. — Mexico, *Galeotti* (No. 2104). — Cauline leaves an inch long. Heads half an inch long, on erect peduncles of half an inch or an inch in length.

19. B. MICROPHYLLA. Bulbostylis microphylla, *Nutt. in Torr. & Gray, Fl.* 2. *p.* 79. Oregon.

20. B. CALIFORNICA, *Gray, Pl. Fendl. p.* 64. Bulbostylis Californica, *Torr. & Gray, Fl. l. c.* California, New Mexico.

21. B. TOMENTELLA (sp. nov.): foliis suboppositis omnibus cordatis petiolatis crenulatis reticulatis supra scabrido-puberulis subtus caule ramisque mollissime cinereo-tomentosis; capitulis pedicellatis secus ramos floridos paniculatos racemosis; involucro 30-floro campanulato pluriseriali, squamis omnibus obtusis margine scariosis, extimis rotundatis tomentosis, interioribus latiuscule linearibus glaberrimis. — Mexico, *Mr. Tate* (in herb. Hook.). — Plant fully as large as B. Cavanillesii, which it resembles, from which it is at once distinguished by the obtuse and scarious scales of the many-flowered involucre.

22. B. CAVANILLESII. Coleosanthus Cavanillesii, *Cass.* Eupatorium squarrosum, *Cav.?* E. nepetæfolium, *H. B. K.! Nov. Gen. & Sp.* 4. *p.* 112. Bulbostylis Cavanillesii (& B. nepetæfolia), *DC.! l. c.* Mexico. — The figure by Cavanilles does not well accord; but De Candolle states that he has the plant from his herbarium. The leaves are sometimes cinereous-tomentose beneath, sometimes glabrate. The exterior involucral scales are glandular, the inner often glabrous; all attenuate-acuminate. The stem of the Humboldtian specimen of Eupatorium nepetæfolium, in the Paris herbarium, is not "hispid-hairy," but villous-velvety, as in B. Cavanillesii, to which it certainly belongs.

23. B. SECUNDIFLORA. Bulbostylis secundiflora, *DC.! l. c.* Mexico.

24. B. PENDULA. Bulbostylis pendula, *DC.! l. c.* Mexico. — What appears to be this species has been collected in Mexico by Mr. Bates and Mr. Seemann.

25. B. HEBECARPA. Bulbostylis hebecarpa, *DC.! l. c.; Hook. & Arn.! Bot. Beech. p.* 296. Western Mexico.

26. B. HARTWEGI. Eupatorium rigidum, *Benth.! Pl. Hartw. no.* 598. *p.* 88. Guatemala, *Hartweg*, *Skinner*, *Œrsted*.

* * * * *Folia petiolata, cordato-deltoidea seu hastata, opposita: capitula* 10 – 50-*flora, corymbosa: involucrum pluriseriale.*

+ Capitula multiflora.

27. B. CORDIFOLIA, *Ell. Sk.* 2. *p.* 290; *Torr. & Gray, Fl.* 2. *p.* 80. Georgia, Alabama, and Florida.

28. B. GRANDIFLORA, *Nutt.; Torr. & Gray, l. c.* East and west sides of the Rocky Mountains.

29. B. FENDLERI, *Gray, Pl. Fendl. p.* 63. Mew Mexico.

+ + Capitula pluriflora.

30. B. HASTATA, *Benth.! Bot. Voy. Sulph. p.* 21. South California, *Hinds, Barclay.*

Aug. "In dense bunches; flowers yellow." — This so much resembles B. brachyphylla (Clavigera brachyphylla, *Gray*, *Pl. Fendl. p.* 63) that it might well be taken for a variety of it with toothed and mostly opposite leaves, except that its pappus is barely barbellate under a lens (not as strongly as in B. Riddellii, but rather more so than in B. cylindracea), while in B. brachyphylla it is even plumose. The heads are more corymbose, and on longer, simple, and naked peduncles.

250. B. CYLINDRACEA, *Gray*, *Pl. Lindh.* 2. *p.* 218. Frontiers of Western Texas. A small state, scarcely a foot high; also collected in 1851. It was gathered in Eastern Texas by Berlandier, whose specimen is placed by De Candolle with B. Cavanillesii.

251. B. RENIFORMIS (sp. nov.): subpuberula; ramis ad apicem usque foliosis; foliis plerisque alternis reniformibus vel ramealibus dilatato-deltoideis grosse crenatis membranaceis longiuscule petiolatis; capitulis parvulis in axillis pl. m. fasciculatis brevissime pedicellatis folio brevioribus; involucro 10-floro glaberrimo, squamis omnibus obtusis, exterioribus ovalibus, intimis linearibus; acheniis pubescentibus;

31. B. COULTERI (sp. nov.): suffruticosa? ramis divaricatis pedunculisque pube brevi glandulosa scabro-hirtellis; foliis oppositis petiolatis hastato-triangulatis acuminatis marginibus utrinque laciniato-2–4-dentatis (dentibus triangulari-subulatis) glanduloso-hirtellis mox glabratis; pedunculis paucis corymbosis gracilibus monocephalis; involucro circiter 12-floro; squamis subtriserialibus laxis, extimis lanceolatis acuminatis; achenio puberulo. — California, *Coulter* (No. 293), in herb. Hook. — A branch only. Leaves with the petiole scarcely an inch long. Heads five lines long, on peduncles of half an inch or more in length.

There is an allied species in Gregg's Mexican collection (No. 479); but my specimen is too poor for characterizing it properly.

* * * * * *Folia longe petiolata subcordata: capitula 7–12-flora in corymbis paniculatis ramosissimis effusis disposita: involucrum tantum biseriale.*

32. B. DIFFUSA. Eupatorium diffusum, *Vahl; DC. Prodr.* 5. *p.* 174. E. capillare, *Desv.* E. leptopodum, *Gardner! in Lond. Jour. Bot.* 5. *p.* 478. Bulbostylis diffusa, *DC. Prodr.* 7. *p.* 268. West Indies, Mexico, Central America, Brazil.

Bulbostylis scorodoniæfolia, *Kunth*, *Ind. Sem. Hort. Berol.* 1846, *p.* 12, would appear from the character to be only B. Cavanillesii.

Bulbostylis subuligera, *Schauer in Linnæa*, 19. *p.* 718 (Zimapan, Mexico, *Aschenborn.*), appears to be, as is stated, very closely allied to B. pedunculosa, *DC.*, and if so it is a Eupatorium.

Bulbostylis pedunculosa, *DC. Prodr.* 5. *p.* 138; *Deless. Ic. Sel.* 4. *t.* 17, (as well De Candolle's own specimens as those of Coulter's Mexican collection, No. 251,) has the achenia merely 5-costate and at length pentagonal; besides, the corolla is considerably ampliate above and rather deeply cleft. It must therefore be removed to Eupatorium, many genuine species of which have a bulbous base to the style.

Bulbostylis glabra, *DC. l. c.* (which came from Brazil), and the nine additional species described by Gardner, in *Lond. Jour. Bot.* 5. *p.* 467–472, are all true Eupatoria, having pentagonal (not striate) achenia; while his Eupatorium leptopodum is Brickellia diffusa.

Bulbostylis spinaciæfolia, *DC. l. c.*, is likewise described with the achenia of Eupatorium. Except in the larger leaves, it would seem to accord with Eupatorium hastile, *Schauer in Linnæa*, 19. *p.* 719, to which probably belongs No. 244 of Coulter's Mexican collection, from Zimapan.

Bulbostylis triangularis, *DC. Prodr.* 7. *p.* 268, may be a Carphephorus.

Bulbostylis? pauciflora, *DC. Prodr.* 5. *p.* 139, should probably be restored to Eupatorium.

Bulbostylis annua, *Nutt. Pl. Gambel.*, is an obscure plant of uncertain genus, either of Asteroideæ or Senecionideæ.

pappo serrulato-scabro. — Mountain valley 35 miles east of El Paso; Oct. — Apparently herbaceous, and two feet or more in height, paniculately much branched. Cauline leaves an inch or an inch and a half in length, and mostly wider than long, thin, veiny. Heads only three lines long. Achenia somewhat angled, but 10-striate.

252. B. BACCHARIDEA (sp. nov.): minutim glanduloso-puberula, glabrata; caulibus suffruticosis ramosissimis usque ad apicem foliosis; foliis plerisque alternis coriaceis ovato-rhomboideis vel cuneato-oblongis grosse inæqualiter dentatis valde reticulatis basi in petiolum angustatis; corymbulis axillaribus breviter pedunculatis vel ramulos breves terminantibus oligocephalis folia vix superantibus; involucro cylindraceo 15–18-floro, squamis omnibus obtusis, exterioribus ovalibus oblongisve, interioribus linearibus; pappo scabro. — Mountains near El Paso; Oct. — A bushy plant, apparently two or three feet high; the flowering branches virgate, loaded with heads. Leaves crowded, an inch or less in length, dentate with several salient teeth, thickish, rather scabrous, somewhat resinous, punctate as are all the species. Heads narrow, four or five lines long. Pappus very minutely scabrous.

253. B. LACINIATA (sp. nov.): scabro-puberula; caulibus fruticosis ramosissimis; ramis virgatis ad apicem usque conferte foliosis; foliis plerisque alternis membranaceis ovato-cuneatis oblongisve inciso-lobatis seu laciniato-dentatis petiolatis; capitulis breviter pedicellatis in ramos floridos subspicato-paniculatis confertis; involucro cylindraceo 9-floro, squamis obtusis submucronatis, extimis ovato-oblongis, intimis linearibus; acheniis puberulis; pappo scabro. — Mountain valley, 40 miles east of El Paso; Oct. (Also Saltillo, *Berlandier*, *Gregg* (No. 336), and in Western Mexico, *Seemann.*) — A much-branched shrubby plant, 3–5 feet high. Leaves variable, 5 to 12 lines long, the larger sometimes deltoid-ovate and deeply laciniate-lobed, most of them narrowed at the base. Heads narrow, 5 lines long; the involucre glabrous. Pappus minutely scabrous.

254. EUPATORIUM WRIGHTII (sp. nov.): fruticosum, cinereo-puberulum; caule ramoso (1–2-pedali) usque ad apicem folioso; foliis plerisque oppositis ovatis obtusis triplinerviis subintegerrimis in petiolum marginatum contractis; capitulis corymbosis circa 12-floris; involucri subbiserialis squamis lineari-oblongis obtusis. — Sides of the Guadalupe Mountains, 40 miles east of El Paso; Oct. — Leaves half or three quarters of an inch, or on the branches of the dense corymb two or three lines, long, with a margined petiole about half that length, somewhat like those of E. cuneifolium, *Willd.*, but commonly broader near the base. Heads three lines long.

255. E. AGERATIFOLIUM, *DC.* β. TEXENSE, *Torr. & Gray*, *Fl.* 2. *p.* 90; *Gray*, *Pl. Lindh.* 2. *p.* 219. E. Lindheimerianum, *Scheele in Linnæa*, 21. *p.* 599. Mountain valleys beyond the Limpia.

256. E. SOLIDAGINIFOLIUM (sp. nov.): glabellum, suffruticosum; caule ramosissimo ramisque floridis virgatis foliosis; foliis oppositis lanceolatis et ovato-lanceolatis acutis subintegerrimis membranaceis e basi obtusa triplinerviis petiolatis; capitulis parvis 3–5-floris in cymulas axillares breviter pedunculatas congestis paniculam thyrsoideam foliosam efficientibus; involucri squamis circiter 8 lanceolatis trinerviis acutatis, externis brevioribus; stylis apice crasso-clavatis; acheniis hirto-puberulis. — Mountains between the Limpia and the Rio Grande, New Mexico; Aug. — Stems

apparently two or three feet high. Leaves approximate, an inch and a half and on the flowering branches an inch long, the largest half an inch wide near the base, thence tapering gradually to the apex, entire, or the cauline obscurely denticulate; petiole one or two lines long. Heads barely two lines in length, in dense and more or less pedunculate axillary clusters, the lower ones shorter than the leaves, the upper confluent into a thyrsoid panicle. I am not acquainted with any species with which this may be particularly compared.*

257. Conoclinium betonicum, *DC.*, var.? integrifolium: foliis lanceolato-oblongis basi cuneato-contractis rarius subhastatis subintegerrimis utrinque cauleque molliter pubescentibus. — Wet places on the Rio Grande, Texas; Aug. — This could scarcely be taken for the same species as De Candolle's C. betonicum, which has sagittiform-cordate leaves; but specimens gathered near Monterey by Major Eaton, although they have barely subhastate leaves, tend to connect them. Dr. Gregg's collection has the same plant, from Ojo Caliente, near Saltillo. The scales of the involucre are about 25, hirsute on the back. Achenia glabrous. Receptacle strongly conical.

258. C. dissectum (sp. nov.): herbaceum, puberulum vel glabellum; caulibus erectis; foliis subsessilibus profunde 3–5-fidis partitisve, segmentis laciniato-pinnatifidis; involucri squamis circa 25 subbiserialibus subulato-lanceolatis dorso striatis pubescentibus; acheniis glabellis. — Damp places, Rio Seco, and on the Rio Grande, Texas. — Stems one or two feet high from a perennial root, herbaceous, or somewhat lignescent at the base, slender, simple or branched, very leafy to near the summit. Leaves two inches or less in length, ovate in circumscription, all remarkably laciniate-dissected, the lower less deeply than the upper; the lobes lanceolate or linear. Corymb nearly simple. Heads twice as large as in C. cœlestinum; the flowers of the same color. Receptacle convex-conical.

259. C. dissectum, var. caule graciliore, foliis minoribus. — Valley beyond the Pecos; Aug. Also at San Antonio de las Alanzanes, near Saltillo, Mexico, *Gregg.*

260. Trichocoronis rivularis, *Gray, Pl. Fendl. p.* 66, *adnot.* "In the outlet of a spring tributary to the San Felipe; blooming profusely both above and beneath the surface of the water. Flowers white." Also on the Rio Grande, Texas. In the Hookerian herbarium are specimens gathered by Berlandier near Monterey.

* A singular species of Eupatorium, on account of the foliaceous squarrose tips of the scales of its involucre (which may be compared to that of Sericocarpus), is in Coulter's collection, both the Californian and the Mexican. This and E. liatrideum, *DC.*, which has the same peculiarity, should form a separate section of the series *Imbricata*: —

Eupatorium sagittatum (sp. nov. Imbricata, Phyllacrocephala): puberulum; caule gracili paniculato; foliis oppositis petiolatis hastato-sagittatis integris subtus crebre punctatis; pedunculis solitariis ternisve terminalibus monocephalis; involucro cylindraceo 30–40-floro; squamis 20–30 coriaceis vix striatis albidis appressis appendice deltoidea foliacea squarrosis; acheniis glabris angulis acutissimis hispidulis. — California, No. 294; and Sonora Alta, Mexico, No. 252, *Coulter.* Between Mexico and Mazatlan, *Gregg.* — Stems herbaceous, apparently erect, the base unknown. Leaves about an inch long, lanceolate-triangular, either sagittate or hastate, the lobes two or three lines long, rather obtuse. Heads five or six lines long; the involucral scales imbricated in four or five series, all but the innermost abruptly foliaceous-appendiculate. Flowers probably rose-color.

261. T. Wrightii, *Gray, Pl. Fendl. p.* 65. Low or wet places, near Austin and San Marcos, Texas; July. — There is a third species in Gregg's last Mexican collection.*

262. Machæranthera (Dieteria) canescens, var. glabra: foliis lanceolatis viridibus cauleque scabridis fere glabris; ramulis puberulis; capitulis laxe corymbosis; involucri campanulato-turbinati squamis pluriserialibus apicibus viridibus parvis vix squarrosis. — Sand-bars of the Rio Grande below El Paso, and at Presidio de San Elisario, New Mexico; Sept. — This is better marked in its characters than some of the species described by Nuttall and adopted in the *Flora of North America;* but I am confident that Dieteria canescens, pulverulenta, incana, divaricata, viscosa, and sessiliflora, *Nutt., Torr. & Gray, Fl.* 2. *p.* 100, are all forms of one widely spread and very polymorphous species, which varies according to situation, &c. D. asteroides, *Torr. in Emory, Rep. p.* 142 (which has *lanceolate* leaves), accords with one of Wright's specimens, except that the involucral scales are looser and with rather longer tips.

* Trichocoronis Greggii (sp. nov.): pusilla; caule procumbente vel fluitante; foliis oblongis integerrimis subamplexicaulibus; pedunculo solitario monocephalo; tubo corollæ fauce campanulata æquilongo; involucri squamis linearibus; pappo plurisquamellato-subcoroniformi et 2–3-aristellato. — Between Mexico and Mazatlan, *Gregg.* — Leaves thickish, 2–3 lines long. Peduncle simple, one or two inches long. Head twice as large as that of T. Wrightii; the involucre, &c. similar.

Stevia trichopoda, *Pl. Fendl. p.* 64, is the same as S. podocephala, *DC.* The pappus of some of the exterior flowers is occasionally awnless.

The genus Carphochæte is confirmed by two additional species. The character must be somewhat extended as to the pappus: —

CARPHOCHÆTE, *Gray, Pl. Fendl. p.* 65.

Capitulum 4–6-florum, homogamum. Involucrum cylindricum; squamis lanceolatis substriatis imbricatis, exterioribus brevioribus. Receptaculum nudum. Corollæ tubulosæ, hypocraterimorphæ, involucrum superantes, lobis lanceolatis glabris. Styli rami filiformes. Achenia gracilia 10-striata, costis alternis fortioribus subpentagona. Pappus paleaceus; paleis 5–14 elongatis lineari-lanceolatis denticulatis uninerviis, nervo crasso in aristam barbellato-scabram corolla subæquilongam sensim exserente, atque paucis (1–5) parvis exterioribus muticis. — Herbæ basi suffruticosa, vel suffrutices, Mexicanæ; foliis oppositis sessilibus angustiis uninerviis punctatis integerrimis; capitulis terminalibus sæpius laxe corymbosis; floribus roseis vel albidis circiter unciam longis.

1. C. Wislizeni (*Gray, Pl. Fendl. l. c.*): glaberrima; caulibus spithamæis; foliis anguste linearibus elongatis; squamis involucri vix ciliatis impunctatis subulato-acuminatis; pappo e paleis 5 aristatis et 5 exterioribus parvis ovalibus cuneatisve enerviis. — Mountains near Cosiquiriachi, Northern Mexico, Wislizenus. — Leaves two inches or more in length, scarcely a line wide.

2. C. Grahami (sp. nov.): caulibus gracilibus pedalibus et ultra puberulis; foliis linearibus seu lineari-oblongis obtusissimis, superioribus parvis dissitis; squamis involucri arachnoides-ciliatis mucronatis impunctatis; pappo paleis 7–9 aristatis cum 1–3 exterioribus parvis oblongis enerviis. — Mexico, *Graham* (in herb. Benth.), *Seemann.* — Cauline leaves an inch or an inch and a half long, two or three lines wide, the uppermost much smaller, conspicuously dotted. Heads corymbose. Branches of the style very long.

3. C. Bigelovii (sp. nov.): puberula, fruticosa; foliis oblongis confertis; squamis involucri subacuminatis resinoso-punctatis; paleis pappi 12–14 aristatis cum 1–3 parvis lanceolatis muticis uninerviis. — On the boundary between Mexico and New Mexico, *Dr. I. H. Bigelow.* Communicated in a letter to Dr. Torrey. — The leaves barely half an inch long. Heads larger than in the two preceding. Achenia half an inch long. Corolla two thirds of an inch long.

263. Machæranthera tanacetifolia, *Nees, Ast. p.* 224; *DC. Prodr.* 5. *p.* 262; *Hook. Bot. Mag. t.* 4624. Aster tanacetifolius, *H. B. K.! Nov. Gen. & Sp.* 4. *p.* 95. A. chrysanthemoides, *Willd. in Spreng. Syst.* 3. *p.* 538. Chrysopsis (Pappochroma) coronopifolia, *Nutt. in Jour. Acad. Philad.* 4. *p.* 34. Dieteria coronopifolia, *Nutt. in Trans. Amer. Phil. Soc.* 7. *p.* 300; *Torr. & Gray, Fl. l. c.* Valley of the Rio Grande, New Mexico, and on the Pecos; Sept. (San Antonio de las Alanzanes, Mexico, *Gregg.*) — Humboldt found the plant growing in the Botanic Garden at Mexico; and Nees founded on it his genus Machæranthera (so named from the lanciform tips of the anthers, which are just the same, however, in most Asters): but it has not been identified until the present year, when Sir William Hooker has figured under this name specimens raised in the Royal Botanic Gardens at Kew, from Mr. Wright's seeds. He did not observe, however, that it is the same as the well-known Dieteria coronopifolia, *Nutt.* (as I had determined from the specimen in the herbarium of the Paris Museum), probably because the specimen figured has all the upper leaves simply pinnatifid: but similar wild ones have all the lower leaves bipinnately parted. Kunth described the rays as white: Nees had remarked that they were purplish in the dried specimen preserved in the herbarium of Willdenow; and Gregg notes that they were pale purple in his Mexican specimens. In Texas, and in the cultivated plant, they are usually deep violet, and are quite showy. It is not "suffruticose," although the stems become somewhat indurated; but the root is biennial or annual. — The older name must replace Nuttall's Dieteria.

271. M. parviflora (sp. nov.): glabra, subviscosa; caule ramosissimo; foliis parvis pinnatilobatis lobisque utrinque 3–5 sublinearibus; involucri squamis 2–3-serialibus lineari-oblongis acutiusculis disco brevioribus; acheniis sericeis; pappo corolla disci breviore.— Along the Rio Grande, New Mexico; Sept. — Stems a foot or so in height, from an annual root. Cauline leaves half an inch long, those of the branches smaller; the lobes a line or less in length. Heads three lines in diameter. Rays three lines long, purple. Pappus soft, not very copious; that of the ray rather shorter than that of the disk. — Very much resembles Psilactis Coulteri; but the leaves are pinnatifid, the achenia are silky-villous, and the pappus always present in the ray.

264. Aster multiflorus, *Ait.; Torr. & Gray, Fl.* 2. *p.* 125. Valley of the Rio Grande, New Mexico, and plains at the base of the Guadalupe Mountains; Sept. Dr. Gregg collected it in Mexico, below Saltillo. — To this species belongs A. hebecladus, *DC.*, and A. scoparius, *DC.*, established on specimens from Berlandier's collection.

† A. spinosus, *Benth. Pl. Hartw. p.* 20. Banks of the Rio Grande below El Paso. Dr. Gregg gathered it at Saltillo.

265. A. divaricatus, *Torr. & Gray, l. c.* Along the Rio Grande, New Mexico.

266. Erigeron modestum, *Gray, Pl. Fendl. p.* 68, & *Pl. Lindh. p.* 220, excl. syn. Distasis modestæ, *DC.* On the San Felipe; July. Also in the coll. of 1851.*

* De Candolle's Erigeron ? (Pterigeron) decurrens belongs to the tribe Cynareæ, in which, with a second and larger-flowered species from tropical New Holland, it forms a new genus.

267. E. DIVERGENS, *Torr. & Gray, Fl.* 2. *p.* 175; *Hook. in Lond. Jour. Bot.* 6. *p.* 242. E. flagellare, *Gray, Pl. Fendl. p.* 68. Valley of the Limpia; Aug. Also in the coll. of 1851. — Fendler's and Wright's specimen, I find, accord with Nuttall's, and especially with Geyer's, which has flagelliform branches. The root sometimes appears as if perennial.

268. E. DIVERGENS, var. CINEREUM. E. cinereum, *Gray, Pl. Fendl. p.* 68. New Mexico; the locality not recorded.

269. DIPLOPAPPUS ERICOIDES, *β.* HIRTELLA, *Gray, Pl. Fendl. p.* 69. Valley of the Pecos and of the Limpia; Aug. – Oct.*

270. PSILACTIS ASTEROIDES, *Gray, Pl. Fendl. p.* 72. Along the Pecos, Limpia, and Rio Grande, New Mexico; Aug. — The lower cauline leaves, in specimens from the coll. of 1851, are spatulate and toothed. — This genus should probably be reduced to a section of Machæranthera (Dieteria, *Nutt.*), which shows a tendency to a reduction of the pappus in the ray.

271. Vide p. 90.

272. DISTASIS MODESTA, *DC.! Prodr.* 5. *p.* 279. Diplostelma bellioides, *Gray, Pl. Fendl. p.* 72. — Hills on the Rio Frio and Turkey Creek, Western Texas; June. — Berlandier's plant, on which Distasis was founded, proves on inspection to be a slender state of the plant on which my Diplostelma was established, much like some of the specimens in Wright's collection. The outer, paleaceous pappus is larger, however, in all my specimens. The heads vary considerably in size and in the number of the flowers. The anthers are not caudate. In some dried specimens the rays are violet-purple.

273. KEERLIA BELLIDIFOLIA, *Gray & Engelm. in Proceed. Amer. Acad.* 1. *p.* 47, *& Pl. Lindh.* 2. *p.* 220. Hills of the Rio Frio, Texas; June; a very slender form. — De Candolle characterized his genus Keerlia by its *flat receptacle and subterete achenia* (in these respects distinguished from the Australian genus Brachycome), its pluriserial involucre of lanceolate acuminate scales with submembranaceous margins, and its pappus of very short paleæ more or less united in a minute crown. The first of the three species differs from the others, as well as from the subtribe the genus is placed in, by its yellow rays: the achenia likewise are not striate, the corollas have a slender tube, and the scales of the involucre are coriaceous. The plant, moreover, has so entirely the aspect and the involucre of Xanthocoma, that De Candolle was probably thence led to adduce the Brachycome xanthocomoides, *Less.*, as a synonym. In fact, the K. linearifolia would be a true Xanthocoma, were it not for a minute paleaceo-coroniform pappus and the lanceolate-linear appendages to the style, which refer it rather to Gutierrezia § Hemiachyris.† It is not the same as

* Arctogeron, *DC.* is congeneric with this and Diplopappus alpinus, *Nutt.* Of the latter, Burke collected in the Rocky Mountains a taller and more developed, probably less alpine state, if not a new species; with stems six inches high, and linear leaves six to ten lines long, and the narrowly linear scales of the involucre only biserial.

† GUTIERREZIA (HEMIACHYRIS; pappo brevissimo pl. m. coroniformi, radii conformi vel obsoleto) ALAMANI: caule spithamæo e basi suffruticuloso repente parce ramoso, ramis monocephalis; foliis linearibus vel lanceolatis; ligulis 12 – 15 involucro late campanulato duplo longioribus; acheniis glabellis;

Lessing's Brachycome xanthocomoides, of which I have seen an original specimen, barely in flower, communicated by Schlechtendal to the herbarium of the Paris Museum. This is a diffusely spreading plant; the rays, I think, are not yellow; the receptacle is conical, and the involucre, ovaries, corolla, &c. are the same as in Aphanostephus, to which I should refer the plant, were it not that the appendages of the style in the perfect flowers are oblong-lanceolate. Keerlia ramosa, De Candolle's second species, founded on a plant collected by Keerl himself, has a *strongly conical* receptacle (which is abundantly manifest in De Candolle's own specimen, as well as in those retained by Martius), and plainly belongs to De Candolle's next genus; indeed, it is difficult to distinguish it from Aphanostephus ramosissimus itself. (The coroniform pappus of the latter is minutely setulose-fringed; of the former, more setulose and less coroniform.) Keerlia skirrobasis, De Candolle's third species, which is figured in Delessert's *Icones*, also has a well-marked conical receptacle, and is the same species as his own Leucopsidium Arkansanum, and is a strict congener of his earlier-published Aphanostephus ramosissimus, as I have already remarked, in *Pl. Fendl. p.* 71. Keerlia, *DC.*, must therefore be divided between Gutierrezia and Aphanostephus. Singularly enough, however, while none of De Candolle's species really accord with his character, I some years ago received a Texan plant that does, in the essential points of a flat receptacle, a minute coroniform pappus, and acuminate membranaceously-margined involucral scales; and this was described under the name of Keerlia bellidifolia. To this a second and in some respects different species of Lindheimer's later collection (K. effusa) was added recently, but before I had obtained the information above recorded. And for these, as the case now stands, since they are already published under this name, I propose to continue the name Keerlia, with a new character, as subjoined.*

pappo in radio et disco conformi brevissimo paleaceo-coroniformi. — Keelia linearifolia, *DC. ! Prodr.* 5. *p.* 310. — Mexico, *Alaman* (v. sp. in herb. *DC.*), *Ghiesbrecht* (v. sp. in herb. Mus. Par.), *Mackenzie* (v. sp. in herb. *Hook.*). Although large for the genus, the heads are smaller than those of Gutierrezia (Odontocarpha, *DC. !*) Gayana, in which they are also solitary; and the pappus is nearly the same as that of G. Texana. — In Xanthocoma humilis, which Dr. Halstead gathered in Mexico, the achenia, or at least the ovaries, are short and compressed, glabrous, and the appendages of the style are short and obtuse. The stems are somewhat floccose-woolly when young.

* KEERLIA, *Gray*, *Pl. Lindh.* 2. *p.* 221, non *DC. !*

Capitulum pluriflorum radiatum; ligulis 5 – 15 uniserialibus fœmineis; fl. disci hermaphroditis aut abortu masculis, 5-dentatis. Involucrum turbinatum, imbricatum, pauciseriale; squamis oblongis cuspidato-mucronatis nitidis membranaceis, marginibus scariosis, extimis brevibus. Receptaculum planum nudum. Styli rami fl. disci breves, appendice aut brevissima obtusa aut gracili lanceolata superati. Achenia obovata, pl. m. compressa, disci vel centralia inania gracilia, disco epigyno parvo, pappo minimo coroniformi superata. — Herbæ Texanæ, annuæ vel perennes? caulibus gracilibus effuse ramosis; foliis alternis spathulatis oblongisve subsessilibus integerrimis; capitulis parvulis pedunculatis solitariis vel paniculatis; ligulis albis vel cæruleis.

1. K. BELLIDIFOLIA: annua, hirsutulo-pubescens; caule humili e basi diffuse ramoso; foliis membranaceis, infimis obovatis, ramealibus lineari-spathulatis, omnibus deorsum attenuatis; ligulis (cyaneis) 7 – 15 lineari-oblongis; fl. disci 15 – 25 plerisque fertilibus; appendicibus styli brevibus obtusissimis; acheniis clavato-fusiformibus hirtellis 7 – 9-nerviis leviter (exterioribus præsertim) compressis coronula parva inte-

274. Aphanostephus ramosissimus, *DC.! Prodr.* 5. *p.* 310. A. Riddellii, *Torr. & Gray, Fl.* 2. *p.* 189. Egletes ramosissima, *Gray, Pl. Fendl. p.* 71, *& Pl. Lindh.* 2. *p.* 220. Prairies near Austin, Texas; May. The form with strict and subsimple upright stems. It flowers during the whole summer, and often becomes very much branched and diffuse later in the season. It is a pretty plant in cultivation. The copious heads droop before anthesis, and are usually tinged with pink or purple underneath. The ripe achenia are prismatic, as in A. Arkansanus, but not strongly ribbed and sulcate. The base of the corolla is at length frequently indurated.

275. A. ramosissimus; a diffusely branched, more softly pubescent variety, with smaller heads. Prairies along the Rio Grande, Texas; July.

276. A. humilis. Leucopsidium humile, *Benth. Pl. Hartw. p.* 18. Egletes humilis, *Gray, Pl. Fendl. p.* 71. Valley of the Rio Grande, 60 or 70 miles below El Paso; Sept. "Rays purple." Perhaps a dwarf variety of A. Arkansanus; but the pappus is entire and equably setulose-ciliate.

† A. Arkansanus. Leucopsidium Arkansanum, *DC.! Prodr.* 6. *p.* 43. Keerlia skirrobasis, *DC.! Prodr.* 5. *p.* 310; *Hook. Ic. Pl. t.* 240. Egletes Arkansana, *Nutt. in Trans. Amer. Phil. Soc. n. ser.* 7. *p.* 394; *Torr. & Gray, Fl.* 2. *p.* 411. Eastern Texas; common. — Having followed Nuttall in referring this plant to Egletes, I subsequently did the same with its strict congeners, the preceding species. But the recent examination of Egletes bellidiflora, Domingensis, and viscosa (Platystephium, *Gardner*) leads to a different conclusion. Egletes has compressed achenia (becoming somewhat turbinate by the great thickening of the pappus), with only marginal, thickened ribs, and very short rays. The styles, moreover, as well as the odor and aspect of the plants, show that they are genuine Anthemideæ. The achenia of Aphanostephus are prismatic or terete, strongly striate or ribbed on all sides; the rays are elongated; the herbage is destitute of aromatic odor; and the style (well figured in *Deless. Ic. Sel. t.* 18) is the same as in many other Bellideæ.

‡ Bellis integrifolia, *Michx. Fl.* 2. *p.* 131. Western frontiers of Texas; coll. of 1851. There is a congener of this in Gregg's last collection, made between the city of Mexico and Mazatlan.*

gra superatis. — *Gray & Engelm. Proceed. Amer. Acad.* 1. *p.* 47; *Pl. Lindh. l. c.* — Western Texas, *Lindheimer*, *Wright*.

2. K. effusa: perennis? caule virgato ultrapedali ad apicem usque folioso hirsuto; foliis utrinque hispidis coriaceo-membranaceis, infimis spathulatis, cæteris oblongis e basi lata arcte sessilibus, costa subtus prominula, ramis floridis in paniculam decompositam effusam diliquescentibus; pedunculis filiformibus divaricatis minutim bracteolatis; ligulis 5–7 oblongis; fl. disci 7–10 fere omnibus sterilibus; appendicibus styli lineari-lanceolatis acutis; acheniis radii plano-compressis obovatis calloso-marginatis parce hirtellis (ad margines præsertim) faciebus fere enerviis apice acutatis, disci abortivis gracilibus; pappo minimo setuloso-coroniformi. — *Gray, Pl. Lindh.* 2. *p.* 222. — Upper Guadalupe, near Camanche Spring, on shady declivities, *Lindheimer*. "Camancheries," Texas, *Berlandier*, No. 1878 (v. in herb. *DC.*).

Keerlia linearifolia, *DC.* = Gutierrezia Alamani: vide supra, p. 91.

K. ramosa, *DC.* = Aphanostephus sp. A. ramosissimo valde affinis.

K. skirrobasis, *DC.* = Aphanostephus Arkansanus (Leucopsidium Arkansanum, *DC.*).

* Bellis Mexicana (sp. nov.): annua? pilis patentibus hirsuta; caule erecto folioso; ramis monocephalis; foliis radicalibus caulinisque inferioribus spathulatis dentatis in petiolum longe attenuatis superi-

277. GYMNOSPERMA CORYMBOSUM, *DC. Prodr.* 5. *p.* 312; *Torr. & Gray, Fl.* 2. *p.* 192; *Gray, Pl. Lindh.* 2. *p.* 222. Hills along the Pecos and Limpia, also on the Rio Grande, in Texas. — G. multiflorum and G. scoparium, *DC.*, are scarcely distinct from this. As to De Candolle's opposite-leaved species, G. nudatum is Flaveria linearis, *Lag.*, as already referred in the *Flora of North America*, and I may now add that his G. oppositifolium is Flaveria longifolia, *Gray, Pl. Fendl. p.* 88.

278. GUTIERREZIA EUTHAMIÆ, *Torr. & Gray, Fl.* 2. *p.* 193; var. caule altiore. Side of mountains near El Paso; Sept. A smaller form was gathered on the Limpia.

279. G. MICROCEPHALA, *Gray, Pl. Fendl. p.* 74, *adnot.* Brachyris microcephala, *DC.! Prodr.* 5. *p.* 313, non *Hook.* Along the Rio Grande, 60 or 70 miles below El Paso; Sept.

280. G. ERIOCARPA (sp. nov.): diffuso-ramosissima; ramulis divergentibus subcorymbosis capitula solitaria gerentibus; foliis angustissime linearibus; involucro hemisphærico disco convexo brevioribus, squamis lineari-oblongis acutis; ligulis 10–12; fl. disci circiter 30; pappo conformi e paleis circa 12 lineari-lanceolatis subulatisve integris haud raro inter se subconcretis achenio turbinato villosissimo dimidio breviore; receptaculo alte conico. — Prairies along the Rio Grande, Texas. (Also between Laredo and Bexar, Feb., 1828, *Berlandier;* v. sp. in herb. Hook.) — Stems 1–3 feet high, very leafy. Leaves an inch or less in length, half a line wide, those of the branches almost setaceous. Heads barely two lines in diameter; the rays linear-oblong. Achenia turbinate, 10-ribbed, very strongly silky-villous. Pappus of more numerous, longer, narrower and acute paleæ than in the allied G. sphærocephala (*Pl. Fendl.*), sometimes all distinct, often irregularly concreted more or less, similar in the ray and disk. G. sphærocephala has the receptacle equally conical.*

281. SOLIDAGO PETIOLARIS, *Ait.; Torr. & Gray, Fl.* 2. *p.* 203; var. Mountains between the Limpia and the Rio Grande; Aug. A bad name for the species, since the leaves are nearly or quite sessile. This state is nearly allied to S. velutina, *DC.*

282. S. NEMORALIS, *Ait.; Torr. & Gray, Fl.* 2. *p.* 220; var. *β.* & *γ.*, verging to S. incana, *Torr. & Gray*, which is probably not distinct.† Valley of the Limpia, and base of the Gaudalupe Mountains; Sept. Some of the specimens have narrowly lanceolate leaves, and are S. decemflora, *DC.! Prodr.* 5. *p.* 332, except that Berlandier's are very starved and late specimens, having been gathered in December.‡ De Candolle's S. puberula is also S. nemoralis, the ordinary form.

oribus lanceolatis sessilibus integerrimis mucronatis; involucri squamis lineari-lanceolatis acutis hirsutis; ligulis albis. — Mexico, *Gregg.*

* No. 538 of Gregg's Mexican collection (from near Saltillo) accords rather better than Coulter's No. 315 (from Zimapan) with the character of Hemiachyris glutinosa, *Schauer in Linnæa*, 19. *p.* 724; but both differ from it in having a pappus in the ray as well as disk, and of more numerous small paleæ.

† Solidago mollis, *Bart. Ind. Sem. Hort. Gœtt.*, as I learn from specimens of the plant cultivated in the Botanic Garden of Halle, 1849, is exactly S. incana (var. *α.*), *Torr. & Gray, Fl.*, which name should give place to Bartling's, if the species be distinct.

‡ Solidago puncticulata, *DC.! l. c.*, which is compared with this, is S. odora.

† S. Radula, *Nutt.* var. rotundifolia. S. rotundifolia, *DC.! Prodr.* 5. *p.* 339. S. scaberrima, *Torr. & Gray, Fl.* 2. *p.* 221. Near Austin, Texas. (Near New Braunfels, *Lindheimer*, 1850.) — By numerous intermediate states this is plainly connected with S. Radula. Probably what I referred to S. decemflora, in *Pl. Lindh.* 2. *p.* 222, likewise belongs here.

283. Linosyris heterophylla (sp. nov.): suffruticosa, glabra; caulibus simplicibus vel apice fastigiato-corymbosis; foliis anguste linearibus mucronatis uninerviis, superioribus integerrimis, inferioribus parce laciniato-dentatis; capitulis plurimis confertim fasciculato-corymbosis 12-floris; involucro subcylindraceo floribus dimidio breviore, squamis glabellis ecarinatis lineari-oblongis obtusis apice ciliolatis. — Valley of the Pecos; Aug. — Stems a foot high, very leafy, as well as the slender and somewhat angled branches. Leaves thickish, punctate, tapering to the base; the lower, two or three inches long and one or two lines wide, usually beset with one or two sharp and salient teeth or lobes on each side; the upper, an inch long and half a line wide, obscurely one-nerved. Heads more or less peduncled, crowded, four lines long. Involucre cylindraceous-campanulate; the scales about 15, slightly glutinous-glandular, as are the flowering branches and peduncles, rather concave, appressed, with a very narrow scarious margin, which is fimbriate-ciliate at the obtuse apex, the exterior successively shorter, their tips obscurely greenish. Appendages of the style triangular-lanceolate, acutish. Alveoli of the receptacle lacerate-toothed. Achenia short, turbinate but compressed, silky-canescent. — The allied L. pluriflora, of which I have only some capituli, has a more campanulate 15 – 18-flowered involucre, with lanceolate, moderately acute scales.

284. L. Wrightii (sp. nov.): suffruticosa, glabra; caulibus simplicibus; foliis oblanceolatis mucronato-acuminatis uninerviis integerrimis marginibus hirtello-scabris; capitulis plurimis in corymbum compositum fasciculato-confertis 9 – 10-floris; involucro campanulato floribus subdimidio breviore, squamis ovato-oblongis obtusissimis subcarinatis glabris marginibus subciliatis. — Valley of the Rio Grande, 60 or 70 miles below El Paso; Sept. — Stems a foot or more in height from a woody base. Leaves dull green, a little scabrous, thickish, all tapering to the base; the lower, two inches long and nearly three lines wide above the middle; the upper, similar but smaller. Heads crowded, three lines long. Scales of the involucre all appressed, obscurely greenish at the tips. Appendages of the style triangular-lanceolate, acute. Achenia short, silky-canescent. — Allied to L. lanceolata, but not puberulent, the leaves only one-nerved, the involucre shorter, &c. Both, with the preceding and L. hirtella, are strict congeners.

285. L. hirtella (sp. nov.): cinereo-hispidula; caulibus e basi suffruticosa simplicibus virgatis; foliis spathulato-linearibus mucronato-apiculatis uninerviis integerrimis vel inferioribus dentibus 1 – 3 instructis; capitulis in corymbum simplicem confertis 14-floris; involucro campanulato floribus subdimidio breviore, squamis oblongis obtusiusculis fere ecarinatis glabris. — Valley of the Limpia, "growing in dense bunches"; Aug. — Stems slender, 12 to 18 inches high, clothed, as are the leaves, with a short cinereous-hispid pubescence. Leaves about an inch long, and the larger a line wide towards the apex. Heads rather crowded in a small and

nearly simple terminal corymb, solitary or in pairs on the more or less recurved peduncles, four lines long. Scales of the involucre obscurely herbaceous near the tip. Appendages of the style short, triangular-lanceolate, acute. Achenia short, silky-villous.

286. L. (CHRYSOTHAMNUS) GRAVEOLENS, *Torr. & Gray, Fl. 2. p.* 234. Base of the Guadalupe Mountains, New Mexico; Sept. — Here belongs No. 102 of Geyer's collection, which in the published account is wrongly referred to L. viscidiflora. The latter, abundantly gathered by Fremont, Geyer, and Burke, has the involucre viscid only when young, and not always then, whence Nuttall's later specific name of *pumila* is preferable. Burke also gathered L. albicaulis, in the Rocky Mountains, confirming the character of that species.

287. L. (CHRYSOTHAMNUS) PULCHELLA (sp. nov.): fruticosa, ramosissima, glabra; ramis gracilibus apice corymbosis; foliis anguste linearibus uninerviis, ramealibus subulatis; capitulis subfasciculatis 5-floris; involucro angusto pentagono floribus subdimidio breviore, squamis plurimis oblongo-lanceolatis cuspidatis valde carinatis albis dorso ad apicem viridibus arcte quinquefariam imbricatis; acheniis acute 5–6-angulatis fere glabris; pappo copioso, setis rigidulis omnibus æquilongis. — A shrubby plant, apparently one or two feet high; the slender branchlets whitish. Leaves coriaceous, 8 or 9 lines long. Involucre 4 lines long; the chartaceous appressed scales imbricated in five vertical ranks, about six scales in each, the exterior successively shorter, all very much carinate, herbaceous on the back next the apex which is acuminate-cuspidate. Corolla, style, &c., as in the other species of the section Chrysothamnus. Receptacle small, alveolate-toothed, as in the others. Achenia fully two lines long, glabrous to the naked eye; but sparingly and minutely pubescent under a lens. Pappus half an inch long, of slender, but rather rigid bristles, all of the same length and strength. — This curious species is allied to Chrysothamnus depressus, *Nutt. Pl. Gamb.*, which is a smaller plant, with more slender and tapering involucral scales. These are more or less evidently quinquefarious in all the proper Chrysothamni, but in none do they appear so strictly so as in these two species, on account of their greater number and of their strong carination.

289. L. CORONOPIFOLIA (sp. nov.): glabra, subglutinosa; caulibus e basi suffrutescente simplicibus; foliis pinnatipartitis, lobis utrinque 2–4 rhachique lineari-filiformibus; capitulis ad apicem caulis capitato-congestis 9–11-floris; involucro cylindraceo-campanulato floribus subdimidio breviore, squamis lineari-oblongis appressis ecarinatis obtusis. — Along the Rio Grande, Texas; Sept. — Stems 12–18 inches high, leafy to the top. Leaves an inch or more in length; the slender lobes 5 to 8 lines long, punctate. Heads 4 lines long, sessile or nearly so, crowded in a terminal subglobose glomerule. Scales of the involucre thickish, nearly flat, a little greenish towards the tip. Appendages of the style triangular-lanceolate. Achenia short, silky-canescent. — An undoubted congener of No. 283, 284, and 285, which, with L. pluriflora and L. lanceolata, I cannot generically distinguish from Linosyris punctata, villosa, and Tartarica of the Old World; and L. lanceolata too closely resembles L. viscidiflora well to allow Nuttall's genus Chrysothamnus to stand for the 4–5-flowered species, notwithstanding the slender appendages of the style. On

the other hand, I am unable to draw a marked line of distinction between this L. coronopifolia and a small group of plants with 15–25-flowered heads and more herbaceous tips to the scales of the involucre, on one of which De Candolle founded his *Aplodiscus*, as a section of Aplopappus. Indeed, the A. (Aplodiscus) discoideus, *DC.!* is the same species as the Linosyris Mexicana, *Schlecht. Hort. Hal. p. 7. t. 4* (as well as Baccharis? veneta, *H.B.K.!*). Gregg's No. 580, gathered between San Luis Potosi and Mexico, is a variety of this with pinnatifid leaves. No. 114 of Hartweg's Mexican collection is an allied species, with much smaller heads; and here likewise belongs Aplopappus (Aplodiscus) Menziesii, *Torr. & Gray*, of California. A. (Aplodiscus) ramulosus, *DC.!*, which is Gregg's No. 625 (from Real del Monte, and 790 of his last collection), appears also to be of this group, although of a different habit, and with nearly subulate appendages to the style. Linosyris Drummondii, *Torr. & Gray*, of which better flowering specimens were recently gathered at Port Lavaca, Texas, by M. Trécul, has the many-flowered heads and the involucre of this group, with the foliage of L. heterophylla.*

288. Aplopappus (Blepharodon) blephariphyllus (sp. nov.): scabro-puberulus, subcinereus; caulibus erectis herbaceis usque ad apicem foliosis; ramis subcorymbosis monocephalis; foliis spathulato-oblongis (ramealibus lineari-oblongis) coriaceis crebre serratis et pectinato-setigeris; involucro nudo hemisphærico, squamis pluriserialibus lanceolato-subulatis glabellis apicibus brevibus subsquarrosis; pappo biseriali rigido achenio brevi sericeo-pubescente subduplo longiore. — Plains at the eastern base of the Guadalupe Mountains; Oct. — Plant a foot or less in height from a suffrutescent? base, rigid, with much the aspect of a Grindelia. Leaves about an inch long, thick, scabrous, serrate all round with closely set teeth, which are tipped with rigid rather short bristles. Involucre half an inch in diameter. Rays 15–18. Pappus not copious.

290. A. spinulosus, *DC.*, var. glaber, *Gray, Pl. Fendl. p. 75.* On the Rio Grande, Texas. — Whole plant a little glandular, but entirely destitute of pubescence.

291. A. spinulosus, *DC.* Sideranthus spinulosus, *Fraser, ex Steud.; Nees in Neu-Wied. Riese, Appx. p. 14.* Hills and prairies, from the Rio Frio to the San Felipe. Various forms, principally those with canescent and very spinulose leaves.

† A. rubiginosus, *Torr. & Gray, Fl. 2. p. 240.* On the Rio Grande, Texas. — A. phyllocephalus, *DC.* appears to be an abnormal state of this species.†

292. A. gracilis, *Gray, Pl. Fendl. p. 76.* Dieteria (Sideranthus) gracilis, *Nutt. Pl. Gamb., in Jour. Acad. Philad. (n. ser.) 1. p. 177.* Between the Pecos and the Limpia; Aug. The canescent form; erect, a span to a foot high, with long and slender, divergent branches. Leaves small, rather appressed.

* Crinitaria? humilis, *Hook.! Fl. Bor. Am.*, is Aster (Oxytripolium) angustus, the Tripolium angustum, *Lindl.*

† Aplopappus (Blepharodon) gymnocephalus, *DC.*, collected in Mexico by Alaman, Berlandier, Tate, Bates, and Coulter, has the rays to all appearance yellow in some specimens, while in others they have assumed a reddish hue underneath (as noticed by De Candolle), as if they had been pale purple or rose-color, in which case the plant would be a Machæranthera. Perhaps it is M. setigera, *Nees in Linnæa, 19. p. 722.* The receptacle is strongly fimbrilliferous.

293. A. GRACILIS; a less hairy form, like Gambell's plant. Valley of the Rio Grande, below El Paso; Oct.

294. A. GRACILIS; a more glabrate and less setigerous variety. Valley of the Rio Grande, 60 or 70 miles below El Paso; Sept.

295. APLOPAPPUS (PRIONOPSIS) CILIATUS, *DC. Prodr.* 5. *p.* 346. Donia ciliata, *Nutt. in Jour. Acad. Philad.* 2. *p.* 118; *Hook. Exot. Fl. t.* 45. Prionopsis ciliata, *Nutt. in Trans. Amer. Phil. Soc.; Torr. & Gray, Fl.* 2. *p.* 245. Prairies of the Pecos; Aug. — In these specimens the pappus is scarcely at all deciduous. Prionopsis and Pyrrocoma can be received only as sections of Aplopappus.*

† XANTHISMA TEXANUM, *DC.! Prodr.* 5. *p.* 94. Var. *α.* BERLANDIERI: involucri squamis obtusissimis, extimis tantum apiculatis vel mucronato-acuminatis. Southern Texas, *Berlandier!* On the Nueces, *Trécul.* — Var. *β.* DRUMMONDII: involucri squamis fere omnibus cuspidato-acuminatis. Centauridium Drummondii, *Torr. & Gray, Fl.* 2. *p.* 246; *Gray, Pl. Lindh.* 2. *p.* 223. Middle and Western Texas, *Drummond, Riddell, Wright, Lindheimer.* — I believe the two are only varieties of the same species; indeed, my cultivated specimens serve to connect them. I noticed at the time that Drummond's plant, on which Centauridium was founded, agreed in many respects with De Candolle's character of Xanthisma: but in that the involucral scales were said to be very obtuse; in ours they are remarkably cuspidate-pointed. Moreover, the appendages of the style, although long and slender, are flat, and entirely Asteroid in character. De Candolle's prior name should replace ours, but the genus must occupy the position I had assigned to it. — I have elsewhere remarked that the cauline leaves are often toothed, and that the radical ones are laciniate-pinnatifid, or even bipinnatifid.

† BRADBURIA HIRTELLA, *Torr. & Gray, Fl.* 2. *p.* 250. Western Texas. Also gathered by Trécul. — The obpyramidal ray-achenia are strongly three-angled. The truly filiform appendages of the style are quite Vernoniaceous in character. The root is annual.

296. GRINDELLIA SQUARROSA, *Dunal,* var. GRANDIFLORA: capitulis fere duplo majoribus. — G. Texana, *Scheele in Linnæa,* 21. *p.* 60. G. grandiflora, *Hook. Bot. Mag. t.* 4628. On the San Pedro River; July. Achenia quadrangular-compressed, somewhat margined, smooth and even. — The same as Lindheimer's No. 418. I think No. 363 of Coulter's Californian collection, and one of Fremont's from the same region, are not distinct from it.

297. G. INULOIDES, *Willd.; Torr. & Gray, l. c.* Prairies of the Rio Seco; June. —

* From the genus is to be excluded De Candolle's sect. ? *Leucopsis,* the species of which belong to Noticastrum and to Chrysopsis; and also the sect. ? *Pyrochæta.* For A. ? Hænkei, *DC.! l. c. p.* 349, is, if I mistake not, a glabrate state of Corethrogyne filaginifolia, to which also belongs Corethrogyne virgata, *Benth.!* The species is not very well characterized in the *Flora of North America.* The synonym of Diplopappus leucophyllus, *Lindl.* is to be transferred from this species to C. tomentella (as appears from the original specimens in the Hookerian herbarium), to which also belong both No. 267 and No. 268 of Coulter's Californian collection, and C. obovata, *Benth.!* And I suspect that No. 1772 of Hartweg's Mexican collection is a glabrate state of the same species.

Aplopappus florifer, *Hook. & Arn. Bot. Beech. Suppl. p.* 351 (Erigeron ? florifer, *Hook. Fl. Bor.-Am.*, and Stenotus florifer, *Torr. & Gray, Fl.*) is Townsendia grandiflora!

The form with rather large heads. The ripe achenia are turgid, with two sharp narrow margins, transversely rugose, the crustaceous walls very thick. If G. microcephala, *DC.* has smooth achenia, it is probably a distinct species. Otherwise it is to No. 297 what the small-flowered G. squarrosa is to No. 296. — G. inuloides *β. Torr. & Gray*, belongs to G. integrifolia. G. stricta, *DC.! Prodr.* 7. *p.* 278, is apparently a slender and small form of G. integrifolia, *β.* virgata, *Torr. & Gray*. G. discoidea, *Hook. & Arn.* (non *Nutt.*) is, I believe, G. anomala, *DC.*, so that Nuttall's name may be retained for the Oregon species.

298. Chrysopsis canescens, *Torr. & Gray, Fl.* 2. *p.* 256. Valley of the San Pedro and of the Limpia; July.

299. C. foliosa, *Nutt. in Trans. Amer. Phil. Soc.; Torr. & Gray, Fl.* 2. *p.* 256; var. minus canescens; foliis parvulis sæpius setoso-ciliatis. — Mountains east of El Paso; Sept.

LAPHAMIA, *Nov. Gen.*

Capitulum pluri-multiflorum, nunc homogamum discoideum, nunc radiatum homochromum; ligulis paucis, ovalibus oblongisve, 2-3-dentatis, discum haud superantibus. Involucrum uni-biseriale; squamis æqualibus, oblongis vel lanceolatis, membranaceis, uninerviis, carinatis, apice ciliatis. Receptaculum planum, scrobiculatum, nudum. Flores disci hermaphroditi. Corollæ (extus viscoso-glandulosæ) tubulosæ, fauce pl. m. ampliata, dentibus 5 ovatis patentibus. Antheræ basi sagittatæ vel bidentatæ. Styli rami fl. disci angusti sed complanati, in appendicem subulatam hispidam producti. Achenia conformia, lineari-oblonga, compressa, præsertim ad nervos marginales hirtella. Pappus aut plane nullus, aut unisetosus, aut (in specie forte aliena) plurisetosus, setis hirtellis. — Herbæ vel potius suffrutices rupicolæ, humiles vel nanæ, puberulæ; caudice crasso lignoso caules plures foliosos proferente; foliis alternis et oppositis, ovatis, cordatis, oblongisve, sæpius dentatis petiolatis, atomis resinosis conspersis vel minute punctatis; capitulis solitariis vel corymbosis terminalibus; floribus flavis.

I dedicate this genus to I. A. Lapham, Esq., of Milwaukee, Wisconsin, author of a catalogue of the plants of that State, and a zealous explorer of its botany. In order to their proper arrangement, I give the five known species in the text, although the two with unisetose pappus have not been received from Mr. Wright. The position of the genus is uncertain, "neither the form of the style nor the habit being very decidedly that of any of the great tribes of Compositæ," as Mr. Bentham remarks of his genus Perityle; to which genus this is manifestly allied, through the unisetose species. It has a similar habit, and exactly the same kind of style, involucre, &c.; but the pappus wants the crown of squamellæ, and in two species there is no pappus at all. I think that both genera belong rather to the Asteroideæ, notwithstanding the tendency to have opposite leaves. — The first section might be taken for a separate genus.

§ 1.? Pappothrix. Involucrum 5-8-phyllum, 12-15-florum, cylindraceum, disco æquale. Ligulæ nullæ. Corollæ disci fauce infundibulari-cylindracea elongata e tubo brevi. Pappus e setis circiter 20 conformibus, sed inæquilongis, capillaribus, rigidis, hirtellis, corolla dimidio brevioribus, majoribus achenio quadrangulari-compresso æquilongis.

300. Laphamia rupestris (sp. nov.): subviscoso-pubescens, nana; caulibus diffusis ramosis usque ad apicem foliosis; foliis sæpissime oppositis rotundatis, nunc reniformi-subcordatis grosse dentatis incisisve longe petiolatis; capitulis subcorymbosis breviter pedunculatis folia floralia subæquantibus. (Tab. IX.) — Crevices of rocks, on mountains, in the Pass of the Limpia; Aug. Also in the collection of 1851. — Stems slender, 3 to 5 inches long, very numerous from a branching woody caudex, as thick as a man's thumb. Leaves not rarely alternate, especially the lower ones, rather thin, pubescent when young, sprinkled with some very minute resinous particles (as in Eupatorium), veiny, variable in shape and in the degree of toothing, sometimes deeply laciniate-incised, sometimes barely crenate-toothed, from half an inch to an inch in breadth: petioles 3 to 5 lines long. Heads cylindraceous, 3 lines long, on peduncles of nearly the same length. Scales of the involucre oblong-lanceolate, ciliate. Branches of the style narrowly subulate. Achenia narrowly oblong, hirsute, compressed, but more or less quadrangular. Pappus of about 20 rather rigid, but capillary, unequal, barbellate-hispid bristles.

§ 2. Laphamia vera. Involucrum campanulatum, 10 – 15-phyllum, 18 – 30-florum, disco paullo brevius. Ligulæ 4 – 6, in unica specie nullæ. Corollæ disci fauce ampliata cylindracea tubo gracili valde glanduloso vix longiore. Achenia compressa, binervia, exteriora nunc trinervia. Pappus unisetosus aut nullus.

* *Capitula parvula corymbosa: pappus nullus.*

301. L. halimifolia (sp. nov.): glabella, nana; caulibus rigidis usque ad apicem foliosis; foliis plerumque alternis ovatis basi cuneatis vel rhomboideis grosse et irregulariter dentatis nitidulis resinoso-punctulatis; capitulis confertim corymbosis; ligulis late ovalibus. (Tab. IX.) — Crevices of rocks, on the summit of hills, near the San Pedro River; July. Also (much better specimens) in the collection of 1851. — Caudex woody, nearly an inch thick, branching, bearing numerous somewhat upright and slender stems, from 3 to 6 inches high. Leaves rather firm in texture, an inch or less in length, 5 to 8 lines wide, three-nerved from the base, veiny, beset with from 2 to 4 usually strong salient teeth on each side: petiole 3 lines long. Heads numerous, in the specimens of the later collection very numerous, in a naked and compound fastigiate corymb, scarcely more than 2 lines long, 18 – 20-flowered. Scales of the involucre about 10, linear-lanceolate, glabrous, villous-ciliate at the tip. Ligule short and broad, 3-toothed at the apex. Branches of the style in the disk-flowers setaceous-subulate. Achenia narrow, margined with two strong nerves, which are minutely hispid, the sides nearly glabrous.

‡ L. angustifolia (sp. nov.): glabella, nana; caulibus simplicibus confertis e caudice crassissimo; foliis oppositis vel alternis lanceolatis resinoso-punctatis utrinque grosse 1 – 2-dentatis; capitulis laxe corymbosis; ligulis nullis. — Between Texas and El Paso; coll. of 1851; the locality not yet given. — Nearly related to L. halimifolia, and with a similar very thick and woody caudex, which sends up a close tuft of stems, in these specimens all simple and barely three inches high, fastigiate; the leaves less veiny, much narrower (one or two lines wide), and more com-

monly opposite. The heads also are fewer, and rather larger (nearly 3 lines long), but have about the same number of flowers, which are very similar, except that there are no rays. I notice that one or two of the exterior corollas occasionally become somewhat ampliate and irregular.

