PROCEEDINGS

OF THE

AMERICAN ACADEMY

OF

ARTS AND SCIENCES.

VOL. II.

FROM MAY, 1848, TO MAY, 1852.

SELECTED FROM THE RECORDS.

BOSTON AND CAMBRIDGE:
METCALF AND COMPANY.
1852.

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Three hundred and eighth meeting.

May 30, 1848. — ANNUAL MEETING.

The VICE-PRESIDENT, Mr. Everett, in the chair.

The Reports of the Treasurer, and of the Auditing Committee, were read by Mr. Peirce, in the absence of the Treasurer.

Professor Gray, from the Committee of Publication, stated that there were various papers ready for publication, and that the materials at the disposal of the Committee were likely to be sufficient to furnish a volume of the Memoirs annually.

He also communicated a paper from Dr. John L. Le Conte, of New York, giving an account of a new fossil pachyderm, the *Platygonus compressus*, found at Galena, Iowa.

Mr. Bond communicated the following

"OBSERVATIONS ON MAUVAIS'S COMET OF JULY 4TH, 1847,

Made at the Cambridge Observatory.

(Continued from Vol. I., p. 169, of the Proceedings.)

Cambridge Mean Solar Time.					Comet's A. R.			Comet's Dec. N.			Star of Comparison. A. R.			Star of Comparison. Dec. N.			No. of Comp.	
1848.	d.	h.	m.	s.	h.	m.	s	°	′	″	h.	m.	s.	°	′	″		
Feb.	29	12	43	55	10	57	23.1	18	42	48	10	56	16.84	18	43	11.5	11	B. Z. 456.
March	1	15	22	00	10	54	37.8	18	36	57	10	56	16.84	18	43	11.5	12	"
"	1	16	37	00	10	54	30.2	18	36	46	10	58	40.53	18	33	34.2	2	"
"	24	9	55	30	10	07	23.0	16	03	44	10	07	46.79	16	09	03.0	12	B. Z. 280.
April	21	9	09	00	9	37	41.8	12	29	07	9	38	11.70	12	20	29.4	5	18 Leonis.

" The positions are referred to the mean equinox of Jan. 1st, 1848.

" This comet is remarkable for the length of time during which it was visible, it having been discovered in July, 1847. When last seen, its distance from the earth was three hundred millions of miles, and from the sun three hundred and fifty millions; yet it was still bright enough to admit of pretty good determinations.

"A scintillation or twinkling of its central light was frequently remarked, an indication, perhaps, of a solid nucleus."

Professor Agassiz related some observations he had made upon the form of the extremities in the embryonic state of birds.

Dr. C. T. Jackson stated that he had obtained a considerable quantity of foliated tellurium from specimens of gold ore found near Frederick, Virginia.

Mr. Cole read a letter from Mr. Spencer of Canistota, New York, detailing the history of his attempts at constructing achromatic microscopes, and of the improvements he had effected: — referred to the Rumford Committee.

Miss Maria Mitchell of Nantucket, the discoverer of the comet which bears her name (Vide *Proceedings*, Vol. I. p. 183), was chosen an Honorary Member of the Academy.

Dr. Joseph Leidy of Philadelphia was elected a Corresponding Member.

At the annual election, the following officers were duly elected for the ensuing year: —

Jacob Bigelow, M. D., . . *President.*
Edward Everett, LL. D., *Vice-President.*
Asa Gray, M. D., ... *Corresponding Secretary.*
A. A. Gould, M. D., . . . *Recording Secretary.*
J. Ingersoll Bowditch, . *Treasurer.*
John Bacon, Jr., M. D., . . *Librarian and Cabinet-Keeper.*

The Standing Committees were filled as follows: —

Rumford Committee.

Eben N. Horsford, Benjamin Peirce,
John Ware, Joseph Lovering,
Francis C. Lowell.

Committee of Publication.

Asa Gray, Louis Agassiz, W. C. Bond.

Committee on the Library.

A. A. Gould, D. H. Storer, Benjamin Peirce.

Three hundred and ninth meeting.

August 10, 1848. — Quarterly Meeting.

The Vice-President in the chair.

Dr. Gould, from the Library Committee, presented a report on the condition and pressing wants of the Library; and the annual appropriation for its care and increase was voted.

Dr. Gray, from the Committee of Publication, submitted a statement of bills due, and an estimate of the expenses liable to be incurred during the year in carrying on the printing of the *Memoirs* and the *Proceedings* of the Academy; and the annual appropriation was voted for the purpose.

The Corresponding Secretary submitted a memoir on the development of the ova and on the diseases of Limnæa, by Dr. Henry I. Bowditch.

Mr. Epes Sargent Dixwell, Henry I. Bowditch, M. D., and Mr. Edward C. Cabot, were elected Fellows of the Academy.

John L. Le Conte, M. D., of New York, and Professor James Hall, of Albany, were elected Corresponding Members.

Three hundred and tenth meeting.

October 3, 1848. — Monthly Meeting.

The President in the chair.

The Corresponding Secretary read letters from Messrs. E. S. Dixwell, Henry I. Bowditch, and Edward C. Cabot, accepting the fellowship of the Academy. Also a letter from the Hon. Secretary of the Navy, requesting suggestions from the Academy in respect to the projected astronomical expedition of Lieutenant Gillis to some southern point in South America. Referred to Professor Peirce and Mr. Bond.

Mr. Everett stated that he had received information, through the Danish Chargé d'Affaires at Washington, that the conditions of the award of the King of Denmark's medal for the discovery of telescopic comets would probably be so far waived in favor of Miss Mitchell, as to the time and mode of announcing the discovery, that she would receive the medal.

Mr. Everett, having alluded to the letter addressed to himself, as President of the University, by W. C. Bond, Esq., Director of the Observatory, announcing the discovery, on the 16th of September, of an eighth satellite of Saturn,* read a short paper on the discovery of the other satellites by Huyghens, Cassini, and Sir William Herschel, and on the name proper to be given to the satellite discovered by the Messrs. Bond. Adopting the nomenclature proposed by Sir John Herschel, in his late work on the Cape Observations, Mr. Everett suggested that the new satellite, which comes next to Iapetus, might be called either "Prometheus" or "Hesper," sons of Iapetus; or, if a brother of Saturn were preferred, it might be called "Hyperion." Some discussion arose on this point; and a committee, consisting of Messrs. Everett, Felton, Sparks, Peirce, and Bond, was appointed on the subject of the discovery, and of a name proper to be given to it.

Professor Agassiz gave an account of the fossil Cetacea

* Mr. Bond's letter is as follows: —

"*Observatory, Cambridge, Sept.* 25, 1848.

"Dear Sir, —

"On the evening of the 16th of this month a small star was noticed, situated nearly in the plane of Saturn's ring, and between the satellites Titan and Iapetus. It was regarded at the time as accidental. It was, however, recorded, with an estimated position in regard to Saturn.

"The next night favorable for observation was the 18th, and, while comparing the relative brightness of the satellites, the same object, similarly situated in regard to the planet, was again noticed, and its position more carefully laid down. But still at the time we scarcely suspected its real nature.

"From accurate measurements on the evening of the 19th, the star being found to partake of the retrograde motion of Saturn, that portion of the heavens toward which the planet was approaching was carefully examined, and every star near its path for the two following nights laid down on a diagram, and micrometric measures of position and distance with objects in the neighbourhood were taken.

"The evening of the 20th was cloudy. On the 21st the new satellite was found to have approached the primary, and it moved sensibly among the stars while under observation. Similar observations were repeated on the nights of the 22d and 23d. Its orbit is exterior to that of Titan. It is less bright than either of the two inner satellites discovered by Sir William Herschel.

"Respectfully,

"W. C. BOND."

"PRESIDENT EVERETT."

which have been found in the United States, and which are much more numerous than is generally supposed. He showed nearly perfect sculls of four distinct species, belonging to three different genera, and various parts of three more species. Of these seven species, six belong to the family of Zeuglodonts, and one to that of the true Dolphins. They were all found in the lower tertiary deposits of the Southern States. The new types described by Professor Agassiz were discovered by Mr. Holmes of Charleston, South Carolina, and by Mr. Markoe of Washington. It is intended to publish extensive illustrations of all these fossils.

Professor Gray, from the Publishing Committee, announced that a new volume of *Memoirs* was nearly ready for distribution, and proposed that a committee should be appointed to fix some general rules for the disposition of the publications of the Academy. Messrs. Everett, Felton, Gray, Sparks, Agassiz, Walker, and Gould were appointed a committee for this purpose.

Three hundred and eleventh meeting.

November 8, 1848. — QUARTERLY MEETING.

The PRESIDENT in the chair.

Mr. Everett, from the committee appointed at the last meeting on the discovery of the eighth satellite of Saturn, and on a name suitable to be given to it, read a detailed report, which was referred to the Committee of Publication for the purpose of having it appended to the third volume of Memoirs about to be issued [where it has been printed in full].

Professor Gray presented a Memoir, entitled "Plantæ Fendlerianæ Novi-Mexicanæ: an Account of a Collection of Plants made chiefly in the Vicinity of Santa Fé, New Mexico, by Augustus Fendler; with Descriptions of the New Species, Critical Remarks, and Characters of other undescribed or little known Plants from surrounding Regions"; and made some general observations on the characteristics of the vegetation of New Mexico, now first brought to the notice of botanists.

"Desirous to render the occupation of New Mexico by the United States troops subservient to the advancement of science, and to make known the vegetation of a region which had scarcely been visited by a naturalist, Dr. Engelmann and myself, with the coöperation of one or two friends who patronized the enterprise, induced Mr. Fendler to undertake a botanical exploration of the country around Santa Fé. In execution of this plan, Mr. Fendler left Fort Leavenworth, on the Missouri, on the 10th of August, 1846, with a military train, he having been allowed by the Secretary of War a free transportation for himself, his luggage, and collections.

"Mr. Fendler travelled the well-beaten track of the Santa Fé traders to the Arkansas, and then followed that river up to Bent's Fort, which he reached on the 5th of September. On the 25th of September the Arkansas was crossed, four miles above Bent's Fort, and the westerly course was now changed to a southwestern direction, through an arid and very barren region, where the shrubby *Atriplex* was the most characteristic plant, and furnished almost the only fuel to be obtained. Thus far the country was a comparatively level, or rather rolling, prairie, rising gradually from one thousand to more than four thousand feet above the sea. But on Sept. 27th, the base of the mountain chain was reached, which is an outlier of the Rocky Mountains, and attains in the Raton Mountains the elevation of eight thousand feet. West of these, in dim distance, the still higher Spanish Peaks appear, which have only been visited, very cursorily, by the naturalists of Major Long's expedition in 1820. Scattered Pine-trees are here seen for the first time on the Rio de los Animos (or Purgatory River of the Anglo-Americans), which issues from the Raton Mountains. The party several times crossed large perfectly level tracts, which at this season, at least, showed not a sign of vegetation; in other localities of the same description, nothing but a decumbent species of Opuntia was observed. The sides of the Raton Mountains were studded with the tall *Pinus brachyptera*, Engelm., and the elegant *Pinus concolor*. Descending the mountains, the road led along their southeastern base, across the head-waters of the Canadian.

"On the 11th of October, Mr. Fendler obtained the first view of the valley of Santa Fé, and was disagreeably surprised by the apparent sterility of the region where his researches were to commence in the following season. The mountains rise probably to near nine thousand feet above the sea-level, two thousand feet above the town, but do not reach the line of perpetual snow, and are destitute, therefore, of strictly alpine plants. Their sides are studded with the two Pines already mentioned, with *Pinus flexilis*, &c.

"The Rio del Norte, twenty-five or thirty miles west from Santa Fé, is probably two thousand feet lower than that town. Its flora is meagre; but some interesting plants were obtained on its sandy banks, or on the black basaltic rocks, which in other places rise directly from its brink. South and southwest of Santa Fé, an almost level and sterile plain extends for fifteen miles, which supports little vegetation, except four or five *Cacteæ*, some Grasses, and here and there a bush of the *Shrub Cedar*. To the west and north there is a range of gravelly hills, thinly covered with *Cedar* and the *Nut Pine*. The valleys between the hills appear to have a fertile soil, but cannot be cultivated for want of irrigation. They furnished some very interesting portions of Mr. Fendler's collection.

"By far the richest and most interesting region about Santa Fé, for the botanist, is the valley of the Rio Chiquito (*little creek*) or Santa Fé Creek. It takes its origin about sixteen or eighteen miles northeast of the town, from a small mountain lake or pond, runs through a narrow, chasm-like valley, which widens about three miles from Santa Fé, and opens into the plain just where the town is built. Below, the stream is almost entirely absorbed by the numerous irrigating ditches, which are most essential for the fertilization of the otherwise sterile fields. Most of the characteristic plants of the upper part of the creek and of the mountain-sides are those of the Rocky Mountains, or of allied forms; some of which, such as *Atragene Ochotensis* or *alpina*, *Draba aurea*, &c., have never before been met with in so low a latitude (under 36°).

"Mr. Fendler made his principal collections from the beginning of April to the beginning of August, 1847, in the region just described. At that time, unforeseen obstacles obliged him to leave the field of his successful researches. He quitted Santa Fé on the 9th of August, followed the usual road to Fort Leavenworth, which separates from the 'Bent's Fort road' at the Mora River, and unites with it again at the 'Crossing of the Arkansas.' The first part of the route from Santa Fé to Vegas leads through a mountainous, wooded country, of much botanical interest, crossing the water-courses of the Pecos, Ojo de Bernal, and Gallinas. From Vegas the road leads northeastwardly through an open prairie country, occasionally varied with higher hills, as far as the Round Mound (6,655 feet high, according to Dr. Wislizenus). The principal water-courses on this part of the route, all of which furnished different remarkable species, were the Mora, Ocaté, Colorado (the head of the Canadian), and Rock Creek, all of which empty into the Canadian. Rabbit's Ear Creek and McNees Creek (the head-waters of the north fork of the Canadian) are east of the mountains altogether. From thence the Cimarron was reached, where the Cold Spring, Upper, Middle, and Lower Spring, and Sand Creek are interesting localities. On September 4th, Mr. Fendler recrossed the Arkansas, and reached Fort Leavenworth on the 24th of that month.

" The systematic enumeration of the plants collected by Mr. Fendler, at this time presented to the Academy, extends to the close of the Compositæ (Nos. 1 – 462) ; and embraces the following new species, viz. : — *Thalictrum Fendleri.* *Berberis Fendleri*, a beautiful and very distinct species, allied to B. Canadensis. *Argemone hispida*, — also gathered by Fremont and Wislizenus, — allied to A. grandiflora. *Nasturtium sphærocarpum*, a species with almost exactly globose silicles, as its name indicates. *Streptanthus micranthus*, and *S. linearifolius*. *Cardamine cordifolia*, a species most resembling C. asarifolia of the Old World. *Sisymbrium incisum*, which has the pods of S. Sophia, but with longer pedicels and much coarser foliage. *Vesicaria Fendleri*, a very distinct species of a genus which appears to have its principal focus in Texas and New Mexico. *Lepidium alyssoides*, which was also found by Fremont. *Drymaria sperguloides*, and *D. tenella*, two remarkable narrow-leaved species. *Arenaria Fendleri*, a grassy-leaved species of a group not before found in the New World. *Sidalcea Neo-Mexicana*, and *S. candida*, belonging to a new genus, of which Sida diploscypha, *Torr. & Gr.*, is the type. *Ceanothus Fendleri*. *Dalea nana*, Torr. ined., allied to D. aurea. *Astragalus diphysus*, and *A. cyaneus ;* and four new species of *Phaca*, viz. *P. Fendleri*, *P. gracilenta*, *P. macrocarpa*, and *P. picta*. *Calliandra herbacea*, a small, depressed herb. *Mimosa borealis*, a shrub, found north of lat. 37°, also gathered in flower by Mr. Gordon. *Potentilla diffusa*, and *P. crinita*. *Œnothera* (*Pachylophis*) *eximia*, the largest and most striking species of the section, and apparently one of the handsomest of the genus ; and *Œ.* (*Salpingia*) *Fendleri*, also a very showy species. The new Cacteæ are *Mammillaria papyracantha*, *Cereus Fendleri*, and *Opuntia phæacantha*, described by Dr. Engelmann, who has very successfully investigated this family. *Ribes leptanthum*. *Philadelphus microphyllus*, a charming species. *Archemosa Fendleri*. *Cy-*

mopterus Fendleri. Thaspium? montanum. Of Loranthaceæ, *Phoradendron juniperinum*, Engelm., with two *Arceuthobia* which Dr. Engelmann considers distinct from the A. oxycedri of the Old World. *Galium Fendleri*, and *G. asperrimum.*

"The following are the new Compositæ of the collection, viz.: — *Clavigera brachyphylla. Brickellia Fendleri. Aster Fendleri. Erigeron canum, E. cinereum*, and *E. flagellare. Townsendia Fendleri* and *T. eximia*, two interesting additions to a genus characteristic of the region (and still another is added from farther south). *Gutierrezia* (*Hemiachyris*) *sphærocephala. Franseria tenuifolia*, and *F. tomentosa. Bidens tenuisecta. Sanvitalia Aberti. Heterospermum tagetinum. Lowellia aurea*, a new genus allied to Dysodia. *Schkuhria Neo-Mexicana. Actinella argentea*, the most showy species of the genus. *Amauria? dissecta*, also found by Fremont. *Senecio Fendleri. Cirsium ochrocentrum. Crepis ambigua. Macrorhynchus purpureus.*

"Numerous species and several new genera are characterized in notes to the memoir, of which the greater part are from the North-Mexican collections of Dr. Wislizenus and Dr. Gregg."

Mr. James D. Dana, of New Haven, presented a continuation of his brief synopsis of the characters of the Crustacea obtained during the cruise of the vessels of the United States Exploring Expedition, as follows: —

Conspectus Crustaceorum quæ in Orbis Terrarum circumnavigatione, CAROLO WILKES *e Classe Reipublicæ Fœderatæ Duce, lexit et descripsit* JACOBUS D. DANA. Pars II.*

Familia III. CALANIDÆ.

Oculi simplices; etiam sæpe alii duo inferiores deorsum spectantes. *Pedes mandibulares maxillaresque* articulati et longe setigeri. *Sacculus oviger* unicus. *Antennæ anticæ* elongatæ, non appendiculatæ. *Antennæ posticæ* apice setigeræ.

Genera notis sequentibus distinguenda: † —

* Vide Partem I., Vol. I. p. 149.

† Membra pedalia Cyclopaceorum ordine sequentia: —

I. Pedes mandibulares duo (membra cephalothoracis, ad normam, *quarta*, — ct. iv.).

II. Maxillæ duæ (ct. v.).

- Oculis inferioribus nullis.
  - Antennis anticis nec angulo flexis, nec articulatione geniculatis.
    - Pedibus posticis (ct. xii.) non prehensilibus, sæpe obsoletis.
      - Pedibus anticis (ct. vii.) majoribus quam maxillipedes (ct. vi.), lateraliter porrectis, non geniculatis. . . . . . . 1. CALANUS.
      - Pedibus anticis minoribus quam maxillipedes. Maxillipedibus sub corpore geniculatis. Abdomine longissimo. 2. SCRIBELLA.
    - Pedibus posticis elongatis, subulatis, uno subprehensili; pedibus anticis duplo geniculatis, sub corpore gestis, apice deflexis. . . . 3. EUCHÆTA.
  - Antennis anticis angulo levissimè flexis, nunquam articulatione geniculatis. Pedibus posticis *maris* prehensilibus. . 4. UNDINA.
  - Antennâ anticâ *maris* dextrâ geniculante.
    - Maxillipedibus duplo geniculatis, inflexis, setis longis, nudis. . . . . 5. CANDACE.
    - Max. rectis, setis longis, setulosis. . . . . 6. CYCLOPSINA.
- Oculis superioribus nullis, inferioribus grandibus. Antennâ anticâ dextrâ *maris* geniculante; aliis *Calano* affinibus. . . . . 7. CATOPIA.
- Oculis inferioribus et superioribus.
  - Antennâ anticâ dextrâ *maris* non geniculante, ambabus flexilibus, setis diffusis. Pedibus posticis parvulis, uniarticulatis. . . . . 8. ACARTIA.
  - Antennâ anticâ dextrâ *maris* geniculante; setis non diffusis. Pede postico dextro crasso, prehensili. . . . 9. PONTELLA.

Genus I. CALANUS. (*Leach.*)

Rostrum furcatum. *Antennæ anticæ* sive leviter curvatæ, sive rectæ, *maris* non geniculantes. *Pedes postici* (ct. xii.) obsolescentes, *maris* non prehensiles. *Pedes antici* (ct. vii.) elongati, latè porrecti, maxillipedibus (ct. vi.) majores, non geniculati. *Oculi inferiores* nulli. Cephalothorax 4 – 5-articulatus. *Rami antennarum posticarum* subæqui, ramo breviore ad apicem 3-setis instructo, in dorso setigero.*

III. Maxillipedes (vel maxillæ) duo (ct. vi.).

IV. Pedes antici (vel maxillipedes) duo (ct. vii.).

V., VI., VII., VIII., et sæpe IX. Pedes biremes octo vel decem (ct. viii., ix., x., xi., xii.).

In ambiguis, etiam numeri (*scil.* ct. iv., ct. v., *etc.*) sæpe subjuncti.

Mandibulum articulus pedis mandibularis primus est, et "palpi" articuli sequentes pedis reliqui sunt.

* Species optime distinguendæ sunt: —

1. Per gestum antennarum anticarum; etiam per setas, præcipuè apicales et subapicales; per longitudinem et numerum articulorum:

2. Per maxillipedes, et pedes anticos:

Syn. — Cyclops, *Müller.* — Calanus, *Leach.* — Cetochilus? *Roussel de Vauzème.*

I. Setæ Antennarum Anticarum apicales subapicalibus longiores.

A. *Styli caudales curti.*

1. Calanus rotundatus. — Frons rotundata. Cephalothorax 4-articulatus, crassus, posticè obtusus. Antennæ anticæ corpore vix breviores, 24-articulatæ, duplo curvatæ, apicibus fronte paulo posteriores, articulo ultimo elongato ; setis apicalibus articulum æquantibus, anticis apice remotis, setis subapicalibus minutis. Styli caudales brevissimi ; setis inæquis, secundis abdomine longioribus et apice divaricatis.

Long. $\frac{1}{12}''$. — *Hab.* in mari Pacifico, lat. aust. 32° 24′, long. occ. 166° ; lat. bor. 3°, long. orient. 176° ; lat. bor. 28°, long. orient. 171° 30′. — Lect. die 9 Ap., 1840 ; die 19 Ap., 1841 ; et die 17 Maii, 1841.

2. Calanus comptus. — Frons rotundata. Cephalothorax 4-articulatus, posticè obtusus. Antennæ anticæ tenuissimæ, cephalothorace paulo longiores, fermè 24-articulatæ, duplo curvatæ, apicibus fronte posteriores, articulo ultimo elongato (forsan duplice) ; setis apicalibus articulum fere æquantibus, anticis apice remotis, posticâ penultimâ articuli longitudine, anticâ penultimâ et antepenultimis minutis. Styli caudales breves ; setis strictis, rectis, duobus paulum longioribus.

Long. $\frac{1}{12}''$. — *Hab.* in mari Pacifico, lat. bor. 40°, long. occ. 157° ; lat. bor. 45°, long. occ. 156° ; lat. aust. 21½°, long. occ. 136°. — Lect. diebus 2, 6 Jul., 1841 ; 13 Aug., 1839.

3. Calanus nudus. — Frons rotundata, prominulus. Cephalothorax 4-articulatus, posticè subacutus. Antennæ anticæ cephalothorace vix longiores, fermè 18-articulatæ, articulo ultimo non longiore ; setis totis brevissimis, apicalibus articulo non longioribus, et anticis apice vix remotis, subapicalibus minutis. Styli caudales paulum oblongi, setis rectis, strictis, abdomine non longioribus.

Long. $\frac{1}{20}''$. — *Hab.* in mari Atlantico, lat. bor. 8° – 0°, long. occ. 21° – 18°, et lat. aust. 0° – 6°, long. occ. 18° – 25°. — Lect. diebus 20, 22, 25 Oct., et 1, 3, 5, 8, 12 Nov., 1838.

3. Per pedes posticos thoracicos :

4. Per numerum segmentorum cephalothoracis, et characteres segmentorum antici posticique :

5. Per stylos caudales et eorum setas :

Articulatio cephalothoracis non valet *genera* distinguere. Numerus segmentorum abdominis per ætatem variat, et vix valet *species* distinguere.

4. Calanus Magellanicus. — Frons rotundata. Cephalothorax 4-articulatus, posticè obtusus. Antennæ anticæ corpore breviores, duplo curvatæ, apicibus fronte valde posteriores, articulis quatuor ultimis brevibus, subæquis; setis totis perbrevibus, apicalibus articulo* brevioribus, anticis apice remotis, subapicalibus posticis minutis, anticis obsoletis. Styli caudales perbreves, setis abdominem fere æquantibus.

Long. $\frac{1}{24}''$. — *Hab.* in mari Pacifico, lat. aust. 52°, prope Patagoniam. Lect. die 27 Mar., 1839.

5. Calanus crassus. — Frons rotundata. Cephalothorax crassus, 4-articulatus, posticè vix subacutus. Antennæ anticæ corpore breviores, apicibus fronte valde posteriores, setis brevibus, apicalibus paulo longioribus, subapicalibus minutis, aut obsoletis. Styli caudales perbreves, setis subæquis abdomine paulo brevioribus.

Long. $\frac{1}{16}''$. — *Hab.* in mari Atlantico, lat. aust. 9°, long. occident. 17° 30′. — Lect. die 9 Maii, 1842.

6. Calanus furcicaudus. — Frons triangulata. Cephalothorax 4-articulatus, capite subito angustatus, posticè obtusus. Antennæ anticæ corpore paulo breviores, duplo curvatæ, apicibus fronte posteriores, fermè 24 (26 ?)-articulatæ; articulo ultimo paulo longiore; setis brevibus, prope basin numerosis, apicalibus articulo paulo longioribus et anticis apice parcè remotis, subapicalibus minutis. Styli caudales setæque latè divaricati, setis inæquis, secundis abdomine longioribus.

Long. $\frac{1}{12}''$. — *Hab.* in mari Pacifico, lat. bor. 3°, long. orient. 173°. — Lect. die 28 Ap., 1841.

7. Calanus arcuicornis. — Frons obtusa. Cephalothorax 4-articulatus, capite angustatus, posticè subacutus. Antennæ anticæ cephalothorace vix longiores, leviter arcuatæ, apicibus fronte vix posteriores, articulis 4 ultimis subæquis, setis perbrevibus, apicalibus articulo valde brevioribus, duabus uncinatis, subapicalibus obsoletis, prope basin paucis brevibus uncinatis. Abdomen angustum, lineare. Styli caudales per breves, setis strictis, rectis, abdominis longitudine.

Long. $\frac{1}{16}''$. — *Hab.* in mari Pacifico, lat. aust. 32° 24′, long. orient. 178° 15′. — Lect. die 9 Ap., 1840.

B. *Styli caudales valde elongati.*

8. Calanus turbinatus. — Frons obtusa. Cephalothorax anticè crassus, posticè attenuatus (idcirco, segmentum posticum abdomine

* In his, "setæ articulo breviores" et aliis similibus, articulus ille has setas gerens *passim* intelligentus.

parcè latius) obtusiusculus. Antennæ anticæ duplo leviter curvatæ, corpore breviores, tenuissimæ, articulis 5 ultimis subæquis; setis totis perbrevibus, apicalibus subapicalibusque articulo non longioribus. Styli caudales tenues, paralleli, setis dimidio brevioribus.

Long. $\frac{1}{12}''$. — *Hab.* in mari "Sulu." — Lect. die 29 Jan., 1842.

9. Calanus stylifer. — Frons truncata. Cephalothorax curtus, posticè abdomine valde latior et longè acutus, 5-articulatus, segmento ultimo brevissimo. Antennæ anticæ duplo paululum curvatæ, apicibus fronte non posteriores; setis perbrevibus, apicalibus et penultimâ posticâ fere articuli longitudine, penultimâ anticâ et antepenultimis brevissimis. Styli caudales tenues, fere abdominis longitudine, recti, paralleli, setis non longioribus, unâ valde externâ.

Long. $\frac{1}{12}''$. — *Hab.* in mari Atlantico, lat. aust. 23° – 24°, long. occ. 41° – 43°. — Lect. die 19 Nov., 1838, et 9 Jan., 1839.

10. Calanus curtus. — *C. stylifero* similis, sed curtior. Cephalothorax 5-articulatus, segmentis 4 posticis subæquis. Antennæ anticæ corpore paululo longiores,* tenuissimæ, duplo paulum curvatæ, apicibus fronte vix anteriores; setis perbrevibus, apicali anticâ longiore, articulum non superante. Styli caudales tenues, fere abdominis longitudine, vix recti, setis non longioribus, flexuosis, unâ valde externâ.

Long. $\frac{1}{20}''$. — *Hab.* in mari "Sulu"; etiam freto Sundæ. — Lect. die 27 Jan., et die 2 Mar., 1842.

11. Calanus scutellatus. — Latè depressus. Cephalothorax 4-articulatus, segmento antico anticè fortè arcuato, posticè latè producto et acuto, segmento postico utrinque longè acuto, et divaricato. Antennæ anticæ corpore paululo longiores, duplo curvatæ, apicibus fronte vix anteriores; setis brevibus, apicali anticâ penultimâque posticâ articuli longitudine, aliis subapicalibus perbrevibus. Styli caudales tenues, fere abdominis longitudine, parcè divaricati.

Long. $\frac{1}{16}''$. — *Hab.* in mari "Sulu." — Lect. die 27 Jan., 1842.

II. Setæ Antennarum Anticarum apicales subapicalibus non longiores.

A. *Setæ caudales totæ mediocres. Frons obtusa, non elongata.*

a. Cephalothorax 4-articulatus.

12. Calanus pavo. — Frons subtriangulata, obtusa. Cephalothorax posticè obtusus. Antennæ anticæ corpore dimidio longiores, duplo

* I. e. stylis exclusis, ut passim.

curvatæ, articulo ultimo longiore, setis longiusculis. Abdomen brevissimum. Styli caudales breves, divaricati, setis fere corporis longitudine, latis, eleganter plumiformibus, flabellatim divaricatis.

Long. $\frac{1}{24}''$. — *Hab.* in mari Atlantico, lat. bor. 12°, long. occ. 24°. — Lect. die 9 Oct., 1838.

13. Calanus levis. — Frons obtusa. Cephalothorax mediocris, posticè subacutus. Antennæ anticæ corpore vix longiores, duplo leviter curvatæ, apicibus fronte non anteriores; setis brevibus, 4 – 5 remotis longioribus, apicalibus et anticâ penultimâ fere articuli longitudine, posticis penultimâ antepenultimâque paulo longioribus, subæquis, anticâ antepenultimâ obsoletâ. Styli caudales parce oblongi, setis rectis, appressis, abdominis longitudine.

Long. $\frac{1}{20}''$. — *Hab.* in mari Atlantico juxta "Rio de Janeiro." — Lect. die 7 Jan., 1839.

14. Calanus medius. — Frons rotundata. Cephalothorax posticè obtusus. Antennæ anticæ cephalothorace paulo longiores, duplo curvatæ, apicibus fronte posteriores; setis perbrevibus, 4 – 5 remotis longioribus, posticâ apicali et anticâ penultimâ largè articuli longitudine, posticâ penultimâ paulo breviore, posticâ antepenultimâ duplo longiore. Styli caudales breves, setis appressis, abdomine brevioribus.

Long. $\frac{1}{16}''$. — *Hab.* in mari Pacifico, lat. bor. 44°, long. occ. 153°. — Lect. die 6 Jul., 1841.

15. Calanus placidus. — Frons rotundata. Cephalothorax posticè obtusus. Antennæ anticæ corporis longitudine, duplo leviter curvatæ, apicibus fronte paulo posteriores; setis apicalibus brevibus, posticis penultimâ antepenultimâque valde elongatis, anticâ penultimâ dimidio breviore. Styli caudales breves.

Long. $\frac{1}{12}''$. — *Hab.* in mari Pacifico, prope insulas "Kingsmill"; etiam lat. bor. 40°, long. occ. 157°. — Lect. die 30 Ap., et 2 Jul., 1841.

16. Calanus recticornis. — Frons obtusa. Cephalothorax posticè rotundatus. Antennæ anticæ corpore longiores, rectissimæ, apicibus fronte non anteriores, articulo primo (2?) crassè oblongo, ultimo paulum demisso; setis brevibus, articuli secundi subelongatâ, articuli antepenultimi posticâ longiore (= 4 artic.), penultimis posticâ et anticâ paulo brevioribus, apicali posticâ minore, articulo longiore, duabus aliis apicalibus brevibus et subuncinatis. Styli caudales breves; setis mediocribus, parcè diffusis.

Long. $\frac{1}{12}''$. — *Hab.* in mari "Sulu." — Lect. die 1 Feb., 1842.

b. Cephalothorax 5 – 6-articulatus.

1. *Cephalothorax posticè obtusus aut breviter subacutus.**

17. Calanus setuligerus. — Frons rotundata. Cephalothorax 5 (6 ?)-articulatus, posticè obtusus, articulis subæquis. Antennæ anticæ corpore paulo longiores, duplo curvatæ, setis prope basin plerumque duplo longioribus quam articuli et numerosis, setâ articuli sexti (forsan quinti) longiore, setis duabus posticis subapicalibus longis, subæquis, apicalibus brevibus, anticâ penultimâ longiore quam articulus. Styli caudales perbreves; setis mediocribus, parcè diffusis, secundis fere duplo longioribus.

Long. $\frac{1}{16}''$. — *Hab.* in mari Atlantico, lat. bor. 6° – 9°, long. occ. 21° – 24°. — Lect. diebus 13 – 18 Oct., 1838.

18. Calanus pellucidus. — Frons rotundata. Cephalothorax 5-articulatus, posticè obtusus, articulo ultimo brevi. Antennæ anticæ corporis longitudine, setis subapicalibus posticis longiusculis. Styli caudales oblongi.

Long. $\frac{1}{24}''$. — *Hab.* in mari Atlantico, lat. bor. $14\frac{1}{2}$°, long. occ. 21°. — Lect. die 5 Oct., 1838.

19. Calanus affinis. — Frons rotundata. Cephalothorax 5-articulatus, posticè obtusus, articulis posticis subæquis. Antennæ anticæ corporis longitudine, apicibus fronte posteriores; setis brevibus, duabus posticis subapicalibus prælongis, anticâ penultimâ dimidio breviore, apicalibus brevibus. Styli caudales perbreves, setis diffusis, secundis fere duplo longioribus quam primæ.

Long. $\frac{1}{12}''$. — *Hab.* in mari prope insulam "Sumatra." — Lect. die 3 Mar., 1842.

20. Calanus flavipes. — Frons triangulata, vix prominula. Cephalothorax 5-articulatus, posticè attenuatus, obtusus aut subacutus. Antennæ anticæ corpore paulo longiores, duplo leviter curvatæ, apicibus fronte vix posteriores; setas *affini* similes. Styli caudales oblongi, setis mediocribus, non diffusis. Abdomen 2-articulatum; — an adultum ?

Long. $\frac{1}{10}''$. — *Hab.* in mari Atlantico, prope "Rio de Janeiro." — Lect. die 7 Jan., 1839.

21. Calanus tenuicornis. — Frons rotundata. Cephalothorax 5-articulatus, posticè obtusus, articulis posticis subæquis. Antennæ anticæ sesqui corporis longitudine, tenuissimæ, duplo levissimè curvatæ,

* Anguli postici cephalothoracis adulti sæpe elongati et subacuti aut acuti.

apicibus fronte vix posteriores, articulis tribus ultimis subæquis; setis brevibus, articuli tertii setâ longiore, setis duabus posticis subapicalibus prælongis, anticâ penultimâ prope dimidio breviore, apicalibus brevibus. Styli caudales oblongi (latitudine duplo longiores).

Long. $\frac{1}{12}''$. — *Hab.* in mari Pacifico, lat. bor. 40°, long. occ. 157°. — Lect. die 2 Jul., 1841.

22. Calanus sanguineus. — Frons rotundata. Cephalothorax 5-articulatus, posticè obtusus aut subacutus, articulis posticis subæquis. Antennæ anticæ corporis longitudine, fere rectæ, apicibus fronte vix posteriores; setis brevibus, articuli tertii longiore, subapicalibus *tenuicorni* fere similibus. Styli caudales paulum oblongi, setis mediocribus, diffusis, secundis longioribus.

Long. $\frac{1}{10}''$. — *Hab.* in mari Pacifico, lat. bor. 32°, long. occ. 175°; lat. bor. 44°, long. occ. 153°; forsan in mari "Sulu." — Lect. die 28 Màii, et die 6 Jul., 1841, etiam die 28 Jan., 1842. — Var. *perspicax* (oculus transversim reniformis) in mari "Viti," Jul., 1840.

23. Calanus mundus. — Frons rotundata. Cephalothorax posticè obtusus, 5-articulatus, articulis posticis subæquis. Antennæ anticæ corpore parcè longiores, bene rectæ, apicibus fronte non posteriores, articulo primo (2do ?) crassè oblongo et setis inflexis instructo; setis perbrevibus, articuli secundi longiore, apicalibus brevibus, posticâ antepenultimâ longâ, posticâ penultimâ duplo breviore, anticâ penultimâ paulo minore (articulum æquante), anticâ antepenultimâ minutâ. Abdomen 4–5-articulatum. Styli caudales breves, setis appressis, secundis longioribus.

Long. $\frac{1}{10}''$. — *Hab.* in mari Pacifico, lat. bor. 44°, long. occ. 154°. *C. recticorni* affinis; sed cephalothorax 5-articulatus.

24. Calanus inauritus. — Frons rotundata. Cephalothorax posticè obtusus, 5-articulatus, articulo ultimo brevissimo. Antennæ anticæ fere rectæ, corpore paulo breviores, articulo primo valde elongato (an duplice ?) tribus setis pendulis subclavatis et aliis setis brevibus uncinatis instructo, setis apicalibus et anticis subapicalibus perbrevibus, subapicalibus posticis articulo vix longioribus, inæquis. Styli caudales breves, setis parcè diffusis aut appressis.

Hab. in mari Atlantico, lat. bor. 6°, long. occ. 21°. — Lect. die 22 Oct., 1838.

2. *Cephalothorax posticè acutus, angulis posticis abdomini appressis.*

25. Calanus simplicicaudus. — Frons obtusa. Cephalothorax 5-

articulatus, segmento postico angusto et posticè brevissimè acuto. Antennæ anticæ corpore paulo longiores, basi arcuatæ, alioque fere rectæ, apicibus fronte parcè posteriores ; setis brevibus, duabus subapicalibus posticis longis, inæquis, anticâ penultimâ duplo breviore, apicalibus brevibus. Abdomen 2-articulatum : (an adultum ?). Styli caudales paulum oblongi.

Hab. in mari Pacifico, lat. bor. 45°, long. occ. 153°.

C. flavipedi abdominem et angustum articulum cephalothoracis posticum affinis ; antennarum anticarum setas apicales subapicalesque *C. sanguineo* similis.

26. Calanus appressus. — Frons obtusa. Cephalothorax posticè attenuatus, angulis posticis elongatè acutis abdominem appressis, 5-articulatus, articulis posticis longitudine subæquis. Antennæ anticæ corpore paulo longiores, duplo leviter curvatæ, articulo ultimo valde graciliore quam penultimus ; setis brevibus, duabus posticis subapicalibus prælongis, subæquis, strenuis, anticâ penultimâ duplo breviore, apicalibus articulo non longioribus. Styli caudales breves ; setis secundis longioribus.

Long. $\frac{1}{12}''$. — *Hab.* in mari Pacifico, lat. bor. 25°, long. orient. 167° ; in mari juxta "Sumatra" ; etiam lat. aust. 30°, long. orient. 13°. — Lect. die 14 Maii, 1841, et die 4 Mar., et 21 Apr., 1842.

3. *Cephalothorax posticè longè acutus, angulis posticis remotis.*

27. Calanus communis. — Frons rotundata. Cephalothorax posticè longè acutus, 5-articulatus, articulis posticis subæquis. Antennæ anticæ corpore paulo longiores, duplo leviter curvatæ, apicibus fronte non anteriores, setis apicalibus brevibus, duabus posticis subapicalibus longis, subæquis, anticâ penultimâ quadruplo breviore, setis totis aliis brevibus. Styli caudales perbreves, setis secundis duplo longioribus.

Long. $\frac{1}{10}''$. — *Hab.* in mari Atlantico, inter lat. bor. 8° et lat. aust. 5°, long. occ. 23° – 15° ; etiam, lat. aust. $4\frac{1}{2}$° – 1°, long. occ. 25° – $30\frac{1}{2}$°. — Lect. diebus 18, 20, 27, 31 Oct., 2, 3, 8, 12 Nov., 1838 ; 13, 16 Maii, 1842.

C. affini similis ; sed anguli postici cephalothoracis longè acuti. An distinctio vera ?

28. Calanus amænus. — *C. communi* antennas anticas setasque caudales affinis. Cephalothorax 5-articulatus, sed articulo ultimo brevissimo ; angulis posticis longè acutis.

Long. $\frac{1}{10}''$. — *Hab.* in mari Pacifico prope insulas "Samoa," et in mari "Sulu." — Lect. die 26 Feb., 1841, et die 1 Feb., 1842.