* * *Capitula solitaria vel corymbosa: pappus e seta unica.* (Monothrix, *Torr.*)

L. Lindheimeri (sp. nov.): caulibus e basi lignea assurgentibus puberulis ad apicem usque foliosis; foliis plerumque alternis ovatis oblongisve subintegerrimis glabris; capitulis circ. 25-floris laxe corymbosis; ligulis obovatis apice tridentatis; seta pappi tubum corollæ disci tantum æquante. — "Perpendicular rocks on the banks of the Guadalupe River, near New Braunfels, Texas, exposed to the full glare of the sun," *Lindheimer:* flowering in May, 1850. — Stems 6 or 8 inches high. Leaves rather thin, 6 to 10 lines long, on petioles of 3 lines long. Peduncles slender, an inch or less in length, bearing one or two setaceous bracts, loosely corymbose. Heads 3 lines in length; the involucral scales lanceolate, 12 or 14. Branches of the style as in the preceding species. Young achenia minutely hispid on the acute margins, otherwise glabrous.

L. Stansburii (sp. nov.): puberula; caulibus e basi suffruticosa erectis parce ramosis, ramis apice nudis monocephalis; foliis plerisque alternis rotundatis subdentatis; capitulis plusquam 30-floris; ligulis oblongis apice bidentatis disco sublongioribus; seta pappi corolla disci paullo breviore. — Near the Great Salt Lake, Utah, *Capt. Stansbury;* communicated by Dr. Torrey. Stems nearly a foot high. Head three lines long and as broad. Scales of the involucre about 15, lanceolate-oblong. Branches of the style filiform-subulate.

302, 303. Baccharis angustifolia, *Michx., Fl.* 2. *p.* 125; *Gray, Pl. Lindh.* 2. *p.* 224. On the Rio Grande and Nueces, Texas. The same as Lindheimer's plant so named.

304. B. salicina, *Torr. & Gray, Fl.* 2. *p.* 258. B. salicifolia, *Nutt.*, non *Pers.* Banks of the Pecos and its tributaries; Oct. I have no authentic specimen of B. salicina for comparison. Ours belong to a plant of three or four feet in height, with mostly linear leaves, two inches long and two or three lines wide, sparingly toothed, or the uppermost entire. Involucre in the fertile plant three lines long; the exterior scales ovate, the others oblong-lanceolate, acute; scales of the sterile heads ovate. — Good specimens of the plant, with oblong-lanceolate leaves, as briefly characterized by Nuttall, occur in the collection of 1851.

305. B. cærulescens, *DC. Prodr.* 5. *p.* 402. On the Rio Grande and Nueces; common.

306. B. Texana, *Gray, Pl. Fendl. p.* 75, & *Pl. Lindh.* 2. *p.* 224. Western Texas; common. — A shrubby variety of this was gathered in the prairies on the San Felipe.

307. B. Wrightii (sp. nov.): herbacea, glabra; caulibus ramosissimis gracilibus ramisque flexuosis acute angulatis, ramulis apice monocephalis; foliis sparsis parvis linearibus et lineari-subulatis integerrimis uninerviis; involucro pl. masc. hemisphærico, squamis pauciserialibus lanceolatis acutis. — Valley of the Limpia; Aug. — Plant two feet or more in height, with much the aspect of Aster (Oxytripolium)

spinosa; the stems herbaceous from a suffrutescent base? very much branched, not rigid. Cauline leaves seven or eight lines long and scarcely a line wide, those of the branches successively smaller and more subulate. Involucre of the sterile heads three lines long; of the fertile, unknown.

308. Tessaria (Phalacrocline; recept. nudum, pappi setæ fl. hermaph. clavellatæ) borealis: fruticosa, argenteo-incana; ramis conferte foliosissimis; foliis lanceolatis mucronato-acutatis integerrimis sessilibus; capitulis subsessilibus paucis corymboso-confertis; involucro campanulato, squamis exterioribus ovatis tomentosis, interioribus linearibus apice scarioso-fimbriatis; floribus hermaphroditis 6 – 8. — Tessaria borealis, *Torr. & Gray, in Emory, Rep. p.* 143; *Gray, Pl. Fendl. p.* 75, *adnot.* Polypappus sericeus, *Nutt.! Pl. Gamb. in Jour. Acad. Philad. (n. ser.)* 1. *p.* 178. — Sand-banks on the Rio Grande at Presidio de San Elisario, New Mexico; Oct. (Called *Cachimilla.*) — This remarkable plant accords sufficiently well with De Candolle's second section of Tessaria, *Ruiz & Pav.*, except that the receptacle is naked, showing scarcely a trace of the villous hairs, and the bristles of the pappus of the hermaphrodite flowers are conspicuously clavellate at the apex. These central flowers are apparently fertile, although the style is undivided, as it likewise is in the genuine Tessariæ. The anthers are manifestly caudate at the base, rather more so than in the South American species. The pappus occupies only a single series. The involucre, receptacle, and the habit of the plant are much as in Berthelotia lanceolata, *DC.*, which, moreover, has the anthers nearly as much caudate as those of Tessaria. Moreover, in at least one species of the first section of Tessaria, the pappus of the single hermaphrodite-sterile flower is more or less paleaceous-concreted at the base; so that these two genera are nearly related, and must stand side by side.

309. Conyza subdecurrens, *DC. Prodr.* 5. *p.* 379? *Gray, Pl. Fendl. p.* 78. Borders of a pond, in a valley between the Pecos and the Limpia; Aug. — Perhaps this is an undescribed species; but the specimens perfectly accord with De Candolle's description, except that the "adnate-sessile" base of the leaf is very little decurrent, some of the leaves are even pinnatifid-toothed, the stems are hirsute, and the heads, which in Fendler's specimen are barely two lines in diameter, are still smaller (but much more numerous and crowded) in Wright's plant.*

‡ Borrichia frutescens, *DC. Prodr.* 5. *p.* 489. Between Western Texas and El Paso; coll. of 1851. A form with broad and toothed leaves, the lower becoming green and glabrate.

† Eclipta erecta, β. brachypoda, *Torr. & Gray, Fl.* 2. *p.* 269. Along the Rio Grande, below El Paso; Oct.

310. Euphrosyne ambrosiæfolia (sp. nov.): villoso-hispido; foliis 2 – 3-pinnatipartitis; paniculis subfoliosis; involucri squamis exterioribus 5 ovatis acuminatis margine vix scariosis; acheniis sub turgidis immarginatis. — Mountains near El Paso; Sept. — A coarse cinereous-hirsute plant, two or three feet high, with the aspect of an Ambrosia. The root is annual, as I suppose is that of E. parthenifolia also.

* Conyza Altaica, *DC.*, ex spec. *Karel. & Kiril.* 771, is the same as Aster (Oxytripolium, Conyzopsis) angustus, *Torr. & Gray*, the Tripolium angustum, *Lindl.!*

The leaves are more compoundly dissected than in that species, which shows traces of similar hispid hairs. But this is more decidedly distinguished by its ovate and acuminate outer involucral scales, with scarcely any margin (those of E. parthenifolia being rounded and with broad hyaline margins), and by the marginless achenia. The achenia of E. parthenifolia I do not find so much flattened, nor with such thickened margins, as it is delineated in Delessert's figure. Dr. Gregg collected it in Cohahuila.

311. Melampodium cinereum, *DC.! Prodr.* 5. *p.* 518; *Gray, Pl. Fendl. p.* 78, *& Pl. Lindh.* 2. *p.* 225. M. leucanthum, *Torr. & Gray, Fl.* 2. *p.* 271. Hills, near Austin, Texas; May.

311[a]. M. cinereum, var. ramosissimum, caulibus gracillimis; foliis linearibus, aliis integerrimis, aliis sinuato-dentatis vel subpinnatifidis; capitulis minoribus. — M. ramosissimum, *DC.! l. c.; Torr. & Grag, l. c.* Prairies from Austin to the Limpia. Also New Mexico, Wislizenus, &c. A summer state of the species.

312. Silphium laciniatum, *Linn.; Torr. & Gray, Fl.* 2. *p.* 275. Prairies near San Marcos, Texas.*

313. Berlandiera lyrata, *Benth. Pl. Hartw.; Gray, Pl. Fendl. p.* 78. Valley of the Limpia; Aug. "Rays marked with purple veins underneath." A green, scarcely at all canescent variety. The canescent form occurs in the collection of 1851, mostly with more pinnatifid leaves, passing into

314. B. lyrata, var. foliis plerisque subbipinnatifidis laciniatis. — Hills along a tributary of the Pecos; Aug.

315. Parthenium incanum, *H.B.K.! Nov. Gen. & Sp.* 4. *p.* 260. *t.* 391; *DC.! Prodr.* 5. *p.* 532. P. ramosissimum, *DC.! l. c.* Declivities on the San Pedro River, and in prairies between the Pecos and the Limpia; Aug. Dry valley between Mapimi and Guajaquilla, and near Parras. Also at Cerros Bravos (No. 490); Northern Mexico, *Gregg.* Our plant is decidedly shrubby, two or three feet high, with variously sinuate-pinnatifid or lobed canescent leaves; the flowering branches more or less herbaceous. It is the same as Berlandier's No. 1342, on which P. ramosissimum was founded. But I find no essential difference between it and Berlandier's No. 632, from mountains near the city of Mexico, which is the same as Humboldt's plant, and which I suspect is not an annual, but is more or less woody at the base. The flowers, achenia, and pappus are the same in both: the achenia, at least in Berlandier's No. 632, are not broadly margined, as represented in Kunth's figure, but the slender marginal nerves separate from below upwards, as in the other species. The awns of the pappus are subulate-setaceous, at first erect or a little spreading, at length divergent or even recurved.

316. P. Hysterophorus, *Linn.; DC. l. c.*, var. hirto-canescens; foliis lyrato-pinnatifidis nunc subbipinnatifidis, segmentis brevibus obtusissimis. — On the Rio Grande, Texas and New Mexico. Near Parras and Buena Vista (No. 86), *Gregg.* — Only a variety of P. Hysterophorus, I believe, but a remarkable one. The root is that of an annual; but the stems are occasionally lignescent towards the base.

* Silphium doronicifolium, *Kunze, Ind. Sem. Hort. Lips.* 1846, is only S. terebinthinaceum.

317. IVA DEALBATA (sp. nov.): herbacea, cano-tomentosa; foliis alternis cuneato-oblongis 3 – 5-fidis vel laciniato-pinnatifidis venosis, segmentis lanceolatis subintegris acutis; capitulis glabellis parvis in thyrsum terminalem angustum nudiusculum congestis; involucro 5-phyllo, squamis orbiculatis mucronatis margine lato scarioso villosi-ciliato cinctis; floribus fœmineis 5; acheniis subglobosis. — In a mountain valley, between the Limpia and the Rio Grande, New Mexico; Sept. — Root annual? Stems nearly simple, one or two feet high, clothed with a somewhat deciduous implexed white wool, terete, leafy to the contracted and dense panicle. Leaves two to four inches long, clothed with a fine and matted white wool, which is more or less deciduous from the upper surface, very veiny, the older ones often venulose-bullate, contracted into a short margined petiole, or subsessile; some of the lower, undivided and sparingly toothed; the upper, more triangular in outline and pinnately parted, the lower lobes half an inch to an inch long, lanceolate or linear-lanceolate. Heads subsessile, crowded, not canescent, in fruit barely a line wide. Involucre uniserial. Corolla of the fertile flowers a very short truncate tube. Achenia somewhat glandular, pyriform-globose. — The foliage and inflorescence bring this plant near to Euphrosyne; but there is no inner series of hyaline involucral scales, as in that genus and Cyclachæna, and the achenia are globular.

318. AMBROSIA CORONOPIFOLIA, *Torr. & Gray, Fl. 2. p.* 291. Fields at Presidio de San Elisario; Sept. — Fruit, as described in the *Flora of North America*, pretty large, turgid, and entirely destitute of projecting points or tubercles.*

‡ FRANSERIA TENUIFOLIA, var. TRIPINNATIFIDA, *Gray, Pl. Lindh.* 2. *p.* 227. Ambrosia fruticosa (excl. β.) & A. confertiflora, *DC.! l. c.* A. longistylis? *Gray, Pl. Fendl. p.* 80. Western frontiers of Texas; coll. of 1851. — The specimens are young, and less than a foot high, from an apparently perennial, thickish, but hardly woody root. I think the stem is not really woody in Berlandier's specimens, on which De Candolle's Ambrosia fruticosa is founded. Lindheimer has a taller form of the species in his collection of 1851, from New Braunfels, with the stems four or five feet high. The foliage varies much. The species is well distinguished by the small fruit being armed all over with short and stout incurved and uncinate spines.

319. F. TENUIFOLIA, var. lobis foliorum latioribus sæpius brevioribus. On the Leona and Nueces; June. — A coarser form, of which very few specimens were gathered.

320. F. HOOKERIANA, *Nutt.; Torr. & Gray, Fl.* 2. *p.* 294. Road-sides, valley of the Rio Grande, New Mexico; Oct.

321. HYMENOCLEA MONOGYRA, *Torr. & Gray, Pl. Fendl. p.* 79, *adnot.* Banks of a tributary of the Pecos; Oct. — The stems of this curious plant are three or four

* Ambrosia psilostachya, *DC. Prodr.* 5. *p.* 526, is the same as No. 429 and 430 of Lindheimer's Texan collection (A. Lindheimeriana and A. glandulosa, *Scheele*), which, as the tubercles of the fruit were sometimes wanting or very obscure, I took for mere varieties of A. coronopifolia. They are perhaps sufficiently distinct.

De Candolle's specimen of A. integrifolia, from the Paris Garden, is A. bidentata. A. hispida, *Pursh*, which I have seen in the Sherardian herbarium, is a plant which has not been detected since the time of Catesby.

feet high, much branched and leafy; the filiform leaves two inches long. The sterile and fertile capitula are intermixed in the ample panicles, which are loaded with the silvery-scarious fruit.

† HALEA TEXANA, *Gray, Pl. Fendl. p.* 83, *& Pl. Lindh.* 2. *p.* 227. Rocky prairies, Austin, Texas; May. — The pappus is often obsolete. — H. Ludoviciana was collected by Berlandier.

† HELIOPSIS LÆVIS, γ. SCABRA, *Torr. & Gray, Fl.* 2. *p.* 303. Eastern Texas.*

322. ZINNIA (DIPLOTHRIX †) GRANDIFLORA, *Nutt. in Trans. Amer. Phil. Soc. (n. ser.)* 7. *p.* 348; *Torr. & Gray, Fl.* 2. *p.* 298; *Torr. in Emory, Rep. t.* 4; *Gray, Pl. Fendl. t.* 81. Hills between the Pecos and the Limpia; Aug. Also in the coll. of 1851. — Ray-achenia with a pappus of two teeth or short awns; those of the disk with one, two, or sometimes three setiform awns, or some of them awnless. Rays usually five.

323. Z. (DIPLOTHRIX) PUMILA, *Gray, Pl. Fendl. p.* 81, *adnot.* Hills near El Paso; Oct. "Rays white. Stems 6 – 12 inches high," woody. Also from Buena Vista, in the second collection of Gregg; "flowers yellowish-white." — The woody, depressed stems are a quarter of an inch in diameter at the base. Heads larger

* Andrieuxia Mexicana, *DC.* (as is noted by Reuter in the Candollean herbarium) is described and figured from a specimen of Heliopsis buphthalmoides, or canescens, the same as Galeotti's No. 2109, and Linden's No. 345. Hooker's specimen of Andrieux's No. 303 is the same thing.

† ZINNIA, *Linn.*

§ 1. ZINNIA, *DC.* Herbæ annuæ, foliis ovatis seu lanceolatis. Ligulæ plures. Achenia radii calva. Z. species omnes *DC. Prodr.* (Z. intermedia, *Engelm.* = Z. tenuiflora, *Jacq.*)

§ 2. DIPLOTHRIX. Suffrutices multicaules ramosissimi, humiles vel depressi; foliis anguste lanceolatis vel acerosis. Capitula parvula pluriflora. Ligulæ 4 – 5, ovales seu rotundatæ. Achenia radii apice sæpius bidentata seu biaristellata (raro tridentata, nempe dente ex angulo interno instructa); disci 1 – 2- (raro 3-) aristata. — Diplothrix, *DC. Prodr.* 5. *p.* 611.

* *Herba diffusa, basi tantum suffruticosa, ligulis intense croceis.*

Z. LINEARIS, *Benth. Pl. Hartw. no.* 117. *p.* 17. Mexico, *Hartweg.*

* * *Suffrutices vel suffruticuli, caulibus fastigiatis confertisve foliosissimis; foliis impresso-punctatis rigidis; ligulis ratione capituli magnis flavis mox sulphureis vel ochroleucis; involucro sæpius angusto; receptaculo parvo.*

Z. GRANDIFLORA (*Nutt., Torr. & Gray, l. c.*): scabro-hispidula, spithamæa; foliis linearibus trinerviis; ligulis maximis. — Vide supra.

Z. PUMILA (*Gray, Pl. Fendl. l. c.*): puberula, mox glabrata; foliis angustissime linearibus obtusis uninerviis; ligulis parvulis (2 – 4 lin. longis). — Vide supra.

Z. JUNIPERIFOLIA: foliis glabellis subulato-acerosis acutis trinerviis nervo medio marginibusque crassioribus; pedunculis capitulo foliisque longioribus nunc subelongatis. — Diplothrix juniperifolia, *DC.! l. c.* — San Luis Potosi, *Berlandier.* (Very imperfect specimens.) Near Buena Vista, New Leon, *Gregg* (No. 68). Heads twice the size of those of Z. pumila and Z. acerosa; but the ligules in the specimens smaller proportionally. They are "bright orange" in Gregg's specimen, but have not yet become chartaceous. Leaves rigid, six to twelve lines long.

Z. ACEROSA: foliis glabellis filiformi-acerosis vel setaceis obscure uninerviis, supremis pedunculo æqualibus. — Diplothrix acerosa, *DC.! l. c.* Vide p. 106.

§ 3. HETEROGYNE. Herbæ suffrutescentes multicaules, foliis linearibus. Ligulæ paucæ, parvæ, persistentes, seu 2 – 3 vel omnes plane deficientes, atque acheniis apice biaristellatis stylo tantum superatis.

Z. ANOMALA. Vide p. 106.

than in Gregg's former specimens, on which the species was founded. Ray-achenia with two very small teeth, or sometimes none.

324. Z. (DIPLOTHRIX) ACEROSA. Diplothrix acerosa, *DC.! Prodr.* 5. *p.* 611. Hills beyond the Pecos; Aug. — Stems woody, fastigiately much branched and tufted, a span high, the branches crowded with the setaceous leaves, which are mostly six or eight lines long (in Berlandier's as well as in Wright's specimens). Heads much as in Z. grandiflora, but smaller, and only half, or less than half, their size. Involucre three lines long, narrow, on a peduncle of about the same length; the scales ciliate. Rays four or five, at first apparently light yellow, becoming papery and ochroleucous or sulphur-color, as in the two foregoing species. Ray-achenia often biaristulate; and sometimes the inner angle is likewise produced into a tooth or short awn. Pappus in the disk-flowers of one, two, or rarely three slender awns, more or less unequal, or in some of the exterior achenia reduced to squamellate teeth.

325. Z. (HETEROGYNE) ANOMALA (sp. nov.): hispidulo-scabra; caulibus e basi frutescente pluribus adscendentibus spithamæis foliosis apice monocephalis; foliis anguste linearibus acutis rigidulis trinerviis hispidulo-ciliatis, summis pedunculo longioribus; floribus fœmineis 5 – 6 in ambitu corolla omnino destitutis, seu 1 – 3 ligula brevissima ovata persistente instructis; acheniis radii et disci sæpissime biaristellatis. (TAB. X.) — Prairies beyond the Pecos; Aug. (Also gathered by Berlandier, January, 1828, in Northern Mexico.) — Plant with nearly the foliage and mode of growth of Zinnia grandiflora, *Nutt.*, but with larger heads and inconspicuous ligules, when these are present at all. Involucre nearly half an inch long, cylindraceous-oblong, many-flowered; the scales rather thin, marked with a greenish line below the sphacelate-scarious margin. The yellow ligules, when present, one or two lines long, usually shorter than the achenium and the style. Receptacle, disk-flowers (orange-colored), &c., as in Zinnia; the chaff entire, obtuse. Achenia of the ray triangular-obcompressed, with the margins produced into two paleaceous teeth or subulate short awns; of the disk compressed, commonly two-awned; but in some flowers the awns are nearly obsolete; in others there are three or four (when the achenium is quadrangular-compressed), one from each angle, or rarely five or six.

‡ Z. ANOMALA, var. magis hirtella; floribus radii omnibus ligulatis; ligulis aut brevissimis ovatis aut anguste oblongis disco æquilongis. — Between Texas and El Paso; coll. of 1851.

326. LEPACHYS COLUMNARIS, & var. PULCHERRIMA, *Torr. & Gray, Fl.* 2. *p.* 315. Prairies, Western Texas; May.

327. L. COLUMNARIS, var. TAGETES. Rudbeckia Tagetes, *James in Long, Exped.* 2. *p.* 68. Obeliscaria Tagetes, *DC.* Valley of the Rio Grande below El Paso; Sept. Also in the coll. of 1851. — This is the same as Fendler's No. 424; and it was also gathered by Wislizenus between Santa Fé and El Paso. It holds its characters very well, and has not yet occurred with large rays, nor with an elongated disk; so that it is perhaps a distinct species.

† L. (LOPHOCHÆNA) PEDUNCULARIS, *Torr. & Gray, Fl.* 2. *p.* 315. Near Austin, Texas.

† L. PEDUNCULARIS, var. PICTA; pube molliore striguloso-cinerea; foliis lyrato-pinnatipartitis, segmentis 5 – 7, terminali nunc obovato obtuso dentibus obtusis, nunc ovato pinnatifido seu laciniato dentibusque acutatis; ligulis brevibus brunneo-purpureis apice flavis. — Coast of the Gulf of Mexico (near Galveston ?), Texas. — Differs from the preceding as L. columnaris, var. pulcherrima does from the normal state of that species; and also in the much less dissected leaves, clothed with a softer and more cinereous pubescence. Yet I conceive it to be only a variety. I have had both forms in cultivation from Mr. Wright's seeds. The naked peduncles are sometimes two feet long. The root is, I believe, annual or biennial.

328. HELIOMERIS MULTIFLORA, *Nutt. in Jour. Acad. (n. ser.)* 1. *p.* 171; *Gray, Pl. Fendl. p.* 84. Mountain valley, 30 miles east of El Paso; Oct. — The same as Gambell's and Fendler's plant. The shorter-leaved variety found by Fremont was also gathered by Burke in the Rocky Mountains.

329. H. TENUIFOLIA, *Gray, Pl. Fendl. p.* 84, *adnot.* Rocky cliffs of Turkey Creek, June; and valley beyond the Pecos, Aug. Also in the coll. of 1851. — Stem woody, the branches only herbaceous.

330. SIMSIA (BARRATTIA) CALVA, *Gray, Pl. Lindh.* 2. *p.* 228. Hills near Austin and Turkey Creek, Texas; June. — The root is tuberous.

331. S. LAGASCÆFORMIS, *DC. Prodr.* 5. *p.* 577; *Benth. Pl. Hartw. no.* 145: var. glabrior; acheniis sericeis demum glabratis. Valleys in the mountains east of El Paso; Sept. — Rays very short.*

332. VIGUIERA CORDIFOLIA (sp. nov.): caule erecto hispido; foliis utrinque hirto-scaberrimis cordatis acutis subsessilibus obsolete serratis rigidis, caulinis omnibus oppositis; panicula corymbosa nuda oligocephala; involucri squamis biserialibus coriaceis oblongis acuminatis, exterioribus brevioribus hispidulis, interioribus glabratis; ligulis paucis brevibus; receptaculo planiusculo; paleis lanceolatis cuspidatis; acheniis adpresse sericeis. — Plains at the base of the Guadalupe Mountains, near a fine spring; Oct. — Stem two or three feet high, stout, leafy to the top. Leaves about three inches long and two in width, acute or acuminate, strongly three-ribbed at the base, veiny, very rough. Peduncles an inch or less in length. Heads half an inch long. Paleæ of the receptacle as long as the disk-flowers, smooth, pungently pointed. Awns of the pappus paleaceous, subulate, nearly as long as the achenium; the short paleæ two or three interposed on each side, truncate, denticulate or incised. — Evidently related to V. sessilifolia, *DC.*

* To Simsia also belongs, I believe, the Helianthus amplexicaulis, *DC.! Prodr.* 5. *p.* 589. The species are not well defined: but the subjoined appears to be an exceedingly well-marked new species: —

SIMSIA SANGUINEA (sp. nov.): parce hispida; caule ramoso, ramis gracilibus oligocephalis; foliis fere omnibus alternis basi auriculata sessilibus scabris, caulinis trilobis lobis dentatis, ramealibus lanceolatis et linearibus integerrimis; involucri squamis lanceolato-subulatis caudato-acuminatis; ligulis 10 – 12 oblongis sanguineis; paleis receptaculi cuspidatis corollisque disci apice rubro tinctis; acheniis obcordato-ovalibus planis breviter 1 – 2-aristatis. — Mountains, Mexico (in the temperate region), *Ghiesbrecht*, No. 305 (v. sp. herb. Mus. Par.): also collected by Galeotti. — The heads are fully half an inch in diameter; the scales of the involucre glandular-scabrous and very sparingly hispid; the deep red ligules four lines long. Achenia two or three lines long, appressed-pubescent, soon nearly glabrous, flat, wingless; the awns small, terete, one of them usually a line long, the other shorter, often very short or obsolete.

333. V. laxa, *DC.! Prodr.* 5. *p.* 580 (V. Texana, *Torr. & Gray, Fl.* 2. *p.* 318); & var. brevipes. V. brevipes, *DC.! l. c.; Gray, Pl. Lindh.* 2. *p.* 228. Hills of the San Pedro River to the mountains east of El Paso. — The specimens mostly belong to the V. brevipes, *DC.;* but this is a mere variety of his V. laxa, which name is much preferable.

334. Heliomeris multiflora, *Nutt.* (vide No. 328); a depauperate and narrow-leaved variety. Valley of the Limpia, and near El Paso; Sept.

335. Helianthus petiolaris, *Nutt. l. c.; Torr. & Gray, Fl.* 2. *p.* 319, var. canescens: caulibus foliisque junioribus strigoso-canescentibus; petiolis haud elongatis. — Valley of the Rio Grande sixty or seventy miles below El Paso; Sept. — The same plant has been gathered by Fremont. Much more silvery-canescent specimens occur in Mr. Wright's collection of 1851, with ovate and often sub-cordate leaves. They are very young, however: but they not improbably belong to an undescribed species.

336. H. Maximiliani, *Schrad.; Torr. & Gray, Fl.* 2. *p.* 325. On the San Pedro River; Nov.

337. H. grosse-serratus, *Martens*, var. γ. *Torr. & Gray, l. c.* Plains at the base of the Guadalupe Mountains; Oct. A form with the upper leaves nearly entire and sessile.

338. H. ciliaris, *DC. Prodr.* 5. *p.* 587. Saline prairies on the Leona, June; also on the Rio Frio and Rio Grande, Texas. Dr. Gregg gathered it near Matamoras; and Mr. Wright has it abundantly in his collection of 1851. Some specimens have linear-lanceolate leaves, as De Candolle describes them; others have them broadly lanceolate, strongly sinuate-undulate, and triplinerved, or the upper ones, which are closely sessile and not attenuate below, three-nerved from the base. It belongs to the section *Atrorubentes*, as characterized in the *Flora of North America.*

† Actinomeris (Achæta) Wrightii, *Gray, Pl. Fendl. p.* 85, *adnot., & Pl. Lindh.* 2. *p.* 229. Near Austin, Texas.*

339. Coreopsis tinctoria, *Nutt.* Bed of the Limpia; Aug.

340. C. cardaminefolia, *Torr. & Gray, Fl.* 2. *p.* 346. Calliopsis cardaminefolia, *DC. Prodr.* 5. *p.* 568. Bed of the Rio Nueces; June. This is the same as No. 441 of Fendler's collection, which in *Pl. Fendl.* I inadvertently referred to C. tinctoria.

341. = No. 339. Near Austin, Texas.

† Coreopsis coronata, *Hook. Bot. Mag. t.* 3460; *Torr. & Gray, Fl.* 2. *p.* 345. Western Texas. This has been cultivated in the Cambridge Botanic Garden for several years past. It is much handsomer than C. Drummondii; the larger bright-yellow rays being neatly marked with purple lines or spots at the base. The achenia are rather broadly winged.

* Actinomeris pauciflora, *Nutt.* has been received from Dr. Chapman (Middle Florida) with stems not at all winged, the peduncles monocephalous, the upper leaves occasionally alternate, and the head destitute of rays. Wings of the achenia narrow, but variable.

De Candolle's specimen of A. oppositifolia belongs to A. helianthoides, a state with larger leaves than usual.

‡ C. Drummondii, *Torr. & Gray, l. c.*, var. foliis caulinis 5–7-sectis, segmentis (inf. sæpe trisectis) fere omnibus anguste lanceolatis seu linearibus; capitulis paullo minoribus; acheniis maturis dorso tuberculatis marginibus valde incurvis incrassatis. — Western Texas.

342. Thelesperma (Cosmidium) filifolia, *Gray, in Kew Jour. Bot.* 1. *p.* 252. Coreopsis filifolia, *Hook. Bot. Mag. t.* 3505. Cosmidium filifolium, *Torr. & Gray, Fl.* 2. *p.* 350. Hills of the Rio Frio, Texas; June. — The root is truly perennial. — Specimens of T. (Cosmidium) simplicifolia from Saltillo (No. 114 of Gregg's collection) show a few trisected leaves; so that it may pass into T. filifolia; but the fruit is not yet known.

343. T. gracilis, *Gray, l. c.* Cosmidium gracile, *Torr. & Gray, Fl.* 2. *p.* 350. Margins of a creek between the Pecos and the Limpia; Aug. — Pappus a pair of persistent diverging horns.

344. T. (Abuceros, pappus nullus) longipes (sp. nov.): suffruticosa, e basi ramosissima; ramis abbreviatis congestis conferte foliosis in pedunculum longissimum simplicem nudum monocephalum desinentibus; foliis 3–5-sectis, segmentis integerrimis vel 2–3-sectis lineari-filiformibus; ligulis nullis; acheniis subclavato-linearibus incurvis rugosis calvis. — Hills and dry banks of the San Pedro or Devil's River; July. Also abundant in the collection of 1851. — Stems six or eight inches high, woody or lignescent, very numerous and crowded, and extremely leafy, each terminated by a filiform naked peduncle of from six to ten inches in length. Leaves glabrous; the segments twelve to eighteen lines long, more slender than T. gracilis. Involucre nearly as in the last-named species, but smaller, two or three lines long, in fruit three or four lines broad, shorter than the flowers. Paleæ of the receptacle one-nerved, carinate, deciduous with the achenia, but not adhering to them as in the other species. Achenia slender, almost terete, tuberculate-rugose when mature, especially on the back, the summit terminated with an obscurely coroniform epigynous disk, but destitute of a pappus. In every other respect it is truly a Thelesperma; plainly showing that in this subtribe, as well as in the Heleniеæ, in which numerous similar cases occur, the absence of a pappus is not of generic importance, when there is a complete accordance in other characters.

345. Bidens bipinnata, *Linn.; Torr. & Gray, Fl.* 2. *p.* 354. Fields at Isletta, New Mexico; Oct.*

346. B. tenuisecta, *Gray, Pl. Fendl. p.* 86. Hill-sides near the Pass of the Limpia; Aug.

347. B. chrysanthemoides, *Michx.; Torr. & Gray, l. c.* In the San Felipe Creek, Western Texas; Nov.

348. Heterospermum dicranocarpum (sp. nov.): subglabrum; caule erecto apice corymboso-paniculato; foliis 3–5-sectis, segmentis filiformibus; pedicellis gra-

* Bidens Beckii, *Torr.*, belongs to the section *Psilocarpæa.* The only mature fruit which I have seen was communicated by Dr. Engelmann, from St. Louis. The teretish linear achenia are about half an inch long, obtusely angled, smooth, bearing from four to six rigid and divergent awns, which are about an inch long, pungent, retrorsely barbed only near the apex.

cilibus; acheniis extimis lineari-oblongis teretiusculis intus verrucoso-tuberculatis breviter biaristatis, interioribus lineari-subulatis lævibus sensim longioribus et longius aristatis, centrali persistente majore; aristis subulatis persistentibus lævissimis divergentibus vel recurvis. — Plains between the Guadalupe Mountains and the Pecos; Oct. — The specimens are wholly in fruit, the involucres, paleæ, &c. fallen, and for the most part only single achenia remaining, persistent at the extremity of the slender pedicels. Of the loose achenia those which were doubtless exterior, or belonging to the ray-flowers, are scarcely two lines long, linear-oblong, rather thicker at the truncate apex, slightly obcompressed, smooth on the back (minutely striate and scabrous), wingless, but the thickened edges incurved against a thick ridge of the inner face, both the edges and ridge tuberculate-verrucose: they are terminated by two very short divaricate and uncinate recurved rigid awns, which are not at all barbed, and are perfectly persistent. The disk achenia are successively more narrow and slender, three to five lines long, smooth, not margined, the longer ones rostrately subulate, bearing a pair of rigid and subulate awns which are divergent, but not uncinate, rigid and subulate, smooth, not at all barbed or hispid. — Flowering specimens are needed; but I am confident that the plant is a Heterospermum.

349. H. TAGETINUM, *Gray, Pl. Fendl. p.* 87. Valley in the mountains 35 miles east of El Paso; Oct. — I fear that this may not be sufficiently distinct from H. pinnatum. It includes Gregg's No. 395, from Cohahuila, and Coulter's No. 377. A specimen from New Granada has the achenia, all but the central sterile ones, equally awnless. — The awns are articulated and deciduous, as they are also in H. pinnatum itself.*

* Electra, *DC.* is to Coreopsis what Delucia, *DC.* is to Bidens. The central achenia are more or less infertile, and in one instance I detected on them, in an authentic specimen of E. Mexicana, a pair of small subulate awns, showing an affinity to Heterospermum. It is still more allied to a genus which has hitherto been very obscure, namely, Guardiola, *Humb. & Bonpl.;* from which the exterior bracteal involucre, the yellow flowers with large rays, those of the disk more hermaphrodite, and especially the glabrous filaments, serve to distinguish it. We appear to have two species, which, however, are not as well marked as could be desired, viz.: —

1. ELECTRA MEXICANA (*DC.! Prodr.* 5. *p.* 630): glaberrima; foliis lato-lanceolatis utrinque acuminatis acute serratis; tubulo ligularum gracili glabro.

2. E. GALEOTTII (sp. nov.): pubescens, nunc glabrata; foliis oblongo-lanceolatis vel ovato-lanceolatis grosse parceque serratis inferioribus interdum trisectis; ligulis magnis tubulo pl. m. hirto. — Cordilleras of Mexico, *Galeotti*, No. 2086, 2087. Mexico, *Mr. Bates*, *Mr. Parkinson* (in herb. Hook.).

In both, the achenia are more or less emarginate at the apex; the exterior oval or elliptical; the interior successively longer and narrower, very flat, and apparently not maturing the seed. — Guardiola is the same genus as Tulocarpus of Hooker and Arnott. I append a revised character: —

GUARDIOLA, *Humb. & Bonpl.*

Capitulum pluriflorum heterogamum; ligulis 1 – 5 fœmineis parvis; fl. disci 5 – 20 hermaphroditis abortu sterilibus. Involucrum nudum (ecalyculatum), tubulosum vel campanulatum, duplex; exterius triphyllum subherbaceum; interius e squamis 3 – 5 scariosis paleis receptaculi referentibus. Receptaculum planum, paleis oblongo-linearibus inter flores onustum. Flores radii et præsertim disci tubo prælongo filiformi; ligula oblonga 2 – 3-dentata discum paullo superante; disci limbo campanulato profunde 5-fido, lobis linearibus. Filamenta villosissima! Styli rami fl. disci elongati, subulato-filiformes, hispidi. Achenia radii oblonga leviter obcompressa basi dorso squamulæ brevi carnosulæ accreta! Ovaria disci inania.

350. Oligogyne Tampicana, *DC. Prodr.* 5. *p.* 629, *& Deless. Ic. Sel.* 4. *t.* 38; *Gray, Pl. Fendl. p.* 87, *adnot.* On the Rio Grande, Texas. — Besides the two strong awns, as figured in the work above cited, there are commonly two or three shorter intermediate ones. Many of the heads are subsessile. The genus appears to be scarcely distinct from Blainvillea, on the one hand; while, on the other, the want of laciniate wings to the ray-achenia and the shorter appendages to the style alone distinguish it from Synedrella.

351. Sanvitalia Aberti, *Gray, Pl. Fendl. p.* 87. Damp valleys near the Rio Grande below El Paso; Sept. "Flowers white. Plant two or three feet high." The specimens are less than a foot high, from an annual root. Leaves sometimes linear. The fruit as described in *Pl. Fendl.*, from Lieut. Abert's specimens. The disk is greenish; the paleæ lanceolate, cuspidate, rather rigid, and longer than the flowers. Ligules at most two lines long. The species is remarkable for the extremely short and conical awns to the ray-achenia.*

Pappus nullus. — Herbæ glabræ ramosæ (basi suffrutescentes?); foliis oppositis petiolatis ovato-lanceolatis subtriplinerviis dentibus callosis serrulatis; capitulis terminalibus corymbosis; floribus albis.

1. G. Mexicana: foliis lanceolato-ovatis basi subcuneatis truncatisve triplinerviis serratis, serraturis appressis; involucro oblongo-campanulato, squamis oblongis obtusis; ligulis 3–5, tubo inferne villoso, fl. disci 10–15. — G. Mexicana, *Humb. & Bonpl.! Pl. Æq.* 1. *p.* 144. *t.* 41; *H. B. K. Nov. Gen. & Sp.* 4. *p.* 247. — Mexico; province of Michoacan, *Humboldt.* — The specimen in the herbarium of the Paris Museum is poor and young. Heads three or four lines long.

2. G. atriplicifolia (sp. nov.): foliis triangulato-lanceolatis hastatisve acuminatis basi 5–7-nerviis argute serratis, serratulis subulatis inferioribus paucis laciniato-elongatis patentibus; involucro breviter campanulato, squamis late ovalibus abrupte mucronato-acuminatis; ligulis 3 (–5?) tubo glabro; fl. disci 15–20. — Morelia, Mexico, *Galeotti*, No. 2418 (v. sp. in Mus. Par.); at an elevation of 7,000 feet. — The root is annual. The flowers are stated by the collector to be white. The tube of the ray-corolla is scarcely longer than the broadly oval nine-nerved ligule. Achenium as in the next species, but perfectly glabrous.

3. G. Tulocarpus: foliis oblongo-lanceolatis basi obtusis vel acutiusculis calloso-serrulatis; capitulis fasciculato-confertis; involucro cylindrico angusto, squamis lineari-oblongis acutis; ligula solitaria tubo glaberrimo; fl. disci 4–5. — Tulocarpus Mexicanus, *Hook. & Arn. Bot. Voy. Beech. p.* 298, *t.* 63. — Tepic, Mexico, *Lay & Collie.* Between the city of Mexico and Mazatlan, *Gregg.* — Probably No. 2407 of Galeotti's collection from Zimapan, which I have seen in the Paris herbarium, belongs to this species. Involucre three lines long, less than a line wide, looking like that of a Tagetes or a Stevia. Achenia minutely hairy under a lens. The flowers are stated by Hooker and Arnott to be yellow, but Dr. Gregg noted that they are white. The styles I find to be deeply two-cleft.

* Sanvitalia procumbens, *Lam.* is inadvertently described by De Candolle as having the *exterior* (instead of the *inner*) disk-achenia winged and aristellate. The outer ones are wingless and exaristate, as stated in the generic character and as figured by Cavanilles, &c.

S. ocymoides, *DC.* requires to be again examined. An authentic (unless misplaced) specimen of Berlandier's plant, which I possess, has the ligules by no means "very small," but longer than the awns of the ray-achenia, the exterior disk-achenia roughened and awnless, the inner ones surrounded with a continuous ciliate wing and mostly biaristellate; — indeed, it is not to be distinguished from S. procumbens.

S. acinifolia, *DC.* was gathered by Gregg near San Luis Potosi (No. 577), but with the innermost achenia slightly, if at all, winged.

S. tragiæfolia, *DC.*, which has more hispid and rough foliage than the others, and very short ligules, only half the length of the conspicuous awns, was gathered at Walnut Springs, near Monterey, by Dr.

352. Ximenesia encelioides, *Cav.* δ. cana, *DC. Prodr.* 5. *p.* 627; *Gray, Pl. Fendl. p.* 87. On the Rio Grande, Texas; and from the Limpia to the Rio Grande, New Mexico. There is a very dwarf state in the collection of 1851.

† Verbesina Virginica, *Linn.* var. *β. Torr. & Gray, Fl.* 2. *p.* 359. V. polycephala, *DC.! Prodr.* 5. *p.* 616. Western Texas. — V. microptera, *DC.* is, I believe, another form of V. Virginica.

353. Zexmenia brevifolia (sp. nov.): fruticosa, scabro-hispidula; ramis subherbaceis gracilibus pedunculo nudo monocephalo terminatis; foliis ovalibus ovatisve obtusis haud venosis subintegerrimis petiolatis; involucro subtriseriali, squamis exterioribus apice foliaceo ovato patulo instructis; acheniis (immaturis) exalatis angulis acutissimis dense ciliolatis; paleolis pappi inter aristas pl. m. coroniformi-concretis. — Rocky banks of a mountain stream between the Limpia and the Rio Grande, New Mexico, Sept. (Hills near Messilas, Northern Mexico, *Gregg*, No. 534.) — A shrubby or suffruticose, branching plant, two or three feet high; the branches slender. Leaves opposite, from half to three quarters of an inch long; the petioles two or three lines long. Heads three or four lines long. Exterior scales of the involucre more or less foliaceous and lax; the others appressed, inappendiculate, oblong, the innermost lanceolate and acute, a little shorter than the disk. Rays 5 to 8, small. Paleæ of the receptacle lanceolate, attenuate-acuminate, conduplicate, a little shorter than the disk-flowers. Achenia (immature) glabrous except the ciliolate very acute angles; those of the ray triquetrous and 1 – 3-awned, of the disk compressed and unequally 2-awned. Between the awns are several lanceolate or oblong and pectinate-incised squamellæ or paleæ, which are irregularly more or less united into a crown, or sometimes almost distinct. The ripe achenia are probably more or less winged. — A manifest congener of the next, and of Lipochæta strigosa, *DC.*

354. Z. Texana: strigoso-hispida; caulibus e basi suffrutescente erectis gracilibus; foliis rhombeo-lanceolatis seu ovato-lanceolatis basi acuta sessilibus parce dentatis nunc subhastato-lobatis, ramealibus lanceolatis integriusculis; pedunculis elongatis nudis monocephalis; involucro biseriali, squamis exterioribus lanceolatis subfoliaceis interiores oblongas æquantibus; acheniis pl. m. obcordato-alatis, radialibus glabris, disci appresse hirsutis; aristis basi cum coronula paleacea calyciformi concretis. — Lipochæta (Catomenia) Texana, *Torr. & Gray, Fl.* 2. *p.* 357; *Gray, Pl. Lindh.* 2. *p.* 229. Prairies near New Braunfels, Texas. — The achenia vary greatly as to the wing, even in the same capitulum, just as is the case in species of Verbesina and Actinomeris. Those of the ray are obcompressed-triangular,

Gregg (No. 163). Many of the disk-achenia are more or less two-toothed at the apex, or aristulate, as indeed they are, though obscurely, in De Candolle's plant from Berlandier. Of all the species, this is the one to which the phrase " ligulæ minimæ " is most applicable. These are ovate, obtuse, 2 – 3-denticulate at the apex. — Allied to this species is

Sanvitalia angustifolia (*Engelm. in coll. Gregg.*): caulibus diffusis; foliis lanceolatis strigoso-hispidis; ligulis parvis aristis brevioribus acutiusculis setulis 3 – 5barbato-apiculatis; acheniis disci exterioribus fere exalatis subcalvis, interioribus anguste alatis biaristellatis. — Highlands near Buena Vista, Mexico, *Gregg* (No. 274).

sometimes three-winged, but often only two-winged, the wings sometimes half as wide as the body of the achenium. The disk-achenia are sometimes almost as broadly winged, sometimes with the wings very narrow or obsolete, except at the apex, where they project in an obcordate form: they are separated from the pappus by a narrow neck or sinus. The awns vary greatly in length, and are occasionally little longer than the firm, calyculate, lacerate crown with which their bases are confluent, but they are commonly elongated, at least one of them. Except for the awns and the wings of the achenium (which appear also in W. helianthoides, *H. B. K.*), the plant would evidently fall into Wedelia; indeed, its whole aspect is that of Wedelia hispida, *H. B. K.* — This species and the preceding, with Lipochæta strigosa, *DC.*, so perfectly accord with the generic characters of Zexmenia of Llave and Lexarza (doubtfully referred by De Candolle to his Lipochæta) that I feel obliged to restore that genus; the more so, as they are apparently not congeneric with the Sandwich Island species, for which in strictness the name should be retained, the oldest species being a Lipotriche of Lessing.* Moreover, Lipochæta umbellata, *DC.*, which might claim the generic name from its being the species figured in Delessert's Icones, is surely a congener of De Candolle's Lasianthæa, notwithstanding its smaller capitula. Again, there are some species closely allied to Lasianthæa helianthoides, but with a pauciserial involucre, which would also accord with the character of Zexmenia. Since the genus which is to comprise these plants must needs be remodelled and extended, it is best to revive at once the oldest name.†

* For these, however, Nuttall has established his genus Microchæta (which has priority over Microchæte of Bentham); and Macræa, *Hook. fil.* is probably not distinct. They are very closely related to Wollastonia, *DC.*, and perhaps not to be separated from that genus. At least Nuttall's Microchæta procumbens and M. strigulosa (Wollastonia procumbens and W. strigulosa) are genuine species of Wollastonia.

† ZEXMENIA (LASIANTHÆA) HELIANTHOIDES: foliis ovato-oblongis ovatisve basi nunc subcordatis breviter petiolatis subserratis reticulatis supra bullatis strigilloso-puberis subtus cauleque velutino-villosis; capitulis 5–7 in umbellam foliis fulcrantem congestis singulis breviter pedunculatis; involucro 4-seriali, squamis omnibus ovatis appressis inappendiculatis; ligulis aureis; lobis corollæ intus barbatis; filamentis villosulis; paleis intermediis pappi conspicuis inter se et cum aristis (deorsum alis confluentibus) coalitis. — Lasianthus helianthoides, *Zucc. in herb. Acad. Monac.* Lasianthæa helianthoides, *DC. Prodr.* 5. *p.* 608. — Mexico, *Karwinski;* and near Cuernavaca (Valladolid), &c., *Ghiesbrecht* (v. sp. in herb. Par. No. 379, 150). — Heads three quarters of an inch long, on stout peduncles; involucre over half an inch in diameter. Paleæ of the receptacle shorter than the involucre, much shorter than the long and slender disk-corollas.

Z. (LASIANTHÆA) GREGGII (sp. nov.): foliis ovato-lanceolatis acuminatis serrulatis reticulatis scabris basi cordata sessilibus, floralibus parvulis; capitulis 3 umbellatim dispositis pedunculis dimidio terve brevioribus; involucro late campanulato triseriali, squamis omnibus ovatis inappendiculatis appressis; ligulis auriantiacis brevissimis; corollæ disci lobis puberis; filamentis glabris; pappi paleis intermediis conspicuis inter se et cum aristis basi in alam ciliatam extensis coalitis. — Between the city of Mexico and Mazatlan, *Gregg.* — Heads half an inch in length and breadth; the involucre much like that of the preceding. Rays, in the specimen, not longer than the disk-flowers. Pappus as in Z. helianthoides.

Z. (LASIANTHÆA) GHIESBRECHTII (sp. nov.): foliis ovato-lanceolatis acuminatis serrulatis reticulatis submembranaceis hirtulo-scabris basi subcordatis breviter petiolatis; pedunculis solitariis ternisve foliis summis duplo capitulo pluries longioribus superne incrassatis; involucro hemisphærico triseriali, squamis inappendiculatis exterioribus rotundo-ovatis appressis; ligulis (ut videtur aureis) disco paullo longioribus; pappi

355. Flourensia cernua, *DC. Prodr.* 5. *p.* 593. Prairies, east of El Paso; Sept.: also in the coll. of 1851. (Near Saltillo, *Gregg*, No. 421.) — A much-branched, resiniferous shrub, from three to five feet high.

356. Flaveria Contrayerba, *Pers.; DC. Prodr.* 5. *p.* 635. Rio Grande, Texas and New Mexico.

357. F. chloræfolia, *Gray, Pl. Fendl. p.* 88, *adnot.* Saline marshes near Presidio de Rio Grande. — Plant two or three feet high.

358. Dysodia chrysanthemoides, *Lagasca; DC. Prodr.* 5. *p.* 640; *Gray, Pl. Fendl. p.* 88. D. fastigiata, *DC.! l. c., excl. syn.* Mountain valleys, between the Limpia and El Paso; Sept. — The specimens belong to the form with the pappus shorter than the achenium, and not longer than the disk-corolla. De Candolle's D. fastigiata, described from Alaman's Mexican specimens, is only D. chrysanthemoides with a rather longer pappus. But the Bœbera fastigiata, *H. B. K.* (a name that De Candolle has inadvertently omitted to cite) is a different species, of which Humboldt and Bonpland's specimens accord so well with Lagasca's description of his D. tagetiflora, that I restore that name, completing the character from the specimens preserved in the herbarium of the Paris Museum.* — I should likewise refer

squamellis inter aristas graciles parvis. — Mexico, *Ghiesbrecht*, No. 385. Var. β. foliis membranaceis vix scabris basi plerumque acutis longius petiolatis. — Mexico, *Ghiesbrecht*, No. 387 (v. sp. in herb. Mus. Par.). — On the ticket the plant is said to grow in a warm region, and to be "arborescent." Peduncles stout, three or four inches long. Involucre two thirds of an inch in diameter. Flowers smaller than those of Z. helianthoides, but very similar. The awns of the pappus are more slender, and the crown of paleolæ minute.

Z. (Lasianthæa) crocea (sp. nov.): foliis oblongo-ovatis acuminatis serrulatis reticulatis basi subcordatis brevissime petiolatis canescenti-villosis subtus mollissimis; pedunculis solitariis elongatis monocephalis hirsutis; involucro hemisphærico biseriali, squamis exterioribus lanceolato-oblongis apice foliaceo laxo interiores ovales subsuperantibus; ligulis aurantiacis vel flammeis discum paullo excedentibus; aristis pappi basi dilatatis, squamellis intermediis minutis. — Mexico, *Ghiesbrecht* (No. 387, in herb. Mus. Par.). — Head half an inch or more in length, on a peduncle of three or four inches long. Involucre strictly biserial, much as in Z. Texana; the short and narrow chaff of the receptacle, the slender disk-corollas with a very short limb, and the long exserted anthers, &c. as in the foregoing species, of which it is a true congener.

Z. (Lasianthæa) Seemannii (sp. nov.): foliis oblongo-lanceolatis vel sublinearibus obtusis vel acutiusculis basi in petiolum brevem angustatis subintegerrimis coriaceis parallele triplinerviis ramis ramulisque angulatis scabris; capitulis axillaribus subsolitariis et terminalibus umbellatis pedunculis longioribus; involucro cylindraceo pluriseriali, squamis oblongis chartaceis appressis appendice brevissima abrupta subherbacea obtusissima terminatis, exterioribus seriatim brevioribus; ligulis flavis elongatis; pappi paleolis parvulis aristis basi paleaceo-dilatatis confluentibus. — Cerro de Pinal, N. W. Mexico, *Seemann* (herb. Hook.). — Stem paniculately branched; the branches slender, erect, scabrous with a minute and closely appressed strigulose pubescence. Leaves somewhat shining, two to four inches long, from three to seven lines wide, glabrate beneath, hispid-scabrous above. Heads four or five together in a sessile terminal umbel or fascicle, and subsolitary in the upper axils. Involucre cylindrical or subclavate-oblong, nearly half an inch long, but narrow; the slightly squarrose tips of the inner scales rounded and partly separated by a notch from the appressed body of the scale. Ligules six or eight, about five lines long. Disk-corollas, paleæ of the receptacle, &c., much as in the several preceding species. — Apparently related to the discoid Lipochæta fasciculata, *DC.*, but a remarkably distinct species.

* Dysodia tagetiflora (*Lag. Nov. Gen. & Sp. p.* 29): caule erecto; ramis fastigiatis pedunculo nudo apice incrassato terminatis; foliis villosulis pinnatipartitis, segmentis linearibus argute serratis; involucro

to D. chrysanthemoides No. 432 of Coulter's Mexican collection, Gregg's No. 540, from Saltillo, and a plant of Galeotti's collection, without a number, which, having coarser segments to the leaves, more dilated at their apex, are probably D. pubescens, *Lagasca*, *DC.*

359. Hymenatherum (Aciphyllæa) acerosum: fruticulosum, glabrum; ramis ad apicem usque foliosis capitulo solitario subsessili terminatis; foliis oppositis (raro alternis) et in axillis fasciculatis acerosis integerrimis; involucro cylindraceo; pappo e paleis 18–20 angustis in aristas setasve scabras inæquales 3–5-partitis. — Dysodia? (Aciphyllæa) acerosa, *DC.! Prodr.* 5. *p.* 641. Aciphyllæa acerosa, *Gray*, *Pl. Fendl. p.* 91, *adnot.* Calcareous hills of the San Felipe: also on the Rio Grande, Texas; July–Sept. — Two or three species of Hymenatherum now known to me having as many as eighteen or twenty paleæ to the pappus, and one having some of the paleæ cleft into from three to five setæ or setose teeth, I cannot avoid referring the present plant to this genus, with which it accords in habit much better than with Dysodia. A revision of the genus, as I should now receive it, is appended.*

octophyllo (squamis obovato-oblongis valde carinatis) bracteis 6–8 lineari-subulatis integerrimis cincto; ligulis obovatis (aurantiacis?) exsertis; pappi setis in phalanges 8–10 alternas dimidio breviores basi tantum paleaceo-concretis. — Bœbera fastigiata, *H. B. K.! Nov. Gen. & Sp.* 4. *p.* 198. B. tagetiflora, *Spreng.*

* HYMENATHERUM, *Cass.*

Capitulum multiflorum heterogamum; ligulis fœmineis. Involucrum turbinatum vel campanulatum, e squamis 10–15 fere ad apicem cupulato-concretis gamophyllum, basi bracteatum seu ebracteatum. Receptaculum planum, nudum vel subalveolatum. Styli rami fl. disci cono brevissimo obtuso capitellati. Achenia gracilia, striata, nunc subangulata. Pappus e paleis 10–20 nunc omnibus nunc alternis trifidis (raro 5-fidis), lobis setiformibus inæqualibus vel lateralibus dentiformibus. Herbæ humiles vel suffruticuli; ramis monocephalis; foliis angustis involucrisque grosse glandulosis; floribus flavis siccate nunc viridescentibus.

Hymenatherum, *Cass. Bull. Philom.* 1817, 1818, *& Dict. Sci. Nat.* 22. *p.* 313.

Hymenatherum (excl. § 2), Aciphyllæa § ? Dysodiæ, & Gnaphalopsis, *DC. Prodr.*

Hymenatherum & Aciphyllæa, *Gray*, *Pl. Fendl. p.* 88, 91, *adnot.*

§ 1. Aciphyllæa. Pappus e paleis 18–20 (conformibus vel alternis minoribus) profunde trifidis, lobis setiformibus, lateralibus sæpius 2–3-fidis. Achenia teretia multistriata. — Fruticulus ericoideus glaber; foliis acerosis integerrimis plerisque oppositis; capitulis ramulos foliosos terminantibus sessilibus.

1. H. acerosum: vide supra. Dysodia? (Aciphyllæa) acerosa, *DC. Prodr.* 5. *p.* 641.

§ 2. Dysodiopsis. Pappus 10-paleaceus; paleis conformibus rigidis, aut submuticis aut triaristatis. Achenia 4–5-angulata. — Herbæ perennes? glabræ, Dysodiæ facie; foliis superioribus vel omnibus alternis linearibus integerrimis seu laciniatis haud pinnatipartitis; capitulis pedunculatis pl. m. bracteatis.

2. H. tagetoides, *Gray*, *Pl. Fendl. l. c.* Vide p. 116.

3. H. Wrightii, *Gray*, *Pl. Fendl. l. c.* Vide p. 116.

§ 3. Hymenatherum verum. Pappus 10–20-paleaceus; paleis 1–3-aristatis vel alternis muticis. Achenia subteretia. — Herbæ annuæ seu perennes, nunc suffruticuli, humiles, glabræ vel pubescentes; foliis pinnatipartitis inferioribus tantum oppositis, lobis filiformibus subulatisve integerrimis; capitulis pedunculatis basi haud vel parce bracteatis.

* *Species annuæ; foliis muticis haud rigidis; pedunculis breviusculis bracteolis subulatis instructis.*

4. H. bœberoides (sp. nov.): glabrum, diffusum; foliis pinnati- (7-) partitis, lobis filiformi-linearibus breviusculis; pedunculis subcorymbosis breviusculis multibracteatis; involucro hemisphærico ebracteato;

† H. (DYSODIOPSIS) TAGETOIDES, *Gray, Pl. Fendl. p.* 88. Dysodia tagetoides, *Torr. & Gray, Fl.* 2. *p.* 361. Western Texas. — This and the next, with the characters of Hymenatherum, have the aspect of Dysodia.

† H. (DYSODIOPSIS) WRIGHTII, *Gray, Pl. Fendl. l. c., & Pl. Lindh.* 2. *p.* 229. Near Austin, Texas.

360, partim. H. POLYCHÆTUM (sp. nov.): annum, glabrum; caule diffuse ramoso; foliis pinnatipartitis, lobis 9 – 13 filiformibus muticis grosse glandulosis; pedunculis subcorymbosis brevibus parce setaceo-bracteatis; involucro turbinato ebracteato; pappo corolla disci paullo breviore e paleis 18 – 20 linearibus subconformibus bi-

pappo e paleis brevibus obovatis 10 – 16, quarum 5 – 8 obcordato-bifidis arista setiformi e sinu exserente corollam disci æquante lobis obtusis muticis, alternis paullo minoribus obtusissimis integerrimis. — Mexico, *Mr. Bates.* — This I possess from Sir William Hooker's duplicates. It much resembles the next, but is a coarser plant, with larger heads, and still more of the aspect of a Dysodia. The heads are a quarter of an inch in diameter, very many-flowered; the rays ten or twelve, obovate, nearly three lines long. The paleæ of the pappus are broader in proportion and the lobes of the aristate ones more rounded than in any other species.

5. H. NEÆI (*DC. l. c.*): glabrum; caulibus diffusis apice ramosis; pedunculis brevibus parce bracteatis; foliis pinnatipartitis, lobis filiformibus; involucro campanulato ebracteato; pappo e paleis 10 oblongis bifidis cum arista setiformi corollam adæquante e sinu exserente, lobis acutis muticis. — I have taken the character of the pappus, &c. from a fragment of a Mexican specimen (collected by Mr. Tate), intermixed with the following, which accords with De Candolle's character (except that there are sometimes one or two small additional paleæ, which are awnless and entire). My notes upon his specimen are not sufficient absolutely to identify it with this species. But I have little doubt that the plant of Neé came from Mexico, not from Chili.

7. H. DIFFUSUM (sp. nov.): glabrum; caulibus diffusis vel decumbentibus; foliis pinnatipartitis, lobis filiformibus; pedunculis subcorymbosis minutim parceque bracteatis; involucro hemisphærico seu turbinato ebracteato; pappo e paleis anguste oblongis 10 apice breviter bisetosis et longe uniaristatis, atque 5 – 7 multo minoribus subulatis vel subulato-aristulatis integerrimis. — Mexico, *Mr. Tate* (in herb. Hook.). — Plant with the aspect, foliage, &c. of the preceding; the heads about the same size (two and a half lines in diameter), a little larger than in the following species. Awns about the length of the disk-corolla.

8. H. POLYCHÆTUM, sp. nov. Vide supra, No. 360.

* * *Species perennes vel suffruticulosæ; foliorum lobis rigidulis sæpius setoso-apiculatis; pedunculis elongatis fere nudis.*

+ Pappi paleæ 10, omnes subconformes pl. m. aristatæ.

9. H. TENUIFOLIUM, *Cass.* H. tenuilobum, *DC. l. c.* Vide p. 118.

10. H. BELENIDIUM, *DC. Prodr.* 7. *p.* 292. H. Candolleanum, *Hook. & Arn. Jour. Bot.* 3. *p.* 320.

+ + Pappi paleæ 5 uniaristatæ, et 5 alternæ breviores muticæ.