29. Calanus bellus. — Frons rotundata. Cephalothorax posticè longè acutus, 5-articulatus, articulis posticis subæquis. Antennæ anticæ corpore paululo longiores, vix duplo curvatæ, apicibus fronte non anteriores; setis brevibus, tertii articuli longâ, duabus posticis subapicalibus longis, subæquis, apicalibus brevibus, anticâ penultimâ paulo longiore. Styli caudales breves, setis diffusis, secundis fere duplo longioribus.

Long. $\frac{1}{8}''$. — *Hab.* in mari "Sulu," et freto "Banca." — Lect. die 2 Feb., et die 2 Mar., 1842.

C. setuligero affinis; sed anguli postici cephalothoracis non obtusi, et setæ caudales valde diffusiores. *C. communi* similis; sed seta tertii articuli antennarum anticarum longa est.

B. *Setæ caudales secundæ longissimæ. Frons sive obtusa, sive triangulato-acuta; rostro longè furcato, brachiis setiformibus.*

30. Calanus gracilis. — Gracilis. Frons rotundata. Cephalothorax elongatus, 5-articulatus, posticè obtusus, articulis posticis subæquis. Antennæ anticæ sesqui corpore longiores, rectæ, 160° inter sese divaricatæ; setis brevibus, duabus posticis subapicalibus longis, apicalibus et anticis subapicalibus brevibus. Abdomen curtum, 4-articulatum. Styli caudales breves, setis secundis dimidio corporis longioribus.

Long. $\frac{1}{8}''$. — *Hab.* in mari Atlantico, lat. aust. $4\frac{1}{2}°$, long. occ. 25°. — Lect. die 13 Maii, 1842.

31. Calanus elongatus. — Elongatus. Frons breviter triangulata subacuta, rostro longè et tenuiter furcato. Cephalothorax 4-articulatus, anticè angustatus, posticè obtusus. Antennæ anticæ sesqui corporis longitudine, rectæ, et latissimè divaricatæ, apicibus fronte vix anteriores, articulo penultimo abbreviato; setis plerumque brevibus, paucis remotis longiusculis, apicalibus diffusis articulo longioribus, subapicalibus posticis longis, inæquis, anticâ penultimâ minus dimidio breviore, anticâ antepenultimâ obsoletâ. Antennæ posticæ ramo curto 2-articulatæ. Abdomen curtissimum. Styli caudales brevissimi.

Long. $\frac{1}{5}''$. — *Hab.* in mari "Sulu." — Lect. die 1 Feb., 1842.

32. Calanus attenuatus. — Elongatus. Frons triangulata, acuta, rostro longè et tenuiter furcato. Cephalothorax anticè valde angustatus, posticè obtusus, 5-articulatus, articulo ultimo brevi. Antennæ anticæ corpore valde longiores, prope basin arcuatæ, alioque rectæ et

latissimè divaricatæ, apicibus fronte paulo anteriores, articulo penultimo abbreviato; setis vix brevibus, plerumque fractis, fere æquis, apicalibus et subapicalibus inæquis longiusculis, anticâ antepenultimâ obsoletâ. Antennæ posticæ ramo curto multiarticulato. Abdomen curtissimum. Styli caudales perbreves, setis secundis dimidio corporis longioribus.

Long. $\frac{1}{8}''$. — *Hab.* in mari Pacifico, prope insulas "Kingsmill"; etiam in mari Sinensis. — Lect. die 13 Ap., 1841, et die 15 Feb., 1842.

C. *Frons valde elongata; rostro breviter valdeque furcato. Setæ caudales secundæ longissimæ* (?).

33. Calanus rostrifrons. — Gracillimus. Frons valde elongata, subacuta. Cephalothorax anticè paulo angustior, posticè rotundatus, 5-articulatus, articulo postico brevi, articulis penultimo antepenultimoque posticè acutis. Antennæ anticæ corpore valde longiores, leviter arcuatæ, latè divaricatæ, apicibus fronte anteriores, setâ articuli secundi longiusculâ, setis apicalibus articulo vix longioribus, duabus subapicalibus posticis longis. Abdomen curtum. Styli caudales latitudine fere duplo longiores; setis latissimè diffusis.

Long. $\frac{1}{8}''$. — *Hab.* in mari "Sulu." — Lect. die 2 Feb., 1842.

34. Calanus cornutus. — Gracillimus. Frons valde elongata, subacuta. Cephalothorax posticè rotundatus, 5-articulatus, articulo postico fere obsoleto, articulis tribus precedentibus posticè acutis. Antennæ anticæ sesqui corporis longitudine, fere rectæ, vix arcuatæ, apicibus fronte paululo anterioribus; setâ articuli tertii longiusculâ, setis apicalibus et penultimis brevibus, posticâ antepenultimâ longiore. Abdomen curtum. Styli caudales elongati; setis valde diffusis.

Long. $\frac{1}{8}''$. — *Hab.* in mari Atlantico, lat. bor. 1°, long. occ. 18°. — Lect. die 3 Nov., 1838.

Genus II. SCRIBELLA. (*Dana.*)

Antennæ anticæ elongatæ, pauci-articulatæ, longè setigeræ, setis diffusis, *maris* non geniculantes. *Antennæ posticæ* simplices (?). *Maxillipedes* (ct. vi.) maximi, pedibus proximis majores, 4-articulati, geniculati et prorsum flexi. *Oculi inferiores* nulli. *Cephalothorax* 4–5-articulatus, capite non discreto. *Abdomen* valde elongatum, cephalothorace non brevius. *Styli caudales* oblongi, divaricati. [Sæpius, e basi pedis biremis, seta grandis lateraliter porrecta.]

Syn. — Scribella, *D.*, Amer. Jour. Sci., Ser. 2da, I. 227.

1. Scribella scriba. — Antennæ anticæ latè (130°) divaricatæ, fere corporis longitudine, 7-articulatæ, articulis secundo, quarto et duabus ultimis brevioribus, setis longissimis. Seta pedium biremium externa grandis, eleganter plumiformis. Abdomen 5-articulatum, cephalothorace longius, setis basalibus duabus longiusculis rectis. Styli caudales tenues, setâ externâ fere styli longitudine.

Long. $\frac{1}{20}''$. — *Hab.* in mari Atlantico, lat. bor. $4\frac{1}{2}° - 7°$, long. occ. $20° - 22°$; et lat. aust. 1°, long. occ. 30° 30′. — Lect. diebus 22, 23, 24, 26 Oct., 1838, 16 Maii, 1842. Forsan in mari Pacifico, prope insulas "Kingsmill"; an eadem species? — Lect. Ap., 1841.

2. Scribella setiger. — Antennæ anticæ fere corporis longitudine, latè divaricatæ, 7-articulatæ, articulis 3 ultimis brevissimis, tertio quartoque prælongis, setis longissimis. Seta pedium biremium externa longa, nuda, tenuissimè subclavata. Abdomen 5-articulatum, segmentis subæquis, setis basalibus duabus, unâ prælongâ, alterâ brevi. Styli caudales tenues, setâ externâ valde longiore quam stylus et prope basin styli insitâ.

Long. $\frac{1}{20}''$. — *Hab.* in mari Pacifico, prope insulas "Kingsmill." — Lect. die 18 Ap., 1841.

3. Scribella abbreviata. — Antennæ anticæ latè divaricatæ, 7-articulatæ, articulis duabus ultimis brevibus, tertio, quarto, quintoque subæquis. Setæ externæ pedium biremium obsoletæ (an distinctio sexualis?). Abdomen 4-articulatum setis basalibus dimidio abdominis valde brevioribus, subæquis, curvatis. Styli caudales paulum divaricati; setâ externâ perbrevi. — An S. *setigeræ* femina? Vix credo.

Long. $\frac{1}{24}''$. — *Hab.* in mari Pacifico, prope "Tierra del Fuego"; etiam lat. aust. 24°, long. occ. 175°; lat. bor. $44\frac{1}{2}°$, long. occ. 153°. — Lect. die 21 Jan., 1839; die 21 Ap., 1840; die 7 Jul., 1841.

Genus III. EUCHÆTA. (*Philippi.*)

Frons acuta. *Rostrum* transversim emarginatum. *Antennæ anticæ* duplo leviter curvatæ, nunquam minimè angulo flexæ, *maris* non geniculantes. *Pedes postici* (ct. xii.) ambo maris valde elongati, subulati. *Pedes antici* (ct. vii.) maxillipedibus (ct. vi.) majores, duplo geniculati et sub corpore gesti, penecillum setarum nudarum reflexum ferentes. *Oculi inferiores* nulli. *Cephalothorax* 4–5-articulatus, capite non discreto.

Syn. — Euchæta, *Philippi*, Archiv für Naturgeschichte, Vol. IX. p. 55.

1. EUCHÆTA COMMUNIS. — Cephalothorax nudus, 4-articulatus, posticè obtusus. *Feminæ :* antennæ anticæ corpore vix breviores, setis paucis remotis prælongis, rectis, et aliis duabus flexis longissimis, apicalibus prælongis, posticâ antepenultimâ fere articuli longitudine. Setæ caudales rectæ, secundâ sæpius corporis longitudine. Ova cærulea. *Maris :* antennæ anticæ corpore paulo breviores, angulo levissimè flexæ, setis brevibus, paucis articulum apicalem vix superantibus. Pedes postici longissimi, longè subulati. Setæ caudales abdominis longitudine.

Long. $\frac{1}{8}''$. — *Hab.* in mari Atlantico, lat. bor. 9° – 0°, long. occ. 17° – 23°, et lat. aust. 0° – 13°, long. occ. 17° – 32°. — Lect. diebus 15, 18, 20, 24, 26, 27, 29, 30, 31 Oct., et 1, 3, 5, 9, 12 Nov., 1838 ; etiam die 11 Maii, 1842.

2. EUCHÆTA CONCINNA. — Cephalothorax nudus, ellipticus, capite lateraliter arcuatus, angulis posticis paulum productus et obtusus ; *feminæ* 4-articulatus, *maris* 5-articulatus articulo postico perbrevi. Antennæ anticæ corpore paulo breviores, *feminæ*, *marisque* iis *E. communis* fere similes, setâ antepenultimâ posticâ brevissimâ. Setæ caudales abdomine breviores, secundâ *feminæ* fere corporis longitudine, *maris* abdominem paulo superantibus.

Long. $\frac{1}{10}''$. — *Hab.* in freto "Banca." — Lect. die 1 Mar., 1842.

3. EUCHÆTA PUBESCENS. — *Feminæ :* Cephalothorax pubescens, capite lateraliter angulatus, 5-articulatus, articulo postico perbrevi, subacuto. Antennæ anticæ corpore paulo breviores, setas *E. communi* fere similes, setis antepenultimis brevissimis. Pedes antici apice 5-articulati et subelongati. Abdomen 4-articulatum, articulo primo secundum longitudine duplo superante. Seta caudalis secunda fermè corporis longitudine.

Long. $\frac{1}{12}''$. — *Hab.* in mari Pacifico, in Archipel. "Paumotu." — Lect. die 29 Aug., 1839.

4. EUCHÆTA DIADEMA. — *Feminæ :* Cephalothorax pubescens, capite lateraliter angulatus, 4-articulatus, posticè obtusus. Antennæ anticæ fere corporis longitudine, setas *E. communi* fere similes, setâ posticâ penultimâ dimidium posticæ apicalis superante, setis antepenultimis brevissimis. Pedes antici apice 5 – 7 articulati, perbreves. Abdomen elongatum, articulo primo secundum longitudine paulo superante. Seta caudalis secunda corpore longior, nuda.

Long. $\frac{1}{7}''$. — *Hab.* in mari Pacifico, prope insulas "Kingsmill." — Lect. diebus 23, 24, 25 Mar., 1841.

Genus IV. UNDINA. (*Dana.*)

Antennæ anticæ ante medium angulo leviter flexæ, apicibus fronte posteriores, *maris* non geniculantes. *Pedes postici* (ct. xii.) *maris* grandes, dextro subcheliformi. *Pedes antici* (ct. vii.) elongati, maxillipedibus sæpe majores et valde porrecti, non geniculati. *Oculi inferiores* nulli. *Cephalothorax* 4–5-articulatus, capite non discreto.

1. UNDINA VULGARIS. — Frons obtusa. Cephalothorax 4-articulatus, posticè rotundatus. Antennæ anticæ corporis longitudine, ad articulum octavum leviter reflexæ; setis brevibus, setâ articuli tertii longâ, flexâ, setis apicalibus perbrevibus, unâ uncinatâ, posticâ antepenultimâ longiusculâ, penultimis anticâ posticâque paulo brevioribus, hâc ad extremitatem uncinulatâ. Abdomen 5-articulatum. Styli caudales breves, setâ secundâ duplo longiore.

Long. $\frac{1}{12}''$. — *Hab.* in freto "Banca," juxta insulam "Sumatra"; etiam in mari Atlantico, lat. aust. 4°–9°, long. occ. $17\frac{1}{2}$°–25°. — Lect. die 1 Mar., et diebus 9, 13 Maii, 1842.

2. UNDINA SIMPLEX. — Frons obtusa. Cephalothorax posticè rotundatus, 5-articulatus, articulo ultimo breviore. Antennæ anticæ corporis longitudine, articulo primo elongato; setis perbrevibus, setâ articuli secundi longiusculâ, flexâ, setis penultimis articuli longitudine et rectis, posticâ antepenultimâ dimidio longiore, apicalibus minutis, unâ uncinatâ.

Long. $\frac{1}{20}''$. — *Hab.* in mari Pacifico, prope insulas "Kingsmill," et lat. bor. 25°, long. orient. 167°. — Lect. die 25 Mar., et die 14 Maii, 1841.

3. UNDINA INORNATA. — Frons rotundata. Cephalothorax posticè vix acutus, 5-articulatus, articulo postico brevi. Antennæ anticæ corporis longitudine, setis perbrevibus, setâ articuli secundi (tertii ?) longiusculâ, rectâ, setâ apicali posticâ articuli longitudine, anticâ penultimâ sublongâ, posticâ brevi, posticâ antepenultimâ articulum vix superante. Styli caudales parcè oblongi.

Long. $\frac{1}{12}''$. — *Hab.* in mari Atlantico, lat. bor. 4°, long. occ. 19°. — Lect die 27 Oct., 1838.

Genus V. CANDACE. (*Dana.*)

Frons quadrata. *Oculi inferiores* obsoleti. *Antennæ anticæ* regulariter et breviter setigeræ, transversæ; dextrâ *maris* articulatione geniculante. *Maxillipedes* (ct. vi.) pedibus proximis majores, duplo geniculantes et inflexi, 4 articulati, setis nudis, longis. *Pedes postici maris* dispares, dextro prehensili. *Abdomen* mediocre. *Styli caudales* breves, setis strictè appressis. [Animal sæpius partim nigrescens.]

Syn. — Candace, *D.*, Amer. Jour. Sci., Ser. 2da, I. 228. 1846.

1. Candace ornata. — *Maris :* Cephalothorax 5-articulatus, articulis posticis quatuor, angulis posticis longè acutis, dextro longiore. Antennæ e basi arcuatæ, alioque rectè transversæ, corpore parcè breviores, articulo secundo paulum oblongo ; setis brevibus, quorum paucis secundo articulo parcè longioribus, apicali posticâ articuli longitudine, posticâ penultimâ paulo longiore, anticâ penultimâ breviore. Antennarum posticarum ramus brevis tenuis, valde brevior. Pes posticus dexter mediocris, articulo ultimo subuncinato, appendice laterali subcorneâ, articulum uncinatum longitudine superante.

Long. $\frac{1}{8}''$. — *Hab.* in mari Atlantico, lat. bor. 9° – 7°, long. occ. 19° – 21° ; etiam lat. aust. 6°, long. occ. 24°. — Lect. diebus 13, 18 Oct., 8 Nov., 1838.

2. Candace pachydactyla. — *Maris :* Cephalothorax 4-articulatus, angulis posticis longè acutis et setâ minutâ extus instructis. Antennæ anticæ fermè corporis longitudine, 23-articulatæ, e basi arcuatæ, deinde rectè transversæ ; dextrâ 21-articulatâ, medio incrassulatâ, articulo geniculationem præcedente valde elongato, et versus apicem subtilissimè pectinato, sequente non breviore. Antennarum posticarum rami longitudine subæqui. Pes posticus dexter crassus, apice rotundatus, appendice laterali crassè falcatâ, obtusâ.

Long. $\frac{1}{12}''$. — *Hab.* in mari Atlantico, lat. aust. 1° – 11°, long. occ. 14° – 30°. — Lect. diebus 7, 9, 13, 16 Maii, 1842.

3. Candace Ethiopica. — *Maris :* *C. ornatæ* antennas anticas et cephalothoracem affinis. Cephalothorax 4-articulatus. Antennæ anticæ e basi arcuatæ ; articulo antennæ dextræ articulationem geniculantem precedente omnino subtilissimè pectinato. Pes posticus dexter subclavatus, obtusus, setâ elongatâ, appendice laterali setaceâ, longâ, corneâ, flexâ. Antennarum posticarum ramus brevis parvus.

Long. $\frac{1}{12}''$. — *Hab.* in mari Pacifico, lat. aust. 18°, long. occ. 124° ; lect. die 8 Aug., 1839 : lat. bor. 15°, long. 180° ; lect. Dec., 1841.

4. Candace curta. — *Maris :* *C. ornatæ* similis. Cephalothorax 5-articulatus, posticè acutus. Pes posticus dexter apice subulatus, appendice laterali curtâ, spiniformi. Antennæ anticæ corpore parcè lon-

giores, a basi arcuatæ; articulis 13, 14, 15, 16, 17 antennæ dextræ incrassulatis, articulo 17 elongato apice prominulo, partim subtilissimè pectinato, sequentibus sex brevibus, et tenuissimis.

Long. $\frac{1}{12}''$. — *Hab.* in mari Pacifico prope "Valparaiso." — Lect. die 10 Ap., 1839.

5. Candace aucta. — *Feminæ:* Cephalothorax 5–6-articulatus, posticè subacutus aut obtusus. Antennæ anticæ fere corporis longitudine, e basi arcuatæ, apice prorsum parcè flexæ, articulo secundo longo et crasso. Abdomen 2–3-articulatum.

Long. $\frac{1}{24}''$. — *Hab.* in mari Pacifico, lat. aust. 9°, long. occ. 174°; etiam prope insulas "Kingsmill"; quoque in mari "Sulu." — Lect. die 26 Jan., 1841; die 14 Ap., 1841; Dec., 1841; die 28 Jan., 1842.

6. Candace truncata. — *Feminæ:* Cephalothorax posticè truncatus. Antennæ anticæ corporis longitudine, prope articulum sextum flexæ, deinde rectè transversæ et tenuissimæ; articulo secundo crasso, non longiore quam articulus tertius quartusve.

Long. $\frac{1}{12}''$. — *Hab.* in mari Pacifico, prope insulas "Samoa" et "Kingsmill," et in mari "Sulu." — Lect. die 25 Mar., et die 1 Ap., 1841; die 2 Feb., 1842.

Genus VI. CYCLOPSINA. (*Milne Edwards.*)

Rostrum furcatum. *Antennæ anticæ* sive rectæ, sive leviter curvatæ, *maris* dextrâ articulatione geniculante. *Maxillipedes* (ct. vi.) pedibus proximis majores, non geniculati, setis longis spinulosis instructi. *Oculi inferiores* nulli. *Cephalothorax* 4–7 articulatus, capite sæpe discreto. *Antennæ posticæ* iisdem *Calani* similes. *Pes posticus dexter maris* grandis et prehensilis. [Maxillipedes, et *maris* antennam anticam dextram pedemque posticum dextrum, *Pontellæ* affinis; antennam posticam, oculos, et habitum, *Calano* similis. *Si oculi inferiores adsunt, species Pontellæ pertinent.*]

Syn. — Cyclopsina (C. castor), *Milne Edwards.* — Cetochilus? *Roussel de Vauzème.* — Monoculus (M. Castor), *Jurine.* — Cyclops (C. castor), *Desmarest.* — Dioptomus (D. castor), *Westwood.* — Non Cyclopsina *Bairdii.*

1. Cyclopsina longicornis. — Frons rotundata. Cephalothorax posticè obtusus, 5-articulatus, articulis posticis æquis. Antennæ anticæ sesqui corporis longitudine, rectiusculæ, setis brevibus, duabus subapicalibus posticis prælongis, subæquis, apicalibus perbrevibus, anticâ penultimâ articuli longitudine. Styli caudales breves.

Long. $\frac{1}{8}''$. — *Hab.* in mari Atlantico, lat. aust. 4°, long. occ. 21°. — Lect. die 7 Nov., 1838. — An *Cetochilo septentrionali* (Goodsir) affinis?

2. Cyclopsina calanina. — Gracilis. Frons triangulata. Cephalothorax posticè obtusus, 6-articulatus, capite vix discreto, articulis posticis æquis. Antennæ anticæ corpore longiores, tenuissimæ, rectiusculæ, apicibus fronte non posteriores; setis brevibus, apicalibus anticis articuli longitudine, subapicalibus totis valde brevioribus; antenna *maris* dextra medio leviter incrassata. Styli caudales elongati, divaricati.

Long. $\frac{1}{10}''$. — *Hab.* in mari Pacifico, prope insulam "El Gran Cocal." — Lect. die 25 Mar., 1841.

3. Cyclopsina tenuicornis. — *Maris:* Frons triangulata. Cephalothorax posticè fere obtusus, 7-articulatus, capite discreto, articulis posticis æquis. Antennæ anticæ corpore longiores, apicibus fronte vix anteriores, tenuissimæ, rectiusculæ, setis brevibus, anticis apicalibus fere articuli longitudine, posticâ penultimâ paulo longiore. Abdomen 3-articulatum. Styli caudales elongati divaricati.

Long. $\frac{1}{16}''$. — *Hab.* in mari Pacifico, prope insulam "Depeyster"; lect. die 22 Mar., 1841. Etiam (?) in Archip. "Paumotu"; lect. Aug. 13, 1839.

4. Cyclopsina gracilis. — *Maris:* Antennæ anticæ corpore valde longiores; abdomen 4-articulatum; aliis *C. tenuicorni* similis.

Long. $\frac{1}{16}''$. — *Hab.* in mari Pacifico, lat. bor. 25°, long. orient. 167°. — Lect. die 14 Maii, 1841. — An var. *C. tenuicornis*.

Genus VII. CATOPIA.

Antennas posticas et antennarum habitum anticarum *Calano* affinis. Antennam anticam *maris* dextram *Pontellæ* affinis. *Oculi* superiores nulli; oculus inferior unicus (?).

Catopia furcata. — Gracilis. Caput quadratum, non discretum. Cephalothorax 4-articulatus, posticè 4-dentatus, dentibus acutis, externis longioribus. Styli caudales oblongi, divaricati. Antennæ anticæ corpore longiores, duplo curvatæ, apicibus fronte non anteriores; setis totis brevibus.

Long. $\frac{1}{16}''$. — *Hab.* in freto "Banka." — Lect. die 2 Mar., 1842.

Genus VIII. ACARTIA. (*Dana.*)

Antennæ anticæ rectiusculæ, flexiles, setis irregulariter diffusis, dextrâ *maris* non geniculante. *Maxillipedes* (ct. vi.) pedibus proximis majores, recti, setis setulosis longis instructi. *Pedes postici* (ct. xii.)

parvuli, uni-articulati, 2 setas divaricatas gerentes. *Oculi* duo inferiores et duo superiores. *Setæ caudales* mediocres.

1. ACARTIA LIMPIDA. — Gracilis. Frons triangulata. Cephalothorax posticè obtusus, 5-articulatus, capite discreto. Antennæ anticæ latè divaricatæ, rectiusculæ, vix corporis longitudine, 7 – 8-articulatæ, articulis ultimis tribus brevibus, precedentibus longis; setis prælongis, penultimâ posticâ dimidio breviore quam apicales. Styli caudales oblongi, tenues.

Long. $\frac{1}{20}''$. — *Hab.* prope Patagoniam. — Lect. diebus 14, 15 Jan., 1839.

2. ACARTIA NEGLIGENS. — Gracillima. Frons triangulata. Cephalothorax angustus, posticè minutè apiculatus, capite fere discreto. Antennæ anticæ fere corporis longitudine, tenuissimæ, latissimè divaricatæ, apicibus fronte paulo anteriores, 7 – 9-articulatæ, articulis tribus ultimis brevibus; setis prælongis, posticâ penultimâ apicales æquante. Styli caudales tenuissimi, oblongi, setis latè divaricatis.

Long. $\frac{1}{16}''$. — *Hab.* in mari Pacifico, prope insulas "Kingsmill," et lat. bor. 28°, long. orient. 171°. — Lect. diebus 15 Ap., et 17 Maii, 1841.

3. ACARTIA TONSA. — Frons rotundata. Cephalothorax posticè obtusus, 6-articulatus, capite discreto. Antennæ anticæ multiarticulatæ, rectæ, apicibus fronte non anteriores, setis plerumque brevibus, paucis longiusculis (3 – 4-articulos simul sumtos longitudine æquantibus). Styli caudales perbreves.

Long. $\frac{1}{18}''$. — *Hab.* in "Port Jackson" Novi-Hollandiæ. — Lect. Mar., 1840.

4. ACARTIA LAXA. — Gracilis. Frons rotundata. Cephalothorax 4-articulatus, capite non discreto, posticè longè acutus. Antennæ anticæ, rectiusculæ, corpore paulo longiores, nusquam fronte anteriores, multiarticulatæ, articulo primo longiore, setis longiusculis, valde inæquis. Abdomen breve. Styli caudales paulum oblongi, setis latissimè diffusis, abdomine non longioribus.

Long. $\frac{1}{15}''$. — *Hab.* in mari "Sulu," et freto "Banka." — Lect. diebus 2 Feb., et 2 Mar., 1842.

Genus IX. PONTELLA.

Rostrum furcatum. *Oculi* duo *superiores*, pigmentis sive coalitis sive remotis; duo *inferiores* coaliti. *Antennæ anticæ* multiarticulatæ, setis non diffusis, antennâ dextrâ *maris* geniculante. *Cephalo-*

thorax 4–7-articulatus, segmento cephalico sæpe discreto. *Maxillipedes* (ct. vi.) grandes, recti, setis longis, setulosis. *Pedes antici* (ct. vii.) minores. *Pes posticus* (ct. xii.) *dexter maris* crassus, prehensilis.

Syn. — Pontia, *Milne Edwards.** — Irenæus, *Goodsir.* — Broteas, *Lovén.*

I. Pontellæ calanoideæ. Antennæ Anticæ duplo curvatæ, ad apices fronte non anteriores. Antennæ Posticæ, ad apicem rami minoris, 3-setigeræ.

1. Pontella elliptica. — *Feminæ :* Frons rotundata. Cephalothorax crassus, 4-articulatus, capite inermis, angulis posticis acutis, remotis. Oculi superiores remotiusculi, inferiores minuti. Antennæ anticæ duplo curvatæ, apicibus fronte valde posterioribus, corpore breviores, setis brevibus, subapicalibus perbrevibus, apicalibus vix articuli longitudine. Styli caudales oblongi, setis valde inæquis. (Cærulea, dorso sæpe argentea.)

Long. $\frac{1}{16}''$. — *Hab.* in freto "Banka." — Lect. die 2 Mar., 1842.

2. Pontella brachiata. — *Maris :* Frons subtriangulata. Cephalothorax 6–7-articulatus anticè angustior, inermis, angulis posticis acutis, remotis. Oculi superiores remotiusculi aut coaliti. Antennæ anticæ corporis longitudine, duplo curvatæ, apicibus fronte non anterioribus, setis brevibus, posticâ penultimâ articulum longitudine fere duplo superante, anticâ apicali breviore, aliis apicalibus et subapicalibus brevioribus ; antenna dextra medio paulum incrassata, fere 23-articulata, duabus articulis medianis anticè unidentatis, articulo antepenultimum præcedente elongato, duplice. Pes posticus dexter maximus, digito elongato, rectè inflexo.

Long. $\frac{1}{12}''$. — *Hab.* in mari Pacifico, lat aust. 42°, long. occ. 78° 45′; lect. die 3 Ap., 1839. In syrtis "Lagulhas"; lect. die 8 Ap., 1842. — *Feminæ* (an ejus speciei ?) frons vix triangulata ; styli caudales divaricati ; abdomen 3-articulatum (*maris* 4) ; anguli postici cephalothoracis divaricati. — Lect. in syrtis "Lagulhas" die 8 Ap., 1842.

II. Antennæ Anticæ ad apices fronte anteriores.

A. *Caput lateribus inerme.*

1. Cephalothorax posticè obtusus aut brevissimè acutus.

3. Pontella plumata. — *Feminæ :* Frons rotundata. Cephalo-

* *Pontia* Papilionum generis vocabulum, itaque *Pontella* hic scripsa.

thorax curtus, obesus, 6-articulatus, capite discreto, segmento postico perbrevi, et posticè vix acuto. Antennæ anticæ corpore paulo longiores, latè divaricatæ, fere rectæ, setis raris sublongis, apicalibus articulo plus duplo longioribus, subapicalibus brevioribus. Antennæ posticæ ramos valde inæquæ, setis ramorum et palporum sequentium fere corporis longitudine, instar plumarum. Styli caudales parce oblongi.

Long. $\frac{1}{12}$. — *Hab.* in mari Atlantico, lat. bor. 5°, long. occ. 21°.

4. PONTELLA TURGIDA. — Frons rotundata. Cephalothorax crassus, obesus, 5 – 6 articulatus, capite discretus, posticè obtusus. Oculi superiores approximati. Antennæ anticæ corporis longitudine, fermè 21-articulatæ, 60° – 90° divaricatæ et prope medium obsoletè reflexæ ; setis brevibus, penultimâ posticâ longiore quam apicales aut aliæ subapicales. Antennæ posticæ ramos valde inæquæ, setis longis. Styli caudales oblongi. — *Maris* antenna antica dextra 10 – 12-articulata, articulo submediano latè subovato et apice acuto, articulis tribus sequentibus valde elongatis, ultimo triplice.

Long. $\frac{1}{24}''$. — *Hab.* in mari *Atlantico*, lat. bor. $8\frac{1}{2}$° – 0°, long. occ. 23° – 18° ; lect. diebus 15, 22, 23, 26 Oct., 1838. Lat. aust. 1° – $4\frac{1}{2}$°, long. occ. $17\frac{1}{2}$° – $21\frac{1}{2}$° ; lect. diebus 5, 6, 7 Nov., 1838. Lat. aust. 4° 30′, long. occ. 25° ; lect. die 13 Maii, 1842. Lat. bor. 0° 15′, long. occ. 31° ; lect. die 17 Maii, 1842. In mari *Pacifico* prope insulas " Kingsmill " ; lect. diebus 13, 28 Ap., 1841. In syrtis " Lagulhas " ; lect. die 8 Ap., 1842.

5. PONTELLA CURTA. — Frons rotundata. Cephalothorax curtus, crassiusculus, 5-articulatus, capite discreto, angulis posticis brevissimè acutis. Antennæ anticæ corpore breviores, rectæ, 105° divaricatæ, setis brevibus, apicali anticâ longiore. Antennæ posticæ ramos valde inæquæ, minore plus dimidio breviore. Styli caudales oblongi, non divaricati.

Long. $\frac{1}{20}''$. — *Hab.* prope insulam " Mindoro " et in freto " Sunda " ; lect. diebus 24 Jan. et 4 Mar., 1842. In syrtis " Lagulhas " ; lect. die 8 Ap., 1842.

6. PONTELLA CONTRACTA. — Frons rotundata. Cephalothorax 6 – 7-articulatus, capite discreto, angulis posticis brevissimè acutis, segmento postico fere obsoleto. Antennæ anticæ cephalothorace non longiores, 100° – 110° divaricatæ, rectæ, fermè 17-articulatæ, setis brevibus, apicali anticâ longiore. Rami antennarum posticarum valde inæqui. Styli caudales elongati. [Abdomen 2-articulatum.]

Long. $\frac{1}{18}''$. — *Hab.* in mari Pacifico, lat. aust. $18\frac{1}{4}$°, long. occ. 121°

30′; lect. die 7 Aug., 1839. An eadem species in mari Atlantico, lat. aust. 2°, long. occ. 20°; lect. die 6 Nov., 1838.

7. Pontella media. — Frons rotundata. Cephalothorax 5-articulatus, segmento postico brevissimo et valde angusto, non acuto, capite vix discreto. Oculi superiores remotiusculi, inferiores parvuli. Antennæ anticæ corporis longitudine, duplo curvatæ, fere transversæ, apicibus fronte anteriores, setis brevibus, rectis, apicalibus articuli longitudine, posticâ penultimâ parce longiore, aliis subapicalibus brevioribus. Styli caudales oblongi. [Abdomen 2-articulatum.]

Long. $\frac{1}{20}''$. — *Hab.* in mari "Sulu"; lect. die 27 Jan., 1842.

8. Pontella crispata. — *Feminæ:* Frons subtriangulata, obtusa. Cephalothorax 7-articulatus, segmento postico brevissimo, obtuso aut subacuto. Oculi superiores remotiusculi, inferiores mediocres. Antennæ anticæ vix corporis longitudine, latè divaricatæ, apicibus fronte valde anterioribus et prorsum curvatis; setis brevibus, prope basin confertis et paucis uncinatis, apicalibus et posticâ antepenultimâ articulo parce longioribus, posticâ penultimâ paulo longiore. Styli caudales parce oblongi, setis subæquis. [Abdomen 4-articulatum.]

Long. $\frac{1}{15}''$. — *Hab.* in mari *Pacifico*, prope insulas "Kingsmill"; lect. diebus 22, 26 Mar., 1841. In mari *Atlantico*, lat. bor. $8\frac{1}{2}$°, long. occ. 23° 45′; lect. die 15 Oct., 1838.

9. Pontella detruncata. — Frons obtusa. Cephalothorax 5–6-articulatus, capite discreto, angulis posticis rectè truncatis et extus brevissimè acutis. Antennæ anticæ 22–24-articulatæ, vix corporis longitudine, late divaricatæ, apicibus fronte valde anterioribus et prorsum curvatis; setis brevibus, rectis, posticâ penultimâ longiore quam apicales vel aliæ subapicales. Styli caudales breves. Antenna dextra *maris*, medio incrassata, subteres, 12–13-articulata, articulo tertio elongato, obsoletè articulato, septimo (octavo?) brevi et subtriangulato duabus sequentibus tenuibus, longis. Pes posticus dexter *maris* crassissimè cheliformis, manu subovatâ, pollice laterali, obtuso, dimidio breviore, digito elongato, tenui et curvato.

Long. $\frac{1}{12}''$–$\frac{1}{16}''$. — *Hab.* in mari Pacifico, lat. aust. 26° 8′, long. occ. 178°; lect. die 18 Ap., 1840. Lat. aust. 5° 20′, long. orient. 175° 30′; lect. die 25 Mar., 1841: etiam prope insulas "Kingsmill."

10. Pontella simplex. — Frons obtusiuscula. Cephalothorax subgracilis, capite obsoletè discreto, segmento postico brevi et perangusto. Oculi superiores, subremoti, inferiores mediocres. Antennæ anticæ

cephalothorace breviores, 9-articulatæ, 100° divaricatæ; setis totis brevibus. Styli caudales elongati. [Abdomen 2-articulatum. An specimen adultum ?]

Long. $\frac{1}{20}''$. — *Hab.* in mari Pacifico, lat. aust. 32° 24′, long. orient. 178°. — Lect. die 9 Ap., 1840.

11. Pontella exigua. — Gracilis. Frons obtusa. Cephalothorax 6-articulatus, capite discreto, segmento postico brevi, obtuso. Oculi inferiores maximi, valde elongati, subclaviformi. Antennæ anticæ corpore valde breviores, 120° (?) divaricatæ, setis perbrevibus, apicali anticâ longiore, subapicalibus brevibus. Antennæ posticæ tenues, ramo majore plus duplo longiore. Styli caudales oblongi. [An adultum? Abdomen 2-articulatum.]

Long. $\frac{1}{30}''$. — *Hab.* in mari Atlantico, lat. bor. $7\frac{1}{2}$° et $4\frac{3}{4}$°, long. occ. $23\frac{3}{4}$° et 19°; lect. diebus 16, 24 Oct., 1838.

2. Cephalothorax posticè productus et acutus.

* *Seta antennarum anticarum apicalis setis subapicalibus brevior.*

12. Pontella agilis. — *Feminæ : P. crispatæ* antennas similis. Anguli postici cephalothoracis acuti, fronte rotundatâ. Setæ antennarum anticarum fere rectæ prope basin confertæ. — Forsan *P. crispatæ* cephalothorax interdum posticè acutus et species non differt.

Long. $\frac{1}{8}''$. — *Hab.* in mari Atlantico, lat. aust. $19\frac{1}{2}$°, long. occ. $38\frac{3}{4}$°; lect. die 17 Nov., 1838: etiam (?) lat. bor. $9\frac{1}{4}$°, long. occ. 24° 18′.

13. Pontella acutifrons. — *Maris : P. crispatæ* et *agili* similis. Anguli postici cephalothoracis acuti. Frons acuta et prominens; rostro longissimè furcato et valde inflexo. Setæ antennarum anticarum rectæ, prope basin fere articuli secundi longitudine, posticâ penultimâ plus duplo longiore quam apicales. Antenna dextra medio incrassulata, subteres 12–13-articulata; articulis secundo et quinto æquis, septimo brevissimo, octavo valde elongato, subattenuato, recto, fere duplo longiore quam nono; nono ad apicem anticam instar spinæ valde producto; articulis sequentibus (ultimis) tribus, normalibus. Pes posticus dexter latissimè cheliformis, manu subquadratâ, pollice breviter spiniformi, digito recto, apice minuto inflexo, valde breviore quam manus.

Long. $\frac{1}{7}''$. — *Hab.* in mari Pacifico, prope insulam "El Gran Cocal," lat. aust. 5° 40′, long. orient. 175° 30′; etiam prope insulas "Kingsmill"; lect. diebus 25 Mar., 1 Ap., 1841.

14. Pontella acuta. — Frons longè acuta, rostro brevi, vix inflexo.

Cephalothorax 5-articulatus, capite discreto, angulis posticis elongatis, acutis. Oculi superiores remoti, inferiores parvi. Antennæ anticæ subtransversæ, fere corporis longitudine, fermè 21–22-articulatæ, apicibus fronte paulo anterioribus, et prorsum leviter curvatis, setis prope basin confertis longiusculis, posticâ penultimâ duplo longiore quam articulus, apicalibus et aliis subapicalibus brevioribus. Styli caudales oblongi. Antenna dextra *maris* subteres, fermè 13-articulata, articulo secundo longo, 6 sequentibus brevibus, proximis duobus elongatis et tenuibus, parce arcuatis, subæquis, 3 proximis (ultimis) normalibus. Pes posticus dexter *maris* latus, manu apice late orbiculatâ, pollice nullo, digito vix manus longitudine, paulum inflexo. [Cyanea. Abdomen 4-articulatum.]

Long. $\frac{1}{10}''$. — *Hab.* prope insulam "Mindoro"; lect. die 24 Jan., 1842. In mari Sinensi; lect. die 15 Feb., 1842.

† *Seta antennarum anticarum apicalis subapicalibus longior.*

15. Pontella rubescens. — *Feminæ:* Frons rotundata. Cephalothorax 6-articulatus, capite discreto, segmento septimo obsoleto, angulis posticis acutis. Oculi superiores remoti; inferiores pigmentum bilobati. Antennæ anticæ fere 120° divaricatæ et rectæ; setis brevibus, apicali vix longiore quam articulus. Ramus major antennarum posticarum fere triplo longior. Styli caudales elongati, paralleli. [Abdomen 3-articulatum.]

Long. $\frac{1}{15}''$. — *Hab.* in mari Pacifico, prope insulam "Upolu"; lect. die 24 Feb., 1841. Prope insulam "El Gran Cocal"; lect. die 25 Mar., 1841.

16. Pontella emerita. — *Feminæ:* Crassa. Frons obtusa. Cephalothorax 6–7-articulatus, capite discreto, angulis posticis longè acutis, segmento postico brevi. Oculi superiores remoti. Antennæ anticæ cephalothorace vix longiores, fermè 100° divaricatæ, rectæ. Ramus major antennarum posticarum fere quadruplo longior. Styli caudales breves. [Abdomen 2-articulatum segmentis subæquis.]

Long. $\frac{1}{10}''$. — *Hab.* in mari prope Promontorium Bonæ Spei; lect. die 12 Ap., 1842.

17. Pontella regalis. — *Feminæ:* Crassissima. Frons rotundata. Cephalothorax 5–6-articulatus, angulis posticis longè acutis, capite discreto brevi. Oculi superiores remoti, inferiores parvi. Antennæ anticæ cephalothorace breviores, 100°–110° divaricatæ, duplo leviter curvatæ. Ramus major antennarum posticarum quadruplo longior.

Styli caudales brevissimi. [Abdomen 2-articulatum, segmento secundo brevi.]

Long. $\frac{1}{7}''$. — *Hab.* in mari "Sulu"; lect. die 27 Jan., 1842.

18. Pontella perspicax. — Frons rotundata. Cephalothorax 6-articulatus, capite discreto, segmento postico non breviore, angulis posticis longè acutis. Oculi inferiores grandes et prorsum valde elongati. Antennæ anticæ corpore valde breviores, 100° – 110° divaricatæ, fermè 21-articulatæ, ante medium obsoletè flexæ. Styli caudales elongati. Antenna antica dextra *maris* 9 – 10-articulata, articulo quarto lato, subovato. Pes posticus dexter vix crassus; manu angustâ, breviusculâ, digito vix longiore acuminato, pollice setiformi, longissimo, reflexo. [Abdomen 5-articulatum.]

Long. $\frac{1}{12}''$. — *Hab.* in mari Atlantico, lat. aust. 0° 40′, long. occ. 18°; lect. die 3 Nov., 1838. Forsan, lat. bor. 7° 25′, long. occ. 20°; lect. die 17 Oct., 1838.