11. H. HARTWEGI. H. Berlandieri, *Benth. Pl. Hartw., non DC.* Vide p. 117.

12. H. PENTACHÆTUM, *DC.* H. Berlandieri, *DC.* Vide p. 117.

13. H. n. sp.? Texas, *Trécul;* a plant with nearly the pappus of H. pentachætum, but with different foliage and habit. My specimen is not sufficient for proper determination.

§ 4. GNAPHALOPSIS. Pappus, etc. ut in Hymenatheris veris subsect. * * + +. Herba annua vel subperennis, undique floccoso-lanosissima; foliis spathulatis plerumque alternis integerrimis; capitulis solitariis sessilibus.

14. H. GNAPHALOPSIS, *Gray, Pl. Fendl. p.* 90 (gnaphalodes) *& p.* 115, *adnot.* Gnaphalopsis micropoides, *DC.! Prodr.* 7. *p.* 258.

H. Kunthii, *Less.* is Lasthenia obtusifolia, *Cassini.*

Tagetes Wislizeni, *Gray, Pl. Fendl. p.* 92, is the same as T. multiseta, *DC.*, with the lobes of the leaves scarcely setose.

setosis (raro 3 – 4-setosis) et uniaristatis. — Prairies at the Pass of the Limpia; Aug. — Stem much branched from the base, a span high, leafy, the branches somewhat fastigiate. Leaves an inch or less in length, not rigid, perfectly glabrous; the lobes two to four lines long, not setigerous or pointed, filiform, as well as the rhachis. Peduncles about an inch long. Involucre two lines long. Rays about 10, oblong. Paleæ of the pappus all similar, except that about five of them are smaller, and one or two often reduced to a subulate or setaceous rudiment. The capillary awn of the larger ones is a little shorter than the disk-corolla; the lateral setiform lobes are as slender, but about one third the length of the awn, sometimes rather longer, when there are occasionally two minute teeth below them. This and H. tenuifolium induce me to refer Aciphyllæa acerosa to Hymenatherum. — Mixed with this in the distribution were some specimens of Lowellia aurea, q. v. p. 118.

361. H. PENTACHÆTUM (*DC.! Prodr.* 5. *p.* 642): caulibus suffruticulosis cæspitosis depressis; ramis abbreviatis conferte foliosis pedunculos solitarios elongatos parce setaceo-bracteolatos gerentibus; foliis cinereo-puberulis glabratisve pinnatipartitis, lobis 5 – 9 acerosis rigidis; involucro campanulato fere ebracteato; pappo e paleis 5 brevibus obovato-oblongis obtusis truncatisve muticis, et 5 iis alternis majoribus oblongo-lanceolatis in aristam breve corollam disci adæquantem productis, lobis lateralibus brevissimis subulatis aut subnullis. — *Gray, Pl. Fendl. p.* 90, *adnot.* Hills of the San Pedro River; Aug. — De Candolle overlooked the five unawned paleæ of the pappus, which exist in all specimens, requiring therefore a modification of the character, if, as I prefer, we retain this name instead of H. Berlandieri, *DC.*, which is only a more glabrate and slender variety of the same species. Rarely I find one or two of the larger paleæ scarcely awned, or replaced by a truncate palea. The awn is usually about the length of the palea that bears it.

362. H. PENTACHÆTUM, *DC.*, var. foliis glabellis nitidulis; pedunculis gracilioribus. H. Berlandieri, *DC.! l. c.* — On the Rio Frio and Rio Grande, Texas. — The involucre is rather more turbinate in this more slender variety. This is just the same as one of the specimens of De Candolle's H. Berlandieri: the other (of which the corresponding specimens in Hooker's herbarium are marked as gathered between Laredo and Bexar, therefore in Texas) is merely a still smoother and more slender state of the species, viz.: —

363. H. PENTACHÆTUM, *DC.*, var. graciliore, foliis nitidulis fere glabris. H. Berlandieri, *DC. l. c.* — Western borders of Texas.

364. H. HARTWEGI: caulibus vix suffruticulosis erectis laxe ramosis; pedunculis gracilibus nudis fastigiato-subcorymbosis; foliis glabellis pinnatipartitis, lobis 3 – 5 filiformi-acerosis rigidulis; involucro campanulato fere ebracteato; pappo e paleis 5 obovatis muticis et 5 alternis duplo longioribus oblongis in aristam corollam disci subæquantem productis, lobis lateralibus brevissimis acutis. — H. Berlandieri, *Benth. Pl. Hartw. p.* 18, non *DC.* Hills near El Paso, Sept. — The stems and branches are more sparsely leafy, the peduncles more numerous and clustered, and the lobes of the leaves fewer, and proportionally longer, than in H. pentachætum. In Hartweg's plant, the small heads are narrow, the involucre scarcely above a line in

diameter; in ours, the involucre is campanulate and twice as broad; but I notice no further difference.

365. H. TENUIFOLIUM (*Cass. l. c.*): caulibus herbaceis gracilibus duriusculis laxe ramosis; pedunculis elongatis nudis; foliis pinnatipartitis scabro-puberulis, lobis subulatis brevibus junioribus setigero-mucronatis; involucro turbinato basi breviter parceque bracteato; pappo corollam disci æquante e paleis 10 conformibus oblongis seu lineari-oblongis setoso-triaristatis, aristulis lateralibus brevioribus, vel uniaristatis cum lobis lateralibus 2 (nunc 3–4) setaceis. — H. tenuilobum, *DC. Prodr.* 5. *p.* 642. Hills and bluffs of the San Felipe, and on the Rio Grande, Texas; July. — I have cultivated this from seeds sent by Mr. Wright from the Rio Grande; and it proved to be a diffusely branched perennial, or at least to continue two or three years, although the root in indigenous specimens seems to be that of an annual. Besides the pappus, which so well distinguishes it, the stems are more slender and elongated than in any of the foregoing, sometimes a foot long, the branches terminated by nearly naked peduncles of three or four inches in length; and the lobes of the leaves (cinereous-puberulent in the wild plant) are short and subulate, only one or two lines in length. Involucre three lines long, smooth, subtended by three or four small and subulate appressed bracts. Rays oblong. Paleæ of the pappus all alike, except that a few are rather smaller, cleft into one or sometimes two capillary awns and two short lateral setæ or setaceous teeth, and occasionally showing a pair of minute additional teeth. Sometimes the principal lateral lobes are merely setaceous or subulate teeth; often one or both of them are as slender as the proper awn, and of half or two thirds of its length. — I was enabled to inspect the original of Cassini's Hymenatherum tenuifolium in the Jussiæan herbarium, where it is marked "Chili? *Neé;* donné par M. Thibaud in 1809." I have little doubt that it came from Northern Mexico, instead of Chili, and that it is identical with the species here described. At least its pappus accords very well with this species, and with no other known to me.

366. H. GNAPHALOPSIS, *Gray, Pl. Fendl. p.* 90 *&* 115. Gnaphalopsis micropoides, *DC.! Prodr.* 7. *p.* 258. Calcareous hills of the San Felipe, and of the Rio Grande, Texas; July. — This singular plant, with the aspect of a Micropus or Gnaphalium, has all the characters of a genuine Hymenatherum. The thick woolly covering conceals the sparse Tagetineous glands of the leaves and involucre. The specimens received by De Candolle from Berlandier were very imperfect.

360, partim. LOWELLIA AUREA, *Gray, Pl. Fendl. p.* 91. Prairies at the Pass of the Limpia; Aug. — This plant has so exactly the aspect and floral structure of Hymenatherum polychætum (except as to the pappus, which was not noticed), that the specimens were mingled in the distribution. The specimens are rather smaller than Fendler's, and the truncate paleæ of the pappus are nine or ten in number, two of them, however, being occasionally more or less united. The pappus ought sufficiently to distinguish it from Hymenatherum, although there is some approach to it in the latter genus. But, on the other hand, the discovery of rays and pinnate leaves in Thymophylla, and the confirmation of Lagasca's character as to the pappus of T. setifolia, invalidates the characters of Lowellia.

367. THYMOPHYLLA GREGGII, *Gray, Pl. Fendl. p.* 91, *adnot.;* var. RADIATA. (TAB. VII.) — Rocky banks of streams east of the Guadalupe Mountains, and on the Pecos, Oct.; growing in large bunches. — Excepting the rays, which are uniformly present in these specimens, I find nothing to distinguish this from Dr. Gregg's plant, in which no rays are to be detected. No. 284 in Dr. Gregg's collection of 1848, 1849, from Buena Vista, also rayless, is T. setifolia, *Lagasca*, as also is No. 445 of Coulter's collection, from Zimapan. A flower of this species is added to Plate VII., to show the pappus of five or six separate paleæ, as characterized by Lagasca. In T. Greggii these are united into an entire, or sometimes slightly lobed, crown or cup. The lower leaves in both are pinnately 3 – 7-parted.

368. CHRYSACTINIA MEXICANA, *Gray, Pl. Fendl. p.* 93, *adnot.* Rocky banks of streams east of the Guadalupe Mountains; Oct. "Only a few specimens seen." Also in the collection of 1851. — The distinction between the divisions Tageteæ and Porophylleæ is annihilated by this plant, which has the rays of the former and the pilose pappus of the latter; as it likewise is by the genus Nicolletia, which has both a pilose and a paleaceous pappus in the same flowers. I subjoin the characters of the latter genus, now confirmed by the discovery of a second species, as they have been published only in a volume which is not so well known to botanists as it should be.*

369. POROPHYLLUM SCOPARIUM (sp. nov.): ramis e basi fruticosa erectis rigidis superne nudiusculis; foliis involutis filiformibus glandulis parcis vel nullis apice calloso-mucronatis; involucri campanulati brevi squamis 8 oblongo-linearibus concavis obtusis coriaceis viridibus parce glanduloso-lineatis; acheniis erostratis pube-

* NICOLLETIA, *Gray in Frem. Rep. Exped.* 2. *p.* 315.

Capitulum heterogamum multiflorum; ligulis fœmineis; corollis disci tubulosis æqualiter 5-dentatis. Involucrum campanulatum e squamis 8 – 12 membranaceis liberis. Receptaculum convexum favosum. Styli rami florum radii appendice angusta glabra, disci appendice elongata filiformi hispida, superati. Achenia lineari-elongata, subteretia, puberula. Pappus duplex; exterior e setis pluribus capillaribus denticulato-scabris; interior e paleis 5 lanceolatis hyalinis, nervo in aristam scabram producto. — Herbæ nanæ, annuæ, glabræ, odore haud ingratæ; foliis pinnatipartitis plerisque alternis, lobis sæpius grosse uniglandulosis; capitulis majusculis terminalibus; floribus rubicundis?

1. N. OCCIDENTALIS (*Gray, l. c.*): caule crassiusculo; foliis subcarnosis, lobis brevibus; involucro multifloro basi folioso-bracteato, squamis 10 – 12 oblongis subbiserialibus; pappi paleis lanceolatis e basi sensim angustatis arista brevi superatis. — Sandy banks of the Mohave River in the interior of California, *Fremont.*

2. N. EDWARDSII (sp. nov.): caule exili; lobis foliorum filiformibus elongatis; involucro anguste campanulato 25-floro basi squamulis ovato-subulatis parce bracteato, squamis 8 lanceolatis uniserialibus: pappi paleis ovato-lanceolatis arista gracili superatis. (TAB. VIII.) — Near Guajuquilla, Chihuahua, Mexico, Aug., *Dr. Edwards.* Described and figured from a specimen in Dr. Torrey's herbarium. — The plant is an annual, three inches high, with the heads only half as large as those of N. occidentalis. The flowers are said to be pink-colored. Each lobe of the leaves bears, towards its tip, a single very large gland; and there are a few in the scales of the involucre. The inner paleæ of the pappus are not unlike those of Adenophyllum; but in place of the five cuneiform and truncate paleæ we have a series of 20 to 40 very slender capillary bristles, as long as the paleæ, and somewhat clustered alternate with and exterior to them, so that on tearing off a palea two small clusters of bristles, one on each side of its base externally, are detached with it.

rulis. — Rocky banks of the San Pedro River, and mountains east of El Paso; July – Sept. — Stems one or two feet high from a woody base, rigid, loosely corymbose at the summit. Leaves thickish, 12 to 18 lines long, those of the flowering branches small and sparse. Heads barely half an inch long. Involucre not glaucous, nor colored except with one or two purplish glandular lines or spots. Pappus yellowish, exserted to twice the length of the involucre. The corollas appear to be yellow.

370. P. Greggii (sp. nov.): caulibus e basi suffruticosa adscendentibus rigidis; foliis coriaceis anguste linearibus mucronatis parce glandulosis; involucri campanulati squamis 5 – 7 oblongis obtusis vel acutiusculis planis viridulis glandulis oblongis notatis; acheniis erostratis pubescentibus. — Hills in the Pass of the Limpia; Aug. (Also Valley of Parras, Cohahuila, *Dr. Gregg.*) — Stems 8 to 12 inches high, simple or branched. Leaves one or two inches long, a line or less in width, often curved, rigid, more or less glandular. Heads two thirds of an inch long. Scales of the involucre five or six lines long, rather broad and flat, chartaceous, in Wright's specimens only five in number, while in Gregg's there are seven. The flowers in both are yellow. Achenia three lines long, rather shorter than the fulvous pappus.*

371. Agassizia suavis, *Gray & Engelm. Proceed. Amer. Acad.* 1. *p.* 50, *& Pl. Lindh.* 2. *p.* 229. Gaillardia simplex, *Scheele in Linnæa*, 22. *p.* 160. Rocky hills, Austin, Texas; May. — This is now in cultivation in the Cambridge Botanic Garden. The flowers exhale a fragrance much like that of the Heliotrope.

372. Gaillardia pinnatifida, *Torr. in Ann. Lyc. N. Y.* 2. *p.* 214; *Gray, Pl. Fendl. p.* 95. Valley of the Pecos, Limpia, and Rio Grande, New Mexico; Aug.

373. G. pulchella, *Foug.; Torr. & Gray, Fl.* 2. *p.* 366. Prairies, near Austin, Texas; May. — This is the same as Lindheimer's No. 103 of the second distribution, enumerated in *Pl. Lindh.* 2. *p.* 230, and there wrongly referred to G. picta.

374. G. pulchella, var. capitulis minoribus. Hills of the Rio Frio; June. Dr. Gregg found this to extend as far into Mexico as Reynosa and Monterey; and he also gathered what I take to be G. lanceolata at Saltillo.

375. Palafoxia Hookeriana, β. subradiata, *Torr. & Gray, Fl.* 2. *p.* 368. Valley of the Rio Grande, 60 or 70 miles below El Paso; Sept.

† P. Texana, *DC. Prodr.* 5. *p.* 125; *Torr. & Gray, l. c.* From Austin to the Rio Grande, Texas; May – Aug. — The pappus varies much in size, and is either acute or obtuse.†

* The Mexican species greatly need revision. The subjoined is a well-marked new species, with the heads resembling those of P. Greggii.

Porophyllum amplexicaule (*Engelm. ined.*): glaucum; caulibus basi fruticosis teretibus erectis; foliis ovato-lanceolatis acutis semiamplexicaulibus carnosis eglandulosis siccate nervulosis, caulinis plerisque oppositis; involucri campanulati squamis circiter 8 oblongis acutiusculis subplanis viridulis parce lineato-glandulosis; floribus flavis; acheniis minute hirtulis. — Near Messillas, Cohahuila, Mexico, *Gregg.* — Stems two feet high. Leaves an inch or more in length, four lines wide at the base, thence tapering to an acute point. Heads three quarters of an inch long; the pappus tawny.

† Palafoxia Lindenii (sp. nov.): tenuiter cinereo-puberula; ramis floriferis glandulosis; foliis oblongo-lanceolatis obtusis sæpe mucronulatis in petiolum attenuatis, inferioribus subtrinervatis; capitulis

376. FLORESTINA TRIPTERIS, *DC.*, var. pappi paleis brevioribus obtusissimis vel retusis basi callosa in nervum vix vel haud producta. — Prairies beyond the Pecos; Aug. "Flowers purple." — The pappus is composed of shorter and rounder scales than in Berlandier's plant; by no means "acute and with a thickish mid-nerve," as described by De Candolle. In comparing it with Berlandier's plant, I find that, while some flowers of the latter have oblong and acutish paleæ, with a strong mid-nerve, others have them obovate and obtuse, with the nerve vanishing above the middle; and there is no difference in other respects. The pappus doubtless varies as it does in Palafoxia Texana and P. callosa.

377. PALAFOXIA (FLORESTINARIA) CALLOSA, *Torr. & Gray, Fl.* 2. 369. Florestina callosa, *DC.* Cliffs of Turkey Creek, and on the Rio Grande, Texas.

† P. CALLOSA, var. pappo aut minimo aut plane nullo. — Austin, Texas. — The achenia are pubescent in the plant with a very short pappus, as in the ordinary state of the species. They are glabrous in a variety which is destitute of pappus, at least in specimens raised in the Cambridge Botanic Garden.

378. HYMENOPAPPUS FLAVESCENS, *Gray, Pl. Fendl. p.* 97. Valley of the Rio Grande, fifty miles below El Paso; Sept. Also in the collection of 1851. — The lobes of the leaves are finer than in Fendler's No. 464, but much as in his No. 463; and even the rameal leaves are pinnately parted.

† H. CORYMBOSUS, *Nutt.; Torr. & Gray, Fl.* 2. *p.* 370; *Gray, Pl. Lindh.* 2. *p.* 230. Austin, Texas.

379. BAHIA ABSINTHIFOLIA, *Benth. Pl. Hartw. p.* 18; var. DEALBATA: pappi paleis paullo brevioribus et latioribus; foliis nunc integerrimis oblongis seu lanceolatis, nunc trilobatis lobis integris, nunc præsertim superioribus tripartitis lobis linearibus, terminali sæpe 2-3-lobato. — B. dealbata, *Gray, Pl. Fendl. p.* 99, *adnot.* — Calcareous hills of the San Felipe and the Pecos, and valley of the Rio Grande below El Paso. — The plant varies greatly in its foliage, and, although more canescent and with a rather shorter pappus, evidently passes into B. absinthifolia, *Benth.* It is a true congener of B. ambrosioides.

380. RIDDELLIA ARACHNOIDEA, *Gray, Pl. Fendl. p.* 94, *adnot.* Psilostrophe gnaphalodes, *DC.! Prodr.* 7. *p.* 261. Hills on the Rio Frio and Rio Grande, Texas; June, July. — De Candolle's genus Psilostrophe, placed among the "Compositæ incertæ sedis," is founded on an imperfect specimen of this plant, gathered by Berlandier at San Luis Potosi. The name has priority over Nuttall's Riddellia, and would in strictness supersede it, if, as I suppose, this plant is generically inseparable from Riddellia tagetina, notwithstanding the difference in the pappus.

381. AMBLYOLEPIS SETIGERA, *DC. Prodr.* 5. *p.* 668. Prairies from Seguin to the Rio Grande, Texas. (Muskit prairies, twelve miles southwest of New Braunfels, May, *Lindheimer*, 1850.) — I first received this striking plant from Mr. Wright in the

discoideis homogamis multi- (plus 20-) floris semipollicaribus subturbinatis; involucri squamis vix biserialibus linearibus apice obtuso sphacelatis pubescenti-viscosis; pappo (conformi ?) e paleis 10 æquilongis oblongo-lanceolatis muticis corolla subdimidio brevioribus; achenio fere glabro. — "Vera Cruz, Antigua, June, 1838," *Linden*, in herb. Hook. "Vera Cruz, Mexico, on sand-hills near the sea, 1840," *Galeotti*, *no.* 2627. — Root annual. Lower leaves two inches long, including the petiole.

year 1848, and have had it in cultivation for three or four years in the Cambridge Botanic Garden; where it proves to be one of the handsomest annuals of the family, of very neat foliage, and producing a succession of large, bright golden-yellow, long-peduncled capitula during the whole summer. The pappus resembles that of a Gaillardia, except that it is nerveless and awnless.

382. Helenium tenuifolium, *Nutt. in Jour. Acad. Philad.* 7. *p.* 66; *Torr. & Gray, Fl.* 2. *p.* 385. Bed of the Limpia, Aug.

383. Actinella scaposa, *Nutt.; Torr. & Gray, Fl.* 2. *p.* 382. Hills of the Rio Frio; June. Also, the villous form, in the collection of 1851.

384. A. linearifolia, *Torr. & Gray, l. c.; Gray, Pl. Lindh.* On the Leona; June. — A larger and more strict form, 18 inches high, with larger capitula, occurs in the collection of 1851.

385. A. odorata, *Gray, Pl. Fendl. p.* 101, *adnot.* Hymenoxys odorata, *DC.! Prodr.* 5. *p.* 661; *Deless. Ic. Sel.* 4. *t.* 42. Low banks of the Rio Grande, below El Paso; Sept. — Berlandier's specimens were collected between Laredo and Bexar, Texas, according to the ticket in Hooker's herbarium, &c. — A. chrysanthemoides, *H. B. K.!* is a close congener of this species; as is A. integrifolia, *H. B. K.!* (Oxylepis lanata, *Benth.!*), which is omitted by De Candolle, of the entire-leaved species. Hymenoxys anthemoides, *Cass.* and H. Hænkeana, *DC.*, although rayless, will form on this account only a section (Hymenoxys) of Actinella. Cephalophora radiata, *Hook. & Arn.* is, I believe, no more than a variety of A. heterophylla, *Pers.*, which I think sometimes wants the rays. C. fruticosa, *Hook. & Arn.* (which is also C. Doniana, *Hook. & Arn.*) is a distinct species, and very likely the C. radiata of Lessing. These being removed, Cephalophora will be restricted to De Candolle's first section, with globose heads and a reflexed linear involucre.

SARTWELLIA, *Nov. Gen.*

Capitula pluriflora, conferte fastigiato-corymbosa, heterogama; fl. radii ligulatis fœmineis 3 – 5; disci 9 – 12 tubulosis hermaphroditis. Involucrum disco brevius, 5 – 6-phyllum, squamis ovalibus membranaceis æqualibus. Receptaculum subplanum nudum. Ligulæ ovales, corollas disci (limbo cyathiformi 5-fido) haud superantes. Styli rami fl. disci breves, complanati, revoluti, apice truncati. Achenia teretia, 10-costata, pappo calyculato integro margine multi-denticulato, tubum proprium corollæ disci adæquante, coronata. — Herba erecta, multicaulis, pedalis, glabra; radice annua? foliis oppositis filiformi-linearibus integerrimis impunctatis; capitulis parvulis breviter pedicellatis; floribus aureis.

386. Sartwellia Flaveriæ. (Tab. VI.) — Prairies of the Rio Seco, Texas, and mountain valleys and plains of the Pecos, and base of the Guadalupe Mountains; July – Oct. — The figure and generic character render a detailed description of this plant unnecessary. It is entirely different from any published genus known to me, and is chiefly remarkable from its invalidating the distinctions of the subtribe *Flaverieæ*, to which, on account of its whole habit and general characters, I am obliged to refer it, notwithstanding the pappus and the pedicellate (not glomerate nor strictly fascicled, though crowded) capitula. I take pleasure in dedicating the

genus to Dr. Henry P. Sartwell, of Penn Yan, New York, one of my earliest and most valued botanical correspondents, a zealous student and collector of the plants of Western New York, and author of the excellent *Carices Americæ Septentrionalis Exsiccatæ*, of which two volumes have already appeared.

387. Bahia pedata (sp. nov.): annua, puberula; caule erecto apice nudiusculo corymbosi-oligocephalo; foliis alternis petiolatis pedatisectis, segmentis obovato-oblongis obtusis brevibus parce insico-dentatis lobatisve, fol. suprem. linearibus subintegerrimis; involucro laxo disco breviore, squamis oblongis obtusis; acheniis parce pilosis; pappi paleis 10–12 obovato-oblongis obtusis tubo corollæ disci brevioribus. — Between W. Texas and El Paso; the record of the locality lost. — Stems about a foot high. Leaves about an inch long and wide, trisected, with the lateral divisions two-parted or two-cleft, and the middle one 3–5-lobed or incised, all the divisions or lobes obtuse; the upper leaves smaller, with narrower divisions, gradually reduced to mere bracts. Peduncles one or two inches long. Heads about the size of those of B. absinthifolia, No. 379; the yellow rays, &c. similar. Involucre almost glabrous; the scales about 10, membranaceous, lax, two lines long, nearly uniserial. Pappus one third of the length of the achenium, shorter than the glandular proper tube of the disk corolla; the paleæ with an evident midnerve which is thickened at the base. — This is a manifest congener of Bahia ambrosioides and B. absinthifolia, although only minutely pubescent. Before observing the pappus I had taken it for the ambiguous plant which, in *Plantæ Fendlerianæ*, *p.* 104, I had called Amauria? dissecta. Indeed, the latter, although probably a distinct species (having more dissected foliage, &c.), is to the former just what Monolopia lanceolata, *Nutt.! Pl. Gamb.* (= 323, California, *Coulter*), having discrete scales of the involucre, is to Bahia sect. Eriophyllum; or what Lasthenia (Hologymne) glabrata is to Lasthenia glaberrima and obtusifolia; what Baeria, *Fish. & Meyer*, is to Burrielia proper; Burrielia (Ptilomeris, *Nutt.*) calva, to the other species of that section; Hecubæa, *DC.*, to Helenium; Acarphæa, *Pl. Fendl.*, to Chænactis; Sabazia urticæfolia, *DC.*, to Galinsoga parviflora; Oxyura, *DC.*, to Layia (*Gray, Pl. Fendl. p.* 103); Coinogyne, *Less.*, to Jaumea; Villanova, *Lag.*, to Achyropappus;* and Thelesperma, sect. Abuceros, p. 109, to the rest of that genus.

388. Baileya multiradiata, *Harv. & Gray, Pl. Fendl. p.* 106, *adnot.; Torr. in Emory, Rep. p.* 144. *t.* 6. Mountain valleys between the Limpia and the Rio Grande; Aug. The scarious persistent rays are very numerous, in several series.

389. B. pleniradiata, *Harv. & Gray, l. c.* Valley of the Rio Grande, 25 miles below El Paso; Sept.

† Varilla Texana (sp. nov.): suffrutescens, humilis; foliis plerisque alternis carnosis obtusis; pedunculis solitariis ramos terminantibus prælongis monocephalis; capitulo ovoideo; pappo nullo. — Saline plains, from the Nueces to the Rio Grande,

* Amblyopappus, *Hook. & Arn.*, which I had thought was too near Achyropappus, is the same plant as Infantea Chilensis, *Remy, in Gay, Fl. Chil.*, and Aromia tenuifolia, *Nutt.*

Heliogenes, *Benth.! Pl. Hartw. p.* 42, is certainly the same as Aganippea, *DC.!*; even the species appear to be the same.

Texas; Sept. Also gathered by M. Trécul in the same district. — "Plant growing in dense tufts, much branched from the base," a span to a foot high. Leaves crowded, 8 to 12 lines long, linear or filiform, fleshy, apparently terete, very obtuse. Peduncle naked, three to five inches long. Head four lines in diameter, subglobose-ovoid, larger and rounder than in V. Mexicana, the short involucre less tubinate. Receptacle, paleæ, flowers, &c. nearly the same; but I find no traces of a pappus. The capitula have considerable resemblance to those of Salmea, the only genus with which I can compare this and the plant to which I gave the name of Varilla Mexicana, *Pl. Fendl. p.* 106, *adnot.* But the style is not asteroid in character, the achenia are not obcompressed nor two-awned, &c. The present plant is truly a congener of V. Mexicana, although destitute of a pappus.

390. ARTEMISIA FILIFOLIA, *Torr. in Ann. Lyc. N. Y.* 2. *p.* 211; *Torr. & Gray, Fl.* 2. *p.* 417. Valley of the Rio Grande below El Paso; Sept. "Stems three to five feet high, much branched."

391. A. DRACUNCULOIDES, *Pursh; Torr. & Gray, Fl.* 2. *p.* 416; *Gray, Pl. Fendl. p.* 106. Hills near El Paso; Sept. Also on the Rio Grande, Texas.

392. A. LUDOVICIANA, *Nutt.; Torr. & Gray, Fl.* 2. *p.* 420. Mountains beyond the Pass of the Limpia; Aug.

393. GNAPHALIUM POLYCEPHALUM, *Michx.* Bed of a stream, between the Pecos and the Limpia; Aug.

394. G. MICROCEPHALUM, *Nutt. in Trans. Amer. Phil. Soc. (n. ser.)* 7. *p.* 404, ex. char. Valley between El Paso and the Guadalupe Mountains; Oct. — Plant two feet high, loosely paniculate-branched above; the small heads subcorymbose. It is the same species as a small unnamed specimen from California, *Douglas*, in the Hookerian herbarium. Perhaps it is also G. ramosissimum, *Nutt.*

395. G. SPRENGELII, *Hook. & Arn. Bot. Beech. p.* 150; *Torr. & Gray, Fl.* 2. *p.* 427. Mountain valleys, beyond the Pass of the Limpia; Aug. — Approaches G. luteo-album too nearly, and probably no more than a variety of it.

396. G. LUTEO-ALBUM, *Linn.* G. Sprengelii, *Gray, Pl. Fendl. p.* 107 (no. 519). Bed of a stream, between the Pecos and the Limpia; and valley of the Rio Grande below El Paso; Aug., Sept.*

397. SENECIO LONGILOBUS, *Benth. Pl. Hartw. p.* 18; *Gray, Pl. Fendl. p.* 108: forma glabra. Valley of the Rio Grande, thirty miles below El Paso; Sept.

398. S. LONGILOBUS, *Benth.* = 397. Between the Limpia and the Rio Grande. — The root seems plainly to be annual.

399. S. LONGILOBUS, var. glabrescens, foliis majoribus. Plains between the Pecos and the Limpia; Aug.

400. S. LONGILOBUS, var. floccoso-incana. With the foregoing. — It is the same as Fendler's No. 470, and Gregg's No. 572.

* I may here correct a transposition in the characters of Angianthus and Phyllocalymma, as printed in the Conspectus of the Genera of the Angiantheæ, contributed to Hooker's *Journal of Botany and Kew Garden Miscellany*, for April, 1851. It is Angianthus, and not Phyllocalymma, which has the bristles of the pappus subplumose. This character should read thus: —

ANGIANTHUS, *Wendl.* Pappi setæ superne subplumosæ.

PHYLLOCALYMMA, *Benth.* Pappi setæ nudæ.

401. S. FILIFOLIUS, *Nutt.*, var. JAMESII, *Torr. & Gray, Fl.* 2. *p.* 444. Sides of mountains, near El Paso; Sept. "Stems one or two feet high." — Differs from S. longilobus principally in the shorter lobes of the leaves, especially the terminal one, and in the suffrutescent base to the stem.

402. S. SPARTIOIDES, *Torr. & Gray, Fl.* 2. *p.* 438. Salt plains, at the Western base of the Guadalupe Mountains; Aug. — Heads larger than in S. longilobus; the leaves all entire.

‡ S. TAMPICANUS, *DC. Prodr.* 6. *p.* 427. Between W. Texas and El Paso; coll. of 1851. Stems a foot high from an annual or biennial root, branching above; the leaves and branches glabrous, but showing vestiges of floccose wool. Radical and lowest cauline leaves petioled; the petiole naked at the base. Lobes of the leaves oblong or cuneate, small, all coarsely incised. Heads numerous, corymbose, three lines long.

403. S. AUREUS, *Linn.*, var. BOREALIS, *Torr. & Gray, Fl.* 2. *p.* 442? Mountains beyond the Limpia; Aug. The flowers have all fallen from the involucres; they were probably those of the preceding year.*

404. HAPLOESTHES GREGGII, *Gray, Pl. Fendl. p.* 109, *adnot.* On the Rio Grande, Texas. "Leaves somewhat succulent."

405. CENTAUREA AMERICANA, *Nutt.; Torr. & Gray, Fl.* 2. *p.* 453. Prairies of Western Texas; May.

406. CIRSIUM ALTISSIMUM, *Spreng.; DC. Prodr.* 6. *p.* 640; *Torr. & Gray, Fl.* 2. *p.* 457; var. lanugine deciduo. Banks of a stream between the Pecos and the Limpia; Aug.

407. C. UNDULATUM, *Spreng.; DC. Prodr.* 6. *p.* 643; *Torr. & Gray, l. c.* Prairies, near San Antonio, Texas; May. — Various forms of the species are in the collection of 1851. It is common and very widely spread throughout the Western region.

408. C. UNDULATUM, var. *β. Torr. & Gray, l. c.* C. Hookerianum, *Nutt. in Trans. Amer. Phil. Soc.* 7. *p.* 418. Cnicus discolor, *Hook. Fl. Bor.-Am.* (parte). Valley between the Pecos and the Limpia; Aug. Also in the coll. of 1851. — I fear this also passes into C. ochrocentrum, *Gray, Pl. Fendl. p.* 110. Perhaps it is likewise C. canescens, *Nutt.;* which can hardly be the next.

‡ C. VIRGINIANUM, *Michx.*, var. *γ. Torr. & Gray, l. c.* Between Western Texas and El Paso; coll. of 1851.

409. PEREZIA RUNCINATA, *Lagasca; Gray, Pl. Fendl. p.* 110, *adnot.* Clarionea runcinata, *Don; DC. Prodr.* 7. *p.* 62. Bluffs above Austin, and on the Rio Grande, Texas.

410. P. NANA (*Gray, Pl. Fendl. l. c.*): caulibus e caudice lanato repente foliosis monocephalis; foliis rotundatis vel cuneato-obovatis amplexicaulibus coriaceis reticulatis minute glanduloso-scabridis nitidis undique spinuloso-dentatis; capitulo 20–30-floro subsessili folium summum haud superante; involucro campanulato ebracteato triseriali, squamis ciliolatis mucronato-cuspidatis, extimis ovatis, intimis

* Senecio ? flocciferus, *DC.* is a Malacothrix, probably M. saxatilis.

lanceolatis; acheniis glanduloso-puberis; pappo albo, setis pluriserialibus conformibus. — Prairies beyond the Pecos; Aug. Valley near Messillas, Northern Mexico, *Gregg;* who states that the plant grows from six inches to a foot high. — Mr. Wright's specimens are from two to five inches in height. Leaves one to two inches in diameter. Head nine to twelve lines in length; the flowers light purple. Pappus of copious and rather soft uniform bristles, not in the least clavellate or thickened at the apex. Achenia (immature) apparently as in the preceding and following species.*

* Perezia, *Lagasca*, should without much doubt have the extension given to it by Lessing; that is, it should comprise Clarionea and Homoianthus, *DC.* But even Perezia of De Candolle must include Acourtia, *Don*, *DC.!* (Perezia, *Llave & Lex.*), Dumerilia, *Less.*, *DC.*, and Proustia, sect. Thelecarpæa, *DC.* (P. reticulata, *Don*). The achenia are similar in all, linear or somewhat fusiform, attenuate above, or with a more or less narrowed neck, and dilated at the apex into an epigynous disk which bears the pappus. There is no available distinction between what is called the biserial pappus of Perezia, *DC.*, &c., and the uniserial pappus of Acourtia. When the bristles are very copious, as in P. runcinata, *Lag.* (Clarionea, *DC.*, but a genuine Candollean Perezia) and P. nana, they of course occupy more than one series; but this is equally the case in Don's Acourtia formosa, and in A. rigida, *DC.;* while in A. hebeclada and my Perezia Wrightii, the bristles being finer and perhaps fewer, they apparently occupy only one series. In A. formosa and in several others, the bristles of the pappus are pretty rigid and more or less clavellate or thickened (but not penicillate) at the apex; but this character, which is of no more importance here than in the genus Aster, is scarcely evident in some closely allied species, and disappears entirely in P. Wrightii, P. nana, &c. There are a considerable number of Mexican species congeneric with De Candolle's species of Acourtia, but I do not possess sufficient materials for their complete elucidation. I should remark, however, that

Perezia turbinata, *Llave & Lex. Nov. Veg. Descr.* 1. *p.* 25, is doubtless the original Acourtia formosa, *Don*, but not of De Candolle. Seemann gathered the plant in question in the northwestern part of Mexico. The capitula are at least 25 – 30-flowered, and an inch in length, as P. turbinata is described: the multiserial involucre may be justly likened to that of Serratula coronata, with which Don compares the head of his Acourtia formosa; and its form is strikingly turbinate, from the shorter exterior scales passing into the numerous similar bracts which are imbricated on the upper part of the short peduncle. The involucral scales are all lanceolate, attenuate-acuminate, of a dry and chartaceous texture, exactly as in Perezia, *DC.*, of which it is surely a true species. The copious and rigid bristles of the pappus certainly occupy more than one series; the longer ones are a little thickened or more strongly denticulate near the apex, but by no means "penicillate." The foliage apparently exhales the fragrance of lemon in drying, as is the case with some other species.

P. Wislizeni, *Gray, Pl. Fendl. p.* 111, is an allied species, with a very many-flowered hemispherical involucre; the exterior scales broadly ovate and lax; the head more like that of P. (Clarionea, *DC.*) carthamoides than any other. The bristles of the rather copious pappus are rigid, and a little clavellate-thickened at the apex.

P. fruticosa, *Llave & Lex. l. c.*, accords very well as to the description with Acourtia formosa, *DC.! Prodr.* 7. *p.* 66 (non *Don*), which I have seen from various parts of Mexico. It is in the Hookerian herbarium from Mackenzie, and also a specimen from a plant raised in Kew Garden. The corymbose heads are only about half an inch long; the scales of the somewhat campanulate involucre ovate and ovate-lanceolate, mucronate-acute, imbricated in about four series. The heads are not more than 15-flowered. The bristles of the rather rigid pappus are obscurely clavellate-thickened at the apex. Plainly this is not Don's Acourtia formosa; the heads of which are said to be as large as those of Serratula coronata! and the achenia to be half an inch long. — Dumerilia Alamani, *DC.! l. c. p.* 67, belongs, I believe, to the same species as his Acourtia formosa. It appears to be a state with the corymb imperfectly developed, the heads sessile and fascicled on a very short peduncle among the upper leaves. The capitulum which I examined was 11-flowered!

411. P. Wrightii (sp. nov.): glabella; caule bipedali folioso herbaceo e radice perenni? collo lanugine densa obtecto; foliis tenuiter membranaceis oblongi-ovatis crebre spinuloso-denticulatis majoribus duplicato-dentatis basi sæpissime auriculata sessilibus; corymbo composito polycephalo; capitulis subfasciculatis 8–11-floris; involucro viscoso-subpuberulo vix triseriali, squamis oblongis obtusiusculis; acheniis glandulosis; pappo albo molli e setis tenuibus. — On the Rio Seco and westward; also on the Rio Grande, Texas; June. — Stem rather slender, angled, glabrous, or the branches a little puberulent, leafy to the top. Leaves thin, membranaceous or

P. rigida, Acourtia rigida, *DC.! l. c.* A formosa, *Hook. & Arn. Bot. Beech. p.* 437; *Benth.! Bot. Voy. Sulph. p.* 122, non *DC.*, nec *Don.* Trixis latifolia, *Hook. & Arn.* This is closely related to the last, but has smaller, 9–15-flowered heads, with the inner scales of the involucre obtuse, at least in De Candolle's specimen.

P. platyphylla, *Gray, Pl. Fendl. p.* 111, is probably only a variety of P. rigida; and so, possibly, is Coulter's No. 336, from Zimapan.

P. hebeclada, Acourtia hebeclada, *DC.! l. c.*, is well figured in Delessert's *Icones.* The involucre accords well with that of Perezia proper, except that the exterior scales are looser and more herbaceous.

P. microcephala, Acourtia microcephala, *DC. l. c.*, is allied to the last, but with smaller heads and softer pappus.

P.? moschata, *Llave & Lex. l. c.*, I have not been able to identify. — Ghiesbrecht's Mexican collection has a species, which is said to exhale a strong odor of musk; but its corymbs are flat, the scales of the involucre not linear nor with reflexed points, and the leaves are adnate-decurrent. I add its characters.

P. adnata (sp. nov.): herbacea, glanduloso-puberula; caule elato ramisque ad apicem usque foliosissimis; foliis subglutinosis coriaceo-membranaceis ovato-oblongis crenato-denticulatis (dentibus mucronatis) basi cordato-amplexicaulibus sinubus decurrenti-adnatis; capitulis fasciculatis subsessilibus in corymbum amplum compositum confertis; involucro 11-floro cylindraceo, squamis ovatis oblongisque appressis mucrone apiculatis viscoso-lanatis (mox subglabratis), extimis 2–3 bracteantibus lanceolatis vel subulatis. — Morelia, Mexico, *Ghiesbrecht*, No. 378, in pine forests, Sept. (v. sp. in herb. Mus. Par.). — The leaves are from three to five inches long; the narrow heads about half an inch in length. Bristles of the pappus not at all clavellate, nearly uniserial.

P. patens (sp. nov.): lævigata, glaucescens; ramis gracilibus divergentibus; foliis chartaceis oblongis ovatisve basi cordato-amplexicaulibus spinuloso-denticulatis mucronatis laxe reticulatis; pedunculis subcorymbosis subulato-bracteolatis monocephalis; involucro circiter 20-floro campanulato, squamis chartaceis 4–5-seriatis obtusis, interioribus lanceolatis oblongisve, extimis ovatis brevibus sæpius mucronatis. — Northwestern part of Mexico, *Seemann.* — Var. *β.* ramis flexuosis; foliis acutis vel acuminatis; pedunculis glanduloso-puberulis abbreviatis. Chiapas, *Linden*, No. 439. Mexico, *Parkinson* (in herb. Hook.). — Var. *γ.* foliis caulinis pl. m. runcinato-lobatis, cæt. var. *β.* Mexico, *Galeotti*, No. 2001. "Flowers rose-color, lemon-scented." — I believe this is likewise in Berlandier's collection.

P. Seemannii (sp. nov.): lævissima, glaucescens; caule erecto folioso; foliis coriaceis rigidis lanceolatis spinuloso-denticulatis deorsum angustatis sessilibus, ramulorum parvulis integerrimis cuspidatis; capitulis 8–10-floris in corymbum amplum compositum laxum dispositis; pedunculis subulato-bracteolatis; involucro turbinato 3–4-seriali, squamis lanceolatis sensim acuminatis minute glandulosis, extimis brevibus cuspidatis in bracteolas pedunculi transeuntibus. — Northwestern part of Mexico, *Seemann.* — Apparently herbaceous and two or three feet high, rigid, very smooth. Cauline leaves three or four inches long and six or eight lines wide, broadest above the middle; those of the flowering branches gradually reduced to bracts. The summit of the stem or principal branches divides into a large and open compound corymb. Peduncles six to twelve lines long, the upper part crowded with small appressed bracts. Heads narrow, six or seven lines long. Involucre nearly as in the species of De Candolle's genus Perezia. Achenia with a narrowed neck. Pappus of rather soft and fine strongly denticulate bristles, not at all clavellate, in a single series.

P. nudicaulis (sp. nov.): scapo e caudice lanato glabro gracili aphyllo apice paniculato polycephalo;

chartaceo-membranaceous; the cauline, three to five inches long, and two or more in breadth, reticulated; the lowest, rather obovate and with a narrowed base; the principal cauline, either truncate, or usually auriculate, or sagittate-cordate at the closely sessile base; those of the flowering branches smaller and not auriculate. Heads numerous, in an ample compound corymb, on short pedicels; the peduncles and pedicels glandular-puberulent, subtended by small subulate bracts, five or six lines long, 8–11- (usually 10-) flowered. Involucre small, not longer than the mature achenia, of 12 to 15 scales; the exterior ones oblong-ovate, the innermost oblong-linear, greenish, not scarious. Corolla pale purple. Achenia 5-ribbed, linear-fusiform, attenuate at the summit and terminated by a somewhat enlarged disk, as in the whole genus. Pappus of rather copious soft and white capillary bristles, which are similar and nearly equal, scabrous, not at all thickened at the apex. — This species is well distinguished by its membranaceous leaves and small heads.

412. P. Wrightii, var. subpuberula; foliis rigidiusculis minute glanduloso-scabrellis. — Hills between the Pecos and the Limpia; Aug. — "Corolla light purple." This is plainly only a variety of the last, from a dry and exposed locality. It is more allied to Perezia (Acourtia, *DC.*) microcephala than to any other species; but that species has the scales of the involucre slender and attenuate-acuminate, as in P. hebeclada.

413. Trixis angustifolia, *DC. Prodr.* 7. *p.* 69. Hills near the Limpia; Aug. Dr. Gregg has it from near San Luis Potosi, where it was originally collected by Berlandier. — I should refer this to T. corymbosa, *Don*, except that the leaves are not petioled. — Berlandier found T. frutescens in Southern Texas, as well as in Mexico.

414. Leria nutans, *DC. Prodr.* 7. *p.* 42; *Gray, Pl. Lindh.* 2. *p.* 232. Hills near Austin, Texas, and on the San Pedro River. Also on the Rio Grande, Texas.

415. Stephanomeria minor, *Nutt.; Torr. & Gray, Fl.* 2. *p.* 472. Valley of the Pecos and of the Limpia; Aug. — This is the genus Jamesia, *Nees in Neu-Wied, Reise* (not of *Torr. & Gray*); his Jamesia pauciflora being Stephanomeria runcinata, *Nutt.*

foliis radicalibus runcinato-pinnatifidis glabratis; involucro 12-floro 3–4-seriali, squamis lineari-oblongis, exterioribus gradatim brevioribus ovalibus; pappo tenui. — Guatemala, *Skinner* (herb. Hook.). Scape about a foot high. Heads five or six lines in length, on subulate-bracteate peduncles. Pappus fuscous, uniserial, rather fine and soft.

P. (Dumerilia, *Less.*) Humboldtii, the Proustia Mexicana, *Don, fide Less.*, I have not seen. Notwithstanding its five-flowered heads it would appear to be, as Lessing suggests, a congener of Acourtia formosa, *Don.* The only five-flowered species I have seen is

P. (Dumerilia) reticulata, the Proustia reticulata, *Lag.*, *Don in Trans. Linn. Soc.; DC.! Prodr.* 7. *p.* 27. Mexico, *Mendez* (in herb. *DC.*). Oaxaca, *Galeotti*, No. 2097. — The leaves are all narrowed at the base, not at all clasping; the branchlets are puberulent; the inflorescence is thyrsoid; the flowers are "light yellow"; the scales of the involucre all oblong and very obtuse. The bristles of the copious pappus are somewhat thickened at the apex. The heads are sometimes only four-flowered, sometimes six-flowered!

416. Lygodesmia aphylla, *DC. Prodr.* 7. *p.* 198; *Torr. & Gray, Fl.* 2. *p.* 485. Low prairies, Austin, Texas; May. — This form bears a number of cauline leaves, but they are all filiform.

417. L. juncea, *Don; Hook. Fl. Bor.-Am.* 1. *p.* 295. *t.* 103; *Gray, Pl. Fendl. p.* 113. Prairies on the Pecos; Aug. The heads are larger than in Fendler's plant, an inch long.

418. Krigia occidentalis, *Nutt.*, var. mutica, *Torr. & Gray, Fl.* 2. *p.* 468. Prairies near San Marcos, Texas. — The awned and the awnless states of this plant grow together: in the latter the paleaceous pappus is also somewhat reduced in size. Some specimens of this awnless variety of Krigia occidentalis are mixed with those of Apogon gracilis, *DC.* in Berlandier's collection (between Bexar and Austin, April, 1828), whence was doubtless derived De Candolle's character "acheniis brevissime papposis" of the last-named species. The larger specimens belong really to Apogon, are wholly destitute of pappus, and entirely accord with Apogon humilis, *Ell.*

† Crepis ambigua, *Gray, Pl. Fendl. p.* 114. Hills between the Limpia and the Rio Grande; Aug.

Nymphæa elegans, *Hook.* — No. 3. p. 7, which I referred with doubt to Nymphæa Mexicana, *Zucc.*, has been figured as a new species by Hooker, in *Bot. Mag. t.* 4604, under the above name, from living plants raised from seeds taken from Wright's dried specimens. The flowers have a pale blue tint.

Wislizenia. — Cleomella Coulteri, *Harv. ined.*, mentioned on p. 12, is Wislizenia refracta, *Engelm. p.* 11. *t.* 2.

Laphamia, p. 99. — The disk-corollas are wrongly said in the character to be five-toothed. They are commonly four-toothed in all the species, and they are so represented in the analyses of the two species figured on Plate IX.

L. (Monothrix) Stansburii, p. 101. — Dr. Torrey informs me that he has figured this plant in the notice of the plants collected by Captain Stansbury (appended to his report on the exploration of the Salt Lake region), under the name of *Monothrix Stansburii*, that name having been chosen, and the plate struck off, before he was aware that I thought it needful to join these two species with unisetose pappus to a genus of which two species have no pappus at all. Should it be preferred to retain them as a separate genus, they will of course bear Dr. Torrey's name of Monothrix. Otherwise that name would designate merely a subgenus of Laphamia.

INDEX.

[The names of plants described or regularly enumerated, as well as those of natural orders, are printed in small capitals. Synonyms, and the names of genera and species variously mentioned, but not characterized, are in Roman.]

EXPLANATION OF THE PLATES.

PLATE I. GREGGIA CAMPORUM, p. 9.

Fig. 1. A flower enlarged.
" 2. The pistil, with the lobed hypogynous disk, more magnified.
" 3. The silique, in dehiscence, showing the seeds, &c., magnified.
" 4. The same cut across.
" 5. A thin transverse section of the silique, more magnified, showing the compression contrary to the dissepiment.
" 6. A seed more magnified.
" 7. Transverse section of the same.
" 8. A portion of the tissue of the dissepiment, highly magnified.

PLATE II. WISLIZENIA REFRACTA, Engelm., p. 11.

Fig. 1. Vertical section of a flower-bud, magnified.
" 2. An expanded flower, magnified.
" 3. Transverse section of the ovary, magnified, showing the four ovules in place.
" 4. The pistil, magnified, with the ovary vertically divided.
" 5. The fruit, with its stipe and pedicel, enlarged.
" 6. Magnified vertical section of the fruit, and of the single seed which fills each cell.
" 7. The persistent fenestrate dissepiment from which the valves have fallen, with a part of the style and stipe, magnified.
" 8. One of the valves from the same.
" 9. A seed detached, magnified.
" 10. A transverse section of the same.

PLATE III. *A.* TALINOPSIS FRUTESCENS, p. 15.

Fig. 1. A small fructiferous branch of the plant, of the natural size.
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" 3. A detached petal with its fascicle of stamens, magnified.
" 4. A stamen, more magnified.
" 5. Pistil, equally magnified.
" 6. Vertical section of the same, showing the placenta and ovules.
" 7. An ovule detached, more magnified.
" 8. Dehiscent pod, with the persistent calyx, enlarged.

FIG. 9. Inside view of the same (without the calyx) laid open; showing the six-valved endocarp, with the three filiform sutural nerves, and the three recurved valves of the exocarp.
" 10. Placenta, with some of the seeds still attached to their filiform funiculi, equally magnified with the preceding.
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FIG. 1. A dehiscent capsule, of the natural size.
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" 3. Transverse section of the same.
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" 5. The same, with the thin and loose arilliform testa removed.
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" 7. Magnified transverse section of the same.
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PLATE IV. MORTONIA SEMPERVIRENS, p. 35.

FIG. 1. Diagram of the flower, with the bract and bractlets.
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" 3. An expanded flower, enlarged.
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" 5. The detached calyx laid open, to show the perigynous disk, petals, and stamens.
" 6. A stamen more magnified; inside view.
" 7. The same, seen externally.
" 8. The style, with the stigmas, magnified.
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" 11. Vertical section of the same.
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" 13. The embryo detached entire, magnified.

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" 3. Branch of the var. α., in fruit.
" 4. Diagram of the flower. (The æstivation of the petals not determined.)
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" 9. Achenium and pappus, magnified.
" 10. A separate bristle of the exterior pappus, more magnified.
" 11. An awned palea of the inner pappus, equally magnified.

PLATE IX. *A.* LAPHAMIA (PAPPOTHRIX) RUPESTRIS, p. 100.

Fig. 1. A flower, enlarged.
" 2. A bristle from the pappus, more magnified.
" 3. A stamen, much magnified.
" 4. The style, magnified.
" 5. The receptacle and involucre, enlarged.
" 6. A mature achenium, with the pappus, magnified.
" 7. Transverse section of the achenium and embryo, magnified.

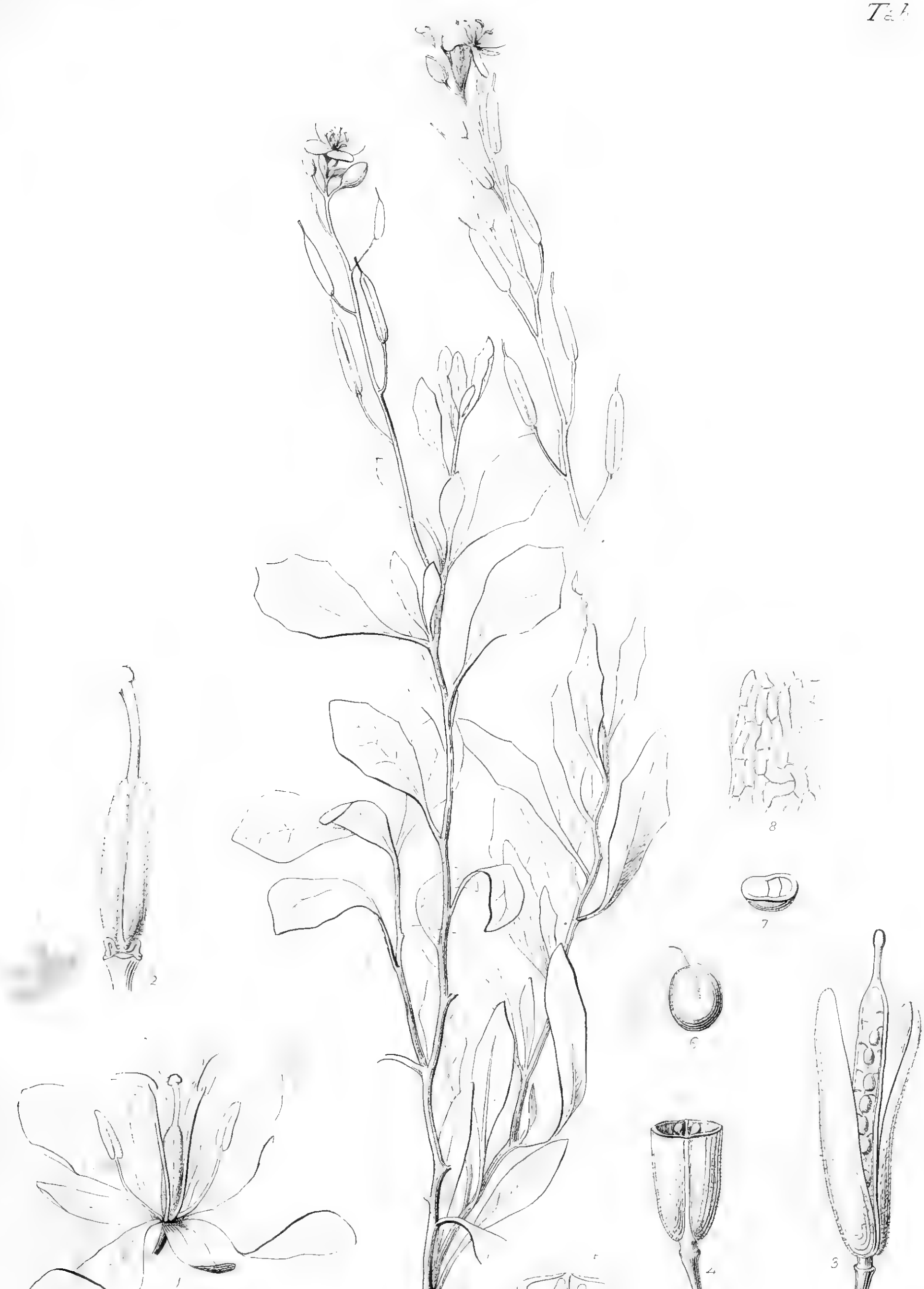
PLATE IX. *B.* LAPHAMIA HALIMIFOLIA, p. 100.

Fig. 1. Vertical section of a head, enlarged.
" 2. A ray-flower, magnified.
" 3. A disk-flower, magnified.
" 4. Corolla of the latter laid open.
" 5. A detached stamen, more magnified.
" 6. Style of a disk-flower, highly magnified.
" 7. A ripe achenium, magnified.
" 8. Transverse section of the same.

PLATE X. ZINNIA (HETEROGYNE) ANOMALA, p. 106.

Fig. 1. A plant with most of the ray-flowers destitute of ligules.
" 2. A branch of the variety with short ligules to all the ray-flowers.
" 3. Vertical section of a head of the plant represented in Fig. 1, magnified.
" 4. One of the ray-flowers wholly destitute of corolla, more magnified.
" 5. Another ray-flower from the same head, with a short ligule.
" 6. Transverse section of a ray-achenium.
" 7. Style of a ray-flower, more magnified.
" 8. A disk-flower, magnified, with
" 9. The accompanying palea of the receptacle.
" 10. A disk-corolla laid open, and more magnified.
" 11. A detached stamen, more magnified.
" 12. Style of a disk-flower, magnified.
" 13. An achenium of the disk, with its subtending palea, transversely divided, magnified.
" 14. Summit of a disk-achenium which exhibits a 4-awned pappus.

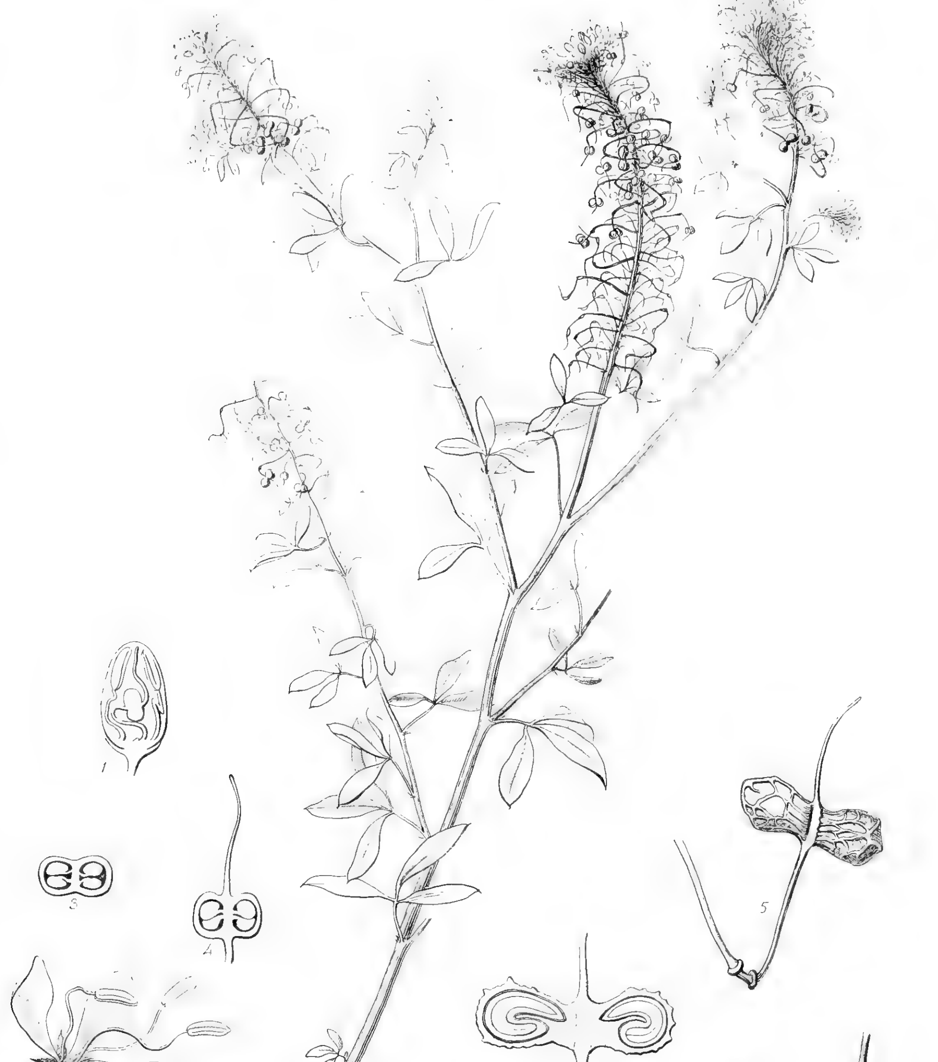
EXPLICIT. KAL. MART. MDCCCLII.



GREGGIA CAMPORUM.