19. Pontella strenua. — *Maris :* Frons acutiuscula. Cephalothorax 5 – 6-articulatus, angulis posticis longe acutis, capite discreto. Oculi superiores remoti, inferiores mediocres. Antennæ anticæ fere corporis longitudine, 80° – 90° divaricatæ, 17 – 18 articulatæ, ad medium obsoletè flexæ. Ramus major antennarum posticarum fere triplo longior. Styli caudales breves. Antenna antica dextra *maris* 12 – 14-articulata, articulo mediano subovato, apice antico acuto. Pes posticus dexter crassiusculus, manu ovali, breviore quam carpus, pollice tenuissimo, acuto, parcè longiore, digito mediocri, subulato, rectiusculo. [Abdomen 5-articulatum.]

Long. $\frac{1}{12}''$. — *Hab.* in mari Pacifico, lat. aust. 3°, long. orient. 175°.

20. Pontella protensa. — *Maris :* Crassa. Frons rotundata. Cephalothorax 5 – 6-articulatus, capite discreto, brevi, angulis posticis longè acutis. Oculi superiores remoti, inferiores mediocres. Antennæ anticæ basi vix 60° divaricatæ et medio fere 70°. Ramus antennarum posticarum major plus quadruplo longior. Styli caudales oblongi. Antenna *maris* antica dextra *P. strenuæ* similis. [Abdomen 5-articulatum.]

Long. $\frac{1}{16}''$. — *Hab.* in fretis "Banka" et "Sunda"; lect. diebus 1, 4 Mar., 1842.

B. *Caput lateribus armatum.*

21. Pontella hebes. — *Feminæ :* Frons truncata. Cephalothorax 4-articulatus, posticè rotundatus. Oculi superiores disjuncti, infe-

riores parvi. Antennæ anticæ fere corporis longitudine, transversæ, apicibus fronte paulo anterioribus, prorsum parce curvatis, prope basin setis confertis longiusculis, et unâ sublongâ mobili. Setis apicalibus articuli longitudine, posticâ penultimâ paulo longiore, aliis subapicalibus brevibus. Styli caudales vix oblongi. [Abdomen 3-articulatum.]

Long. $\frac{1}{16}''$. — *Hab.* prope insulam "Sumatra"; lect. die 3 Mar., 1842.

22. Pontella frivola. — *Feminæ P. hebetis* similis. Sed cephalothorax posticè acutus; abdomen 4-articulatum. An species differt? — *Long.* $\frac{1}{16}''$. *Hab.* prope insulam "Sumatra"; lect. die 3 Mar., 1842.

Maris (an hæc species?) antenna antica dextra 9-articulata, subteres, incrassulata, articulis 2, 3, 4, 5, 6 totis longis, 3 sequentibus (ultimis) normalibus, articulo quarto longiore et crassiore, subcylindrico. Antennæ posticæ tenuissimæ, ramis fere æquis. Abdomen 4-articulatum, tenue; stylis parce oblongis. Anguli postici cephalothoracis acuti, dextro longiore. — *Long.* $\frac{1}{12}''$. *Hab.* in mari "Sulu"; lect. die 28 Jan., 1842.

23. Pontella detonsa. — Caput discretum, subtriangulatum, fronte obtusiusculâ. Cephalothorax 7-articulatus, segmento septimo brevissimo, posticè obtuso aut obtusiusculo. Oculi superiores remoti, inferiores subgrandes, vix elongati. Antennæ anticæ cephalothorace breviores, rectæ, fere 100° divaricatæ, 20–22-articulatæ, setis totis perbrevibus. Styli caudales elongati, vix divaricati. Antenna dextra *maris* paululum incrassata, teretiuscula, fermè 20-articulata. [Cyanea; interdum dorso margaritacea. Abdomen 3-articulatum.]

Long. $\frac{1}{8}''-\frac{1}{15}''$. — *Hab.* in mari Pacifico, lat. aust. 18° 10′, long. occ. 125° 20′; lect. die 8 Aug., 1839. Lat. aust. 12° 45′, long. occ. 171°; lect. die 5 Feb., 1841. Lat. aust. 11°, long. occ. 170°; lect. die 1 Feb., 1841. Lat. aust. 5° 30′, long. orient. 175° 50′, prope insulam "El Gran Cocal"; lect. die 25 Mar., 1841. Prope insulam "Mindoro"; lect. die 24 Jan., 1842.

24. Pontella argentea. — Caput discretum, subtriangulatum, fronte obtusum. Cephalothorax 5 (–6)-articulatus, posticè brevissimè acutus articulis tribus posticis subæquis. Oculi superiores remoti, inferiores subgrandes non elongati. Antennæ anticæ cephalothorace breviores, fere 90° divaricatæ et levissimè incurvatæ, 18–20-articulatæ, setis totis perbrevibus, duabus apicalibus subuncinatis. Styli caudales parce oblongi. [Viridescens, dorso argentea. Abdomen 3-articulatum.]

Long. $\frac{1}{12}''$. — *Hab.* in mari Atlantico, lat. aust. 40° 35′, long. occ. 60°, prope "Rio Negro." — Lect. die 24 Jan., 1839.

25. Pontella speciosa. — Caput discretum, subtriangulatum, fronte obtusum. Cephalothorax 5–7-articulatus, posticè acutus aut obtusiusculus. Oculi superiores remoti, inferiores mediocres. Antennæ anticæ cephalothoracis longitudine, fere rectæ, prope 110° divaricatæ, 21–22-articulatæ; setis brevibus, apicali anticâ et penultimâ posticâ longioribus, articulum paulo superantibus. Styli caudales oblongi. Antenna dextra *maris* pauci-articulata, articulo quinto latè ovato. Pes posticus dexter *maris* crassus, manu latâ apice truncatâ et obtusè dentatâ, pollice e basi manus producto, elongato, spiniformi, digito prælongo, incurvato. [*Maris* cephalothorax 6-articulatus, et abdomen 4-articulatum; color viridis, dorso argenteus. *Feminæ* cephalothorax 7-articulatus, segmento ultimo brevissimo; abdomen 3-articulatum; color ochreus, medio lætè ruber.]

Long. $\frac{1}{12}''$. — *Hab.* prope fretum Sundæ; lect. die 4 Mar., 1842.

26. Pontella princeps. — *Feminæ:* Caput discretum, subtriangulatum, fronte obtusiusculum. Cephalothorax 6-articulatum, posticè longè acutus, articulis tribus posticis subæquis. Oculi superiores remoti; inferiores mediocres parce elongati. Antennæ anticæ cephalothorace parce breviores, rectiusculæ, fermè 110° divaricatæ, setis brevibus, apicali anticâ longiore. Styli caudales perbreves. [Cyanea, dorso margaritacea. Abdomen 4-articulatum, distortum.]

Long. $\frac{1}{4}''$. — *Hab.* in mari Pacifico, prope insulam "Tongatabu"; lect. die 29 Mar., 1840.

27. Pontella fera. — Caput vix discretum, subtriangulatum, fronte rotundatum. Cephalothorax 6–7-articulatus, posticè obtusus aut obtusiusculus, segmento postico brevissimo. Oculi superiores remoti, inferiores grandes, non elongati. Antennæ anticæ vix cephalothoracis longitudine, fermè 21-articulatæ, 130° divaricatæ, setis prope basin sublongis, confertis, aliis brevibus, apicali anticâ et penultimâ posticâ articulo vix longiore. Styli caudales elongati, divaricati. Antenna antica dextra *maris* subteres 11–12-articulata, articulo secundo longo, tertio brevissimo, quarto sub quintum producto, proximo spinam inversam ferente. Pes posticus dexter *maris* tenuis, manu subcylindricâ, digito tenuissimo, ad apicem spatulato et concavo.

Long. $\frac{1}{12}''$. — *Hab.* in mari Pacifico, lat. aust. 11° – 12° 45′, long. occ. 170° – 171°; lect. diebus 1, 5 Feb., 1840.

Familia IV. CORYCÆIDÆ.

Oculi duo grandes plus minusve remoti, lenticulis duabus prolatis maximis, et corneis oblatis instar conspicillorum, constructi; quoque duo oculi connati minutissimi. *Antennæ anticæ* pauci-articulatæ, simplicissimæ. *Antennæ posticæ* simplicissimæ. *Pedes mandibulares maxillaresque* brevissimi. *Sacculi ovigeri* duo.

Genus I. CORYCÆUS.

Corpus crassum, anticè rotundatum. *Conspicilla* fronte affixa. *Antennæ posticæ* pedibus anticis majores. *Pedes antici* sexu vix dissimiles digito subuncinato tenuique confecti. *Abdomen* pauci-articulatum, appendicibus basi nullis, stylis caudæ styliformibus.

1. ANTENNÆ POSTICÆ MACRODACTYLÆ, DIGITO NON BREVIORE QUAM CARPUS.*

A. *Setæ caudales stylis valde breviores.* [*Cephalothorax posticè* (*ad segmentum tertium*) *acutus, segmento quarto minore.*]

1. CORYCÆUS GRACILIS. — Cephalothorax gracilis, ventre non carinato. Antennæ anticæ breviter setulosæ. Conspicilla fere contigua. Antennarum posticarum carpus digito brevior, setâ longâ, setulosâ. Abdomen uni-articulatum, apice subcylindrico fere triplo longius, basi angustum. Styli caudales abdomine breviores, setis brevissimis.

Long. $\frac{1}{30}''$. — *Hab.* in mari Atlantico, lat. bor. 1° 30′, long. occ. 18° 20′, et lat. aust. 2° 20′, long. occ. 20°.

2. CORYCÆUS DECURTATUS. — Cephalothorax ventre carinatus. Antennæ anticæ breviter setulosæ. Conspicilla fere contigua. Antennarum posticarum carpus digito brevior setâ nudâ elongatâ, etiam setâ alterâ setulosâ breviore. Abdomen basi crassum, apice subcylindrico fere quadruplo longius. Styli caudales vix dimidii abdominis longitudine, setis brevissimis.

Hab. in mari Pacifico, prope insulam "Duke of Clarence."

3. CORYCÆUS DEPLUMATUS. — Conspicilla remotiuscula. Antennæ anticæ brevissimè setulosæ, 7-articulatæ. Antennarum posticarum car-

* *Carpus* est articulus elongatus antennarum posticarum secundus (aut primus et secundus simul sumti). *Digitus* articulis tertio quartoque compositus, plus minusve discretis. Carpus setâ longâ sive nudâ sive setulosâ ad basin ornatus, et sæpe unâ duabusve lateralibus aut apicalibus.

pus digito brevior, setâ setulosâ longâ, et aliâ nudâ. Abdomen uni-articulatum, tenue. Styli caudales vix dimidii abdominis longitudine; setis plus dimidio brevioribus.

Hab. in mari Atlantico, lat. bor. 9° 20′, long. occ. 24° 15′.

4. CORYCÆUS VARIUS. — Cephalothorax crassus. Conspicilla remotiuscula. Antennæ anticæ longè setulosæ. Antennarum posticarum carpus digito brevior, setâ longâ, nudâ. Abdomen 2-articulatum, segmento secundo cylindrico, breviore quam primum. Styli caudales abdomine paulo breviores, setis dimidio brevioribus.

Long. $\frac{1}{20}''$. — *Hab.* in mari Atlantico, lat. bor. 7° 25′, long. occ. 22°; lat. aust. 1° – 7°, long. occ. 18° – 21°. In mari Pacifico, lat. aust. 15° 30′, long. occ. 138° 30′; lat. aust. 33°, long. orient. 153° 30′, prope Australiam; quoque prope insulas "Ladrones."

5. CORYCÆUS LONGISTYLIS. — Cephalothorax crassus. Conspicilla remotiuscula. Antennæ anticæ longè setulosæ. Antennarum posticarum carpus digito vix brevior, ad apicem internum dentiformis, nudus et acutus, setâ basali longâ, nudâ; digito setam nudam ad basin ferente. Abdomen uni-articulatum, dimidio apicali cylindrico. Styli caudales tenues, abdomine valde longiores, setis perbrevibus.

Long. $\frac{1}{10}''$. — *Hab.* in mari Sinensi.

B. *Setæ caudales stylis non valde breviores, sæpe longiores.*

* Cephalothorax posticè obtusus.

6. CORYCÆUS OBTUSUS. — Conspicilla lata. Antennæ anticæ tenues, setis longiusculis. Antennarum posticarum carpus digito non brevior, setâ longâ nudâ. Abdomen 2-articulatum, subtus ad basin apiculatum, segmento secundo dimidium primi longitudine superante. Styli caudales dimidii abdominis longitudine, setis stylo parce longioribus.

Long. $\frac{1}{30}''$. — *Hab.* in mari Pacifico, prope insulam "El Gran Cocal."

† Cephalothorax posticè acutus.

7. CORYCÆUS CRASSIUSCULUS. — Cephalothorax crassiusculus, segmento quarto posticè subacuto. Conspicilla contigua. Antennarum posticarum carpus digito vix brevior, setâ nudâ. Abdomen uni-articulatum, apice subcylindrico fere dimidio breviore quam pars basalis elliptica. Styli caudales dimidium abdominis longitudine superantes, setis paulo longioribus.

Long. $\frac{1}{20}''$. — *Hab.* in mari "Sulu," prope insulam "Panay."

8. Corycæus laticeps. — Cephalothorax crassus, segmento quarto breviter acuto. Conspicilla remotiuscula. Antennæ anticæ 7-articulatæ, setis dimidio brevioribus. Antennarum posticarum carpus digito paulo brevior, setâ longâ, nudâ. Abdomen 2-articulatum; segmento secundo cylindrico, dimidio breviore. Styli caudales dimidio abdominis breviores, setis parce longioribus.

Long. $\frac{1}{20}''$. — *Hab.* in mari Atlantico, lat. bor. 4° – 5°, long. occ. 19° – 22°, et lat. aust. 0° 15′ – 1°, long. occ. 18° 30′, et 31°.

9. Corycæus vitreus. — Cephalothorax crassus, segmento quarto brevissimè acuto. Conspicilla remotiuscula. Antennæ anticæ longè setulosæ. Antennarum posticarum carpus digito vix brevior, setâ nudâ, longâ. Abdomen 2-articulatum, apice cylindrico brevi. Styli caudales dimidii abdominis longitudine, setis stylos paulum superantibus.

Long. $\frac{1}{15}''$. — *Hab.* in mari Pacifico, lat. aust. 18°, long. occ. 124° 30′.

10. Corycæus agilis. — Cephalothorax crassiusculus, segmento quarto subrectangulato. Conspicilla remotiuscula. Antennæ anticæ breviter setulosæ. Antennarum posticarum carpus digito paulo brevior, setâ longâ, nudâ. Abdomen 2-articulatum, crassum, segmento secundo tenuiter subcylindrico, paulo breviore quam primum. Styli caudales tenuissimi, dimidio abdominis longiores, setâ paulo breviore.

Long. $\frac{1}{30}''$. — *Hab.* in mari Pacifico, prope insulam "Tongatabu."

11. Corycæus orientalis. — Cephalothorax crassus, segmento quarto rectangulato, subacuto. Conspicilla remota. Antennæ anticæ breviter setulosæ. Antennarum posticarum carpus digito paulo longior, setâ longâ, nudâ, digito articulis duabus subæquis composito. Abdomen 2-articulatum, ad basin infra rectangulatum. Styli caudales breves, setis vix longioribus.

Long. $\frac{1}{20}''$. — *Hab.* in mari "Sulu," prope insulam "Panay."

2. Antennæ Posticæ microdactylæ, digitus carpo brevior.

A. *Seta carpi antennarum posticarum nuda.*

* Styli caudales abdomine non breviores.

Digitus carpo paulo brevior.

12. Corycæus lautus. — Cephalothorax ad segmentum quartum obtusus. Conspicilla remotiuscula. Antennæ anticæ longissimè setulosæ. Antennarum posticarum carpus digito paulo longior, setâ longâ, nudâ, digito subæquè 2-articulato, et ad basin setam nudam longam fe-

rente. Abdomen 2-articulatum, segmentis fere æquis. Styli caudales tenuissimi, abdomine valde longiores, setis perbrevibus.

Long. $\frac{1}{15}''$. — *Hab.* in mari Pacifico, prope insulas "Kingsmill."

Digitus carpo valde brevior, uncinatus.

13. Corycæus speciosus. — Cephalothorax ad segmentum quartum longè acutus. Conspicilla non contigua. Antennæ anticæ setis longissimæ. Abdomen 2-articulatum, articulo primo crasso, secundo cylindrico, dimidio breviore. Styli caudales abdomine longiores, divaricati, setis brevibus. [Pedes biremes 4 posteriores utrinque protensi.]

Long. $\frac{1}{16}''$. — *Hab.* in mari Atlantico, lat. bor. 5° – 7°, long. occ. 21° – 22°.

14. Corycæus remiger. — Cephalothorax ad segmentum quartum longè acutus. Conspicilla remota, parvula. Antennæ anticæ setis longissimæ. Abdomen 3-articulatum, segmento ultimo subito angustiore, cylindrico. Styli caudales fermè abdominis longitudine, divaricatæ, setis stylo paulo brevioribus. (*C. specioso* pedes biremes similis.)

Long. $\frac{1}{15}''$. — *Hab.* in mari Atlantico, lat. aust. 11°, long. occ. 29°.

† Styli caudales abdomine breviores. [Cephalothorax posticè (ad segmentum tertium) longè acutus.]

15. Corycæus latus. — Cephalothorax crassus, segmento quarto posticè longè acuto. Conspicilla remota. Antennæ anticæ mediocriter setigeræ. Abdomen crassum, posticè attenuatum, segmento ultimo subcylindrico. Styli caudales dimidio abdominis breviores, divaricati, setis paulo longioribus.

Long. $\frac{1}{24}''$. — *Hab.* in mari Atlantico, lat. bor. 3° 45′ – 4° 20′, long. occ. 19° 30′ – 18° 30′; etiam lat. aust. 6° 20′, long. occ. 24°.

16. Corycæus venustus. — Cephalothorax mediocris, segmento quarto breviter acuto. Conspicilla remotiuscula. Antennæ anticæ longè setigeræ. Antennarum posticarum carpus digito fere duplo longior, apice interno dentiformi, setâ longâ, nudâ, digito subæque 2-articulato. Abdomen 2-articulatum, segmento primo paulo latiore et longiore. Styli caudales abdomine paulo breviores, divaricatæ, setis abdominis longitudine.

Long. $\frac{1}{16}''$. — *Hab.* in mari Pacifico, prope insulas "Kingsmill."

B. *Seta carpi antennarum posticarum setulosa.* [*Cephalothorax posticè longè acutus.*]

17. Corycæus pellucidus. — Cephalothorax gracilis, ventre max-

imè carinato. Conspicilla fere contigua. Antennæ anticæ 7-articulatæ, setis fere brevibus. Antennarum posticarum carpus ad apicem internum apiculatus, digito brevi. Abdomen 1-articulatum, apice obliquè truncato. Styli caudales dimidio abdominis longiores, setis vix majoribus.

Long. $\frac{1}{25}''$. — *Hab.* in mari Atlantico, lat. bor. 4° – 7°, long. occ. 19° 30′ – 21° 30′; quoque lat. aust. 2° 20′, long. occ. 20°.

18. Corycæus concinnus. — *C. pellucido* similis. Cephalothorax paulo crassior; abdomen gracilius; styli breviores, dimidium abdominis longitudine non superantes. Antennæ anticæ 3-articulatæ.

Long. $\frac{1}{25}''$. — *Hab.* in mari Pacifico, lat. aust. 15° 35′, long. occ. 138° 30′; quoque leucas 80 ab insulâ "Tongatabu" versus austrum.

19. Corycæus productus. — Antennæ anticæ 5 – 7-articulatæ, brevissimè setulosæ. Antennarum posticarum carpus ad apicem acutus, et digitus brevis, 3-articulatus. Abdomen elongatum, ad apicem oblique non truncatum. Styli caudales dimidio breviores, setis stylo paulo longioribus.

Long. $\frac{1}{30}''$. — *Hab.* in mari Atlantico, lat. bor. 8° 35′, long. occ. 23° 40′.

20. Corycæus longicaudatus. — Cephalothorax mediocris, segmento quarto longè acuto. Conspicilla fere contigua. Antennæ anticæ 7-articulatæ, setis longiusculis, antennâ brevioribus. Antennarum posticarum carpus ad apicem internum acutus, et digitus parvulus, 3-articulatus. Abdomen mediocre, subellipticum. Styli caudales longiores, setis dimidio brevioribus.

Long. $\frac{1}{18}''$. — *Hab.* in mari Atlantico, lat. bor. 5° – 0° 50′, long. occ. 18° – 20°; quoque lat. aust. 2° 20′, long. occ. 20°.

Genus II. ANTARIA.

Corpus crassum, anticè rotundatum. *Conspicilla* fronte affixa. *Antennæ posticæ* parvæ, ad apicem breviter setigeræ, pedibus anticis (ct. vii.) non majores, carpo posticè angulato. *Pedes antici* sexu vix dissimiles (?), digito tenui subuncinato. *Abdomen* pauci-articulatum. [Cephalothorax posticè obtusus.]

1. Antaria crassimana. — Pedes antici pervalidi, antennis posticis valde majores, articulo secundo abdomen longitudine fere æquante. Abdomen 3-articulatum, segmentis primo tertioque perbrevibus. Styli caudales abdomine triplo et setæ duplo breviores.

Long. $\frac{1}{30}''$. — *Hab.* in mari Atlantico, lat. bor. 1°, long. aust. 18°.

2. Antaria gracilis. — Conspicilla remota. Pedes antici mediocres, antennis posticis paululo majores. Abdomen sensim attenuatum. Styli caudales abdomine quadruplo breviores, setis dimidio abdominis longioribus.

Long. $\frac{1}{20}''$. — *Hab.* in mari Atlantico, lat. bor. 5° – 7°, long. occ. 21° – 22° ; lat. aust. 2° 20′, long. occ. 20°.

3. Antaria obtusa. — Conspicilla remota, parvula. Pedes antici parvuli, antennis posticis paululo majores. Abdomen sensim attenuatum, apice obsoletè 3-articulatum. Styli caudales dimidio abdominis paulo breviores, setis longiores. Cephalothorax posticè rotundatus.

Long. $\frac{1}{20}''$. — *Hab.* in mari "Sulu," prope insulam "Panay."

Genus III. COPILIA.

Corpus depressum, fronte latè quadratum, et conspicilla ad angulos anticos gerens. *Antennæ posticæ* digitiformes, digito elongato, subulato. *Abdomen* pauci-articulatum appendicibus ad basin nullis.

1. Copilia mirabilis. — Cephalothorax fronte latus, parce excavatus posticè paulo latior, segmentis posticis latere obtusis, posticè ad apicem dorsalem spinigero. Antennæ posticæ ad articulum primum setulosæ, digito longo. Abdomen tenue, cephalothoracis dimidio brevius, obsoletè 5-articulatum. Styli abdomine longiores, tenuissimi.

Long. $\frac{1}{16}''$. — *Hab.* in mari Pacifico, prope insulas "Kingsmill."

2. Copilia quadrata. — Cephalothorax anticè bene quadratus, fronte parce excavatus, segmentis latere obtusis, postico brevissimo. Abdomen 4-articulatum, tenue, segmentis secundo tertioque non longioribus quam primum, quarto dimidium abdominis longitudine superante et lateribus parce excavato. Styli abdomine longiores, tenuissimi.

Hab. in mari Pacifico, lat. aust. 15° 20′, long. occ. 148° ; quoque lat. bor., prope long. orient. 165°.

Genus IV. SAPPHIRINA.

Corpus depressum. *Sexus* antennas posticas stylosque caudales similes, et abdomen, pedesque antici (*vel* maxillipedes, ct. vii.) dissimiles. *Antennæ posticæ* pediformes, digito tenui, 2-articulato, ad apicem unguiculato. *Abdomen feminæ* 5 – 6-articulatum, thorace subito angustius, appendices breves ad basin latere gerens ; *maris* 4 – 5-articulatum, thorace subito non angustius, appendicibus nullis.

Pedes antici maris digitum elongati, *feminæ* breves. *Styli* caudales laminati. — *Mares* sæpe lætè opalini aut fulgidè metallini, interdum cærulei. *Feminæ* sæpius incoloratæ, plus minusve pellucidæ; interdum opacæ et azuleæ.

1. *Conspicilla conjuncta.*

1. Sapphirina iris. — Antennæ posticæ abbreviatæ, digito dimidii carpi longitudine. Lamellæ caudales tenuiter falciformes, divaricati; setis tribus, duabus apicalibus dimidio styli longioribus, alterâ externâ. — *Feminæ:* Corpus gracillimum valde elongatum (latitudine maximâ plus quintuplo longius). Conspicilla fronte insita. Abdomen 6-articulatum, segmento primo sequentibus vix angustiore. *Maris:* Corpus lineari-ellipticum, anticè rotundatum. Conspicilla inferiora, fronte remotiuscula.

Long. $\frac{1}{3}''$. — *Hab.* in mari Pacifico, lat. aust. 41°, long. occ. 76° 24′.

2. Sapphirina angusta. — Digitus antennarum posticarum carpo valde (non duplo) brevior. Lamellæ caudales elongatæ, subovatæ, ad apicem internum prominulo, subacuto; setis quatuor, duabus apicalibus dimidio lamellæ brevioribus, aliis duabus externis brevioribus. — *Feminæ:* Corpus valde elongatum (latitudine maximâ fere quadruplo longius). Conspicilla fronte insita. Abdomen 6-articulatum, segmento primo angustiore, tertio, quarto, quintoque lunatis et latus acutis, primo secundoque fere æquis.

Long. $\frac{1}{8}''$. — *Hab.* in mari Pacifico, lat. aust. 43°, long. occ. 78° 45′; etiam ad syrtas "Lagullas," lat. aust. 35° 50′, long. orient. 23°.

3. Sapphirina elongata. — Digitus antennarum posticarum tenuis, dimidio brevior quam carpus. Lamellæ caudales latæ, breviter ovatæ, apice interno vix prominulo, setis quatuor, totis dimidio lamellæ breviores. — *Feminæ:* Corpus angustè elongatum, valde convexum. Conspicilla fronte insita. Abdomen 5-articulatum, segmento primo parvulo, secundo majore sed valde minore quam sequens, sublunato.

Long. $\frac{1}{10}''$. — *Hab.* in mari Pacifico, lat. bor. 15°, long. orient. 179°.

4. Sapphirina metallina. — Lamellæ caudales fere rectangulatæ, apice subtruncatæ, setis quatuor apicalibus subæquis, parcè brevioribus quam lamellæ. — *Maris:* Corpus valde depressum, angustato-ellipticum, 9-articulatum, segmento ultimo tecto, primo oblongo, quarto dimidio breviore quam quintum.

Long. $\frac{1}{10}''$. — *Hab.* in mari Pacifico, prope insulas "Kingsmill."

5. Sapphirina coruscans. — Digitus antennarum posticarum paulo

brevior quam carpus, tenuis, unguiculo elongato. Lamellæ caudales subovatæ, ad apicem rotundatæ, apice interno setam brevem gerente, setis aliis quatuor, totis brevibus (lamellâ fere quadruplo brevioribus). — *Maris :* Corpus depressum, elongato-ovatum, posticè angustatum, segmento primo (fere duplice) parce oblongo, aliis segmentis fere similibus. Conspicilla fronte insita, prominentia.

Long. $\frac{1}{16}''$. — *Hab.* in mari Pacifico, lat. aust. 18° 10′, long. occ. 125° 30′.

6. Sapphirina inæqualis. — Digitus antennarum posticarum carpo non brevior, tenuis, unguiculo brevi. Lamellæ caudales oblongæ, subovatæ, apice interno prominulo, subacuto, setis quatuor, setis dimidio lamellæ non longioribus. — *Feminæ :* Corpus longè ovatum, segmentis cephalothoracis tribus ultimis dissimilibus, segmento ultimo breviore et latere acuto, penultimo obtuso. Conspicilla fronte insita. Abdomen 6-articulatum, segmento primo fere obsoleto aut tecto, secundo posticè acuto.

Long. $\frac{1}{12}''$. — *Hab.* in mari Pacifico, lat. aust. 43°, long. occ. 78° 45′.

7. Sapphirina ovata. — Digitus antennarum posticarum fermè longitudine carpi, articulis duabus digiti subæquis. Lamellæ caudales graciles, lanceolatæ, parce divaricatæ ; setis 4 – 5, unâ internâ, unâ aut duabus apicalibus, et aliis duabus externis, totis dimidio lamellæ valde brevioribus. — *Feminæ :* Corpus valde depressum. Cephalothorax ovatus, segmento antico paulo oblongo, segmentis duobus ultimis latere rotundatis, ultimo angustiore. Conspicilla fronte insita. Abdomen elongato-ellipticum, 5-articulatum, segmento primo non angustiore. — Rubescens.

Long. $\frac{1}{12}''$. — *Hab.* in freto "Balabac," prope insulam "Borneo."

8. Sapphirina splendens. — Digitus antennarum posticarum tenuis, carpo vix brevior. Lamellæ caudales ovato-rotundatæ, apice interno acuto ; setis quatuor, duabus apicalibus dimidio lamellæ non longioribus, aliis externis. — *Maris :* Corpus valde depressum, ovatum. Conspicilla fronte insita. Segmento primo (vix duplice) transverso, aliis longitudine subæquis, latere obtusis.

Long. $\frac{1}{15}''$. — *Hab.* in mari Pacifico, prope insulam "Assumption," lat. bor. 19° 30′, long. orient. 144° 30′.

9. Sapphirina ovalis. — Digitus antennarum posticarum crassus, carpo fere longior, articulis digiti valde inæquis, unguiculo dimidium digiti longitudine æquante. Lamellæ caudales ovatæ, setis quinque, unâ

internâ, duabus apicalibus, et aliis externis, totis paulo brevioribus quam lamellæ. — *Feminæ :* Corpus valde convexum. Cephalothorax ellipticus, 5-articulatus, segmento antico non oblongo, postico parvo. Conspicilla fronte insita. Abdomen 5-articulatum, segmento primo minore, latere truncato, tertio quartoque lunatis. — Opaca, azulea.

Hab. in mari Pacifico, prope insulam "Tongatabu," versus Austrum.

10. Sapphirina detonsa. — Digitus antennarum posticarum tenuis, carpo paulo brevior, unguiculo dimidii digiti longitudine. Lamellæ caudales approximatæ, subovatæ, latitudine plus duplo longiores, setis brevissimis (obsolescentibus). — *Feminæ :* Corpus valde convexum. Cephalothorax ellipticus, 5-articulatus, segmento primo non oblongo, aliis latera obtusis. Conspicilla fronte insita. Abdomen 5-articulatum, segmento primo fere obsoleto aut tecto, secundo latere obtuso, tertio quartoque lunatis. — Translucens, brunnescens.

Long. $\frac{1}{15}''$. — *Hab.* in mari Pacifico, lat. aust. 15°, long. occ. 138° 45′.

11. Sapphirina indigotica. — Digitus antennarum posticarum tenuis, fere carpi longitudine, et unguiculo fere dimidii digiti. Lamellæ caudales subovatæ, apice interno vix prominulo, setis quatuor, duabus apicalibus, aliis externis, totis dimidio lamellæ vix brevioribus. — *Feminæ :* Corpus valde convexum. Cephalothorax ellipticus. Conspicilla fronte insita. Abdomen 6-articulatum, segmento primo parvulo, tertio, quarto, quintoque lunatis. — Opaca, et azulea.

Long. $\frac{1}{16}''$. — *Hab.* in mari Pacifico, lat. bor. 28°, long. orient. 177°.

12. Sapphirina orientalis. — Digitus antennarum posticarum tenuis, fermè carpi longitudine, unguiculo minus dimidio digiti. Lamellæ caudales breviter ovatæ, prope apicem internum dente acuto armatæ, setis quatuor, duabus apicalibus, aliis externis, totis brevibus, vix dimidii lamellæ longitudine. — *Maris :* Corpus valde depressum, subovatum, 10-articulatum, segmento antico latiore et paulo transverso, aliis sensim angustioribus. Conspicilla fronte insita. — *Feminæ* (?) : Corpus convexum. Cephalothorax ellipticus, 5-articulatus, segmento antico non transverso, postico ad latus truncato, angulis posticis acutis. Conspicilla fronte insita. Abdomen 6-articulatum, segmento primo minore, lateribus truncatis, secundo lateribus rotundatis, tribus sequentibus lunatis. — *Maris* color, opalinus ; *feminæ* indigoticus, opacus.

Long. $\frac{1}{10}''$. — *Hab.* in mari "Sulu."

2. *Conspicilla non contigua.*

13. SAPPHIRINA OVATO-LANCEOLATA. — Digitus antennarum posticarum dimidio carpi paulo longior, articulis duabus digiti valde inæquis. Lamellæ caudales latitudine duplo longiores, non divaricatæ, setis quinque, totis brevibus, unâ brevissimâ ad apicem internum insitâ. — *Maris :* Corpus ovato-lanceolatum, 10-articulatum, segmento antico vix oblongo, tribus penultimis lunatis et latera subacutis aut obtusis. Conspicilla subremota, inferiora, et fronte remota. Splendidè opalina. *Long.* $\frac{1}{7}''$. — *Feminæ :* Corpus ovato-lanceolatum, abdomine (articulo primo brevissimo excluso) vix angustiore. Cephalothorax 4-articulatus, segmento antico fere duplice, aliis inter sese similibus, latere obtusis. Conspicilla remotiuscula, fronte insita. Abdominis segmenta secundum tertium quartumque latè sublunata ea latere subacuta. — Vix diaphana. — *Long.* $\frac{1}{16}''$.

Hab. in mari Atlantico, prope "Rio de Janeiro"; quoque lat. aust. 23°, long. occ. 41°.

14. SAPPHIRINA GEMMA. — Digitus antennarum posticarum carpo parce brevior, tenuis, articulis duabus digiti valde inæquis, unguiculo brevi. Lamellæ caudales subellipticæ, latitudine duplo longiores, ad apicem internum minutè apiculato, setis quatuor, brevibus, duabus apicalibus, aliis externis. — *Feminæ :* Corpus gracillimum, elongatum. Cephalothorax 5-articulatus articulatione primâ fere obsoletâ, segmento antico parce oblongo, posticis inter sese similibus, sensim minoribus. Abdomen valde angustius, 6-articulatum, segmentis primo secundoque subæquis, sequentibus vix lunatis. Conspicilla remotiuscula, inferiora, prope frontem insita. — *Maris :* Corpus oblongo-subellipticum 10-articulatum, segmento antico paulo transverso, posticis ad latis non acutis. Conspicilla remotiuscula, inferiora et fronte remota. — Color *maris* opalinus et flammeus; *feminæ* nullus, sacculorum pallidè cyaneus.

Long. $\frac{1}{8}''$. — *Hab.* in mari Australis, ad syrtas "Lagullas." — An *Sapphirinæ indicatori* pertinet?

15. SAPPHIRINA BELLA. — Digitus antennarum posticarum tenuis, fermè carpi longitudine, articulis digiti fere æquis, unguiculo parvulo. Lamellæ caudales divaricatæ, angustæ, lanceolatæ, setis quatuor, duabus apicalibus, aliis externis, totis perbrevibus. — *Maris :* Corpus ovatum, 9-articulatum, segmento ultimo tecto, antico parce oblongo, ad latus totis obtusis. Conspicilla parvula, remotiuscula, inferiora, prope frontem insita. — Splendidè versicolor.

Long. $\frac{1}{15}''$. — *Hab.* in mari Pacifico, prope insulas "Kingsmill."

16. Sapphirina opalina. — Digitus antennarum posticarum tenuis, carpo fere longior, unguiculo brevi. Lamellæ caudales suborbiculatæ, apice interno producto, acuto, setis dimidio lamellæ vix longioribus. — *Maris :* Corpus ovatum, 10-articulatum, articulatione primâ fere obsoletâ, segmento postico tecto, quatuor penultimis latere ad angulos posticos acutis. Conspicilla remotiuscula, fronte insita. — Splendidè opalina.

Long. $\frac{1}{8}''$. — *Hab.* in mari Atlantico, lat. bor. 1° – 0°, long. occ. 17° – 18° ; quoque lat. aust. 4° 30′, long. occ. 25°.

17. Sapphirina versicolor. — Digitus antennarum posticarum tenuis, carpo vix longior, unguiculo longiusculo (dimidium digiti longitudine fere æquante). Lamellæ caudales latæ, latitudine breviores, apice interno producto et acuto, setis quatuor, brevissimis. — *Maris :* Corpus ovatum, 10-articulatum, segmento antico transverso, semicirculari, aliis longitudine subæquis, quatuor penultimis ad latera minutè acutis. Conspicilla remotiuscula, fronte insita. — Opalina. — *S. opalinæ* affinis.

Long. $\frac{1}{10}''$. — *Hab.* in mari Atlantico, prope "Rio de Janeiro," lat. aust. 24°, long. occ. 43°.

18. Sapphirina tenella. — Digitus antennarum posticarum tenuis, carpo longior, unguiculo parvulo. Lamellæ caudales latitudine duplo longiores, setis dimidio lamellæ valde breviores, unâ ad apicem internum fere obsoletâ. — *Feminæ :* Cephalothorax ovatus, 5-articulatus, articulatione primâ fere obsoletâ, segmento antico non transverso, posticis inter sese similibus, angulo postico subacuto. Abdomen angustum, 6-articulatum, segmento primo brevissimo, secundo latere obtuso, tribus sequentibus lunatis. Conspicilla remotiuscula, fronte insita. — *Maris :* Corpus longe ovatum, 10-articulatum, posticè segmentis sensim minoribus, segmento antico semicirculari, lateribus obtusis. Conspicilla remotiuscula, fronte insita. — *Maris* corpus diaphanum, pulchrè versicolor ; *feminæ* subdiaphanum, non coloratum.

Long. $\frac{1}{12}''$ – $\frac{1}{15}''$. — *Hab.* in mari Atlantico, lat. aust. 20° – 23°, long. occ. 38° 45′ – 41° ; quoque lat. aust. $4\frac{1}{2}$°, long. occ. 25° ; quoque lat. aust. 24°, long. occ. 43°. — An *S. fulgenti* (M. Edwardsii) pertinet ?

19. Sapphirina obesa. — Lamellæ caudales latæ, subellipticæ latitudine non duplo longiores, setis brevissimis, fere obsoletis, unâ ad apicem internum vix dispiciendâ. — *Feminæ :* Cephalothorax latè subovatus, convexus 5-articulatus, segmento antico transverso, ultimis duobus duplo brevioribus quam tertio, quarto ad angulos rotundato, quinto ad angulos subacuto. Abdomen 5-articulatum, segmento primo brevissi-

mo, tribus sequentibus lunatis. Conspicilla remotiuscula, fronte insita. — Brunnescens.

Long. $\frac{1}{16}''$. — *Hab.* in mari Pacifico, prope insulas "Kingsmill."

20. Sapphirina obtusa. — Lamellæ caudales elongatæ, non divaricatæ, setis dimidio lamellæ valde brevioribus. — *Feminæ:* Cephalothorax convexus, 4-articulatus, ad frontem subtruncatus, segmento antico oblongo, lateribus fere parallelis, angulis posticis rotundatis, segmentis aliis dissimilibus, secundo ad latus truncato, tertio rotundato, quarto (vel ultimo) medium ad latus angulato. Abdomen angustum, 5-articulatum, segmento primo parvulo, tribus sequentibus sublunatis. — Rubescens.

Long. $\frac{1}{15}''$. — *Hab.* in mari Pacifico, lat. aust. 43°, long. occ. 78° 45′.

Familia V. MIRACIDÆ.

Oculi duo conspicillis maximis constructi. *Antennæ posticæ* ad apicem setigeræ. *Pedes mandibulares maxillaresque* brevissimi. *Abdomen* feminæ (an *maris* quoque?) 6-articulatum. *Sacculus ovigerus* unicus.

Genus MIRACIA.

Corpus elongatum, non depressum, ad frontem duas appendices falciformes subtus gerens. *Antennæ anticæ* appendiculatæ, flexiles et non geniculantes. *Pedes antici* (ct. vii.) mediocres, uni-unguiculati; *pedes* duo sequentes biremes, lateraliter porrecti. *Pedes abdominis* longè setigeri. *Setæ caudales* elongatæ. — *Setellæ* affinis, sed conspicilla oculorum diversæ.

1. Miracia efferata. — Corpus 10-articulatum, segmento antico valde latiore, aliis sensim attenuatis. Conspicilla fronte insita, maxima, valde prominentia, contigua. Antennæ anticæ mediocres, 7-articulatæ, articulis tertio quinto septimoque brevibus. Styli caudales oblongi, setis duplo longioribus. — Cyanea.

Long. $\frac{1}{16}''$. — *Hab.* in mari Atlantico, lat. bor. 4° – 7°, long. occ. 20° – 21° 30′; quoque lat. aust. 4° 30′, long. occ. 25°.

2. Miracia gracilis. — Corpus gracile, sensim posticè attenuatum, 10-articulatum, segmento antico non latiore. Conspicilla maxima, paulo prominentia, fronte insita. Antennæ anticæ tenuissimæ, articulis secundo, quarto, duobusque ultimis brevibus. Styli caudales oblongi, setis quadruplo longioribus, fere corporis longitudine. — Cyanea et viridis.

Long. $\frac{1}{16}''$. — *Hab.* in mari Pacifico, lat. aust. 32° 24′, long. orient. 177°; quoque prope insulam "Sunday."

Tribus 2. DAPHNIACEA (vel Cladocera).

Corpus testâ plerumque tectum, capite antennisque posticis sæpius exclusis. *Pedes* plures natatorii. *Antennæ anticæ* sæpe obsoletæ, raro elongatæ. *Oculus* compositus. [Membra tota cephalothoracis mandibularia, maxillaria, pediformiaque 12 – 16.]

Tribûs hujus familiæ sunt : —

1. Penilidæ. — Pedes duodecim. Antennæ anticæ obsolescentes.

2. Daphnidæ. — Pedes decem. Antennæ anticæ sive obsoletæ sive uni-articulatæ.

3. Bosminidæ. — Pedes decem. Antennæ anticæ elongatæ, multi-articulatæ.

4. Polyphemidæ. — Pedes octo. Antennæ anticæ obsolescentes.

Familia I. PENILIDÆ.

Genus PENILIA. (*D.*)

Caput discretum, longe rostratum. *Antennæ posticæ* grandes, ramis duobus 2-articulatis. *Abdomen* non inflexum, stylis duobus corneis confectum.

1. Penilia avirostris. — Testa dorso valde tumida, posticè latè bicuspidata et ad medium profondè excavata, marginibus infero posticoque per denticulos eleganter armata. Setæ appendicium abdominis dorsalium stylis caudalibus breviores.

Long. $\frac{1}{20}''$. — *Hab.* in porto "Rio Janeiro." — Lect. die 24 Dec., 1838.

2. Penilia orientalis. — Testa dorso tumida, posticè latè bicuspidata, ad medium paulo excavata, marginibus infero posticoque per denticulos eleganter armata. Setæ appendicium abdominis dorsalium stylis caudalibus fere duplo longiores.

Long. $\frac{1}{16}''$. — *Hab.* prope fretum "Sunda." — Lect. die 5 Mar., 1842.

Familia II. DAPHNIDÆ.

Genus I. DAPHNIA.

Abdomen inflexum. *Antennæ anticæ* obsolescentes. *Antennæ posticæ* birameæ, ramis 3 – 4-articulatis. *Intestina* non convoluta.

1. Daphnia textilis. — Valde tumida, subglobosa, paulo oblonga,

post medium paulo latior, posticè breviter subtriangulata, obtusa. Caput breve, brevissimè acutèque rostratum, *supernè visum* breviter subtriangulatum, obtusum. Rami antennarum valde inæqui, tri-articulati. Testa reticulata areolis bene hexagonis.

Hab. in stagnis prope portum "Sandal wood" ad insulam "Vanua Lebu" in archipelago "Viti."

2. Daphnia australiensis. — Valde tumida, paulo oblonga, capite per constrictionem vix discreto; post medium altior, posticè subtriangulata, obtusa, dorso postico subtilissimè denticulato. Caput breve, *supernè visum* triangulatum, obtusum. Rami antennarum posticarum subæqui, setis longiusculis. Testa reticulata, areolis longè angustissimèque linearibus, obliquis, prope marginem valde latioribus.

Hab. in stagnis prope urbem "Sydney" Novi-Hollandiæ.

3. Daphnia macrura. — Gracilis, elongata, testâ posticè aculeato-productâ, aculeo tenui, paulo breviore quam corpus. Caput grande, corpore non humilius, supra non discretum infra nec rostratum; fronte *latere visâ* rotundatâ, *supernè visâ* bene acutâ. Corpus ad margines dorsales infero-posticosque et aculeus subtilissimè denticulati.

Hab. in stagnis prope urbem "Sydney" Novi-Hollandiæ.

Genus II. SIDA.

Abdomen rectum. *Antennæ anticæ* fere obsoletæ. *Antennæ posticæ* birameæ, ramo uno 2-articulato. *Intestina* non convoluta.

Sida angusta. — Angusto-oblonga, posticè parce altior et rotundato-truncata, capite valde discreto, fere oblongo, paulo humiliore quam corpus, fronte obtusâ. Abdomen testâ fere omnino tectum. Antennæ anticæ fere corporis longitudine, ramis basi brevioribus, 2 et 3-articulatis, uno ramo setis paucis ciliato.

Hab. in stagnis ad insulam "Vanua Lebu."

Genus III. LYNCEUS.

Abdomen inflexum. *Intestina* convoluta. *Antennæ anticæ* fere obsoletæ. *Antennæ posticæ* parvæ.

Lynceus latifrons. — Valde tumidus; *latere visus* rotundatus, capite indiscreto, brevissimo, rostrato, rostro gracili, acuto, ad corpus strictè appresso; *supernè visus*, fronte latissimè truncatâ parce angustiore quam corpus, latere postico breviter triangulato et obtuso.

Hab. in stagnis ad insulam "Vanua Lebu."

Familia IV. POLYPHEMIDÆ.

Pedes octo. Oculus maximus.

Genus POLYPHEMUS.

Caput discretum, magnum. *Antennæ* birameæ, validæ.

Polyphemus brevicaudis. — Testa posticè tumida rotundata. Caput oblongum (paulo brevius quam testa reliqua), conoideum, anticè latius et globulare. Rami antennarum subæqui 3-articulati, parce setigeri. Pedes crassi. Abdomen non inflexum, breve, crassum, parce exsertum, furcatum, ad apicem acutum.

Long. $\frac{1}{30}''$. — *Hab.* in mari Atlantico, lat. aust. 41°, long. occ. 62°. — Lect. die 25 Jan., 1839.

Tribus 3. CYPRIDACEA (vel Ostracoda).

Corpus testâ bivalvi omnino tectum, posticè incurvatum, capite antennisque nunquam exclusis. *Pedes* nulli biremes nec natatorii. *Oculi* vel simplices vel compositi. *Antennæ* quatuor. [Membra cephalothoracis mandibularia, maxillaria, pediformiaque numero decem.]

Genus I. CYPRIS. (*Müller.*)

Testa integra, ad frontem nec perforata nec incisa. *Oculus* unicus. *Antennæ anticæ* setigeræ, subnatatoriæ. *Antennæ posticæ* subpediformes, setigeræ. *Pedes mandibulares* 3–5-articulati. *Maxillæ* quatuor, breves. *Pedes* quatuor, duo uncinis longi confecti, duo sequentes graciles, 4–5-articulati, ad ova pertinentes.

1. Cypris speciosa. — Oblonga, subovata, anticè angustior, subtus fere recta, vix excavata, alioque bene arcuata, altitudine latior et plus duplo longior; ad marginem anticum pubescens, posticum breviter ciliata. Flava et lætè viridis, areis flavis paucis imperfectis viridi circumdatis.

Hab. in stagnis prope urbem "Rio de Janeiro." — Lect. Dec., 1838.

2. Cypris albida. — *Latere visa*, breviter subelliptica, extremitates fere æqua, latè rotundata, subtus recta, supra obsoletè gibbosa; triplo longior quam latitudo, non duplo longior quam altitudo, margine pubescente. Oculus margine superno remotus. Albido-margaritacea, posticè et supernè paulo brunnea.

Long. $\frac{1}{24}''$. — *Hab.* in stagnis prope "Valparaiso."

3. Cypris Chilensis. — *Latere visa*, subovata, post medium parce altior, subtus paululo arcuata, dorsum vix gibbosa, triplo longior quam latitudo, duplo longior quam altitudo, marginibus antico infero posticoque pubescentibus. Antennæ anticæ 7-articulatæ, setis dimidio corporis vix longioribus.

Long. $\frac{1}{16}''$. — *Hab.* in stagnis prope "Valparaiso."

4. Cypris pubescens. — Brevis; *latere visa*, latissimè fabiformis, subtus recta, extremitatibus latè et æque rotundatis, dorso bene arcuato; *supernè visa*, latè ovata, fronte subacuta; ad totam superficiem pubescens. Antennæ anticæ 7-articulatæ, setis vix longioribus quam 5 articuli ultimi simul sumti. Antennæ posticæ crassiusculæ, articulo ultimo fere dimidii penultimi longitudine, setam longam ad apicem gerente, penultimo ad apicem longè setigero. — Pallidè olivacea.

Hab. in stagnis prope urbem "Sydney" Novi-Hollandiæ.

5. Cypris Vitiensis. — Longè subfabiformis; *latere visa*, altitudine plus duplo longior, subtus recta, dorsum arcuata, ante medium paulo altior, extremitate anticâ latius rotundatâ; *supernè visa*, subelliptica, ante medium vix latior, anticè subacuta, posticè rotundata, latitudine duplo longior; ad totam superficiem pubescens. Antennæ anticæ 7-articulatæ, articulis quinque ultimis inter sese longitudine fere æquis, setis antennâ brevioribus.

Long. $\frac{1}{40}''$. — *Hab.* in stagnis prope portum "Nailoa," ad insulam "Vanua Lebu," in archipelago "Viti."

Genus II. CYPRIDINA. (*Milne Edwards.*)

Testa breviter rostrata corpus omnino tegens, et clausa. *Oculi* duo compositi, remoti. *Antennæ anticæ* setis paucis inæquis ad apicem instructæ, setis rectis, sæpe divaricantibus, vix natatoriis. *Antennæ posticæ* 5 – 7 articulis brevissimis longè et plumosè setigeris confectæ. *Pedes mandibulares* 5-articulati, digitiformes, apicem unguiculati. *Maxillæ* sex, breves, breviter setigeræ, paris secundi laminam ciliatam ad basin gerentes, setis longis, plumosis. *Pedes* duo, longissimè vermiformes, omnino flexiles, ad ova pertinentes, ad apicem setis spinulosis partim reversis armati. *Abdomen* spinulis biseriatis confectum.

1. Cypridina luteola. — Compresso-ovoidea; *latere visa*, latè elliptica, anticè breviter rostrata, fronte non prominulâ, marginibus aliis arcuatis, posticè non gibboso; *supernè visa*, angusto-ovata, anticè acuta,

posticè rotundata. Digitus pedis mandibularis ad basin crassus, sensim attenuatus. Antennæ anticæ ad apicem 4–5-setigeræ, setis antennâ non longioribus. — Luteola.

Long. $\frac{1}{12}''$. — *Hab.* in mari "Sulu."

2. Cypridina punctata. — Compresso-ovoidea, punctata; *latere visa*, latè ovalis, posticè gibbosa, infra supraque æquè arcuata, anticè breviter rostrata, fronte prominulâ, rostro gracili, acuminato; *supernè visa*, angusto-elliptica, extremitatibus rotundatis. Spinulæ caudales decem.

Hab. in mari "Sulu."

3. Cypridina olivacea. — Subovoidea; *latere visa*, oblongo-subelliptica, dorsum parcè arcuata, posticè truncata et sparsim ciliata, anticè rostrata, rostro ad apicem rectangulato, fronte prominente; *supernè visa*, longè ovata, anticè obtusa, posticè subtruncata. Antennæ anticæ setis corpore longioribus ad apicem instructæ. Spinulæ caudales octo. — Olivacea.

Long. $\frac{1}{10}''$. — *Hab.* in mari "Sulu."

4. Cypridina gibbosa. — *Latere visa*, angusto-subovata, infra supraque arcuata, posticè valde gibbosa, anticè breviter rostrata, rostro acuto, fronte prominulâ. Antennæ anticæ tribus setis longis aliisque brevioribus ad apicem instructæ, setis antennâ paulo brevioribus. Spinulæ caudales sexdecim. — Fere incolorata. Phosphorescens.

Long. $\frac{1}{20}''$. — *Hab.* in mari Pacifico, lat. aust. 15° 20′, long. occ. 148°. — Lect. die 10 Sept., 1839.

5. Cypridina formosa. — Compresso-ovoidea; *latere visa*, breviter elliptica, infra supraque valde arcuata, margine postico interrupto, non gibboso; *supernè visa*, angusto-elliptica, extremitatibus obtusis. Antennæ anticæ longè setigeræ, setis antennâ parce longioribus. Pedes mandibulares digitum tenues. Spinulæ caudales decem. — Pallidè purpurea et maculis lætè purpureis notata.

Long. $\frac{1}{10}''$. — *Hab.* in mari Pacifico, prope insulam "Upolu." — Lect. die 26 Feb., 1841.

Genus III. CONCHÆCIA. (*Dana.*)

Testa interdum breviter rostrata, corpus omnino tegens, fronte apertâ. *Oculi* simplices. *Antennæ anticæ* 3–4-articulatæ, apicem longè setigeræ. *Spiculum* inter antennas sarcosum, simplex, exsertile. *Antennæ posticæ* 5–7-articulatæ, articulis brevissimis longè setigeris confectæ, ramo altero brevi. *Pedes mandibulares* fermè 5-articulati, non unguiculati, apice interno articuli primi sæpius etiam basi interno secundi simul corneis (instar mandibulæ) et denticulatis. *Maxillæ* quatuor. *Pedes* quatuor, tenues. *Abdomen* spinulis biseriatis confectum.

1. Conchæcia agilis. — *Supernè visa*, longè ovata, anticè rotundata, posticè acuta; *latere visa*, oblonga, subrectangulata, anticè paulo altior, frontem instar rostri paulo producta, posticè rectè truncata angulo superno acutè rectangulato. Spiculum sagitto-capitatum. Antennæ anticæ 3-articulatæ, setis rectis ad apicem curvatis, unâ crassiore et prope apicem subtilissimè denticulatâ. Pedes mandibulares 5-articulati, articulo secundo valde oblongo, recto, sequentibus sensim attenuatis. — Viridescens.

Long. $\frac{1}{20}''$. — *Hab.* in mari Atlantico, lat. bor. 0° – 4°, long. occ. 17° 30′ – 20° 10′; lat. aust. 0° – 6°, long. occ. 17° 30′ – 24°. — Lect. diebus 25, 26, 27, 29 Oct., et 2, 3, 5, 8 Nov., 1838.

2. Conchæcia rostrata. — *C. agili* similis. — Pedes mandibulares sensim non attenuati, articulis duobus apicalibus fere æquis, vix oblongis, setis longis. Pedes penultimi ultimis duplo longiores longèque setigeri.

Hab. in mari Pacifico, prope insulas "Kingsmill."

3. Conchæcia brevirostris. — *Supernè visa*, brevissimè elliptica, extremitatibus subacutis; *latere visa* literæ ◡ formam similis, dorsam fere recta, posticè rotundata, fronte prominulâ, et truncatâ. Antennæ anticæ setis inæquis, setâ longiore curvatâ prope apicem incrassatâ, nudâ. Spiculum capite cylindrico. Antennæ posticæ 7-articulatæ, articulo secundo non duplo longiore quam sequentes simul sumti. — Albida. Testa lineis parallelis subtilissimè notata.

Long. $\frac{1}{16}''$. — *Hab.* in mari Atlantico, lat. aust. 23°, long. occ. 41° 10′. — Lect. die 19 Nov., 1838.

4. Conchæcia inflata. — *Supernè visa*, brevissimè ovata, frontem rotundata, posticè subacuta; *latere visa* subrotundata, dorsum fere recta, literæ ◡ formam similis, angulis rotundatis, fronte obsoletè prominulâ. Spiculum cylindricum. Antennæ anticæ 3-articulatæ, setis longis, unâ subclavatâ, nudâ. Antennæ posticæ 7-articulatæ, articulo secundo plus duplo longiore quam 5 ultimi simul sumti. Pedes mandibulares 5-articulati, articulo secundo brevi, non longiore quam tertius, basi longè et crassè producto, primo ad apicem pariter producto, his processubus duobus corneis denticulatis instar mandibulæ.

Long. $\frac{1}{15}''$. — *Hab.* in mari Atlantico, lat. aust. 1°, long. occ. 18° ; et lat. aust. 11°, long. occ. 12°. — Lect. die 5 Nov., 1838, et die 6 Maii, 1842.

SUBORDO 2. CORMOSTOMATA.

Os rostriformis. — Tribus quatuor sequentes : —

I. MONSTRILLACEA. — Corpus elongatum (Cyclopi simile). Maxillæ pedesque antici obsoleti. Pedes postici octo natatorii.

II. CALIGACEA. — Corpus sæpius depressum. Maxillæ pedesque toti numero 12 – 14, octo pedes ultimi plerumque natatorii, plurimi testâ tecti.

III. LERNÆACEA. — Corpus depressum aut vermiforme. Antennæ pedesque partim obsoleti.

IV. NYMPHACEA. — Corpus breve, araneiforme, abdomine obsolescente.

Tribus I. MONSTRILLACEA.

Genus MONSTRILLA. (*Dana.*)

Cephalothorax fere cylindricus, 4-articulatus. *Abdomen* 5 – 6-articulatum. *Antennæ* duæ. *Oculi* duo simplices ; quoque oculus inferior sicut *Pontellis*. *Truncus buccalis* parvulus subconicus, maxillis pedibusve non munitus. *Pedes* octo, natatorii.

MONSTRILLA VIRIDIS. — Gracilis, posticè attenuata. Oculi remoti. Antennæ 5-articulatæ, setis antennâ brevioribus. Abdomen 5-articulatum, segmento secundo breviore quam primus vel secundus. Styli caudales oblongi, parvi, divaricati, setis 5 subæquis, diffusis. — Lætè graminea.

Long. $\frac{1}{5}''$. — *Hab.* in mari "Sulu." — Lect. die 3 Feb., 1842.

Tribus 2. CALIGACEA.

Familiæ quinque sequentes : —

1. ARGULIDÆ. — Corpus anticè latè peltatum. Ovarium externum nullum. Pedes antici largè tubulati, suctatorii.

2. CALIGIDÆ. — Corpus anticè latè peltatum. Ovarium externum tubiforme, rectum, ovis uniseriatis. Pedes quatuor antici subprehensiles. Antennæ posticæ carapace tectæ.

3. Dichelestidæ. — Corpus depressum, valde angustum. Antennæ posticæ carapace non tectæ. Ovarium externum tubiforme, ovis uniseriatis.

4. Ergasilidæ. — *Corycæis* affines. Corpus vix depressum, plus minusve Cyclopiforme. Antennæ posticæ carapace non tectæ. Ovarium externum elongatum aut sacculiforme, ovis non uniseriatis.

5. Nicothoidæ. — Corpus plerumque Cyclopiforme, sed e lateribus longissimè alatum. Ovarium externum sacculiforme, ovis non uniseriatis.

Familia II. CALIGIDÆ.

Subfamiliæ Caligidarum nobis sunt : —

1. Caliginæ. — Truncus buccalis subovatus, obtusus. *Maxillæ* trunco remotiusculæ, posticè aculeo-elongatæ. *Tubum* ovigerum externum rectum. Corpus anticè latius. (Genera sunt *Caligus*, *Lepeophtheirus*, *Chalimus*, *Caligeria*, *Calistes*.)

2. Pandarinæ. — Truncus buccalis tenuis acuminatus. Maxillæ ad truncum appressæ, parvulæ, lamellatæ. Tubum ovigerum externum rectum. Corpus posticè interdum latius. (Genera sunt *Pandarus*, *Trebius*, *Nogagus*, *Specilligus*, *Dinematura*, *Phyllophora*, *Euryphora*, *Lepidopus*.)

3. Cecropinæ. — Truncus buccalis tenuis, acuminatus. Maxillæ ad truncum appressæ. Tubum ovigerum externum sub testam convolutum. Corpus posticè latius. (Genera sunt *Cecrops*, *Læmargus*.)

Caligaceorum segmenta corporis auctoribus sæpe malè data. Segmentum abdominis anticum, ovarium externum gestans, thoracis posticum sæpe vocatum.* In Cyclopaceis Caligaceisque ovarium externum ad segmentum secundum abdominis normalem semper pertinet. Si hæc animalia Cyclopaceis Crustaceisque aliis comparentur, affinitates veras educemus. Tabula sequens, membris ordine enumeratis, hæc comparationem exhibet.

* Vide *Hist. Nat. des Crustaces*, par M. Milne Edwards, III. 445 et seq.

SEGMENTA.*	ASTACUS.	LUCIFER.	CYCLOPS.	PONTELLA.	CALIGUS.	PENILIA.	DAPHNIA.	CYPRIS.
1. *Cephalothoracis.*								
I.	Oculi	Oculi	00	00	00	00	00	00
II.	Ant. I.	Ant. I.	Ant. I.	Ant. I.	Ant. I.	Ant. I.	00	Ant. I.
III.	Ant. II.	Ant. II.	Ant. II.	Ant. II.	Ant. II.	Ant. II.	Ant. II.	Ant. II.
IV.	Mand.	Mand.	Mand.	Mand.	Mand.	Mand.	Mand.	Mand.
V.	Max.	Max.	Max.	Max.	Max.	Max.	Max.	Max.
VI.	Max.	Max.	Maxd.	Maxd.	P. verg.	P. nat.	P. nat.	Maxd.
VII.	Maxd.	Maxd.	P. preh.	P. preh.	P. preh.	P. nat.	P. nat.	P. verg.
VIII.	Maxd.	Maxd.	P. nat.	P. nat.	P. nat.	P. nat.	P. nat.	P. ovar.
IX.	Maxd.	P. subnat.	P. nat.	P. nat.	P. nat.	P. nat.	P. nat.	00
X.	P. chel.	P. subnat.	P. nat.	P. nat.	P. nat.	P. nat.	P. nat.	00
XI.	P. verg.	P. subnat.	P. nat.	P. nat.	P. nat.	P. nat.	00	00
XII.	P. verg.	P. subnat.	0 vel 00	P. genit.	00	00	00	00
XIII.	P. verg.	0	00	00	00	00	00	00
XIV.	P. verg.	0	00	00	00	00	00	00
2. *Abdominis.*								
I.	P. rud.	P. rud.	0 vel P. rud.	0 vel 00	0 vel 00	P. rud.	0 vel P. rud.	0 vel 00
II.	P. rud.	P. rud.	0	0	0	0	0	0
III.	P. rud.	P. rud.	0	0	0	0	0	0
IV.	P. rud.	P. rud.	0	0	0	0	0	0
V.	P. rud.	P. rud.	0	0	0	0	0	0
VI.	App. caud.	App. caud.	App. caud.	App. caud	App. caud.	App. caud.	App. caud.	App. caud.
VII.	0	0	00	00	00	00	00	00

* Hæc tabula abbreviationes sequentes continet: —

Ant.	Antennæ.	*P.*	Pedes.	*Preh.*	Prehensiles.
Mand.	Mandibulæ.	*Chel.*	Cheliformes.	*Ovar.*	Ovariani *vel* ovarium.
Max.	Maxillæ.	*Verg.*	Vergiformes.	*Rud.*	Rudimentarii.
Maxd.	Maxillipedes.	*Nat.*	Natatorii.	*Caud.*	Caudales.

Segmenti membra obsoleta, 0 significat; segmentum membraque ambo simul obsoleta, 00.

Subfamilia 1. CALIGINÆ.

Genus I. CALIGUS.

Cephalothorax 2-articulatus; segmento antico latè peltato, fronte discis duobus suctatoriis plerumque instructâ; postico parvulo, non alato. *Oculi* simplices pigmento unico conjuncti. *Antennæ posticæ* prehensiles, et extus basin sæpius spinâ crassâ munitæ. *Pedes* duo antici vergiformes, bifidi ;* duo proximi sequentes subprehensiles digito acuto confecti ; sex sequentes natatorii ; duo reliqui simplices, vergiformes. Venter furculâ parvulâ armatus. *Abdomen* 2–3-articulatum, appendicibus caudalibus sublamellatis, marginem setigeris. [Sexus, antennas posticas, pedes paris secundi, et formam abdominis, valde dissimiles.]

1. Caligus Thymni. — Carapax oblongus, discis suctatoriis subfrontem munitus. Abdomen 3-articulatum, segmento primo ad basin lato, sequentibus duplo latiore ; ano valde prominente. Styli caudales parvuli, ad angulos abdominis posticos insiti, anum vix superantes. Antennæ posticæ spinâ extus basin non munitæ. Furcula simplex, brachiis divergentibus, subacutis. — *Feminæ :* Abdominis segmentum primum oblongum, lateribus rectis et posticè parce divergentibus, angulis posticis prominentibus ; segmentis duobus sequentibus simul sumtis elongatis, et fere longioribus. — *Maris :* Abdominis segmentum primum subquadratum, angulis posticis vix prominentibus, segmentis sequentibus simul sumtis brevioribus.

Long. $\frac{3}{8}''$. — *Hab.* in corpus *Thymni pelamys* mari Atlantico, lat. bor. 27°, long. occ. 19° 30′. — Lect. die 27 Sept., 1838.

2. Caligus productus. — *Feminæ :* Carapax ovatus, discis suctatoriis subfrontem munitus. Segmentum secundum angustum. Abdomen 3-articulatum, segmento primo ad basin perangusto ; ano non prominulo. Styli caudales parce oblongi, terminales. Antennæ posticæ ad basin posticè acutæ et extus basin spinâ munitæ. Furcula simplex, brachiis parce divergentibus, tenuibus, acutis. — Segmentum abdominis anticum oblongum, subellipticum, angulis posticis longè crassèque productis, sequentibus angustis, fere lineatis.

Long. $\frac{1}{4}''$. — *Hab.* intus operculum *Thymni pelamys*, in mari Atlantico, lat. bor. 27°, long. occ. 19° 30′. — Lect die 27 Sept., 1838.

3. Caligus gracilis. — *Feminæ :* Carapax oblongus, fere ellipticus, discis suctatoriis rotundatis. Segmentum secundum transversum, brevissimum. Abdomen 2-articulatum, segmento antico fere quadrato, postico angustiore, parce oblongo, posticè truncato. Styli caudales terminales, paulo oblongi. Furcula ventralis simplex, brachiis divergentibus, truncatis. Antennæ posticæ spinâ oblongâ extus basin munitæ.

Long. $\frac{1}{6}''$. — *Hab.* in corpus Serrani, in mari juxta "Rio de Janeiro."

* Extremitas bifida articulo tertio et apice secundi elongato composita.

4. Caligus (Lepeophtheirus) Bagri. — Carapax subrotundatus, discis suctatoriis non munitus: segmentum secundum fere oblongum. Abdomen 3-articulatum, segmento primo valde latiore; segmentis duobus posticis simul sumtis oblongis, ano prominente. Styli caudales parvuli ad angulos abdominis posticos insiti, anum vix superantes. Antennæ posticæ spinâ extus basin non munitæ. Furcula simplex, brachiis divergentibus, subacutis. — *Feminæ:* Abdominis segmentum primum valde oblongum, posticè truncatum, anticè angustius, lateribus parallelis. — *Maris:* Segmentum abdominis primum latum, paulo oblongum, subhexagonum. Pedes paris secundi crassissimi, digito acuto setâque internâ armato, margine manûs interno fere recto, pollice nullo.

Long. $\frac{1}{4}''$. — *Hab.* in corpus et intus opercula Bagri, juxta "Rio de Janeiro." — Lect. Nov., 1838.

Genus II. CALISTES. (*Dana.*)

Caligo similis. *Cephalothorax* 2-articulatus, segmento postico non alato. *Pedes duo postici* biramei, subnatatorii.

Trebio affinis, ced cephalothorax non 3-articulatus et maxillæ nec lamellares, nec ad truncum buccalem appressæ.

Calistes Trigonis. — *Feminæ:* Cephalothorax subrotundatus, discis suctatoriis nullis. Segmentum secundum parvum, lateribus rotundatis. Abdomen 3-articulatum, segmento primo lato, sequentibus lineatis, ano vix prominente. Styli caudales styliformes, oblongi. Antennæ posticæ spinâ corneâ longâ extus basin munitæ. Furcula simplex, brachiis parallelis. Maxillæ posticè aculeo-furcatæ. Pedes postici natatorii, ramis 3-articulatis, parce subæquis, setis longis. — Segmentum abdominis primum subquadratum, angulis rotundatis, duobus sequentibus fere æquis et simul sumtis non brevioribus quam primum, lineatis.

Long. $\frac{1}{4}''$. — *Hab.* in corpus speciei Trigonis. — Lect. juxta "Rio de Janeiro," Dec., 1838.

Genus III. CALIGERIA. (*Dana.*)

Caligo similis. *Cephalothorax* 2-articulatus, segmento postico bialato. *Pedes duo postici* biramei, setis brevibus, non natatoriis.

Caligeria bella. — *Feminæ:* Cephalothorax rotundatus, discis suctatoriis nullis. Segmentum secundum transversum, angulos posticos alatum, alis latis, approximatis, margine toto arcuato. Abdomen 3-

articulatum, segmento primo lato, tertio posticè truncato, lamellis caudalibus latis, paulo oblongis, contiguis, setis lamellâ brevioribus, fere æquis. Furcula simplex, tenuis, basi angustissimo, brachiis divergentibus. Pedes postici tenues, ramis valde inæquis, ramo breviore 2-articulato, altero 3-articulato. — Segmentum abdominis primum paulo oblongum, subellipticum, angulis posticis rotundatis, segmentis sequentibus dimidio angustioribus, non oblongis, subæquis.

Hab. in branchias speciei Thynni, in mari Atlantico, lat. aust. 11°, long. occ. 14°. — Lect. die 7 Maii, 1842.

Subfamilia 2. PANDARINÆ.

Genus I. NOGAGUS. (*Leach.*)

Cephalothorax 4-articulatus, fronte arcuatâ, segmento secundo ad latera posticè producto, duobus sequentibus non alatis. *Abdomen* stylis brevibus sublamellatis setigerisque confectum. *Oculi* simplices, remotiusculi; (an quoque oculus subtilissimus intermedius?). *Pedes* paris secundi crassè cheliformes; pedes natatorii octo, grandes.

Nogagus validus. — *Feminæ?* Carapax paulo oblongus, ellipticus, segmento secundo ad latera posticè producto, segmentis duobus sequentibus transversis. Pedes secundi paris crassissimè cheliformes, pollice brevi, truncato, digito obtuso. Abdomen 2-articulatum, segmento antico subquadrato, angulis posticis prominulis; segmento postico brevi, transverso, angulis posticis truncatis. Styli caudales latè lamellati, paulo oblongo, setis tribus plumosis.

Hab. in corpus Squali, mari Pacifico prope Novi-Zealandiam. — Lect. die 15 Ap., 1840.

Genus II. SPECILLIGUS. (*Dana.*)

Nogago segmenta cephalothoracis pedesque affinis. *Oculi* duo remotiusculi, et *conspicillis grandibus instructi*, eisque Sapphirinæ similes.

Specilligus curticaudus. — *Feminæ?* Carapax oblongo-ellipticus, anticè arcuatus, discis suctatoriis post antennam anticam munitus. Segmentum secundum ad latera posticè productum, tertium quarto latius et dimidio carapacis parce latius. Pedes secundi paris crassissimè cheliformes, pollice brevi truncato, digito obtuso. Abdomen 2-articulatum, segmento antico paulo oblongo, angulis posticis truncatis et setam minutam gerentibus, segmento postico brevi, ano prominente ; stylis parvulis, triangulatis, ad angulos insitis, anum non superantibus, setis tribus, plumosis.

Hab. in corpus Squali, mari Pacifico prope Novi-Zealandiam. — Lect. die 15 Ap., 1840.

Genus III. PANDARUS. (*Leach.*)

Cephalothorax 4-articulatus, carapace grandi, segmentis sequentibus transversis, secundo ad latera alatè producto, tertio quartoque posticè alatis, et bilobatis. *Abdomen* 2 – 3-articulatum, segmento ultimo tecto, secundo posticè rotundato et utrinque stylis caudalibus sæpius munito. *Pedes* paris secundi crassè cheliformes ; natatorii octo, setis brevissimis. *Oculi* duo, remotiusculi. *Styli caudales* styliformes, acuti, subnudi.

1. Pandarus concinnus. — Carapax paulo oblongus, ellipticus, posticè truncatus et dentatus, angulis posticis paululo elongatis, obtusis. Segmentum secundum brevissimum, alis divaricatis, subrectangulatis, angulis posticis subacutis. Segmenta duo sequentia transversa, subæqua, lobis rotundatis acutè sejunctis. Abdomen 3-articulatum, segmento antico lato, postice profundè excavato, lateribus arcuatis, angulis posticis acutis, bene divaricatis. Styli caudales non tecti.

Hab. in corpus Squali, mari Pacifico juxta insulam " Tongatabu."

2. Pandarus Satyrus. — Carapax vix oblongus, posticè sensim latior, angulis posticis parce prominentibus, margine postico integro, antico obsoletè denticulato. Segmentum secundum brevissimum, alis divaricatis, oblongo-ellipticis. Segmenta cephalothoracis sequentia transversa, primo minore, lobis rotundatis acutè sejunctis. Abdomen 3-articulatum, articulo antico grandi, posticè angusto-excavato, lateribus fere rectis, parce deinde subito angustioribus et angulis posticis internis acutis ; segmento secundo dimidio vix angustiore, oblongo, obovato. Styli caudales non tecti.

Long. 5′′. — *Hab.* in corpus Squali, mari Pacifico juxta insulam " Tongatabu."

3. Pandarus brevicaudus. — Carapax vix oblongus, subellipticus, posticè valde excavatus, angulis posticis longè productis, obtusis. Segmenta sequentia tria transversa. Alæ segmenti secundi non divaricatæ, posticè obtusæ. Segmenta tertium quartumque abdomine non latiora,

margine dorsali postico latè excavato. Segmentum abdominis anticum subquadratum, angulis posticis obliquè truncatis et setâ minutâ extus instructis, posticè angustum, subtruncatum; segmentum secundum parvulum, transversum stylis triplo longioribus.

Long. $\frac{1}{4}''$. — *Hab.* in corpus Squali, mari Pacifico prope Novi-Zealandiam.

Genus IV. DINEMATURA. (*Latreille.*)

Cephalothorax 3-articulatus, segmento secundo parvo, testâ tertii dorsali posticè valde expansâ et profundè bilobatâ, eoque elytroideâ. *Abdomen* 2-articulatum, carapace paulo angustius, oblongus, segmento antico maximo, posticè bilobato, postico parvulo, celato. *Styli caudales* lamellati, terminales.

Dinematura braccata. — Carapax fere rotundatus, abdomine latior, discis suctatoriis post antennas munitus; posticè quadrilobatus, lobis duobus internis angustis, curvatis, subacutis. Segmentum secundum transversum, ad latus subacutum. Segmenti alæ tertii vix oblongæ, dimidii abdominis longitudine, posticè parce latiores, angulis rotundatis, margine postico fere recto. Segmentum abdominis primum profundè bilobatum, secundum quadratum. Styli caudales grandes, subovati, abdominis extremitatem paulo superantes, setis paucis brevissimis.

Long. $\frac{1}{2}''$. — *Hab.* in corpus Squali, mari Pacifico juxta insulam "Tongatabu."

Genus V. LEPIDOPUS. (*Dana.*)

Corpus anticè non latius. *Cephalothorax* 3-articulatus, carapace minore quam abdomen, segmentis duobus sequentibus posticè largè bialatis. *Abdomen* 2-articulatum, segmento postico parvulo, celato, antico maximo et posticè bilobato. *Antennæ posticæ* articulo tenui falciformi confectæ. *Pedes paris secundi superficie terminali latâ prehensili squamatâ instructi. Pedes natatorii* quatuor ultimi similes, latè lamellati.

Lepidopus armatus. — Corpus oblongum, posticè sensim latius. Carapax subquadratus, posticè paulo latior, margine postico vix arcuato. Segmenta duo sequentia subæqua, alis grandibus, fere rotundatis. Abdomen oblongum, carapace valde longius, posticè non angustius, paulo bilobatum, lobis rotundatis. Antennæ posticæ ad apicem longè falciformes et denticulis biseriatis armatæ, articulo penultimo subquadrato.

Pedes paris secundi grandes, articulo penultimo ad apicem spinigero, ultimo crassissimo, superficie terminali oblongâ, squamatâ, squamulis spinulâ armatis.

Long. $\frac{1}{3}''$. — *Hab.* in corpus speciei Musteli (Squalorum familiæ). — — Lect. ad urbem "Rio de Janeiro."

Tribus 4. NYMPHACEA.

Genus ASTRIDIUM. (*Dana.*)

Pycnogono affinis. *Caput* duobus maxillipedibus subtus instructum parvulis, debilibus, apice obtusis, non prehensilibus. *Pedes* octo unguiculo confecti. *Abdomen* perbrevis.

Astridium orientale. — Cephalothorax stellatus, segmentis medio connatis, deinde liberis. Abdomen breve, posticè angustius, obtusum. Truncus buccalis oblongus, subcylindricus, corpore vix brevior. Segmentum corporis primum anticè non transversum, posticè angustius et deinde utrinque longè productum instar rami brevis,* et pedes anticos gerens. Maxillipedes parvuli, obsoletè 3-articulati, obtusi. Pedes crassiusculi, articulo primo vix oblongo, sequentibus sex subæquis, tertio paulo breviore.

Long. $\frac{1}{8}''$. — *Hab.* in mari "Sulu." — Lect. die 11 Feb., 1842.

Mr. Borden, from the committee to whom was referred the paper of Mr. M. Conant, describing his "Solar Index," presented a report, entering fully into the investigation of the principles of the instrument. The conclusion which the committee has arrived at is, that, although the "Solar Index" is not susceptible of sufficient accuracy to be used with advantage for nice scientific purposes, yet, as it can be managed with great facility, it may frequently be found valuable to the surveyor and engineer in making experimental surveys, running preliminary lines, &c., for the purpose of learning the character of the topography of a country, and of acquiring, approximately at least, a knowledge of the relative situation of places.

* Hæc pars postica segmenti primi segmentum corporis secundum vere est, quamvis articulatione verâ non sejuncta.

Professor Horsford presented the following communication, embodying the results of his investigations and experiments on the chemical action of water of various kinds upon the materials ordinarily employed for its transmission and distribution.

"Materials for the transmission of water, to be used as a beverage in any form, should be strong and durable, should admit of ready repair and replacement, be sufficiently cheap to permit general use, and, above all, should impart no deleterious property to the waters served through them. The safety of using water supplied through wooden aqueducts, and the certainty of their rapid decay, are too well known to require more particular mention. Pipes of iron, tin, of tinned iron, tinned copper, tinned lead, glass, and gutta percha, are of comparatively recent introduction. They are believed, so far as experience has shown, to impart few or no deleterious properties to water as a beverage, though all of them are wanting in some of the essential attributes just mentioned.

"As pipes of lead have been long in use, and possess in an eminent degree most of the properties required for aqueduct service, and as the following researches have been more especially directed to ascertain the true value of leaden pipes for the distribution of water, a brief historical sketch of the opinions that have been entertained with regard to the safety of employing them may not be without interest.

"The period of the first employment of lead for transmitting water is unknown; but the fact that it was condemned by Vitruvius, a Roman architect believed to have lived about nineteen hundred years ago, is evidence of its having at that time been long enough in use to furnish the experience which led to its rejection as a material for aqueducts.* Galen, a physician of Amsterdam, who wrote in the seventeenth century, coincided with Vitruvius. Both had observed the formation of white lead in water-pipes, and attributed to it the illness which was known to affect those who drank certain waters served through leaden pipes. Notwithstanding these strongly expressed opinions and occasional fatal consequences from drinking water containing lead in solu-

* Leaden pipes may be seen at this day among the ruins of the Coliseum, and leading to the baths and fountains of Herculaneum and Pompeii.

Kopp thinks lead as a metal was known to the Israelites. *Geschichte der Chemie.* It is certain that it was known and in use 400 years before the Christian era.

tion, public sentiment continued strongly in favor of this kind of pipes; and until about the commencement of the present century no experimental examination of the subject had been undertaken. Dr. Lamb of England, and later Guyton Morveau of France, devoted their attention for a time to this inquiry. Their opinions illustrate the uncertainty which attends the earlier labors in every field of investigation. The one believed that most, if not all, spring waters possess the property of acting upon lead to such an extent as to render their conveyance through leaden tubes unsafe, and this *because of the salts in solution;* — the other, that many natural waters scarcely act on lead at all, and *because of the salts in solution.* The former believed that rain or snow water (eminently pure) does not corrode lead; the latter, that distilled water, the purest of all waters, acts rapidly on it. Dr. Thompson of Glasgow subsequently gave some consideration to the subject, and came to the conclusion, that, though Dr. Lamb's general proposition was true, the lead was not *dissolved*, but *suspended merely*. Such was the doubt upon this point, — the insolubility of oxide of lead, — that a scientific association in Germany made it a prize problem. The honor of deciding the question was accredited to Brendecke, whose views were coincided in by his unsuccessful competitor, Siebold,* and also by Herberger, who prepared his oxide of lead in a different manner, and reported his results at a later period. They decided that *oxide of lead is insoluble* in water.

"The imperfection of the investigation and the injustice of this award have since been established by the labors of Yorke,† and Bonsdorff,‡ who have found that aerated, distilled water, deprived of carbonic acid, oxidates metallic lead and dissolves the oxide in the proportion of from $\frac{1}{7000}$th to $\frac{1}{12000}$th. Even the acute Scheele had remarked the same fact in the last century. Philips denied the accuracy of the conclusions of both Yorke and Bonsdorff, and maintained, with Thompson, that the oxide of lead was not soluble, but was only in suspension. His view was supported by the fact, that filtration seemed to separate the lead from the water that originally contained it. In 1846 Yorke § reviewed the investigation of Philips, and showed that, in filtration, the oxide of lead enters into combination with the woody fibre of the filter-

* *Phar. Cent. Blatt.*, 1835, p. 831; *Buch. Rep.*, III, pp. 155–179.

† *Pogg. Ann.*, XXXIII., pp. 110–112.

‡ *Phar. Cent. Blatt.*, 1836, p. 520; *Buch. Rep.*, V., pp. 55–59.

§ *Phil. Mag.*, XXVIII., pp. 17–20.

ing paper. By filtering for some time through the same paper it became saturated, and the lead in solution passed without detention.