Sprague

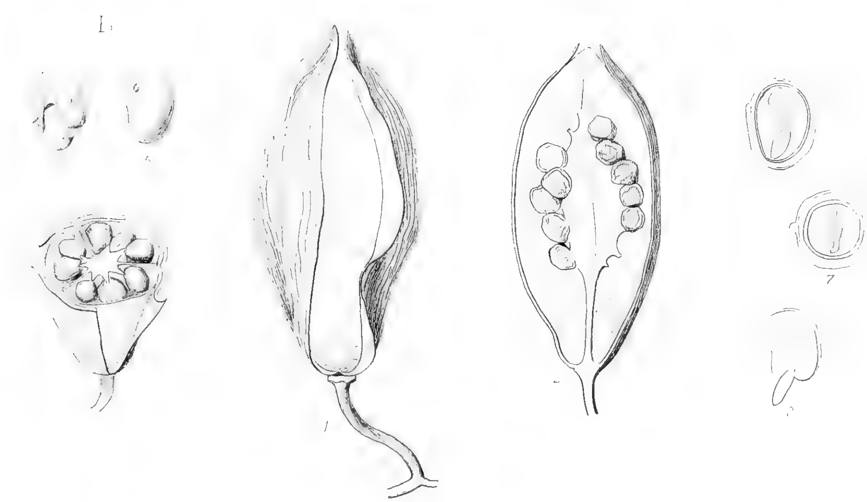
Tab. 2



WISLIZENIA REFRACTA.

Sprague

TALINOPSIS FRUTESCENS

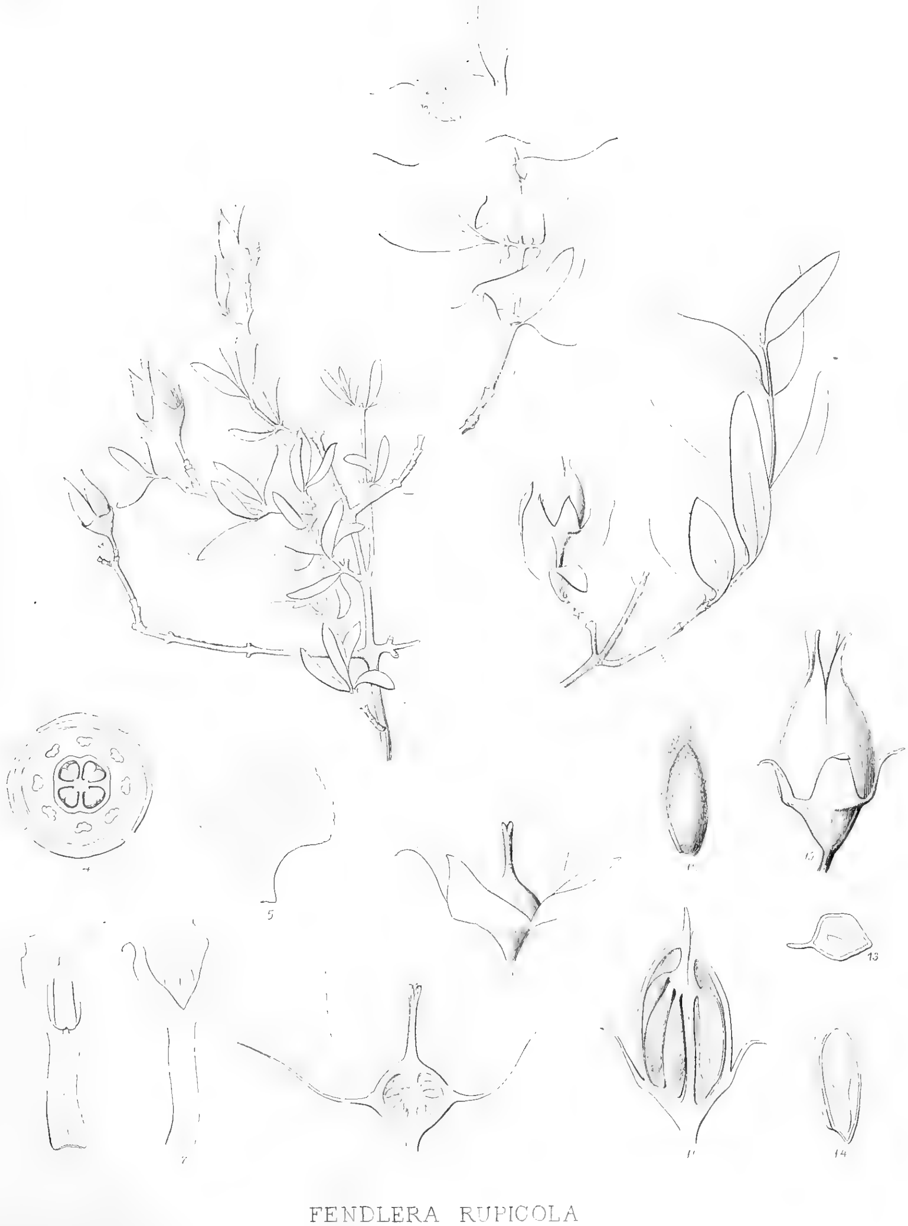


AMOREUXIA SCHEIDEANA.

Tab. 4

Sprague

MORTONIA SEMPERVIRENS.



FENDLERA RUPICOLA

I. Sprague in stone

SARTWELLIA FLAVERIÆ.

Tab. V.

THYMOPHYLLA GREGGII.

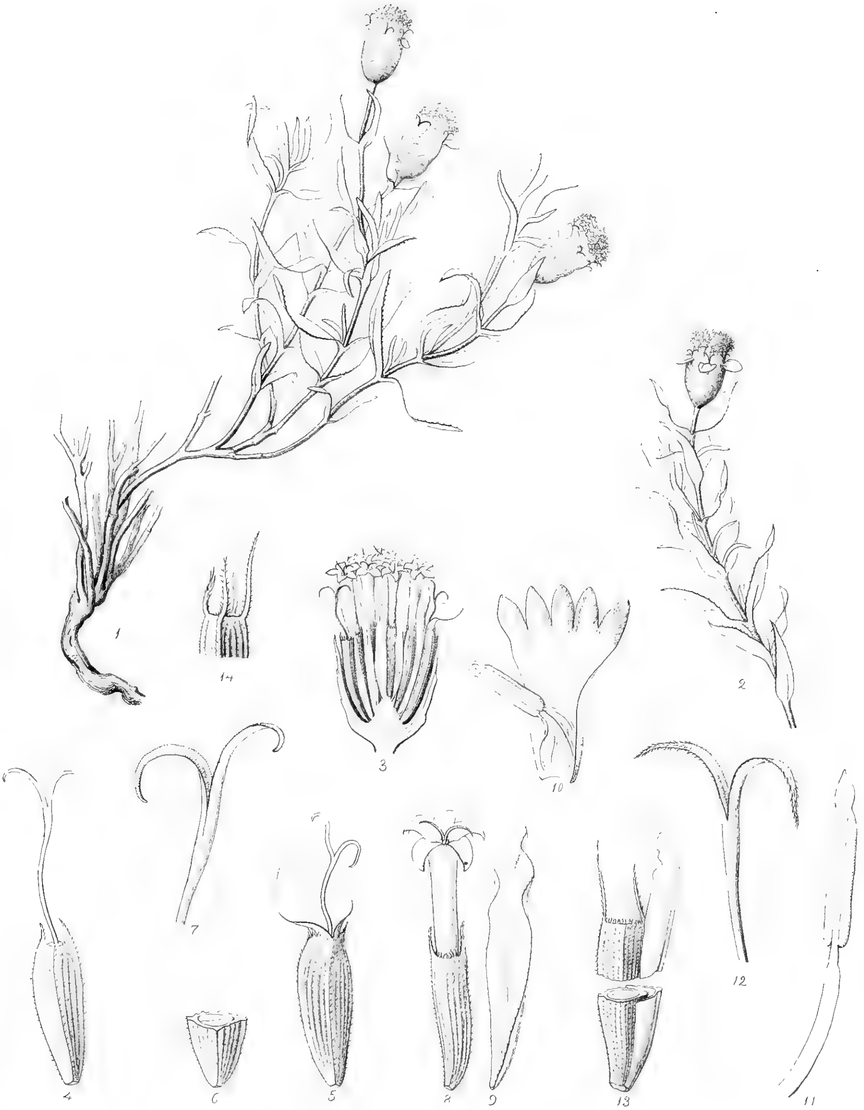
Sprague sc.

NICOLLETIA EDWARDSII

Sprague del.

LAPHAMIA HALIMIFOLIA

LAPHAMIA (PAPPOTHRIX) RUPESTRIS.



ZINNIA (HETEROGYNE) ANOMALA.

I. Sprague ex icone

SMITHSONIAN CONTRIBUTIONS TO KNOWLEDGE.

THE

LAW OF DEPOSIT

OF THE

FLOOD TIDE:

ITS DYNAMICAL ACTION AND OFFICE.

BY

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LIEUTENANT U. S. NAVY.

ACCEPTED FOR PUBLICATION

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Prof. A. Guyot.

Joseph Henry,
Secretary S. I.

In a "Memoir upon the Geological Action of the Tidal and other Currents of the Ocean," published in the fourth volume (New Series) of the Memoirs of the American Academy of Arts and Sciences, I endeavored to trace a permanent and intelligible connection between the currents of the sea and the alluvial deposits on its borders, and in its depths; to show in what manner the structure, position, and amount of these deposits depended on this connection; and, finally, to assign to it the character of a law, subordinate to the higher law of universal gravitation, which had, by a consistent and uniform operation, combined with other laws to give to the great masses of land, called continents, their actual form and body.

The views contained in this Memoir were founded upon observation. An examination of the various parts of the alluvial coast of the United States, through a series of years, had led to the discovery that the shape, extent, and distribution, of the loose material of which they are composed,—quartzose sand,—were chiefly determined by the action of the tides. It was seen that the same forms of deposit were constantly repeated under similar circumstances; and the conclusion was therefore drawn, that the forms and circumstances were mutually dependent.

This being the case, we are enabled to explain the character of the present formations on alluvial coasts; to account for their peculiar shape, and their comparative size; to understand the law of their accumulation, or growth, and to foresee the future results of certain combinations of circumstances, by a study of similar instances elsewhere.

One of the first steps in the Memoir referred to, was to specify the different kinds of deposit that are found below and above the surface of the sea. They were classified under the name of shoals, hooks, bay deposits, bars, beaches, &c.; and their characteristic features being described, the precise and distinct mode of operation of the current, by means of which these features were decided, was stated and illustrated by numerous examples.

The next inquiry was concerning the geographical distribution of these alluvial deposits in all parts of the world. The cases of ocean deposits hitherto adduced, were those of the American shores, and principally of the shores of New England. They were accessible; they exhibited in minute detail all the different results of constructive action, and had been maturely examined and collated. They furnished also the examples for illustration, as they had first suggested the principles to be elucidated. But leaving these districts, the generalization of the views presented, was extended so as to become applicable to the sandy coast of the United States, from Florida to Maine, regarded as a whole; to the gigantic subaqueous accumulations to the North and East, as George's Bank, Newfoundland Bank, &c., to the Bay of Campeachy, and the shores of the Gulf of Mexico on the West and the North, to the belt of sand on the west coast of Peru, which on the North terminates in the Desert of Pachira; and passing from America to Europe, to that most interesting of all similar formations, the countries of the Netherlands, which owe their national peculiarities to the character of their territory, to the sandy region on the southern border of Norway; and, finally, to the well-known Landes of France.

In that part of the investigation which relates to our own coast, and which comprised the introduction of the elementary principles of this theory, the tidal currents referred to owed their origin to purely local causes, and were restricted to limited areas. But in the section devoted to the subject of "Geographical Distribution," the general course of the tidal wave, and the points of divergence and convergence were treated; currents, the influence of which was felt through large spaces, were considered; peculiar systems of waves, the resulting motions of the water occasioned by the conflict and mutual interference of waves approaching each other in different directions, as in the English Channel, and round the Island of Great Britain in the North Sea, or round Ireland in St. George's Channel and the Irish Sea, were mentioned; and lastly, two conspicuous examples were brought forward of the similar action of permanent ocean currents, where they impinged with one continuous direction on a long line of coast on the sea border of Peru, and on the shores of the Gulf of Mexico.

The concluding section of this Memoir was reserved for an inquiry into the geological action of the tides in the past ages of the earth's history. The instances were taken from the tertiary and subsequent periods; and in the cases cited there was no difficulty in determining how the transmission of the tide wave, and consequently the character of the currents during the accumulation of the aqueous deposits in question, had been affected and controlled by the earlier formations.

The geographical distribution of the Dune, or alluvial Flora, on the shores of the United States, and of Nova Scotia, was employed, at the suggestion of Professor A. Gray, of Harvard University, to throw additional light upon this theory; a striking and instructive resemblance was noticed between the bottoms of our principal bays in their present state, and the formation and condition of the valleys in the Swiss Canton Soleure, as described by M. Gressly; and, by means of a somewhat minute description of Nantucket Shoals, and the intervening channels, with their inhabitants, it was attempted to show that, throughout all periods of geology, one of the grand results of the operation of the tidal laws had been to prepare the place suitable to marine animal life.

The preceding is a very brief and general sketch of the theory and its applications, contained in the Memoir mentioned at the beginning of this paper. It is introduced here to give interest to what follows, and to exhibit its connection.

In the section relating to geographical distribution, it was laid down as a fundamental principle, that the deposits on the *ocean border* are only made by the current of the *flood tide*. It was added, by way of explanation, that, "in the *sounds* and *bays*, the *ebb* tide may also leave its burden; since, in its retreat, it may not only meet with obstructions, but must press upon the land, in some parts, precisely as the advancing flood does upon the exterior coast. In a group like the Nantucket Shoals, the ebb, carrying with it the sand that has been loosened on the shore, and, being hindered in its course by the inequalities of the bottom, must also contribute to build up the deposits. These cases are not alleged as exceptions to a law, but are stated as modifications merely, through which the action of the ebb is brought to resemble that of the flood. In general, as the deposit of the flood is made on the shore in the direction of its progress, so the deposit of the ebb is buried in the bosom of the ocean. The former furnishes the material for the alluvial deposit above water; the latter supplies the substances found in the depths of the sea.

"It is not meant to say by this, that the action of the flood and ebb tides is reciprocal. On the contrary, the mode of operation of the flood is essentially accumulative. Its tendency, also, is continually to carry onward the deposit, in the course of its current, so that it performs the double office of increasing the collection at every successive tide, and of advancing from place to place the matter at its disposal." This process, and the law by which it is produced, were proved by the manner in which the materials of wrecks are conveyed along the shore, and the direction (always that of the flood) in which the various forms of deposit are increased. Many well-authenticated instances of the transportation of wrecked matter were adduced.

Since writing that Memoir, I have endeavored to add to the number of these facts and instances, and to extend the inquiries to other parts of the coast of the United States. It is difficult, if not impossible, to make these inquiries through another person, with a perfectly intelligible and satisfactory result. It is safe to rely upon such information only as is collected in personal communication with the wreck-masters themselves. It has not, therefore, been possible to add many facts to those already collected. The following statements, which are well attested, appear to be satisfactory, and to accord with the general law as it has been stated.

I learned from Mr. Joseph H. Skillman, Inspector of the Port, at Greenport, Long Island, that in the month of October, in the year 1842, the whale ship *Plato*, of New Bedford, was wrecked on Neapeaque beach, on the south side of Long Island, and was sold to the wreck-masters. He took part in the purchase. After removing the oil, the upper frame separated from the lower timbers, and drifted to the westward. The wreck-masters built a house on the beach, in which they lived two weeks, employed in rescuing the cargo and materials of the vessel. During this time bricks (spare ones for the "try-works") and wood drifted to the westward, and were collected on the beach in that direction only. Nothing was carried to the eastward. The top frame that had separated was heavy, water-logged, and weighed down with iron fastenings, it floated deep; and, at the time of its drifting to the westward, the wind was blowing from the west. The bricks and firewood constantly advanced in a westerly direction. During three of the fourteen days, passed by the wreckers on the beach, the wind was from the north-west, and one day very strong; at no time did it blow from the east. Before the top timbers broke off, the decks were burnt out to lighten the hull, and get out the copper fastenings; after this was done, the lightened hull began to work to the westward, so that it was necessary to secure it by ropes made fast to stakes driven into the sand.

Mr. Hiram Bishop, a highly reputable ship-carpenter, at Greenport, formerly a resident on the Atlantic side, informed me that the British sloop-of-war *Sylph* was lost on the south side of Long Island, near Southampton, in the winter of 1814–15. The materials of this wreck also were taken up to the westward, some of them beyond Fire Island beach, during the three weeks following her destruction. And, curious to relate, her rudder was found, seven years afterwards, twenty miles to the westward of the place of her loss; it was known by its size, and the king's arrow on the copper. Mr. Bishop also added that the French brig *Le Bon Père de Marseilles*, went to pieces about the year 1838, on the south side of Long Island, opposite Moriches, Brookhaven; that most of her cargo came up near where she struck, but that one piece of her top hamper went one mile and a half to the west.

The above cases are sustained by such reliable testimony, that it seems worth while to preserve them; it is only requisite to add, that the current of the flood tide, on that part of the Long Island shore referred to, runs to the westward.

Proofs of the principle in question, derived from the form and mode of increase of certain deposits were introduced into the Memoir. They were of so decisive a character, that it would be superfluous to multiply them. But there is one statement, made on the authority of Lieutenant-commanding J. N. Maffitt, Hydrographical Assistant in the coast survey of the United States, which is too important to be omitted. Cape Hatteras is a point of divergence of the tide wave; or, in other words, a split of the tides takes place there; in consequence of which, the advancing flood that supplies the harbor of Charleston flows along the coast from the north to the south. Lieutenant Maffitt says that the water, while it runs *flood*, is loaded with sand; but that, when it runs *ebb*, it contains little or none of this matter.

Thus the law of deposit of the flood tide has been already distinctly enunciated, and the facts and observations, by means of which it was inductively inferred, have been fully offered.

The object of the present paper is to search into the mechanical operation of this law, and the uses that it may be thought to have served in the general economy of the globe; to investigate its mode of action, and to assign to it, if admissible, a place among the subordinate fundamental laws that direct the distribution of the loose materials of the earth's crust.

And first, as to how it acts. The law of deposit of the flood tide exhibits itself in the gradual transportation of the matter held in suspension by the water from place to place, along the line of its direction, and in the gradual accumulation of this matter at its terminus, which terminus is the limit of progress, or transmission, of the tide in one course, created by the land or by conflicting streams of the tide, from opposite directions. The mode of immediate supply of the material has been treated elsewhere. It is sufficient to say here that it exists. If the rise of the tide, and its progress from one point to another distant point upon a line of coast, be followed, it will be observed that the water begins to move forwards first at the lower point A, towards B, ascending in height upon the shore, and that this progress and ascent continue during the state of flood. Now if a floating body, a piece of wood for example, be thrown into the water at the first point, but at a distance from the shore, the action of the flood will tend to make it approach the shore, carrying it forwards at the same time in the direction of its course. It will finally reach the shore, upon which it will rise with the surface of the water, and there it will ultimately be left. When the flood tide changes to ebb, and runs in the opposite direction from B to A, preserving apparently an opposite course, and seeming to adhere not less closely to the shore, this piece of wood will not be disturbed, but will remain in the place at which it was left by the flood tide; and if the flood of the next day should rise higher upon the shore than its predecessor, the piece of wood will be lifted still farther up, and again left. And if the floating object should be immersed, so that a part of it will be under the surface, or should be suspended under the water by means of a float, the result will be the same.

And again, if a strong wind should arise from such a quarter as to cause a heavy sea upon the beach, to create a surf, the floating body will be thrown up still farther on the shore; if it be light, to the farthest line to which the surf reaches; if heavy, not so far, perhaps, but that the inner edge of the waves may still break over it. These are the general facts, of which I will directly cite some examples that have fallen under the notice of the most casual observer.

And to these may be added one other, that is, if during the ebb tide a floating object be placed upon the water, outside of the line at which the sea breaks, it will be taken off, but if inside the breakers, it will be cast upon the shore, and there left.

From these facts it appears that there is a mechanical action by means of which the water, when in contact with the shore, ejects the substances either floating upon its surface, or held by it in suspension, and that the effect of the flood current is to transport these substances and place them within the reach of this action, and that of the ebb is to transport these substances beyond the reach of this action. That is to say, what is called the law of deposit of the flood tide may be divided into two distinct phenomena; one of which is the transporting power of the flood current towards, and on to, the shore, the other the dynamical action of the water at the shore.

Concerning the first of these, the transporting power of the flood current towards the shore, which acts equally upon objects on, and below the surface, it is important to bear in mind the service it performs in bringing all suspended matter within reach of the latter power, particularly on an alluvial coast where, in consequence of the destructive agency of storms, great quantities of sand, &c., are continually placed at its disposal. It will be observed that I make here an entire distinction between tidal waves and tidal currents. What the effect, or *modus operandi*, of the oceanic tidal wave might be, if it were permitted to approach a coast without interruption or interference, until it actually impinged upon the continent, will appear hereafter. This, however, is a case not found in nature. Owing to the rapid decrease of depth near the land, and to the broken and indented forms of coasts, the water, the surface of which is raised by the transmitted wave, accumulates, and overflows in every direction, giving rise to currents which, more or less rapid, constitute one of the general features and characteristic conditions of the tides. These currents, though generally appearing to run along the land on the external sea border, do actually press in towards the shore. When running round sharply-turning headlands, they may be deflected for a moment; but the inward pressure from the sea soon carries them back to the coast. In like manner, the ebb tide falls off *from* the shore.

This inward tendency of the flood tide carries all floating objects, or matter held in suspension, either into the harbors, bays, and other recesses of the coast, or upon the outer sea-coast, where it comes under the influence of the wave action. In the first case, the water comes to a state of repose in the interior of the bay, which is very favorable to deposit. But it is the second case which we are to consider, and with regard to which this general statement is correct. It is, if I may so say, the prevailing law or result.

Now, having brought the suspended matter within the reach of the wave action, we are to investigate the nature of that action, by means of which this matter is cast upon the shore, and forced to remain there. To ascertain this, I have had recourse to the experiments of John Scott Russell, Esq., detailed in his Report on Waves, in the proceedings of the British Association for 1844.

In order to discover the motion of water particles during wave transmission, Mr. Russell made an experiment, or series of experiments, which exactly resemble the case we are considering. He studied the motion of small particles visible in the water, of the same or nearly the same specific gravity as water; and of small globules of wax connected by very slender stems, so as to float at required depths. (P. 340.) "The motions of these were observed from above on a minutely divided surface on the bottom of the channel, and from the side through glass windows, themselves accurately graduated, the side of the channel opposite to the window being covered with lines precisely equal to those on the window, and similarly situated." He calls the visible motion of the wave form, along the surface, the *motion of transmission*, the actual motion of the particles themselves, the *motion of translation*.[1]

The wave form is caused by the successive displacement of given masses of water, by a mass preceding them, which has been set in motion by some active force. The moving mass presses upon that before it dislodges it, and occupies its place. "The water particles crowd upon one another in the act of going out of their old places into the new; the crowd forms a temporary heap, visible upon the surface of the fluid; and, as each successive mass is displacing its successor, there is always one such heap, and this heap travels apparently along the channel at that point where the process of displacement is going on; and, although there may be only one crowd, yet it consists successively of always another and another set of migrating particles. The *visible moving heap of crowding particles is the true wave.*" (P. 314.)

"Let us select from the crowd of water particles an individual particle, and watch its behavior during its migration. The progressive agitation first reaches it while in a state of perfect repose; the crowd behind it pushes it forward, and new particles take its place. One particle is urged forward on that before it, and being still urged on from behind, by the crowd still swelling and increasing, it is raised

[1] An apparatus similar to that described by Mr. Russell has been constructed for the purpose of repeating his experiments on waves of the first order.

out of its place and carried forward with the velocity of the surrounding particles; it is urged still on, until the particles which have displaced it have made room for themselves behind it, and then the power diminishes." It finally settles down quietly in its new place. This is the *motion of migration of an individual particle* of water. (P. 315.)

This is the migratory motion, or *motion of translation* of the water particles in the wave of the first order of Mr. Russell's classification; and I shall aim to show, directly, that this is the only wave action to be considered, the only one the process of which applies to the present investigation.

This motion of the water particle is resolved into two components, a vertical motion and a longitudinal motion. "First, the particles begin to rise, scarcely advancing; they next advance as well as rise; they cease to rise but continue advancing; they are retarded and come to rest, descending to their original level." (P. 342.) This is the course of the water particle, as observed by Mr. Russell, by means, as I said before, of visible particles suspended in the water, a mode of investigation precisely analogous to the case of nature, where matter held in suspension, as sand, is transported by the moving water, and brought under the influence of the wave action. "The wave is thus a receptacle of moving power," (p. 347,) "a vehicle for the transmission of mechanical force." (P. 361.) During the translation of the particle, the greatest height accompanied by the progressive motion is at the top of the wave, or in the middle, corresponding to the greatest height, or crest, of the wave. Now when, in travelling along a gradually shoaling channel, approaching a sloping coast, the depth of the water diminishes to an equality with the height of the wave, the wave breaks, or falls to pieces, "the particles in the ridge of the wave pass forward out of it, fall over, and the wave becomes a surge or broken foam, a disintegrated heap of particles, having lost all continuity." (P. 352.) The velocity with which the particles pass forward out of the wave, or are trajected, in other words the velocity of translation, is in proportion to the height of the wave. The mechanical power exerted is, therefore, in proportion to the height of the wave. This is so apparent to every one who has watched the surf, in different stages of violence, that it is hardly worth while to state it.

The wave I have described here is the positive wave of the first order; that is, the wave which makes its appearance in a form wholly raised above the general level of the fluid. And it is this form of wave that is to be seen at all times breaking upon an alluvial coast, and there only; it is the final wave which, inside of, and beyond, all others, comes into actual contact with the beach, and defines the inner limit of the water. This form of wave follows upon the destruction of the waves of the sea, as they break upon the shore, as may be observed at any time on the sea-shore, and to the greatest advantage upon the long, gently sloping, and shallow beaches. "One of the common *sea waves* approaches the shore, consisting of a negative or hollow part, and of a positive part raised above the level." As the water becomes more shallow the positive part increases in height, this increase goes on with the diminution of depth, until at length the wave breaks, and its crest falls forward into the hollow in front. (P. 373.) But it does not cease to travel, though it takes a new form. The water inside of the breaker presents the appearance of a plane, more or less inclined, the surface of which is broken by small raised waves, without any companion hollows, that is, waves of the first order, which are everywhere breaking, and everywhere, therefore, exerting the projectile force, by virtue of which any matter held in suspension is thrown out and forward, while any substances upon which they impinge receive a shock that tends to force them still farther up on the beach.[1]

There are two or three characteristic features of the sea-beaches, which exemplify this action, and which fall under the most cursory observation. I referred to them in the beginning. One is sea-weed, the others shingles, or stones and wrecks. Every one must have noticed how the light sea-weed, which is easily moved, shows by an exact and well-defined line the limit of height of the water at the preceding flood tide. Indeed, there will be several such lines seen on most beaches where the weed is abundant, each one corresponding to different heights, and these lines vary from time to time. The heavier material, however, of the stones and wrecks, is found farther up on the beach, and shows the extent to which the mechanical action of the water has reached in great storms. They are only moved by the violent impulses belonging to the action of waves generated by violent tempests.

Such then I conceive to be the mode of mechanical action, by which the law of deposit of the flood tide operates. The inward tendency of the wave action on the shore, ejects, or repels, as it were, the matters brought under its influence, and the transporting power of the flood current bears them from place to place, bringing them finally under this influence. And further, as the mechanical force of the flood current gives to the breaking wave an inclination in the direction of its course, the projected particle will not strike the beach perpendicularly to its length, but obliquely, so that it will advance, as it rises on the shore; and in this manner, also, the combined action of the two forces leads to the accumulation of deposits in the direction of the flood tide.

Herein is contained an explanation of the connection between the manner in which waves approach sea-beaches, and the local direction of the flood current; which was recorded in the Memoir, p. 140. And lastly, the action of the great oceanic tide wave, if, as was before observed, it approached a sea-coast without interruption, would be similar; that being regarded by Mr. Russell as a wave of the first order.

If this mode of deposit of the flood tide be regarded as a fundamental and permanent law, and it would seem to be so, then it becomes of interest to inquire into its design, and into the results it has effected in the long lapse of time, the *secula seculorum*, during which our earth has been undergoing modification and transformation. And in order to do this briefly, I will select for an example a period in

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[1] This change from the sea wave, or wave of the second order, to the wave of the first order, in the course of which the motion of oscillation of the water particle is transformed into a motion of translation, may be compared to Mr. Russell's case of "Genesis by a column of fluid," acting, to use his language, as a "mechanical prime mover," by means of which that wave is generated which exhibits throughout its action, the "transmission of mechanical force."

the world's history which was most fruitful in producing the present form, and filling up, of our globe, the most active, so to speak, in preparing it for its most perfect development of life; and will apply to it some of the views which readily suggest themselves.

It may be premised, however, that the same views might also be applied to earlier periods of geology. During the first period of organic life, the indications are, I believe, that there were numerous and widely extended seas of little depth, and long shallow beaches, over which the wave of translation would have had free play. But whatever may have been the temporary prevalence of the laws of aqueous deposit during any particular period, as the old red sandstone, or the cretaceous, it is certain that the present *form* of the earth's crust is due to other causes, to mighty revolutions "which elevated entire mountain districts and depressed others." (Agassiz, *Edin. New Phil. Journ.*, No. 35, 1843, p. 4.) A period which produced faults, dislocations, and protrusions, that remain the lasting evidences of the violence that reigned at that epoch.

But the period to which the views that have occurred to me seem particularly to apply, is that subsequent to the tertiary, and preceding the drift, which is supposed to have supplied, or must have supplied the drift material, and over which, on several accounts, the tides and currents of the ocean must have exercised a great and permanent influence. A greater influence than now; because, the matter subjected to their action was much more abundant, and the field over which it was exerted was much more extensive, owing to the greater portions of the European and American continents being under the sea. The epoch of the retreat of the glacial period, as it is called by Agassiz, is the one referred to. The movement of the masses of loaded ice, and the numerous floods formed from the melting ice and snow, both carried with them that immense quantity of diluvium and sand, the detritus of older periods, either made by the ice, and the atmospheric changes accompanying it, or collected by the flood from older degradations, which form the superficial covering of the earth over all its vast plains and slopes. A large portion of this material was carried to the sea; a portion of it was dropped in the progress thither. That which has come in contact with the water, and has been subject to its action, is distinguished by stratification. It is worthy of remark here, that these two characters of the materials, the stratified and unstratified, are found in close connection with each other, owing to the different changes in the level of the sea. Mr. Agassiz has pointed out an interesting example of this in Cambridge, Massachusetts, near Mount Auburn, in the valley of the Charles River, where there is a superficial deposit of stratified sand, overlying the unstratified drift. Every excavation in similarly constituted regions, and the constant recurrence of the valley formations, particularly on the eastern slope of this continent, taken in connection with the materials with which these valleys are filled up, abundantly show that the surface deposit has been carried down to the sea in and by aqueous forces operating on the surface of the elevated lands. At the period referred to, these forces were most active; the streams, as appears from the examination of their ancient beds, were great and impetuous; the amount of material transported was immense. If, when this material was brought down to the sea border, and subjected to the power of the waves and currents of the sea, either by floods or by the subsidence of the land, it had been removed by their action, and distributed over the great depths of the ocean, the form and size of the continents would have been very different from the present. It would have been lost in space, instead of serving, as it does now, to fill up the cavities between the olden strata, to level off plains, and to create the comparatively uniform platform which is the actual stage of human existence.

To prevent this waste and diffusion, and to secure the actually existing state of things, we may conceive to be the office of the law of deposit of the flood tide.

By virtue of this law, which, as I have said before, may be resolved into two modes of action, one the transporting power of the flood, the other the mechanical force of the wave of translation; the sedimentary matter, especially of the coarse sort, is repelled by the sea, returned again to the base of the mountains from which it was originally taken, and distributed with something like equality over the vast spaces that divide them. And the admitted state of gradual elevation of the continents must have been particularly favorable to the operation of this law, on account of the long, shallow, and sloping basins and beaches which it created.

And this view finds some confirmation in the character of the sea bottom. Wherever soundings of great depth have been obtained, the bottom has been found to be of the finest mud, such as, when dry, becomes almost an impalpable powder. And this is the lighter sedimentary matter, which, approaching somewhat to the specific gravity of water, is removed by the river currents penetrating far into the sea, and subsides in the ocean beyond the influence of the tidal currents; the latter being most rapid and most influential nearer the coast. But at a limited distance from the shore, along the sea border of the Atlantic States, and to a limited depth, the bottom is sand, the sand of the beaches. Here, then, is exhibited the outer terminus of this aggregation of the coarser matter around the nuclei of its origin, the skeletons, of which it constitutes, as it were, the flesh and muscles. It has for this purpose been sifted out by the water.

In this paper, reference has been made to the probable effects of the atmospheric fluctuations, which there is every reason to suppose must have been much more violent and very different from those of our time. But it readily suggests itself, that these must have exerted great influence in producing the present state of things, as far as it has been brought about by oceanic forces, (through their control of these forces,) when we consider that the great waves of the sea, which are waves of the second order, after breaking upon a shore, are changed into waves of the first order, in which the particles have the motion of translation, or the projectile force, and that this form of wave continues to the very edge of the water, and ends its life on the dry land, its mechanical force being in proportion to its height.

The effect of general oceanic currents having one constant direction, would be the same as that of the flood current, both in the power of conveying matter, and in that of modifying the manner in which the waves break on the shore, where, of course, this current came in contact with the land.

And finally it will be observed again, that although I have selected the latest period of great organic change, and the one that has been the most fruitful in the creation and supply of loose materials, suited to conform to the aqueous action, as it has been described for the illustration of these views, yet there seems to be no reason to doubt that this law, which operates so actively and beneficially now, was equally efficient in earlier periods of the earth's changes.

The earlier deposits are those of the sea in its depths, and along its shores, and (as it has been said) "our examination of the structure of the existing land is nothing more than the examination of the successive deposits in the ancient ocean, varied by the effects of subterranean movements." (Phillips.)

But these views of the aqueous forces, and their action, assume a special interest from the beginning of the tertiary period, on account of the marked geographical relation of the marine tertiary strata to the present basins and arms of the ocean, and the analogy of the tertiary sediments to the daily production of the existing seas and rivers. The distinct separation of the tertiary from the cretaceous deposits, the difference of the organic remains constituting distinct groups of life, and the similarity or identity of the organic remains of that period, to those of the existing races in the sea and on the land, together with the reasons before mentioned, have led to the opinion that the tertiary commences a new condition of the globe, intimately related to the present state. (Phillips.)

And another reason for this opinion may be added to the above, which seems to me to possess hardly inferior weight; and that is, the general conformity of the tidal motions, both wave and current motions, of the tertiary period to those now existing, and the adaptation of those motions, under the laws of action as here understood, to produce those results which are apparent in the present form and distribution of the tertiary deposits.

DESCRIPTIONS

OF

ANCIENT WORKS IN OHIO.

BY

CHARLES WHITTLESEY,

OF THE LATE GEOLOGICAL CORPS OF OHIO.

ACCEPTED FOR PUBLICATION

BY THE SMITHSONIAN INSTITUTION,

MAY, 1850.

COMMISSION

TO WHICH THIS PAPER HAS BEEN REFERRED.

BRANTZ MAYER.
E. G. SQUIER.

JOSEPH HENRY,
Secretary S. I.

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INTRODUCTORY REMARKS.

My first critical examinations of the ancient tumuli, forts, excavations, ditches, and lines of embankment that abound in Ohio, were made during the years 1837 and 1838, while engaged as a member of the Geological Survey of the State.

The first and second geological reports of the Corps show what progress had been made in the work of describing these venerable ruins, when the Survey was suspended for want of funds.

Long before that time plans and descriptions of many of them had been made, some of which are quite accurate; while others, particularly those described in the travels of Ashe, and the compilation of Priest, are often fictitious. The plan of the great work at Marietta, by the Rev. S. Harris, made in 1802; the Papers of the Ohio Company, edited and published by Dr. S. P. Hildreth; and the surveys of Dr. John Locke and Mr. James McBride, are worthy of reliance. The "Antiquities of Ohio," published in 1819 by Caleb Atwater, is by far the most complete of the early publications on this subject; and considering the new and inaccessible state of the country at that time, and the discouragements and difficulties of making detailed examinations, his plans are in general as correct as could be reasonably expected.

The course which I have pursued has been to visit in person all the known ruins, and if any one had previously examined and correctly described them, to give him credit for the plan, adding, if necessary, some written explanations. When the Geological Survey terminated, about one-third of the works had been examined, and Mr. Joseph Sullivant, of Columbus, Ohio, who took a deep interest in these mysterious remains, proposed that I should continue their survey with a view to a joint publication, he bearing the actual expenses. Under this arrangement, in 1839 and 1840, I made examinations of nearly all the remaining works then discovered, but nothing was effected towards their publication.

In 1845–6 Messrs. E. G. Squier and E. H. Davis, of Chillicothe, commenced a systematic exploration of the numerous earth-works in the rich valley of the Scioto, and finally extended their researches throughout the State of Ohio, and the West.

The results of their labors are extensively and creditably known as composing the first volume of the Smithsonian Contributions. At the request of these gentlemen, I furnished them with such memoranda and plans as they desired, which may be seen in their work, duly credited to me.

Such of my Surveys as were repeated and published by Messrs. Squier and Davis, were, of course, superseded, and became useless; for I find, on comparison, that their plans in general agree exactly with mine, and the exceptions are such as could scarcely be avoided where low walls, almost obliterated by time, or concealed by thickets and standing grain, are to be delineated.

There remained, however, several works not yet described, and it is to this class, with one exception, that the present communication relates.

This memoir may therefore be regarded as a supplement to the descriptive part of the first volume of the Smithsonian Contributions; and so far as Ohio is concerned, the two may be said to present the *descriptive* part of the whole subject of ancient mounds, forts, pyramids, and similar constructions.

Those who choose to speculate upon the objects for which these works were made, the character of the people who built them, and the relation the latter held to races at present known, may rest assured that they have reliable facts on which to proceed.

My object has been throughout merely to present additional facts for the use of the antiquarian, performing the part of a common laborer, who brings together materials wherewith some master workman may raise a perfect edifice. Though the ancient works of Ohio may not all be described, because they are probably not all discovered, yet it can scarcely be doubted that a type or sample of every variety must now be in the possession of the public.

A number of the works described in this paper are of a remarkable character. They consist of heavy excavations, ditches, and moats, without the usual exhibition of walls and embankments.

With regard to the geographical range of artificial mounds and other ancient structures to the northward, I have seen them as far as Point au Chêne, on the Mississippi, in Minnesota, about latitude 47° N. Those of Wisconsin are very numerous, but they are low and of small dimensions. They are about to be described by I. A. Lapham, Esq., of Milwaukie, and I think it will appear that they belong to a different race or a different era from those of Southern Ohio. In fact, those found near the south shore of Lake Erie differ from both, and are probably due to a different age or people.

I do not feel inclined to attribute the great works of Central and Southern Ohio to the progenitors of our Aborigines; but in regard to those of Wisconsin and Minnesota there is room for doubts and ample discussion on this point.

CLEVELAND, O., *April* 3, 1850.

PLATE I.

ANCIENT EXCAVATION, BIG BOTTOM, PIKE COUNTY.

The works here represented are situated on the west bank of the Scioto River near the line between Pike and Ross Counties. The design appears to have been to form a cut or passage from the bottom land above "Switzer's Point," to the bottom land below; but what necessity there was for so expensive a road, is beyond conjecture. The Point (as it is called) is only eighteen or twenty feet above the bottom, and is easy of ascent and descent. Only a very small portion of the earth removed is now to be seen; having been transported to some spot which I did not discover. The banks *E, E, E,* along a part of the edge of the cut, are light; only one and a half feet high and ten broad.

The sections or profiles *a b,* and *c d,* give the dimensions of this ditch, along which the engineers of the Ohio Canal located a portion of their work. If there were any signs of this passage having been acted upon by running water, we might conclude that it had been used for hydraulic purposes; but its sides and bed are very little injured, or worn away; no more so than we might expect from the effect of rains, frost, &c. There are probably other remains in the vicinity, although I could hear of none. At the north-eastern end of the east bank, *E,* is an artificial mound five feet high and thirty broad; and near the termination of the western embankment is a natural one, disconnected with the bank. A little to the west and north-west, is a natural ridge which appears to have been trimmed by art, and to have been used in connection with the lower portion of the western line of embankment. The second bluff is elevated from forty to sixty feet above the river, and is generally under cultivation, as well as the rich bottoms, which are very extensive.

This work has not the appearance of a drain for swampy land or ponds; for it is not on the most direct course to the river. If designed as a work of defence, it has rendered the Point by no means inaccessible; for the bottom land on the other side is comparatively solid ground, and the low bluff presents no natural obstacle. The trench itself, unless filled with water, would be but a slight impediment. It is situated within twelve miles of the "Graded Way," near Piketon, described in the Smithsonian Contributions, I. p. 88. The mass of earth removed is here greater than at Piketon; where a large portion, though not all, is used in forming the bank at the sides.

I think it probable that this class of works was connected with religious or superstitious ceremonies.

PLATE II.

ANCIENT WORK, NEAR TODD'S FORK, WARREN COUNTY, OHIO.

This sketch exhibits very little that is different from the works commonly seen in Ohio, and heretofore described, except the raised part, D, which is analogous to the effigy-mounds described by Dr. Locke, Mr. Taylor, and others, in the north-west. The land had been some years under cultivation (1839), and possibly the full figure was wanting; but, as it was when surveyed, the resemblance to an animal or even a monster was not very striking. If the semblance of legs had been seen on the eastern side, it would be easy to imagine it intended for a living creature, or a caricature of one; but even then, what animal the constructors wished to exhibit would be very doubtful. The western edge is the highest, being four feet, and the eastern about two feet. At *i*, is a small mound within the boundary of the figure, D.

The wall of the rectangular part of C, is low, and without ditches. The semicircle or "sickle," B, has a wall a little heavier, being two feet high by twenty broad, and is better defined. The more northerly of the two segments of small circles, E, with wide openings, is partially obliterated.

At *n*, is a very distinct road, or graded way, from the plain of the work down to the river bottom, a descent of about twenty feet, and steeper than is usual with the roads of the mound-builders.

The embankments at A are low and narrow, but distinct. It is very seldom that lines of embankment descend to the first bottom, as is the case at the north-east corner of the part, C. M is a small mound.

The pits *a*, *a*, *a*, are evidently artificial; but are not capacious enough to have furnished much earth for the walls, and there are no excavations in the vicinity from which the material of these appear to have been taken.

With the high limestone bluff overlooking it on the south, and in the absence of ditches, this work can hardly be considered as one of a military kind. The river is everywhere fordable, and the walls in their best days were slight.

The survey was made under circumstances that did not allow of a minute measurement of all parts of the work. Some of the details are given from an eye sketch, and this obstructed occasionally by a snow-storm.

It is situated about six miles below the great fortification, described in Smithsonian Contributions to Knowledge, I. 18, Pl. 7.

The great number of remains on the Little Miami, between this work and the mouth of the river, indicate a very dense population, in the days of the mound-builders.

PLATE III. No. 1.

WORK, NEAR NEWTOWN, CLERMONT COUNTY, OHIO.

Among the curious structures of the mound-builders, there are none more difficult to explain than this. On a detached ridge, composed of limestone gravel, covered with a clay loam, is a low wall, averaging two feet high, and fifteen feet broad, nearly in the form of a circle; although its north and south diameter is about twenty-five feet the longer. The average diameter of the circle is four hundred and seventy feet. The flat ridge on which the figure A is situated, is about twenty-five feet higher than the adjacent plain; which is from twenty-five to thirty-five feet above the Little Miami River. Outside of the circular figure, there is a space from twenty to thirty feet wide, on the natural surface of the ground. On the two opposite sides of the circle, where it occupies the height of the ridge, is an external ditch, or excavation, enclosing about half the figure. It is from seventy to eighty-five feet broad at the top, and from twelve to eighteen feet deep. The bottom of this trench is not smooth, and is from seven to ten feet higher than the adjacent plain. Its sides are as steep as the gravel and earth will lie. On the east, in the direction *c g*, is an embankment or grade, extending by a gradual slope, from the enclosure A to the plain. It is one hundred and sixty-eight feet wide at the neck, where it joins A, and has, at the edges, raised side-walls, like those made for pavements in cities, with a drain or gutter inside. The space between the side-ways is rounded like a turnpike, as represented in the section *d e*. Its length is six hundred feet, and the side-ways are connected with a low and now almost obliterated wall, turning outwards each way at *i*, *i*. Some distance to the north-east is another traceable fragment *f*, *f*; and this may, with *i*, *i*, have been portions of a large ellipse, now destroyed by time and cultivation.

The earth from the outside ditches of A was used to form the embankment, *c*, *g*, through which a rivulet has cut its way near the eastern extremity. The small circle at *c* represents a mound eight feet high, a little out of the centre of the work. The group of mounds *m*, *m*, *m*, are from two to fourteen feet in height. B is a circle, with a slight inside ditch, and a broad opening for an entrance.

The section, *a*, *b*, gives the position of the ditch, *n*, the bank, *o*, and the space of thirty feet between them, called a berme.

There are some examples of graded ways among the ancient works of Ohio, but none resembling this. The grade at Marietta leads from a strong work down to the Muskingum River, and had an evident purpose, that of access to water. It is principally an excavation and not an embankment. There is also a grade, partly in excavation and partly in bank, from a portion of the Newark works in Licking County, leading to a branch of Licking, or Pataskala River.

The great excavated road at Piketown, likewise descended to water. But here, a grade that might with as little labor have been constructed in a direct line to the Miami River, is made in the opposite direction, away from water. I should judge that the rivulet was not a permanent stream, and therefore could not furnish a constant supply of water. Besides, the graded way instead of terminating at this rivulet, crosses it, and probably by an ancient culvert or sluice, allowed the water to pass under the road.

Without taking such measurements as would be sufficient to estimate the contents of the ditch in cubic yards, it appeared to be about equal to the embankment in capacity. The section *a*, *b*, gives its form, and the position of the low interior wall.

It is not improbable that there may have been outworks connected with this remarkable group that were not seen, or which have been destroyed by the plough.

PLATE III. No. 2.

MOUND NEAR NEWTOWN.

FIGURE A, of the separate sketch, represents the base of an irregular mound, forty feet high, two hundred and fifty feet on the longer axis, and one hundred and fifty on the shorter. It appears to be composed of the light loamy soil of the vicinity, and is the only instance within my observations of a mound with an irregular outline. Where the road ascends the low gravel bluff, from the first to the second bottom, immense numbers of human bones were found in comparative preservation, imbedded in limestone gravel. There is another mound fifteen feet high near the village of Newtown, standing on the *first* bottom. A good notice of the ancient works about Newtown appeared in the "Cincinnati Chronicle," in September, 1839, by Mr. Timothy Day, of Cincinnati, Ohio.

PLATE III. No. 3.

WORK NEAR COLUMBUS, OHIO.

THESE structures are simply circles, or figures approaching to circles, with occasional irregularities. There is a difference of fifty feet in the diameters of the larger one, and the outline bends each way from the curve of a true circle, a few feet, making short straight portions, not capable of representation on our scale. The ditches are at present very slight, and not uniform in depth or breadth. From the top of the bank to the bottom of the ditch, the difference in no place exceeds two and a half feet. On all sides, for miles, is a low clayey plane, inclined to be wet, with very slight undulations. This is the only remarkable fact connected with this work. Its ditch being *external,* and its openings narrow, indicate a work of defence; and if it were known that the ancient inhabitants of the Scioto used palisades, we might safely conclude this to be a place of defence, relying solely on artificial strength. There is no running water in the vicinity.

PLATE IV.

ANCIENT WORKS AT CINCINNATI (NOW OBLITERATED).

FIGURE A is nearly elliptical, the major axis being eight hundred and thirty, and the minor seven hundred and thirty feet; the height of bank two feet; the breadth of base thirty. The entrance on the east is ninety feet wide, guarded by two low oblong mounds, *a, a.* From the entrance, to *b,* is a low wall, or high road, one foot high, and nine broad, and *b* is a mound eight feet high, sixty feet broad, and one hundred and twenty feet long. When, in the progress of city improvement, this mound was removed, a large number of trinkets were found at its base. D is a circular bank, one foot high, fifteen feet broad, and sixty feet in diameter.

C appears to be a portion of an unfinished, or obliterated work, which must have been large, perhaps including the works at A. At B is an enclosure, the parallel sides of which are forty to forty-six feet asunder, seven hundred and sixty feet long, about two feet high, with an opening on the south, thirty feet wide.

F represents an oblong mound, thirty-five feet high, which, until 1843, was not entirely obliterated. General Wayne, whose army encamped near it in 1793, cut off the summit, in order to erect a sentry-box. It was in this mound that the curious carved stone was found, which is described by Squier and Davis, in the first volume of Contributions, page 275. P is an excavation, two feet deep, and fifty feet across; and *m* is a mound nine feet high. The high ridges to the east of Duck Creek are about four hundred feet above low water, and composed of the "Blue Limestone," a member of the Silurian system.

The first bench is within range of high water, that is, sixty-one feet above extreme low water. The second bench is composed of gravel, with strips of sand, into which wells have been sunk at the work, A, ninety feet, to the level of the river, before procuring water.

The plateau rises towards the rear to one hundred and twenty-seven feet, at the foot of the mountains, a mile and a quarter from the river.

It is remarkable that the mound-builders of old, and the city builders of our own times, selected in a great many cases the same sites. Portsmouth, Marietta, Circleville, Chillicothe, Alexandersville, Frankfort, Piketon, and Newark, are on or near the sites of the ancient cities.

Among many mounds and embankments, this people have left very few excavations; thus indicating a want of metallic implements, of the size and kind necessary to remove solid earth. This is likewise manifest, from the fact that no quarries of rock have been discovered which can be referred to their labors. The mounds and walls of stone which they have left, are formed of loose and small stones, such as a man, or at most two men, could lift, and thrown together loosely, without being trimmed or cut.

PLATE V. No. 1.

WORKS IN ADAMS, WASHINGTON COUNTY, OHIO.

A VERY few words will supply what is wanting in the figure, to give a proper idea of this work. The lines are low and almost destroyed by the plough, being, at the time of survey, at most only two feet high. The situation is dry and pleasant, an agreeable place for a village, convenient to water; the soil consists of sand and gravel. The figures 4, 8, 10, &c., indicate the position and height of mounds. These are of earth, excepting two, marked *m*, *m*, which are of sandstone and limestone.

PLATE V. No. 2.

WORK NEAR JACKTOWN, LICKING COUNTY, OHIO.

THIS work is situated eighty rods north of the National Road, and two miles east of Jacktown, Licking County, Ohio.

The ground here is elevated, the enclosure surrounding the summit of a hill, not very abrupt; the soil is a mass of broken sand-rock. From the top of the inner wall, *e*, in the section *a b*, to the bottom of the ditch between the walls, the distance is three feet, generally less; both the height of the wall and depth of the ditch, varying at different points. Of the entrances, *c*, *c*, *c*, the northern is the widest, being forty feet; the eastern twenty-eight, and the other twenty-two feet, and without mounds or barriers. The circles at figures 1, 2, 3, 4, represent mounds of stones, such as one, or at most, two men might carry, loosely thrown together. No. 1 was eighteen feet high, with a base of ninety feet diameter. No. 2, fifteen feet height and seventy feet base. No. 3, the same. Their bases are not regular circles, and all of them are now (May, 1838) much injured by the inhabitants of

Jacktown, who use the stone for cellar walls. This consists of the coarse-grained sandstone of the coal series, and constitutes an excellent material for rough walls.

I did not observe any permanent supply of water in the neighborbood, or any reservoirs within the enclosures, which might otherwise be regarded as defensive work. The largest diameter is seven hundred and fifty feet; the shorter six hundred. The interior space rises above the well and ditch several feet, in an oval or rounded form. One-fourth of a mile to the north-east is another stone mound, like those within the work, which is fifteen feet high, and composed of loose sandstone.

About one mile and a half to the south-west, and on the south side of the National Road, on sec. 10, T. 19, R. 17, is a very large stone mound, originally forty feet high; with a base, one hundred and eighty feet in diameter.

Fifteen feet of the apex was removed, many years since, by a believer in *Robert Kid's* treasures, and a cavity sunk nearly to the bottom with much labor. It is even now a commanding object, rising among the trees of a thrifty western forest. The stones are thrown together promiscuously, but in the general form of a regular cone. Some of them have been carried away for masonry. Stone mounds were doubtless made for the same purposes as the earthen ones, the loose fragments of rocks being convenient, and more easily carried into place than earth. Walls of the same material are sometimes found, as well as some of earth and stone mixed.

I have nowhere seen, nor ever heard of, the mark of a tool on any of these stones.

PLATE V. No. 3.

STONE WORK, PERRY COUNTY, OHIO.

This is found in Perry County, five miles north-west of Somerset, Sec. 21, T. 16, R. 17.

The wall is, and must have been very slight, not, on an average, as large as the stone fence of the New England farmer. The stones may have been heaped together with more regularity than they now present, but were not dressed. At the points, *a, a, a,* the wall increases in volume, like a mound or tower; but, in general, it is not above one foot high and ten feet broad; its greatest height does not exceed four feet. The ground is not strictly inaccessible, but difficult of approach, and at the steepest places the wall is built close to the edge of the bluff.

At *b, b,* the rock, a coarse conglomerate, is bare, and a perpendicular fall, of several feet, is exhibited, with large detached blocks, and here there is no wall. At several other points, large detached blocks, not transported, but in place, form part of the wall. The builders do not appear to have employed great mechanical forces, for detached rocks, and such as two or three yoke of oxen could move, are left within a few feet of the wall, while smaller stones from a distance are used. The rough stones of the wall were found convenient, having fallen from the rocky cliffs, on which the work is built.

The interior space of the enclosure is higher than the exterior, and the whole thickly covered with timber.

A little west of the centre is a mound of loose stone, *m*, fifteen feet high. The principal entrance is at the north-west angle, *c*, where the ascent along a ridge is less than elsewhere, but is still laborious. The work is at least one-fourth of a mile from water, the hill is from three to four hundred feet above the adjacent valleys, and detached from other hills.

The position indicates it to be a fortress, which was not completed or occupied. With a heavy wall, a resolute garrison, well supplied with water and provisions, could here make a protracted defence. I do not think pallisades could have been inserted in the wall, for it was not strong enough to sustain them; and, in general, they could not have been sunk beneath the surface, for it is solid rock.

If "abattis," or other wooden obstructions were relied upon, the wall would have been of little service; but its outline being traced, a few thousand men, in an emergency, could, from the loose rocks of the cliffs, have made a formidable wall, in one night. To this enlarged work they might have added wooden defences of some kind. This sketch was made by examining the perimeter in detail, and noting its parts by the eye, and short measurements; its dimensions are, therefore, not strictly exact.

PLATE V. No. 4.

FORTIFIED SUMMIT, THREE MILES SOUTH OF NEWARK, LICKING COUNTY, OHIO.

On the plan of the Newark valley, given by Squier and Davis, S. C. Vol. I., Plate 36, No. IV., this work might be laid down on the hills overlooking the *South Fork*, at an elevation of about two hundred and fifty feet. The stream washes the base of the hill on which the enclosure stands; and runs between the hills and the Ohio Canal. It is, no doubt, part of the great system of works constructed about Newark and Granville. On the west the wall is light, and the ditch shallow, and on the north neither is traceable; probably never made. The manner in which an interior ditch became serviceable to defence, will appear by examining the vertical section, *a*, *b*, showing the two walls as they rise one above the other, on the steep hill-side. The ascent is very difficult from the creek on the north, all the way to the work; so that the open space in the wall on that side could be easily defended. Why there should be so many unprotected openings in the embankment is more than I can account for.

PLATE VI. No. 1.

ANCIENT EXCAVATION ONE AND A HALF MILES WEST OF MEDINA CENTRE, MEDINA COUNTY, OHIO.

It was with some hesitation that I concluded to regard the ditch represented in Fig. 1 as artificial, and an ancient work, but I am now convinced that it is an excavation, and anterior to the earliest white occupation of this region. To explain its design is more than I shall attempt. If it was intended as a race-way for water power, it need not have been sunk so deep, and should have been connected with the stream at the upper end. It is not low enough at the bottom to allow the water of the river to flow through so as to cut off the bend, if the object was to change the channel without first raising the water above. The ditch itself does not show the action of running water, being remarkably well preserved at the sides and the bottom.

The soil is clayey and retains water.

The trench is not of uniform width, varying from thirty-five to twenty-five at the top; its sides are as steep as such earth will lie.

There is only a slight elevation at the edges of the ditch, showing that the earth taken out was either carried away, or spread evenly over the adjoining surface. In this particular it corresponds with the ditch described heretofore at "Big Bottom."

A part of the ground between this trench and the river is subject to floods, being from nine to fifteen feet above low water. It is commanded by the bluff opposite, which rises twenty-five or thirty feet, so that the place could not have been occupied as a defensive post. The water of the creek is sluggish, and has a muddy bottom; but at ordinary stages it might be passed by men or horses. By damming the stream below its channel, the ditch might be filled with deep water, thus forming a moat difficult of passage, and affording some security, were not the whole overlooked on all sides by higher ground.

The work must, I think, have had some connection with ceremonies, religious or military; but I know of nothing analogous in history or antiquarianism, except those given in these sketches.

PLATE VI. No. 2.

FORTIFIED POSITION, WEYMOUTH, OHIO.

At Weymouth, five miles north-east of Medina Centre, Medina County, the east branch of the Rocky River, which is about fifty feet wide, passes rapidly through a narrow gulf in the rocks, from forty to fifty feet deep, with sides nearly vertical, and composed of soapstone, and thin bands of sandstone interstratified. The fall of the stream is estimated at one hundred and twenty-five feet in a mile and a half, along which numerous mills and machinery are placed.

On a narrow point, protected on all sides but one by the precipice and the stream, the mound-builders entrenched themselves behind three walls of earth, with exterior ditches, at present two and three feet deep. The embankments are also from two to three feet high, and are without openings or gateways.

The occupants must have passed in and out of the work by steps, leading over the walls. In excavating, the rock is found at the depth of two and three feet. The space inside the parallels was used by the present occupants as a burying-ground; but is now abandoned, because graves cannot be sunk to the usual depth without cutting away the gritty sandstone beneath.

It would be difficult to find a position more inaccessible to a foe.

From the inner wall to the point of the hill is three hundred feet; across the neck on the outside parallel is two hundred feet. The space inside the work is, therefore, not large. The soil is a stiff clay. On the south and east the ground rises, but not rapidly.

There is a small mound, *m* inside the enclosure, made partly of earth and partly of stone, and also others outside on the north, very small, and filled with bones.

In the crevices of the walls hundreds of yellow rattlesnakes had their winter abode, until the quarries began to be worked, and their retreats were invaded by the workmen, who killed them in great numbers.

PLATE VI. No. 3.

ENCLOSURE HALF A MILE EAST OF GRANGER, MEDINA COUNTY, OHIO.

About four miles south-east of Weymouth, in the township of Granger, in the same county, is an enclosure of earth now nearly obliterated. It may be seen by a close observer, on the east road half a mile from the "Burg," as the centre of the township is called. The soil is dry and gravelly, though the situation is low, nearly on a level with a swamp of several hundred acres on the north-east. The land to the south and east rises very gradually. The figure forms an imperfect circle, having straight portions of two or three rods in length, and is eighteen rods in diameter. The owner has placed a barn over it on the south side, and a house on the west. As usual, the present proprietor appears to have a special grudge against his predecessors; and by dint of much ploughing and scraping, has nearly demolished the ancient monuments of their labor.

Two very fine and constant springs discharge their waters in rivulets on each side, the only perennial ones, as I am told, within a distance of two miles.

There appears to be but one opening, which looks towards the swamp. Where the wall is untouched it is two feet high, and ten broad; and the ditch is of the same dimensions.

It is very doubtful whether this was intended for defence, or at least for protracted resistance. The ground inside is not smooth, but uneven. The location pleasant; though lower than the surrounding country, except on the swamp side. It was probably a place of residence for families, who cultivated the adjacent lands. About a mile north-east, on a knoll overlooking a large tract, is a low mound containing bones and pieces of hardened clay, with small stone ornaments.

PLATE VII. Fig. A.

NORTH FIELD, SUMMIT COUNTY, OHIO.