"Christison, to whom we are indebted for a careful record of the principal conflicting opinions upon this subject, repeated and extended the experiments of Guyton Morveau, to ascertain the effect of solutions of certain salts in water. He came to the conclusion that arseniates, phosphates, sulphates, tartrates, and even chlorides, acetates, and nitrates, possess the power of protecting lead from the action of the water. Of the nature of this protecting power he acknowledges that he has no clear conception. He assured himself that it does not in all cases arise from the formation of an insoluble coat consisting of the acid of the employed salt united to the oxide of lead, by finding that the coat, which for the most part, in his experiments, consisted of carbonate of lead, readily dissolved in acetic acid. This author has suggested that leaden pipes, before being laid down for service, should be exposed a length of time to solutions of some of the salts, denominated *protecting;* having observed that leaden pipes, which poisoned certain waters when first served, after a time became coated, and passed the same waters without injury to the health of those who drank them.

"The city of London has long been supplied with water distributed through lead, and though occasional excitements upon this subject have sprung up in Great Britain from individual cases of poisoning, the prevailing public sentiment is in favor of lead. Professor Graham states that in London lead only is used for service-pipes. The exemption of Paris from illness derived from this cause is asserted by Tanquerel.* This is believed to be true of all the larger European towns whose inhabitants are supplied with water from public reservoirs. On the other hand, the inhabitants of Amsterdam were poisoned by drinking rainwater that had fallen on leaden roofs; and on replacing the lead with tiles, the maladies ascribed to the former disappeared.

"We find ourselves at the conclusion of the literature of the Old World upon this subject with these impressions: —

"1st. That some natural waters may be served from leaden pipes without detriment to health. 2d. That others may not; and 3d. That we have no method of determining beforehand whether a given water may or may not be transmitted safely through lead.

"Professor Silliman, Jr., in his able report on the various waters sub-

* Tanquerel *on Lead Diseases*, edited by Dana, App., p. 396.

mitted to him by the Water Commissioners, in 1845, has given the results of some experiments upon the action of several waters on lead, which conducted him to the general conclusions above expressed.* Among those who have taken strong ground against leaden service-pipes for the transmission of water may be mentioned Drs. Chilton and Lee of New York, and Drs. Dana and Hayes of Lowell.

"The occasion of the following research was the request by the Board of Consulting Physicians of the city of Boston, in January of 1848, that a comparison of the action of Cochituate Lake, Jamaica Pond, and Croton and Schuylkill River waters upon lead should be instituted. Cochituate water was about to be introduced into Boston for the supply of the city. Jamaica water has been employed in certain sections of the city of Boston since the year 1795, and for the last twenty years served through leaden pipes. Croton River water, since 1842, has been supplied through iron mains and leaden service-pipes to the citizens of New York, a city of 400,000 inhabitants. Schuylkill River water, since the year 1815, has been supplied through iron mains and leaden distribution-pipes to the inhabitants of Philadelphia, a city of 300,000 inhabitants. The inquiry that early presented itself to the Board of Consulting Physicians was the following: — *Will there be greater liability to lead-disease from drinking Cochituate water, served through iron mains and leaden pipes, than there is now from drinking Fairmount or Croton waters similarly served, or Jamaica water possibly less favorably served than Cochituate water will be?*

"To answer this question, Croton, Fairmount, Jamaica, and Cochituate waters were provided with care, and the proposition made that lead should be presented to them all under similar circumstances. It was not proposed to introduce the absolute conditions of actual service in a series of laboratory experiments. It was conceived that, when in contact with lead, all the external circumstances being the same, the differences in the action upon lead would be a kind of exponent of the differences in constitution among the waters. A sufficiently extended series of experiments, it was believed, would reveal all the expedients to be resorted to in order to the fulfilment of the required conditions, and would, if duly extended, furnish replies to the various inquiries into which the main problem of the measure of safety or danger resolved itself.

* *Boston Water-Com. Report,* App., 1845.

"Should the experiments result in showing that the several waters were alike in their action upon lead, then would the citizens of Boston, in drinking Cochituate water served from leaden pipes and iron mains, be as little liable to lead-disease as are the citizens of Philadelphia and New York who drink Schuylkill and Croton water similarly served, and that portion of the citizens of Boston who have for nearly a quarter of a century employed Jamaica water served through lead. Should Cochituate water be found to act less on lead than Jamaica water, all external circumstances being the same, then would the question be affirmatively and more satisfactorily decided; since these two waters occur in the same geological associations, are about equally pure, and the latter has been drunk under less favorable circumstances than Cochituate will be, so far as the relations to lead are concerned. On the other hand, should the inequality in action of the waters be great, and that of the Cochituate uniformly most energetic, then would the question, so far as this mode of investigation could influence it, be decided in the negative.

"The experimental result being favorable, the question of probable future illness to arise from drinking Cochituate water would be decided by an appeal to those physicians of New York, Philadelphia, and Boston, whose extensive practice and standing in the profession demand confidence in their opinions; and by an appeal to public sentiment, where every day's experience among all classes, the less and the more careful, contributes to its formation.

"Such experiments have been made with all the waters above mentioned, and at the same time, in many cases, parallel suites with Albany and Troy reservoir waters, Cambridge well-water, and distilled water, contemplating all the conditions that could be expected to occur. They were conducted in an apartment where, with rare exceptions, no other laboratory labor was carried forward than that connected with this investigation, and in which the tests with hydrosulphuric acid were not made. Whatever influences from temperature or other causes operated upon any one of the waters operated equally upon each of the others. With the exception of Cochituate water, which possessed a yellowish-brown tint, the samples were colorless. A determination of their general relations to each other was made.*

* Professor Silliman, Jr. has made a similar determination of the relations of the Croton, Cochituate, and Fairmount waters. *Water-Com. Report,* 1845.

" *Albany Reservoir Water.* — 500 cubic centimetres evaporated to dryness in a platinum capsule over a water-bath gave, of solid residue, 0.0924gr. Ignited, the above residue lost 0.0198gr.

" *Cambridge Well-water*, that does not act on lead so as to produce known deleterious effects. — 500cc. evaporated to dryness over a water-bath gave, of solid residue, 0.3918gr.; of which 0.0990gr. were expelled by ignition, and of the non-volatile matters 0.0676gr. were insoluble in boiling water.

" *Cambridge Well-water*, that, in an inch-and-a-quarter pipe several years in use dissolves a grain and a half of lead in thirty-six hours. — 500cc. evaporated to dryness over a water-bath gave, of solid residue, 0.1380gr.; of which 0.0540gr. were expelled by ignition.

" *Cochituate Lake Water.* — I. 500cc. evaporated to dryness over a water-bath gave 0.0267gr. of solid residue; of which 0.0122gr. were expelled by ignition, and 0.0050gr. of the remainder insoluble in boiling water. — II. 500cc. over a water-bath gave a solid residue of 0.0267gr.

" *Croton River Water.* — 500cc. evaporated to dryness over a water-bath gave, of solid residue, 0.2175gr.; of which 0.1496gr. were expelled by ignition.

" *Fairmount Water, Schuylkill River.* — 500cc. evaporated to dryness over a water-bath gave, of solid residue, 0.3007gr.; of which 0.1032gr. were expelled by ignition, and of the non-volatile matters 0.0239gr. were insoluble in boiling water.

" *Jamaica Pond Water.* — 500cc. evaporated to dryness over a water-bath gave, of solid residue, 0.0268gr.; of which 0.0115gr. were expelled by ignition, and of the non-volatile matters 0.0070gr. were insoluble in boiling water.

" *Troy Reservoir Water.* — 500cc. evaporated to dryness over a water-bath gave, of solid residue, 0.0593gr.; of which 0.0181gr. were expelled by ignition, and of the non-volatile matters 0.0278gr. were insoluble in boiling water.

" The above results are expressed in tabular form in Table I.

" The following tables of results will sufficiently explain themselves. They exhibit quantities of lead which, for practical purposes, have little more than relative value in the columns in which they occur.

" The experiments were made with bars of lead cast in a common mould, of uniform diameter and length. The quantities of water were constant, or as nearly so as might be, in the same series of experiments. The bars were covered, in test-tubes of a given diameter, with fifteen cubic centimetres.

"After exposure out of direct sunlight, except where otherwise stated, a length of time indicated in the column of days at the left, a suite of similar tubes was filled to the requisite depth with corresponding waters, and the bars transferred with the least delay.

"The waters were then acidulated with acetic acid, received each a drop of acetate of potassa, — which Fresenius has observed decomposes all lead salts not decomposed by hydrosulphuric acid, — and exposed to a stream of washed hydrosulphuric acid till the liquid became clear, if it had been at first discolored by the precipitate of lead. If concentration occurred, it is so stated. The quantities were estimated by a method to be described farther on.

"TABLE I.

	Residue.	Loss upon being Ignited.	Inorganic Matter.	Insoluble after Ignition.
	gr.	gr.	gr.	gr.
Distilled water,	0.0000	0.0000	0.0000	0.0000
Albany "	0.0924	0.0198	0.0726	. . .
Cambridge "	0.3918	0.0990	0.2928	0.0676
Cambridge water that acts on lead,	0.1380	0.0540	0.0840	. . .
Cochituate water,	0.0267	0.0122	0.0145	0.0050
" "	0.0267	. . .	. . .	. . .
Croton "	0.2175	0.1496	0.0679	. . .
Fairmount "	0.3007	0.1032	0.1975	0.0239
Jamaica "	0.0268	0.0115	0.0153	0.0070
Troy "	0.0593	0.0181	0.0412	0.0278

"TABLE II. — *Experiments with Lead to ascertain the Action of Water on Successive Days.* — One bar resting on the bottom of each test tube. Waters replaced at the date of each result.

Days.	Cochituate.	Croton.	Fairmount.	Jamaica.
1	5.000	2.000	7.000	10.000
3	0.500	0.500	0.000	10.000
4	1.000	0.500	2.000	0.000
5	10.000	2.000	5.000	1.000
6	0.100	0.100	0.100	0.500
7	0.100	0.100	0.100	0.100
8	0.200	0.200	0.200	3.000
11	0.100	0.100	0.100	1.000
12	0.100	0.100	0.200	0.500
13	0.000	0.000	0.100	0.500

"The first modification of the experiment was in the extent of surface of lead.

"TABLE III. — *Experiments with Two Bars of Lead.* — In all other respects the conditions were the same as in the foregoing experiments.

Days.	Cochituate.	Croton.	Fairmount.	Jamaica.
1	5.000	5.000	1.000	10.000
3	3.000	2.000	1.000	2.000
4	0.500	0.500	1.000	0.000
5	0.100	0.100	0.100	0.100
6	0.100	0.100	0.100	0.010
7	0.100	0.100	0.010	0.200
8	0.100	0.100	0.010	3.000
11	0.100	0.100	0.100	1.000
12	0.100	0.200	0.100	5.000
13	0.100	0.200	0.200	5.000

"TABLE IV. — *Experiments with Three Bars.* — Other conditions same as before.

Days.	Cochituate.	Croton.	Fairmount.	Jamaica.
1	1.000	0.500	0.500	10.000
3	10.000	2.000	1.000	4.000
4	5.000	0.500	3.000	40.000
5	0.000	0.500	1.000	15.000
6	1.000	0.200	0.100	10.000
7	0.500	0.100	0.100	8.000
8	0.100	0.100	0.100	4.000
11	0.100	0.200	0.200	2.000
12	0.100	0.100	0.100	5.000
13	0.100	0.200	0.100	3.000

"From the foregoing experiments it was deducible, —

"1st. That the action upon lead was most energetic during the first few days of exposure.

"2d. That the differences between the action on one, two, and three bars, the volume of water remaining the same, being inconsiderable, the action could not be dependent upon the *surface* of lead exposed, but upon some other constant condition.

"The observation, that, where the bar touched the containing tube, the action seemed most vigorous, suggested an explanation of the want of uniformity in results. It further suggested experiments with *suspended bars*, the results of which are detailed in the following table.

" TABLE V. — *Experiments with Bars suspended out of Contact with the containing Vessel.* — Waters not exposed to sunlight. Average results of four series of experiments. One bar to each tube. No concentration.

Days.	Cochituate.	Croton.	Fairmount.	Jamaica.
1	15.500	1.500	0.280	80.000
2	0.012	0.012	0.012	2.750
3	0.012	0.001	0.000	0.027
4	0.000	0.000	0.000	0.000

" These experiments and the foregoing seemed to show that, without contact of the solid metal with the containing vessel, the influence of the 'constant condition' was so far enfeebled, after the first few days, as not to have its effects recognized by the ordinary reagents, without concentration, after a period of twenty-four hours' exposure. The following table of results confirms this deduction.

" TABLE VI. — *Experiments with Water several Weeks exposed to Light and the Warmth of the Apartment in which the Experiments were made, by which much of the contained Air had been expelled.* — Bars suspended out of contact with the tube. Volume as in the preceding experiments.

Days.	Cochituate.	Croton.	Fairmount.	Jamaica.	Distilled Water.
1	1.000	0.500	0.000	0.050	25.000
3	0.050	0.010	0.000	2.000	15.000
5	0.010	0.000	0.000	0.050	15.000
7	0.000	0.000	0.000	0.000	15.000
9	0.000	0.000	0.000	0.000	15.000
12	0.000	0.000	0.000	0.000	15.000
17*	0.020	0.010	0.000	0.000	30.000
24*	0.050	0.000	0.000	0.000	0.500
39*	0.500	0.000	0.100	0.100	3.000

" As the street mains are of iron, it was desirable to know if the contact of lead with iron could be more injurious to Cochituate than to Croton, Fairmount, or Jamaica water. Experiments were also made with Albany and Troy reservoir waters, and the Cambridge well-water first in the order of succession in Table I.

* Water concentrated to one fourth of its volume.

"Table VII. — *Experiments with Lead and Iron.* — Iron uppermost. Lead solder. Volume of water as in previous experiments.

Days.	Distilled Water.	Albany.	Cambridge.	Cochituate.	Croton.	Fairmount.	Jamaica.	Troy.
3	8.000	1.000	2.000	1.000	1.000	10.000	10.000	25.000
7	10.000	0.010	0.010	0.010	0.010	0.010	0.500	0.000
9	2.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
11	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
20	0.000	0.100	0.000	0.100	0.000	0.000	0.100	0.000
30	1.000	0.400	0.500	0.800	0.500	0.500	0.500	0.100
48	0.100	0.005	0.100	0.010	0.050	0.000	0.010	Lost.

"The discoloration of the bars of lead was least in this order: — Albany, Cambridge, Croton, Fairmount, Distilled Water, Jamaica, Cochituate. That is, Cochituate, apparently, most promptly and completely coats the lead.

"Table VIII. — *Experiments with Lead and Iron.* — Lead uppermost. Lead solder. Volume of water same as in previous experiments.

Days.	Distilled Water.	Albany.	Cambridge.	Cochituate.	Croton.	Fairmount.	Jamaica.	Troy.
2	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500
3	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
7	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
16	0.010	0.010	0.100	0.010	0.010	0.010	0.010	0.010
26	0.500	0.100	0.010	0.010	0.010	0.010	0.010	0.010
44	3.000	0.050	0.100	0.100	0.100	0.100	0.100	Lost.

"Sections of each bar at first less coated near the iron. Larger measure of protoxide of iron in Cochituate and Croton waters than in the others, as indicated by ferrocyanide of potassium. Discoloration of the bars least in this order: — Fairmount, Distilled Water, Albany, Troy, Croton, Jamaica, Cochituate.

Table IX. — *Experiments with Lead and Iron.* — Soft solder. Volume and other conditions as in previous experiments.

Days.	Distilled Water.	Albany.	Cambridge.	Cochituate.	Croton.	Fairmount.	Jamaica.	Troy.
3	10.000	6.000	6.000	6.000	1.000	10.000	7.000	7.000
12	. .	1.000	Lost.	1.000	1.000	1.000	1.000	2.000
17	30.000	0.000	0.050	0.010	0.500	0.000	0.500	0.000

"As the stopcocks will, many of them, be of brass, it was important to ascertain the influence of this connection.

"TABLE X. — *Experiments with Lead and Brass.* — Surfaces of lead and brass nearly equal. Volume of water as before mentioned.

Days.	Distilled Water.	Albany.	Cambridge.	Cochituate.	Croton.	Fairmount.	Jamaica.	Troy.
1	5.000	2.000	0.500	0.800	25.000	0.100	1.000	5.000
3	8.000	2.000	1.500	1.500	2.000	1.500	1.500	8.000
7	20.000	0.800	10.000	10.000	2.000	1.500	20.000	7.000
33	10.000	0.100	7.000	0.200	0.100	0.100	4.000	7.000
37	20.000	0.800	10.000	2.000	10.000	1.000	8.000	5.000
38	12.000	—	—	0.800	0.800	—	0.400	—
39	2.000	—	—	0.800	0.300	—	0.400	—
40	1.250	—	—	0.400	0.600	—	0.800	—
41	1.500	—	—	—	0.250	—	0.800	—
43	2.000	—	—	1.200	0.500	—	0.800	—

"As some stopcocks may be of copper, a suite of experiments was made to ascertain the effect of this union.

"TABLE XI. — *Experiments with Lead and Copper.* — A bar of lead and copper nail three fourths of an inch long. Lead solder.

Days.	Distilled Water.	Cochituate.	Croton.	Fairmount.
1	5.000	0.500	0.500	0.100
3	1.500	8.000	0.150	0.500
7	20.000	2.500	1.000	1.000
14	25.000	7.000	1.000	1.000
39	10.000	1.000	1.000	1.000
40	1.500	1.000	1.000	0.250
44	1.200	0.500	0.500	1.500
45	2.000	0.200	0.300	2.000
46	5.000	0.800	0.800	3.000
47	3.000	0.050	0.020	1.500
49	2.300	0.010	0.800	2.000

"TABLE XII. — *Experiments with Lead and Tin.* — A half-bar of each soldered without alloy. Volume of water as before mentioned.

Days.	Distilled Water.	Albany.	Cambridge.	Cochituate.	Croton.	Fairmount.	Jamaica.	Troy.
1	40.000	0 500	0.500	0.500	0.500	0.500	0.500	0.500
8	60.000	0.100	0.100	0.100	0.200	0.500	0.800	0.500
32	50.000	1.500	4.000	0.500	0.100	1.500	2.000	—
36	12 000	—	—	0.050	0.050	—	1.500	—
38	1.500	—	—	0.500	1.500	—	3.000	—
39	2.000	—	—	0.500	0.300	—	0.400	—
40	0.500	—	—	0.500	0.500	—	0.700	—
41	2.000	—	—	0.010	0.010	—	0.010	—
43	3.000	—	—	0.010	0.020	—	0.700	—

"Variation in some of the properties of the Cochituate water might be expected to take place. First, *in the percentage of organic matter.* Second, *in temperature.* Third, *in percentage of salts.*

"The effect of increasing the percentage of organic matter is exhibited in the following table.

"TABLE XIII. — *Experiments with Lead in graduated Solutions of Organic Matter (Tannin) in Cochituate Water.*

Days.	Cochituate.	Cochituate and $\frac{1}{100}$ of Tannin.	Cochituate and $\frac{1}{1000}$ of Tannin.	Cochituate and $\frac{1}{10000}$ of Tannin.	Cochituate and $\frac{1}{100000}$ of Tannin.	Distilled Water.
3	1.000	0.800	0.400	0.600	0.600	5.000
5	0.000	20.000*	0.500	0.250	0.250	20.000
6	0.500	2.000	0.500	0.100	0.100	4.000
7	0.000	2.000	0.200	0.000	0.000	3.000
8	0.050	0.500	0.100	0.000	0.000	2.500
10	0.000	0.500	0.000	0.000	0.100	3.000
11	0.000	0.000	0.000	0.000	0.000	2.000
12	0.100	0.000	0.000	0.000	0.000	3.000
13	0.050	0.000	0.000	0.000	0.000	2.000

"The bars of the third and fourth columns became more or less coated with a loose reddish-brown coat of organic matter and lead. The influence of increased organic matter of this form (which is as nearly allied to the vegetable matters that might be expected to occur in lake water as could be readily found) was to lessen the action on lead. The organic matters of lake and river waters consist of living and deceased organisms, animal and vegetable, and of soluble substances derived from decaying vegetation. When exposed a sufficient length of time, these matters become thoroughly inorganic. The carbon becomes carbonic acid, and the hydrogen becomes water, by the consumption of oxygen in solution in the water.

"My experiments have shown, that, if the quantity of organic matter, such as the extract of bark, be more than $\frac{1}{10000}$ of the weight of the water, precipitates of the organic matter in combination with oxide of lead, if any is in solution, will take place. This is one of the methods frequently resorted to for separating organic bodies from solutions.†

* A kind of fungous or flocculent mass fell with the lead, augmenting the volume of the precipitate.

† This precipitate is visible in Croton service-pipes five years in use. It occurs in the Jamaica service-pipes in Boston, and, I have been informed, in those of Fairmount water in Philadelphia.

"The effect of temperature was sought in a variety of ways.* The following experiments are recorded.

"TABLE XIV. — *Experiments with Bars previously coated, exposed to direct Sunlight from the 21st to the 26th of June.* — Bars resting on the bottom of the tubes.

Days.	Cochituate.	Croton.	Jamaica.	Distilled Water.
1	0.100	0.200	3.000	3.000
2	0.250	1.500	2.000	2.000
3	0.100	0.400	2.000	1.000
4	0.050	1.000	1.500	2.000

"The influence of extreme temperature and exposure to air and moisture, under the most favorable circumstances, was ascertained by transmitting steam mixed with air through a leaden pipe thirty-six feet long, coiled like a still-worm, and placed in cold water to produce condensation. One hundred and ten cubic centimetres of the condensed water, after acidulation with acetic acid, were treated with a stream of hydrosulphuric acid. The precipitate was collected on a filter, previously dried at 100° C., and gave 0.0225gr. of sulphide of lead, equal to 0.0196gr. of lead; which is equivalent to 0.8095gr. of lead in a gallon. Whatever influence might result from such changes, it must be remembered that pipes under ground will preserve a tolerably even temperature; and be the effect of increased heat what it may, it has been *more* energetic in Philadelphia than it ever can be in Boston.

"The effect of increasing the percentage of common salt is exhibited in the following table.

"TABLE XV. — *Experiments with Cochituate Water and graduated Solutions of Common Salt.* — Bars and volumes as in the foregoing experiments. No concentration. Bars resting on the bottom of the tubes.

Days.	Pure Cochituate.	Cochituate and $\frac{1}{100}$ of Chloride of Sodium.	Cochituate and $\frac{1}{1000}$ of Chloride of Sodium.	Cochituate and $\frac{1}{10000}$ of Chloride of Sodium.	Cochituate and $\frac{1}{100000}$ of Chloride of Sodium.
1	2.00	.20	.30	1.60	2.00
2	1.80	.10	.15	.60	1.20
3	.20	.10	.08	.08	.30
8	.30	2.50	1.20	.30	.50

* Dr. Hayes has observed that elevation of temperature increases the quantity of lead dissolved in a given time. — *Report of the Consulting Physicians*, 1848, p. 24.

"These results show, —

"1st. The immediate effect of the salt in preventing the action on lead by lessening the solvent power for air; and

"2d. The influence of salt in dissolving the coat formed, by double decomposition, or by the formation of the double salt of the oxide and chloride; as shown in the last suite of results.

"The preceding experiments, as a whole, go to *show that Cochituate water may be distributed through iron mains and leaden service-pipes with as little danger as Schuylkill, Croton, or Jamaica water.*

"The consideration that was to give value to these determinations was that of the health of the citizens of Philadelphia, New York, and Boston, so far as it might be influenced by the waters served through lead in the respective cities. This was to be decided, as already intimated, by an appeal to the most enlightened testimony that could be furnished; that of eminent physicians of extensive practice in the localities where lead pipe is employed."

Professor Horsford then adduced a summary of the numerous medical opinions, chiefly compiled from letters addressed to himself, and which have been already published in the Appendix to the Water-Commissioners' Report of August 14th, 1848.

"The decision of this question does not depend upon the presence or absence of a minute quantity of lead in water that has been standing a given length of time in leaden pipes, or upon the *absolute* freedom from corrosion of pipes long in use. For if a certain quantity, more or less, has found its way into the human system in the every-day regular use of Croton and Schuylkill waters, then must the human system be capable of sustaining without injury this quantity; and the possibility of receiving an equal quantity hereafter by those who drink Cochituate water may be contemplated without solicitude, since the experiment has been made.* Nevertheless, examinations for lead have been made in many well-waters, and also in Croton, Jamaica, Schuylkill, and Troy waters, and Dedham spring water. The results follow.

* To this point more particular reference will hereafter be made.

" TABLE XVI. — *Determinations of Lead in Well-waters served through Leaden Pipes in Cambridge.*

	Volume.	Hours Exposed.	Reduced Volume.	Sulphide of Lead.
				gr.
a	100cc.	36	10cc.	0.000
"	200	36	10	0.000
"	300	36	10	0.000
b	500	12	16	0.000
c	100	12	10	Precipitate.
"	50	12	10	"
"	40	12	10	"
"	30	12	10	0.000
	gallon	12	10	0.100
d	500cc.	12	5	0.000
e	100	12	5	Precipitate.
	gallon	12		0.080
f	300cc.	12	5	Precipitate.
	gallon	12		0.0004
g	500cc.	12	20	0.000
h	200	36	5	0.00005
	gallon			0.00113
i	300cc.	12	10	0.0009
	gallon			0.0136

" *Well in Boston.* — 200cc., first drawn in the morning, gave, when concentrated to 5cc., 0.00003gr. = 0.00068gr. in a gallon. Dr. Charles T. Jackson has detected lead in a well-water in Waltham.

" *Well in Dedham.* — 100cc. of water standing over night in the pipe serving from the reservoir supplied by a forcing-pump, concentrated to 5cc., gave a trace of lead.

" Water supplied from the spring in Dedham, which is known to have corroded leaden pipes, and poisoned at least one individual. — 100cc., at rest twelve hours in leaden pipe several years in use, gave 0.00003gr. = 0.0013gr. in a gallon. Several years since, my friend, Dr. Webster, examined some of this water from the pipes of the gentleman who was made ill, and detected lead, without concentration, by treatment with sulphide of ammonium.* This branch pipe was 150 feet in length. The main pipe, two inches in diameter, is about three quarters of a mile long. This pipe must be capable of holding a gallon in a little more than seven and one third feet, or 540 gallons in its whole length. Thus, the entire morning draught of *spring water* of each

* Such was the quantity of lead in solution, that a white film (of carbonate and hydrate of lead) rose to the surface of this water, after being drawn a short time.

family had ordinarily been at rest twelve hours in the main and lateral pipes. In some instances it had doubtless been longer at rest; and yet, so far as I have been informed, but one well-established case of lead disease is known to have occurred from the use of this water.

"TABLE XVII. — *Determinations of Lead in the Croton Water of New York.* — Drawn, after thirty-six hours' exposure, from leaden pipes, at seven different localities, in the neighbourhood of John Street.

Bottles.	Volume.		Volume.				
1.	500cc.	reduced to	10cc.	gave,	of Sulphide	of Lead,	00
2.	"	"	"	"	"	"	00
3.	"	"	"	"	"	"	00
4.	"	"	"	"	"	"	00
5.	"	"	"	"	"	"	00
6.	"	"	"	"	"	"	00
7.	"	"	"	"	"	"	trace.

"1000cc. derived from bottles 1, 2, and 3, concentrated to 10cc., gave, with hydrosulphuric acid, a precipitate which, ignited with saltpetre and redissolved, gave, with bichromate of potassa and hydrosulphuric acid, distinct precipitates of lead. The whole quantity equalled about 0.0001gr., or for a gallon 0.00045gr.

"*Determination of Lead in the Schuylkill Water of Philadelphia.* — According to Professor Booth, 100 apothecaries' ounces, after exposure 36 hours in leaden pipe, a year and a half in use, concentrated to the bulk of half an ounce, gave not the slightest discoloration after transmitting hydrosulphuric acid through it for an hour.

"*Troy Reservoir Water.* — 2000cc., 24 hours at rest in leaden pipes several years in use, gave, when concentrated to one hundredth of its volume, no trace of lead.

"TABLE XVIII. — *Determinations of Lead in Jamaica Water served through leaden Pipes in the City of Boston.*

"April 13th.			Exposed to the Lead.			Gave of Sulphide of Lead.
No. 6 Hudson Street,		200cc.,	12 hours,	reduced to	20cc.	00
No. 10	" "	"	"	"	"	00
No. 98	" "	"	"	"	"	00
No. 800 Washington Street,		"	"	"	"	00
No. 10 Tyler Street,		"	"	"	"	00

"April 13th. Worcester Railroad Depot, 1000cc., exposed to the lead 36 hours, reduced to 20cc. gave, of sulphide of lead, 00gr.

"June 19th. Worcester Railroad Depot, 500cc., exposed to the lead 36 hours, reduced to 5cc., gave, of sulphide of lead, 0.00002gr.* = 0.00018gr. in a gallon.

"The magnitude of this quantity, and the influence its known presence in a water should have, may be over-estimated.

500 cubic centimetres contain				0.00002gr.
1000	"	"	"	0.00004gr.

"Wiesbaden water contains of arsenious acid, in 1000cc., 0.00045gr.,† — a quantity more than ten times as great as the lead in Jamaica water, and yet this water is renowned for its medicinal virtues. It may be said, that the arsenic is in combination with oxide of iron. Chevallier and Gobley have come to the conclusion, that its occurrence in springs is not dependent upon the presence of iron.‡ It is found in water whose character is determined by the presence of carbonic acid or sulphates. This body occurs in *solution* in waters from nine mineral springs in France. Its occurrence in Germany has been recognized, among others, by Will.§ Tripier found it in Algiers.

"The appearance of leaden pipes taken up after several years' use, in New York, is what might have been expected. I have examined twelve pieces from as many different localities. Most of the specimens that had been in use for only one and two years were covered with a bluish-gray coat, and some of them could scarcely be distinguished from ordinary pipe for sale in the shops. A specimen in use five years is coated with a transparent, exceedingly thin, reddish-brown film, apparently composed of organic matter, oxide of lead, and oxide of iron. The crystalline laminæ upon the inner surface, characteristic of new pipe, are to be seen with the utmost distinctness, and present, with the exception of the coating, no appearance distinguishing it from new pipe.

"Jamaica pipe, in use from fifteen to twenty years, is coated with a thick, reddish coat, which, when dry, may be readily disengaged, and in one specimen examined shows traces of slight corrosion beneath. The corrosion from without was such as to have nearly eaten through in some places. The lead of this pipe contained great proportions of antimony where corrosion occurred, but no sulphide of lead, which, I am informed, occurs in much lead pipe.

* Precipitate ignited, redissolved, and re-precipitated.

† *Compt. Rend.*, Tom. XXIII., pp. 612–615, 634, 635.

‡ *Journ. de Ph. et de Ch.*, 3 Ser., Tom. XIII., pp. 324–333.

§ *Ann. der Chem. und Pharm.*, LXI., pp. 192–204.

"Pipe employed to conduct Dedham spring water is internally corroded, and presents at intervals deep depressions, the result of more extreme local action. Pipe of one well in Cambridge is appreciably corroded. Pipe of wells in Boston is frequently consumed in periods of from six to eighteen months.

"The above results and observations show, that, —

"1st. Many well-waters, in a space of time comparatively short, act on lead. This has been fully established by the researches of Dr. Dana * in this country, and by observations in England.

"2d. That, except after longer exposure than will ordinarily occur in actual use, the amount of lead coming into solution in Croton, Schuylkill, or Jamaica waters is too small to occasion any solicitude.

"Hence it may be inferred from the above, and from the great similarity of Cochituate to Jamaica, Croton, and Schuylkill waters, in its relations to lead, that *the quantity of lead that will be dissolved in Cochituate water in actual service will, for all practical purposes, be of no moment.*

"The recognition and quantitative determination of very minute quantities are not always without difficulty; where many and rapid determinations are required, the processes of gathering upon a filter, washing, drying, igniting, and weighing consume far too much time, and are sometimes less accurate than other and more indirect methods. That which I have employed is based upon the mode of analyzing silver coin proposed by Gay-Lussac,† and adopted quite universally at mints. The same general method has been extended by Gay-Lussac to ascertain the strength of alkalies and bleaching-powder. It is employed with protosulphate of iron and subchloride of mercury for the latter purpose. It is the method of graduated solutions. A gramme of lead in the form of the acetate (common sugar of lead), which contains three atoms of water, is dissolved in 100 grammes or parts of distilled water. This constitutes solution No. 1. Ten parts of this solution are diluted with ninety parts of water to make solution No. 2. Ten parts of solution No. 2, diluted with ninety parts of water, make solution No. 3. In the same manner solutions No. 4, No. 5, and No. 6 are prepared.

"Ten parts of each solution are placed in corresponding test-tubes (about six inches long, five eighths of an inch wide, and closed at one end), and hydrosulphuric acid transmitted through them till the liquid,

* Appendix to Tanquerel, by Dana. † *Annales de Chemie et de Physique.*

first blackened by the formation of sulphide of lead, becomes clear. Test-tube No. 1 contains one tenth of a gramme of lead in the form of sulphide, — a black powder at the bottom. Test-tube No. 2 contains one hundredth of a gramme. No. 3, one thousandth. No. 4, one ten-thousandth. No. 5, one hundred-thousandth. No. 6 yielded no precipitate without concentration. Each succeeding precipitate in the series, setting aside a slight allowance to be made on account of solubility, was one tenth as voluminous as the one above.

"Having prepared this scale of quantities, it is required to determine the amount of lead in a given diluted solution. An experiment is made to ascertain if the quantity be large enough to give a direct precipitate with sulphide of ammonium. This being decided in the negative, fifty cubic centimetres or grammes of water (corresponding with fifty parts of the scale of solutions) are carefully evaporated to dryness and ignited in a small porcellain capsule (to expel any organic matter that may have been present), moistened with nitric acid, and then warmed, with the addition of acetic acid and water, till the volume becomes ten cubic centimetres. A drop of acetate of potassa is then added, and then hydrosulphuric acid gas transmitted through the solution. A precipitate results, or it does not. If it does, to know its value or the amount of lead it contains, the scale is resorted to. Though it might rarely be possible to identify it with either one of two precipitates in the scale, there could be no difficulty in deciding between which two it should fall, or nearest to which one of two it should be placed. If fifty cubic centimetres thus treated yielded no precipitate, one hundred cubic centimetres were evaporated to dryness, and the residue similarly treated. If this failed, five hundred cubic centimetres were taken, and in some instances more, and the same course pursued.

"It was natural to suppose that the presence of foreign bodies, such as occur in natural waters, might embarrass the precipitation. This led to the preparation of a series of graduated solutions of lead, with all the common salts occurring in waters, from the reagents in my laboratory. They were similarly treated with acetate of potassa, free acetic acid, and a stream of hydrosulphuric acid, and though it was possible to see differences in the amounts of the precipitates, they fell very greatly within the differences between the successive members of the graduated series.

"The precipitates in the experiments with bars of lead, the results of which are given in the preceding tables, were estimated from this scale.

They were, however, not ignited and redissolved, as in the examination of waters exposed in lead pipe, and the numbers were intended, as already remarked, to express only relative values.

"*Influence of Nitrates.* — Although medical testimony and public sentiment were conclusive upon the subject of the health of our larger cities, so far as it might be influenced by the lead contained in the reservoir-waters used for culinary and general purposes, it was equally certain that individuals had been poisoned from drinking the waters of wells, and in one case, at least, from drinking water from a spring. It was obvious, therefore, that between these two classes, river, lake, pond, and open reservoir waters on the one hand, and well and some spring waters on the other, there must be differences in their relations to lead. Experiments were made with well-water, and at the same time with the river and lake waters in my possession. The following result shows with what success.

Table XIX.

Days.	Well-water.	Cochituate.	Fairmount.
3	1.00	1.00	.15
5	.20	.00	.60
6	.30	.50	.00
7	.10	.00	.00
8	.00	.05	.00
10	.50	.00	.00
11	.00	.00	.00

"The bars rested on the bottoms of the tubes, and the waters had been some time standing in sunlight. These experiments threw little light upon the subject. The differences in favor of the Cochituate and Fairmount, as compared with a well-water known to act vigorously on lead pipe, were too inconsiderable to be worthy of notice. These waters contained in 500cc.

	Of Solid Residue.	Of Organic Matter.	Of Inorganic Matter.
Well water,	0.1380gr.	0.0540gr.	0.0840gr.
Cochituate,	0.0267	0.0122	0.0145
Fairmount,	0.3007	0.1032	0.1975

"On comparing these, it will be seen that the water which contained the most solid residue acted least on lead, and that the action of that which contained least solid residue was next in order. The comparison of the analyses of waters made by different individuals led to no satisfactory results. Ingredients that might have been presumed to be in all had in some cases not been recognized. The only large suite of analyses made by a single individual first fell under my eye in the early part of June of 1848. In the following table are compared the average total amounts of inorganic matters, and also the relative amounts of the more prominent salts, in three wells, six springs, and six rivers, as determined by Deville.*

	Total.	Nitrates.	Chlorides.	Sulphates.	Carbonates.
Wells,	6455	1701	650	1394	2291
Springs,	3344	86	77	365	2336
Rivers,	1949	65	38	157	1185

"The compounds of sulphuric and carbonic acids with oxide of lead are eminently insoluble. The chlorides are less insoluble, and the nitrates are highly soluble.† The contrast between the quantities of nitrates in well and river waters suggested the experiment with lead and graduated solutions of saltpetre.‡ The results follow.

Table XX.

Days.	Pure Cochituate.	Cochituate and $\frac{1}{1000}$ of Saltpetre.	Cochituate and $\frac{1}{10000}$ of Saltpetre.	Cochituate and $\frac{1}{100000}$ of Saltpetre.	Cochituate and $\frac{1}{1000000}$ of Saltpetre.
1	1.00	1.00	2.25	0.75	0.50
2					
3	0.00	2.00	1.00	0.50	0.10
4	0.50	2.00	0.25	0.10	0.10
5	0.00	2.50	1.00	0.30	0.20
6	0.05	2.50	0.50	0.30	0.00
7					
8	0.00	2.00	0.80	0.05	0.00
9	0.00	1.80	0.70	0.00	0.00

* *Ann. de Chem. et de Phys.*, 3e Série, Tom. XXIII., pp. 33–47.

† Sulphate of lead is soluble in not less than 15000 parts of water. Gmelin. — Carbonate of lead requires 50551 parts of water. Fresenius, *Ann. der Chem. und Phar.*, LIX., S. 117–128. — Chloride of lead requires 135 parts of pure water, 534 of water containing chloride of calcium, and 1636 of water containing hydrochloric acid. Bischof. — Nitrate of lead dissolves in 1.989 parts of water at 63° Fahr. Karsten. — A solution of saltpetre containing 39 parts to 100 of water will still dissolve 110 parts of nitrate of lead. — Gmelin.

‡ O'Henry found nitrates in mineral spring-water in 1839. *Journ. de Pharm.*, Dec., 1838, pp. 634–637. — Liebig found nitrates in twelve wells in Giessen, and none in the wells of the surrounding country, by experiments made in 1827. "This fact has been noticed by Berzelius in Europe. I," says Dr. Dana, "have

TABLE XXI.

Days.	Pure Fairmount.	Fairmount and $\frac{1}{1000}$ of Saltpetre.	Fairmount and $\frac{1}{10000}$ of Saltpetre.	Fairmount and $\frac{1}{100000}$ of Saltpetre.	Fairmount and $\frac{1}{1000000}$ of Saltpetre.
1	0.15	1.00	0.80	0.80	0.80
2					
3	0.60	3.00	1.25	0.25	0.20
4	0.00	1.80	0.50	0.00	0.00
5	0.00	2.25	1.50	0.40	0.10
6	0.00	1.80	0.80	0.05	0.00
7					
8	0.00	2.50	0.80	0.20	0.05
9	0.00	1.80	0.80	0.20	0.00
10	0.00	1.80	0.80	0.20	0.10
11	0.00	1.20	0.80	0.00	0.00

" The mode of action of the saltpetre has been the subject of experiment. I had previously exposed bright bars of lead to natural waters containing traces of nitrates, which were deprived of air and sealed in glass flasks. Months had produced no action upon the lead, and had conducted to the opinion, that lead was not acted upon by nitrates in natural waters. As the reaction of the Cochituate or Fairmount water was perfectly neutral, the decomposition of the saltpetre by free acid, which should expose the lead to uncombined nitric acid, was not possible. Fresenius had observed that the carbonate of lead was less soluble in water containing nitrate of ammonia and ammonia than in pure water. I was aware that alkaline chlorides promoted the solution of certain lead compounds, and it occurred to me that they might be more soluble in waters from the presence of nitrate of potassa, soda, or lime.

" In changing the waters, from day to day, exposure to the air would furnish the oxygen and carbonic acid more directly than the absorption from the surface, for the formation of the hydrated oxide and carbonate, and these might to a slight extent, it seemed possible, experience

confirmed it in the water of a great number of wells in Lowell." *Appendix to Tanquerel*, p. 367. — Guyton Morveau, most of whose labors belong to the last century, mentions saltpetre as one of the salts denominated by him protecting in its influence on leaden pipes, when seeking to find the value as protectors of the different salts occurring in natural waters. CHRISTISON. — Dr. Dana has ascribed a prominent place to nitrates and chlorides in the action of well-waters upon lead. *Appendix to Tanquerel.* — Experiments with graduated solutions of common salt were made. See p. 74.

decomposition with the saltpetre. The decision of this point rested upon the following experiments.

"1. A solution of saltpetre, the usual laboratory reagent, was poured upon a quantity of common white lead, and, after repeated agitation and alternate rest, filtered off and tested with hydrosulphuric acid for lead. There followed an instantaneous, distinct, though not large, precipitate of sulphide of lead. There was an objection to the experiment. White lead prepared from the acetate might not be altogether free from acetate of lead. This, if present, might be brought into solution by the nitrate of potassa.

"2. To settle this point, a portion was carefully ignited upon platinum. Had there been appreciable acetic acid, the mass would have more or less blackened, or would have revealed to the sense of smell some evidence of its presence. It gave no indication whatever.

"3. A quantity of the white lead was then treated with sulphuric acid and alcohol in a test-tube, in the usual manner for detecting acetic acid by the formation of acetic ether. This failed to give a trace of acetic acid. The quantity of white lead was small.

"4. Four ounces of white lead were then boiled three hours with a large measure of diluted soda, filtered, concentrated, and treated with sulphuric acid and alcohol as before. It yielded no distinct trace of acetic acid.

"5. To meet the question fully, and give to the experiment the advantage of the nascent state which in actual practice must occur, and to give to the view an entirely unobjectionable foundation, I added to a solution of nitrate of lead, first, potassa, which threw down a hydrate of lead, and then carbonate of potassa, which threw down a carbonate of lead, until the solution yielded an alkaline reaction. There were then hydrate and carbonate of lead in the precipitate, and nitrate of potassa, carbonate of potassa, and if any lead, a nitrate of lead in solution. The liquor was filtered, and, upon adding hydrosulphuric acid to the filtrate, I obtained a precipitate of the black sulphide, more voluminous than in the first experiment with white lead and a solution of saltpetre.

"6. Soda and carbonate of soda gave the same reaction.

"7. Nitrate of lime in solution gave the same reaction as nitrate of potassa.

"My attention has been drawn by a friend to the following sentence in Berzelius: — 'When nitrate of lime is boiled with carbonate of lead, the oxide of lead is dissolved, while the carbonate of lime is deposited.'* If with the aid of heat such decomposition results, it might be conceived that, favored by the nascent condition, quantity, and time, there might be to some small extent a corresponding decomposition. The first was the principal experiment bearing on this point made at the date of my last letter to the Water-Commissioners, and upon this experiment, and the known solubility of the nitrate, I ascribed the increased action of water consequent upon the addition of nitrates to a slight double decomposition. It had been ascribed by Dr. Dana † to the conversion of the protoxide of iron, in solution as protosulphate, into the peroxide, by which he conceived there would be free sulphuric acid, and therefore free nitric acid, in water containing protosulphate of iron and nitrates. ‡ This explanation would not apply to the action of neutral waters, or of those containing no protosalts of iron, though nitrates were present. The whole subject has undergone a more thorough examination. The conclusion that nitrates are not reduced by lead I have found to be erroneous; for experiment has shown that upon boiling a strong solution of nitrate of potash to expel the air, and introducing a bar of bright lead, it became immediately coated with suboxide of lead, and this without the evolution of gas. There had been a partial reduction of the nitric acid. Upon testing the solution with hydrosulphuric acid, it gave, after long digestion, but a faint discoloration. Upon pouring off the liquor and adding to it oxide of lead, and continuing the digestion, a large quantity of lead was dissolved, which in 66cc. gave of sulphide of lead 0.0106gr. = 0.7296gr. in a gallon. The solution reacted strongly alkaline. As the only known inorganic salts of nitrous acid are its compounds with lead, it was probable that, upon the reduction of the nitric acid to nitrous acid, it had abandoned

* "Lorsqu'on fait boullir du nitrate calcique avec du carbonate plombique il se dissout de l'oxyde plombique tandis que le carbonate calcique reste." — *Traité de Chemie*, 1847, Tom. IV., p. 91.

† *Report of the Joint Special Committee of City of Lowell*, Aug., 1842, pp. 8 – 11.

‡ The change that takes place when a solution of copperas is exposed to the air may be thus represented: — $4 (Fe\,O, So_3) + 2O = Fe_2\,O_3, 3\,S\,O_3 + Fe_2\,O_3, S\,O_3$. The latter compound is insoluble in water. GMELIN. — The constitution of the precipitate, according to MITSCHERLICH and SCHEERER, is $2\,Fe_2\,O_3, S\,O_3 + 3\,H\,O$. WITTSTEIN (*Buch. Rep.*, 3 R., Bd. I., S. 182 – 189) gives it as $2\,Fe_2\,O_3 + 3\,So_3 + 8\,H\,O$. An acid salt remains in solution, which is probably what Dr. Dana would have understood from the statement that the above decomposition produces *free* sulphuric acid.

the potash to unite with the oxide of lead, or a basic soluble salt had been formed, in which potash was present. Upon examining the nitrate of potash employed as a reagent in the first experiment, and which had been purchased for this purpose because it was labelled *pure*, it was found to contain alkaline chlorides, — a circumstance to which the lead in the first experiment might in part be ascribed. A repetition of it with pure nitrate of potash and the hydrate and carbonate of lead, prepared by exposing lead to distilled water in an open vessel, gave but a faint discoloration with hydrosulphuric acid. I am inclined to ascribe to the reduction of the nitric acid much the greater part in the action of nitrates upon lead.

" *Action of Air.* — The importance of air in order to the action of a water upon lead has been intimated in the results already recorded. The following experiments confirm the observations of Yorke, Bonsdorff, and others, and, more recently, of Dr. Hayes, as expressed in his Report to the Consulting Physicians.*

" Experiment 1. — June 17th. An apparatus consisting of a half-gill flask, containing lead scrapings and Cochituate water, filled to half its depth, the lead all below the surface of the water, was connected by a tube, bent twice at right angles, with a vessel of mercury. The cork uniting the tube and the flask was carefully covered with sealing-wax. If, now, in the oxidation of the lead, oxygen should be withdrawn from the space above the water, mercury would rise to occupy its place. The mercury had risen, June 19th, three fourths of an inch; July 1st, four inches; July 22d, six inches; and in August the mercury passed over into the flask. Another similar apparatus prepared on the 16th of May showed, on the 10th of August, mercury at a height of $6\frac{1}{2}$ inches.

" Experiment 2. — A flask of a half-gill capacity was filled to two thirds its depth with distilled water, and boiled five minutes. While hot, and without delay, bars of bright lead were added, and the flask filled from another flask containing distilled water that had been boiling an equal length of time. In this condition a nicely-fitting cork was adjusted to the neck, and expeditiously sealed, so as to prevent the admission of air. Another flask was filled in the same manner with Cochituate water, and sealed. Both are in possession still. The bar in distilled water is quite as bright as when immersed, except around the end in contact with the glass, which has become a little coated. The

* *Report of Consulting Physicians*, Boston, 1848, p. 23.

bar in Cochituate water was bright for some months, but has at length become slightly dimmed in small patches, which may be attributed to the less complete expulsion of the air by boiling, or the less accurate stopping of the flask, though at the time the experiment was made both were regarded as unobjectionable.

"The following experiment shows how much is due to a change of water. The bars in the Cochituate remained quite bright, and those in the other waters were but slightly coated. Two bars in 15cc. for thirteen consecutive days, without changing the water, gave, in Cochituate, 0.500gr.; Croton, 0.500gr.; Fairmount, 0.500gr.; Jamaica, 1.000gr.

"These experiments seemed to show that, without a renewal of the air, the action nearly or quite ceases after a short time. Professor Silliman, Jr., made a similar observation in his experiments with the various waters submitted to him for analysis by the Water-Commissioners in 1845. He used a large volume of water, and yet the bar remained quite bright. There was no *alternate exposure to water and air*. Christison remarks, that, while certain waters might doubtless be kept with safety in leaden cisterns, the covers of the cisterns should not be of lead, but of wood, since the moisture condensing on them, furnishing, as he observes, *pure* water, would act on the lead, and the product falling would poison the water. The joint action of air and water is here presented under exceedingly favorable circumstances. The corrosion of cisterns along the line where air and water meet might be expected.

"It will be readily seen, from considering the important part air plays, how rain-water must act with great vigor upon lead. It contains air, and is surrounded by air, and, aside from temperature, could not be more favorably constituted for acting upon lead. The well-known prevalence of lead maladies in Amsterdam, while leaden roofs were in use, and the restoration of health on their replacement with tile, find here a ready explanation. Dr. Dana has recorded an experiment with rain-water, which furnishes a valuable confirmation of what is stated above.* In a series of experiments with lead pipe of considerable length, if an interval of half a minute, or even less, occurred between the emptying of the pipe and refilling, there was invariably found lead in the water. This has been observed on a large scale in the practical service of lead pipe. Where from any cause the pipes have been empty for a length of time and then filled, the first water drawn con-

* Appendix to Tanquerel.

tains a very considerable quantity of lead. In the experiments of the preceding tables, the tubes intended to receive the bars were previously filled, and thus the transfer of the bar from one tube to another occupied scarcely a second of time. Even this short period was doubtless adequate to provide for some of the oxidation which the bar experienced.* Important as the office of air is, it is not adequate of itself to oxidate lead. A bar of lead scraped bright and placed in a desiccator over sulphuric acid remained undimmed for weeks, — during the whole time of the experiment.

" *Influence of Light and Organized Substances in Water.* — It is a familiar fact, that well-water recently drawn and exposed to the light and warmth a short time loses much of its air, and becomes insipid. Count Rumford has made this fact the foundation of an important investigation. His conclusions in relation to the joint effect of sunlight and solid miscible, but insoluble, substances in expelling the air from waters, and thus showing a difference between lake, river, pond, and reservoir waters, which are exposed to sunlight, and well or spring waters, which are concealed from it, are of great importance in this connection.† I have made numerous experiments upon this subject, which, although still incomplete, taken in connection with the results of Count Rumford, go to establish the following positions: —

" 1st. Well waters contain more air in solution than lake, river, and pond waters, as a class. 2d. Sunlight and heat falling upon water containing solid insoluble substances, organic tissues, or pulverulent matter, expel a portion of the gases. 3d. The germs of animalculæ being

* I see, in the time between the emptying and filling of leaden pipes employed in experimenting, the explanation of much of the discrepancy between the results of different experimenters. If to this be added the unequal exposures to warmth and light which have been permitted by those engaged in experimenting, I am persuaded that most of the differences in results will be fully accounted for.

† He exposed spring water, containing, in a series of experiments, weighed quantities of raw silk, poplar cotton, sheep's wool, eider-down, hare's fur, cotton-wool, ravellings of linen, and Confervæ (hair-weed), to the sun's rays, and observed the quantity of air disengaged by each substance. It amounted in some cases to *one eighth* of the volume of water. *Philosophical Papers*, by Benjamin, Count Rumford, London, 1802, Vol. I., pp. 218 - 263.

The observations of Wöhler in 1843 (*Ann. der Chem. und Pharm.*, Bd. XLI., S. 121), and of Schultz in 1845 (*Journ. fur Prakt. Chem.*, Bd. XXXIV., S. 61 - 63, 1845), upon the evolution of oxygen from waters containing animalculæ and 'green plants,' under the influence of sunlight, were confirmations of some of the experimental results of Count Rumford.

present, oxygen will be given out and immediately expelled, until the maximum of the solvent power for air by the given temperature be attained. 4th. On the withdrawal of sunlight and the reduction of the temperature, the animalculæ cease to evolve oxygen, and that which is in solution becomes the prey of the decaying organic matters present. 5th. The hydrogen of organic bodies (as Liebig has remarked) oxidates first. This position I have verified by a series of observations, to which I will here only refer.

" The following experiment may be mentioned in this connection. Two clear glass globes of about four and a half inches in diameter, filled with waters from two wells in Cambridge, in one of which, after rest of twelve hours in leaden pipe, lead was detected, and in the other of which, after equal exposure, no lead was recognized, were placed in a window of south-southeast exposure. Into each globe a skein of silk weighing 1.25gr. was introduced ; at the end of five days, the quantity of gas evolved was more than twice as great in that containing the well-water that acted on lead as in the other. No admeasurement of the quantity was attempted, for the following reason : I wished to know what would become of these gases, — the water containing organisms which must soon consume their supply of nutriment. In a period equal to the above, the gases were entirely absorbed, and after the lapse of a month, during which time there were several days of brilliant sunshine, no gases appeared. An isolated experiment of this description cannot have much value. But it seemed to me worth recording, as sustaining what Liebig has remarked, that of the elements of organic bodies the hydrogen is more readily oxidated than the carbon, and as illustrating the decay of organic bodies in water.

" Of the various popular reasons why lead should not be employed for distributing water, the following have been found not to be sustained by experiment or authority.

" 1. *The Galvanic Action of Iron and Lead.* — The effect of contact with iron, in most of its points of view, has been investigated. In diluted acids, *bright* lead in contact with iron is positive, — *coated* lead, *negative.* YORKE. — Diluted acid facilitates the solution of iron in contact with lead. RUNGE. — In strong nitric acid, iron, in connection with lead, is *positive.* DELARIVE. — In potash solution or lime-water, bright lead is positive to iron, but *oxidated* or *coated* lead is *negative.* This is also true of these metals in a solution of saltpetre. YORKE. — It is also true in a solution of sal-ammoniac. WETZLAR. — Thus in *acid*, *al-*

kaline, and *saline* solutions, — all the conditions in which Cochituate water can occur, — iron, if not at first, will, after a short interval, be the metal at whose expense the galvanic action will be sustained.

"2. *The Action of Iron-Rust.* — It was natural to suppose that the moist iron-rust flowing from the mains into the leaden pipes might, by reduction to a lower oxide, promote the oxidation and solution of lead. Bars of lead in contact with hydrated peroxide of iron, in open tubes, containing Cochituate, Croton, Jamaica, Fairmount, Albany, and Troy water, arranged on the 15th of May, gave, when tested on the 17th, 22d, and 27th of May, and 7th of June, with ferrocyanide of potassium, no indication of protoxide. The same water in which nails were immersed, tested from time to time, gave occasional evidence of the presence of protoxide of iron. I placed peroxide of iron and bright bars of lead in flasks of distilled and Cochituate water, and sealed them, on the 7th of last June. The flasks are in my possession still, and though the air was expelled only so much as boiling five minutes would accomplish, the bars of lead are quite as undimmed as on the day they were sealed up. It is scarcely necessary to state that the iron rust, in actual service, does not come in contact with *lead*, but with the suboxide, or other coat.*

"3. *The Solubility of the Suboxide of Lead.* — I have been unable to procure the slightest trace of lead in water deprived of its air, after long contact with the suboxide of lead. Mitscherlich remarks of its insolubility.†

"4. *The Action of Alkaline Chlorides upon Lead, in the Absence of Oxygen or Atmospheric Air.* — The following experiment was made and several times repeated by me with graduated solutions of common salt. A flask of one gill capacity, containing a quantity of lead shavings, presenting an extent of surface comparatively great, was one third filled with a solution of common salt. This flask was connected by a tube, bent twice at right angles, with a cup of mercury. The cork, tube, and neck, at the connections, were carefully covered with sealing-wax, that the flask might be air-tight. So arranged, the flask

* Reference has been made to the experiments of Napier upon this point. He made *no experiments with peroxide* of iron, but with *neutral salts* of the peroxide, and he states distinctly that lead exposed to them a little while became coated, and that action *was thereafter arrested.* — *Lond., Edinb., and Dubl. Philos. Mag.*, May, 1844, pp. 365–370.

† *Lehrbuch der Chemie*, 2te Band, S. 511.

was slightly warmed; the air thereby driven out was of course replaced with quicksilver, the upper surface of which, after the original temperature had been reëstablished, was marked. Now, if any decomposition of common salt occurred by the agency of lead, the chlorine would be freed from the sodium, the sodium would decompose the water, hydrogen would be set free, and the column of mercury depressed. Instead of any such result, the column of mercury regularly rose in every instance. An apparatus of this description, several months in action, is still preserved in my laboratory. It might still have been said, that, had the flask been deprived of air, the lead would have been acted on by the simple chloride. The experiment of lead and sea-water, in a flask deprived of air, has been made. The flask was sealed on the 25th of May last. The bar for a long time retained its perfect brightness, and is but very faintly dimmed at this late day, February 1, 1849.

"5. *Action of Organic Matter.* — It has been conceived that organic matter might exert a deleterious influence. Experiments already recorded (p. 15) show that the presence of organic matter increases the protecting power of water which is to be transmitted through lead. If the quantity exceed one ten-thousandth of the weight of the water, precipitates of oxide of lead, united to organic matter, take place. Orfila has remarked the precipitation of the coloring matter from Burgundy by neutralizing it with litharge.* Its influence in withdrawing the oxygen from solution has also been alluded to. In the important researches of Dr. Smith † upon the air and water of towns, it is mentioned that the presence of nitrates in the London water prevents the formation of organic matter, and that organic matter, in filtering through soils, becomes rapidly oxidated. Additional experiments bearing upon this point are recorded farther on.

"*Influence of Impurities in Water.* — It is a prevailing conviction, that the more impure a water is, or, in general terms, the more salts it contains in solution, the less will be its action on lead. The influence of sulphate of magnesia (epsom salts) and chloride of sodium (common salt) in distilled water was the subject of experiment. The action, it will be seen, was more vigorous in distilled than in the impure waters.

* *Toxicologie Générale*, Vol. I. p. 616.

† *Proc. Brit. Ass. Athen.*, No. 1087.

"Table XXII. — *Experiments with Lead and Graduated Solutions of Sulphate of Magnesia (Epsom Salt).*

Days.	Distilled Water.	Distilled Water and $\frac{1}{10000}$ of Epsom Salt.	Distilled Water and $\frac{1}{100000}$ of Epsom Salt.	Distilled Water and $\frac{1}{1000000}$ of Epsom Salt.
1	——	——	——	——
3	5.000	2.500	2.000	1.750
5	20.000	1.500	2.000	1.800
6	4.000	2.500	2.000	1.800
7	3.000	1.800	2.000	1.500
8	2.500	2.500	2.000	0.800
10	3.000	1.800	3.000	1.800
11	2.000	1.500	1.800	1.500
12	3.000	1.200	2.000	0.800
13	2.000	1.200	1.200	0.800

"Table XXIII. — *Experiments with Lead and Graduated Solutions of Chloride of Sodium.*

Days.	Distilled Water.	Distilled Water and $\frac{1}{10000}$ of Salt.	Distilled Water and $\frac{1}{100000}$ of Salt.	Distilled Water and $\frac{1}{1000000}$ of Salt.
1	——	——	——	——
3	5.000	2.500	2.000	1.500
5	20.000	1.800	2.500	2.000
6	4.000	1.800	1.800	2.000
7	3.000	1.800	2.000	2.000
8	2.500	2.000	2.000	1.800
10	3.000	2.500	2.250	2.500
11	2.000	1.800	1.800	1.500
12	3.000	1.200	1.200	1.200
13	2.000	1.000	1.200	1.200

"*Coats that form on Lead.* — In seeking to ascertain the nature of the protecting coat which forms in all the waters hitherto experimented with, the influence of organic matter was first considered. 500cc. of each of several waters were evaporated to dryness over a water-bath, ignited, and redissolved in an equal measure of distilled water. There remained a small insoluble residue, which readily dissolved, with effervescence, in hydrochloric or acetic acid, — indicating carbonate of lime. Bars of lead were exposed to these prepared solutions. A bluish-white coat formed upon the lead in each.

"TABLE XXIV. — *Experiments with the several Waters deprived of their Organic Matter and Carbonate of Lime.**

Days.	Distilled Water.	Albany.	Cambridge.	Cochituate.	Croton.	Fairmount.	Jamaica.	Troy.
1	3.000	0.000	0.500	5.000	6.000	15.000	5.000	4.000
4	1.000	0.000	0.500	0.500	2.500	2.000	12.000	2.000
5	1.500	0.010	0.010	0.020	8.000	1.000	15.000	0.500
8	2.000	0.010	0.500	0.800	10.000	2.000	3.000	1.000
9	0.500	0.050	0.050	0.100	4.000	4.000	1.500	1.500
11	0.500	0.100	0.100	0.100	0.800	0.100	0.100	0.100
18	0.500	0.800	0.800	0.800	20.000	30.000	0.800	0.500
37	1.500	1.000	2.000	1.250	12.000	3.000	0.700	1.500
42	1.250	1.000	1.000	2.000	2.000	20.000	8.000	0.100
44	15.000	1.500	1.000	0.800	0.200	0.100	0.100	0.100
47	15.000	0.500	0.100	1.500	0.500	0.100	0.100	0.100
48	0.200	0.100	0.300	0.100	1.000	0.200	0.100	0.300
49	0.400	0.400	0.500	0.300	2.000	0.500	0.400	0.400
50	0.500	0.200	0.900	1.000	2.000	2.500	1.000	0.100
52	1.750	0.010	1.800	1.800	1.000	3.000	0.100	0.100

"It will be seen, on comparing the results of their actions with those of the natural waters, that they are more protracted and vigorous, that they approach more nearly the action of distilled water, and that no protecting coat can be said to have formed. Three kinds of coating upon lead have fallen under my notice: a bluish-gray one, which, according to Winkelbleck, Mitscherlich, and others, is a simple suboxide; a reddish one, which formed in Croton, Schuylkill, and Jamaica waters; and a white one. The coat of *suboxide* is insoluble in water. When the quantity of oxygen in solution in a given water is small, this coat will be first formed. It is the only one I have seen in Croton pipes less than two years in use. The addition to this coat of slimy organic matter, oxide of iron, and, to some extent, carbonate of lead, forms the *reddish* coat, the impermeable character of which, for all practical purposes, is illustrated in the appearance of Croton pipe five years in use, and already referred to. The *white* coat, it has been observed, consists chiefly of carbonates and sulphates.

"*Solubility of Oxide of Lead.* — I have already noticed the contrariety of opinion upon the solubility of the oxide of lead. I have repeated the experiments of Yorke, and confirmed his results, and am,

* Professor Silliman, Jr., has remarked of the alkaline reaction which the redissolved residues gave. The reaction of the above solutions was not observed. In their extreme dilution, an alkaline reaction could not have been appreciable.

moreover, satisfied that, had Thompson and Philips concentrated the filtrates which they supposed to contain no lead, they would have detected it without difficulty. A flask containing distilled water and lead shavings was corked and placed aside for a few days. A deposit of carbonate and hydrate of lead formed around and upon the lead shavings. The contents of the flask were carefully poured upon a double filter of Swedish paper, and the filtrate concentrated. It gave a distinct precipitate with hydrosulphuric acid.

" *Tea and Coffee Grounds unite with Lead in Solution.* — It has been an occasion of surprise, that numerous families have for a long period employed well-water that corroded leaden pipe so rapidly as to require replacement in from six to eighteen months, and yet, so far as they or their physicians know, have suffered no illness attributable to the water. This fact suggested two considerations: — 1st. Are all lead compounds equally poisonous ? 2d. If so, is the quantity which finds its way into the organism sufficient to produce the maladies attributed to lead ? It may be assumed that water flowing directly through a leaden pipe of an inch bore and not more than thirty feet in length will ordinarily be identical in constitution with that in the source from which it is drawn. That only which has been some time at rest would be expected to contain lead. Accordingly, there is more care that the water first drawn be thrown away. The first morning draught is usually in the form of tea or coffee. The following experiments throw light upon this point. To boiling water containing lead in solution tea was added, in the quantity usually taken in the preparation of the beverage (a gramme to 50cc.), the temperature maintained three minutes just below the boiling point, and the decoction filtered off. The filtrate was evaporated to dryness, ignited, redissolved, and the precipitate with hydrosulphuric acid made and estimated as already described.

" I. 50cc. of lead solution, containing one thousandth of its weight of lead, with 1gr. of black tea, lost ninety-nine hundredths of its lead.

Originally present,	0.05gr. of lead.
After separation from the grounds,	0.0005 "

" II. 55cc. of solution containing one tenth as much lead as the above, with the above quantity of tea, lost more than eleven twelfths of its lead.

Originally present in solution,	0.005gr. of lead.
After separation from the grounds,	0.0004 "

" The experiments with coffee yielded the following results: —

" I. 50cc. of lead solution, containing one thousandth of its weight of lead, with 10cc. of coffee-grounds, were boiled three minutes, and the decoction poured off. The residue was drained through Swedish filtering-paper, the filtrate added to the liquor poured off, and evaporated to dryness, ignited, redissolved, treated with hydrosulphuric acid, and the precipitate estimated as before. It had lost more than forty-nine fiftieths of the lead.

Originally in solution,	0.05gr. of lead.
After separation from the grounds,	0.0009 "

" II. 50cc. of solution, containing one tenth as much lead as that in the last experiment, were boiled with 5cc. of coffee-grounds, and treated as above. It had lost more than eleven twelfths of its lead.

Originally in solution,	0.005gr. of lead.
After separation from the grounds,	0.0005 "

" These results contribute to account for the circumstance mentioned above.

" Other Materials than Lead for Service-pipes. — I have remarked that this investigation was instituted chiefly with a view to determine the trustworthiness of lead. Experiments have, however, to some extent, been made with other substances. The general conditions have been observed in experimenting with them that had been regarded with lead, namely, equal volumes of water to equal surfaces of substance, that comparison might be instituted.

" Table XXV. — *Experiments with Copper Turnings.* Water concentrated to one third of its volume.

Days.	Distilled Water.	Albany.	Cambridge.	Cochituate *a*.	Cochituate *b*.	Cochituate *c*.	Croton.	Fairmount.	Jamaica.	Troy.
1	——	——	——	——	——	——	——	——	——	——
11	0.001	0.500	0.000	0.001	0.002	0.000	0.000	0.000	0.001	0.000
17	1.000	0.500	1.000	0.500	1.000	1.000	0.010	0.500	0.010	0.500
25	0.005	0.001	0.002	0.050	0.080	——	0.002	0.001	0.050	0.001
37	0.000	0.000	——	0.005	0.050	0.050	——	0.000	——	0.010

" These experiments show only a feeble action of aerated water on copper.

" Table XXVI. — *Experiments with Tin.* — The tin contained arsenic as an impurity. Chemically pure tin yielded precisely the same results when exposed to the same waters. Bars of size already mentioned. 10cc. of water concentrated to from 3 to 5cc. Precipitates with hydrosulphuric acid and oxide of tin are both represented in the numbers below.

Days.	Cochituate.	Croton.	Fairmount.	Jamaica.	Distilled Water.	Albany.	Cambridge.	Troy.
1	——	——	——	——	——	——	——	——
2	0.100	0.100	0.000	0.000				
4	0.020	0.010	0.000	0.000	0.100			
6	0.010	0.010	0.000	0.000	0.000			
8	0.001	0.000	0.000	0.000	0.001			
10	0.005	0.000	0.000	0.000	0.000			
12	0.005	0.001	0.001	0.001	0.001	0.500	0.500	0.500
17	1.000	1.000	1.000	1.000	1.000	0.050	2.000	2.000
26	8.000	15.000	10.000	8.000	0.010	0.000	50.000	0.010
38	10.000	25.000	8.000	10.000	3.000	7.000	1.000	10.000
75	10.000	15.000	15.000	10.000	4.000	4.000	7.000	20.000

" The action in ten days' exposure was inconsiderable. No coat formed on the tin.

" A portion of Cochituate water that had been standing two months in tin pipe, which was kindly furnished last February by the engineer of the water-works, was evaporated to dryness with carbonate of soda, and gave with the blowpipe a malleable metallic button. The *precipitated oxide* from this water, that from distilled water acting upon chemically pure tin, and that from Cochituate and the various other waters upon the impure tin, were identical in appearance.

" Lehman remarks of the solubility of tin in solutions of sal-ammoniac, alum, and bisulphate and bitartrate of potassa.* ' Lindes has examined the solutions which by boiling attack tin vessels. According to his experiments, tin is rapidly brought into solution, without precipitating the oxide by alum, sal-ammoniac, and bisulphate of potassa. Without dissolving the oxide, but merely depositing it, chlorides of barium and calcium, neutral carbonate and bicarbonate of potassa, sulphates of potassa, soda, and magnesia, chloride of sodium, tartrates of ammonia and potassa, and borate of potassa.' † These experiments were made with the aid of heat. Time accomplished the same end in all the waters I have employed, including distilled water, producing either solution or deposit of the oxide, *not* upon the tin, but the bottom of the containing vessel. Lindes did not observe that saltpetre acted with the aid of elevated temperature. The time in his experiments

* *Taschenbuch der Chemie*, 1848, S. 192.

† Berzelius, *Jahresbericht*, Vol. XII., S. 110, 1833.

was probably too short, as I have found that tin at common temperatures yields the insoluble oxide in a solution of saltpetre.

"Table XXVII. — *Experiments with Tinned Copper Pipe.** — Two days' exposure. 100cc. condensed to 5cc.

Days.	Distilled Water.	Cochituate.	Croton.	Jamaica.	Fairmount.	Albany.	Cambridge Hard Water.
2	15.000	20.000	10.000	20.000	20.000	20.000	20.000

"Upon the authority of Dr. Hayes† I have ventured to speak of the safe use of tinned copper pipes, notwithstanding the fact of the slow erosion.

"*Iron service-pipes*, such as are employed for the circulation of hot water and steam, for warming purposes, have been proposed, and are in use. I am informed that some persons who laid them down a few months since for the distribution of Cochituate water have decided to replace them with lead, on account of the rust, which unfits the water for washing.

"Iron pipes *tinned* within and without have been submitted to me. I have no knowledge of the durability of the coat of tin. Should it prove to be lasting, this pipe will have the double advantage of the strength of iron and the feeble action which tin experiences.

"A pipe consisting of *gutta percha* and *India rubber* was found to yield an extract to water, which gradually diminished, until the taste was no longer impaired. The strength of the specimen submitted to me was not sufficient to sustain the pressure of actual service.

"Pipes of pure *gutta percha* have been proposed by Dr. Webster, and, from all the experiments I have been able to make, as well as from the known chemical properties of the substance, I shall not be surprised to find that they may be successfully introduced into wells. Its susceptibility to extension when heated, if only to the temperature of boiling water, precludes its use for some of the purposes of service-pipes.

"*Glass pipes* have been used for the transmission of water, where the descent was moderate, and the head inconsiderable. Where the pressure is sufficient to supply the upper rooms of houses, practice has

* The pipe, five eighths of an inch in diameter, was washed with warm diluted hydrochloric acid, then with warm diluted potassa, then with distilled water, and then successively exposed to the different waters mentioned above.

† *Report to the Board of Consulting Physicians*, Boston, 1848.

shown that the pipes are liable to be shattered by the concussion occasioned by shutting off the water.

"SUMMARY OF CONCLUSIONS RELATING TO THE DIFFERENT KINDS OF WATER AND LEADEN SERVICE-PIPE. — The waters used by man, in the various forms of beverage and for culinary purposes, are of two classes, viz.: —

"1. *Open waters, derived from rain-falls and surface drainage, like ponds, lakes, rivers, and some springs; and* 2. *Waters concealed from sunlight, and supplied by lixiviation through soils or rock, or both, of greater or less depth, such as wells and certain springs.*

"They differ, (*a.*) in temperature; well-water, through a large part of the year, is colder than lake, pond, or river water; — (*b.*) in the percentage of gases in solution; recently drawn well-water, in summer particularly, parts with a quantity of air upon exposure to the surface temperature. In winter these relationships must to some extent be inverted, in high latitudes for a longer, and in lower latitudes for a shorter period. (*c.*) They differ in the percentage of inorganic matter in solution; well-waters contain more; — (*d.*) in the relative proportions of salts in solution; well-waters contain more nitrates and chlorides; — and (*e.*) in the percentage of organic matter; well-waters contain less.

"*Relations of Lead to Air and Water.* — (*a.*) Lead is not oxidated in dry air, or (*b.*) in pure water deprived of air. (*c.*) It is oxidated in water, other things being equal, in general proportion to the amount of uncombined oxygen in solution. (*d.*) When present in sufficient quantity, nitrates in neutral waters are, to some extent, reduced by lead. (*e.*) Both nitrates and chlorides promote the solution of some coats formed on lead.

"(*f.*) Organic matter influences the action of water upon lead. If insoluble, it impairs the action by facilitating the escape of air; if soluble, by consuming the oxygen in solution, and by reducing the nitrates when present. The green plants, so called, and animalculæ which evolve oxygen, are abundant in open waters in warm weather only, and of course when the capacity of water to retain air in solution is lowest; so that, although oxygen is produced in open waters by these microscopic organisms, it does not increase the vigor of their action upon lead.

"(*g.*) Hydrated peroxide of iron (iron-rust) in water is not reduced by lead. Hence may be inferred the freedom from corrosion of leaden pipes connected with iron mains, so far as the reduction of the pulverulent peroxide of iron may influence it.

"(*h.*) Alkaline chlorides in natural waters deprived of air do not corrode lead. (*i.*) Salts, generally, impair the action of waters upon lead, by lessening their solvent power for air, and by lessening their solvent power for other salts. A coat of greater or less permeability forms in all natural waters to which lead is exposed. The first coat (*j.*) is a simple suboxide absolutely insoluble in water, and solutions of salts generally. This becomes converted in some waters into a higher oxide, and this higher oxide, uniting with water and carbonic acid, forms a coat (*k.*) soluble in from 7,000 to 10,000 times its weight of pure water. The above oxide unites with sulphuric and other acids which sometimes enter into the constitution of the coat *k*; — uniting with organic matter and iron-rust, it forms another coat (*l.*) which is in the highest degree protective. The perfection of this coat, and of the first above mentioned, may be inferred from the small quantity of lead found in Croton water (New York), after an exposure in pipes of from twelve to thirty-six hours, and from the absence of an appreciable quantity in Fairmount water (Philadelphia), after an exposure of thirty-six hours, when concentrated to one two-hundredth of its bulk.

"*Reasons why the Water of Lake Cochituate served through Iron Mains and Leaden Distribution-pipes may be safely employed as a Beverage in any Form.*

"(*a.*) It has the small measures of air, nitrates, and chlorides, the large proportion of organic matter, soluble and insoluble, and exposure to the sun, above referred to as grounds of distinction in the relations to lead between lake, pond, or river water, and well-water.

"(*b.*) In experiments with Croton, Fairmount, Jamaica, and Cochituate waters, made with lead, lead soldered to iron, to tin, to copper, and to brass, prolonged from mid-winter to the middle of summer, the relations of the last of these waters to lead were found to be as favorable as were those of either of the others.

"(*c.*) Large numbers of individuals in the daily and unrestricted use of Fairmount, Croton, and Jamaica waters served through lead are not known by physicians of great eminence and extensive practice to suffer in any degree from lead maladies.

"(*d.*) A coat forms upon lead in Cochituate, as in the other waters above mentioned, which for all practical purposes becomes, in process of time, impermeable to and insoluble in the water in which it occurs."

Lieutenant C. H. Davis, U. S. N., presented a paper upon the "Geological Action of the Tidal and other Currents of the Ocean."

"The object of this memoir," he said, "is to present the subject of the tides and currents of the ocean as a geological problem. The tides have heretofore been regarded only as an astronomical problem. It is the prevailing opinion among geologists, at present, that the actual condition of the earth and the changes of former periods are to be ascribed to causes now in operation. Among the present active causes of change, the ocean holds a prominent place. But it has been supposed to operate principally by means of the agitations of its surface, or by violent and tumultuous disturbances. The tides and currents of the sea have been treated in a general way only. This memoir announces the discovery of a permanent, systematic, and uniform relation between the tidal currents and those shores which are now, or have been at any earlier period, subjected to their action. The currents created by the tides are to be counted among the most effective agents employed throughout all periods in giving their present form and body to the great continents, and in preparing a suitable home for that marine animal life of which there is such an enormous display in the fossils of earlier strata, and which constitutes at present an important part of the sustenance of man.

"If this agency be established, the whole economy of the earth's condition will appear to be connected with the normal and regular movements of the ocean, rather than with its violent and irregular action. The title of the Geological Action of the Tides does not exclude the consideration of those currents of the ocean produced by other causes, which exert an influence by coming in contact with the land. But these currents hold a subordinate place to the tides. They owe their existence and direction, in part, to the continents, and move always in the same course. But the tides have contributed largely in giving their present forms to the continents, and are themselves constantly undergoing alternate changes of rest and motion, flux and reflux, by which they are peculiarly qualified for their office of distribution and construction. The view now presented will account for the alluvial deposits on this coast, and for similar sandy formations elsewhere, as in Holland, the Landes of France, Northern Peru, &c. It will explain the geological peculiarities of the great plains of North and South America, and suggest the mode of formation of the great deserts. Ascending to the earlier periods of geology, it will account for the situs of the aqueous deposits in those periods, as the post-pliocene, tertiary, and cretaceous. The views presented in the memoir are the result of a study of the tidal currents on the alluvial shores of the United States, and particularly on the New England coast. This study has led to the discovery of a threefold relation in form, amount, and locality between these currents, and the materials transported by them. The certain relation between the tidal currents and the alluvial deposits in structure, position, and amount establishes a principle of conformation in the latter, by means of which the geologist will be enabled to reason back from the deposits of earlier periods to the nature of the currents by which they were made, as the character of the present formations on the borders of the sea and in its depths is readily decided when the peculiarities of the local currents are ascertained." [This memoir has been printed *in extenso* in the current volume of the Memoirs of the Academy, Vol. IV., New Series.]

Dr. Pierson read a communication from Dr. Usher Parsons, of Providence, giving a detailed account of a tornado that passed near Providence, Rhode Island, at 3 o'clock, P. M., taken from minutes made at the time.

"Whilst a heavy rain was falling, a black cloud was seen in the west, which seemed to send down towards the earth a very dark elongated cone. It commenced its career, as its traces afterwards proved, in Johnston, about five miles west-southwest of Providence, and moved in a north-northeast direction, at the rate of ten or twelve miles the hour, passed across the head of Narraganset Bay, and moved onward in a straight line eight or ten miles, towards Dighton. The blackest part of the cloud was the centre of its under or convex side, whence the cone descended. There soon appeared floating substances, both in the cone and cloud, which were mistaken by many persons for birds whirling about and carried along seemingly unable to extricate themselves from the vortex. Among its first ravages was an orchard in Johnston, the trees of which were uprooted or broken, and the fences, and even stone walls, were swept away. Passing along over the summit of a hill or ledge of rocks one hundred feet high, it overthrew and demolished a small powder-house, containing thirty kegs of powder used in blasting, and neither the kegs nor their contents have ever been found. Near this it uprooted a solitary large tree, and carried it twenty or thirty yards, to a valley at the farther side of the hill. Near this it unroofed two barns, a workshop, and a dwelling-house. All the doors of the house were burst open outwardly. A female standing in the middle of a room was hurled out of the door, and carried in a line with the progressive tornado across the road, and lodged against a fence. A wagon standing near was lifted and carried some distance. The approach of a whirlwind was apprehended by a workman in the shop, before it had struck, from the falling of a shower of apples on the roof, which it seems had been carried into the air from the orchard it had passed through, and which were precipitated from the anterior edge of the cloud. In a few seconds the pendant cone reached the shop, and unroofed it. A few rods farther in its progress, it took two women from a cart and carried them into a field. A few rods onward, it was seen approaching by a man who was leading a child, and fearing it would separate them, he clasped the child in his arms and fell on the ground; but they were both raised and borne for several yards. Passing through a potato-field, it dug up the potatoes, and scattered them far and wide. A small pond that lay in its path was drained; and, coursing through a large nursery-garden, it laid the shrubs and small trees as flat as if done by a roller, uprooted or fractured the large trees, and despoiled them of their foliage. An apple-orchard near by was served in like manner. Its approach being now discovered by a school-teacher, from a chamber window, she hastened her little scholars from the chamber, which was over a back kitchen, into the main building, which they had barely reached when a dairy-house was raised in the air and thrown on the school-room, breaking through its roof. It then passed over a bleachery, and destroyed a row of buildings, whose roofs appeared to open, and in a moment to rise up in the air. 'The whole house,' says Mr. Allen, who was within a few fathoms, 'appeared to crumble, and to become a mass of ruins in motion, which one could see through the cloud which enveloped it as a cloak of vapor. At the moment when the lower extremity of the cone passed over the crumbling building, all the *débris* appeared to be shot into the air, as if from an exploded mine.' The noise resembled that of the letting off of steam from an engine, only not so cavernous.

"The tornado had now reached the shore of Narraganset Bay, in crossing which it presented to view a water instead of a land spout, and established their essential identity in the minds of any who doubted.

In passing land, loose substances, as the *débris* of trees and buildings, are raised; in passing water, vapor and spray are raised, as in the ocean-spouts, by one and the same power. The shape of the lower cone is, however, better defined and more uniform in the water than in the land spout, the supply of materials to form the latter being more variable on land. There is, however, an exception to this, when the land-spout passes over desert sands, which give the appearance of moving pillars of dust extending from the earth to the skies. Bruce, in his travels, describes them as tall pillars, and says he sometimes saw many of them travelling together.

"The materials raised on the land were precipitated from the cloud before it had passed half way across the water, and on the opposite side it began to raise other movable substances. The water over which it passed was thrown into violent ebullition, like an immense cauldron, giving off a dense vapor and spray from its surface over an area of three hundred feet in diameter. A flash of light or electricity was seen by two observers darting through the cone, which was followed by a lessened commotion of the water, and a fall of rain. The track of the tornado was two to three hundred feet wide, deviating little if any from this width for several miles, its limits being strongly marked on the ground and upon trees. Even the same tree, that stood on the margin of the track, had its trunk killed, the sap being dried, as it were, on one side, and not on the other. Peltier describes similar effects from a spout in Fontenay, where 'the side of trees affected by the meteor was dried, while the opposite side preserved the sap.' The diameter of the shaft or cone, midway between the cloud and earth, was apparently less than fifty feet.