The engineers who selected the site of this fortification, understood very well the art of turning natural advantages to good account. Why they did not embrace in their plan the whole of the level space within the crest of the bluff, is not easily explained, unless we presume that their numbers were few, and not sufficient to defend the whole. On all sides, the gulleys are from eighty to one hundred and ten feet deep, worn, by running water, into the blue and yellow hard pan that here forms the bluffs of the valley of the Cuyahoga River. The earth is as steep as it will stand; and, in fact, is subject to slides, that lie in terraces, resembling platforms, made by art. Before the ground was cultivated, the ditches are said by Milton Arthur, Esq., the owner of the land, to have been so deep that a man standing in them could not look over the wall.

The soil is gravel, but at about ten feet depth is the impervious "hard pan," or "upland drift," of this region. In the gully on the north the water is permanent at all seasons, running over green shales and sandstones, on which the drift rests. But the ancient inhabitants appear to have dug wells within the fort, at the points indicated by large black dots, which the old settlers say were stoned up, like our wells.

On the western face of the bluff, near where the road descends, is a small spring, not reliable at all seasons. At the north end of the ditch of the *inner* wall, at the neck, there was a narrow space left as a passage into the work, but none in the outer wall. There are low mounds at *m*, *m*. The approach is along a sharp ridge called a "hog's back," merely broad enough for a single road track, for the distance of thirty rods, and the sides are as steep as any part of the bluffs adjacent. The points of land across the ravines are on the same level with the work.

It is not very evident why a few rods of ground were cut off by lines at the south-west angle, nor why part of the ditch was made on the inside on the north and west.

It is very remarkable that, while all the works in northern Ohio are of a military character, there are no evidences of attacks by a foe, or of the destruction or overthrow of any of them.

On the west bank of the river, opposite this spot, is another similar work.

PLATE VII. Nos. 1, 2, 3.

Figure No. 1, Plate VII., is situated in Lick Township, Jackson County, Ohio, on the west half of the north-east quarter of Sec. 19, T. 7, R. 18, on high ground, about one-fourth of a mile north-west of Salt Creek.

The soil is clayey, the work slight, with only one opening which is on the east, and to my knowledge without running water in the vicinity. The ditch being interior, indicates that the work was built for some other purpose than defence, probably for ceremonial uses.

Figure No. 2, Plate VII., is on the same quarter section on the east half, and lies near the road from Jackson to Richmond, on the left hand. The prospect from this mound is extended and delightful. On the west, between this and No. 1, is a ravine and a small stream. As the soil is sandy, it is certain that the mound, attached to the rectangle on the south-west, was somewhat higher at first than it is at present.

Neither of these works is perfectly square or rectangular, but irregular in form, approaching a square.

No. 2 is clearly not a work of defence, and probably intended as a "high place" for superstitious rites. A more charming spot for such observances could not be chosen, if we admit that external circumstances and scenery had any connection with the sentiments of the worshippers; and we must allow that the mound-builders were alive to the beauty of scenery.

Sketch No. 3, is in Franklin township, Ross County, Ohio, on the land of Mr. George Johnson, about one mile west of the Scioto River. Entry No. 488. The soil is clayey, and the work is pleasantly situated, though the ground is not high.

The work is not more than half a mile from the rich bottom lands of the Scioto, which its builders probably cultivated.

A very large *Pyrula perversa*, about eight inches long, now in the State Cabinet at Columbus, was found near Mr. Johnson's house, about two feet below the surface, on the bottoms. There were two of them, which lay touching each other at the apex; the one in the cabinet being entire. This shell-fish is said to exist in the Gulf of Mexico, and on the coast of the Southern States; and has been found in many places at the West, in and about the ancient works. At Portsmouth, Ohio, six or seven were found buried in the soil, beneath the parallels of the great work described in the Smithsonian Contributions. They were at a depth of twenty-five feet in river alluvium. In Kentucky, the same shell has been frequently found, adjacent to old walls and mounds. They were probably used by the ancient race for religious and other ceremonies, as is said to be still the case among the Hindoos.

PLATE VII. Fig. B.

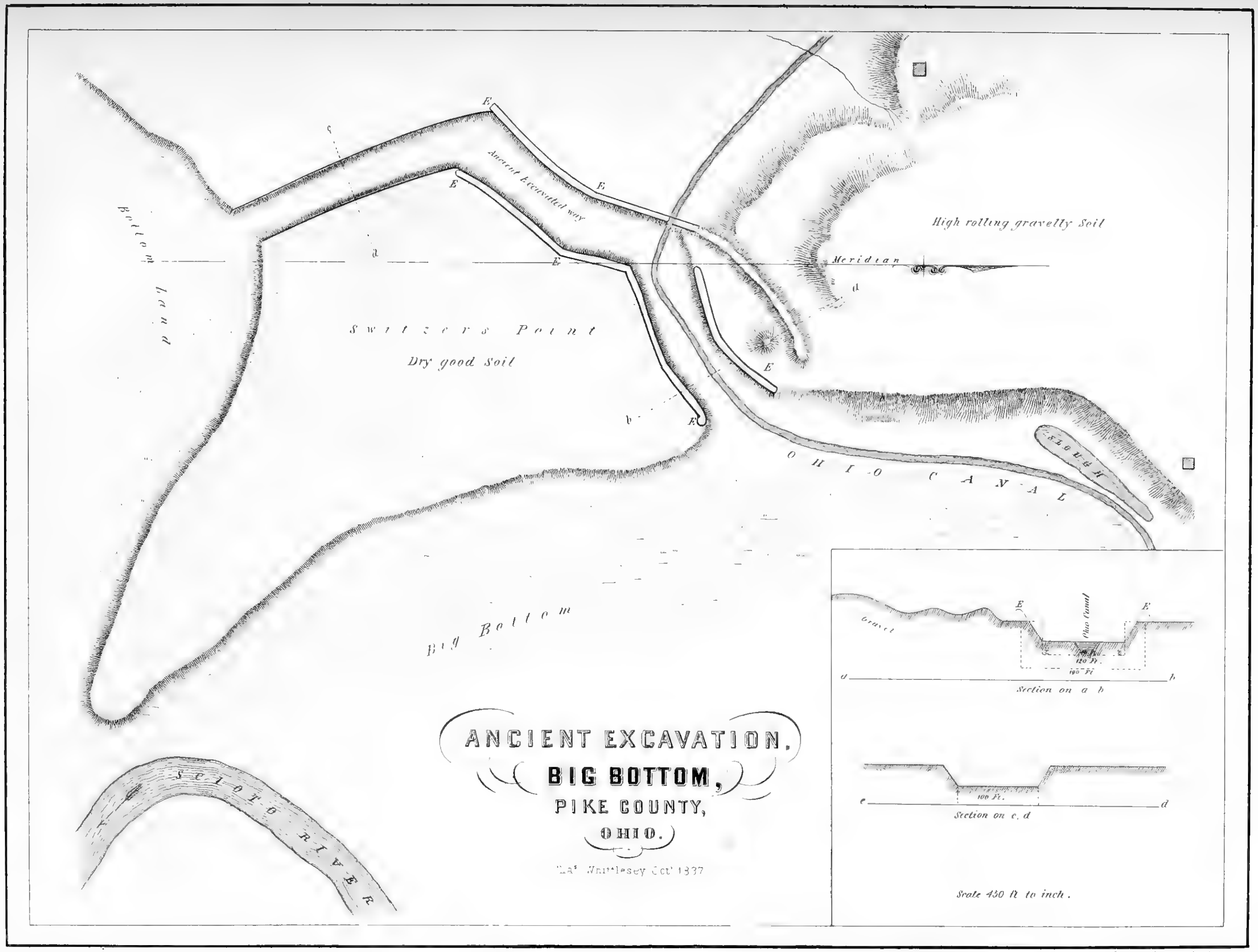
THREE MILES AND A HALF EAST OF PAINESVILLE, LAKE COUNTY, OHIO.

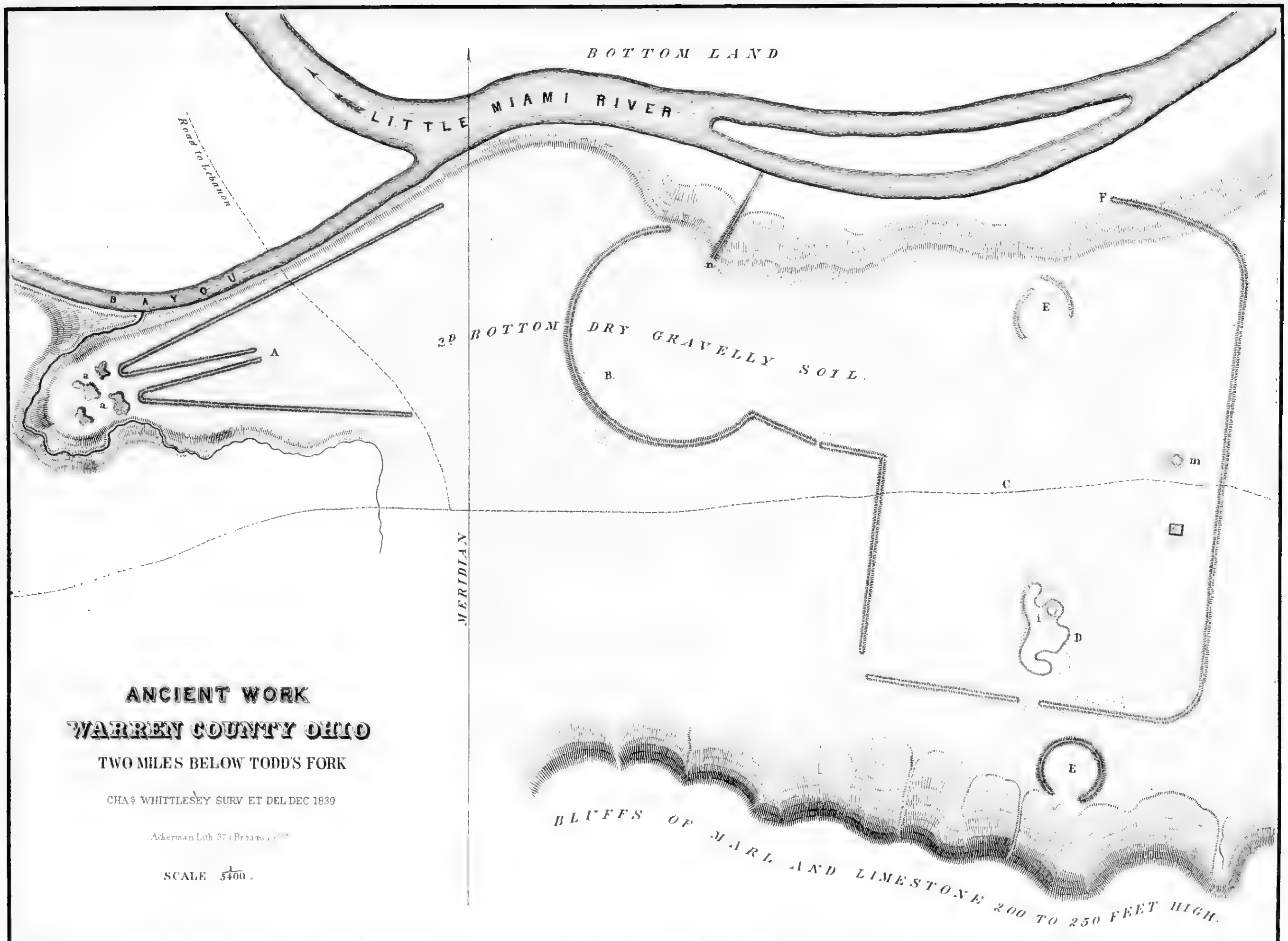
This drawing represents a "stronghold" admirably situated for security and resistance. A long, narrow, natural wall of slate, or shale rock, is left standing between the creek and the river; its direction east and west; its elevation above the water is from eighty to ninety feet; and its faces as nearly perpendicular as the soft shale will allow. Except at the western extremity, a person might leap from the top to the bottom; though it is so steep as to be absolutely inaccessible, without ropes or bushes, or something by which to drag one's self up. The decomposing shale, or "soapstone," is very slippery, forming a greasy clay, always wet. The distance is two hundred and thirty feet from the point A to the first parallel, which is low, being only one and a half to two feet above the natural surface; its ditch about one foot deep, but like all the walls and ditches it varies at different points. Just in rear of this wall the ground rises gently four or five feet, and thence the plateau is nearly level for four hundred feet to the next parallel, and as far as a rise of land about three hundred feet to the east, where the promontory joins the main land. On each side back of the parallels are low bottom lands; but from thence forward to the point on the north is a water-washed bluff, and on the south a flat, through which the creek wanders very irregularly. The Grand River is about two chains wide, but fordable in ordinary stages. Over the whole promontory is a thick growth of hemlock, causing a perpetual shade within the area of the work.

The outer parallels at B are much stronger and better defined than the others, ranging from eight to ten feet in height from the bottom of the ditch. They are not straight or parallel, but irregular in direction as well as height, and are remarkably well preserved. There is an appearance of slight openings, but I think them due to travel in more recent times, wearing down the walls where they are crossed by paths; for although there is no road through the works, there are very old paths and trails, used not only by visitors, but by cattle running at large in the woods. This work appears upon the whole to have been without apertures, being in this respect like the one at Weymouth, Medina County, where the entrance of the occupants was probably by temporary wood work over the walls.

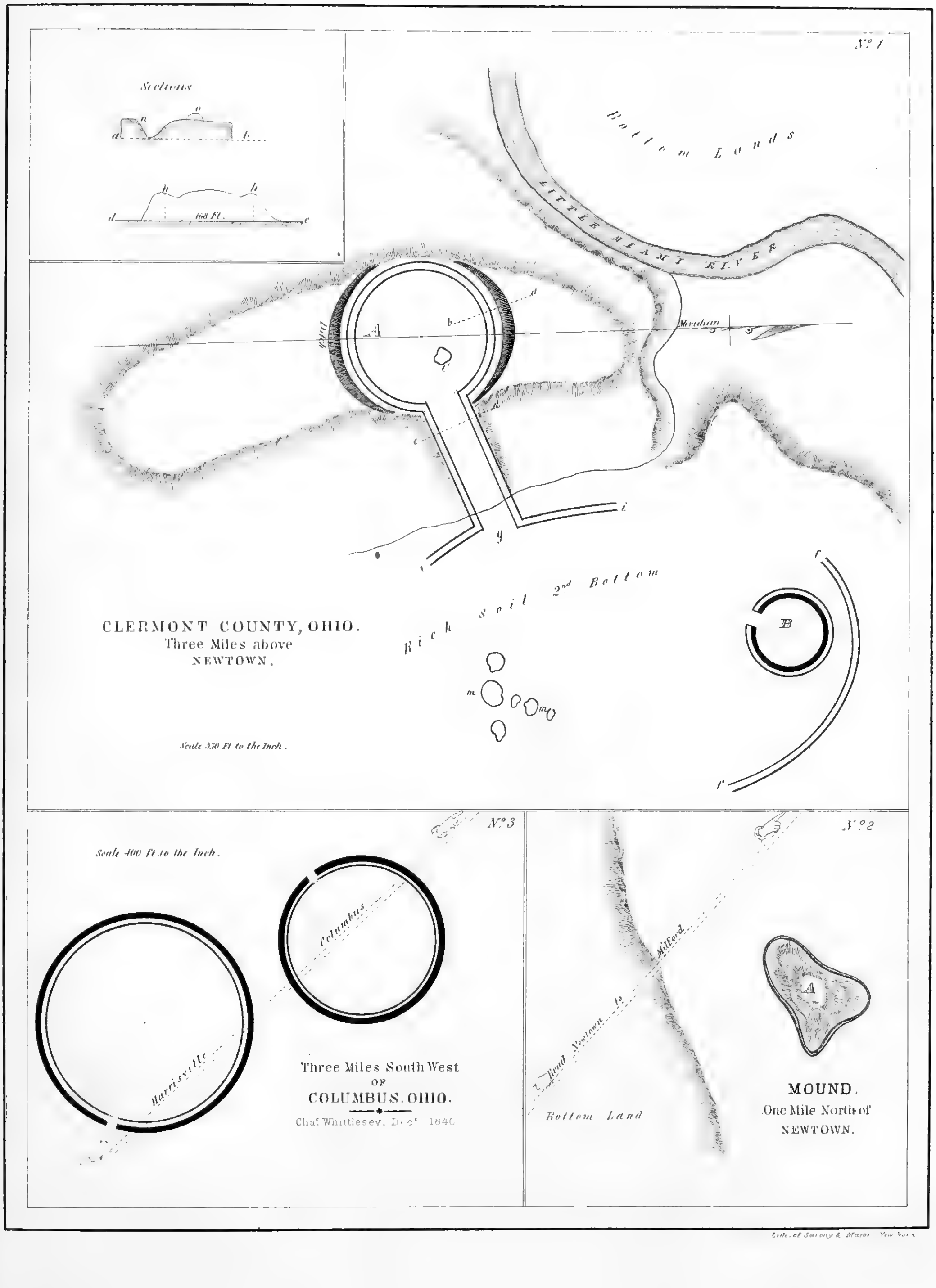
In a direct line, this work is about three miles from Lake Erie. The outer parallels are from fifteen to eighteen feet broad at the base, and from four to four and a half feet high, as shown in the section *a*, *b*.

1.

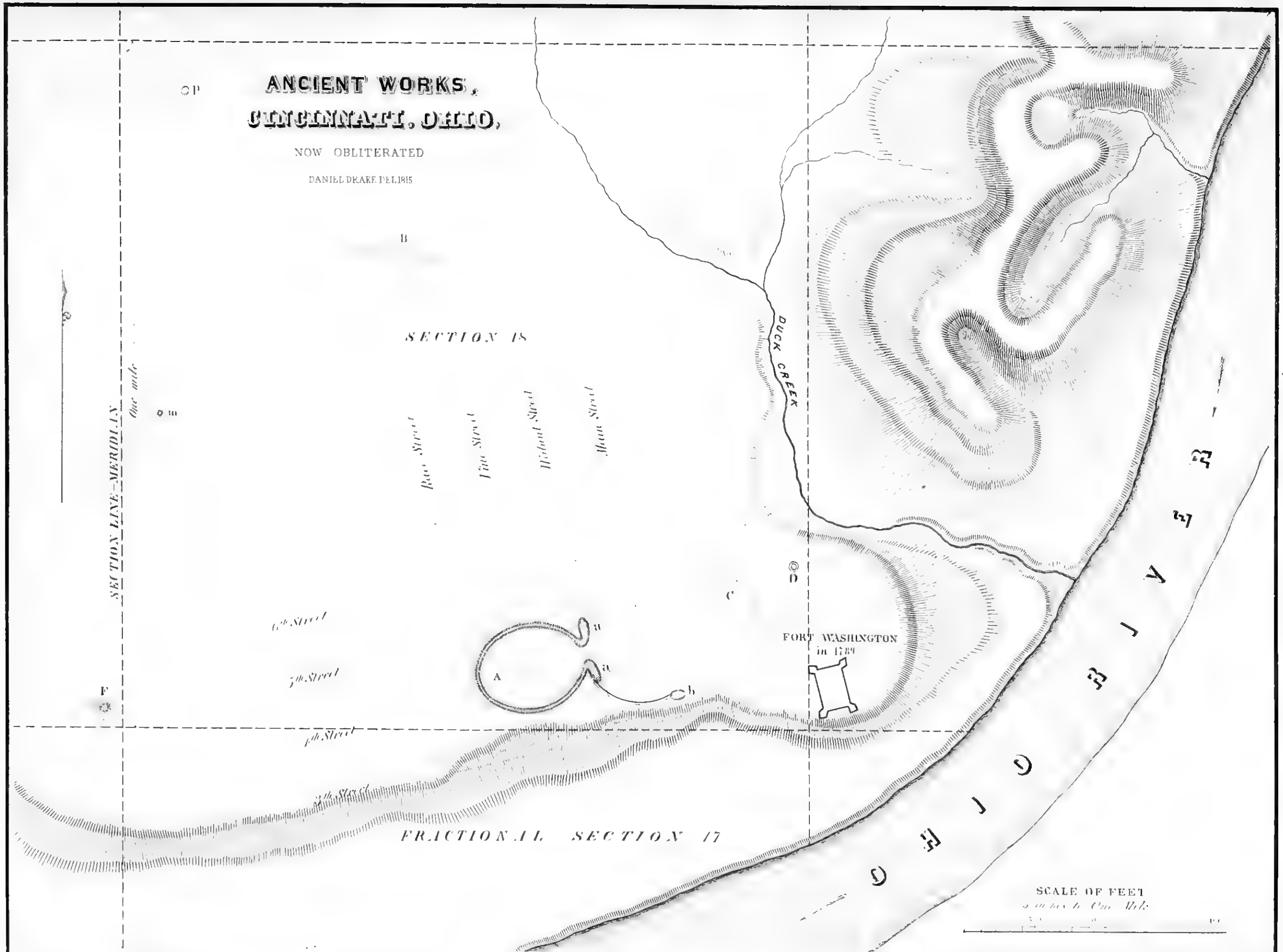

ANCIENT EXCAVATION,
BIG BOTTOM,
PIKE COUNTY,
OHIO.
Chas. Whittlesey Oct. 1837
High rolling gravelly Soil
Meridian
Ancient Excavated way
Switzers Point
Dry good Soil
Bottom Land
Big Bottom
OHIO CANAL
SLOUGH
SCIOTO RIVER
Ohio Canal
120 Ft.
160 Ft.
Section on a b
100 Ft.
Section on c, d
Scale 450 ft to inch.



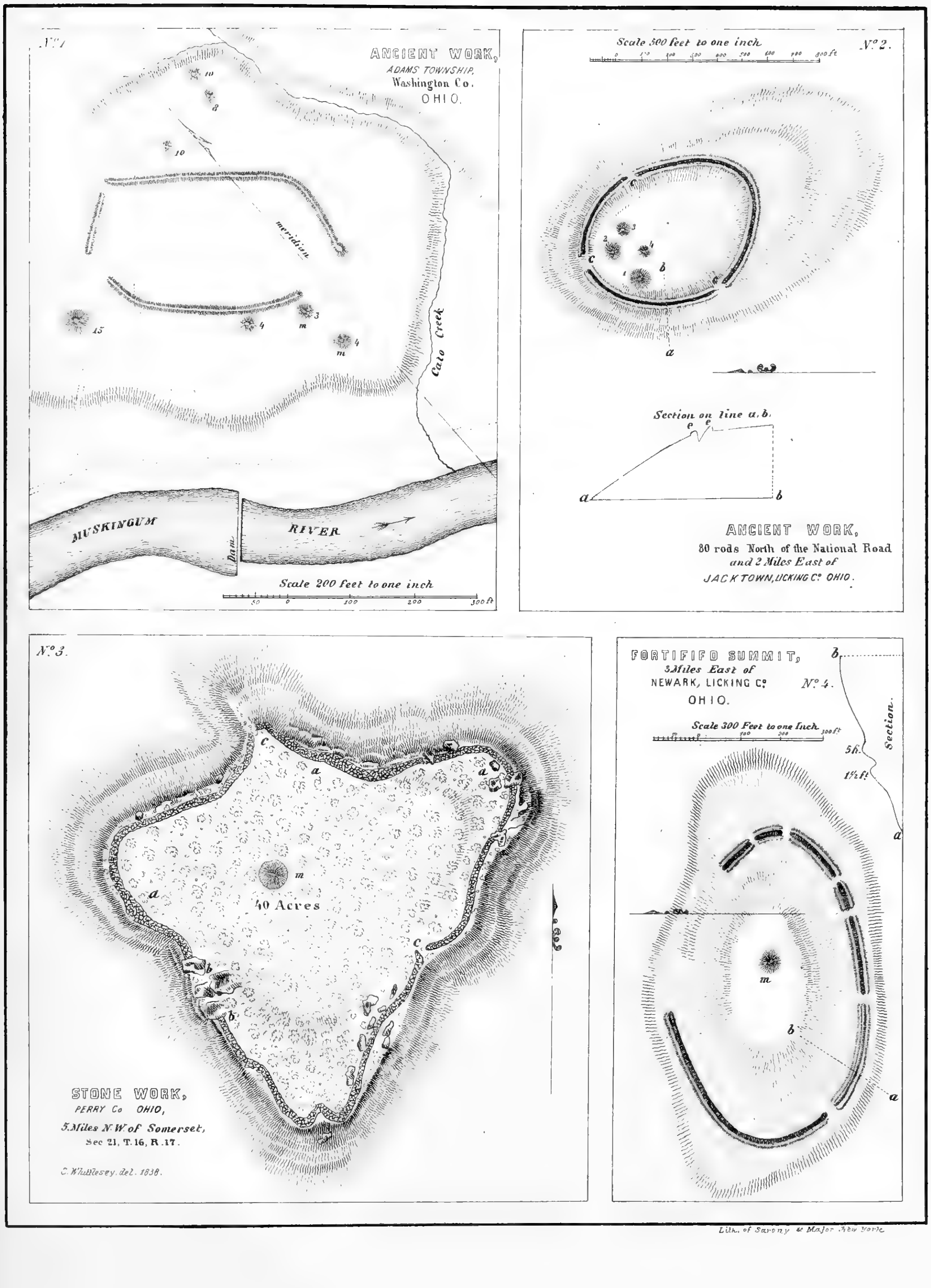
ANCIENT WORK
WARREN COUNTY OHIO
TWO MILES BELOW TODD'S FORK
CHAS WHITTLESEY SURV ET DEL DEC 1839
Ackerman Lith 37 Broadway
SCALE $\frac{1}{5400}$.



Lith. of Sarony & Major New York

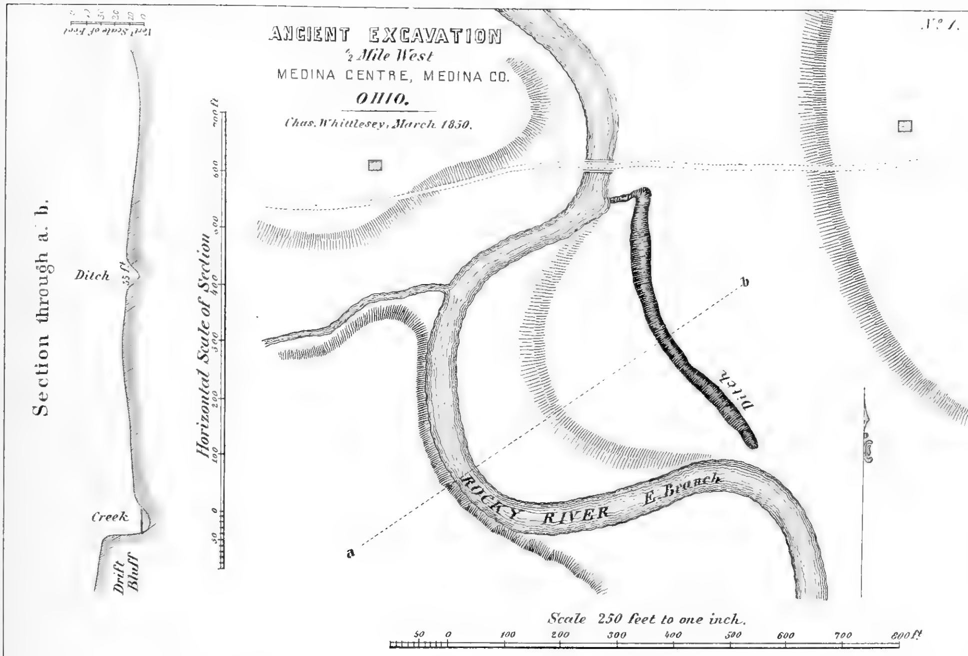

ANCIENT WORKS,
OF
CINCINNATI, OHIO,
NOW OBLITERATED
DANIEL DRAKE Del. 1815
SECTION 18
Race Street
Vine Street
Walnut Street
Main Street
6th Street
5th Street
4th Street
3rd Street
SECTION LINE-MERIDIAN
One mile
DUCK CREEK
FORT WASHINGTON
in 1789
FRACTIONAL SECTION 17
OHIO RIVER
SCALE OF FEET
A
B
C
D
F
a
a
b
m

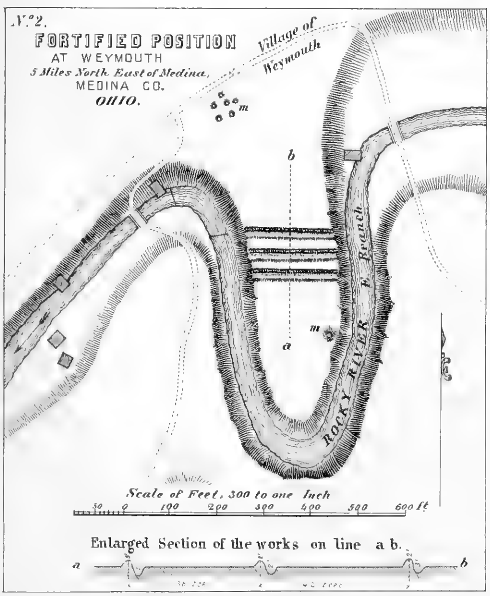
V

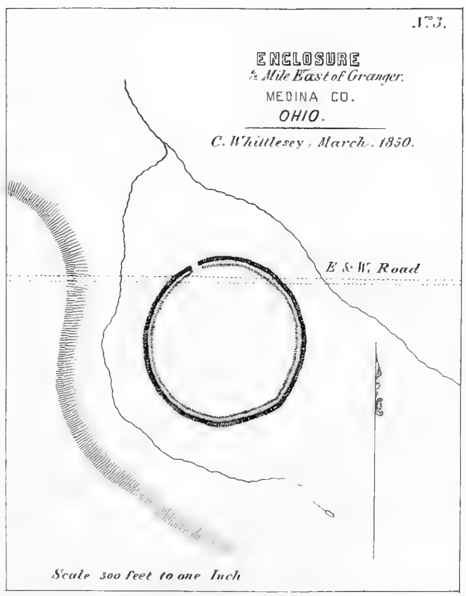


Lith. of Sarony & Major New York

V.I.

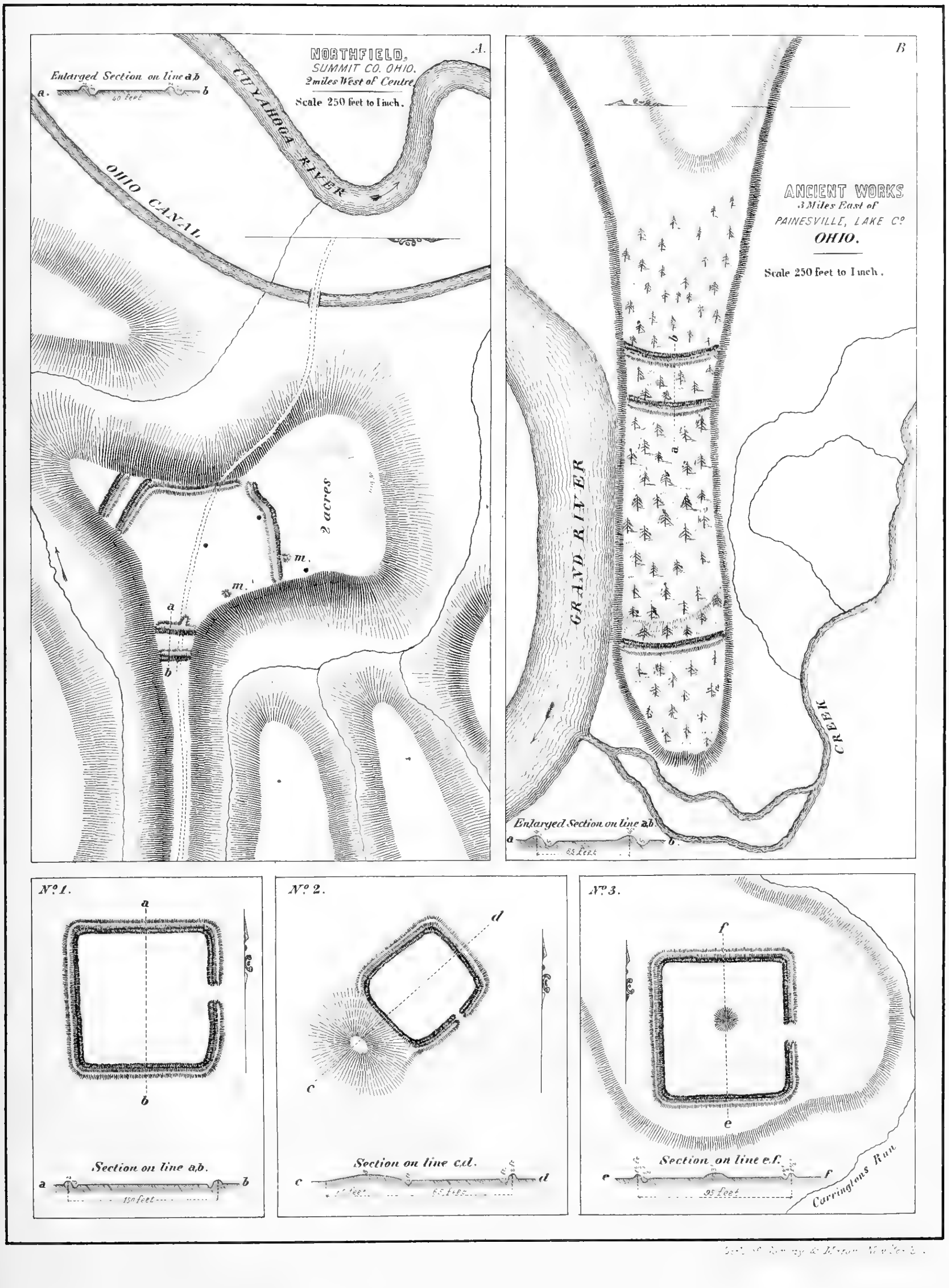






Lith. of Sarony & Major, New York

VII.


NORTHFIELD,
SUMMIT CO. OHIO.
2 miles West of Centre.
Scale 250 feet to 1 inch.
A.
Enlarged Section on line a.b
40 feet
CUYAHOGA RIVER
OHIO CANAL
2 acres
B
ANCIENT WORKS
3 Miles East of
PAINESVILLE, LAKE Co
OHIO.
Scale 250 feet to 1 inch.
GRAND RIVER
CREEK
Enlarged Section on line a.b
65 feet
No. 1.
Section on line a.b.
150 feet
No. 2.
Section on line c.d.
65 feet
No. 3.
Section on line e.f.
95 feet
Carringtons Run

APPENDIX I. TO VOLUME III.

OF THE

SMITHSONIAN CONTRIBUTIONS TO KNOWLEDGE;

CONTAINING

AN EPHEMERIS OF THE PLANET NEPTUNE

FOR THE YEAR 1852.

BY SEARS C. WALKER, ESQ.

GIDEON & Co., Printers, Washington, D. C.

SMITHSONIAN INSTITUTION, *June 1st*, 1851.

This Ephemeris of the Planet Neptune for the year 1852, prepared for the Nautical Almanac, is presented for publication in the Smithsonian Contributions, by authority of the Hon. WM. A. GRAHAM, Secretary of the Navy.

Signed,

JOSEPH HENRY,
Secretary of the Smithsonian Institution.

CHARLES HENRY DAVIS, LIEUT.,
Superintendent of the Nautical Almanac.

LETTER

FROM

LIEUTENANT C. H. DAVIS,

SUPERINTENDENT OF THE NAUTICAL ALMANAC,

TO

JOSEPH HENRY, LL.D.,

SECRETARY OF THE SMITHSONIAN INSTITUTION.

CAMBRIDGE, *May* 1*st*, 1851.

DEAR SIR:

With the permission of the honorable Wm. A. Graham, Secretary of the Navy, I have the pleasure of transmitting to you for publication in the Smithsonian Contributions, Mr. Sears C. Walker's Ephemeris of the planet Neptune for 1852, prepared for the Nautical Almanac.

The following table of the perturbations of Neptune from 1854 to 1860 has been computed by Mr. F. W. Ebener, now an assistant in the preparation of the Nautical Almanac, and revised by Mr. Walker.

Very respectfully,

Your ob't serv't,

CHARLES HENRY DAVIS.

JOSEPH HENRY, LL.D.

PERTURBATIONS OF NEPTUNE'S TRUE LONGITUDE AND RADIUS VECTOR, TO BE APPLIED ACCORDING TO THEIR SIGN TO THE ELLIPTIC VALUES.

	δv ♆	δr ♆
	″	
1854, January 1,	− 18.17	+ 0.01793
" April 1,	− 15.62	+ 0.01831
" July 1,	− 12.84	+ 0.01864
" October 1,	− 9.63	+ 0.01893
1855, January 1,	− 6.11	+ 0.01916
" April 1,	− 2.29	+ 0.01932
" July 1,	+ 1.66	+ 0.01941
" October 1,	+ 5.92	+ 0.01944
1856, January 1,	+ 10.38	+ 0.01940
" April 1,	+ 14.77	+ 0.01928
" July 1,	+ 19.13	+ 0.01908
" October 1,	+ 23.40	+ 0.01882
1857, January 1,	+ 27.48	+ 0.01848
" April 1,	+ 31.27	+ 0.01807
" July 1,	+ 34.76	+ 0.01761
" October 1,	+ 37.89	+ 0.01708
1858, January 1,	+ 40.56	+ 0.01651
" April 1,	+ 42.73	+ 0.01589
" July 1,	+ 44.39	+ 0.01523
" October 1,	+ 45.52	+ 0.01454
1859, January 1,	+ 46.08	+ 0.01384
" April 1,	+ 46.05	+ 0.01313
" July 1,	+ 45.46	+ 0.01242
" October 1,	+ 44.34	+ 0.01172
1860, January 1,	+ 42.66	+ 0.01104

EPHEMERIS OF NEPTUNE FOR 1852 FOR MEAN NOON, WASHINGTON.

MEAN NOON, WASHINGTON.

Date.	Neptune's Right Ascension.			Neptune's Declination.			Date.	Neptune's Right Ascension.			Neptune's Declination.		
1852.	°	′	″	°	′	″	1852.	°	′	″	°	′	″
Jan. 1	339	3	48.39	— 9	42	49.68	Feb. 24	340	43	59.59	— 9	2	44.68
2	339	5	10.29	— 9	42	16.45	25	340	46	7.94	— 9	1	53.78
3	339	6	33.72	— 9	41	42.62	26	340	48	16.32	— 9	1	2.87
4	339	7	58.65	— 9	41	8.21	27	340	50	24.73	— 9	0	11.96
5	339	9	25.07	— 9	40	33.22	28	340	52	33.17	— 8	59	21.06
6	339	10	52.95	— 9	39	57.67	29	340	54	41.58	— 8	38	30.19
7	339	12	22.27	— 9	39	21.56	Mar. 1	340	56	49.96	— 8	57	39.35
8	339	13	53.00	— 9	38	44.90	2	340	58	58.26	— 8	56	48.55
9	339	15	25.13	— 9	38	7.70	3	341	1	6.47	— 8	55	57.80
10	339	16	58.65	— 9	37	29.97	4	341	3	14.58	— 8	55	7.11
11	339	18	33.51	— 9	36	51.71	5	341	5	22.55	— 8	54	16.48
12	339	20	9.69	— 9	36	12.94	6	341	7	30.34	— 8	53	25.93
13	339	21	47.19	— 9	35	33.66	7	341	9	37.94	— 8	52	35.49
14	339	23	25.97	— 9	34	53.88	8	341	11	45.30	— 8	51	45.16
15	339	25	6.02	— 9	34	13.61	9	341	13	52.41	— 8	50	54.95
16	339	26	47.33	— 9	33	32.86	10	341	15	59.23	— 8	50	4.87
17	339	28	29.86	— 9	32	51.64	11	341	18	5.74	— 8	49	14.93
18	339	30	13.58	— 9	32	9.96	12	341	20	11.91	— 8	48	25.14
19	339	31	58.45	— 9	31	27.83	13	341	22	17.71	— 8	47	35.51
20	339	33	44.44	— 9	30	45.26	14	341	24	23.10	— 8	46	46.05
21	339	35	31.55	— 9	30	2.25	15	341	26	28.06	— 8	45	56.79
22	339	37	19.77	— 9	29	18.82	16	341	28	32.55	— 8	45	7.74
23	339	39	9.07	— 9	28	34.99	17	341	30	36.56	— 8	44	18.92
24	339	40	59.39	— 9	27	50.77	18	341	32	40.05	— 8	43	30.35
25	339	42	50.68	— 9	27	6.18	19	341	34	43.00	— 8	42	42.03
26	339	44	42.93	— 9	26	21.22	20	341	36	45.36	— 8	41	53.96
27	339	46	36.13	— 9	25	35.89	21	341	38	47.13	— 8	41	6.14
28	339	48	30.26	— 9	24	50.20	22	341	40	48.27	— 8	40	18.57
29	339	50	25.28	— 9	24	4.15	23	341	42	48.75	— 8	39	31.25
30	339	52	21.17	— 9	23	17.75	24	341	44	48.54	— 8	38	44.18
31	339	54	17.89	— 9	22	31.05	25	341	46	47.62	— 8	37	57.36
Feb. 1	339	56	15.40	— 9	21	44.07	26	341	48	45.96	— 8	37	10.82
2	339	58	13.69	— 9	20	56.81	27	341	50	43.54	— 8	36	24.62
3	340	0	12.75	— 9	20	9.27	28	341	52	40.32	— 8	35	38.79
4	340	2	12.53	— 9	19	21.45	29	341	54	36.27	— 8	34	53.34
5	340	4	13.02	— 9	18	33.35	30	341	56	31.39	— 8	34	8.28
6	340	6	14.21	— 9	17	45.02	31	341	58	25.67	— 8	33	23.60
7	340	8	16.08	— 9	16	56.46	April 1	342	0	9.07	— 8	32	39.30
8	340	10	18.62	— 9	16	7.68	2	342	2	11.53	— 8	31	55.38
9	340	12	21.78	— 9	15	18.67	3	342	4	3.01	— 8	31	11.85
10	340	14	25.51	— 9	14	29.44	4	342	5	53.51	— 8	30	28.71
11	340	16	29.77	— 9	13	40.02	5	342	7	43.03	— 8	29	45.97
12	340	18	34.55	— 9	12	50.42	6	342	9	31.57	— 8	29	3.66
13	340	20	39.82	— 9	12	0.64	7	334	11	19.11	— 8	28	21.79
14	340	22	45.54	— 9	11	10.70	8	342	13	5.62	— 8	27	40.36
15	340	24	51.67	— 9	10	20.62	9	342	14	51.06	— 8	26	59.39
16	340	26	58.18	— 9	9	30.40	10	342	16	35.41	— 8	26	18.88
17	340	29	5.02	— 9	8	40.04	11	342	18	18.65	— 8	25	38.83
18	340	31	12.15	— 9	7	49.54	12	342	20	0.76	— 8	24	59.23
19	340	33	19.56	— 9	6	58.90	13	342	21	41.72	— 8	24	20.09
20	340	35	27.21	— 9	6	8.16	14	342	23	21.50	— 8	23	41.45
21	340	37	35.05	— 9	5	17.35	15	342	25	0.08	— 8	23	3.33
22	340	39	43.08	— 9	4	26.49	16	342	26	37.44	— 8	22	25.74
23	340	41	51.27	— 9	3	35.60	17	342	28	13.54	— 8	21	48.68

Ephemeris of Neptune—Continued.

MEAN NOON, WASHINGTON.

Date.	Neptune's Right Ascension.			Neptune's Declination.			Date.	Neptune's Right Ascension.			Neptune's Declination.		
1852.	°	′	″	°	′	″	1852.	°	′	″	°	′	″
April 18	342	29	48.37	— 8	21	12.14	June 11	343	16	26.97	— 8	4	20.43
19	342	31	21.91	— 8	20	36.13	12	343	16	30.68	— 8	4	21.48
20	342	32	54.14	— 8	20	0.68	13	343	16	32.56	— 8	4	23.28
21	342	34	25.04	— 8	19	25.79	14	343	16	32.62	— 8	4	25.83
22	342	35	54.56	— 8	18	51.47	15	343	16	30.86	— 8	4	29.13
23	342	37	22.70	— 8	18	17.72	16	343	16	27.24	— 8	4	33.18
24	342	38	49.45	— 8	17	44.56	17	343	16	21.77	— 8	4	37.98
25	342	40	14.77	— 8	17	11.98	18	343	16	14.48	— 8	4	43.53
26	342	41	38.64	— 8	16	39.99	19	343	16	5.40	— 8	4	49.81
27	342	43	1.05	— 8	16	8.60	20	343	15	54.53	— 8	4	56.79
28	342	44	22.00	— 8	15	37.81	21	343	15	41.85	— 8	5	4.48
29	342	45	41.49	— 8	15	7.63	22	343	15	27.39	— 8	5	12.88
30	342	46	59.52	— 8	14	38.08	23	343	15	11.17	— 8	5	22.00
May 1	342	48	16.10	— 8	14	9.15	24	343	14	53.17	— 8	5	31.84
2	342	49	31.22	— 8	13	40.85	25	343	14	33.42	— 8	5	42.39
3	342	50	44.80	— 8	13	13.19	26	343	14	11.92	— 8	5	53.64
4	342	51	56.82	— 8	12	46.17	27	343	13	48.69	— 8	6	5.58
5	342	53	7.22	— 8	12	19.80	28	343	13	23.73	— 8	6	18.21
6	342	54	16.00	— 8	11	54.09	29	343	12	57.06	— 8	6	31.53
7	342	55	23.18	— 8	11	29.03	30	343	12	28.70	— 8	6	45.53
8	342	56	28.77	— 8	11	4.64	July 1	343	11	58.65	— 8	7	0.21
9	342	57	32.74	— 8	10	40.92	2	343	11	26.93	— 8	7	15.57
10	342	58	35.07	— 8	10	17.87	3	343	10	53.56	— 8	7	31.59
11	342	59	35.75	— 8	9	55.50	4	343	10	18.53	— 8	7	48.27
12	343	0	34.77	— 8	9	33.83	5	343	9	41.86	— 8	8	5.60
13	343	1	32.11	— 8	9	12.85	6	343	9	3.56	— 8	8	23.57
14	343	2	27.75	— 8	8	52.56	7	343	8	23.64	— 8	8	42.17
15	343	3	21.67	— 8	8	32.98	8	343	7	42.12	— 8	9	1.39
16	343	4	13.89	— 8	8	14.12	9	343	6	59.02	— 8	9	21.24
17	343	5	4.38	— 8	7	55.97	10	343	6	14.32	— 8	9	41.69
18	343	5	53.12	— 8	7	38.55	11	343	5	28.05	— 8	10	2.74
19	343	6	40.10	— 8	7	21.86	12	343	4	40.25	— 8	10	24.38
20	343	7	25.32	— 8	7	5.88	13	343	3	50.93	— 8	10	46.60
21	343	8	8.75	— 8	6	50.61	14	343	3	0.10	— 8	11	9.39
22	343	8	50.39	— 8	6	36.06	15	343	2	7.78	— 8	11	32.74
23	343	9	30.27	— 8	6	22.25	16	343	1	13.98	— 8	11	56.64
24	343	10	8.39	— 8	6	9.18	17	343	0	18.73	— 8	12	21.07
25	343	10	44.76	— 8	5	56.84	18	342	59	22.07	— 8	12	46.15
26	343	11	19.38	— 8	5	45.23	19	342	58	24.00	— 8	13	12.77
27	343	11	52.24	— 8	5	34.36	20	342	57	24.53	— 8	13	38.94
28	343	12	23.32	— 8	5	24.22	21	342	56	23.70	— 8	14	5.65
29	343	12	52.58	— 8	5	14.81	22	342	55	21.55	— 8	14	32.87
30	343	13	20.01	— 8	5	6.14	23	342	54	18.09	— 8	15	0.61
31	343	13	45.61	— 8	4	58.21	24	342	53	13.35	— 8	15	28.86
June 1	343	14	9.38	— 8	4	51.03	25	342	52	7.37	— 8	15	57.59
2	343	14	31.32	— 8	4	44.60	26	342	51	0.15	— 8	16	27.80
3	343	14	51.45	— 8	4	38.92	27	342	49	51.74	— 8	16	57.48
4	343	15	9.77	— 8	4	33.99	28	342	48	42.14	— 8	17	27.62
5	343	15	26.27	— 8	4	29.81	29	342	47	31.40	— 8	17	58.21
6	343	15	40.94	— 8	4	26.38	30	342	46	19.51	— 8	18	29.24
7	343	15	53.79	— 8	4	23.70	31	342	45	6.53	— 8	19	0.69
8	343	15	4.83	— 8	4	21.77	Aug. 1	342	43	52.46	— 8	19	32.55
9	343	16	14.04	— 8	4	20.58	2	342	42	37.35	— 8	20	4.81
10	343	16	21.42	— 8	4	20.13	3	342	41	21.18	— 8	20	37.44

Ephemeris of Neptune—Continued.

MEAN NOON, WASHINGTON.

Date.	Neptune's Right Ascension.			Neptune's Declination.			Date.	Neptune's Right Ascension.			Neptune's Declination.		
1852.	°	'	"	°	'	"	1852.	°	'	"	°	'	"
Aug. 4	342	40	4.04	— 8	21	10.44	Sept. 27	341	20	45.11	— 8	53	52.86
5	342	38	45.91	— 8	21	43.80	28	341	19	23.83	— 8	54	25.19
6	342	37	26.84	— 8	22	17.51	29	341	18	3.44	— 8	54	57.11
7	342	36	6.85	— 8	22	51.57	30	341	16	43.98	— 8	55	28.62
8	342	34	45.94	— 8	23	25.95	Oct. 1	341	15	25.46	— 8	55	59.72
9	342	33	24.19	— 8	24	0.64	2	341	14	7.93	— 8	56	30.39
10	342	32	1.61	— 8	24	35.63	3	341	12	51.41	— 8	57	0.62
11	342	30	38.22	— 8	25	10.92	4	341	11	35.95	— 8	57	30.41
12	342	29	14.05	— 8	25	46.48	5	341	10	21.56	— 8	57	59.74
13	342	27	49.13	— 8	26	22.30	6	341	9	8.25	— 8	58	28.60
14	342	26	23.51	— 8	26	58.36	7	341	7	56.07	— 8	58	56.98
15	342	24	57.21	— 8	27	34.65	8	341	6	45.07	— 8	59	24.87
16	342	23	30.29	— 8	28	11.17	9	341	5	35.26	— 8	59	52.24
17	342	22	2.76	— 8	28	47.89	10	341	4	26.70	— 9	0	19.09
18	342	20	34.67	— 8	29	24.79	11	341	3	19.40	— 9	0	45.41
19	342	19	6.06	— 8	30	1.86	12	341	2	13.39	— 9	1	11.21
20	342	17	36.95	— 8	30	39.08	13	341	1	8.69	— 9	1	36.48
21	342	16	7.37	— 8	31	16.46	14	341	0	5.34	— 9	2	1.15
22	342	14	37.38	— 8	31	53.97	15	340	59	3.39	— 9	2	25.23
23	342	13	6.98	— 8	32	31.59	16	340	58	2.83	— 9	2	48.70
24	342	11	36.23	— 8	33	9.33	17	340	57	3.68	— 9	3	11.54
25	342	10	5.15	— 8	33	47.16	18	340	56	6.00	— 9	3	33.78
26	342	8	33.78	— 8	34	25.07	19	340	55	9.80	— 9	3	55.41
27	342	7	2.17	— 8	35	3.03	20	340	54	15.09	— 9	4	16.42
28	342	5	30.34	— 8	35	41.03	21	340	53	21.90	— 9	4	36.80
29	342	3	58.32	— 8	36	19.04	22	340	52	30.30	— 9	4	56.53
30	342	2	26.14	— 8	36	57.06	23	340	51	40.29	— 9	5	15.60
31	342	0	53 84	— 8	37	35.09	24	340	50	51.85	— 9	5	34.02
Sept. 1	341	59	21.45	— 8	38	13.12	25	340	50	5.01	— 9	5	51.77
2	341	57	49.01	— 8	38	51.15	26	340	49	19.79	— 9	6	8.85
3	341	56	16.55	— 8	39	29.17	27	340	48	36.22	— 9	6	25.25
4	341	54	44.09	— 8	40	7.16	28	340	47	54.31	— 9	6	40.96
5	341	53	11.68	— 8	40	45.12	29	340	47	14.04	— 9	6	55.98
6	341	51	39.36	— 8	41	22.99	30	340	46	35.41	— 9	7	10.31
7	341	50	7.19	— 8	42	0.78	31	340	45	58.44	— 9	7	23.94
8	341	48	35.17	— 8	42	38.46	Nov. 1	340	45	23.20	— 9	7	36.86
9	341	47	3.33	— 8	43	16.03	2	340	44	49.72	— 9	7	49.05
10	341	45	31.73	— 8	43	53.46	3	340	44	18.00	— 9	8	0.52
11	341	44	0.38	— 8	44	30.73	4	340	43	48.05	— 9	8	11.26
12	341	42	29.32	— 8	45	7.81	5	340	43	19.89	— 9	8	21.27
13	341	40	58.61	— 8	45	44.68	6	340	42	53.54	— 9	8	30.54
14	341	39	28.27	— 8	46	21.36	7	340	42	29.05	— 9	8	39.06
15	341	37	58.35	— 8	46	57.83	8	340	42	6.42	— 9	8	46.83
16	341	36	28.89	— 8	47	34.06	9	340	41	45.64	— 9	8	53.85
17	341	34	59.91	— 8	48	10.06	10	340	41	26.73	— 9	9	0.12
18	341	33	31.46	— 8	48	45.79	11	340	41	9.70	— 9	9	5.62
19	341	32	3.58	— 8	49	21.20	12	340	40	54.55	— 9	9	10.35
20	341	30	36.32	— 8	49	56.30	13	340	40	41.29	— 9	9	14.32
21	341	29	9.69	— 8	50	31.10	14	340	40	29.93	— 9	9	17.52
22	341	27	43.71	— 8	51	5.59	15	340	40	20.50	— 9	9	19.93
23	341	26	18.45	— 8	51	39.75	16	340	40	13.00	— 9	9	21.57
24	341	24	53.94	— 8	52	13.57	17	340	40	7.42	— 9	9	22.43
25	341	23	30.19	— 8	52	47.03	18	340	40	3.76	— 9	9	22.51
26	341	22	7.24	— 8	53	20.13	19	340	40	2.05	— 9	9	21.82

Ephemeris of Neptune—Continued.

MEAN NOON, WASHINGTON.

Date.	Neptune's Right Ascension.			Neptune's Declination.			Date.	Neptune's Right Ascension.			Neptune's Declination.		
1852.	°	′	″	°	′	″	1852.	°	′	″	°	′	″
Nov. 20	340	40	2.28	— 9	9	20.34	Dec. 12	340	48	17.75	— 9	5	31.39
21	340	40	4.45	— 9	9	18.09	13	340	49	2.36	— 9	5	12.17
22	340	40	8.55	— 9	9	15.05	14	340	49	48.82	— 9	4	52.20
23	340	40	14.60	— 9	9	11.24	15	340	50	37.13	— 9	4	31.49
24	340	40	22.59	— 9	9	6.65	16	340	51	27.27	— 9	4	10.05
25	340	40	32.53	— 9	9	1.28	17	340	52	19.26	— 9	3	47.90
26	340	40	44.40	— 9	8	55.13	18	340	53	13.10	— 9	3	25.03
27	340	40	58.22	— 9	8	48.20	19	340	54	8.77	— 9	3	1.44
28	340	41	13.98	— 9	8	40.48	20	340	55	6.23	— 9	2	37.14
29	340	41	31.68	— 9	8	31.98	21	340	56	5.44	— 9	2	12.14
30	340	41	51.32	— 9	8	22.71	22	340	57	6.38	— 9	1	46.45
Dec. 1	340	42	12.91	— 9	8	12.67	23	340	58	9.06	— 9	1	20.07
2	340	42	36.45	— 9	8	1.85	24	340	59	13.46	— 9	0	53.02
3	340	43	1.92	— 9	7	50.25	25	341	0	19.59	— 9	0	25.32
4	340	43	29.32	— 9	7	37.88	26	341	1	27.41	— 8	59	56.95
5	340	43	58.66	— 9	7	24.74	27	341	2	36.91	— 8	59	27.92
6	340	44	29.92	— 9	7	10.83	28	341	3	48.06	— 8	58	58.23
7	340	45	3.08	— 9	6	56.15	29	341	5	0.86	— 8	58	27.89
8	340	45	38.16	— 9	6	40.70	30	341	6	15.29	— 8	57	56.91
9	340	46	15.21	— 9	6	24.50	31	341	7	31.32	— 8	57	25.29
10	340	46	54.16	— 9	6	7.55	32	341	8	48.94	— 8	56	53.03
11	340	47	35.01	— 9	5	49.85	33	341	10	8.15	— 8	56	20.14

Date 1852.		Heliocentric co-ordinates of Neptune for mean noon, Washington, referred to the apparent equinox and equator.			Logarithm of Neptune's distance from the Earth.
		x	y	z	Log. Δ
January	7	27.89188	— 9.83185	— 4.751536	1.4852396
	15	.90094	.80989	.742538	.4866768
	23	.90997	.78793	.733741	.4879150
	31	.91898	.76589	.724937	.4889322
February	8	.92798	.74384	.716152	.4897129
	16	.93696	.72182	.707360	.4902456
	24	.94591	.69982	.698566	.4905268
March	3	.95483	.67782	.689770	.4905509
	11	.96372	.65583	.680977	.4903032
	19	.97259	.63388	.672185	.4898097
	27	.98145	.61182	.663386	.4890803
April	4	.99030	.58981	.654584	.4881179
	12	.99913	.56781	.645772	.4869426
	20	28.00794	.54576	.636949	.4855743
	28	.01674	.52371	.628119	.4840339
May	6	.02554	.50164	.619278	.4823511
	14	.03430	.47955	.610329	.4805521
	22	.04304	.45744	.601574	.4786651
	30	.05176	.43531	.592712	.4767258
June	7	.06048	.41317	.583849	.4747662
	15	.06918	.39101	.574987	.4728306
	13	.07785	.36884	.566123	.4709446
July	1	.08650	.34666	.557257	.4691375
	9	.09514	.32449	.548388	.4674568
	17	.10376	.30231	.539517	.4659296
	25	.11236	.28014	.530644	.4645896
August	2	.12093	.25796	.521768	.4634626
	10	.12947	.23578	.512890	.4625736
	18	.13798	.21361	.504010	.4619424
	26	.14647	.19144	.495127	.4615851
September	3	.15494	.16928	.486242	.4615088
	11	.16339	.14712	.477355	.4617170
	19	.17182	.12495	.468467	.4622045
	27	.18022	.10278	.459576	.4629647
October	5	.18860	.08060	.450681	.4639844
	13	.19697	.05841	.441784	.4652535
	21	.20532	.03621	.432884	.4667244
	29	.21366	.01399	.423980	.4683751
November	6	.22198	— 8.99174	.415069	.4701721
	14	.23029	.96949	.406142	.4720793
	22	.23858	.94721	.397214	.4740572
	30	.24685	.92492	.388280	.4760645
December	8	.25511	.90261	.379337	.4780658
	16	.26335	.88029	.370388	.4800201
	24	.27157	.85796	.361432	.4818899
	32	.27977	.83563	.352470	.4836414
	40	.28795	.81329	.343506	.4852454

OCCULTATIONS

VISIBLE IN THE UNITED STATES

DURING THE YEAR

1852.

COMPUTED BY JOHN DOWNES,

AT THE

EXPENSE OF THE FUND APPROPRIATED BY CONGRESS

FOR THE ESTABLISHMENT OF A

Nautical Almanac,

AND PUBLISHED BY THE SMITHSONIAN INSTITUTION.

WASHINGTON.
1851.

Smithsonian Institution.

PREFACE.

For the purpose of facilitating the accurate determination of the geographical position of important points in the United States, the Regents of the Smithsonian Institution authorized the preparation of lists of occultations and co-ordinates of reduction to particular places for the years 1848 and 1849. Congress has, since, ordered the publication of an American Nautical Almanac; and, as lists of Occultations will form a regular part of this ephemeris, Mr. Preston, the late Secretary of the Navy, directed that the expense of computing these tables for 1850 should be defrayed from the appropriation for the almanac—the printing and distribution to be done by the Smithsonian Institution. A similar order has been given by Mr. Graham, the present Secretary of the Navy, relative to the tables for 1851 and 1852.

Copies of these elements will be forwarded to all persons disposed to advance the science of geography, with the request, that the results of the observations which may be made, be sent to the Smithsonian Institution, or published in some accessible scientific journal.