"The length of the visible cone that shot down from the cloud varied every minute. Sometimes it seemed to elongate in a tapering form quite to the earth, and then to shorten again. This, of course, was an optical illusion, for there is no descent of the spout in such cases, but merely a condensation of vapor, whose particles are constantly ascending, whether visible or not. And were the condensation of vapor to descend as far and wide upon the earth as the dynamic effects of the tornado extend, we should see the form of the terrestrial cone shooting upward to meet the descending inverted cone, — they would be continuous from the earth upward; and this, in fact, is exhibited in water-spouts, the water supplying the vapor to make a continuous visible spout, extending from its surface into the cloud, which slightly resembles in form an astral lamp.

"I took Professor Espy to view the ground soon after the tornado had passed, who drew my attention to the position of trees that were prostrated, and which lay with their tops turned inward and forward. He explained this in accordance with his published theory, which maintains that the dynamic effects upon the trees are of two kinds, — one resulting from the inward and vertical attraction, produced by a vacuum in the cloud, drawing the trees inward toward the cone, and upward, and uprooting them; the other, from its progressive course, which fells them with their tops forward. He states in his book that in nine spouts he has visited in New Jersey, the trees and corn all exhibited an inward and forward direction. He attaches less importance to the gyratory motion than Read, Redfield, and others have done, and believes it to be accidental. And Dr. A. D. Bache, of Philadelphia, who accompanied Professor Espy in some of his examinations of the traces of a spout, says: — 'I think it made out that there was a rush of air from all directions, at the surface of the ground, toward the moving meteor, this rush of air carrying objects with it. The effects all indicate a moving column of rarefied air, without any whirling motion near the surface of the earth.' In support of the same opinion, I may mention that the roofs of the barns and the wagons in the Providence tornado were lifted upwards, and carried along in a straight line, without being whirled round. Although the electrical effects attendant upon water-spouts and whirlwinds prove that they are closely connected with atmospheric electricity, yet no theory has been advanced that satisfactorily explains all the phenomena. Peltier has given the most rational exposition of the *modus operandi* of electricity of any writer I have met with. He has attempted to illustrate it by artificial means and experiments, and with apparent success. On this point Espy differs from him, in referring the dynamic effects of spouts chiefly, if not wholly, to a vacuum in the cloud, which he seems to believe may exist independently of electricity. It is, however, improbable that any rush of air, unaided by electricity, can produce a drying up of the leaves and of the sap in a tree. The electric fluid, moreover, is often seen darting through such meteors, as was the case in the spout now described."

Professor Edward Salisbury, of Yale College, and Dr. J. Mason Warren, were elected Fellows of the Academy.

Three hundred and twelfth meeting.

November 14, 1848. — Monthly Meeting.

The President in the chair.

Colonel Graham, of the U. S. Topographical Engineers, gave an account of the labors of the commissioners for running the boundary between the United States and Canada, as established by the Treaty of Washington, and stated that the maps, which were destroyed by fire at Washington when nearly completed, were now in course of reconstruction from the field-notes, &c., copies of which, by direction of the government, were deposited in different places, so as to guard against their destruction by fire, or other casualty.

Professor Webster exhibited remarkably fine specimens of beryl from Royalton, and idocrase from Sanford, near Wells, Maine.

Mr. Desor made some remarks on the retrogression of Niagara Falls, illustrated by plans, and gave reasons for believing that, in their future retrogression, the gradual diminution in the height of the cataract which has been taught by other geologists would not take place.

Professor Lovering read a paper on the causes of the remarkable differences in the strength of ordinary magnets and electro-magnets of the same shape and size, as follows: —

"It is well known that the strength of ordinary magnets does not increase in the same proportion as their weight; but much more slowly. For example, a magnet weighing only three grains has lifted two hundred and fifty times its own weight. A magnet weighing twenty-five grains sometimes lifts forty-five times its own weight. Peschel's new method of magnetizing is considered very efficient, because it will give to a magnet which weighs one pound the power to lift about twenty-six pounds. Magnets of two pounds' weight will rarely lift ten times their own weight. A magnet in the possession of Mr. Peale, of Philadelphia, (the largest natural magnet known,) weighs fifty-two pounds and lifts three hundred and ten pounds; that is, only six times its own weight. These cases are not strictly comparable, because the shape and quality of the iron are not the same in all of them. They indicate, however, with sufficient exactness for my present purpose, that the strength of a magnet, as compared with its weight, is very much less for large magnets than for small ones. It is not difficult to explain this general fact. When one bar of iron is magnetized by another, according to the laws of ordinary magnetic induction, the action is superficial. The most we can do is to bring the surfaces of the two bars into contact on one side. If the mass of iron is thick, the interior portions are so far removed from the inducing magnet, that they receive only a part of the magnetic development of which they are susceptible. This difficulty is removed, if we begin by dividing the thick bar into a number of thin pieces. These may be magnetized separately, and to saturation. When we come to reunite them, we encounter another difficulty. Each piece tends to induce a magnetic state, opposite to its own, in its neighbours ; a state, accordingly, which is opposite to that which its neighbours have already acquired. As soon as the pieces are brought together, a part of the magnetism, originally developed, becomes latent again ; and the united strength of all is not so great as the sum of the powers possessed by the parts when tried separately.

" In 1820, it was discovered that the conducting-wire of a galvanic battery possessed magnetic properties, and was capable of inducing magnetism in a bar of soft iron placed at right angles to its own length. This elementary force, first announced by Arago, was soon multiplied in a wonderful degree by the application of Schweigger's principle to it. At length large masses of iron, which defied the ordinary methods of touch, were magnetized to saturation. Magnets which acquire their magnetism from the induction of electricity (electro-magnets) have been made of such a size and power as to lift ten thousand pounds. Professor Henry gave an account, in *Silliman's Journal*, of an electro-magnet constructed by him, as early as 1831, which, weighing twenty-one pounds, was able to lift seven hundred and fifty pounds ; that is, more than thirty-five times its own weight. I frequently experiment with electro-magnets of a half-pound weight, which lift one hundred and seventy-five times their own weight. With a good current, magnets no heavier than this may be made to lift five hundred times their own weight.

" At the present day, the old statical theory of magnetism has been supplanted by the electro-dynamical theory of Ampere. According to the views of this eminent physicist, all magnets are in one sense electro-magnets. In the electro-magnet properly so called, the inducing currents are obtained from a galvanic battery, and are made to flow through a wire which is wound many times around the iron to be magnetized. Each particle of the iron is supposed to contain, even in its unmagnetic state, currents of electricity, circulating around it. As the direction of these currents is not definite, the particle exhibits no magnetic polarity. As soon, however, as it is exposed to the action of the battery currents, these native currents of the iron assume a direction parallel to one another and to that of the currents in the external wire. When its currents are thus directed, the iron has the properties of a magnet. The magnetism of iron, however developed, consists simply in the magnetic properties of these electrical currents. These currents, moreover, are not created by the inducing agent, but only directed. They are always flowing, but not always in parallel directions. If we take a magnet, in which the currents are already directed, and draw it over a piece of common iron, the currents of the latter are turned round so as to be parallel to those of the former. The only difference between a magnet made in this way, by ordinary touch, as it is called, and an electro-magnet, consists wholly in the source of the inducing and directing currents. In one case, we take them from a battery; in the other, we use those of a permanent magnet.

"If this be so, the difference which is observed in the strength of an electro-magnet and an ordinary magnet must proceed from a corresponding difference in the inducing currents. The battery currents have a greater magnetizing power than the currents of a well-magnetized bar of steel, either because they are stronger in themselves, or because they act from a more favorable position. Now, I have shown by direct experiment that the currents from the galvanic battery are not in themselves so abundant as those which are flowing around a piece of magnetized steel. We suspend a delicate magnetic needle and oscillate it, first in front of one extremity of a helix, through which a battery current is flowing, and then at the same distance from one pole of a steel magnet. From the rapidity of the oscillations we can easily calculate the relative magnetic forces of the helix and the steel bar. It will be necessary to eliminate that part of the motion which belongs to the earth's influence. This is done by oscillating the same needle, when removed from the action both of the helix and steel bar. From this experiment we learn that the battery currents are not nearly so magnetic, and therefore not so abundant, as those of the steel bar. A helix possesses directive power like a compass-needle, but much feebler than a very weak needle of steel, although the current from a powerful battery flows in the helix. Two helices attract and repel as two magnets; a single helix and a magnet attract and repel as two magnets. In both cases, particularly in the first, the action is much weaker than when we experiment on two magnets. In all the electro-dynamical motions, it is well known that those are the weakest which are produced by the reciprocal action of currents alone, and that a great gain is effected when we substitute for one or both of the currents some kind of iron or steel magnet. Moreover, in electro-dynamical induction, the same superiority appears on the side of the currents of the steel magnets. The currents induced by such magnets are much stronger than those induced by a battery current. When the battery current flows around a piece of soft iron, making it an electro-magnet, then we have the best possible source for induced currents. From all these facts, many of which are familiar, I infer that the battery currents, although possessing a greater magnetizing power than those attached to a steel magnet, are, nevertheless, of less intrinsic energy.

"Whence, then, the question recurs, does this superior efficiency of the weaker currents in imparting magnetism to iron proceed? One cause, without doubt, is the favorable position in which the inducing currents act upon the dispersed currents of the unmagnetic iron. The superficial action of one piece of iron or steel upon another, to which we have already referred, when interpreted by the light of Ampere's theory, amounts to this. The inducing currents of the original magnet and the induced or directed currents of the other bar touch, like any two circles external to one another, only at a single point. If the circulation was around the whole mass of each bar, these circles must still rapidly separate from one another. When we add to this that the flow is about each single particle in each bar, it is obvious that the currents which direct and those which are directed are, for the most part, so remote from one another, and so oblique, as to act at a very great mechanical disadvantage. Moreover, the portions of the circuit which are opposite to the adjacent portions exert a contrary action to that of the latter, and diminish the small result which otherwise might be produced. In electro-magnetizing, the battery current flows wholly round the piece of iron to be magnetized. Throughout the whole circulation, every portion of it is near to at least some part of the iron, so as to act favorably upon it. When we magnetize iron by touch, we can, it is true, turn the different sides up and touch it on all of them. We might even make the original magnet hollow, and insert the bar to be magnetized inside of it, so that all parts should be touched at the same time. Even then the position, as will appear upon reflection, will not be so favorable as where the battery current flows around the bar of soft iron; inasmuch as two concentric systems of small circles cannot be brought into such close proximity as one system of small circles concentric with a single large circle. We may select an experiment in which these comparatively weak currents from the battery no longer enjoy their favorable position, and then their weakness is plainly manifested. Let a hollow cylinder of iron be taken and placed outside of the helix, instead of inside. In this case, the battery current which flows in the helix, though intrinsically possessing the same magnetic power as before, produces little or no effect on the external iron cylinder.

"Another cause of the superiority of electro-magnets is connected with a peculiarity in the position of the poles of permanent steel magnets. These poles, if the bar has any considerable thickness, are at a little distance inside of the extremities of the magnetic axis. This displacement has been well explained by the interference of contiguous currents in different portions of the thickness of the bar; their mutual action prevents the planes of motion around the individual particles of iron near the extremities from being strictly parallel to one another, or perpendicular to the magnetic axis. In the electro-magnet, the currents of the iron are maintained in a strictly parallel direction by the controlling and ever-present activity of the battery current, the direction of which is preserved uniform by the rigidity of the wire. Every one knows how rapidly the power of a magnet diminishes with the distance from its pole, and may understand, therefore, how much of force is lost if the pole is inside of the extremity of the bar, and inaccessible. The pole of the electro-magnet is at the extremity of the bar; we may bring the keeper into actual contact with it; and for this reason, also, it must appear superior to ordinary magnets. In consequence of this difference in the position of the pole, or the seat of maximum force, the power of the electro-magnet diminishes as the square of the distance from the extremity, while that of the common magnet only diminishes at the same rate as the distance from the extremity increases; the law being, in both cases, that the force diminishes as the square of the distance from the *pole* increases."

Three hundred and thirteenth meeting.

December 6, 1848. — Monthly Meeting.

The President in the chair.

The Corresponding Secretary read a letter from Professor Salisbury, of Yale College, accepting the fellowship of the Academy, which was conferred at the last quarterly meeting.

He also announced the donation of the first volume of the *Smithsonian Contributions to Knowledge*, accompanied by several documents stating the purposes of the Smithsonian Institution, and making certain inquiries respecting the library, &c., of the American Academy.

Hon. Nathan Hale was appointed a member of the Committee on Meteorology, to fill the vacancy left by the decease of Dr. Hale.

Mr. Everett announced that, on the 25th of November last, Mr. George P. Bond discovered a new comet, the seventh which he had discovered independently of other observers. In this instance, such was the velocity of the comet, and its position in respect to a star in the field of view, that Mr. Bond was able to see the comet *actually move*; — this, it was said, had never before been a matter of direct observation in the case of any of the heavenly bodies.

Mr. Everett also announced the transmission of the King of Denmark's comet-medal to Miss Mitchell.

The committee on the distribution, &c., of the Academy's publications made a report upon the subject, and proposed the following resolves, which were adopted.

1. "That the forthcoming volume of the Memoirs of the Academy (Vol. III., New Series) be furnished, on application, to Fellows of the Academy resident in the United States at such distance from Boston that they are not liable to the payment of annual dues, on the payment of three dollars per copy, and the preceding volumes at two dollars per copy.

2. "That the fourth article of the third chapter of the Statutes be amended, so that it shall read as follows, viz.: — 'It shall be the duty of the Corresponding Secretary, with the advice and consent of the

President, to distribute copies of the Memoirs to the Fellows of the Academy resident in foreign countries as they shall deem expedient.'

3. "That five hundred copies of the fourth volume (New Series) be printed, of which one hundred shall be furnished to the authors of the memoirs respectively, for immediate distribution."

Three hundred and fourteenth meeting.

January 2, 1849. — MONTHLY MEETING.

The PRESIDENT in the chair.

Dr. Charles T. Jackson stated that he had discovered the presence of manganese in the water of streams, &c., almost universally. He had detected it in water from the middle of Lake Superior, in Cochituate water, &c. It has usually been regarded as iron in previous analyses. He regarded the observation as having an important bearing in accounting for the deposits of bog manganese at the outlets of lakes and in bogs, as well as for the source of the oxide of manganese in the blood.

Dr. Jackson also remarked upon the importance of having permanent marks fixed along our coast, at mean low water, to serve as a future indication in respect to the elevation or subsidence of the land. It was thought that the proper observations might best be made, and the marks fixed, by the United States Coast Survey. On motion of Dr. Jackson, a committee, consisting of Dr. Jackson, Mr. Desor, and Dr. Gay, was appointed to confer with the proper authorities upon this subject.

Professor Peirce presented a memoir entitled "Researches in Analytical Mechanics. No. I. Upon the Fundamental Principles of Mechanics." In this memoir, the various principles which have been proposed and adopted as a basis of the science are discussed historically and philosophically, and a new form is proposed, which is thought by the author to be more general, and less exceptionable than the others which have been given. "A system of bodies in motion," he remarked, " must be regarded mechanically as a system of forces or powers which is a perfect representative of all the single powers of which the system is compounded, and this, too, at whatever time or times the component powers may have been introduced into the system. The question of the simultaneous introduction of the partial powers is of no importance. Any power which is at any time communicated to the system is preserved in the system unchanged in amount or direction."

Dr. B. A. Gould, Jr., presented a discussion of the observations of the planet Metis, with a determination of its orbit, accompanied by a computation of the subsequent perturbations of the orbit, and an ephemeris.

" All observations known to me have been used, with the exception of a few extrameridional ones at times when meridian observations were numerous. They are as follows, — corrected for parallax and reduced to Berlin mean time and decimals of a day.

" OBSERVATIONS OF METIS, 1848.

No.	Mean Berlin Time.		α	δ	Place.	Ast. Soc. Not. VIII.	Ast. Nachr. XXVII.
1	Apr. 26.510104	E.	223° 53′ 38″.7	—12° 31′ 46″.3	Markree	p. 175	p. 334
2	.584930	M.	52 29.1	31 33.1	"	174	192,331
3	.633460	E.	51 48.9	31 26.9	"	175	334
4	28.478664	E.	24 22 2	26 31.6	"	175	334
5	29.488233	E.	9 11.5	23 50.0	"	175	334
6	30.499384	E.	222 53 49.2	20 52.4	Camb. E.	177	
7	.547582	M.	53 5.2	20 46.6	"	176	
8	May 1.511634	E	38 28.0	18 10.3	"	177	
9	.544158	M.	38 5.4	18 2.5	"	176	
10	2.540726	M.	22 52.6	15 25.3	"	176	
11	.566836	E.	22 26 4	15 25.4	"	177	
12	3.444364	E.	9 12.6	13 8.0	Markree	175	334
13	.517743	E.	8 1.6	12 52.8	Camb. E.	177	
14	.537294	M.	. . . .	12 47.1	"	176	
15	4.533866	M.	221 52 36 0	10 10.4	"	176	
16	.571414	E.	52 5 2	10 8.4	"	177	
17	5.477282	E.	38 19 5	7 47.3	Markree	175	334
18	.503099	M.	37 54.5	7 42.7	Hamburg	177	202
19	.503183	M.	37 54 8	7 37 7	Altona		209
20	.530446	M.	37 37.5	7 32 6	Camb. E.	176	
21	.554108	M.	37 8.4	7 33.0	Markree	174	331
22	6.499673	M.	22 50.2	5 12.1	Hamb.	177	202
23	.499761	M.	22 54.5	5 6.6	Altona		209
24	.527015	M.	22 27.0	5 2.8	Camb. E.	176	
25	.588627	E.	21 30.0	4 46 6	"	177	
26	7.486770	M.	7 54.5	2 37.9	Berlin		222
27	.496248	M.	7 48 5	2 40.9	Hamb.	177	202
28	.496322	M.	7 51.6	2 36.6	Altona		209
29	.523590	M.	7 25.8	2 31.4	Camb. E.	176	
30	8.483351	M.	220 52 59.3	—12 0 11.8	Berlin		222

No.	Mean Berlin Time.		α	δ	Place.	Ast. Soc. Not. VIII.	Ast. Nachr. XXVII.
31	May 8.492829	M.	220° 52′ 54″.6	−12° 0′ 14″.1	Hamburg	p. 174	p. 202
32	.492913	M.	52 54.0	0 7 6	Altona		209
33	.520168	M.	52 26 4	−11 59 55.2	Camb. E.	176	
34	9.479936	M.	38 10.7	57 43.7::	Berlin		222
35	.489411	M.	38 0.4	57 47.6	Hamb.	177	202
36	.489497	M.	38 1.8.·.	57 44 6.·.	Altona		209
37	.489500	M.	38 6.6	57 43.4	Göttingen		236
38	.516753	M.	37 35.7	57 34.9	Camb. E.	176	
39	.540422	M.	37 17.2	57 35.9	Markree	174	331
40	10.476524	M.	23 26.7	55 21.9	Berlin		222
41	.486003	M.	23 19.3	55 24.4	Hamb.	177	202
42	.486086	M.	23 18.8	55 14.8	Altona		209
43	.513341	M.	22 51.0	55 16.4	Camb. E.	176	
44	.537012	M.	22 34.6	55 14.8	Markree	174	331
45	11.473115	M.	8 44.3	52 58.4	Berlin		222
46	.482199	M.	8 43.5	52 56.3	Altona		209
47	.482597	M.	8 41.5	53 2.1	Hamb.	177	202
48	.482680	M.	8 40.5	53 5.5	Göttingen		236
49	.509936	M.	.....	52 59.7	Camb. E.	176	
50	12.479200	M	219 54 15.5	50 50.2	Hamb.	177	202
51	.479282	M.	54 13.2	50 40.8	Altona		209
52	.488501	E.	54 7.2	50 52.9	Markree	175	334
53	.506536	M.	.....	50 40 1	Camb. E.	176	
54	.530147	M.	53 27.0	50 38.2	Markree	174	331
55	.549492	E.	53 12 0	50 37.6	Camb. E.	177	
56	13.466315	M.	39 58 2	48 34.0	Berlin		222
57	.475803	M.	39 47.3	48 34.8	Hamb.	177	202
58	.475890	M.	39 52.7	48 30.1	Altona		209
59	.477231	E.	39 49.9	48 37.0	Markree	175	334
60	.503144	M.	39 23.4	48 23.7	Camb. E.	176	
61	.526815	M.	39 7.2	48 26.7	Markree	174	331
62	14.462948	M.	25 46.1	46 27.1	Berlin		222
63	.472416	M.	25 37.0	46 21.9	Hamb.	178	202
64	.472508	M.	25 43.1	46 20.4	Altona		209
65	15.469027	M.	11 19.0	.....	Hamb.		202
66	.496378	M.	.....	44 3.8	Camb. E.	176	
67	.546605	E.	10 37.5	44 15.3	"	177	
68	16.516602	M.	218 57 13.9	42 17.0	Markree	174	331
69†	.540250	E.	56 51.9	42 12.2	Camb. E.	177	
70†	18.485982	E.	30 31.8	38 33.5	Markree	175	334
71	.486306	M.	.....	38 28.9	Camb. E.	176	
72†	19.474176	E.	17 36.3	36 48.1	Markree	175	334
73	.506647	M.	17 8.8	36 47.0	"	174	331
74	21.448990	M	217 52 13.5	33 36 7	Hamb.	178	270
75	22.436212	M.	39 57.5	32 8.0	Berlin		254
76	.445297	M.	39 56.9	32 4.0	Altona		209
77	.445678	M.	39 50.4	32 8.4	Hamb.	178	270
78	.473033	M.	.....	32 7.8	Camb. E.	176	
79	.496704	M.	39 12 9	32 3.4	Markree	174	331
80	23.442006	M.	27 49.7	30 42.1	Altona		209
81	.442400	M.	27 43.2	30 49.4	Hamb.	178	270
82	.469745	M.	27 24.0	30 25.4	Camb. E	176	
83	24.438958	M.	15 56.4	29 20.8	Altona		209
84	.439127	M.	15 58 9	29 28.0	Hamb.	178	
85	.439211	M.	15 58.8	29 25.0	Göttingen		270
86	.587937	E.	14 14.4	29 13.5	Camb. E.	177	
87	25.537044	E.	3 15 1	27 53.8	Markree	175	334
88	26.432221	M	216 53 17.1	27 3.0	Altona		270
89	.432616	M	53 11.3	27 1.2	Hamb.	178	270
90	.483278	M	216 52 30.9::	−11 27 6.0	Markree	174	331

No.	Mean Berlin Time.		α	δ	Place.	Ast. Soc. Not. VIII.	Ast. Nachr. XXVII.
91	May 27.428987	M.	216° 42′ 21″.5	−11° 26′ 3″.8	Altona		p. 270
92	.429382	M	42 17.7	26 10.8	Hamburg	p. 178	270
93	.456722	M.	41 53.8	26 1.2	Camb. E.	176	
94	29.473979	M.	20 58.5	24 25.7	Markree	174	331
95	.533195	E.	20 25.3	24 28.5	"	175	334
96	.541550	E.	20 24.4	24 34.5	"	175	334
97	30.419771	M.	11 34.9	23 47.2	Hamb.	178	
98	.447118	M.	11 18.1	. . . . .	Camb. E.	176	
99	.507419	E.	10 41.8	23 40.5	"	177	
100	31.443949	M.	1 48.4	23 12.1	"	176	
101	June 1.413445	M.	215 52 49.6	22 42.1	Hamb.	178	
102	.462339	E.	52 25.9	22 41.6	"	178	299
103	2.461270	M.	43 32.2	22 23.7	Markree	174	331
104†	.504320	E.	43 19.0	22 33.2	"	175	334
105	3.477010	E.	35 3.6	22 13 3	Hamb.	178	299
106†	.498423	E.	34 50.1	22 18.3	Markree	175	334
107	5.428353	M.	19 43.6	. . . . .	Camb. E.	176	
108	.491207	E.	18 56.2	22 8.0	"	177	21
109†	.516247	E.	18 50.5	22 14 6	Markree	175	334
110	.526832	E.	18 48.7	22 20.7	"	175	334
111	6.425267	M	12 0.0	. . . . .	Camb. E.	176	
112	.481021	E.	11 42.6	22 14.1	"	177	
113	.516420	E.	11 32.4	22 11.0	Hamb.		299
114	7.479212	E.	4 51.7	22 31.0	"		299
115	.529944	E.	4 28.9	22 37.1	Camb. E.	206	
116	13.542084	E.	214 31 4.0	26 42.3	"	206	
117	15.553554	E.	23 0.0	29 19.1	Markree		334
118	19.560015	E.	11 46.7	35 37.6	"		334
119	20.425106	E.	10 9.5	36 57.4	Geneva		383
120	.495681	E.	10 0.3	37 17.6	Markree		334
121	21.436715	E.	8 39.0	38 47.8	Geneva		383
122	22.491386	E.	7 26.9	41 5.0	Camb. E.	206	
123	26.464622	E.	6 56.6	50 19 8	Geneva		383
124	28.458603	E.	8 49.8	55 33·8	"		383
125	.467084	E.	8 56.5	55 39.0	"		383
126	.506224	E.	8 50.8	55 34.7:	Markree		334
127	July 3.455846	E.	20 18.9	−12 10 42.7	Geneva		383
128	4.451389	E.	23 40.4	14 2.8	"		383
129	.461157	E.	23 42 7	14 4.9	"		383
130	5.445196	E.	27 24.1	17 27.2	"		383
131	.455880	E.	27 22.6	17 26.4	"		383
132	.495052	E.	27 29.6	17 24.3	Camb. E.	206	
133	.504386	E.	27 33.1	17 39.8	"	206	
134	6.456574	E.	31 32.0	20 56.5	Geneva		383
135	.460596	E.	31 26.9	20 59.7	Camb. E.	206	
136	.446302	E.	31 32.4	20 54.7	Geneva		383
137	8.446739	E.	40 37.0	28 21.8::	"		383
138	.454434	E.	40 39.1	28 14.0	"		383
139	12.447272	E.	215 3 1.1	43 56.0	Camb. E.	206	
140	13 435726	E.	9 10.4::	. . . . .	Geneva		383
141	.470256	E.	9 33.7	48 10.2	Camb. E.	206	
142	15.458790	E.	23 12.9	56 38.3	"	206	
143†	27.443123	E.	217 10 33.4	−13 53 54.9	"	206	
144	Aug. 4.427226	E.	218 43 53 3	−14 36 52.7	"	206	
145	.433155	E.	44 7.3	36 51.4	"	206	

" The letters E. and M. show whether the observation was made with a meridian or with an equatorial instrument.

"The declination of the comparison star Bessel XIV. 424, used at Markree on the 2d, 3d, and 5th of June, is apparently wrong.

Weisse gives	—11°	11′	44″.4
Challis finds	—11	11	33.0
Rümker "	—11	11	41.6

"In the four observations at Markree where the planet was referred to this star, the mean between the declinations given by Professors Challis and Rümker has been assumed for the comparison star, and the planet's south declination therefore diminished by 7″.1.

"In the star to which the planet was referred at Markree on the 18th and 19th of May, the conclusion of Mr. Graham, that there is an error of $4^{s.}$ in the R. A. of 4848 Br. Assoc. Catal., is evidently correct. The observations of Metis on those days harmonize much better with the rest of the series, however, by taking the position of the star there given, with this correction, than by taking the one which Mr. Graham obtained on the 25th of May, and the former has therefore been used for the comparison. The other determination gives, —

	$\Delta\alpha$	$\Delta\delta$
70	—3″.1	+6″.6
72	—9.1	+5.6

"The right ascension of the Cambridge observation of May 16 (A. S. Notices, p. 177) is given $14^{h.}\ 33^{m.}\ 47^{s.}.46$, where the minutes should evidently be 35, instead of 33.

"In the Cambridge observation of July 27, as given in the Notices of the Astr. Soc., p. 206, there is an error in the right ascension of 20 seconds of time. The observation clearly was $14^{h.}\ 28^{m.}\ 42^{s.}.1$.

"Is there not a mistake of $1^{m.}$ in the Hamburg observations of May 15th and June 6th, and the Cambridge Mer. of June 5th?

"From three normal places for April 28.5, June 16.5, and August 4.5, I have computed three different ellipses, the normal places differing from one another according to the number of observations from which they were constructed. The observations of Professor Challis at Cambridge in England, on the 4th of August, have been of great service, and contributed in a high degree to the precision of the new orbit. The fact that so small and faint an object was observed so near the sun, three weeks after any other published observations, furnishes of itself a sufficient tribute to the skill and unwearied efforts of the observer, and the great power of the Northumberland equatorial. It is much to be regretted that no observations were made by any of the large Munich refractors, as they might, at the least, have been able to fill out a great part of the series up to Professor Challis's last observation.

" The three orbits are as follows : —

Epoch. June 16.5 Berlin M. T.; M. Eq. 1848.0.

	I.	II.	III.
M	157° 6′ 53″.25	156° 15′ 45″.9	156° 8′ 4″.85
☊	68 28 32.6	68 28 3.3	68 27 56.1
π	70 56 50.8	71 35 14.75	71 41 2.2
i	5 35 32.88	5 35 33.4	5 35 34.4
φ	7 2 52.73	7 6 43.85	7 7 14.52
μ	962″.647	963″.244	963″.272

" These three orbits satisfy the series of observations almost equally well, Orbit I. giving the majority of the Right Ascensions somewhat too large, and II. and III. somewhat too small. The sum of the errors is smallest in II., — the sum of their squares in III. The Orbit III. gives the following absolute places, to which is annexed the aberration in decimals of a day.

" METIS. MEAN BERLIN NOON.

Date.	α	δ	Log. Δ	Aberration.
1848.				d.
Apr. 26.0	224° 1′ 6″.3	—12° 33′ 5″.2	0.213024	0.009664
30.0	223 1 14.2	12 22 17.2	.211839	.009638
May 4.0	222 0 33.8	12 11 37.7	.211857	.009639
8.0	221 0 6 8	12 1 22.7	.213069	.009666
12.0	220 0 56.8	11 51 50.5	.215446	.009719
16.0	219 4 7.2	11 43 17.5	.218948	.009797
20.0	218 10 30.2	11 35 56 2	.223502	.009900
24.0	217 20 55 0	11 29 59.4	.229049	.010028
28.0	216 36 1 8	11 25 37.2	.235479	.010178
June 1.0	215 56 27.9	11 22 58.3	.242729	.010349
5.0	215 22 36.8	11 22 9.1	.250679	.010540
9 0	214 54 52.7	11 23 15.3	.259229	.010750
13.0	214 33 22.8	11 26 16 3	.268280	.010976
17.0	214 18 9.7	11 31 13.1	.277725	.011217
21.0	214 9 12.0	11 38 2.7	.287490	.011473
25.0	214 6 25.3	11 46 38.4	.297486	.011740
29.0	214 9 42 9	11 56 58 2	.307650	.012018
July 3 0	214 18 56.6	12 9 7.4	.317909	.012304
7.0	214 33 53.9	12 22 52.6	.328211	.012600
11 0	214 54 21.6	12 38 7.5	.338488	.012902
15.0	215 20 3.5	12 54 46.5	.348707	.013209
19 0	215 50 41 2	13 12 36 7	.358819	.013520
23.0	216 26 6.5	13 31 36.2	.368805	.013834
27.0	217 6 2 6	13 51 40.7	.378635	.014150
31 0	217 50 18 7	14 12 41.8	.388286	.014469
Aug. 4.0	218 38 41.8	14 34 31.9	.397732	.014787
8.0	219 20 59.6	– 14 57 6.7	0.406956	0.015105

" The comparison of this ephemeris with observation is contained in the following table.

" Comparison of Orbit III. with Observation.

C. — O.

Obs.	Δα	Δδ	Obs.	Δα	Δδ	Obs.	Δα	Δδ	Obs.	Δα	Δδ
1	+3″.6	+ 2″.0	38	+ 1″.2	— 5″.8	74	— 3″3	— 1″.0	110	— 8″.1	+ 1″.9
2	+6.7	+ 1.1	39	— 1.4	— 1 9	75	— 2.9	— 1 1	111	+ 6.3	. . .
3	+3.6	+ 2.6	40	— 2.4	— 1.9	76	— 9 1	— 4.3	112	+ 0.6	— 0.4
4	—1 8	+ 4.2	41	— 3 3	+ 2.0	77	— 2.8	+ 0.1	113	—27 4	— 9.4
5	—4.5	+ 7.5	42	— 3 0	— 7.6	78	. . .	+ 3 6	114	— 3.1	— 1.1
6	+0.9	— 6.3	43	+ 0.6	— 2.1	79	— 3.1	— 0.4	115	— 2 4	— 1.9
7	+1 2	— 1.1	44	— 3.8	— 0.4	80	— 8.1	— 2.4	116	— 3.9	— 6.6
8	+2 6	— 5.3	45	+ 1.2	— 6.0	81	— 1.9	+ 4.9	117	— 1.4	+ 7.3
9	—4.3	— 7.7	46	— 3.1	— 6 7	82	— 2.5	—16.8	118	— 3.0	+16.3
10	+0.5	— 5.3	47	— 4.4	— 0 8	83	— 4.0	— 5.8	119	— 1.2	+ 2.7
11	+3.1	— 1.0	48	— 3.3	— 1.6	84	— 6 7	+ 1.5	120	+ 0.3	+14.0
12	—2.4	+ 1.0	49	. . .	+ 0 6	85	— 6.5	— 1.3	121	— 1.6	— 3 6
13	+0.8	— 2 5	50	— 7.0	+ 3.2	86	— 6 2	— 1.9	122	+ 0 7	+ 3.0
14	. . .	— 5.1	51	— 4.8	— 6.1	87	— 2.9	—13 3	123	— 1.5	+ 7.5
15	+0.7	— 4.1	52	— 1.9	+ 7 2	88	— 8.1	— 5.9	124	+ 5.6	+ 3.9
16	—2.7	+ 1.4	53	. . .	— 3.1	89	— 2 6	— 7.6	125	— 0.6	— 0.0
17	—1.0	— 1.0	54	— 2.6	— 1.9	90	+ 3.6	+ 0.4	126	+ 7.8	— 4.8
18	+0.5	+ 1.6	55	— 4.4	+ 0 2	91	— 5 8	— 5.2	127	+ 1 2	— 1.5
19	+0.1	— 6.4	56	— 1.7	— 2.1	92	— 3 2	+ 1.7	128	— 0.3	— 0 2
20	—7.3	— 6.5	57	+ 1 0	— 0.3	93	+ 2.9	— 6.3	129	— 0.5	— 0.1
21	+0.3	— 3 4	58	— 4.5	— 5.0	94	— 3.7	— 1.0	130	— 2.5	+ 1.4
22	+0.4	+ 1.3	59	— 2.8	+ 2.3	95	— 6.3	+ 4.4	131	+ 1.5	— 1.5
23	—3.9	— 4.4	60	+ 0 3	— 7.2	96	—10.6	+10.6	132	+ 3.5	—11.9
24	—1.1	— 3.8	61	— 2.7	— 1.5	97	—13.8	— 1.7	133	+ 1.7	+ 1.7
25	+0.1	—10.5	62	+ 0.2	— 0.9	98	— 2.1	. . .	134	— 2.4	— 2.0
26	+3.4	— 3.4	63	+ 1.2	— 4.9	99	— 1.4	— 5.0	135	+ 3.8	+ 0.1
27	—2 5	+ 1.2	64	— 5 1	— 6 4	100	— 5.0	— 2.2	136	— 0 4	— 5.7
28	—5.9	— 3.0	65	+19.3	. . .	101	— 2 7	— 6.3	137	+ 1.1	+ 6.5
29	—0.9	— 4.2	66	. . .	—15.8	102	— 5.2	— 5 6	138	+ 1.2	— 3.1
30	+2.9	— 0 7	67	— 3.5	+ 2.0	103	— 2 4	— 2.5	139	— 2.1	— 2.7
31	—1.8	+ 3.1	68	— 5.6	— 0 0	104	—11.8	+ 7 8	140	+ 8.5	. . .
32	—1.3	— 3.3	69	— 2 2	— 2.2	105	—10.3	— 1.4	141	— 1.3	— 2.8
33	+1.3	—11.9	70	— 1.5	— 1.6	106	— 7.6	+ 3.8	142	+ 0 5	— 4.0
34	—1.0	— 3.0	71	. . .	— 6 2	107	—17.2	. . .	143	+ 2 4	+ 1.4
35	+0.6	+ 2.4	72	— 7.4	— 2.6	108	+ 1.5	— 3.6	144	+ 4.8	+ 1.2
36	—0.9	— 0.6	73	— 5.5	— 0.3	109	— 4.1	+ 3.3	145	— 4.7	— 1.1
37	—5 5	— 1.7									

" For this orbit the perturbations by Jupiter, since the opposition of 1848, have been computed. The influence of Saturn was found quite unappreciable, and that of Mars very insignificant, although the latter planet will be nearly in heliocentric conjunction with Metis during the month of April next. Their difference of latitude is, however, very considerable.

" The variations of the osculating elements are as follows. They are to be algebraically added to the elements in Orbit III

Date.	Δi	$\Delta ☊$	$\Delta \varphi$	$\Delta \pi$	$\Delta \mu$	$\iint \frac{d\mu}{dt^2}$	ΔL
1848, July 28.5	−0″.33	+0″.67	− 7″.49	+17″.32	−0″.049	−0″.76	−0″.29
Sept. 8.5	0.70	0.82	15.14	29 38	−0.097	3.82	2.01
Oct. 20.5	1.09	+0.36	22.73	35 87	0.143	8 85	5.06
Dec. 1.5	1.48	−0 76	30.38	37.92	0.186	15.78	9.33
1849, Jan. 12.5	1.87	2.55	37.28	34.88	0.226	24.46	14.69
Feb. 23 5	2 23	4.99	43.62	28.76	0.260	34.68	20.97
Apr. 6.5	2.54	8.02	49.34	21.12	0.288	46.22	28.01
May 18.5	2.81	11.54	54.43	11.65	0 309	58.81	35.59
June 29.5	3.00	15.40	59.97	6.16	0.323	72.12	43.51
Aug. 10.5	3 13	19.46	64 08	4 12	0.351	86.32	51.43
Sept. 21.5	3.17	23.54	67.96	6.69	0.345	100.92	59.25
Oct 23 5	−3.14	−27.44	−71.67	+16.71	−0 332	−116.08	−66.68

" Hence result the following osculating elements for April 6.5 : —

" METIS.

1849. April 6.5, Mean Equinox 1849.0. M. B. T.

M	234°	45′	32″.9		
L	306	27	46.5		
☊	68	28	38.5		
π	71	42	13.7		
i	5	35	31.9	Log. μ	2.9836193
φ	7	6	25.18	Log. a	0.3775915
μ		962″.985		Log. e	9.0924492

" These elements give the following ephemeris for the reappearance of Metis in 1849. The great diversity of the elements calculated from normal places so little different would of itself indicate that great exactness cannot be expected. And, were it not so, the unavoidable insecurity of the extrameridional observations at the discovery, and immediately before the disappearance, of the planet, would warn us to expect at least an uncertainty of one or two minutes in the predicted place.

" METIS. MEAN BERLIN MIDNIGHT.

Date.	α	δ	Log. Δ	Aberr. Time.
1849.				d.
Mar. 15	310° 36′ 51″	−21° 26′ 41″	0.499212	0.018680
16	311 1 45	21 21 50	.497747	
17	311 26 34	21 16 58	.496262	.018553
18	311 51 16	21 12 5	.494760	
19	312 15 53	21 7 10	.493240	.018425
20	312 40 24	21 2 15	.491702	
21	313 4 49	20 57 18	.490147	.018294
22	313 29 9	20 52 20	.488575	
23	313 53 24	20 47 21	.486986	.018161
24	314 17 32	20 42 20	.485379	
25	314 41 34	−20 37 20	0.483756	0.018027

Date.	α	δ	Log. Δ	Aberr. Time.
1849.				
Mar. 26	315° 5′ 30″	−20° 32′ 19″	0.482116	d.
27	315 29 19	20 27 17	.480459	0.017890
28	315 53 2	20 22 15	.478784	
29	316 16 38	20 17 13	.477091	.017752
30	316 40 7	20 12 10	.475380	
31	317 3 29	20 7 7	.473651	.017612
Apr. 1	317 26 44	20 2 4	.471904	
2	317 49 52	19 57 1	.470140	.017470
3	318 12 54	19 51 58	.468358	
4	318 35 48	19 46 55	.466559	.017327
5	318 58 35	19 41 53	.464742	
6	319 21 16	19 36 51	.462908	.017182
7	319 43 49	19 31 49	.461057	
8	320 6 15	19 26 47	.459188	.017035
9	320 28 34	19 21 47	.457301	
10	320 50 46	19 16 46	.455397	.016887
11	321 12 50	19 11 47	.453476	
12	321 34 46	19 6 48	.451536	.016738
13	321 56 35	19 1 51	.449579	
14	322 18 16	18 56 54	.447604	.016587
15	322 39 50	18 51 59	.445611	
16	323 1 15	18 47 5	.443601	.016435
17	323 22 32	18 42 13	.441573	
18	323 43 42	18 37 22	.439528	.016282
19	324 4 42	18 32 32	.437464	
20	324 25 35	18 27 45	.435383	.016127
21	324 46 19	18 22 59	.433284	
22	325 6 54	18 18 15	.431168	.015971
23	325 27 20	18 13 33	.429034	
24	325 47 37	18 8 54	.426883	.015814
25	326 7 45	18 4 17	.424715	
26	326 27 44	17 59 42	.422530	.015656
27	326 47 34	17 55 9	.420328	
28	327 7 15	17 50 39	.418108	.015498
29	327 26 46	17 46 11	.415872	
30	327 46 8	17 41 45	.413618	.015338
May 1	328 5 20	17 37 23	.411347	
2	328 24 22	17 33 5	.409060	.015178
3	328 43 14	17 28 49	.406755	
4	329 1 56	17 24 36	.404434	.015017
5	329 20 29	17 20 27	.402097	
6	329 38 51	17 16 21	.399743	.014856
7	329 57 2	17 12 19	.397373	
8	330 15 3	17 8 20	.394987	.014694
9	330 32 54	17 4 25	.392584	
10	330 50 34	−17 0 34	0.390165	0.014532

"The elements computed by me on the 28th of May last, and published in No. 639 of the *Astronomischen Nachrichten* (XXVII. p. 237), gave the right ascension, at the beginning of August, a minute and a half of arc too large, and the declination nine seconds too far south. These elements were deduced from meridian observations at an interval of but thirty days, and furnish a strong testimony to the importance of basing the orbits computed from a small arc upon meridian observations alone, if possible."