The following remarks will give a more definite idea of the nature and object of this publication.

JOSEPH HENRY, *Secretary S. I.*
CHARLES H. DAVIS, *Superintendent of the Nautical Almanac.*

The present lists of occultations are very much extended by the introduction of occultations visible on any part of the earth. The form of the list is also somewhat altered; that which is now adopted will probably be retained in the astronomical ephemeris.

Bessel's formulæ (Astron. Nachr., No. 145, and Astron. Jahrbuch for 1831) are preserved unaltered. The several columns of the general list now contain, 1, the date; 2, the star's name; 3, the star's magnitude; 4, the limiting parallels of visibility; 5, Washington mean time of the moon's true conjunction with the star in right ascension; 6, Washington hour angle, in time, of the star at the time of true conjunction; 7, co-ordinate q at the time of true conjunction; 8, hourly variation p' of co-ordinate p; 9, hourly variation q' of co-ordinate q; 10, logarithmic sine of the star's declination; 11, logarithmic cosine of the star's declination.

At the time of true conjunction $p = 0$; for any other time ☌ $+ (t), p = (t)\,p'$, and $q = y + (t)\,q'$.

H being for true conjunction, $h = H +$ sidereal equivalent of (t), and, for the same reason, $T =$ ☌ $+ (t)$. The notation is made to correspond to these changes.

The sign + will hereafter be given to west longitudes, and the sign − to east longitudes. The value of the constant k has been changed by retaining Mr. Airy's correction of the lunar parallax, and rejecting the correction of $\frac{1}{360}$ part of semi-diameter, which was before applied. The small table containing the values of log. $A = \frac{1 - e^2}{\sqrt{(1 - e^2 \sin^2 \varphi)}}$ and of log. $B = \frac{1}{\sqrt{(1 - e^2 \sin^2 \varphi)}}$ is retained.

The object in increasing the general list is, to provide the means of frequent determinations of the longitude throughout the earth; to make it especially useful to geographers in general, to the boundary and other surveyors of the Government in the interior, to the coast survey of the United States on both oceans, and to the explorers of unknown parts of the continent.

At the close of the general list will be found Bessel's formulæ, and an example of their use, together with some suggestions as to the manner in which the lists may be rendered more convenient to those who resort to them habitually.

CHARLES HENRY DAVIS, *Superintendent.*

For facilitating the Calculation of Occultations of Planets and Stars by the Moon, *for the Year* 1852.

1852.	Star's Name.	Mag.	Limiting Parallels. Northern.	Limiting Parallels. Southern.	Washington. Mean Time of ☌.	At Washington Mean Time of ☌. *H*	*Y*	*p′*	*q′*	Log sin *D*	Log cos *D*
			°	°	h. m.	h. m. s.					
Jan. 1	ξ² Ceti	4	+90	+20	2 51.6	− 4 46 10	+0.9908	0.5183	+.1960	+9.1322	9.9960
1	B. A. C. 830	6	+32	−41	10 14.2	+ 2 23 28	−0.1054	.5207	+.1913	+9.2442	.9932
1	B. A. C. 845	4	+90	+ 9	11 29.0	+ 3 36 00	+0.8098	.5225	+.1906	+9.2170	.9940
3	B.A.C. 1272	6	+23	−45	3 59.3	− 5 09 36	−0.2694	.5479	+.1485	+9.4645	.9808
3	δ¹ Tauri	4	+68	− 4	10 52.5	+ 1 29 52	+0.4566	.5544	+.1391	+9.4707	.9802
3	63 Tauri	6	+90	+63	11 06.9	+ 1 43 47	+1.3008	.5574	+.1384	+9.4515	.9819
3	δ² Tauri	4½	+84	+ 6	11 24.6	+ 2 00 50	+0.6310	.5554	+.1384	+9.4683	.9804
3	B.A.C. 1361	6	−23	−72	11 45.6	+ 2 21 07	−1.0257	.5507	+.1376	+9.5060	.9764
3	δ³ Tauri	5	+50	−18	12 02.0	+ 2 37 02	+0.1965	.5550	+.1369	+9.4801	.9792
3	ε Tauri	3½	−19	−71	13 25.4	+ 3 57 33	−0.9563	.5635	+.1228	+9.5092	.9761
3	B.A.C. 1468	6	+70	− 1	21 23.2	+11 39 03	+0.4782	.5623	+.1223	+9.5006	.9770
3	*i* Tauri	5½	+88	+ 9	23 38.9	−10 10 00	+0.6570	.5640	+.1188	+9.5034	.9767
4	ο Tauri	5	−35	−68	15 20.2	+ 4 57 50	−1.1382	.5695	+.0888	+9.5699	.9678
4	ζ Tauri	3½	+39	−21	19 36.8	+ 9 05 06	+0.0195	.5761	+.0806	+9.5552	.9700
5	141 Tauri	6	− 1	−65	5 39.2	− 5 14 49	−0.6886	.5794	+.0589	+9.5809	.9660
5	6 Geminor.	6	−24	−67	10 01.7	− 1 02 13	−1.0160	.5806	+.0476	+9.5907	.9642
5	η Geminor.	4	+ 6	−54	11 05.8	− 0 00 28	−0.5592	.5835	+.0454	+9.5836	.9655
5	μ Geminor.	3	+12	−46	14 24.2	+ 3 10 21	−0.4604	.5852	+.0384	+9.5844	.9654
6	*d* Geminor.	6	+72	+11	2 01.7	− 9 38 52	+0.4983	.5939	+.0097	+9.5723	.9674
6	δ Geminor.	3	+46	− 9	13 29.1	+ 1 21 48	+0.1288	.5950	−.0175	+9.5782	.9664
6	63 Geminor.	6	+80	+14	16 32.3	+ 4 17 53	+0.5796	.5973	−.0250	+9.5688	.9679
7	μ² Cancri	5	+15	−44	8 28.4	− 4 23 30	−0.4103	.5939	−.0644	+9.5738	.9671
7	η Cancri	6	+33	−27	18 27.9	+ 5 12 33	−0.0898	.5938	−.0882	+9.5531	.9703
7	39 Cancri	6	+42	−20	21 26.4	+ 8 04 01	+0.0575	.5921	−.0949	+9.5449	.9715
7	40 Cancri	6	+43	−18	21 29.0	+ 8 06 35	+0.0900	.5922	−.0949	+9.5441	.9716
8	83 Cancri	6	+72	0	13 11.8	− 0 47 03	+0.5020	.5906	−.1302	+9.4976	.9774
9	37 Leonis	6	+90	+ 9	13 08.5	− 1 44 30	+0.7427	.5802	−.1740	+9.3975	.9860
9	42 Leonis	6	−13	−74	15 18.4	+ 0 20 36	−0.9028	.5750	−.1770	+9.4329	.9835
9	B.A.C. 3579	6	− 7	−75	18 16.3	+ 3 12 02	−0.8067	.5737	−.1814	+9.4158	.9847
9	*i* Leonis	6	−10	−75	19 42.7	+ 4 35 17	−0.8646	.5733	− 1830	+9.4100	.9851
11	ν Virginis	4½	+50	−25	3 52.5	+11 36 24	+0.2113	.5616	−.2176	+9.1075	.9964
11	B.A.C. 3996	6	+90	+41	5 20.2	−10 58 56	+1.2451	.5622	−.2186	+9.0204	.9976
11	*c* Virginis	5	+39	−37	19 23.7	+ 2 35 31	+0.0143	.5565	−.2257	+8.8581	.9989
13	80 Virginis	6	+85	+27	5 40.3	+11 42 49	+1.1140	.5514	−.2252	−8.9081	.9986
14	ξ¹ Libræ	6	+48	−26	17 31.1	− 1 39 05	+0.2345	.5563	−.1990	−9.2918	.9915
14	ξ² Libræ	5	+ 9	−68	18 35.3	− 0 37 05	−0.4739	.5578	−.1979	−9.2730	.9922
15	ο² Libræ	6	+75	+36	6 17.1	+10 40 39	+1.1923	.5574	−.1834	−9.4016	.9857
15	γ Libræ	4½	+25	−45	11 49.5	− 7 58 30	−0.1239	.5623	−.1759	−9.3924	.9864
15	η Libræ	4½	+40	−30	15 35.6	− 4 20 18	+0.1559	.5626	−.1708	−9.4184	.9846
15	θ Libræ	4½	+66	− 7	19 51.1	− 0 13 46	+0.5727	.5622	−.1659	−9.4479	.9822
15	49 Libræ	5½	+25	−44	22 46.6	+ 2 35 33	−0.0955	.5652	−.1601	−9.4428	.9827
16	χ Ophiuchi	5	+43	−24	10 17.6	−10 17 58	+0.2648	.5682	−.1397	−9.4926	.9780
16	B.A.C. 5579	5	−58	−90	16 35.6	− 4 13 27	−1.2715	.5746	−.1287	−9.4769	.9795
17	29 Ophiuchi	6	−36	−90	1 16.4	+ 4 08 35	−1.0541	.5764	−.1113	−9.5051	.9765
17	ξ Ophiuchi	4½	+53	−10	9 21.1	+11 55 40	+0.4960	.5729	−.0950	−9.5532	.9703
17	B.A.C. 5866	6	+68	+ 3	10 55.9	−10 32 59	+0.7148	.5725	−.0907	−9.5601	.9693
17	B.A.C. 5954	6	+68	+ 5	16 52.9	− 4 48 58	+0.7535	.5731	−.0790	−9.5701	.9677
17	58 Ophiuchi	5	+43	−17	18 52.6	− 2 53 41	+0.3766	.5750	−.0748	−9.5661	.9684
18	B.A.C. 6088	6	+67	+31	2 39.4	+ 4 36 03	+1.0877	.5725	−.0583	−9.5878	.9648
18	μ¹ Sagittarii	3½	−34	−90	7 43.3	+ 9 28 46	−0.9412	0.5808	−.0460	−9.5562	9.9699

For facilitating the Calculation of Occultations of Planets and Stars by the Moon, *for the Year* 1852.

1852.	Star's Name.	Mag.	Limiting Parallels. Northern.	Limiting Parallels. Southern.	Washington Mean Time of ☌.	At Washington Mean Time of ☌. H	Y	p′	q′	Log sin D	Log cos D
			°	°	h. m.	h. m. s.					
Jan 18	14 Sagittarii	6	+ 5	−54	7 55.0	+ 9 40 02	−0.2608	0.5781	−.0460	−9.5688	9.9679
22	45 Aquarii	6	−30	−90	22 07.7	− 3 54 53	−1.0619	.5344	+.1618	−9.3850	.9868
23	50 Aquarii	6	+13	−60	0 50.8	− 1 16 45	−0.3623	.5317	+.1646	−9.3920	.9864
23	56 Aquarii	6	+43	−28	3 46.1	+ 1 33 10	+0.1924	.5273	+.1662	−9.4225	.9843
23	74 Aquarii	6	+41	−32	15 36.7	−10 57 35	+0.1216	.5231	+.1793	−9.3320	.9897
24	ψ^1 Aquarii	6	+ 9	−70	3 14.9	+ 0 20 03	−0.4945	.5181	+.1888	−9.2352	.9935
24	ψ^2 Aquarii	5	+26	−49	4 20.3	+ 1 23 34	−0.1816	.5172	+.1894	−9.2394	.9934
24	ψ^3 Aquarii	5	+59	−18	4 53.2	+ 1 55 31	+0.3953	.5163	+.1898	−9.2574	.9928
25	30 Piscium	4½	+83	+16	3 54.3	+ 0 17 15	+0.9641	.5077	+.2022	−9.0759	.9969
25	33 Piscium	5	+83	+17	5 44.5	+ 2 04 20	+1.0030	.5005	+.2078	−9.0564	.9972
26	20 Ceti	5	+88	+46	7 49.6	+ 3 26 02	+1.3005	.5036	+.2082	−8.5322	.9997
26	33 Ceti	6	+ 1	−88	17 27.6	−11 11 53	−0.6934	.5037	+.2081	+8.4601	.9998
26	*f* Piscium	6	−31	−87	21 25.8	− 7 20 13	−1.1708	.5038	+.2077	+8.6943	.9995
27	ν Piscium	5	+ 6	−78	0 18.9	− 4 50 10	−0.6100	.5023	+.2070	+8.9167	.9985
28	ξ^1 Ceti	5	−14	−82	3 18.8	− 2 17 18	−0.9360	.5090	+.1988	+9.1515	.9956
28	ξ^2 Ceti	4	+90	+24	11 22.5	+ 5 32 36	+1.0402	.5134	+.1943	+9.1322	.9960
28	B. A. C. 830	6	+35	−39	18 51.7	−11 11 12	−0.0593	.5161	+.1897	+9.2441	.9932
28	B. A. C. 845	4	+90	+12	20 07.8	− 9 57 22	+0.8610	.5183	+.1889	+9.2170	.9940
30	B.A.C. 1272	6	+25	−43	13 22.0	+ 6 01 05	−0.2313	.5502	+.1496	+9.4645	.9808
30	δ^1 Tauri	4	+71	− 2	20 22.7	−11 11 59	+0.5020	.5479	+.1373	+9.4707	.9802
30	δ^2 Tauri	4½	+90	+ 8	20 55.3	−10 40 25	+0.6775	.5488	+.1367	+9.4683	.9804
30	δ^3 Tauri	5	+53	−15	21 33.4	−10 03 33	+0.2403	.5479	+.1358	+9.4801	.9792
30	ε Tauri	3½	−14	−71	22 58.4	− 8 41 24	−0.9213	.5456	+.1336	+9.5093	.9761
31	B.A.C. 1468	6	+74	+ 2	7 04.7	− 0 51 29	+0.5230	.5567	+.1202	+9.5006	.9771
31	*i* Tauri	5½	+90	+10	9 22.6	+ 1 21 46	+0.6671	.5583	+.1169	+9.5034	.9767
31	*l* Tauri	5½	+23	−39	16 50.6	+ 8 34 41	−0.2627	.5609	+.1037	+9.5385	.9724
Feb 1	o Tauri	5	−32	−68	1 18.3	− 7 15 55	−1.1079	.5644	+.0876	+9.5699	.9678
1	ζ Tauri	3½	+41	−19	5 38.3	− 3 05 15	+0.0531	.5710	+.0795	+9.5552	.9700
1	3 Geminor.	6	−53	−68	19 07.6	+ 9 54 17	−1.2482	.5754	+.0496	+9.5943	.9636
1	η Geminor.	4	+ 8	−52	21 17.1	+11 58 54	−0.5328	.5796	+.0451	+9.5836	.9655
2	μ Geminor.	3	+14	−44	0 36.9	− 8 48 47	−0.4352	.5816	+.0382	+9.5844	.9654
2	δ Geminor.	3½	+47	− 9	23 45.5	−10 33 40	+0.1418	.5946	−.0186	+9.5782	.9664
3	63 Geminor.	6	+82	+15	2 48.4	− 7 37 57	+0.5913	.5977	−.0261	+9.5687	.9680
4	η Cancri	6	+33	−28	4 30.6	− 6 56 42	−0.0942	.5977	−.0894	+9.5531	.9703
4	39 Cancri	6	+41	−21	7 26.5	− 4 07 49	+0.0499	.5981	−.0967	+9.5449	.9715
4	40 Cancri	6	+43	−19	7 28.4	− 4 05 54	+0.0833	.5983	−.0967	+9.5441	.9716
4	83 Cancri	6	+70	− 1	22 54.7	+10 43 50	+0.4763	.5972	−.1320	+9.4976	.9774
5	37 Leonis	6	+90	+ 6	22 15.4	+ 9 10 21	+0.6934	.5895	−.1773	+9.3975	.9860
6	42 Leonis	6	−15	−74	0 21.5	+11 11 41	−0.9311	.5844	−.1807	+9.4329	.9835
6	*i* Leonis	6	−12	−75	4 38.1	− 8 41 26	−0.8968	.5829	−.1870	+9.4100	.9851
6	*l* Leonis	6	+90	+49	11 44.7	− 0 50 50	+1.2759	.5849	−.1978	+9.2931	.9914
7	ν Virginis	4½	+46	−29	11 45.7	− 2 42 43	+0.1379	.5724	−.2227	+9.1074	.9964
8	*c* Virginis	5	+35	−42	2 45.8	+11 45 19	−0.0674	.5669	−.2306	+8.8580	.9989
9	80 Virginis	6	+85	+18	12 00.5	− 4 09 29	+1.0002	.5594	−.2287	−8.9080	.9986
10	ξ^1 Libræ	6	+42	−31	23 08.2	+ 5 45 27	+0.1259	.5603	−.1999	−9.2918	.9915
11	ξ^2 Libræ	5	+ 4	−77	0 12.3	+ 6 47 21	−0.5793	.5617	−.1987	−9.2731	.9922
11	o^2 Libræ	6	+75	+26	11 46.2	− 6 02 59	+1.0789	.5596	−.1839	−9.4015	.9857
11	γ Libræ	4½	+20	−52	17 16.9	− 0 43 47	−0.2310	.5636	−.1761	−9.3924	.9864
11	η Libræ	4½	+34	−36	21 01.8	+ 2 53 14	+0.0483	.5636	−.1700	−9.4186	.9845
12	θ Libræ	4½	+58	−13	1 16.4	+ 6 58 50	+0.4654	0.5631	−.1636	−9.4479	9.9822

For facilitating the Calculation of Occultations of Planets and Stars by the Moon, *for the Year* 1852.

1852.	Star's Name.	Mag.	Limiting Parallels. Northern.	Southern.	Washington Mean Time of ☌.	At Washington Mean Time of ☌. *H*	*Y*	*p'*	*q'*	Log sin *D*	Log cos *D*
			°	°	h. m.	h. m. s.					
Feb 12	49 Libræ	5½	+19	−51	4 11.2	+ 9 47 31	−0.2075	0.5656	−.1588	−9.4428	9.9826
12	χ Ophiuchi	5	+37	−29	15 42.8	− 3 05 25	+0.1631	.5668	−.1388	−9.4927	.9779
13	29 Ophiuchi	6	−45	−90	6 46.4	+11 25 52	−1.1516	.5735	−.1101	−9.5051	.9765
13	ξ Ophiuchi	4½	+47	−15	14 55.0	− 4 43 06	+0.4068	.5692	−.0939	−9.5533	.9703
13	B.A.C. 5866	6	+63	− 3	16 31.5	− 3 10 03	+0.6275	.5688	−.0909	−9.5602	.9693
13	B.A.C. 5954	6	+65	0	22 32.3	+ 2 37 46	+0.6708	.5690	−.0783	−9.5701	.9677
14	58 Ophiuchi	5	+38	−22	0 32.7	+ 4 33 45	+0.2930	.5704	−.0738	−9.5661	.9684
14	B.A.C. 6088	6	+67	+24	8 25.3	−11 50 41	+1.0137	.5679	−.0565	−9.5878	.9648
14	B.A.C. 6098	6	−51	−90	8 47.3	−11 29 29	−1.1614	.5761	−.0554	−9.5490	.9709
14	μ Sagittarii	4	−40	−90	13 33.4	− 6 53 41	−1.0224	.5756	−.0455	−9.5562	.9699
14	14 Sagittarii	6	+ 4	−55	13 45.3	− 6 42 13	−0.2678	.5728	−.0444	−9.5688	.9679
15	28 Sagittarii	6	+21	−33	3 31.5	+ 6 34 12	+0.0986	.5703	−.0145	−9.5836	.9655
15	30 Sagittarii	6	+ 7	−48	5 28.6	+ 8 27 05	−0.1534	.5708	−.0101	−9.5797	.9661
15	31 Sagittarii	6	− 7	−65	6 02.4	+ 8 59 36	−0.4107	.5716	−.0079	−9.5752	.9669
15	33 Sagittarii	6	−43	−90	6 51.8	+ 9 47 13	−1.0086	.5740	−.0068	−9.5647	.9686
15	ν^1 Sagittarii	5	+44	−12	6 53.8	+ 9 49 11	+0.4683	.5683	−.0068	−9.5905	.9643
15	ν^2 Sagittarii	5	+38	−16	7 18.1	+10 12 37	+0.3896	.5686	−.0057	−9.5892	.9645
15	B.A.C. 6448	6	+67	+17	7 40.9	+10 34 35	+0.9270	.5662	−.0046	−9.5982	.9629
15	ξ^2 Sagittarii	4	−69	−90	8 28.8	+11 20 45	−1.2717	.5746	−.0035	−9.5601	.9693
15	ο Sagittarii	4½	−16	−80	11 28.2	− 9 46 14	−0.5724	.5717	+.0031	−9.5727	.9673
15	B.A.C. 6561	6	−17	−83	14 51.8	− 6 29 55	−0.6067	.5708	+.0108	−9.5717	.9675
15	B.A.C. 6607	6	+32	−23	18 23.8	− 3 05 25	+0.2750	.5669	+.0184	−9.5861	.9650
15	50 Sagittarii	6	0	−59	20 54.7	− 0 39 53	−0.3215	.5683	+.0238	−9.5748	.9670
15	B.A.C. 6671	6	−24	−90	22 55.2	+ 1 16 21	−0.7558	.5695	+.0281	−9.5663	.9683
16	4 Capricor.	6	+69	+21	19 51.8	− 2 30 53	+0.9851	.5525	+.0709	−9.5784	.9663
21	30 Piscium	4½	+83	+24	11 13.8	+ 9 24 26	+1.0837	.5089	+.2040	−9.0759	.9969
21	33 Piscium	5	+83	+28	13 03.9	+11 11 25	+1.1249	.5083	+.2048	−9.0564	.9972
23	33 Ceti	6	+10	−72	0 46.0	− 2 05 50	−0.5321	.5045	+.2094	+8.4603	.9998
23	*f* Piscium	6	−19	−87	4 44.3	+ 1 45 56	−1.0088	.5045	+.2089	+8.6938	.9995
23	ν Piscium	5	+15	−64	17 40.2	− 9 39 39	−0.4353	.5054	+.2062	+8.9166	.9985
24	ξ^1 Ceti	5	− 2	−79	10 45.4	+ 6 56 59	−0.7518	.5036	+.1991	+9.1514	.9956
24	B. A. C. 755	6	−39	−80	18 05.8	− 9 55 04	−1.2354	.5094	+.1948	+9.2350	.9935
24	ξ^2 Ceti	4	+90	+41	18 52.9	− 9 09 17	+1.2414	.5127	+.1945	+9.1322	.9960
25	B. A. C. 830	6	+46	−28	2 26.5	− 1 48 43	+0.1368	.5139	+.1895	+9.2441	.9932
25	B. A. C. 845	4	+90	+26	3 43.4	− 0 34 02	+1.0637	.5159	+.1885	+9.2169	.9940
26	B.A.C. 1272	6	+37	−31	21 37.1	− 7 56 00	−0.0290	.5349	+.1457	+9.4644	.9808
27	δ^1 Tauri	4	+90	+10	4 47.0	− 0 59 47	+0.7045	.5420	+.1354	+9.4707	.9802
27	δ^2 Tauri	4½	+90	+21	5 20.4	− 0 27 30	+0.8817	.5429	+.1347	+9.4683	.9804
27	δ^3 Tauri	5	+67	− 5	5 59.4	+ 0 10 14	+0.4392	.5417	+.1340	+9.4801	.9792
27	ε Tauri	3½	− 3	−71	7 26.1	+ 1 34 10	−0.7343	.5395	+.1318	+9.5093	.9761
27	B.A.C. 1468	6	+90	+13	15 43.7	+ 9 35 28	+0.7203	.5487	+.1193	+9.5006	.9770
27	*i* Tauri	5½	+90	+21	18 05.0	+11 52 04	+0.8644	.5517	+.1145	+9.5034	.9767
28	*l* Tauri	5½	+34	−29	1 33.9	− 4 54 12	−0.0791	.5530	+.1024	+9.5385	.9724
28	ο Tauri	5	−18	−68	10 25.0	+ 3 38 41	−0.9406	.5562	+.0859	+9.5699	.9678
28	ζ Tauri	3½	+52	−10	14 51.7	+ 7 56 06	+0.2304	.5631	+.0772	+9.5552	.9700
29	141 Tauri	6	+10	−50	1 16.8	− 6 1 05	−0.4991	.5681	+.0557	+9.5808	.9660
29	3 Geminor.	6	−32	−67	4 42.2	− 2 43 09	−1.0980	.5664	+.0492	+9.5943	.9636
29	6 Geminor.	6	−11	−67	5 48.6	− 1 39 09	−0.8381	.5665	+.0460	+9.5907	.9642
29	η Geminor.	4	+17	−41	6 55.0	− 0 35 11	−0.3763	.5709	+.0438	+9.5836	.9665
29	μ Geminor.	3	+22	−34	10 19.9	+ 2 42 18	−0.2808	0.5735	+.0361	+9.5844	9.9654

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			°	°	h. m.	h. m. s.					
Mar. 1	δ Geminor.	3½	+55	− 2	10 01.9	+ 1 30 53	+0.2739	0.5871	−.0201	+9.5782	9.9664
1	63 Geminor.	6	+90	+22	13 08.7	+ 4 30 33	+0.7224	.5901	−.0274	+9.5687	.9680
2	μ^2 Cancri	5	+21	−38	5 16.5	− 3 59 10	−0.3039	.5899	−.0666	+9.5737	.9672
2	η Cancri	6	+38	−23	15 17.8	+ 5 38 42	−0.0007	.5924	−.0908	+9.5531	.9703
2	39 Cancri	6	+40	−22	18 15.8	+ 8 29 46	+0.0353	.5932	−.0979	+9.5448	.9715
2	40 Cancri	6	+42	−20	18 17.7	+ 8 31 36	+0.0688	.5933	−.0979	+9.5441	.9716
3	83 Cancri	6	+74	+ 2	9 52.1	− 0 30 28	+0.5320	.5943	−.1333	+9.4977	.9774
4	37 Leonis	6	+90	+ 6	9 12.6	− 2 04 10	+0.6997	.5903	−.1798	+9.3976	.9860
4	42 Leonis	6	−14	−74	11 18.0	− 0 03 37	−0.9221	.5855	−.1832	+9.4329	.9835
4	*i* Leonis	6	−12	−75	15 32.6	+ 4 01 16	−0.8964	.5849	−.1898	+9.4100	.9852
4	*l* Leonis	6	+90	+45	22 34.7	+10 47 20	+1.2454	.5882	−.2004	+9.2931	.9915
5	ν Virginis	4½	+42	−33	22 10.4	+ 9 30 10	+0.0649	.5789	−.2274	+9.1073	.9964
6	*c* Virginis	5	+29	−48	12 47.7	− 0 24 42	−0.1690	.5753	−.2360	+8.8579	.9989
7	80 Virginis	6	+85	+ 6	20 58.1	+ 6 35 56	+0.8205	.5703	−.2347	−8.9081	.9986
8	94 Virginis	6	+82	+43	10 11.7	− 4 38 53	+1.2767	.5686	−.2269	−9.1533	.9956
9	ξ^1 Libræ	6	+39	−33	6 50.1	− 8 45 01	−0.0837	.5712	−.2049	−9.2918	.9915
9	ξ^2 Libræ	5	− 8	−90	7 51.8	− 7 45 30	−0.7777	.5727	−.2036	−9.2730	.9922
9	o^2 Libræ	6	+75	+ 9	19 01.8	+ 3 00 20	+0.8464	.5699	−.1875	−9.4015	.9857
10	γ Libræ	4½	+ 8	−67	0 21.8	+ 8 08 42	−0.4473	.5738	−.1798	−9.3924	.9864
10	η Libræ	4½	+22	−49	3 59.6	+11 38 35	−0.1737	.5733	−.1738	−9.4186	.9845
10	θ Libræ	4½	+44	−25	8 06.3	− 8 23 41	+0.2357	.5727	−.1663	−9.4478	.9822
10	49 Libræ	5½	+ 7	−67	10 55.5	− 5 40 40	−0.4417	.5749	−.1620	−9.4425	.9827
10	χ Ophiuchi	5	−24	−42	22 08.3	+ 5 07 32	−0.0657	.5746	−.1406	−9.4927	.9779
11	B.A.C. 5758	6	+69	+45	14 35.3	− 3 01 38	+1.2260	.5709	−.1081	−9.5612	.9691
11	ξ Ophiuchi	4½	+33	−28	20 49.5	+ 2 58 49	+0.1784	.5745	−.0941	−9.5533	.9703
11	B.A.C. 5866	6	+46	−16	22 23.5	+ 4 29 23	+0.3976	.5737	−.0909	−9.5602	.9693
12	B.A.C. 5954	6	+49	−14	4 18.3	+10 11 10	+0.4434	.5733	−.0777	−9.5701	.9677
12	58 Ophiuchi	5	+25	−34	6 17.7	−11 53 51	+0.0694	.5748	−.0733	−9.5661	.9684
12	B.A.C. 6088	6	+67	+ 8	14 04.2	− 4 24 29	+0.7901	.5712	−.0553	−9.5878	.9648
12	μ^1 Sagittarii	3½	−60	−90	19 08.9	+ 0 29 05	−1.2314	.5780	−.0441	−9.5563	.9699
12	14 Sagittarii	6	−11	−77	19 20.6	+ 0 40 26	−0.5507	.5754	−.0441	−9.5688	.9679
13	B.A.C. 6343	6	+66	+32	5 37.6	+10 34 54	+1.0980	.5673	−.0215	−9.6028	.9620
13	28 Sagittarii	6	+10	−45	9 00.8	−10 09 13	−0.1069	.5715	−.0136	−9.5836	.9655
13	30 Sagittarii	6	− 4	−61	10 57.3	− 8 16 55	−0.3570	.5717	−.0091	−9.5796	.9662
13	31 Sagittarii	6	−18	−84	11 30.9	− 7 44 32	−0.6125	.5727	−.0080	−9.5752	.9669
13	33 Sagittarii	6	−20	−90	12 20.1	− 6 57 05	−1.2075	.5745	−.0058	−9.5647	.9686
13	ν^1 Sagittarii	5	+30	−23	12 22.0	− 6 55 17	+0.2650	.5688	−.0058	−9.5905	.9643
13	ν^2 Sagittarii	5	+25	−28	12 46.2	− 6 31 57	+0.1871	.5690	−.0047	−9.5892	.9645
13	B.A.C. 6448	6	+67	+ 3	13 09.0	− 6 09 59	+0.7228	.5668	−.0035	−9.5982	.9629
13	*o* Sagittarii	4½	−27	−90	16 55.5	− 2 31 35	−0.7684	.5716	+.0042	−9.5726	.9673
13	B.A.C. 6561	6	−28	−90	20 18.3	+ 0 43 56	−0.8002	.5707	+.0120	−9.5717	.9675
13	B.A.C. 6607	6	+21	−34	23 50.6	+ 4 08 39	+0.0825	.5661	+.0196	−9.5861	.9651
14	50 Sagittarii	6	−10	−74	2 21.3	+ 6 34 01	−0.5089	.5670	+.0250	−9.5748	.9670
14	B.A.C. 6671	6	−36	−90	4 21.7	+ 8 30 08	−0.9406	.5685	+.0293	−9.5663	.9683
15	4 Capricor.	6	+68	+10	1 21.0	+ 4 45 41	+0.8295	.5532	+.0724	−9.5784	.9663
15	20 Capricor.	6	+ 9	−59	20 35.6	− 0 38 25	−0.3107	.5483	+.1072	−9.5258	.9741
15	η Capricor.	5	+70	+10	22 50.3	+ 1 31 53	+0.8396	.5434	+.1115	−9.5431	.9718
16	30 Capricor.	6	+ 5	−64	5 18.1	+ 7 47 06	−0.4077	.5437	+.1221	−9.5037	.9767
16	γ Capricor.	4	+ 7	−64	15 59.4	− 5 52 07	−0.4080	.5386	+.1377	−9.4740	.9798
16	δ Capricor.	3½	+ 2	−72	19 23.4	− 2 34 28	−0.5130	0.5372	+.1430	−9.4609	9.9811

For facilitating the Calculation of Occultations of Planets and Stars by the Moon, *for the Year* 1852.

1852.	Star's Name.	Mag.	Limiting Parallels. North-ern.	Limiting Parallels. South-ern.	Washington Mean Time of ☌.	At Washington Mean Time of ☌. H	Y	p′	q′	Log sin D	Log cos D
			°	°	h. m.	h. m. s.					
Mar 17	45 Aquarii	6	−32	−90	11 22.1	−11 5 23	−1.0874	0.5305	+.1636	−9.3851	9.9868
17	50 Aquarii	6	+12	−62	14 07.2	− 8 25 16	−0.3743	.5272	+.1670	−9.3920	.9864
17	56 Aquarii	6	+75	+50	17 04.9	− 5 32 59	+1.2960	.5223	+.1703	−9.4225	.9843
18	74 Aquarii	6	+43	−30	5 04.2	+ 6 05 03	+0.1648	.5198	+.1822	−9.3320	.9897
18	ψ^1 Aquarii	5½	+14	−64	16 49.4	− 6 30 21	−0.4135	.5165	+.1917	−9.2353	.9935
18	ψ^2 Aquarii	5	+11	−44	17 55.3	− 5 26 20	−0.0951	.5158	+.1924	−9.2393	.9934
18	ψ^3 Aquarii	5	+65	−12	18 28.4	− 4 54 07	+0.4863	.5147	+.1928	−9.2573	.9928
21	*f* Piscium	6	− 9	−87	11 10.5	+ 9 59 39	−0.8640	.5052	+.2113	+8.6940	.9995
22	ν Piscium	5	+24	−53	0 06.2	− 1 26 06	−0.2644	.5065	+.2083	+8.9166	.9985
22	ξ^1 Ceti	5	+ 9	−71	17 11.3	− 8 49 38	−0.5517	.5096	+.2013	+9.1516	.9956
22	ξ Arietis	6	−43	−80	23 29.7	− 2 41 57	−1.2764	.5097	+.1977	+9.2368	.9934
23	B. A. C. 755	6	−20	−80	0 31.9	− 1 41 27	−1.0278	.5104	+.1971	+9.2353	.9935
23	B. A. C. 830	6	+60	−16	8 51.8	+ 6 24 04	+0.3592	.5147	+.1912	+9.2440	.9932
23	38 Arietis	5½	−47	−78	10 08.9	+ 7 38 59	−1.2939	.5129	+.1901	+9.3113	.9907
23	B. A. C. 845	4	+90	+51	10 10.3	+ 7 40 22	+1.2954	.5166	+.1901	+9.2169	.9940
25	B.A.C. 1272	6	+53	−17	4 18.1	+ 0 32 33	+0.2403	.5342	+.1457	+9.4643	.9808
25	δ^1 Tauri	4	+90	+27	11 32.9	+ 7 33 37	+0.9847	.5399	+.1359	+9.4706	.9802
25	δ^2 Tauri	4½	+90	+42	12 06.7	+ 8 06 19	+1.1639	.5411	+.1345	+9.4684	.9804
25	δ^3 Tauri	5	+90	+11	12 46.1	+ 8 44 31	+0.7180	.5401	+.1337	+9.4801	.9792
25	ϵ Tauri	3½	+13	−56	14 14.0	+10 09 35	−0.4657	.5376	+.1315	+9.5093	.9761
25	B.A.C. 1468	6	+90	+31	22 38.7	− 5 41 57	+1.0062	.5460	+.1190	+9.5006	.9770
26	*i* Tauri	5½	+90	+44	1 02.2	− 3 23 11	+1.1537	.5485	+.1140	+9.5033	.9767
26	ι Tauri	4½	−57	−69	6 25.3	+ 1 49 18	−1.2823	.5434	+.1056	+9.5616	.9691
26	*l* Tauri	5½	+51	−14	8 38.7	+ 3 58 17	+0.1997	.5490	+.1020	+9.5385	.9724
26	105 Tauri	6	−40	−68	8 39.4	+ 3 58 58	−1.1923	.5445	+.1021	+9.5641	.9687
26	*n* Tauri	5½	−36	−68	13 51.9	+ 9 01 00	−1.1540	.5478	+.0901	+9.5723	.9674
26	*o* Tauri	5	0	−65	17 39.8	−11 18 53	−0.6720	.5512	+.0857	+9.5698	.9678
26	ζ Tauri	3½	+74	+ 5	22 12.2	− 6 55 49	+0.5123	.5582	+.0761	+9.5553	.9700
27	141 Tauri	6	+26	−33	8 51.8	+ 3 21 34	−0.2287	.5610	+.0550	+9.5808	.9660
27	1 Geminor.	5	−32	−67	9 54.2	+ 4 21 47	−1.1059	.5591	+.0529	+9.5966	.9632
27	3 Geminor.	6	−11	−67	12 22.1	+ 6 44 29	−0.8383	.5604	+.0477	+9.5943	.9636
27	6 Geminor.	6	+ 6	−55	13 30.2	+ 7 50 14	−0.5753	.5617	+.0456	+9.5907	.9642
27	η Geminor.	4	+32	−25	14 38.3	+ 8 55 53	−0.1077	.5640	+.0435	+9.5836	.9655
27	μ Geminor.	3	+38	−18	18 08.7	−11 41 14	−0.0124	.5666	+.0349	+9.5844	.9654
28	δ Geminor.	3½	+76	+12	18 31.7	+11 48 35	+0.5327	.5777	−.0194	+9.5782	.9664
28	63 Cancri	6	+90	+39	21 44.4	− 9 05 57	+0.9849	.5808	−.0276	+9.5688	.9680
29	μ^1 Cancri	6	−33	−67	13 45.4	+ 6 19 05	−1.1143	.5757	−.0651	+9.5928	.9639
29	μ^2 Cancri	5	+34	−25	14 23.1	+ 6 55 27	−0.0760	.5800	−.0663	+9.5737	.9672
30	η Cancri	6	+52	−12	0 43.3	− 7 07 48	+0.2123	.5818	−.0907	+9.5531	.9703
30	39 Cancri	6	+61	− 5	3 46.9	− 4 11 06	+0.3495	.5830	−.0975	+9.5448	.9715
30	40 Cancri	6	+63	− 3	3 49.1	− 4 09 03	+0.3830	.5832	−.0975	+9.5441	.9716
30	γ Cancri	4½	−59	−68	5 04.1	− 2 56 50	−1.2835	.5769	−.1010	+9.5736	.9672
30	83 Cancri	6	+90	+11	19 51.8	+11 17 14	+0.7076	.5842	−.1328	+9.4980	.9773
31	37 Leonis	6	+90	+15	19 44.9	+10 16 25	+0.8565	.5822	−.1793	+9.3975	.9860
31	42 Leonis	6	− 6	−74	21 57.1	−11 36 15	−0.7960	.5776	−.1828	+9.4328	.9835
April 1	*i* Leonis	6	− 5	−75	2 17.2	− 7 25 56	−0.7800	.5773	−.1901	+9.4099	.9852
2	ν Virginis	4½	+45	−31	9 20.3	− 1 31 42	+0.1042	.5757	−.2288	+9.1074	.9964
3	*c* Virginis	5	+29	−48	0 00.0	−11 24 11	−0.1715	.5745	−.2386	+8.8578	.9989
4	80 Virginis	6	+85	0	7 52.3	− 4 41 33	+0.7183	.5750	−.2393	−8.9081	.9986
4	94 Virginis	6	+82	+28	20 49.9	+ 7 47 31	+1.1334	0.5754	−.2314	−9.1533	9.9956

For facilitating the Calculation of Occultations of Planets and Stars by the Moon, *for the Year* 1852.

1852.	Star's Name.	Mag.	Limiting Parallels.		Washington Mean Time of ☌.	At Washington Mean Time of ☌.				Log sin *D*	Log cos *D*
			Northern.	Southern.		*H*	*Y*	*p′*	*q′*		
			°	°	h. m.	h. m. s.					
April 5	ξ^1 Libræ	6	+21	−54	16 55.3	+ 3 08 17	−0.2597	0.5806	−.2104	−9.2918	9.9915
5	ξ^2 Libræ	5	−18	−90	17 55.1	+ 4 05 55	−0.9456	.5820	−.2091	−9.2731	.9922
6	o^2 Libræ	6	+10	− 4	4 44.0	− 9 29 32	+0.6327	.5801	−.1933	−9.4015	.9857
6	γ Libræ	4½	− 3	−86	9 53.2	− 4 31 58	−0.6504	.5847	−.1848	−9.3925	.9864
6	η Libræ	4½	+11	−63	13 23.5	− 1 09 35	−0.3873	.5844	−.1788	−9.4186	.9845
6	θ Libræ	4½	+31	−38	17 21.6	+ 2 39 34	+0.0092	.5838	−.1715	−9.4480	.9822
6	49 Libræ	5½	− 5	−86	20 04.7	+ 5 16 31	−0.6485	.5863	−.1659	−9.4427	.9827
7	χ Ophiuchi	5	+12	−57	6 53.5	− 8 19 19	−0.3065	.5863	−.1450	−9.4927	.9779
7	B.A.C. 5758	6	+69	+17	22 45.3	+ 6 56 08	+0.9467	.5821	−.1102	−9.5612	.9691
8	ξ Ophiuchi	4½	+19	−44	4 46.4	−11 16 35	−0.0883	.5859	−.0964	−9.5533	.9703
8	B.A.C. 5866	6	+30	−32	6 17.1	− 9 49 17	+0.1264	.5851	−.0929	−9.5602	.9693
8	B.A.C. 5954	6	+ 3	−61	12 00.0	− 4 19 29	−0.3471	.5863	−.0800	−9.5605	.9692
8	58 Ophiuchi	5	+11	−51	13 55.2	− 2 28 39	−0.2018	.5853	−.0753	−9.5660	.9684
8	B.A.C. 6088	6	+50	−10	21 26.6	+ 4 45 38	+0.5042	.5812	−.0574	−9.5877	.9648
9	14 Sagittarii	6	−29	−90	3 33.1	+10 40 41	−0.8616	.5856	−.0431	−9.5689	.9679
9	B.A.C. 6343	6	+66	+ 9	12 32.0	− 4 43 07	+0.8067	.5760	−.0216	−9.6028	.9620
9	26 Sagittarii	6	+67	+36	13 55.0	− 3 23 13	+1.1371	.5738	−.0180	−9.6087	.9608
9	28 Sagittarii	6	− 5	−64	15 49.6	− 1 32 50	−0.3828	.5797	−.0133	−9.5836	.9655
9	30 Sagittarii	6	−19	−87	17 43.0	+ 0 16 21	−0.6298	.5798	−.0086	−9.5796	.9662
9	31 Sagittarii	6	−34	−90	18 15.6	+ 0 47 46	−0.8833	.5806	−.0074	−9.5752	.9669
9	ν^1 Sagittarii	5	+14	−40	19 05.5	+ 1 35 48	−0.0172	.5768	−.0057	−9.5905	.9643
9	ν^2 Sagittarii	5	+10	−44	19 29.1	+ 1 58 30	−0.0942	.5772	−.0050	−9.5892	.9645
9	B.A.C. 6448	6	+41	−14	20 51.8	+ 3 20 20	+0.4356	.5748	−.0039	−9.5982	.9629
9	o Sagittarii	4½	−45	−90	23 32.1	+ 5 52 32	−1.0390	.5796	+.0043	−9.5726	.9673
10	B.A.C. 6561	6	−35	−90	2 50.0	+ 9 03 08	−1.0703	.5780	+.0123	−9.5717	.9675
10	B.A.C. 6607	6	+ 6	−51	6 17.4	−11 37 03	−0.1960	.5728	+.0203	−9.5859	.9651
10	50 Sagittarii	6	−26	−90	8 44.5	− 9 15 14	−0.7823	.5745	+.0248	−9.5748	.9670
10	B.A.C. 6671	6	−58	−90	10 42.6	− 7 21 27	−1.2089	.5752	+.0293	−9.5663	.9683
10	B.A.C. 6864	6	+67	+23	23 56.1	+ 5 23 42	+1.0007	.5594	+.0584	−9.5943	.9636
11	4 Capricor.	6	+55	− 7	7 20.0	−11 27 52	+0.5551	.5568	+.0737	−9.5785	.9663
12	20 Capricor.	6	− 5	−78	2 22.2	+ 6 55 35	−0.5621	.5497	+.1090	−9.5258	.9741
12	η Capricor.	5	+61	− 6	4 35.4	+ 9 04 24	+0.5840	.5451	+.1125	−9.5430	.9718
12	30 Capricor.	6	− 4	−88	11 01.3	− 8 42 22	−0.6501	.5444	+.1235	−9.5037	.9767
12	γ Capricor.	4	− 6	−86	21 39.5	+ 1 35 25	−0.6396	.5385	+.1392	−9.4739	.9799
13	δ Capricor.	3½	−11	−90	1 03.2	+ 4 52 37	−0.7396	.5360	+.1448	−9.4608	.9811
13	29 Aquarii	6	+74	+60	8 39.7	−11 45 03	+1.2987	.5271	+.1542	−9.4823	.9790
13	45 Aquarii	6	−53	−90	17 01.8	− 3 38 21	−1.2897	.5289	+.1645	−9.3850	.9868
13	50 Aquarii	6	+ 2	−78	19 47.2	− 0 57 58	−0.5737	.5258	+.1680	−9.3919	.9864
13	56 Aquarii	6	+75	+27	22 45.2	+ 1 54 43	+1.1000	.5207	+.1713	−9.4225	.9843
14	74 Aquarii	6	+34	−39	10 46.8	−10 25 00	−0.0078	.5177	+.1832	−9.3320	.9897
14	ψ^1 Aquarii	5½	+ 6	−76	22 35.2	+ 1 02 54	−0.5619	.5142	+.1927	−9.2351	.9935
14	ψ^2 Aquarii	5	+23	−53	23 41.5	+ 2 07 14	−0.2412	.5133	+.1934	−9.2393	.9934
15	ψ^3 Aquarii	5	+56	−20	0 14.8	+ 2 39 36	+0.3412	.5120	+.1941	−9.2573	.9928
15	30 Piscium	4½	+83	+21	23 29.5	+ 1 14 59	+1.0469	.5057	+.2072	−9.0758	.9969
16	33 Piscium	5	+83	+25	1 20.4	+ 3 02 53	+1.0970	.5055	+.2081	−9.0563	.9972
21	B.A.C. 1272	6	+67	− 6	10 06.9	+ 8 08 43	+0.4403	.5367	+.1478	+9.4643	.9808
21	δ^1 Tauri	4	+90	+46	17 20.8	− 8 51 06	+1.1978	.5421	+.1377	+9.4706	.9802
21	δ^3 Tauri	5	+90	+24	18 33.9	− 7 40 18	+0.9317	.5417	+.1361	+9.4801	.9792
21	ϵ Tauri	3½	+25	−42	20 01.6	− 6 15 22	−0.2522	.5395	+.1335	+9.5092	.9761
22	B.A.C. 1468	6	+90	+52	4 26.0	+ 1 52 43	+1.2345	0.5479	+.1203	+9.5005	9.9770

For facilitating the Calculation of Occultations of Planets and Stars by the Moon, *for the Year* 1852.

1852.	Star's Name.	Mag.	Limiting Parallels. North-ern.	Limiting Parallels. South-ern.	Washington Mean Time of ☌.	At Washington Mean Time of ☌. H	Y	p'	q'	Log sin D	Log cos D
			°	°	h. m.	h. m. s.					
Apr 22	ι Tauri	4½	−26	−69	12 13.0	+ 9 24 26	−1.0527	0.5450	+.1067	+9.5616	9.9691
22	*l* Tauri	5½	+67	− 1	14 26.6	+11 33 33	+0.4385	.5507	+.1031	+9.5385	.9724
22	105 Tauri	6	−18	−68	14 27.3	+11 34 14	−0.9596	.5460	+.1031	+9.5641	.9687
22	*n* Tauri	5½	−15	−68	19 40.1	− 7 23 28	−0.9168	.5485	+.0940	+9.5724	.9674
22	*o* Tauri	5	+15	−48	23 29.4	− 3 41 51	−0.4289	.5522	+.0865	+9.5698	.9678
23	ζ Tauri	3½	+90	+20	4 03.1	+ 0 42 31	+0.7661	.5589	+.0769	+9.5553	.9700
23	141 Tauri	6	+41	−18	14 46.9	+11 04 06	+0.0286	.5607	+.0558	+9.5808	.9660
23	1 Geminor.	5	−11	−67	15 49.9	−11 55 03	−0.8547	.5577	+.0530	+9.5966	.9632
23	3 Geminor.	6	+ 6	−55	18 19.1	− 9 31 01	−0.5838	.5600	+.0484	+9.5943	.9636
23	η Geminor.	4	+48	−10	20 36.7	− 7 18 17	+0.1543	.5632	+.0441	+9.5836	.9655
24	μ Geminor.	3	+54	− 5	0 09.3	− 3 53 12	+0.2521	.5644	+.0376	+9.5844	.9654
25	δ Geminor.	3½	+90	+28	0 54.3	− 4 01 21	+0.8119	.5738	−.0192	+9.5782	.9664
25	63 Geminor.	6	+90	+67	4 10.7	− 0 52 05	+1.2700	.5762	−.0273	+9.5687	.9680
25	μ^1 Cancri	6	−12	−68	20 33.6	− 9 05 08	−0.8584	.5695	−.0638	+9.5928	.9639
25	μ^2 Cancri	5	+51	−10	21 12.8	− 8 27 21	+0.1940	.5738	−.0662	+9.5737	.9672
26	η Cancri	6	+71	+ 3	7 49.2	+ 1 45 46	+0.4832	.5749	−.0896	+9.5530	.9703
26	39 Cancri	6	+85	+ 1	10 58.2	+ 4 47 47	+0.6213	.5754	−.0962	+9.5448	.9715
26	40 Cancri	6	+90	+12	11 00.3	+ 4 49 51	+0.6554	.5756	−.0962	+9.5440	.9716
26	γ Cancri	4½	−25	−68	12 17.5	+ 6 04 13	−1.0375	.5691	−.0994	+9.5735	.9672
26	Mars.		+57	− 9	15 57.1	+ 9 35 43	+0.3006	.5741	−.1070	+9.5411	.9721
27	83 Cancri	6	+90	+29	3 32.9	− 3 13 53	+0.9927	.5752	−.1310	+9.4976	.9774
28	η Leonis	3½	−47	−73	0 15.7	− 7 16 16	−1.2750	.5656	−.1706	+9.4776	.9795
28	37 Leonis	6	+90	+31	4 19.7	− 3 21 05	+1.0844	.5716	−.1773	+9.3975	.9860
28	42 Leonis	6	+ 7	−68	6 32.4	− 1 13 10	−0.5855	.5670	−.1803	+9.4328	.9835
28	*i* Leonis	6	+ 8	−68	11 01.5	+ 3 06 20	−0.5753	.5664	−.1885	+9.4099	.9852
29	ν Virginis	4½	+54	−23	19 07.6	+10 03 40	+0.2619	.5655	−.2272	+9.1073	.9964
30	π Virginis	5	−49	−83	1 41.2	− 7 36 42	−1.3240	.5636	−.2319	+9.1119	.9963
30	*c* Virginis	5	+36	−41	10 12.6	+ 0 36 34	−0.0533	.5656	−.2375	+8.8579	.9989
May 1	80 Virginis	6	+81	+42	18 42.7	+ 7 57 00	+0.7537	.5703	−.2401	−8.9081	.9986
2	94 Virginis	6	+82	+27	7 47.2	− 3 26 55	+1.1306	.5729	−.2332	−9.1533	.9956
3	ξ^1 Libræ	6	+18	−58	3 53.0	− 8 05 45	−0.3169	.5816	−.2133	−9.2920	.9915
3	ξ^2 Libræ	5	−22	−90	4 52.6	− 7 08 25	−1.0032	.5833	−.2120	−9.2732	.9922
3	o^2 Libræ	6	+66	−10	15 36.2	+ 3 10 55	+0.5411	.5832	−.1970	−9.4016	.9857
3	γ Libræ	4½	− 8	−90	20 41.7	+ 8 04 48	−0.7461	.5883	−.1889	−9.3925	.9864
4	η Libræ	4½	+ 6	−71	0 09.1	+11 24 17	−0.4924	.5890	−.1820	−9.4186	.9845
4	θ Libræ	4½	+25	−45	4 03.5	− 8 50 18	−0.1077	.5892	−.1747	−9.4479	.9822
4	49 Libræ	5½	−11	−90	6 44.0	− 6 16 04	−0.7661	.5918	−.1699	−9.4427	.9827
4	ψ Ophiuchi	5	+70	+56	16 07.9	+ 2 46 01	+1.2987	.5872	−.1507	−9.5274	.9739
4	χ Ophiuchi	5	+ 5	−67	17 20.0	+ 3 55 19	−0.4485	.5935	−.1486	−9.4927	.9779
5	B.A.C. 5758	6	+69	+ 4	8 48.7	− 5 12 23	+0.7614	.5909	−.1136	−9.5612	.9691
5	ξ Ophiuchi	4½	+ 9	−56	14 39.9	+ 0 25 01	−0.2710	.5951	−.1004	−9.5533	.9703
5	B.A.C. 5866	6	+20	−43	16 08.1	+ 1 49 45	−0.0613	.5943	−.0955	−9.5602	.9693
5	B.A.C. 5954	6	+20	−41	21 41.0	+ 7 09 33	−0.0297	.5936	−.0819	−9.5701	.9677
5	58 Ophiuchi	5	0	−64	23 32.9	+ 8 57 03	−0.3965	.5954	−.0782	−9.5660	.9684
6	B.A.C. 6088	6	+36	−23	6 50.5	− 8 03 31	+0.2899	.5914	−.0594	−9.5878	.9648
6	B.A.C. 6161	6	+66	+27	10 43.4	− 4 18 41	+1.0532	.5875	−.0499	−9.6046	.9617
6	14 Sagittarii	6	−40	−90	11 47.7	− 3 16 59	−1.0212	.5957	−.0467	−9.5689	.9679
6	24 Sagittarii	6	+66	+36	19 35.4	+ 4 12 35	+1.1410	.5838	−.0278	−9.6116	.9603
6	26 Sagittarii	6	+66	+14	22 48.0	+ 7 17 44	+0.8935	.5842	−.0189	−9.6087	.9608
7	28 Sagittarii	6	−17	−84	0 39.0	+ 9 04 28	−0.6069	0.5903	−.0152	−9.5836	9.9655

For facilitating the Calculation of Occultations of Planets and Stars by the Moon, *for the Year* 1852.

1852.	Star's Name.	Mag.	Limiting Parallels. Northern.	Limiting Parallels. Southern.	Washington Mean Time of ☌.	At Washington Mean Time of ☌. *H*	*Y*	*p′*	*q′*	Log sin *D*	Log cos *D*
			°	°	h. m.	h. m. s.					
May 7	30 Sagittarii	6	−32	−90	2 28.9	+10 50 04	−0.8517	0.5903	−.0102	−9.5797	9.9662
7	31 Sagittarii	6	−49	−90	3 00.4	+11 20 23	−1.1018	.5909	−.0077	−9.5752	.9669
7	ν^1 Sagittarii	5	+ 2	−54	3 48.7	−11 53 08	−0.2489	.5873	−.0065	−9.5904	.9643
7	ν^2 Sagittarii	5	− 2	−60	4 11.6	−11 31 11	−0.3251	.5872	−.0052	−9.5892	.9645
7	B.A.C. 6448	6	+26	−28	4 33.0	−11 10 34	+0.1976	.5851	−.0047	−9.5982	.9629
7	*o* Sagittarii	4½	−66	−90	8 06.9	− 7 44 49	−1.2598	.5892	+.0046	−9.5726	.9673
7	B.A.C. 6607	6	− 7	−68	14 39.5	− 1 27 05	−0.4353	.5833	+.0191	−9.5860	.9651
7	χ^3 Sagittarii	6	+66	+53	16 37.8	+ 0 26 46	+1.2500	.5752	+.0239	−9.6134	.9599
7	50 Sagittarii	6	−41	−90	17 01.8	+ 0 49 50	−1.0148	.5836	+.0263	−9.5748	.9670
8	B.A.C. 6864	6	+67	+ 3	7 46.5	− 8 58 09	+0.7343	.5682	+.0593	−9.5944	.9636
8	4 Capricor.	6	+38	−23	14 58.0	− 2 02 08	+0.2911	.5523	+.0743	−9.5784	.9663
9	17 Capricor.	6	+68	+35	3 24.0	+ 9 57 37	+1.1505	.5536	+.0991	−9.5745	.9670
9	20 Capricor.	6	−20	−90	9 31.5	− 8 07 28	−0.8179	.5563	+.1101	−9.5257	.9741
9	η Capricor.	5	+43	−25	11 42.1	− 6 01 20	+0.3159	.5514	+.1137	−9.5430	.9718
9	30 Capricor.	6	−24	−90	17 59.3	+ 0 03 15	−0.9059	.5504	+.1247	−9.5037	.9767
10	γ Capricor.	4	−21	−90	4 26.0	+10 09 27	−0.8933	.5427	+.1410	−9.4739	.9799
10	δ Capricor.	3½	−27	−90	7 46.2	−10 36 46	−0.9920	.5406	+.1460	−9.4607	.9811
10	29 Aquarii	6	+72	+27	15 15.9	− 3 21 18	+1.0950	.5298	+.1562	−9.4823	.9790
11	50 Aquarii	6	−12	−90	2 15.0	+ 7 17 23	−0.8194	.5277	+.1694	−9.3919	.9864
11	56 Aquarii	6	+75	+ 8	5 11.2	+10 08 11	+0.8449	.5225	+.1728	−9.4224	.9843
11	74 Aquarii	6	+31	−53	17 06.6	− 2 17 43	−0.2460	.5182	+.1846	−9.3319	.9897
12	ψ^1 Aquarii	5½	− 7	−90	4 51.7	+10 06 52	−0.7838	.5140	+.1940	−9.2349	.9935
12	ψ^2 Aquarii	5	+11	−68	5 57.0	+10 10 15	−0.4654	.5123	+.1954	−9.2393	.9934
12	ψ^3 Aquarii	5	+42	−33	6 30.2	+10 42 29	+0.1152	.5113	+.1957	−9.2572	.9928
13	30 Piscium	6	+83	+ 8	5 42.4	+ 9 11 29	+0.8509	.5041	+.2083	−9.0757	.9969
13	33 Piscium	5	+83	+11	7 33.5	+11 03 22	+0.9039	.5041	+.2090	−9.0563	.9972
14	33 Ceti	6	+12	−71	19 29.3	− 2 00 02	−0.5162	.5025	+.2151	+8.4593	.9998
14	*f* Piscium	6	−15	−87	23 28.5	+ 1 52 36	−0.9725	.5025	+.2147	+8.6940	.9995
15	ν Piscium	5	+22	−57	12 25.9	− 9 31 29	−0.3157	.5050	+.2124	+8.9166	.9985
16	ξ^1 Ceti	5	+11	−70	5 30.2	+ 7 04 14	−0.5259	.5093	+.2058	+9.1516	.9956
16	ξ Arietis	6	−36	−80	11 47.5	−10 49 13	−1.2212	.5106	+.2023	+9.2368	.9934
16	B. A. C. 755	6	−15	−80	12 49.5	− 9 48 58	−0.9654	.5109	+.2019	+9.2349	.9935
20	*o* Tauri	5	+22	−40	5 13.6	+ 3 49 45	−0.3090	.5564	+.0881	+9.5698	.9678
20	ζ Tauri	3½	+90	+27	9 44.9	+ 8 11 41	+0.8900	.5626	+.0792	+9.5553	.9700
20	141 Tauri	5½	+49	−11	20 23.2	− 5 32 10	+0.1675	.5645	+.0575	+9.5808	.9660
20	1 Geminor.	5	− 2	−66	22 25.8	− 3 31 49	−0.7133	.5614	+.0554	+9.5965	.9632
20	3 Geminor.	6	+14	−45	23 53.9	− 2 08 55	−0.4393	.5634	+.0501	+9.5943	.9636
21	6 Geminor.	6	+29	−29	1 02.1	− 1 03 04	−0.1727	.5648	+.0468	+9.5907	.9642
21	η Geminor.	4	+58	− 3	2 10.4	+ 0 02 47	+0.3003	.5673	+.0446	+9.5836	.9655
21	μ Geminor.	3	+65	+ 3	5 41.5	+ 3 26 22	+0.4023	.5685	+.0381	+9.5844	.9654
22	48 Geminor.	6	−46	−66	2 59.3	− 0 01 45	−1.2170	.5669	−.0105	+9.6156	.9595
22	δ Geminor.	3½	+90	+40	6 20.0	+ 3 11 40	+0.9890	.5762	−.0188	+9.5782	.9664
23	μ^1 Cancri	6	+ 1	−64	2 00.6	− 1 50 44	−0.6724	.5702	−.0645	+9.5928	.9639
23	μ^2 Cancri	5	+64	0	2 39.9	− 1 12 52	+0.3864	.5742	−.0644	+9.5737	.9672
23	η Cancri	6	+90	+16	12 54.7	+ 8 39 31	+0.7231	.5745	−.0878	+9.5531	.9703
23	39 Cancri	6	+90	+22	16 30.8	−11 52 14	+0.8253	.5745	−.0954	+9.5448	.9715
23	40 Cancri	6	+90	+34	16 33.0	−11 50 09	+1.1754	.5757	−.0954	+9.5379	.9725
23	γ Cancri	4½	−10	−68	17 50.9	−10 35 03	−0.8472	.5679	−.0986	+9.5736	.9672
24	83 Cancri	6	+90	+38	9 17.5	+ 4 18 08	+0.1190	.5721	−.1306	+9.4979	.9774
25	η Leonis	3½	−26	−73	6 23.9	+ 0 39 26	−1.0884	0.5601	−.1687	+9.4777	9.9795

For facilitating the Calculation of Occultations of Planets and Stars by the Moon, *for the Year* 1852.

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			°	°	h. m.	h. m. s.					
May 25	37 Leonis	6	+90	+56	10 33.5	+ 4 40 13	+1.3008	0.5655	−.1751	+9.3976	9.9860
25	42 Leonis	6	+17	−55	12 49.4	+ 6 51 20	−0.3916	.5607	−.1791	+9.4328	.9835
25	*i* Leonis	6	+18	−55	17 25.4	+11 17 43	−0.3831	.5596	−.1858	+9.4099	.9852
27	ξ Virginis	5	−37	−81	2 14.0	− 5 01 39	−1.2371	.5536	−.2239	+9.1981	.9945
27	ν Virginis	4½	+66	−14	2 30.2	− 4 46 01	+0.4433	.5560	−.2239	+9.1075	.9964
27	π Virginis	5	−31	−83	9 17.3	+ 1 47 05	−1.1754	.5537	−.2292	+9.1121	.9963
27	*c* Virginis	5	+45	−33	18 06.5	+10 18 12	+0.1049	.5553	−.2344	+8.8581	.9989
29	80 Virginis	6	+85	+ 9	3 43.0	− 5 14 42	+0.8720	.5601	−.2378	−8.9081	.9986
29	94 Virginis	6	+82	+36	17 11.3	+ 7 45 08	+1.2280	.5640	−.2313	−9.1533	.9956
30	ξ^1 Libræ	6	+22	−55	13 47.1	+ 3 36 27	−0.2752	.5748	−.2126	−9.2918	.9915
30	ξ^2 Libræ	5	−19	−90	14 47.9	+ 4 35 02	−0.9694	.5766	−.2114	−9.2730	.9922
31	o^2 Libræ	6	+68	− 8	1 43.4	− 8 53 45	+0.5671	.5780	−.1973	−9.4016	.9857
31	γ Libræ	4½	− 7	−90	6 53.5	− 3 55 19	−0.7382	.5840	−.1888	−9.3925	.9864
31	η Libræ	4½	+ 6	−71	10 23.6	− 0 33 08	−0.4890	.5849	−.1830	−9.4186	.9845
31	θ Libræ	4½	+25	−45	14 20.6	+ 3 14 56	−0.1096	.5857	−.1760	−9.4480	.9822
31	49 Libræ	5½	−12	−90	17 02.6	+ 5 50 42	−0.7753	.5891	−.1705	−9.4427	.9827
June 1	ψ Ophiuchi	5	+70	+50	2 30.4	− 9 03 19	+1.2791	.5856	−.1529	−9.5274	.9739
1	χ Ophiuchi	5	+ 3	−70	3 42.8	− 7 53 43	−0.4745	.5922	−.1500	−9.4927	.9779
1	B.A.C. 5758	6	+68	+ 1	19 12.0	+ 6 59 06	+0.7110	.5921	−.1151	−9.5612	.9691
2	ξ Ophiuchi	4½	+ 5	−60	1 01.7	−11 25 02	−0.3300	.5974	−.1016	−9.5533	.9703
2	B.A.C. 5866	6	+17	−46	2 29.4	−10 00 49	−0.1227	.5968	−.0982	−9.5602	.9693
2	B.A.C. 5954	6	+17	−45	7 59.8	− 4 43 30	−0.0996	.5970	−.0846	−9.5701	.9677
2	58 Ophiuchi	5	− 3	−70	9 50.8	− 2 56 56	−0.4679	.5988	−.0796	−9.5660	.9684
2	B.A.C. 6088	6	+31	−27	17 03.8	+ 3 58 52	+0.2057	.5957	−.0604	−9.5878	.9648
2	B.A.C. 6161	6	+66	+19	20 53.8	+ 7 39 45	+0.9601	.5922	−.0515	−9.6046	.9617
2	14 Sagittarii	6	−46	−90	21 57.1	+ 8 40 36	−1.1046	.6008	−.0488	−9.5689	.9679
3	24 Sagittarii	6	+66	+25	5 37.7	− 7 57 02	+1.0347	.5906	−.0291	−9.6116	.9603
3	B.A.C. 6343	6	+44	−13	7 28.3	− 6 10 49	+0.4638	.5922	−.0241	−9.6028	.9620
3	26 Sagittarii	6	+66	+ 7	8 47.3	− 4 54 53	+0.7841	.5903	−.0203	−9.6087	.9608
3	28 Sagittarii	6	−22	−90	10 36.4	− 3 10 06	−0.7079	.5965	−.0164	−9.5835	.9655
3	30 Sagittarii	6	−38	−90	12 24.3	− 1 26 28	−0.9534	.5969	−.0113	−9.5796	.9662
3	31 Sagittarii	6	−59	−90	12 55.3	− 0 56 37	−1.2020	.5977	−.0099	−9.5751	.9669
3	ν^1 Sagittarii	5	− 4	−62	13 42.7	− 0 11 06	−0.3564	.5939	−.0075	−9.5905	.9643
3	ν^2 Sagittarii	5	− 8	−68	14 05.1	+ 0 10 26	−0.4325	.5942	−.0073	−9.5892	.9645
3	B.A.C. 6448	6	+20	−34	14 26.2	+ 0 30 42	+0.0849	.5918	−.0061	−9.5981	.9629
4	B.A.C. 6607	6	−13	−78	0 20.8	+10 02 11	−0.5530	.5901	+.0192	−9.5859	.9651
4	χ^3 Sagittarii	6	+67	+33	2 16.5	+11 53 31	+1.1151	.5820	+.0244	−9.6134	.9599
4	50 Sagittarii	6	−51	−90	2 39.8	−11 44 10	−1.1288	.5918	+.0241	−9.5748	.9670
4	B.A.C. 6864	6	+57	− 6	17 04.8	+ 2 08 08	+0.5892	.5756	+.0598	−9.5943	.9636
5	4 Capricor.	6	+29	−31	0 06.1	+ 8 53 53	+0.1448	.5728	+.0753	−9.5785	.9663
5	B.A.C. 7049	6	+68	+40	5 00.0	−10 22 56	+1.1847	.5652	+.0860	−9.5897	.9644
5	17 Capricor.	6	+69	+20	12 14.1	− 3 24 22	+0.9856	.5612	+.1002	−9.5745	.9670
5	20 Capricor.	6	−29	−90	18 12.9	+ 2 21 45	−0.9663	.5636	+.1116	−9.5256	.9741
5	η Capricor.	5	+34	−30	20 20.4	+ 4 24 53	+0.1548	.5583	+.1153	−9.5430	.9718
5	27 Capricor.	6	+70	+37	22 37.3	+ 6 37 02	+1.1776	.5535	+.1190	−9.5573	.9697
6	γ Capricor.	4	−32	−90	12 41.3	− 3 47 29	−1.0508	.5499	+.1421	−9.4739	.9799
6	δ Capricor.	3½	−40	−90	15 57.1	− 0 38 06	−1.1497	.5471	+.1473	−9.4608	.9811
6	29 Aquarii	6	+73	+13	23 17.3	+ 6 27 51	+0.9147	.5358	+.1578	−9.4823	.9790
7	50 Aquarii	6	−23	−90	10 03.6	− 7 06 18	−0.9847	.5330	+.1714	−9.3919	.9864
7	56 Aquarii	6	+73	+15	12 56.6	− 4 18 42	+0.6650	0.5276	+.1741	−9.4224	9.9843

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			°	°	h. m.	h. m. s.					
June 8	74 Aquarii	6	+12	−65	0 40.2	+ 7 3 31	−0.4167	0.5228	+.1857	−9.3319	9.9897
8	ψ^1 Aquarii	5½	−17	−90	12 14.9	− 5 42 17	−0.9513	.5166	+.1954	−9.2349	.9935
8	ψ^2 Aquarii	5	+ 2	−83	13 20.1	− 4 39 02	−0.6328	.5157	+.1961	−9.2392	.9934
8	ψ^3 Aquarii	5	+33	−42	13 52.9	− 4 07 12	−0.0560	.5147	+.1965	−9.2573	.9928
9	30 Piscium	4½	+83	− 2	12 52.2	− 5 47 13	+0.6847	.5051	+.2092	−9.0756	.9969
9	33 Piscium	5	+82	+ 1	14 42.5	− 4 00 01	+0.7382	.5048	+.2098	−9.0562	.9972
10	20 Ceti	5	+88	+38	16 52.3	− 2 33 36	+1.2537	.5010	+.2154	−8.5314	.9997
11	33 Ceti	6	+ 4	−84	2 32.4	+ 6 50 39	−0.6561	.5012	+.2154	+8.4611	.9998
11	*f* Piscium	6	−36	−87	6 34.5	+10 46 11	−1.2297	.5014	+.2151	+8.6940	.9995
11	ν Piscium	5	+16	−65	19 29.6	− 0 40 08	−0.4338	.5031	+.2126	+8.9168	.9985
12	ξ^1 Ceti	5	+ 6	−77	12 35.8	− 8 02 38	−0.6250	.5072	+.2062	+9.1516	.9956
12	ξ Arietis	6	−47	−81	18 53.7	− 1 55 23	−1.3116	.5085	+.2028	+9.2368	.9934
12	B. A. C. 755	6	−21	−81	19 55.8	− 0 55 01	−1.0551	.5094	+.2021	+9.2349	.9935
13	B. A. C. 830	6	+61	−15	4 15.4	+ 7 10 13	+0.3718	.5149	+.1966	+9.2442	.9932
13	38 Arietis	5½	−42	−78	5 30.7	+ 8 23 18	−1.2715	.5126	+.1958	+9.3113	.9907
13	B. A. C. 845	4	+90	+50	5 32.1	+ 8 24 41	+1.3065	.5165	+.1958	+9.2169	.9940
14	B.A.C. 1272	6	+69	− 5	23 14.6	+ 0 51 27	+0.4640	.5395	+.1517	+9.4644	.9808
15	δ^1 Tauri	4	+90	+50	6 22.8	+ 7 45 57	+1.2365	.5460	+.1416	+9.4707	.9802
15	δ^3 Tauri	5	+90	+27	7 34.8	+ 8 55 40	+0.9761	.5458	+.1400	+9.4801	.9792
19	μ^1 Cancri	6	+ 6	−61	7 51.5	+ 5 47 35	−0.6115	.5756	−.0614	+9.5928	.9639
19	μ^2 Cancri	5	+68	+ 3	8 32.4	+ 6 27 03	+0.4419	.5796	−.0648	+9.5736	.9672
19	η Cancri	6	+90	+18	19 00.0	− 7 28 43	+0.7475	.5792	−.0899	+9.5531	.9703
19	39 Cancri	6	+90	+26	22 08.2	− 4 27 28	+0.8892	.5790	−.0965	+9.5448	.9715
19	40 Cancri	6	+90	+28	22 10.3	− 4 25 24	+0.9236	.5792	−.0965	+9.5441	.9716
19	γ Cancri	4½	− 5	−68	23 27.3	− 3 11 13	−0.7739	.5727	−.0987	+9.5736	.9672
20	83 Cancri	6	+90	+59	14 44.6	+11 32 33	+1.1280	.5758	−.1310	+9.4976	.9774
21	η Leonis	3½	−20	−73	11 44.2	+ 7 47 01	−1.0046	.5618	−.1688	+9.4777	.9795
21	42 Leonis	6	+22	−49	18 09.3	−10 01 27	−0.3065	.5616	−.1795	+9.4328	.9835
21	*i* Leonis	6	+23	−50	22 45.6	− 5 34 48	−0.2970	.5601	−.1861	+9.4099	.9852
22	ι Leonis	4	−53	−79	22 03.4	− 7 05 05	−1.3366	.5514	−.2141	+9.2937	.9914
23	ξ Virginis	5	−30	−81	7 49.7	+ 2 21 23	−1.1596	.5502	−.2225	+9.1983	.9945
23	ν Virginis	4½	+73	− 9	8 06.1	+ 2 37 14	+0.5342	.5525	−.2228	+9.1075	.9964
23	π Virginis	5	−24	−83	14 59.4	+ 9 16 38	−1.0998	.5497	−.2274	+9.1122	.9963
23	*c* Virginis	5	+50	−28	23 58.3	− 6 02 35	+0.1903	.5500	−.2323	+8.8588	.9989
25	80 Virginis	6	+85	+14	10 24.4	+ 3 14 12	+0.9543	.5521	−.2347	−8.9081	.9986
26	ξ^1 Libræ	6	+23	−52	21 30.1	−10 52 52	−0.2300	.5655	−.2101	−9.2918	.9915
26	ξ^2 Libræ	5	−17	−90	22 32.7	− 9 52 26	−0.9343	.5673	−.2090	−9.2730	.9922
27	o^2 Libræ	6	+71	− 6	9 47.7	+ 0 58 18	+0.6153	.5694	−.1943	−9.4015	.9857
27	γ Libræ	4½	− 6	−90	15 06.7	+ 6 05 44	−0.7110	.5756	−.1862	−9.3925	.9863
27	η Libræ	4½	+ 8	−68	18 42.7	+ 9 33 48	−0.4608	.5765	−.1815	−9.4186	.9845
27	θ Libræ	4½	+27	−44	22 46.2	−10 31 40	−0.0790	.5776	−.1741	−9.4480	.9822
28	49 Libræ	5½	−10	−90	1 32.3	− 7 51 42	−0.7544	.5806	−.1697	−9.4428	.9827
28	χ Ophiuchi	5	+23	−69	12 28.6	+ 2 39 57	−0.4569	.5586	−.1491	−9.4927	.9779
29	B.A.C. 5758	6	+68	+ 2	4 17.3	− 6 07 40	+0.7295	.5867	−.1149	−9.5613	.9691
29	ξ Ophiuchi	4½	+ 7	−59	10 13.1	− 0 25 39	−0.3237	.5925	−.1010	−9.5533	.9703
29	B.A.C. 5866	6	+17	−46	11 42.0	+ 0 59 47	−0.1155	.5920	−.0986	−9.5602	.9693
29	B.A.C. 5954	6	+17	−45	17 17.5	+ 6 22 12	−0.0952	.5931	−.0841	−9.5701	.9677
29	58 Ophiuchi	5	− 3	−70	19 10.1	+ 8 10 21	−0.4672	.5951	−.0792	−9.5661	.9684
30	B.A.C. 6088	6	+31	−27	2 28.6	− 8 48 19	+0.2067	.5931	−.0617	−9.5878	.9648
30	14 Sagittarii	6	−50	−90	7 24.4	− 4 04 09	−1.1468	0.5987	−.0490	−9.5682	9.9680

For facilitating the Calculation of Occultations of Planets and Stars by the Moon, *for the Year* 1852.

1852.	Star's Name.	Mag.	Limiting Parallels.		Washington Mean Time of ☌.	At Washington Mean Time of ☌.				Log sin *D*	Log cos *D*
			Northern.	Southern.		*H*	*Y*	*p′*	*q′*		
			°	°	h. m.	h. m. s.					
Jun 30	24 Sagittarii	6	+66	+25	15 08.3	+ 3 21 34	+1.0320	0.5891	—.0285	—9.6116	9.9603
30	B.A.C. 6343	6	+44	—13	16 59.5	+ 5 08 23	+0.4577	.5913	—.0233	—9.6028	.9620
30	26 Sagittarii	6	+66	+ 6	18 18.9	+ 6 24 43	+0.7789	.5895	—.0208	—9.6087	.9608
30	28 Sagittarii	6	—23	—90	20 08.5	+ 8 09 59	—0.7191	.5958	—.0156	—9.5836	.9655
30	30 Sagittarii	6	—39	—90	21 56.7	+ 9 54 01	—0.9663	.5966	—.0118	—9.5797	.9661
30	ν^1 Sagittarii	5	— 4	—63	23 15.5	+11 09 41	—0.3675	.5937	—.0079	—9.5905	.9643
30	ν^2 Sagittarii	5	— 8	—69	23 38.0	+11 31 18	—0.4440	.5942	—.0079	—9.5892	.9645
30	B.A.C. 6448	6	+17	—35	23 59.0	+11 51 34	+0.0748	.5918	—.0067	—9.5982	.9629
July 1	B.A.C. 6607	6	—14	—80	9 54.1	— 2 36 28	—0.5685	.5916	+.0187	—9.5859	.9651
1	χ^3 Sagittarii	6	+66	+31	11 49.8	— 0 45 15	+1.1010	.5836	+.0237	—9.6134	.9599
1	50 Sagittarii	6	—52	—90	12 13.0	— 0 22 57	—1.1455	.5929	+.0249	—9.5748	.9670
2	B.A.C. 6864	6	+55	— 7	2 34.7	—10 33 56	+0.5683	.5793	+.0587	—9.5943	.9636
2	4 Capricor.	6	+22	—32	9 33.1	— 3 51 07	+0.1216	.5769	+.0746	—9.5784	.9663
2	B.A.C. 7049	6	+67	+36	14 24.5	+ 0 49 35	+1.1574	.5695	+.0855	—9.5897	.9644
2	17 Capricor.	6	+68	+18	21 34.4	+ 7 43 50	+0.9572	.5664	+.1002	—9.5744	.9670
3	20 Capricor.	6	—31	—90	3 28.9	—10 34 17	—0.9908	.5685	+.1119	—9.5256	.9741
3	η Capricor.	5	+32	—32	5 35.1	— 8 32 33	+0.1254	.5635	+.1157	—9.5430	.9718
3	27 Capricor.	6	+69	+33	7 50.3	— 6 22 02	+1.1434	.5577	+.1203	—9.5572	.9697
3	30 Capricor.	6	—37	—90	11 38.8	— 2 41 30	—1.0829	.5629	+.1266	—9.5037	.9767
3	γ Capricor.	4	—34	—90	21 42.8	+ 7 01 59	—1.0772	.5553	+.1433	—9.4739	.9799
4	δ Capricor.	3½	—42	—90	0 55.8	+10 08 32	—1.1757	.5522	+.1486	—9.4607	.9811
4	29 Aquarii	6	+72	+11	8 09.6	— 6 52 01	+0.8762	.5407	+.1593	—9.4822	.9790
4	50 Aquarii	6	—25	—90	18 46.1	+ 3 24 07	—1.0130	.5379	+.1727	—9.3919	.9864
4	56 Aquarii	6	+70	— 5	21 36.5	+ 6 09 06	+0.6273	.5328	+.1756	—9.4224	.9843
5	τ^2 Aquarii	5½	+76	+52	7 11.7	— 8 33 31	+1.3189	.5246	+.1859	—9.3947	.9862
5	74 Aquarii	6	+11	—67	9 09.9	— 6 38 56	—0.4483	.5267	+.1877	—9.3319	.9897
5	ψ^1 Aquarii	5½	—19	—90	20 34.9	+ 4 25 31	—0.9797	.5212	+.1968	—9.2348	.9935
5	ψ^2 Aquarii	5	0	—86	21 39.2	+ 5 27 55	—0.6630	.5201	+.1976	—9.2392	.9934
5	ψ^3 Aquarii	5	+31	—44	22 11.6	+ 5 59 20	—0.0893	.5186	+.1982	—9.2572	.9928
6	30 Piscium	4½	+80	— 4	20 55.1	+ 4 03 30	+0.6506	.5078	+.2104	—9.0755	.9969
6	33 Piscium	5	+83	— 1	22 44.4	+ 5 49 40	+0.7039	.5071	+.2111	—9.0561	.9972
8	20 Ceti	5	+88	+35	0 43.5	+ 7 05 22	+1.2241	.5019	+.2160	—8.5311	.9998
8	33 Ceti	6	+ 3	—86	10 21.6	— 7 32 25	—0.6790	.5015	+.2156	+8.4615	.9998
8	*f* Piscium	6	—26	—87	14 20.4	— 3 40 13	—1.1231	.5012	+.2152	+8.6942	.9995
9	ν Piscium	5	+15	—66	3 18.0	+ 8 55 58	—0.4538	.5022	+.2124	+8.9169	.9985
9	ξ^1 Ceti	5	+ 5	—79	20 26.0	+ 1 35 22	—0.6414	.5057	+.2056	+9.1516	.9956
10	ξ Arietis	6	—50	—80	2 45.2	+ 7 43 48	—1.3268	.5068	+.2020	+9.2369	.9934
10	B. A. C. 755	6	—23	—80	3 47.5	+ 8 44 24	—1.0708	.5075	+.2015	+9.2349	.9935
10	B. A. C. 830	6	+61	—17	12 09.1	— 7 08 18	+0.3583	.5126	+.1958	+9.2441	.9932
10	38 Arietis	6	—44	—78	13 24.7	— 5 54 53	—1.2844	.5104	+.1950	+9.3114	.9907
10	B. A. C. 845	4	+90	+48	13 26.2	— 5 53 30	+1.2930	.5143	+.1950	+9.2170	.9940
12	B.A.C. 1272	6	+68	— 6	7 19.7	+10 44 24	+0.4576	.5373	+.1513	+9.4645	.9808
12	δ^1 Tauri	4	+90	+49	14 29.3	— 6 19 43	+1.2300	.5439	+.1413	+9.4707	.9802
12	δ^3 Tauri	5	+90	+26	15 41.6	— 5 09 46	+0.9698	.5436	+.1398	+9.4801	.9792
12	ε Tauri	3½	+28	—39	17 08.3	— 3 45 55	—0.2004	.5421	+.1368	+9.5092	.9761
13	B.A.C. 1468	6	+90	+63	1 25.5	+ 4 15 00	+1.2972	.5518	+.1239	+9.5006	.9771
13	ι Tauri	4½	—17	—69	9 04.5	+11 38 41	—0.9491	.5503	+.1101	+9.5616	.9691
13	*l* Tauri	5½	+76	+ 4	11 15.6	—10 14 42	+0.5339	.5568	+.1065	+9.5385	.9724
13	105 Tauri	6	—10	—68	11 16.3	—10 14 02	—0.8496	.5518	+.1065	+9.5641	.9687
13	*n* Tauri	5½	— 7	—68	16 22.7	— 5 18 06	—0.7969	0.5551	+.0965	+9.5724	9.9674

For facilitating the Calculation of Occultations of Planets and Stars by the Moon, *for the Year* 1852.

1852.	Star's Name.	Mag.	Limiting Parallels. Northern.	Limiting Parallels. Southern.	Washington Mean Time of ☌.	At Washington Mean Time of ☌. H	Y	p′	q′	Log sin D	Log cos D
			°	°	h. m.	h. m. s.					
Jul. 13	ο Tauri	5	+22	−40	20 07.0	− 1 41 33	−0.3032	0.5594	+.0894	+9.5698	9.9678
14	ζ Tauri	3½	+90	+27	0 34.3	+ 2 36 26	+0.8898	.5658	+.0813	+9.5553	.9700
14	141 Tauri	6	+39	−20	11 01.7	−11 18 21	+0.0064	.5702	+.0583	+9.5808	.9660
14	1 Geminor.	5	0	−64	12 03.1	−10 19 12	−0.6874	.5671	+.0559	+9.5966	.9632
18	η Leonis	3½	−21	−73	18 06.5	− 8 03 09	−1.0205	.5679	−.1716	+9.4777	.9795
19	42 Leonis	6	+21	−51	0 23.9	− 1 59 18	−0.3303	.5679	−.1814	+9.4328	.9835
19	*i* Leonis	6	+22	−51	4 54.9	+ 2 21 59	−0.3224	.5662	−.1882	+9.4099	.9852
20	ι Leonis	4	−63	−79	3 48.8	+ 0 27 42	−1.3630	.5562	−.2162	+9.2938	.9914
20	ξ Virginis	5	−32	−81	13 27.2	+ 9 46 15	−1.1912	.5541	−.2243	+9.1983	.9945
20	ν Virginis	4½	+70	−11	13 43.4	+10 01 55	+0.4933	.5560	−.2245	+9.1075	.9964
20	π Virginis	5	−27	−83	20 32.2	− 7 23 13	−1.1347	.5527	−.2290	+9.1122	.9963
21	*c* Virginis	5	+47	−31	5 26.4	+ 1 12 56	+0.1479	.5523	−.2335	+8.8582	.9989
22	80 Virginis	6	+85	+11	15 50.5	+10 27 41	+0.9099	.5507	−.2342	−8.9081	.9986
24	ξ^1 Libræ	6	+21	−55	3 20.3	− 3 15 15	−0.2780	.5604	−.2079	−9.2918	.9915
24	ξ^2 Libræ	5	−20	−90	4 24.0	− 2 13 45	−0.9881	.5621	−.2067	−9.2730	.9922
24	o^2 Libræ	6	+68	− 8	15 51.8	+ 8 49 52	+0.5756	.5631	−.1923	−9.4016	.9857
24	γ Libræ	4½	− 9	−90	21 17.0	− 9 56 32	−0.7608	.5690	−.1842	−9.3925	.9864
25	η Libræ	4½	+ 5	−72	0 57.5	− 6 23 52	−0.5076	.5696	−.1788	−9.4186	.9845
25	θ Libræ	4½	+25	−46	5 06.4	− 2 23 59	−0.1211	.5708	−.1715	−9.4480	.9822
25	49 Libræ	5½	−13	−90	7 56.3	+ 0 19 44	−0.8030	.5737	−.1673	−9.4428	.9827
25	ψ Ophiuchi	5	+70	+54	17 51.8	+ 9 53 31	+1.2930	.5711	−.1492	−9.5275	.9739
25	χ Ophiuchi	5	+ 2	−72	19 07.7	+11 06 35	−0.4985	.5774	−.1464	−9.4927	.9779
26	B.A.C. 5758	6	+69	+ 1	11 19.1	+ 2 41 41	+0.7068	.5793	−.1131	−9.5612	.9691
26	ξ Ophiuchi	4½	+ 5	−62	17 23.3	+ 8 32 09	−0.3554	.5851	−.0996	−9.5533	.9703
26	B.A.C. 5866	6	+16	−48	18 54.1	+ 9 59 30	−0.1443	.5847	−.0962	−9.5602	.9693
27	B.A.C. 5954	6	+16	−46	0 37.7	− 8 30 00	−0.1210	.5859	−.0834	−9.5701	.9677
27	58 Ophiuchi	5	− 5	−73	2 32.7	− 6 39 20	−0.4961	.5880	−.0787	−9.5661	.9684
27	B.A.C. 6088	6	+30	−28	10 00.7	+ 0 31 28	+0.1886	.5861	−.0599	−9.5878	.9648
27	B.A.C. 6161	6	+66	+19	13 57.9	+ 4 19 36	+0.9543	.5837	−.0508	−9.6046	.9617
27	14 Sagittarii	6	−50	−90	15 03.3	+ 5 22 26	−1.1418	.5918	−.0476	−9.5689	.9679
27	24 Sagittarii	6	+66	+25	22 56.7	−11 02 17	+1.0283	.5832	−.0272	−9.6116	.9603
28	B.A.C. 6343	6	+43	−14	0 50.0	− 9 13 19	+0.4484	.5855	−.0235	−9.6028	.9620
28	26 Sagittarii	6	+66	+ 6	2 11.0	− 7 55 27	+0.7748	.5839	−.0197	−9.6087	.9608
28	28 Sagittarii	6	−24	−90	4 02.6	− 6 08 06	−0.7364	.5903	−.0152	−9.5836	.9655
28	30 Sagittarii	6	−40	−90	5 52.9	− 4 22 03	−0.9842	.5910	−.0108	−9.5796	.9661
28	31 Sagittarii	6	−15	−90	6 24.6	− 3 51 32	−1.2351	.5920	−.0097	−9.5752	.9669
28	ν^1 Sagittarii	5	− 5	−64	7 13.1	− 3 04 55	−0.3795	.5884	−.0072	−9.5904	.9643
28	ν^2 Sagittarii	5	− 9	−70	7 36.0	− 2 42 55	−0.4562	.5887	−.0065	−9.5892	.9645
28	B.A.C. 6448	6	+19	−35	7 57.5	− 2 22 16	+0.0673	.5865	−.0059	−9.5982	.9629
28	B.A.C. 6607	6	+18	−81	18 02.5	+ 7 19 42	−0.5750	.5872	+.0182	−9.5860	.9651
28	χ^3 Sagittarii	6	+65	+32	20 02.1	+ 9 14 53	+1.1082	.5792	+.0243	−9.6134	.9599
28	50 Sagittarii	6	−53	−90	20 23.4	+ 9 35 17	−1.1548	.5887	+.0249	−9.5748	.9670
29	B.A.C. 6864	6	+56	− 6	10 56.6	− 0 24 13	+0.5802	.5760	+.0593	−9.5943	.9636
29	4 Capricor.	6	+35	−31	17 59.4	+ 6 22 57	+0.1355	.5742	+.0756	−9.5784	.9663
29	B.A.C. 7049	6	+67	+39	22 53.3	+11 06 11	+1.1806	.5681	+.0860	−9.5896	.9645
30	17 Capricor.	6	+68	+20	6 06.2	− 5 56 26	+0.9831	.5644	+.1016	−9.5744	.9670
30	20 Capricor.	6	−54	−90	12 02.7	− 0 12 34	−0.9670	.5679	+.1121	−9.5257	.9741
30	η Capricor.	5	+34	−30	14 09.4	+ 1 49 36	+0.1553	.5626	+.1172	−9.5430	.9718
30	27 Capricor.	6	+69	+37	16 25.0	+ 4 00 32	+1.1790	.5578	+.1209	−9.5572	.9697
30	30 Capricor.	6	−34	−90	20 14.3	+ 7 41 50	−1.0520	0.5625	+.1281	−9.5037	9.9767

For facilitating the Calculation of Occultations of Planets and Stars by the Moon, *for the Year* 1852.

1852.	Star's Name.	Mag.	Limiting Parallels. North-ern.	Limiting Parallels. South-ern.	Washington Mean Time of ☌.	At Washington Mean Time of ☌. H	Y	p'	q'	Log sin D	Log cos D
			°	°	h. m.	h. m. s.					
Jul. 31	γ Capricor.	4	−31	−90	6 19.2	− 6 33 48	−1.0371	0.5555	+.1449	−9.4739	9.9799
31	δ Capricor.	3½	−38	−90	9 32.2	− 3 27 16	−1.1334	.5537	+.1496	−9.4607	.9811
31	29 Aquarii	6	+72	+14	16 45.4	+ 3 31 40	+0.9287	.5426	+.1605	−9.4822	.9790
Aug. 1	50 Aquarii	6	−21	−90	3 20.2	−10 14 01	−0.9534	.5403	+.1741	−9.3919	.9864
1	56 Aquarii	6	+74	− 1	6 09.9	− 7 29 41	+0.6888	.5346	+.1776	−9.4224	.9843
1	74 Aquarii	6	+ 4	−77	17 39.8	+ 3 38 51	−0.5661	.5294	+.1893	−9.3319	.9897
2	ψ¹ Aquarii	5½	−14	−90	5 00.8	− 9 20 45	−0.8993	.5241	+.1987	−9.2348	.9935
2	ψ² Aquarii	5	+ 5	−78	6 04.7	− 8 18 46	−0.5817	.5225	+.1998	−9.2391	.9934
2	ψ³ Aquarii	5	+36	−40	6 36.9	− 7 47 34	−0.0082	.5211	+.2001	−9.2571	.9928
3	30 Piscium	4½	+80	+ 1	5 11.3	− 9 52 34	+0.7473	.5101	+.2122	−9.0755	.9969
3	33 Piscium	5	+83	+ 4	6 59.8	− 8 07 07	+0.8020	.5099	+.2130	−9.0560	.9972
4	20 Ceti	5	+88	+49	8 50.2	− 7 00 08	+1.3369	.5042	+.2173	−8.5307	.9997
4	33 Ceti	6	+ 9	−75	18 26.4	+ 2 20 05	−0.5608	.5027	+.2154	+8.4619	.9998
4	*f* Piscium	6	−17	−87	22 24.5	+ 6 11 38	−1.0023	.5022	+.2160	+8.6945	.9995
5	ν Piscium	5	+22	−58	11 21.0	− 5 13 18	−0.3298	.5027	+.2128	+8.9169	.9985
6	ξ¹ Ceti	5	+12	−69	4 30.3	+11 27 21	−0.5149	.5049	+.2054	+9.1517	.9956
6	ξ Arietis	6	−34	−80	10 51.0	− 6 22 34	−1.1973	.5099	+.2017	+9.2370	.9934
6	B. A. C. 755	6	−14	−80	11 52.5	− 5 22 51	−0.9471	.5062	+.2010	+9.2352	.9935
6	B. A. C. 830	6	+70	−10	20 17.3	+ 2 47 38	+0.4873	.5110	+.1952	+9.2443	.9932
6	38 Arietis	5½	−30	−78	21 33.5	+ 4 01 37	−1.1585	.5085	+.1944	+9.3114	.9907
8	B.A.C. 1272	6	+79	0	15 49.6	− 2 57 52	+0.5758	.5337	+.1499	+9.4645	.9808
9	δ³ Tauri	5	+90	+35	0 16.7	+ 5 13 07	+1.0859	.5406	+.1377	+9.4802	.9792
9	ε Tauri	3½	+34	−33	1 44.3	+ 6 37 55	−0.0899	.5383	+.1368	+9.5093	.9761
9	ι Tauri	4½	−10	−69	17 50.7	− 0 47 19	−0.8513	.5463	+.1092	+9.5616	.9691
9	*l* Tauri	5½	+87	+ 9	20 03.0	+ 0 20 38	+0.6353	.5527	+.1048	+9.5385	.9724
9	105 Tauri	6	− 4	−68	20 03.7	+ 0 21 19	−0.7546	.5480	+.1048	+9.5642	.9687
10	*n* Tauri	5½	− 1	−67	1 13.2	+ 5 20 21	−0.7026	.5516	+.0954	+9.5724	.9674
10	*o* Tauri	5	+27	−35	4 59.7	+ 8 59 04	−0.2113	.5555	+.0887	+9.5699	.9678
10	ζ Tauri	3½	+90	+34	9 29.4	−10 40 30	+0.9815	.5626	+.0799	+9.5553	.9700
10	141 Tauri	6	+55	− 6	20 01.5	− 0 30 37	+0.2635	.5666	+.0576	+9.5808	.9660
10	1 Geminor.	5	+ 4	−58	21 03.8	+ 0 29 25	−0.6098	.5642	+.0549	+9.5966	.9632
10	3 Geminor.	6	+20	−39	23 30.0	+ 2 50 23	−0.3388	.5662	+.0505	+9.5943	.9636
11	6 Geminor.	6	+35	−23	0 37.3	+ 3 55 17	−0.0765	.5861	+.0499	+9.5907	.9642
11	η Geminor.	4	+65	+ 2	1 44.5	+ 5 00 08	+0.3948	.5704	+.0450	+9.5835	.9655
11	μ Geminor.	3	+73	+ 8	5 12.3	+ 8 20 23	+0.4950	.5728	+.0372	+9.5844	.9654
11	ω Geminor.	6	−36	−66	21 50.6	+ 0 22 04	−1.1392	.5733	−.0014	+9.6164	.9593
12	48 Geminor.	6	−33	−66	2 01.9	+ 4 23 56	−1.1110	.5749	−.0110	+9.6156	.9595
12	δ Geminor.	3½	+90	+45	5 16.9	+ 7 31 40	+1.0629	.5849	−.0195	+9.5782	.9664
13	μ¹ Cancri	6	+ 6	−57	0 18.5	+ 1 50 07	−0.5871	.5820	−.0659	+9.5928	.9639
16	ξ Virginis	5	−42	−81	20 48.8	− 5 04 28	−1.2782	.5616	−.2290	+9.1982	.9945
16	ν Virginis	4½	+62	−17	21 04.6	− 4 49 14	+0.3842	.5638	−.2291	+9.1075	.9964
17	π Virginis	5	−36	−82	3 42.7	+ 1 34 53	−1.2314	.5600	−.2336	+9.1122	.9963
17	*c* Virginis	5	+40	−37	12 23.0	+ 9 57 06	+0.0242	.5599	−.2379	+8.8582	.9989
18	80 Virginis	6	+82	+ 1	21 58.2	− 5 37 10	+0.7470	.5563	−.2373	−8.9080	.9986
19	94 Virginis	6	+82	+22	11 02.4	+ 6 58 31	+1.0745	.5565	−.2297	−9.1523	.9956
20	ξ¹ Libræ	6	+11	−68	8 54.8	+ 4 06 38	−0.4624	.5629	−.2090	−9.2911	.9915
20	ξ² Libræ	5	−32	−90	9 57.9	+ 5 07 30	−1.1447	.5644	−.2077	−9.2730	.9922
20	o² Libræ	6	+57	−17	21 20.1	− 7 54 25	+0.4077	.5652	−.1923	−9.4015	.9857
21	γ Libræ	4½	−19	−90	2 44.1	− 2 42 00	−0.9249	.5694	−.1845	−9.3925	.9863
21	η Libræ	4½	− 4	−89	6 24.0	+ 0 49 59	−0.6719	0.5702	−.1784	−9.4184	9.9846

For facilitating the Calculation of Occultations of Planets and Stars by the Moon, *for the Year* 1852.

1852.	Star's Name.	Mag.	Limiting Parallels. North-ern.	Limiting Parallels. South-ern.	Washington Mean Time of ☌.	At Washington Mean Time of ☌. *H*	*Y*	*p′*	*q′*	Log sin *D*	Log cos *D*
			°	°	h. m.	h. m. s.					
Aug 21	θ Libræ	4½	+16	−56	10 32.5	+ 4 49 48	−0.2852	0.5702	−.1718	−9.4479	9.9822
21	49 Libræ	5½	−24	−90	13 22.4	+ 7 33 13	−0.9656	.5732	−.1666	−9.4427	.9827
21	ν Scorpii	4	+71	+51	18 12.8	−11 46 59	+1.2862	.5677	−.1575	−9.5142	.9755
21	ψ Ophiuchi	5	+70	+31	23 18.9	− 6 52 04	+1.1347	.5696	−.1480	−9.5275	.9739
22	χ Ophiuchi	5	− 7	−88	0 35.0	− 5 38 43	−0.6574	.5757	−.1461	−9.4927	.9779
22	B.A.C. 5758	6	+59	− 8	16 52.6	+10 02 35	+0.5604	.5760	−.1116	−9.5613	.9691
22	ξ Ophiuchi	4½	− 3	−73	23 00.3	− 8 03 30	−0.5001	.5812	−.0975	−9.5533	.9703
23	B.A.C. 5866	6	+ 8	−57	0 32.4	− 6 34 47	−0.2876	.5806	−.0950	−9.5602	.9693
23	B.A.C. 5954	6	+ 8	−55	6 19.6	− 1 00 41	−0.2592	.5816	−.0811	−9.5701	.9677
23	58 Ophiuchi	5	−12	−87	8 16.0	+ 0 51 20	−0.6344	.5834	−.0765	−9.5661	.9684
23	4 Sagittarii	5	+66	+39	14 56.1	+ 7 16 19	+1.1776	.5765	−.0609	−9.6059	.9614
23	B.A.C. 6088	6	+23	−36	15 49.9	+ 8 08 08	+0.0612	.5813	−.0586	−9.5878	.9648
23	B.A.C. 6161	6	+66	+10	19 50.6	+11 59 40	+0.8352	.5782	−.0491	−9.6046	.9617
23	14 Sagittarii	6	−66	−90	20 56.8	−10 56 36	−1.2720	.5868	−.0468	−9.5689	.9679
24	24 Sagittarii	6	+66	+16	4 57.8	− 3 13 46	+0.9190	.5776	−.0258	−9.6116	.9603
24	B.A.C. 6343	6	+36	−20	7 49.8	− 0 25 59	+0.3399	.5937	−.0222	−9.6028	.9620
24	26 Sagittarii	6	+60	− 1	8 15.0	− 0 04 01	+0.6683	.5782	−.0185	−9.6087	.9608
24	28 Sagittarii	6	−31	−90	10 08.5	+ 1 45 11	−0.8505	.5848	−.0136	−9.5836	.9655
24	30 Sagittarii	6	−50	−90	12 00.5	+ 3 33 00	−1.1105	.5855	−.0096	−9.5796	.9662
24	ν¹ Sagittarii	5	−11	−72	13 22.1	+ 4 51 34	−0.4877	.5826	−.0063	−9.5905	.9643
24	ν² Sagittarii	5	−15	−80	13 45.4	+ 5 13 58	−0.5649	.5829	−.0052	−9.5892	.9645
24	B.A.C. 6448	6	+13	−41	14 11.1	+ 5 38 52	−0.0368	.5808	−.0041	−9.5982	.9629
25	B.A.C. 6607	6	−20	−90	0 22.7	− 8 32 33	−0.6711	.5812	+.0203	−9.5859	.9651
25	χ³ Sagittarii	6	+66	+24	2 22.2	− 6 37 31	+1.0261	.5735	+.0251	−9.6135	.9599
25	50 Sagittarii	6	−59	−90	2 46.1	− 6 14 33	−1.2139	.5648	+.0243	−9.5748	.9670
25	B.A.C. 6864	6	+51	−10	17 34.4	+ 8 01 05	+0.5150	.5708	+.0599	−9.5944	.9636
26	4 Capricor.	6	+25	−35	0 39.9	− 9 08 57	+0.0718	.5696	+.0754	−9.5784	.9664
26	B.A.C. 7049	6	+67	+34	5 43.1	− 4 16 27	+1.1368	.5632	+.0861	−9.5896	.9645
26	17 Capricor.	6	+68	+17	13 02.8	+ 2 47 44	+0.9491	.5598	+.1024	−9.5744	.9671
26	20 Capricor.	6	−32	−90	19 04.8	+ 8 37 06	−1.0046	.5632	+.1140	−9.5257	.9741
26	η Capricor.	5	+33	−32	21 13.3	+10 41 07	+0.1284	.5581	+.1178	−9.5430	.9718
26	27 Capricor.	6	+69	+35	23 30.9	−11 06 01	+1.1623	.5535	+.1215	−9.5572	.9698
27	30 Capricor.	6	−36	−90	3 23.2	− 7 21 34	−1.0762	.5587	+.1286	−9.5037	.9767
27	γ Capricor.	4	−31	−90	13 35.9	+ 2 30 31	−1.0438	.5526	+.1453	−9.4739	.9799
27	δ Capricor.	3½	−38	−90	16 51.1	+ 5 39 17	−1.1345	.5504	+.1511	−9.4607	.9811
28	29 Aquarii	6	+72	+16	0 08.9	−11 17 10	+0.9513	.5399	+.1617	−9.4822	.9790
28	50 Aquarii	6	−18	−90	10 49.3	− 0 57 11	−0.9209	.5386	+.1753	−9.3919	.9864
28	56 Aquarii	6	+74	+ 1	13 40.3	+ 1 48 28	+0.7345	.5335	+.1783	−9.4224	.9843
29	74 Aquarii	6	+18	−58	1 14.7	−10 58 35	−0.3153	.5286	+.1908	−9.3319	.9897
29	ψ¹ Aquarii	5½	− 8	−90	12 38.7	+ 0 04 52	−0.8173	.5238	+.2003	−9.2348	.9935
29	ψ² Aquarii	5	+10	−71	13 42.8	+ 1 07 02	−0.4970	.5225	+.2013	−9.2391	.9934
29	ψ³ Aquarii	5	+41	−35	14 15.1	+ 1 38 20	+0.0791	.5214	+.2018	−9.2572	.9928
30	30 Piscium	4½	+83	+ 8	12 51.7	− 0 24 28	+0.8760	.5112	+.2142	−9.0754	.9969
30	33 Piscium	5	+83	+12	14 40.2	+ 1 21 00	+0.9341	.5109	+.2148	−9.0560	.9972
Sept. 1	33 Ceti	6	+19	−61	2 04.7	+11 46 05	−0.3757	.5040	+.2185	+8.4619	.9998
1	*f* Piscium	6	− 5	−87	6 02.5	− 8 22 40	−0.8138	.5035	+.2178	+8.6946	.9995
1	ν¹ Piscium	5	+33	−46	18 58.6	+ 4 11 59	−0.1241	.5037	+.2143	+8.9172	.9985
2	ξ¹ Ceti	5	+24	−54	12 08.3	− 3 06 53	−0.2931	.5056	+.2063	+9.1517	.9956
2	ξ Arietis	6	−15	−80	18 29.5	+ 3 03 34	−0.9766	.4943	+.2027	+9.2371	.9934
2	B. A. C. 755	6	+ 1	−80	19 32.2	+ 4 04 33	−0.7183	0.5064	+.2020	+9.2352	9.9935

For facilitating the Calculation of Occultations of Planets and Stars by the Moon, *for the Year* 1852.

1852.	Star's Name.	Mag.	Limiting Parallels.		Washington Mean Time of ☌.	At Washington Mean Time of ☌.				Log sin *D*	Log cos *D*
			Northern.	Southern.		*H*	*Y*	*p′*	*q′*		
			°	°	h. m.	h. m. s.					
Sept. 3	B. A. C. 830	6	+90	+ 3	3 57.8	−11 44 08	+0.7234	0.5109	+.1958	+9.2444	9.9932
3	38 Arietis	5½	−13	−78	5 14.2	−10 29 56	−0.9281	.5086	+.1947	+9.3115	.9907
4	B.A.C. 1272	6	+90	+15	23 50.3	+ 6 50 35	+0.8232	.5306	+.1490	+9.4645	.9808
5	ε Tauri	3½	+48	−20	9 52.7	− 7 25 51	+0.1506	.5347	+.1377	+9.5093	.9761
6	ι Tauri	4½	+ 4	−63	2 13.6	+ 8 23 25	−0.6250	.5424	+.1077	+9.5616	.9691
6	106 Tauri	5½	+90	+23	4 28.1	+10 33 30	+0.8726	.5480	+.1040	+9.5385	.9724
6	105 Tauri	6	+10	−56	4 28.8	+10 34 13	−0.5292	.5434	+.1040	+9.5642	.9687
6	n Tauri	5½	+12	−52	9 43.5	+ 1 38 25	−0.4802	.5461	+.0949	+9.5724	.9674
6	o Tauri	5	+40	−22	13 33.8	− 4 38 57	+0.0129	.5503	+.0874	+9.5698	.9678
6	ζ Tauri	3½	+90	+54	18 08.4	− 0 13 44	+1.2123	.5577	+.0778	+9.5553	.9700
7	141 Tauri	6	+72	+ 6	4 52.4	+10 08 07	+0.4794	.5612	+.0563	+9.5808	.9660
7	1 Geminor.	4	+16	−43	5 55.3	+11 08 52	−0.4032	.5583	+.0542	+9.5966	.9632
7	3 Geminor.	6	+32	−26	8 24.2	−10 27 28	−0.1289	.5607	+.0489	+9.5943	.9636
7	6 Geminor.	6	+47	−12	9 32.8	− 9 21 19	+0.1350	.5669	+.0472	+9.5907	.9642
7	η Geminor.	4	+84	+14	10 41.3	− 8 15 13	+0.6055	.5645	+.0446	+9.5837	.9655
7	μ Geminor.	3	+90	+20	14 12.9	− 4 51 05	+0.7034	.5670	+.0359	+9.5844	.9654
8	ω Geminor.	6	−19	−66	7 09.4	+11 28 51	−0.9652	.5681	−.0030	+9.6164	.9593
8	48 Geminor.	6	−18	−66	11 25.1	− 8 24 49	−0.9419	.5695	−.0124	+9.6156	.9595
8	δ Geminor.	3½	+90	+63	14 43.5	− 5 13 41	+1.2442	.5790	−.0195	+9.5782	.9664
9	μ^{1} Cancri	6	+14	−47	10 02.7	−10 37 35	−0.4459	.5774	−.0676	+9.5929	.9639
9	μ^{2} Cancri	5	+82	+11	10 40.5	−10 01 14	+0.6002	.5818	−.0676	+9.5737	.9672
9	η Cancri	6	+90	+24	21 04.0	− 0 01 09	+0.8634	.5836	−.0937	+9.5531	.9703
10	39 Cancri	6	+90	+33	0 08.7	+ 2 56 37	+0.9927	.5842	−.1007	+9.5449	.9715
10	40 Cancri	6	+90	+35	0 10.8	+ 2 58 39	+1.0266	.5844	−.1007	+9.5441	.9716
10	γ Cancri	4½	+ 2	−65	1 26.2	+ 4 11 16	−0.6567	.5781	−.1030	+9.5736	.9672
11	η Leonis	3½	−19	−73	12 33.0	−10 00 41	−1.0053	.5742	−.1764	+9.4777	.9795
15	80 Virginis	6	+75	− 9	6 17.7	+ 4 30 07	+0.5704	.5655	−.2430	−8.9081	.9986
15	94 Virginis	6	+82	+ 9	19 35.0	− 6 41 04	+0.8880	.5658	−.2351	−9.1533	.9956
15	95 Virginis	6	+81	+39	19 46.0	− 6 30 22	+1.2624	.5656	−.2346	−9.1751	.9951
16	ξ^{1} Libræ	6	0	−86	16 08.6	−10 51 58	−0.6557	.5720	−.2130	−9.2918	.9915
16	ξ^{2} Libræ	5	−63	−90	17 09.7	− 9 53 02	−1.3524	.5736	−.2117	−9.2730	.9922
17	o^{2} Libræ	6	+43	−30	4 11.6	+ 0 44 39	+0.1705	.5731	−.1958	−9.4015	.9857
17	ζ^{1} Libræ	4	+75	+65	6 21.4	+ 2 49 39	+1.3434	.5703	−.1927	−9.4455	.9824
17	ζ^{3} Libræ	6	+75	+22	7 22.4	+ 3 48 22	+1.0529	.5711	−.1910	−9.4430	.9826
17	ζ^{4} Libræ	6	+74	+28	8 18.7	+ 4 42 38	+1.1205	.5712	−.1894	−9.4494	.9821
17	γ Libræ	4½	−36	−90	9 26.4	+ 5 47 51	−1.1474	.5777	−.1877	−9.3924	.9864
17	η Libræ	4½	−18	−90	13 00.3	+ 9 13 45	−0.9007	.5782	−.1808	−9.4185	.9845
17	θ Libræ	4½	+ 3	−74	17 02.1	−10 53 24	−0.5218	.5781	−.1736	−9.4480	.9822
17	49 Libræ	5½	−42	−90	19 47.5	− 8 14 09	−1.1929	.5806	−.1690	−9.4430	.9826
18	ν Scorpii	4	+71	+21	0 30.7	− 3 41 31	+1.0266	.5746	−.1604	−9.5142	.9755
18	ψ Ophiuchi	5	+70	+11	5 29.7	+ 1 06 10	+0.8762	.5761	−.1503	−9.5275	.9739
18	χ Ophiuchi	5	−21	−90	6 44.1	+ 2 17 47	−0.8958	.5824	−.1471	−9.4927	.9779
18	B.A.C. 5758	6	+63	−22	22 42.1	− 6 20 31	+0.3077	.5805	−.1133	−9.5612	.9691
19	ξ Ophiuchi	4½	−17	−90	4 43.8	− 0 32 36	−0.7425	.5852	−.0984	−9.5533	.9703
19	B.A.C. 5866	6	− 5	−76	6 14.6	+ 0 54 43	−0.5317	.5845	−.0946	−9.5602	.9693
19	B.A.C. 5954	6	− 4	−74	11 56.9	+ 6 24 02	−0.5018	.5847	−.0843	−9.5701	.9677
19	58 Ophiuchi	5	−27	−90	13 51.9	+ 8 14 36	−0.8742	.5864	−.0736	−9.5661	.9684
19	4 Sagittarii	5	+66	+16	20 27.6	− 9 24 46	+0.9279	.5784	−.0607	−9.6059	.9614
19	B.A.C. 6088	6	+10	−50	21 21.0	− 8 33 27	−0.1799	.5832	−.0582	−9.5878	.9648
20	B.A.C. 6161	6	+56	− 6	1 19.6	− 4 43 57	+0.5909	0.5797	−.0484	−9.6046	9.9617

For facilitating the Calculation of Occultations of Planets and Stars by the Moon, *for the Year* 1852.

1852.	Star's Name.	Mag.	Limiting Parallels.		Washington Mean Time of ☌.	At Washington Mean Time of ☌.				Log sin D	Log cos D
			Northern.	Southern.		H	Y	p'	q'		
			°	°	h. m.	h. m. s.					
Sep 20	24 Sagittarii	6	+62	0	10 24.1	+ 3 59 48	+0.6822	0.5781	—.0261	—9.6116	9.9603
20	B.A.C. 6343	6	+22	—33	12 17.8	+ 5 49 15	+0.1055	.5801	—.0211	—9.6028	.9620
20	26 Sagittarii	6	+42	—14	13 15.1	+ 6 44 22	+0.4412	.5785	—.0186	—9.6087	.9608
20	28 Sagittarii	6	—18	—89	15 32.8	+ 8 56 52	—0.6387	.5825	—.0137	—9.5913	.9641
20	ν^1 Sagittarii	5	—24	—90	18 45.9	—11 57 22	—0.7142	.5822	—.0050	—9.5905	.9643
20	ν^2 Sagittarii	5	—28	—90	19 09.1	—11 35 01	—0.7907	.5822	—.0039	—9.5892	.9645
20	B.A.C. 6448	6	+ 1	—56	19 30.9	—11 14 00	—0.2645	.5802	—.0039	—9.5982	.9629
21	B.A.C. 6576	6	+66	+15	3 35.4	— 3 28 40	+0.9082	.5729	+.0156	—9.6165	.9593
21	B.A.C. 6607	6	—33	—90	5 46.2	— 1 21 46	—0.8896	.5794	+.0216	—9.5859	.9651
21	χ^3 Sagittarii	6	+66	+ 8	7 45.9	+ 0 33 29	+0.8087	.5717	+.0262	—9.6134	.9599
21	B.A.C. 6864	6	+38	—22	23 01.7	— 8 44 18	+0.3153	.5674	+.0621	—9.5944	.9636
22	4 Capricor.	6	+16	—46	6 14.5	— 1 47 02	—0.1128	.5653	+.0773	—9.5784	.9663
22	B.A.C. 7049	6	+67	+18	11 15.6	+ 3 03 28	+0.9552	.5590	+.0879	—9.5896	.9645
22	17 Capricor.	6	+68	+ 5	18 39.6	+10 11 55	+0.7793	.5560	+.1020	—9.5744	.9670
23	20 Capricor.	6	—46	—90	0 45.3	— 7 55 03	—1.1698	.5589	+.1144	—9.5257	.9741
23	η Capricor.	5	+24	—41	2 55.1	— 5 49 39	—0.0300	.5553	+.1182	—9.5430	.9718
23	27 Capricor.	6	+69	+21	5 14.3	— 3 35 09	+1.0104	.5489	+.1227	—9.5572	.9697
23	30 Capricor.	6	—50	—90	9 09.2	+ 0 11 49	—1.2283	.5537	+.1297	—9.5037	.9767
23	γ Capricor.	4	—42	—90	19 29.1	+10 11 11	—1.1773	.5476	+.1462	—9.4739	.9798
23	δ Capricor.	3½	—52	—90	22 46.7	—10 37 41	—1.2627	.5456	+.1517	—9.4608	.9811
24	29 Aquarii	6	+72	+ 8	6 09.9	— 3 28 43	+0.8448	.5354	+.1624	—9.4822	.9790
24	50 Aquarii	6	—24	—90	16 58.1	+ 6 59 01	—1.0113	.5344	+.1758	—9.3919	.9864
24	56 Aquarii	6	+61	—13	18 51.9	+ 8 47 20	+0.4796	.5298	+.1783	—9.4224	.9842
25	74 Aquarii	6	+15	—62	7 33.4	— 2 52 22	—0.3720	.5256	+.1916	—9.3318	.9897
25	ψ^1 Aquarii	5½	— 8	—90	19 04.6	+ 8 18 12	—0.8166	.5200	+.2019	—9.2362	.9934
25	ψ^2 Aquarii	5	+ 9	—73	20 09.5	+ 9 21 14	—0.5243	.5193	+.2027	—9.2391	.9934
25	ψ^3 Aquarii	5	+39	—36	20 42.1	+ 9 52 51	+0.0554	.5186	+.2027	—9.2571	.9928
26	30 Piscium	4½	+83	+10	19 29.9	+ 8 01 17	+0.9101	.5095	+.2159	—9.0754	.9969
26	33 Piscium	5	+83	+15	21 19.2	+ 9 47 28	+0.9725	.5094	+.2163	—9.0559	.9972
27	B. A. C. 147	6	—32	—90	13 41.2	+ 1 41 58	—1.2023	.5066	+.2207	—8.3608	.9999
28	33 Ceti	6	+26	—54	8 52.4	— 3 38 38	—0.2554	.5041	+.2208	+8.4621	.9998
28	*f* Piscium	6	+ 3	—87	12 50.7	+ 0 13 05	—0.6852	.5037	+.2202	+8.6946	.9995
29	ν Piscium	5	+41	—37	1 47.6	—11 11 25	+0.0339	.5043	+.2167	+8.9172	.9985
29	ξ^1 Ceti	5	+34	—43	18 57.8	+ 5 30 09	—0.1010	.5065	+.2087	+9.1517	.9956
30	ξ Arietis	5½	— 2	—73	1 19.0	+11 40 37	—0.7746	.5068	+.2047	+9.2373	.9934
30	B. A. C. 755	6	+ 8	—74	2 21.7	—11 18 23	—0.5882	.5072	+.2040	+9.2382	.9934
30	B. A. C. 830	6	+90	+16	10 47.6	— 3 06 49	+0.9454	.5118	+.1976	+9.2444	.9932
30	38 Arietis	5½	+ 1	—78	12 04.0	— 1 52 35	—0.7084	.5097	+.1965	+9.3116	.9907
Oct. 1	SATURN.		—35	—76	0 56.5	+10 37 41	—1.2045	.5125	+.1855	+9.3982	.9860
2	B.A.C. 1272	6	+90	+34	6 48.2	— 8 24 00	+1.1010	.5301	+.1498	+9.4645	.9807
2	ε Tauri	3½	+67	— 5	16 54.8	+ 1 23 52	+0.4317	.5325	+.1349	+9.5093	.9761
3	ι Tauri	4½	+21	—45	9 25.8	— 6 36 45	—0.3415	.5381	+.1096	+9.5616	.9690
3	*l* Tauri	5½	+90	+46	11 42.0	— 4 24 59	+1.1679	.5450	+.1043	+9.5386	.9724
3	105 Tauri	6	+26	—38	11 42.7	— 4 24 19	—0.2441	.5404	+.1043	+9.5642	.9687
3	*n* Tauri	5½	+29	—34	17 01.6	+ 0 44 11	—0.1939	.5439	+.0934	+9.5724	.9674
3	*o* Tauri	5	+58	— 7	20 55.3	+ 4 30 11	+0.3033	.5471	+.0868	+9.5699	.9678
4	141 Tauri	6	+90	+22	12 29.4	— 4 27 11	+0.7749	.5563	+.0560	+9.5808	.9659
4	1 Geminor.	5	+33	—26	13 33.5	— 3 25 17	—0.1178	.5533	+.0540	+9.5964	.9632
4	3 Geminor.	6	+49	—11	16 05.2	— 0 58 44	+0.1560	.5559	+.0477	+9.5942	.9636
4	6 Geminor.	6	+67	+ 4	17 15.2	+ 0 08 46	+0.4236	0.5573	+.0456	+9.5907	9.9642

For facilitating the Calculation of Occultations of Planets and Stars by the Moon, *for the Year* 1852.

1852.	Star's Name.	Mag.	Limiting Parallels.		Washington Mean Time of ☌.	At Washington Mean Time of ☌.				Log sin *D*	Log cos *D*
			Northern.	Southern.		*H*	*Y*	*p′*	*q′*		
			°	°	h. m.	h. m. s.					
Oct. 4	η Geminor.	4	+90	+31	18 25.0	+ 1 16 13	+0.9001	0.5595	+.0435	+9.5837	9.9655
4	μ Geminor.	3	+90	+39	22 01.0	+ 4 44 42	+0.9979	.5614	+.0358	+9.5844	.9653
5	ω Geminor.	6	− 1	−62	15 20.4	− 2 32 23	−0.6989	.5613	−.0030	+9.6164	.9593
5	48 Geminor.	6	0	−61	19 42.4	+ 1 40 15	−0.6781	.5625	−.0121	+9.6156	.9595
6	μ^1 Geminor.	6	+28	−31	18 55.6	+ 0 03 10	−0.1971	.5692	−.0666	+9.5928	.9638
6	μ^2 Geminor.	5	+90	+27	19 34.4	+ 0 40 34	+0.8614	.5733	−.0678	+9.5737	.9671
7	η Cancri	6	+90	+43	6 15.1	+10 57 56	+1.1166	.5753	−.0930	+9.5531	.9703
7	39 Cancri	6	+90	+56	9 24.9	− 9 59 13	+1.2437	.5760	−.0998	+9.5448	.9715
7	γ Cancri	4½	+16	−49	10 44.5	− 8 42 27	−0.4283	.5698	−.1032	+9.5735	.9672
8	η Leonis	3½	− 8	−73	22 44.5	+ 1 58 52	−0.8412	.5673	−.1771	+9.4777	.9795
9	42 Leonis	6	+29	−43	5 00.3	+ 8 01 06	−0.1890	.5686	−.1868	+9.4328	.9834
9	*i* Leonis	6	+28	−45	9 28.8	−11 40 05	−0.2081	.5686	−.1948	+9.4099	.9852
14	o^2 Libræ	6	+33	−40	13 32.5	+11 53 32	−0.0140	.5833	−.2019	−9.4016	.9857
14	ζ^1 Libræ	4	+74	+29	15 38.1	−10 05 42	+1.1366	.5805	−.1986	−9.4455	9824
14	ζ^3 Libræ	6	+74	+ 7	16 37.0	− 9 09 01	+0.8466	.5816	−.1969	−9.4429	.9826
14	ζ^4 Libræ	6	+74	+12	17 31.5	− 8 16 36	+0.9133	.5816	−.1951	−9.4494	.9821
14	γ Libræ	4½	−58	−90	18 36.9	− 7 13 42	−1.3213	.5882	−.1933	−9.3925	.9863
14	η Libræ	4½	−31	−90	22 03.5	− 3 55 03	−1.0849	.5890	−.1866	−9.4185	.9845
15	θ Libræ	4½	− 7	−90	2 07.0	− 0 00 31	−0.7188	.5895	−.1784	−9.4479	.9822
15	ν Scorpii	4	+71	+ 5	9 10.0	+ 6 45 39	+0.7927	.5861	−.1642	−9.5142	.9755
15	ψ Ophiuchi	5	+67	− 4	13 58.4	+11 22 45	+0.6374	.5872	−.1545	−9.5275	.9738
15	χ Ophiuchi	5	−37	−90	15 10.1	−11 28 19	−1.1069	.5940	−.1512	−9.4926	.9779
16	B.A.C. 5758	6	+28	−36	6 34.3	+ 3 19 26	+0.0583	.5918	−.1161	−9.5612	.9691
16	ξ Ophiuchi	4½	−32	−90	12 23.5	+ 8 53 48	−0.9817	.5965	−.1012	−9.5533	.9703
16	B.A.C. 5866	6	−19	−90	13 51.1	+10 19 00	−0.7753	.5955	−.0973	−9.5602	.9693
16	B.A.C. 5954	6	−19	−90	19 22.0	− 8 23 16	−0.7511	.5954	−.0834	−9.5702	.9677
16	58 Ophiuchi	5	−45	−90	21 13.1	− 6 36 32	−1.1181	.5968	−.0782	−9.5661	.9684
17	4 Sagittarii	5	+61	− 2	3 36.0	− 0 28 44	+0.6524	.5887	−.0627	−9.6058	.9614
17	B.A.C. 6088	6	− 3	−69	4 27.7	+ 0 20 53	−0.4403	.5932	−.0600	−9.5878	.9647
17	7 Sagittarii	6	+66	+27	4 47.7	+ 0 40 03	+1.0688	.5869	−.0588	−9.6140	.9598
17	B.A.C. 6161	6	+37	−22	8 18.8	+ 4 02 54	+0.3183	.5892	−.0495	−9.6046	.9616
17	24 Sagittarii	6	+40	−17	17 06.3	−11 30 19	+0.4045	.5871	−.0265	−9.6116	.9603
17	B.A.C. 6343	6	+ 8	−50	18 57.8	− 9 43 11	−0.1653	.5888	−.0228	−9.6029	.9620
17	26 Sagittarii	6	+25	−31	20 17.5	− 8 26 37	+0.1584	.5867	−.0181	−9.6087	.9608
18	ν^1 Sagittarii	5	−40	−90	1 15.5	− 3 40 12	−0.9761	.5898	−.0052	−9.5905	.9643
18	ν^2 Sagittarii	5	−45	−90	1 38.1	− 3 18 27	−1.0517	.5902	−.0052	−9.5891	.9645
18	B.A.C. 6448	6	−14	−77	1 59.4	− 2 58 03	−0.5319	.5873	−.0026	−9.5982	.9629
18	B.A.C. 6576	6	+56	− 4	9 52.0	+ 4 36 24	+0.6250	.5789	+.0177	−9.6165	.9593
18	B.A.C. 6607	6	−52	−90	11 59.8	+ 6 39 20	−1.1511	.5856	+.0227	−9.5860	.9651
18	χ^1 Orionis	5½	+65	+30	13 50.2	+ 8 25 34	+1.0897	.5756	+.0278	−9.6225	.9580
18	χ^2 Orionis	6½	+65	+21	13 53.1	+ 8 28 20	+0.9938	.5760	+.0278	−9.6210	.9583
18	χ^3 Orionis	6	+49	−10	13 56.9	+ 8 32 00	+0.5275	.5781	+.0278	−9.6135	.9599
19	B.A.C. 6864	6	+23	−37	4 55.3	− 1 03 16	+0.0427	.5712	+.0633	−9.5943	.9636
19	4 Capricor.	6	+ 2	−64	12 01.4	+ 5 47 21	−0.3798	.5683	+.0788	−9.5785	.9663
19	B.A.C. 7049	6	+65	− 1	16 58.7	+10 33 55	+0.6822	.5610	+.0895	−9.5897	.9644
20	17 Capricor.	6	+54	−11	0 17.7	− 6 22 35	+0.5116	.5572	+.1038	−9.5744	.9670
20	η Capricor.	5	+11	−57	8 29.2	+ 1 31 48	−0.2866	.5547	+.1191	−9.5430	.9718
20	27 Capricor.	6	+69	+ 3	10 47.4	+ 3 45 16	+0.7504	.5502	+.1228	−9.5572	.9697
20	φ Capricor.	6	+69	+42	13 34.1	+ 6 26 21	+1.2263	.5470	+.1283	−9.5594	.9694
21	κ Capricor.	5	+70	+30	2 09.5	− 5 23 22	+1.1334	0.5373	+.1493	−9.5243	9.9742

For facilitating the Calculation of Occultations of Planets and Stars by the Moon, *for the Year* 1852.

1852.	Star's Name.	Mag.	Limiting Parallels. North-ern.	Limiting Parallels. South-ern.	Washington Mean Time of ☌.	At Washington Mean Time of ☌. *H*	*Y*	*p′*	*q′*	Log sin *D*	Log cos *D*
			°	°	*h. m.*	*h. m. s.*					
Oct. 21	29 Aquarii	6	+68	− 6	11 39.5	+ 3 48 11	+0.6143	0.5341	+.1625	−9.4823	9.9790
21	50 Aquarii	6	−43	−90	22 29.1	− 9 42 34	−1.2235	.5319	+.1766	−9.3919	.9864
22	56 Aquarii	6	+59	−15	1 22.9	− 6 54 10	+0.4455	.5272	+.1790	−9.4224	.9842
22	τ^2 Aquarii	5½	+76	+34	11 08.6	+ 2 33 45	+1.2045	.5190	+.1906	−9.3947	.9862
22	74 Aquarii	6	+ 5	−77	13 08.8	+ 4 30 21	−0.5612	.5215	+.1925	−9.3318	.9897
23	ψ^1 Aquarii	5½	−21	−90	0 44.6	− 8 14 27	−1.0170	.5171	+.2020	−9.2349	.9935
23	ψ^2 Aquarii	5	0	−90	1 49.7	− 7 11 10	−0.6909	.5162	+.2028	−9.2391	.9934
23	ψ^3 Aquarii	5	+31	−46	2 22.5	− 6 39 20	−0.1099	.5147	+.2035	−9.2571	.9928
24	30 Piscium	4½	+83	+ 3	1 20.9	− 8 20 19	+0.7940	.5061	+.2168	−9.0754	.9969
24	33 Piscium	5	+83	+ 7	3 11.0	− 6 33 16	+0.8606	.5054	+.2175	−9.0560	.9972
25	33 Ceti	6	+25	−56	14 58.5	+ 4 14 53	−0.2835	.5021	+.2224	+8.4622	.9998
25	*f* Piscium	6	+ 2	−87	18 57.9	+ 8 7 44	−0.7039	.5021	+.2219	+8.6948	.9995
26	ν Piscium	5	+42	−37	7 57.7	− 3 13 51	+0.0479	.5036	+.2186	+8.9172	.9985
27	ξ^1 Ceti	5	+37	−40	1 09.9	−10 30 19	−0.0461	.5066	+.2109	+9.1517	.9956
27	ξ Arietis	6	+ 2	−80	7 31.3	− 4 19 37	−0.7053	.5071	+.2072	+9.2371	.9934
27	B. A. C. 830	6	+90	+22	16 59.6	+ 4 52 41	+1.0371	.5127	+.2000	+9.2444	.9932
27	38 Arietis	5½	+ 7	−74	18 16.0	+ 6 06 53	−0.6152	.5104	+.1992	+9.3116	.9907
28	SATURN.		−32	−76	3 15.7	− 9 08 55	−1.1852	.5123	+.1913	+9.3811	.9871
29	B.A.C. 1272	6	+90	+53	12 55.2	− 0 29 31	+1.2767	.5323	+.1512	+9.4645	.9807
29	ω^1 Tauri	6	−33	−71	13 26.0	+ 0 00 18	−1.1639	.5255	+.1512	+9.5174	.9751
29	ε Tauri	3½	+85	+ 5	23 01.1	+ 9 17 33	+0.6229	.5355	+.1363	+9.5093	.9761
30	ι Tauri	4½	+32	−32	15 32.0	+ 1 16 55	−0.1304	.5403	+.1095	+9.5617	.9690
30	105 Tauri	6	+38	−26	17 49.2	+ 3 29 37	−0.0303	.5415	+.1059	+9.5642	.9687
30	*n* Tauri	5½	+41	−22	23 08.6	+ 8 38 40	+0.0259	.5444	+.0949	+9.5724	.9673
31	*o* Tauri	5	+76	+ 5	3 03.0	−11 34 41	+0.5294	.5480	+.0873	+9.5699	.9677
31	141 Tauri	6	+90	+38	18 41.8	+ 3 32 39	+1.0174	.5554	+.0573	+9.5809	.9659
31	1 Geminor.	5	+47	−13	19 46.4	+ 4 35 02	+0.1215	.5526	+.0552	+9.5966	.9632
31	3 Geminor.	6	+64	+ 1	22 19.3	+ 7 02 44	+0.3760	.5547	+.0489	+9.5942	.9636
31	6 Geminor.	6	+90	+17	23 29.7	+ 8 10 48	+0.6694	.5562	+.0468	+9.5907	.9642
Nov. 1	η Geminor.	4	+90	+50	0 40.2	+ 9 18 50	+1.1500	.5576	+.0447	+9.5836	.9655
1	μ Geminor.	3	+90	+62	4 18.1	−11 10 44	+1.2503	.5600	+.0361	+9.5844	.9654
1	ω Geminor.	6	+14	−41	21 50.3	+ 5 44 57	−0.4451	.5577	−.0014	+9.6163	.9593
2	48 Geminor.	6	+16	−41	2 16.2	+10 01 37	−0.4265	.5589	−.0126	+9.6155	.9595
2	$\varkappa$ Geminor.	4	−46	−65	16 20.1	− 0 24 19	−1.2252	.5574	−.0443	+9.6218	.9582
3	μ^1 Cancri	6	+43	−17	1 57.2	+ 8 52 25	+0.0621	.5631	−.0669	+9.5928	.9639
3	γ Cancri	4½	+30	−34	18 10.9	+ 0 31 32	−0.1768	.5618	−.1020	+9.5735	.9672
5	η Leonis	3½	+ 5	−69	7 20.4	−11 37 22	−0.6307	.5655	−.1770	+9.4777	.9795
5	42 Leonis	6	+42	−31	13 49.5	− 5 21 52	+0.0344	.5583	−.1844	+9.4328	.9834
5	*i* Leonis	6	+40	−33	18 27.5	− 0 53 29	+0.0096	.5578	−.1923	+9 4099	.9852
6	ι Leonis	4	−33	−79	17 39.1	− 2 29 58	−1.2042	.5541	−.2230	+9.2937	.9914
7	ξ Virginis	5	−24	−81	3 15.6	+ 6 46 38	−1.1071	.5550	−.2332	+9.1981	.9945
7	ν Virginis	4½	+76	− 8	3 31.6	+ 7 02 09	+0.5636	.5573	−.2332	+9.1074	.9964
7	π Virginis	5	−24	−83	10 15.5	−10 27 58	−1.1064	.5556	−.2390	+9.1121	.9963
7	*c* Virginis	5	+45	−35	18 58.9	− 2 02 35	+0.0878	.5583	−.2448	+8.8581	.9989
12	B.A.C. 5758	6	+21	−45	16 52.4	− 8 34 19	−0.0812	.6026	−.1179	−9.5612	.9691
12	ξ Ophiuchi	4½	−42	−90	22 31.1	− 3 09 29	−1.1166	.6074	−.1049	−9.5533	.9703
12	B.A.C. 5866	6	−28	−90	23 56.0	− 1 48 01	−0.9152	.6069	−.0996	−9.5602	.9693
13	B.A.C. 5954	6	−28	−90	5 16.3	+ 3 19 10	−0.8993	.6069	−.0861	−9.5702	.9677
13	58 Ophiuchi	5	−62	−90	7 03.8	+ 5 02 16	−1.2636	.6086	−.0807	−9.5661	.9684
13	4 Sagittarii	5	+48	−13	13 13.9	+10 57 12	+0.4733	0.6003	−.0641	−9.6058	9.9614

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			°	°	h. m.	h. m. s.					
Nov. 13	B.A.C. 6088	6	−12	−84	14 03.9	+11 45 04	−0.6045	0.6051	−.0614	−9.5878	9.9647
13	7 Sagittarii	6	+66	+12	14 23.1	−11 56 27	+0.8814	.5984	−.0614	−9.6140	.9598
13	B.A.C. 6161	6	+27	−32	17 47.0	− 8 40 54	+0.1376	.6013	−.0530	−9.6046	.9616
14	24 Sagittarii	6	+29	−27	2 13.1	− 0 35 31	+0.2141	.5988	−.0279	−9.6116	.9603
14	B.A.C. 6343	6	− 2	−62	4 03.6	+ 1 10 30	−0.3512	.6013	−.0252	−9.6029	.9620
14	26 Sagittarii	6	+14	−42	5 20.5	+ 2 24 17	−0.0333	.5990	−.0196	−9.6087	.9608
14	B.A.C. 6369	6	+65	+36	6 27.4	+ 3 28 32	+1.1500	.5929	−.0169	−9.6285	.9567
14	ν^1 Sagittarii	5	−54	−90	10 07.9	+ 7 00 07	−1.1556	.6020	−.0059	−9.5905	.9643
14	ν^2 Sagittarii	5	−62	−90	10 29.7	+ 7 21 03	−1.2303	.6023	−.0059	−9.5892	.9645
14	B.A.C. 6448	6	−24	−90	10 50.2	+ 7 40 41	−0.7193	.6003	−.0059	−9.5982	.9629
14	B.A.C. 6576	6	+40	−16	18 26.1	− 9 01 36	+0.4129	.5913	+.0158	−9.6165	.9593
14	χ^1 Sagittarii	5½	+65	+12	22 16.0	− 5 20 47	+0.8670	.5869	+.0264	−9.6225	.9580
14	χ^3 Sagittarii	6	+34	−22	22 22.4	− 5 14 40	+0.3130	.5895	+.0264	−9.6135	.9599
15	B.A.C. 6864	6	+11	−50	12 50.1	+ 8 39 23	−0.1751	.5828	+.0618	−9.5943	.9636
15	4 Capricor.	6	−10	−83	19 42.9	− 8 43 28	−0.5952	.5793	+.0783	−9.5784	.9663
16	B.A.C. 7049	6	+49	−15	0 31.0	− 4 06 07	+0.4493	.5709	+.0896	−9.5897	.9644
16	17 Capricor.	6	+40	−24	7 36.9	+ 2 44 17	+0.2780	.5664	+.1045	−9.5745	.9670
16	η Capricor.	5	− 1	−74	15 34.9	+10 25 08	−0.5119	.5627	+.1205	−9.5430	.9718
16	χ Capricor.	5½	+68	+31	17 22.9	−11 50 40	+1.1267	.5549	+.1242	−9.5695	.9678
16	27 Capricor.	6	+56	−11	17 49.5	−11 25 00	+0.5112	.5576	+.1243	−9.5572	.9697
16	ϕ Capricor.	6	+69	+18	20 32.0	− 8 48 11	+0.9793	.5530	+.1297	−9.5594	.9694
17	ϵ Capricor.	5	+70	+30	6 15.9	+ 0 35 46	+1.1324	.5446	+.1469	−9.5366	.9726
17	κ Capricor.	5	+70	+11	8 50.2	+ 3 04 51	+0.8917	.5444	+.1501	−9.5243	.9742
17	29 Aquarii	6	+53	−19	18 09.4	−11 54 25	+0.3794	.5378	+.1648	−9.4823	.9790
18	56 Aquarii	6	+45	−28	7 40.0	+ 1 10 27	+0.2178	.5292	+.1813	−9.4224	.9842
18	τ^2 Aquarii	5½	+76	+30	17 19.0	+10 31 38	+1.1574	.5208	+.1917	−9.3947	.9862
18	74 Aquarii	6	− 7	−90	19 18.0	−11 32 56	−0.7752	.5230	+.1936	−9.3318	.9897
19	ψ^1 Aquarii	5½	+30	−46	6 48.3	− 0 23 15	−0.1316	.5157	+.2030	−9.2763	.9921
19	ψ^2 Aquarii	5	−12	−90	7 53.1	+ 0 39 39	−0.8954	.5153	+.2043	−9.2391	.9934
19	ψ^3 Aquarii	5	+20	−58	8 25.7	+ 1 11 18	−0.3175	.5147	+.2044	−9.2572	.9928
20	30 Piscium	4½	+77	− 8	7 20.4	− 0 33 23	+0.6070	.5044	+.2173	−9.0755	.9969
20	33 Piscium	5	+83	− 4	9 10.5	+ 1 13 40	+0.6761	.5037	+.2181	−9.0560	.9972
21	33 Ceti	6	+18	−64	21 03.5	−11 52 37	−0.4129	.4993	+.2228	+8.4621	.9998
22	*f* Piscium	6	− 5	−87	1 03.9	− 7 58 48	−0.8262	.4995	+.2225	+8.6948	.9995
22	ν Piscium	5	+37	−42	14 06.9	+ 4 42 44	−0.0533	.5010	+.2193	+8.9172	.9985
23	ξ^1 Ceti	5	+34	−45	7 22.4	− 2 30 21	−0.1170	.5047	+.2120	+9.1518	.9956
23	ξ Arietis	5½	− 1	−75	13 44.6	+ 3 41 14	−0.7644	.5054	+.2085	+9.2371	.9934
23	B. A. C. 755	6	+13	−67	14 47.5	+ 4 42 21	−0.4996	.5061	+.2079	+9.2353	.9935
23	B. A. C. 830	6	+90	+19	23 13.8	−11 05 41	+0.9924	.5116	+.2015	+9.2444	.9932
24	38 Arietis	5½	+ 5	−76	0 30.2	− 9 51 27	−0.6525	.5093	+.2008	+9.3116	.9907
25	B.A.C. 1272	6	+90	+58	19 03.8	+ 7 26 29	+1.3050	.5341	+.1534	+9.4645	.9807
25	ω^1 Tauri	6	−21	−71	19 34.4	+ 7 56 11	−1.1311	.5272	+.1534	+9.5174	.9751
26	ϵ Tauri	3½	+90	+ 7	5 06.2	− 6 49 51	+0.6665	.5379	+.1384	+9.5093	.9761
26	ι Tauri	4½	+36	−29	21 30.4	+ 9 02 46	−0.0629	.5432	+.1114	+9.5617	.9690
26	105 Tauri	6	+42	−23	23 46.6	+11 14 26	+0.0401	.5445	+.1077	+9.5642	.9687
27	*n* Tauri	5½	+46	−19	5 03.7	− 7 38 53	+0.1032	.5469	+.0984	+9.5724	.9673
27	*o* Tauri	5	+85	+ 9	8 56.3	− 3 54 00	+0.6104	.5516	+.0894	+9.5699	.9678
28	141 Tauri	6	+90	+46	0 28.2	+11 06 27	+1.1163	.5591	+.0583	+9.5808	.9659
28	1 Geminor.	5	+53	− 8	1 32.3	−11 51 37	+0.2216	.5563	+.0561	+9.5966	.9632
28	3 Geminor	6	+74	+ 7	4 04.2	− 9 24 58	+0.5022	0.5583	+.0528	+9.5942	.9636

ELEMENTS

For facilitating the Calculation of Occultations of Planets and Stars by the Moon, *for the Year* 1852.

1852.	Star's Name.	Mag.	Limiting Parallels. North-ern.	Limiting Parallels. South-ern.	Washington Mean Time of ☌.	At Washington Mean Time of ☌. H	Y	p′	q′	Log sin D	Log cos D
			°	°	h. m.	h. m. s.					
Nov. 28	6 Geminor.	6	+90	+23	5 14.2	− 8 17 21	+0.7734	0.5596	+.0476	+9.5907	9.9642
28	η Geminor.	4	+90	+62	6 24.2	− 7 09 45	+1.2546	.5618	+.0454	+9.5836	.9655
29	ω Geminor.	6	+21	−33	3 27.9	−10 50 04	−0.3238	.5601	−.0013	+9.6164	.9593
29	48 Geminor.	6	+23	−32	7 53.2	−10 34 04	−0.2984	.5610	−.0127	+9.6155	.9595
29	52 Geminor.	6	−35	−65	8 51.2	− 5 38 09	−1.1374	.5574	−.0127	+9.6281	.9568
29	κ Geminor.	4	−29	−65	21 56.6	+ 6 59 34	−1.0907	.5585	−.0446	+9.6218	.9582
30	μ¹ Cancri	6	+52	−10	7 35.3	− 7 42 11	+0.2068	.5631	−.0648	+9.5928	.9639
30	γ Cancri	4½	+38	−25	23 55.7	+ 8 03 45	−0.0255	.5600	−.1018	+9.5735	.9672
Dec. 2	η Leonis	3½	+14	−59	13 42.9	− 3 27 26	−0.4719	.5537	−.1726	+9.4776	.9795
2	42 Leonis	6	+51	−23	20 21.8	+ 2 57 58	+0.1934	.5507	−.1828	+9.4327	.9834
3	*i* Leonis	6	+50	−25	1 07.4	+ 7 33 56	+0.1675	.5494	−.1901	+9.4099	.9852
3	*k* Leonis	6	−33	−75	7 40.6	−10 06 03	−1.1874	.5456	−.1971	+9.4121	.9850
4	ι Leonis	4	−22	−79	1 03.3	+ 6 41 53	−1.0735	.5434	−.2199	+9.2937	.9914
4	ξ Virginis	5	−15	−81	11 00.6	− 7 40 35	−0.9819	.5441	−.2295	+9.1980	.9945
4	ν Virginis	4½	+90	0	11 17.3	− 7 24 29	+0.7166	.5463	−.2294	+9.1073	.9964
4	A¹ Virginis	5½	−37	−81	12 14.8	− 6 28 52	−1.2514	.5436	−.2302	+9.1973	.9945
4	π Virginis	5	−15	−83	18 16.4	− 0 39 18	−0.9872	.5444	−.2349	+9.1120	.9963
4	11 Virginis	6	−29	−83	22 33.2	+ 3 29 03	−1.1719	.5446	−.2374	+9.0622	.9971
5	*c* Virginis	5	+52	−28	3 20.1	+ 8 06 25	+0.2201	.5465	−.2403	+8.8579	.9989
6	80 Virginis	6	+83	− 5	13 37.0	− 6 46 05	+0.6522	.5551	−.2452	−8.9081	.9986
7	94 Virginis	6	+82	+ 8	3 12.8	+ 6 21 18	+0.8802	.5610	−.2392	−9.1534	.9955
7	95 Virginis	6	+81	+37	3 24.0	+ 6 32 09	+1.2557	.5605	−.2392	−9.1751	.9951
7	ξ¹ Libræ	6	−66	−90	23 48.6	+ 2 12 37	−0.7945	.5712	−.2213	−9.2919	.9915
8	*o*² Libræ	6	+32	−42	11 38.3	−10 24 07	−0.0416	.5812	−.2050	−9.4016	.9857
8	ζ¹ Libræ	4	+74	+25	13 44.6	− 8 22 37	+1.1048	.5792	−.2019	−9.4455	.9824
8	ζ³ Libræ	6	+74	+ 5	14 43.9	− 7 25 39	+0.8102	.5806	−.2003	−9.4429	.9826
8	ζ⁴ Libræ	6	+74	+ 9	15 38.5	− 6 33 04	+0.8738	.5812	−.1987	−9.4494	.9821
12	B.A.C. 6576	6	+36	−20	4 59.4	+ 3 19 51	+0.3431	.5995	+.0165	−9.6165	.9593
12	χ¹ Sagittarii	5½	+65	+ 6	8 43.7	+ 6 55 03	+0.7889	.5966	+.0248	−9.6225	.9580
12	χ³ Sagittarii	6	+30	−26	8 49.9	+ 7 01 01	+0.2400	.5992	+.0248	−9.6135	.9599
12	*h*¹ Sagittarii	6	+65	+39	12 53.7	+10 54 54	+1.1725	.5916	+.0384	−9.6266	.9571
12	B.A.C. 6864	6	+ 7	−55	22 54.8	− 3 27 55	−0.2522	.5917	+.0645	−9.5944	.9636
13	4 Capricor.	6	−14	−90	5 35.2	+ 2 56 51	−0.6720	.5895	+.0794	−9.5785	.9663
13	B.A.C. 7049	6	+43	−20	10 14.7	+ 7 25 42	+0.3574	.5810	+.0913	−9.5897	.9644
13	17 Capricor.	6	+34	−30	17 08.0	− 9 56 39	+0.1845	.5760	+.1070	−9.5745	.9670
14	η Capricor.	5	− 6	−83	0 51.4	− 2 30 23	−0.5998	.5733	+.1218	−9.5430	.9718
14	χ Capricor.	5½	+68	+21	2 36.2	− 0 49 25	+1.0177	.5653	+.1257	−9.5695	.9678
14	27 Capricor.	6	+50	−17	3 02.0	− 0 24 33	+0.4098	.5662	+.1276	−9.5572	.9697
14	φ Capricor.	6	+69	+10	5 39.6	+ 2 07 22	+0.8712	.5635	+.1315	−9.5594	.9694
14	ε Capricor.	5	+70	+20	15 06.0	+11 13 47	+1.0184	.5537	+.1494	−9.5366	.9726
14	κ Capricor.	5	+70	+ 4	17 35.8	−10 21 41	+0.7796	.5531	+.1528	−9.5243	.9742
15	29 Aquarii	6	+46	−25	2 38.9	− 1 37 02	+0.2721	.5471	+.1666	−9.4823	.9790
15	56 Aquarii	6	+39	−34	15 47.8	+11 06 02	+0.1106	.5367	+.1836	−9.4224	.9842
16	τ¹ Aquarii	6	+75	+31	0 16.7	− 4 41 13	+1.1746	.5270	+.1932	−9.4082	.9853
16	τ² Aquarii	5½	+76	+ 8	1 12.6	− 3 47 04	+0.8608	.5271	+.1943	−9.3948	.9862
16	74 Aquarii	6	−12	−90	3 09.0	− 1 54 12	−0.8716	.5290	+.1962	−9.3318	.9897
16	ψ¹ Aquarii	5½	−49	−90	14 24.6	+ 9 00 46	−1.3131	.5223	+.2054	−9.2349	.9935
16	ψ² Aquarii	5	−19	−90	15 28.2	+10 02 25	−0.9911	.5211	+.2062	−9.2391	.9934
16	ψ³ Aquarii	5	+15	−65	16 00.1	+10 33 26	−0.4188	.5193	+.2068	−9.2572	.9928
17	30 Piscium	4½	+69	−13	14 32.8	+ 8 26 40	+0.5034	0.5072	+.2188	−9.0755	9.9969

ELEMENTS

For facilitating the Calculation of Occultations of Planets and Stars by the Moon, *for the Year* 1852.

1852.	Star's Name.	Mag.	Limiting Parallels. Northern.	Limiting Parallels. Southern.	Washington Mean Time of ☌.	At Washington Mean Time of ☌. H	Y	p′	q′	Log sin D	Log cos D
			°	°	h. m.	h. m. s.					
Dec. 17	33 Piscium	5	+75	−10	16 21.5	+10 12 19	+0.5721	0.5062	+.2194	−9.0560	9.9972
18	20 Ceti	5	+88	+45	18 18.8	+11 26 09	+1.3207	.4997	+.2239	−8.5309	.9997
19	33 Ceti	6	+14	−70	3 58.5	− 3 10 02	−0.4942	.4989	+.2233	+8.4621	.9998
19	*f* Piscium	6	− 9	−87	7 58.2	+ 0 43 06	−0.9036	.4986	+.2225	+8.6946	.9995
19	ν Piscium	5	+33	−46	21 00.2	−10 36 23	−0.1270	.4997	+.2193	+8.9172	.9985
20	ξ¹ Ceti	5	+30	−48	14 16.5	+ 6 11 24	−0.1802	.5028	+.2118	+9.1517	.9956
20	ξ Arietis	5½	− 5	−80	20 39.5	−11 36 17	−0.8220	.5034	+.2083	+9.2371	.9934
20	B. A. C. 755	6	+10	−72	21 42.5	−10 35 03	−0.5572	.5042	+.2076	+9.2353	.9935
21	B. A. C. 830	6	+90	+15	6 09.9	− 2 21 59	+0.9376	.5096	+.2013	+9.2444	.9932
21	38 Arietis	5½	+ 2	−78	7 26.5	− 1 07 35	−0.7065	.5073	+.2005	+9.3115	.9907
23	B.A.C. 1272	6	+90	+53	2 02.3	− 7 47 24	+1.2747	.5336	+.1538	+9.4645	.9807
23	ω¹ Tauri	6	−32	−71	2 33.0	− 7 17 41	−1.1548	.5266	+.1537	+9.5174	.9751
23	ε Tauri	3½	+87	+ 6	12 03.5	+ 1 54 58	+0.6431	.5380	+.1389	+9.5093	.9761
24	ι Tauri	4½	+36	−29	4 23.3	− 6 16 45	−0.0764	.5447	+.1119	+9.5617	.9690
24	105 Tauri	6	+39	−26	6 10.9	− 4 32 45	−0.0221	.5453	+.1101	+9.5642	.9687
24	*n* Tauri	5½	+45	−19	11 53.6	+ 0 58 34	+0.0920	.5499	+.0969	+9.5724	.9673
24	*o* Tauri	5	+83	+ 9	15 44.5	+ 4 41 48	+0.5992	.5531	+.0911	+9.5699	.9677
25	141 Tauri	6	+90	+45	7 07.7	− 4 26 29	+1.1082	.5629	+.0582	+9.5808	.9659
25	1 Geminor.	5	+53	− 8	8 11.4	− 3 25 02	+0.2178	.5599	+.0561	+9.5966	.9632
25	3 Geminor.	6	+74	+ 7	10 41.6	− 1 00 01	+0.4978	.5617	+.0517	+9.5942	.9636
25	6 Geminor.	6	+90	+22	11 50.7	+ 0 06 41	+0.7686	.5630	+.0496	+9.5907	.9642
25	η Geminor.	4	+90	+61	13 00.1	+ 1 13 39	+1.2480	.5660	+.0451	+9.5836	.9655
26	ω Geminor.	6	+22	−33	9 47.9	− 2 42 34	−0.3175	.5649	−.0004	+9.6164	.9593
26	48 Geminor.	6	+23	−48	14 09.6	+ 1 29 49	−0.2925	.5661	−.0120	+9.6155	.9595
26	52 Geminor.	6	−34	−65	15 06.8	+ 2 24 56	−1.1269	.5629	−.0144	+9.6281	.9568
27	κ Geminor.	4	−28	−65	4 01.5	− 9 08 08	−1.0780	.5638	−.0447	+9.6218	.9582
27	μ¹ Cancri	6	+55	− 8	13 06.1	− 0 22 59	+0.2430	.5686	−.0655	+9.5928	.9639
28	γ Cancri	4½	+39	−25	5 39.9	− 8 24 39	−0.0147	.5651	−.1010	+9.5735	.9672
29	η Leonis	3½	+15	−58	19 09.5	+ 3 46 30	−0.4597	.5522	−.1732	+9.4776	.9795
30	42 Leonis	6	+52	−22	1 47.7	+10 11 16	+0.2033	.5521	−.1826	+9.4327	.9834
30	*i* Leonis	6	+50	−24	6 33.5	− 9 12 36	+0.1770	.5504	−.1899	+9.4098	.9852
30	*k* Leonis	6	−32	−75	13 07.8	− 2 51 34	−1.1844	.5449	−.1994	+9.4121	.9850
31	ι Leonis	4	−22	−79	6 38.0	− 9 56 06	−1.0742	.5414	−.2185	+9.2936	.9914
31	ξ Virginis	5	−15	−81	16 43.0	− 0 10 51	−0.9849	.5401	−.2273	+9.1979	.9945
31	ν Virginis	4½	+90	+ 1	16 59.9	+ 0 05 31	+0.7268	.5422	−.2281	+9.1072	.9964
32	π Virginis	5	−15	−83	0 05.9	+ 6 57 40	−0.9927	.5396	−.2331	+9.1119	.9963
32	*c* Virginis	5	+53	−28	9 20.5	− 8 05 49	+0.2242	0.5404	−.2378	+8.8577	9.9989

NOTE.

B. A. C.—British Association Catalogue.

PREDICTION OF OCCULTATIONS.

In the prediction of an occultation for a particular place, the principal objects of determination are, the instant of *immersion*, or of the star's disappearance behind the moon's limb; of *emersion*, or of the star's re-appearance; and the points on the moon's border where these appearances take place.

The calculations, according to the method of the late Professor Bessel, are greatly facilitated by means of the elements given in the preceding list. Those who may wish to consult Prof. Bessel's original paper on this subject, will find it in Schumacher's *Astronomische Nachrichten,* Vol. VII., page 1; also in the *Berliner Astronomisches Jahrbuch* for 1831, page 257. The process of computation is shown by the following equations:

d = Longitude from Washington, of the place, + West, − East.

ϕ = Geographical North Latitude of the place.

ϕ' = Geocentric North Latitude of the place.

r = Earth's radius at the place, or the distance of the observer's position from the earth's centre.

It is unnecessary to calculate ϕ' and r separately, as we have

$$r \sin \phi' = \frac{(1-e^2)\sin \phi}{\sqrt{(1-e^2 \sin^2 \phi)}} \qquad\qquad r \cos \phi' = \frac{\cos \phi}{\sqrt{(1-e^2 \sin^2 \phi)}}$$

in which e denotes the eccentricity of the earth's meridians.

The logarithms of $\dfrac{1-e^2}{\sqrt{(1-e^2 \sin^2 \phi)}} = \log A$, and of $\dfrac{1}{\sqrt{(1-e^2 \sin^2 \phi)}} = \log B$, derived from $e = {\cdot}081697$, according to the latest determination of Prof. Bessel, may be taken from the following table, where the geographical latitude of the place is the argument.

ϕ	Log A	Log B
0	9.9971	0.0000
10	9.9971	0.0000
20	9.9973	0.0002
30	9.9975	0.0004
40	9.9977	0.0006
50	9.9979	0.0009
60	9.9982	0.0011
70	9.9984	0.0013

$$r\sin\phi' = A\sin\phi$$
$$r\cos\phi' = B\cos\phi$$

$$a = r\cos\phi'\sin(h - d)$$
$$b = r\cos\phi'\cos(h - d)$$

$$\log\lambda = 9{\cdot}4192$$

$$u = a \qquad u' = b\lambda$$
$$v \quad r\sin\phi'\cos D - b\sin D \qquad v' = a\lambda\sin D$$

$$m\sin M = p - u \qquad n\sin N = p' - u'$$
$$m\cos M = q - v \qquad n\cos N = q' - v$$

$$\log k = 9{\cdot}4350$$

$$\cos\psi = \frac{m\sin(M - N)}{k}$$
$$Q = 270° - N \mp \psi$$
$$t = -\frac{m}{n}\cos(M - N) \mp \frac{k\sin\psi}{n}$$

Upper signs for Immersion; under signs for Emersion.

$$\tan P = \frac{u + tu'}{v + tv'}$$
$$V = Q + P$$

Mean Solar Time of the Star's apparent contact with the moon's limb

$$= T - d + t$$

Angle from *North Point* $= Q$

Angle from *Vertex* $= V$

The angle ψ is to be taken out positive and less than 180°. If $\log m\sin(M - N)$ be greater than log k, cos ψ will evidently be greater than 1, or impossible, and there will be no occultation, except in some rare instances where the moon's limb passes very close to the star, when log cos ψ will result very near 0. In these cases, a re-calculation should be made according to the method which follows, using

$$t = -\frac{m}{n}\cos(M-N),$$

which may give log $m\sin(M-N)$ less than log k, when the star will be occulted. On the other hand, it may happen that in these cases of very near approach, a first determination may give a cos ψ less than 1, which a re-calculation will show to be impossible. The angle ψ is then to be considered $= 0°$ when $m\sin(M-N)$ is positive, and we shall have $Q = 270°-N$. When $m\sin(M-N)$ is negative, $\psi = 180°$, or $Q = 270°-N+180°$. We shall also have, at the time of nearest approach,

$$\text{star's distance from moon's limb} = 57' \times \left(m\sin(M-N) - \cdot 2725\right), \text{ nearly},$$

the error in this computed distance increasing *with* the distance.

By *Angle from North Point*, is to be understood the arc included between the star when in contact, and the point where the limb is intersected by an arc of a great circle passing from the moon's centre to the North Pole; and by *Angle from Vertex*, the arc between the star at contact, and the point where the limb is intersected by an arc of a great circle passing from the moon's centre to the zenith. These angles are reckoned from the North point and from the vertex, towards the right hand round the circumference of the moon's disc, as seen with an inverting telescope. For *direct* vision, add 180° to the angles given by the equations.

The results obtained by the above equations are only approximate, yet the computed times of immersion and emersion will usually be within one or two minutes of the truth. The error generally increases with the star's distance from the apparent path of the moon's centre, and may, in some cases, amount to several minutes. For an immersion this error is not of much consequence; but for an emersion, especially of a small star, the time should be determined with greater precision. For this purpose, u' and v' must be computed with

$$h' - d = h - d + \tfrac{1}{2}\mu$$

μ being the symbol by which we express the sidereal equivalent of t in these equations.

$$u' = r\cos\phi'\lambda\cos(h'-d)$$
$$v' = r\cos\phi'\lambda\sin(h'-d)\sin D.$$

Then with these values of u' and v', recompute N, n, ψ, and t, by means of

$$n\sin N = p' - u'$$
$$n\cos N = q' - v'$$
$$\cos\psi = \frac{m\sin(M-N)}{k}$$
$$t = -\frac{m}{n}\cos(M-N) \mp \frac{k\sin\psi}{n}$$

using the M and m obtained by the first computation, and we shall have the time of contact $T - d + t$, generally within a few seconds of the truth.

As a check on the accuracy of the work, we might compute

$$u = r \cos \phi' \sin (h - d + \mu)$$

$$v = r \cos \phi' \cos D - r \cos \phi' \cos (h - d + \mu)$$

and we should have

$$(p + tp' - u)^2 + (q + tq' - v)^2 = k^2 = 0.0741.$$

But if $m \sin M$, $m \cos M$, $\log n \sin N$, and $\log n \cos N$, have been correctly computed, we shall have the following shorter and more convenient check on the subsequent calculations for the time of contact:

$$(m \sin M + tn \sin N)^2 + (m \cos M + tn \cos N)^2 = k^2 = 0.0741.$$

The elements of computation, published in our general list, are given for the instant of the moon's true conjunction with the star in right ascension. It is desirable, however, in computing an occultation for a particular place, to assume a time for the calculation near to the time of the nearest approach of the moon's centre to the star, as seen at that place, and to reduce the elements to this assumed time. This time, for which the nearest tenth of an hour will be sufficiently accurate, will not differ greatly from the time of *apparent* conjunction, as affected by parallax, which may be determined approximately by the following equations. Let $T - d$ be the time of apparent conjunction; then

$$(t) = \frac{\sin (H - d)}{p' \sec \phi - [9.4027] \cos (H - d)}$$

$$T - d = \text{time of true} ☌ - d + (t).$$

The elements corresponding to the time $T - d$ may then be obtained as follows:

$$h - d = H - d + (\mu)$$

$$p = (t)\, p'$$

$$q = Y + (t)\, q'$$

Where occultations are to be generally observed, as at astronomical stations, either temporary or permanent, the observer will find an advantage in looking over the list and selecting, beforehand, all those which may be visible at his station, by observing if his latitude be included between the *limiting parallels* for any given occultation, if the time $(T - d)$ be favourable as regards the absence of daylight, and if the star's hour-angle $(h - d)$ be not greater than its semidiurnal arc for the given latitude.

For obtaining the time

$$T - d = ☌ - d + (t),$$

it will be well to tabulate the values of

$$(t) = \frac{\sin (H - d)}{p' \sec \phi - [9.4027] \cos (H - d)}$$

for every half hour of $(H - d)$ as far as the greatest semidiurnal arc computed for the latitude of the station with a declination of 30°.

It will also be found advantageous to have tabulated values of

$$u = r \cos \phi' \sin (h - d)$$
$$u' = r \cos \phi' \lambda \cos (h - d)$$

which should be given for every minute (in time) of $(h - d)$, from 0^h to 6^h. If $(h - d)$ exceeds 6^h, the argument will be $12^h - (h - d)$ instead of $(h - d)$. It will be seen by the equations that u will have the same sign as $\sin (h - d)$, and that u' will have the same sign as $\cos (h - d)$.

In the equation

$$v = r \sin \phi' \cos D - b \sin D$$

the term $r \sin \phi' \cos D$ may be tabulated for every tenth minute of declination, from 0° to 30°.

As an example of the practical application of the preceding formulæ, we will make the requisite calculation for an occultation of θ Libræ, which will take place on the 15th of January, 1852, as it will appear at San Diego, California; in north latitude $32° 45' = \phi$, and west longitude from Washington $2^h 40^m 29^s = d$. With the quantities corresponding to this star and date, on page 5, we have the following data:

January 15th, 1852. θ Libræ.

		h. m.			h. m. s.			
☌	=	19 51.1	H	=	− 0 13 46	ϕ	=	+ 32° 45′
d	=	+ 2 40.5	d	=	+ 2 40 29	Y	=	+ 0.5727
☌ − d	=	17 10.6	$H - d$	=	− 2 54 15	p'	=	+ 0.5622
log sin D	=	− 9.4479	log cos D	=	+ 9.9822	q'	=	− 0.1659

Calculation of the time $T - d$ and reduction of the elements.

	log p'	+	9.750		(t)	−	1.4
							h. m. s.
	log sec ϕ	+	0.075	(Reduced to hours and minutes)	(t)	−	1 24 0
log p' sec ϕ =	log (1)	+	9.825	Sid. equiv. of (t)	(μ)	−	1 24 14
	log const		9.403		$H - d$	−	2 54 15
	log cos $(H - d)$	+	9.860	$H - d + (\mu) =$	$h - d$	−	4 18 29
log [9.403] cos $(H - d)$ =	log (2)	+	9.263		☌ − d		17 10·6
	(2)	+	.183	☌ − $d + (t)$	$T - d$		15 46·6
	(1)	+	.668	$(t)p' = -1.4 \times .5622 =$	p	−	.7871
(1) − (2) =	(3)	+	.485	$-1.4 \times -.1659$	$(t)q'$	+	.2323
	log (3)	+	9.686		Y	+	.5727
	log sin $(H - d)$	−	9.838	$Y + (t)q'$	q	+	.8050
$\log \frac{\sin (H - d)}{(3)} =$	log (t)	−	0.152				

Calculation of the Times of Immersion and Emersion, etc.

(Table, page 27, Arg. ϕ)	$\log A$		9.9976
	$\log\sin\phi$	+	9.7332
$\log A\sin\phi =$	$\log r\sin\phi'$	+	9.7308
	$\log\cos D$	+	9.9822
	$\log r\sin\phi'\cos D$	+	9.7130
(Table, page 27, Arg. ϕ)	$\log B$		0.0005
	$\log\cos\phi$	+	9.9248
$\log B\cos\phi =$	$\log r\cos\phi'$	+	9.9253
	$\log\sin(h-d)$	−	9.9559
$\log r\cos\phi'\sin(h-d) =$	$\log u = \log a$	−	9.8812
	$\log\cos(h-d)$	+	9.6321
$\log r\cos\phi'\cos(h-d) =$	$\log b$	+	9.5574
	$\log\lambda$		9.4192
	$\log a\lambda$	−	9.3004
	$\log\sin D$	−	9.4479
	$\log b\sin D$	−	9.0053
$\log a\lambda\sin D =$	$\log v'$	+	8.7483
$\log b\lambda =$	$\log u'$	+	8.9766
	$r\sin\phi'\cos D$	+	.5164
	$b\sin D$	−	.1013
$r\sin\phi'\cos D - b\sin D =$	v	+	.6177
	q	+	.8050
$q - v =$	$m\cos M$	+	.1873
$a =$	u	−	.7607
	p	−	.7871
$p - u =$	$m\sin M$	−	.0264
	v'	+	.0560
	q'	−	.1659
$q' - v' =$	$n\cos N$	−	.2219
	u'	+	.0948
	p'	+	.5622
$p' - u' =$	$n\sin N$	+	.4674
	$\log m\sin M$	−	8.4216
	$\log m\cos M$	+	9.2725
	$\log\tan M$	−	9.1491
	$\log\cos M$	+	9.9957
	$\log m$	+	9.2768
	$\log n\sin N$	+	9.6697
	$\log n\cos N$	−	9.3462
	$\log\tan N$	−	0.3235
	$\log\sin N$	+	9.9558
	$\log n$	+	9.7139
	$\log\frac{m}{n}$	+	9.5629

	M		351°58′.5
	N		115 24.0
	$M-N$		236 34.5
			270 0.0
	$270°-N$		154 36.0
	ψ		125 26.0
For Immersion, $270°-N-\psi =$	Q		29 10.0
	$\log\sin(M-N)$	−	9.9214
	$\log m$	+	9.2768
	$\log m\sin(M-N)$	−	9.1982
	$\log k$		9.4350
$\log\frac{m\sin(M-N)}{k} =$	$\log\cos\psi$	−	9.7632
	$\log\sin\psi$	+	9.9110
	$\log k\sin\psi$	+	9.3460
	$\log n$	+	9.7139
$\log\frac{k\sin\psi}{n} =$	$\log(1)$	+	9.6321
	$\log\cos(M-N)$	−	9.7410
	$-\log\frac{m}{n}$	−	9.5629
$-\log\frac{m}{n}\cos(M-N) =$	$\log(2)$	+	9.3039
	(2)	+	.2014
	(1)	+	.4286
For Immersion, (2) − (1) =	t_1	−	.2272
For Emersion, (2) + (1) =	t_2	+	.6300
	$\log t_1$	−	9.3564
	$\log u'$	+	8.9766
	$\log t_1 u'$	−	8.3330
	$\log v'$	+	8.7483
	$\log t_1 v'$	−	8.1047
	$t_1 v'$	−	.0127
	v	+	.6177
	$v + t_1 v'$	+	.6050
	$t_1 u'$	−	.0215
	u	−	.7607
	$u + t_1 u'$	−	.7822
	$\log(u + t_1 u')$	−	9.8933
$\log\frac{u + t_1 u'}{v + t_1 v'} =$	$\log(v + t_1 v')$	+	9.7818
	$\log\tan P$	−	0.1115

	$T-d$	15h 46.6m
(Reduced to hours and minutes)	t_1	− 0 13.6
IMMERSION: *San Diego Mean Time* =	$T-d+t_1$	15 33.0
	P	−52° 16′.5
Immersion *Angle from North Point* =	Q	29 10.0
Immersion *Angle from Vertex* = $Q+P$ =	V	336 53.5
(Reduced)	t_2	+ 0h 37.8m
EMERSION: *San Diego Mean Time* =	$T-d+t_2$	16 24.4

Calculation for a more accurate determination of the Time, etc., of Emersion.

		h. m. s.
	$h-d$	-4 18 29
Sid. equiv. for $\frac{1}{2}t_2=$	$\frac{1}{2}\mu_2$	$+0$ 18 57
$h-d+\frac{1}{2}\mu_2=$	$h'-d$	-3 59 32
	$\log\cos(h'-d)$	+ 9.7005
	$\log r\cos\phi'$	+ 9.9253
	$\log\lambda$	9.4192
$\log r\cos\phi'\lambda\cos(h'-d)=$	$\log u'$	+ 9.0450
	$\log\sin(h'-d)$	− 9.9370
	$\log r\cos\phi'\lambda$	+ 9.3445
	$\log\sin D$	− 9.4479
$\log r\cos\phi'\lambda\sin(h'-d)\sin D=$	$\log v'$	+ 8.7294
	v'	+ .0536
	q'	− .1659
$q'-v'$	$n\cos N$	− .2195
	u'	+ .1109
	p'	+ .5622
$p'-u'$	$n\sin N$	+ .4513
	$\log n\sin N$	+ 9.6545
	$\log n\cos N$	− 9.3414
	$\log\tan N$	− 0.3131
	$\log\sin N$	+ 9.9539
	$\log n$	+ 9.7006
	$\log m$	+ 9.2768
	$-\log\frac{m}{n}$	− 9.5762
	$\log\cos(M-N)$	− 9.7471
	$\log\sin(M-N)$	− 9.9188
	$\log m\sin(M-N)$	− 9.1956
$\log\frac{m\sin(M-N)}{k}$	$\log k$	9.4350
	$\log\cos\psi$	− 9.7606
	$\log\sin\psi$	+ 9.9124
	$\log k\sin\psi$	+ 9.3474
$\log\frac{k\sin\psi}{n}=$	log (1)	+ 9.6468
$-\log\frac{m}{n}\cos(M-N)$	log (2)	+ 9.3233

(From first determination)	M	351°58′.5
	N	115 56.0
	$M-N$	236 2.5
		270 0.0
	$270°-N$	154 4.0
	ψ	125 11.0
For Emersion $270°-N+\psi=$	Q	279 15.0
	(2)	+ .2105
	(1)	+ .4434
(2) + (1)	t	+ .6539
	$\log t$	+ 9.8155
	$\log n\sin N$	+ 9.6545
	$\log tn\sin N$	+ 9.4700
	$\log n\cos N$	− 9.3414
	$\log tn\cos N$	− 9.1569
	$tn\cos N$	− .1435
(From first determination)	$m\cos M$	+ .1873
$m\cos M+tn\cos N=$	(3)	.0438
	$tn\sin N$	+ .2951
(From first determination)	$m\sin M$	− .0264
$m\sin M+tn\sin N=$	(4)	.2687
	$(4)^2$	.0722
	$(3)^2$	.0019
$(4^2)+(3)^2=k^2=0.0741$	Check	.0741
	$\log u'$	+ 9.0450
	$\log tu'$	+ 8.8605
	$\log v'$	+ 8.7294
	$\log tv'$	+ 8.5449
	tv'	+ .0351
(From first determination)	v	+ .6177
	$v+tv'$	+ .6528
	tu'	+ .0725
(From first determination)	u	− .7607
	$u+tu'$	− .6882
	$\log(u+tu')$	− 9.8377
	$\log(v+tv')$	+ 9.8148
$\log\frac{u+tu'}{v+tv'}=$	$\log\tan P$	− 0.0229

		h. m.
	$T-d$	15 46.6
(Reduced)	t	+ 0 39.2
EMERSION: *San Diego Mean Time* =	$T-d+t$	16 25.8
	P	−46°30′.5
Emersion *Angle from North Point* =	Q	279 15.0
Emersion *Angle from Vertex* = $Q+P$ =	V	232 44.5

Visible at Washington, D. C., during the Year 1852.

Date. 1852.	Star's Name.	Magnitude.	IMMERSION. Sidereal Time.	IMMERSION. Mean Time.	IMMERSION. Angle from N. Point.	IMMERSION. Angle from Vertex.	EMERSION. Sidereal Time.	EMERSION. Mean Time.	EMERSION. Angle from N. Point.	EMERSION. Angle from Vertex.
			h. m.	h. m.			h. m.	h. m.		
January 3	δ^1 Tauri	4	5 51	10 59	72°	111°	7 00	12 08	320°	10°
3	δ^2 Tauri	4½	7 05	12 13	13	64	Star 2′.9 north of ☽'s limb.			
3	δ^3 Tauri	5	7 33	12 41	125	177	8 41	13 49	258	312
6	δ Geminor.	3	8 42	13 38	130	174	9 33	14 29	214	267
6	63 Geminor.	6	12 27	17 22	81	137	13 22	18 17	260	312
8	83 Cancri	6	7 38	12 26	31	352	8 37	13 25	297	280
15	θ Libræ	4½	14 41	19 01	112	96	15 37	19 57	197	195
24	ψ^3 Aquarii	5	1 43	5 29	142	175	2 54	6 41	278	321
31	B. A. C. 1468	6	2 33	5 52	91	45	3 50	7 09	312	288
Febr'y 7	ν Virginis	4½	7 14	10 04	104	53	8 06	10 56	210	162
13	B. A. C. 5866†	6	12 20	14 46	63	14	13 24	15 50	261	219
16	4 Capricorni	6	15 58	18 11	56	12	17 00	19 13	306	270
27	δ^3 Tauri	5	3 45	5 17	94	78	5 11	6 43	309	335
March 1	δ Geminor.	3½	8 47	10 06	97	143	10 03	11 22	246	301
1	63 Geminor.	6	12 45	14 04	54	110	13 36	14 55	285	337
3	83 Cancri	6	8 07	9 19	25	355	9 00	10 12	302	296
12	B. A. C. 6088*	6	12 06	12 42	1	312	12 21	12 57	332	282
23	B. A. C. 830*	6	9 55	9 48	117	166	10 47	10 40	273	317
26	l Tauri	5½	10 01	9 42	141	196	10 44	10 25	227	280
April 2	ν Virginis	4½	8 46	8 00	120	77	9 24	8 38	186	148
9	B. A. C. 6343*	6	12 23	11 09	3	312	12 36	11 22	336	286
24	δ Geminor.	3½	1 46	23 31	6	311	Star 1′.9 north of ☽'s limb.			
26	η Cancri	6	10 25	8 04	64	113	11 40	9 19	260	315
26	39 Cancri	6	14 12	11 51	94	148	15 03	12 42	233	284
26	40 Cancri	6	14 14	11 53	88	142	15 07	12 45	240	290
May 10	29 Aquarii†	6	16 40	13 24	55	5	17 27	14 10	330	284
21	η Geminor.	4	5 25	1 27	93	68	6 55	2 56	281	311
21	μ Geminor.	3	10 25	6 26	92	149	11 30	7 31	260	316
June 5	17 Capricorni†	6	15 28	10 29	52	2	16 19	11 20	314	270
9	30 Piscium*	4½	16 27	11 13	155	104	17 05	11 50	241	190
9	33 Piscium†	5	18 13	12 58	158	107	18 57	13 42	245	196
10	20 Ceti	5	20 32	15 13	27	340	Star 1′.1 north of ☽'s limb.			
23	ν Virginis	4½	14 58	8 48	131	177	15 20	9 11	170	218
25	80 Virginis	6	17 29	11 11	65	110	18 32	12 14	146	195
27	o^2 Libræ	6	16 10	9 45	129	142	16 45	10 19	180	201
30	24 Sagittarii	6	22 57	16 19	5	51	Star 2′.2 north of ☽'s limb.			
July 1	χ^3 Sagittarii	6	17 42	11 01	37	17	18 34	11 52	322	313
2	B. A. C. 7049	6	21 23	14 37	16	29	Star 2′.7 north of ☽'s limb.			
12	δ^3 Tauri†	5	21 14	13 49	80	33	22 01	14 36	319	267
26	B. A. C. 5758	6	20 16	11 56	118	156	21 14	12 54	229	274
27	B. A. C. 6161†	6	23 41	15 16	3	53	Star 0′.8 north of ☽'s limb.			
29	B. A. C. 6864	6	19 21	10 50	187	138	Star 1′.9 south of ☽'s limb.			
August 8	B. A. C. 1272	6	23 18	14 06	138	84	0 21	15 09	272	218
11	η Geminor.	4	12 02	2 40	109	162	12 52	3 31	242	292
24	26 Sagittarii	6	17 58	7 44	139	131	18 51	8 37	214	218
28	56 Aquarii	6	0 25	13 54	91	117	1 32	15 01	328	11
30	30 Piscium	4½	22 22	11 44	105	82	23 46	13 07	223	221
Sept'r 7	μ Geminor.	3	23 32	12 22	89	38	0 27	13 17	294	240
17	ζ^3 Libræ‡	6	20 09	8 21	43	91	21 00	9 12	288	338
18	ψ Ophiuchi	5	17 14	5 22	79	92	18 34	6 42	246	274

Visible at Washington, D. C., during the Year 1852.

Date 1852.	Star's Name.	Magnitude.	IMMERSION. Sidereal Time.	IMMERSION. Mean Time.	IMMERSION. Angle from N. Point.	IMMERSION. Angle from Vertex.	EMERSION. Sidereal Time.	EMERSION. Mean Time.	EMERSION. Angle from N. Point.	EMERSION. Angle from Vertex.
			h. m.	h. m.			h. m.	h. m.		
Sept'r 20	24 Sagittarii*	6	23 14	11 13	91°	139°	0 14	12 13	280°	331°
21	χ^3 Sagittarii	6	19 26	7 22	109	111	20 52	8 48	263	283
30	B. A. C. 830	6	21 26	8 46	98	46	22 29	9 49	318	266
October 4	141 Tauri	6	23 33	10 37	76	24	0 24	11 28	311	257
4	3 Geminor.	6	3 59	15 03	138	87	5 11	16 14	246	215
4	6 Geminor.	6	5 36	16 39	62	44	6 53	17 56	310	343
20	27 Capricorni‡	6	1 47	11 48	42	90	2 09	12 10	1	50
21	29 Aquarii‡	6	2 36	12 33	72	119	3 21	13 18	337	27
Nov'r 16	17 Capricorni	6	0 46	9 01	200	244	Star 2'.1 south of ☽'s limb.			
20	30 Piscium	4½	22 39	6 38	158	138	23 53	7 52	272	272
20	33 Piscium	5	1 07	9 06	100	118	2 22	10 21	331	5
27	o Tauri	5	23 33	7 05	116	62	0 34	8 05	280	223
Dec'r 14	φ Capricorni	6	23 40	6 05	63	94	0 26	6 51	344	23
21	B. A. C. 830	6	22 17	4 15	91	39	23 19	5 17	329	281
24	n Tauri	5½	6 11	11 56	138	172	7 23	13 07	244	295
24	o Tauri	5	10 59	16 43	61	115	11 50	17 33	302	353
25	3 Geminor.	6	3 49	9 30	65	12	4 55	10 36	321	359
27	μ^1 Cancri	6	6 36	12 09	85	42	8 05	13 37	257	262
30	ν Virginis	4½	11 31	16 47	20	17	12 35	17 51	272	290

* Whole occultation below the horizon of Washington.
† Immersion below the horizon of Washington.
‡ Emersion below the horizon of Washington.

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APPENDIX.