Professor Lovering read a paper on the "Law of Continuity," and a seeming exception to it, and illustrated it by various magnetical experiments.

"*The law of continuity* supposes that, in the operations of nature, a body passes from one state to another distinct state only by going through all the intermediate states. As to motion, this is obviously true. We cannot conceive of a body getting from one place to another, except by moving, in successive instants of time, through the intermediate positions.

"Leibnitz, who claimed to be himself the originator of this principle, considered it applicable, not only to the position of a body, but to the chemical and physical arrangement of its molecules. He supposed the foundations of this principle to be laid so deep in the arrangements of nature and the structure of the human mind, that man could not, when he reasoned upon the subject, conceive of its non-existence or of any exception to its application. The extreme length to which the law of continuity was pressed by Leibnitz and Bernouilli, in their attempts to demonstrate the laws of mechanics, led Maclaurin and others to reject it altogether. It must be admitted, notwithstanding, that this law of continuity has a firm foundation in truth; and that, under its guidance, man is put into the right path in the investigation of the plan of nature. The method of analysis which began with Leibnitz and Newton, and which in England has been known under the name of fluxions, rests upon this law of continuity. For it supposes a line to *flow* out from a point, a surface from a line, and a solid from a surface; and this, like any other motion, involves the law of continuity. If we admit the usefulness of the principle only in cases of motion, we still give it a wide range; since so many problems, not strictly dynamical, are reduced to cases of motion when investigated by the rules of modern analysis.

"The object of the present communication is not, however, to explain or defend the law of continuity as a sound principle in physical investigation, but to call attention to a few real or apparent exceptions to it with which I have become acquainted in studying the physical forces.

"If we place a bar-magnet on a table, and move over it lengthwise a small compass-needle which is free to move on a horizontal axis only, when this axis is parallel to the axis of the large magnet, the law of continuity will be observed in the changes of dip in the needle while it moves over the bar. If the needle is placed so that its horizontal axis is at right angles to the axis of the large magnet, then there is a remarkable breach of continuity in the sequences of dip. While moving from one end of the bar to the middle, the needle will be vertical all the time. Suddenly, on passing the middle point, it makes half a revolution, so as to bring the end which before pointed to the zenith towards the nadir. Here, then, in the changes of dip in a needle thus exposed, the law of continuity is not observed. If we substitute for the large magnet the magnetism of the earth, we have the same result. A dipping-needle, placed so that the axis on which it turns is in the magnetic meridian, keeps a vertical position while it is carried from the earth's magnetic poles to the earth's magnetic equator. As it crosses the magnetic equator, its two poles suddenly exchange positions with each other.

"There is one view to be taken of these facts which does not require us to believe that the law of continuity is disturbed. In both cases, the needle is constrained by its axis; for this axis is put in such a position that the whole force of nature is decomposed into two others, one of which is destroyed by the axis. If we take the action of the free force, the law of continuity prevails both in regard to the direction and the amount of the force. Still, this example will show that in the motions of a machine, or in any case where the forces of nature are artificially modified, it is not always safe to assume, in unqualified terms, the applicability of the law of continuity.

"A case can be supposed in which the force of gravity will be found in the same predicament. We cannot make the experiment, but it is not difficult to imagine what the result would be if the experiment were tried. I suppose a small tunnel to be cut from any point on the earth's surface to the centre, and so on to the opposite hemisphere. A plumb-line, if brought to the extremity of this opening, would point to the earth's centre; and, if let down into the opening, would still do so, though with diminished force. If it continued to move along the tunnel, at the instant of passing the earth's centre of gravity its direction would suddenly change 180 degrees. In this case, the law of continuity is observed so far as the intensity of the earth's gravity is concerned, but it is broken in regard to the direction of the force. This must necessarily be the case under the influence of central forces, unless there is combined with them another force, like the projectile force, which, in the solar system, unites with the former to carry the planet in a continuous curve around its centre of motion. If the force of projection be ever so small, the planet will move in a curve, however elongated, and change its direction gradually, though it may be with all the rapidity of the comet shooting through its perihelion. When the projectile force is nothing, the motion is rectilinear, and the direction alters abruptly. Here, also, the case is made easy, and the authority of the law of continuity vindicated. For in this instance, as in all others where motion, and not simply directive power, is considered, the velocity gradually diminishes, and prepares the way for a new motion in the opposite direction.

"It is well known, that sometimes the law of the forces of nature changes once or more in passing from one condition of nature to another continuously connected with it. Thus the attraction of a solid sphere is as the square of the distance from the centre inversely, so long as the attracted body is on the outside. When the attracted body comes within the surface, the attraction is directly as the distance from the centre. In the case of a hollow shell, the law of its attraction changes more than once. Within the shell, the attraction is constant for all positions. Outside, it obeys the same law as in a solid sphere. In the thickness itself, the attraction is subject to a third law. The centre of gravity of the attracted body will pass abruptly from one to another of these three conditions; but it is not always safe to represent the whole body by its centre of gravity. As the small body is passing through the surfaces of the large one, neither of the three laws stated above is applicable. Probably no single law will follow the body through the various positions involved in the entering of one of the bodies into the other. The law itself probably changes every instant, and thus the three partial laws, which are so discontinuous, and which are derived from a consideration of only the centre of gravity, will appear to be continuously connected when those links which are neglected when we study the motions wholly through the centre of gravity are restored. The mathematical function itself, therefore, if made so general as to include all the conditions of the experiment, might possibly be continuous from first to last. At any rate, if we give full weight to this apparent breach of continuity in the present mathematical expression of the law of attraction, it by no means follows that the body which is attracted and passes into these various exposures will change its velocity abruptly, as it comes under the sovereignty of one or the other of these laws. The laws may be different, widely different, in themselves, and yet in positions near together each may give a velocity not very different from what the others would have done. Therefore the abrupt change of the law will produce only a gradual change in the velocity of the moving body. This consideration is sufficient to show that the law of continuity is observed, to the exclusion of violent changes in matter. Nevertheless, a mental shock will be occasioned if the law itself shall not appear upon deeper investigation to retain, unbroken and unimpaired, its simplicity and integrity."

Three hundred and fifteenth meeting.

January 31, 1849. — Quarterly Meeting.

The President in the chair.

The Corresponding Secretary read a letter from James Hall, Esq., of Albany, acknowledging the notification of his election as a Fellow of the Academy, and presenting the first volume of his work on the Paleontology of New York.

The Corresponding Secretary also presented from Dr. Bache a copy of his report on the progress of the United States Coast Survey, accompanied by the request that the Academy would submit it to a careful examination, and make such suggestions as might be called for upon the scientific character and value of the survey as now carried on, or which might tend to give greater efficiency to the work. The subject was referred to a committee, consisting of Professor Peirce, Professor Lovering, Mr. Treadwell, and Mr. J. I. Bowditch.

A note from Dr. John Ware, resigning his place on the Rumford Committee, having been read by the President, Mr. Treadwell was appointed to fill this vacancy.

Professor Arnold Guyot, late of Neuchatel, was elected a Fellow of the Academy.

At the request of the committee on the establishment of permanent marks to indicate the water-level on our coast, Lieutenant Davis and Mr. E. C. Cabot were added to the committee.

Mr. Desor exhibited a minute crustacean animal, found in Cochituate water, with a drawing of the same, which he pronounced to be a species of Calanus.

Three hundred and sixteenth meeting.

February 6, 1849. — Monthly Meeting.

The Vice-President, Mr. Everett, in the chair.

The Corresponding Secretary read a letter from Professor Arnold Guyot, signifying his acceptance of the Fellowship of the Academy. He also read a communication from Mr. James D. Dana, of New Haven, upon the importance of having a larger edition of the scientific works embodying the results of the United States Exploring Expedition under Captain Wilkes. Whereupon the President was requested to address the Joint Library Committee of Congress, and to call attention to the memorial presented by the Academy upon that subject, on a former occasion.

Professor Peirce, from the committee appointed on that subject, read the following report upon the results of the United States Coast Survey, and it was ordered that a copy therof be forwarded to Dr. Bache, the Superintendent of the Survey, and another to the Hon. Robert C. Winthrop, Speaker of the House of Representatives.

"The committee of the American Academy of Arts and Sciences, to which were referred the report of the Superintendent of the United States Coast Survey, and the letter of the Superintendent requesting the opinion of the Academy thereupon, respectfully submit the following report.

"The present Superintendent of the Coast Survey of the United States was designated, in 1843, as the proper successor of Mr. Hassler, with extraordinary unanimity, by the science of the whole country. It was believed that his great scientific capacities, nurtured at West Point, and grown to maturity under the most favorable opportunities for development in his own country and during his European travels, united with his admirable judgment and enlarged administrative ability, were precisely adapted to the conduct of this national work, so important to commerce and navigation, and so interesting to science. After the lapse of five years from the date of his appointment, it is deemed reasonable to comply with Professor Bache's request to make a careful examination of his labors, and inquire if the high expectations which had been formed have been realized; if there has been so rich a harvest of valuable results as might have been anticipated; if the best methods of observation have been uniformly adopted; and if the survey has been conducted throughout with proper economy and despatch. Your committee have made this examination to the best of their ability, and have thought it advisable to present their conclusions in as simple and condensed a form as possible. The tone of the report is necessarily laudatory, for the committee are persuaded that the minutest and most conscientious scrutiny will find every thing to approve and nothing to condemn.

"1. The methods and instruments of observation appear to be, in all cases, the most convenient and accurate which are known; while, in some striking instances, they are such as were not known or tried in geodetical operations before they were introduced upon this survey. It is, moreover, grateful to record, that some of the most important of these improvements are of American origin. The committee beg leave to refer to some examples.

"The apparatus for measuring the base-lines is so portable, that six and three fourths miles are measured in ten working-days, and so accurate, that the whole amount of possible error in this distance would not exceed half an inch. This beautiful apparatus, which is incomparably superior to any which has ever before been adopted, is in principle and combination the invention of the Superintendent himself. It is a compensating system, and is in this respect closely allied to the elegant arrangement invented and used by Mr. Borden in the survey of the State of Massachusetts, but the method of compensation is novel and original in an essential and characteristic feature.

"The method which has been finally adopted for the measurement, astronomically, of differences of latitude is that which was invented by Captain Talcott, late of the Corps of Engineers of our army, and which had not before been used for geodetical purposes. A full description of this method has been recently published in an unusually handsome form by the Topographical Bureau of the War Department, in a memoir written by Captain T. J. Lee, which contains some examples from the Coast Survey observations. From this publication, it appears that the latitude is given, by a single night of observation, to the fraction of a second of arc, and that in four or five nights it can be determined with the minutest accuracy of which astronomical measurement is susceptible. The instrument employed is of simple construction, and of little cost, while its accuracy must render it available for some most delicate geodetic and geological researches. It is not impossible that, in the hands of a skilful geologist, it may aid in determining the various densities of the crust of our globe, and thereby serve as a divining-rod for detecting its internal wealth; and it may thus give birth to a new species of practical astrology.

" The use of Morse's magnetic telegraph for the determination of astronomical differences of longitude was too obvious to escape early notice, but it was reserved for the Coast Survey to ascertain its practicability as an exact method. This has been done by a series of refined and careful observations, made under the direction of Mr. Sears C. Walker, from which it appears that differences of longitude thus determined can be employed in the measurement of the earth in a direction perpendicular to the meridian. This conclusion is of great importance in reference to the survey of a coast which deviates from the arc of a meridian so much as that of the United States. The introduction of clockwork into the magnetic operations will undoubtedly contribute to their accuracy, although it remains to be seen which of the different plans that have been devised will be the preferable one.

" Professor Bache's method of employing the great theodolite in the primary triangulation must command the admiration of experienced observers for its conscientious accuracy, and its skilful and faithful determination of every correction and every source of error. His measured angles have rewarded his patience and perseverance, by submitting to the usual tests with a uniform exactness which has never been surpassed, and which proves that one fifth of a second of arc is the greatest error to which any one of his angles is liable. This extraordinary accuracy is not attained at any sacrifice of time; but, on the contrary, the present Superintendent has completed the observations at each station in much less time than was required by his predecessor, because he has rejected an unnecessary and injudicious rule in regard to the selection of days of observation.

" All the other portions of the field work, whether of the reconnoissance, of the primary, secondary, or tertiary triangulation, or of the topography or hydrography, and also the office work, are distinguished for the same scrupulous regard to accuracy and despatch. The observations, indeed, which are made in the field by one set of officers, are reduced and plotted by others in the office, so that there can be no danger of any deception, and every thing must be as good as it appears. The observations of the Superintendent himself are not excepted from this ordeal.

" The committee cannot pass from this head of their inquiry without expressing their commendation of the beautiful execution of the charts, and of the wise liberality with which they are furnished to navigators at a trifling cost.

" 2. The survey has already embraced a very extensive portion of the coast, and numerous discoveries have been made of the highest importance to navigation. ' The field or office work of the survey has been carried into every State on the Atlantic and the Gulf of Mexico, except one.' Every year results have been obtained of a mercantile value incomparably superior to their cost, and which would be sufficient to pay, again and again, for the whole year's work. To say nothing of the many important discoveries of useful channels, or of hidden and unknown dangers, in Long Island Sound, in Buzzard's, Massachusetts, Chesapeake, and Mobile Bays, who can estimate the value of Gedney's Channel* to New York harbour? of the determination of the changes in the main ship-channel, which have been so gratefully acknowledged by the Chamber of Commerce of New York? or of Blake's new channel in Delaware Bay? or of Davis's discoveries of the shoals in the vicinity of Nantucket, for which the insurance-offices of Boston and New York have acknowledged their obligation? Is not each of them separately worth the whole amount which has been expended upon the work? But leaving these remarkable discoveries to the merchants and sailors who are most competent to appreciate them, your committee would draw the attention of the Academy to some other results, of a less practical, but no less scientific, interest.

" 3. From the variety of his scientific attainments, the attention of the Superintendent has been readily drawn to all classes of observations which would conduce to the progress of science, and which could be made by himself or any of his parties without obstructing their other duties. Thus the abstruse problem of the figure of the earth will undoubtedly receive its due consideration when the primary triangula-

* Gedney's and Blake's Channels were discovered during the administration of Mr. Hassler.

tion is completed; and also the local variations of figure in connection with those differences of internal density, the detection of which is already to be enumerated as one of the scientific discoveries which have been made upon the survey.

"The intricate problem of the tides, also, which is still so defective, notwithstanding the labors of Laplace, Airy, Lubbock, and Whewell, will undoubtedly receive new development from the observations of the survey, and the laws of the tides upon the American coast will be ascertained.

"The exploration of the Gulf Stream, which was commenced by Lieutenant Davis, and so indefatigably pursued, even to the sacrifice of his life, by the lamented George M. Bache, has led to results which are of profound scientific importance; and the deep-sea soundings, which have been examined by Professor Bailey, are also replete with interest to the naturalist.

"4. Your committee have few data for arriving at any definite conclusion with regard to the extent of the economy with which the survey has been conducted. They are not, however, aware of any objection to the comparison which has been instituted by the Superintendent with the surveys of the Land Office, and which is very favorable to the Coast Survey. There is certainly no appearance of waste or extravagance in any respect; there are no excessive salaries, no idle *attachés*, nor any apparent disposition to pay too much for services rendered. There seems, on the contrary, to be an anxious desire to husband the appropriations of Congress, and to derive from them the largest possible return of valuable results. It is especially deserving of notice, that the Superintendent has manifested the wisest and most unselfish economy in asking for large appropriations, in order that he may press forward the work as rapidly as possible to its final completion.

"In conclusion, it is the deliberate opinion of the committee, that the present Superintendent of the United States Coast Survey has, by his able and judicious, his energetic and economical administration of this great national work, raised it to the highest state of successful activity and deserved popularity, and that he has thereby fulfilled the high expectations which were raised at his appointment.

"All of which is respectfully submitted by

BENJAMIN PEIRCE,
DANIEL TREADWELL,
J. I. BOWDITCH,
JOSEPH LOVERING."

Professor Lovering, in the absence of the chairman of the Rumford Committee, read the following report on a communication of Mr. James Frost, which was referred to that committee.

" The Rumford Committee, having examined the paper submitted by James Frost, Esq., of Brooklyn, New York, and entitled, 'Description of the Causes of the Explosion of Steam-boilers, and of some newly discovered Properties of Heat, and other Matters: for the Purpose of showing that the Application of Steam for the Production of Motive Force is susceptible both of immense Improvement and Economy,' respectfully report: —

" The chief points which the author claims to have established are, —

" 1st. That steam of 212° Fahr., heated, out of contact with water, to 216°, doubles its volume; and heated to 228°, increases its volume threefold.

" 2d. That steam of low tension, heated to somewhere about 650°, is converted into another body, which the author calls 'stame,' and which, under favorable circumstances, becomes six times as effective as steam not so heated.

" As, in the view of the author, the question of discovery rests upon the truth of the first of these two propositions, the attention of the committee has been particularly directed to its consideration. To this end, the apparatus employed by Gay-Lussac in his determinations of the tension of aqueous vapor at different temperatures was constructed, and a series of experiments made upon steam heated, out of contact with water, from the boiling point to 233°.6. The results arrived at were as follow.

" A volume of steam at 212° Fahr., measuring 15.80 cubic centimetres, or 1580 parts, heated to 216°, became 1600 parts, and heated to 228°, became 1630 parts. According to Mr. Frost, 1580 parts at 212° should have become 3160 parts at 216°, and 4740 parts at 228°. In tabular form we have, at

	Exp.	Frost.	Dif.
212°	1580	1580	——
216°	1600	3160	1560
228°	1630	4740	3110

" The results for higher, intermediate, and lower temperatures are given in the accompanying table. The whole expansion of the steam, when heated from 212° to 228°, was a little more than one thirtieth of its volume at 212°. According to Mr. Frost, it should have been more than ninety times as great as the committee found it to be.

" The experiments of the committee were made with steam under a pressure ranging from 24 to $24\frac{1}{2}$ inches of mercury, that is, under less than atmospheric pressure. This condition could not influence the result unfavorably to the view of Mr. Frost, since the less the pressure, the greater is the expansion with a given elevation of temperature.

Centigrade.	Fahrenheit.	Volumes.	Centigrade.	Fahrenheit.	Volumes.
112°	233.6°	1644	102°	215.6°	1600
111.5	232.7	1642	101.5	214.7	1598
111	231.8	1640	101	213.8	1592
110.5	230.9	1638	100.5	212.9	1588
110	230.0	1634	100	212.0	1580
109.5	229.1	1632	99.5	211.1	1574
109	228.2	1630	99	210.2	1560
108.5	227.3	1628	98.5	209.3	1510
108	226.4	1626	98	208.4	1430
107.5	225.5	1624	97.5	207.5	1280
107	224.6	1622	97	206.6	1130
106.5	223.7	1620	96	204.9	870
106	222.8	1618	95	203.0	650
105.5	221.9	1616	94	201.2	550
105	221.0	1614	93	199.4	350
104.5	220.1	1610	92	197.6	200
104	219.2	1608	91	195.8	150
103.5	218.3	1606	90	194.0	125
103	217.4	1604	70	158.0	000
102.5	216.5	1602			

" The committee deem it unnecessary to consider farther the claims of the alleged newly discovered properties of heat, as set forth in the pamphlet of Mr. Frost.

E. N. HORSFORD,
JOSEPH LOVERING,
DANIEL TREADWELL,
BENJAMIN PEIRCE."

Mr. Foster, of the United States Survey of the Mineral Lands of Lake Superior, being present by invitation, read the subjoined paper.

" *On Certain Phenomena connected with the Rise and Fall of the Waters of the Northern Lakes.*

" During a residence of several summers on the borders of Lake Superior, my attention has been directed to the question, whether its waters were subject to any movement corresponding to the tidal action, and the result of my observations has been, to convince me that they do not rise and fall at stated periods, corresponding to the ebb and flow of the tide. On the other hand, abundant evidence exists that the waters are subject to extraordinary risings, which are independent of the influence of the sun and moon.

" The late Governor Dewitt Clinton * published a memoir on this subject, which embodies many interesting facts. As that memoir is not readily accessible, we will extract such facts as are deemed most important. These risings attracted the attention of the earliest voyageurs in this region. La Hontan relates the following incident : — ' On the 29th of May, 1689, we came to a little deep sort of a river, which disembogues at a place where the water of the lake [Michigan] swells three feet high in twelve hours, and decreases as much in the same compass of time. Our tarrying there for three or four days gave me an opportunity of making the remark.' Charlevoix,† who traversed the Lakes nearly a century ago, in reference to Lake Ontario says : — ' I observed that in this lake, and I am told that the same thing happens in all the rest, there is a sort of flux and reflux, almost instantaneous, the rocks near the banks being covered with water and uncovered again several times in the space of a quarter of an hour, even if the surface of the lake was very calm, with scarce a breath of air. After reflecting for some time on this appearance, *I imagined it was owing to springs at the bottom of the lake, and to the shock of their currents with those of the rivers which fall into them from all sides, and thus produce those intermitting motions.*' Mackenzie, ‡ who wrote in 1789, remarks : — ' A very curious phenomenon was observed at the Grand Portage on Lake Superior, for which no obvious cause could be assigned. The water withdrew with great precipitation, leaving the ground dry which had never before been visible, the fall being equal to four perpen-

* *Transactions of the New York Literary and Philosophical Society*, Vol. II., Part I.

† *Journal Historique d'un Voyage de l'Amérique*, L. XIII.

‡ *Voyage to the Frozen and Pacific Oceans.*

dicular feet, and rushing back with great velocity above the common mark. It continued thus rising and falling for several hours, gradually decreasing, until it stopped at its usual height.'

" Governor Clinton relates the following incident, which happened to Colonel Bradstreet, who commanded an expedition against the Western Indians in 1764: — 'In returning by way of Lake Erie, when about to land the troops one evening, a sudden swell of the lake, without any visible cause, destroyed several of his boats, but no lives were lost. This extraordinary event was looked upon as the precursor of a storm, and accordingly one soon occurred, which lasted several days.' The following occurrence, also related by him, took place on the British side of Lake Erie, on the 30th of May, 1823: — 'A little after sunset, Lake Erie was observed to take a sudden and extraordinary rise, the weather being fine and clear, and the lake calm and smooth. It was principally observed at the mouths of Otter and Kettle Creeks, which are about twenty miles apart. At Otter Creek, it came in, without the least previous intimation, in a swell of nine feet perpendicular height, as was afterwards ascertained, rushed violently up the channel, drove a schooner of thirty-five tons burden from her moorings, threw her upon high ground, and rolled over the ordinary beach into the woods, completely inundating all the adjacent flats. This was followed by two others of equal height, which caused the creek to retrograde a mile and a half, and to overflow its banks, where water was never before seen, by seven or eight feet. The noise occasioned by its rushing with such rapidity along the winding channel was truly astonishing. It was witnessed by a number of persons. At Kettle Creek, several persons were engaged drawing a fish-net in the lake, when suddenly they saw the water coming upon them in the manner above described, and, letting go their net, they ran for their lives. The swell overtook them before they could reach the high bank, and swept them forward with great force, but being expert swimmers they escaped unhurt. The man who was in the skiff, pulling in the sea-line, was driven a considerable distance over the flat, and grounded upon a small eminence, where he remained until the water subsided. There were three successive swells, as at Otter Creek, and the effects were the same, with this difference, — the water rose only seven feet. In both cases, the lake, after the swells had spent their force, gradually subsided, and in about twenty minutes was at its usual height and tranquillity.'

"In 1828, Governor Cass instituted a series of experiments, at the head of Green Bay, to determine the changes in the water-level. These observations extended from the 15th of July to the 30th of August, and from them he infers 'that the changes in the elevation of the waters are entirely too variable to be traced to any regular permanent cause, and that consequently there is no perceptible tide at Green Bay which is the result of observation. And such, it appears to me, is the result of calculation, when the laws that regulate solar and lunar attraction are taken into view.' *

"In the summer of 1834, an extraordinary retrocession of the waters took place at Sault St. Marie, the outlet of the lake. The river at this place is nearly a mile wide, and in the distance of a mile falls 18.5 feet. Its bed is sandstone, and, except in the immediate channel, the average depth of water is two and a half feet. The phenomenon occurred about noon. The day was calm, but cloudy. The water retired suddenly, leaving the bed of the river bare, except for a distance of thirty rods, and remained so for nearly an hour. Persons went out and caught fish in the pools formed in the depressions of the rocks. The return of the waters is represented as having been very grand. They came down like an immense surge, and so sudden was it, that those engaged in catching fish had barely time to escape being overwhelmed.

"A similar phenomenon occurred twice on the same day in the latter part of April, 1842. The lake was free from ice, and no wind was prevailing in the vicinity.

"A few years previously, the precise period my informants could not designate, the current between the foot of the rapids and Fort Brady, which usually flows at the rate of two and a half knots an hour, was observed to set back. The water rose two feet or more, and the rate of the back-current was estimated at two knots an hour. Some of the soldiers at the fort, in order to satisfy themselves, jumped into a boat and rowed into the stream, when they found the current bearing them towards the foot of the rapids. How long this continued, my informants could not designate. A strong wind was prevailing from the south, but it was never before known to have

* Remarks on the Supposed Tides and Periodical Rise and Fall of the North American Lakes, by Major (now Brigadier-General) Henry Whiting, *American Journal of Science*, Vol. XX., Part II. See also a paper by General H. A. S. Dearborn, *Ibid.*, Vol. XVI.

produced such an accumulation of water. These facts I gathered from Mr. Hulburt, Ashmun, and Peck, old residents of Sault St. Marie.

"I have witnessed numerous ebbings and flowings of the waters of Lake Superior.

"In the month of August, 1845, I was coasting in an open boat from Copper Harbour to Eagle River. It was late in the afternoon, and the lake was calm. To the northwest, the clouds indicated that different strata of air were moving in opposite directions. Mirage was beautifully displayed, and I was occupied in tracing out islands, with bold cliffs and spacious harbours, which had no real existence, when suddenly the water about a mile to the northwest was lifted up like a conical hill, to the height of apparently twenty feet, and swept towards the shore, diminishing in size as it advanced. The voyageurs saw it as it came rolling like a great breaker crested with foam, and headed the boat so as to cut the wave. It struck us without doing any injury, and was succeeded by two or three dead swells, when the lake resumed its former tranquillity. The cause which uplifted the water was local, and operated but for a moment. The swell could not, like the *bore* observed at the mouth of the Amazon, have resulted from opposing currents.

"While at Rock Harbour, Isle Royal, in the summer of 1847, I witnessed, on one occasion, the alternate rise and fall of the water, recurring at intervals of ten or fifteen minutes, during an entire afternoon. The variation was from twelve to twenty inches. The day was calm and clear, but the barometer was falling. Before the expiration of forty-eight hours, a violent gale set in.

"On the 23d of July last, I went from Copper Harbour to Eagle River, where I arrived in the evening. The day had been calm, so much so that a sail was useless. In the evening, there sprang up an off-land breeze, as is frequent; but notwithstanding, I observed a strong current flowing into Eagle River. The next day, a storm came on which continued for several days.

"I have witnessed the ebb and flow of the water through the narrow inlets and estuaries, particularly at Copper Harbour, when there was not a breath of wind on the lake. Similar phenomena have been noticed on the Swiss Lakes Constance and Geneva, which are there called *seiches*.

"I have already given Charlevoix's theory to account for them. Volney supposed that Lake Ontario was the seat of an ancient volcano, which occasionally afforded signs of being not entirely extinct, and Governor Clinton was inclined to connect them with earthquake movements. Professor Mather, who observed the barometer at Copper Harbour during one of these fluctuations, remarks: — 'As a general thing, fluctuations in the barometer accompanied fluctuations in the level of the water; but sometimes the water-level varied rapidly in the harbour, while no such variations occurred in the barometer at the place of observation.' *

" As a general rule, these variations in the water-level indicate the approach of a storm, or a disturbed state of the atmosphere. The barometer is not sufficiently sensitive to indicate the sudden elevations and depressions, recurring, as they often do, at intervals of ten or twelve minutes, and the result of observations at such times may be regarded in some degree as negative.† Besides, it may not unfrequently happen, that, while the *effects* are witnessed at the place of observation, the *cause* which produced them may be so far removed as not to influence the barometer.

" From all the facts, we are led to infer that these phenomena result, not from the prevalence of the winds acting on the water, accumulating it at one point and depressing it at others, but from sudden and local changes in the pressure of the atmosphere, giving rise to a series of barometric waves. The water, conforming to the laws which govern two fluids thus relatively situated, would accumulate where the pressure was the least, and be displaced where it was the greatest.

" Again, as has been remarked by De la Beche, a sudden impulse given to the particles of water, either by suddenly increased or diminished pressure, would cause a perpendicular rise or fall, in the manner of a wave, beyond the height or depth strictly due to the mere weight itself. The difference in the specific gravity of the water of the lakes

* *American Journal of Science*, Vol. VI. (Second Series), July, 1848.

† De la Beche (*Survey of Cornwall*), quoting from the MSS. of Mr. Walker, who has devoted much time to the phenomena of tides, says: — " He has found that changes in the height of the water's surface, resulting from changes in the pressure of the atmosphere, are often noticed in a good tide-gage *before* the barometer gives notice of any change. . . . . . If tide-gages at important dock-yards show that a sudden change of sea-level has taken place, indicative of suddenly decreased atmospheric weight, before the barometer has given notice of such change, all that time which elapses between the notices given by the tide-gage and barometer is so much gained, and those engaged with shipping know the value of even a few minutes before the burst of an approaching hurricane."

and the ocean may cause these changes to be more marked in the former than in the latter."

The subject was further discussed by Professor Rogers and Mr. Desor.

Professor Agassiz addressed the Academy upon animal morphology, presenting some original views which he had recently developed upon this subject.

Mr. Bond made the following astronomical communications, viz. : —

1. *Observations on the Satellite of Neptune, made at the Cambridge Observatory*, 1847 – 48.

Cambridge Mean Solar Time.				Angle of Position.	Distance.	No. of Obs.	Observer.	Power.	Remarks.
1847.	d.	h.	m.	°	"				
Oct.	25	7	45	230 0	15.4	3	B^1	300?	Neither the angle of position nor the distance is well determined.
"	27	7	40	28 8	13.5	3	B^1	300	
"	"	7	40?	28.2	13 8	4	B^2	1200	
"	28	7	15	47.5	14.7	3	B^1	400	The satellite is seen without difficulty, and the observations are supposed to be good.
"	"	8	15	46.0	15.2	6	B^2	1200	
"	30	7	00	217.9	15.6	3	B^2	400	Very fine definition. Obs. uncertain from [clouds.
Nov.	2	7	15	34.2	14.0	5	B^2	400?	Dense fog. Satellite faint.
"	3	7	00	51.4	12 6	4	B^1	400?	
"	26	7	05	49.9	15.3	10	B^1	400?	
"	"	7	47	40.1	16 6	5	B^2	1200	
1848.									
July	3	15	47	221.0	16.2	8	B^2	1200	Satellite occasionally obscured by clouds: otherwise it is well seen.
"	"	16	40	217.2	16.2	6	B^1	1200	
"	11	15	15	24 3	12.0	2	B^2	1200?	Fine definition. Obs. interrupted by daylight
"	21	15	0	234 0	16.2	5	B^2	860	Measures very difficult, from haze and moonlight.
Aug.	31	10	17	225 0	17 1	6	B^2	860	
"	"	10	46		16.1	8	B^1	860	Satellite well seen.
Oct.	11	7	50	219.8	16.4	6	B^2	860	
"	12	10	10	245.0	9 6	3	B^1	860	Bad seeing.
"	20	9	54	41.3	15.7	6	B^2	860	
"	"	10	10?		15.8	5	B^1	860	
"	23	7	35	219 5	15 6	5	B^1	860	
"	"	8	05	223 0	17.0	5	B^2	860	
"	28	8	00?	211.8	11.2	3	B^2	1500	Observations difficult.
Nov.	1	7	00	221.5	16.5	4	B^1_2	860	Bad seeing.

" The light of the satellite we have found to be nearly equivalent to that of a star of the fourteenth magnitude, as stars of that class, brought as near to Neptune as is its satellite, about equal the latter in faintness.

" Under good definition, Neptune shows a round disk, distinguishing it from stars of the same brightness. Its color is bluish, resembling the light of Uranus. We have more than once noticed an appearance somewhat of the nature of that from which Mr. Lassell has inferred the existence of a ring; but whether it is caused by a ring, or by the inner satellites which probably exist, or whether it be only an optical appendage, it would be difficult to determine.

"The important object in view in these observations has been the determination of the mean distance of the satellite, in order to ascertain the mass of Neptune. For this purpose measurements near the times of greatest elongation are most valuable. On five occasions, namely, Nov. 26, 1847, July 3, Aug. 31, Oct. 20, and Oct. 23, 1848, the satellite has been observed in this position. The elements of the satellite's orbit from these observations, as computed by Mr. G. P. Bond, are:—

Periodic time, 5.8752 days.
Inclination, 30°
Ascending node, 300° if the motion be *direct.*
Passage of ascending node, 1848, Oct. 30.37, Greenwich M. S. T.
Mean distance, 16.″3 at the mean distance of Neptune.

"These elements have been found by comparing the places of the satellite computed from Professor Peirce's orbit, published in the first volume of the Proceedings of the American Academy, p. 295, with those observed, and thence deducing small corrections for the epoch, period, and mean distance, so as best to satisfy the whole series of *distances.* The following table shows the agreement between the observed and computed places in the corrected orbit.

	Distance. Comp. — Obs.	Position. Comp. — Obs.
1847, Oct. 25,	— 0.″3	+ 0.°3
" " 27,	+ 0.3	+ 5.4
" " 28,	— 0.4	+ 3.2
" " 30,	— 1.4	— 3.7
" Nov. 2,	+ 0.8	+ 1.8
" " 3,	+ 1.1	+ 0.6
" " 26,	+ 0.1	— 1.2
1848, July 3,	+ 0.4	+ 4.1
" " 11,	— 0.4	+ 3.5
" " 21,	+ 0.5	— 5.8
" Aug. 31,	+ 0.2	— 1.3
" Oct. 11,	— 0.1	+ 0.6
" " 12,	— 0.1	— 2.2
" " 20,	+ 0.5	+ 3.3
" " 23,	+ 0.1	+ 2.6
" " 28,	+ 0.1	— 3.7
" Nov. 1,	— 0.7	— 2.8

"The corresponding mass of Neptune is $= \frac{1}{19400}$."

2. *Observations on Encke's Comet*, 1848, *made at the Cambridge Observatory.*

Cambridge Mean Solar Time.	Comet's Mean A. R., Jan. 1, 1848.	Comet's Mean Dec , Jan. 1, 1848.	No. of Obs.
1848. d. h. m. s.	h. m. s.	° ′ ″	
Aug. 27 14 01 44	3 19 28.0	+31 57 01	1
" 29 12 50 53	3 23 31.2	32 36 29	13
" 30 12 57 36	3 25 46.2	32 57 47	11
" 31 12 40 01	3 27 58.9	33 19 03	10
Sept. 5 15 56 49	3 40 36.2	35 17 13	6
" 26 11 26 24	5 07 49.4	46 23 42	10
Oct. 8 16 35 57	7 26 35.9	53 03 36	6
" 27 17 30 39	12 19 51.7	25 05 29	8
Nov. 3 17 33 38	13 07 48.4	11 06 18	6
" 5 17 29 34	13 18 14.7	+ 7 43 58	6
" 13 17 56 08	13 53 52.5	— 3 34 57	10
" 20 18 17 33	14 25 18.8	11 38 55	4
" 21 18 17 02	Compared with Mercury.		2
" 25 18 05 20	14 52 59.4	—16 44 49	4

Date.	Dif. A. R. Comet — Star.	Dif. Dec. Comet — Star.	Star A. R. Jan. 1, 1848.	Star Dec. Jan. 1, 1848.	Mag.
	m. s.	′ ″	h. m. s.	° ′ ″	
Aug. 29	—0 09.33	+5 35.2	3 23 40.54	+32 30 54.3	10
30	—0 18.97	—3 51.3	3 26 05.22	33 01 38.3	11
31	—1 20.05	—2 20.8	3 29 19.00	33 21 23.7	9
Sept. 5	—0 05.70	+1 53.5	3 40 41.87	35 15 19.2	9
26	—0 25.40	—3 51.0	5 08 14.79	46 27 33.2	9
Oct. 8	—1 20.22	+2 44.6	7 27 56.10	53 00 51.6	7
27	—0 06.38	+1 21.8	12 19 58.13	25 04 07.1	8
Nov. 3	—0 21.10	+3 02.3	13 08 09.51	11 03 15.7	9
5	—1 41.06	+1 54.1	13 19 55.74	+ 7 42 04.0	9
13	+0 04.18	—0 11.8	13 53 48.30	— 3 34 45.6	8
20	—3 36.28	+0 25.5	14 28 55.07	11 39 20.5	7
21	at h. m. s. 18 17 02 ☿ A.R. — Comet's A. R. = +7 m. s. 29.35 by two comparisons. 18 05 36 ☿ Dec. — Comet's Dec. = +5′ 44″.3 by one comparison.				
25			14 42 28.75	—15 24 24.0	3

"The observation on the 27th of August was an instrumental reading corrected by a neighbouring star. 'The comet is a misty patch of light, faint and without concentration.' 'Its light is coarsely granulated, so that, were it not for its motion, it might be mistaken for a group of stars of the 21st magnitude.'

"*Aug.* 30*th.* A slight elongation is suspected in the direction south-preceding, position 240°.

"*Aug.* 31*st.* The comet is close to a star of the 12th magnitude, which interferes with the observations.

"The determinations on the 29th, 30th, and 31st may be uncertain to the amount of 10″ or 15″. The difficulty arises not so much from the faintness of the comet as from its want of concentration.

"*Sept.* 26*th.* The comet shows a brush of light *towards* the sun.

" *Oct. 8th.* Comet just visible to the naked eye. The brighter portion is very eccentrically situated with respect to the general mass. The fan-shaped brush of light is very evident on the side *towards* the sun, the angle of the sides opening by 75° or 80°. There is no other appendage which can be called a tail.

" *Oct. 27th.* The general mass of light is on the side of the nucleus, *towards* the sun; a faint ray, probably the commencement of the true tail, is thrown out on the side opposite to the sun.

" *Nov. 3d.* The comet shows a tail of 1° or 2°. The same remarkable appearance of a double tail presents itself as in October. It is plainly visible to the naked eye.

" *Nov. 5th.* Star of comparison is double, distance 10″; that north-preceding is used.

" *Nov. 13th.* Strong daylight; comet shows an almost sparkling central point.

" *Nov. 21st.* The comparisons with Mercury are corrected for refraction and for the planet's motion in the intervals of transit.

" *Nov. 25th.* The comet was caught sight of in the morning twilight at an altitude of about 3°, and immediately compared with α^2 Libræ, which was near it. Four instrumental comparisons were obtained. After correction for differences of refraction and allowing for the comet's motion, the observed places of the comet differed among themselves in A. R. by $0^s.7$, and in Dec. by 13″."

3. *Observations on the Eighth Satellite of Saturn (Hyperion) made at the Cambridge Observatory.*

Cambridge Mean Solar Time.	Distance from Saturn's Centre.	Cambridge Mean Solar Time.	Distance from Saturn's Centre.
1848.	″	1848.	″
Sept. 19.56	+ 256	Oct. 21.42	— 206
21.52	+ 220	23 42	— 178
22.44	+ 192	27.34	+ 88
23.38	+ 145	28.31	+ 136
28 38	— 156	Nov. 1.31	+ 248
Oct. 13.32	+ 202	2.30	+ 198
14.29	+ 152	3.31	+ 228
15.40	+ 92	1849.	
20.31	— 187	Jan. 12.29	— 132

" The sign + indicates that the satellite follows Saturn, and — that it precedes the planet. Owing to the faintness of the new satellite, the distances above given are liable to errors of observation, amounting to three or four seconds. It was found best to refer Hyperion to the limb of Saturn through an intermediate satellite or star. The presence of moonlight, or even the near proximity of Saturn, affects its visibility in a much greater degree than is the case with Mimas, the inner body of the system.

"The following elements, representing somewhat roughly the above places, have been computed by Mr. G. P. Bond.

Period of revolution,	21.18 days.
Mean distance,	214″ at the mean distance of Saturn.
Eccentricity,	0.115
Mean anomaly,	97° Jan. 1st, 1849.
Perisaturnium,	295°

"The line of nodes and the inclination of the orbit coincide nearly with those of the ring."

4. *Observations on Petersen's Second Comet, made at the Cambridge Observatory.*

Corrected for refraction, and referred to the Mean Equinox of Jan. 1st, 1848.

Cambridge Mean Solar Time.	Comet's A. R.	Comet's Dec.	Star of Comparison. A. R.	Star of Comparison. Dec.	No. of Comp.	
1848. d. h. m. s.	h. m. s.	° ′ ″	h. m. s.	° ′ ″		
Nov. 25 6 56 41	20 35 11.2	+ 37 24 15	20 40 03.75	+ 33 24 13.8	2	ε Cygni.
27 6 58 34	20 43 45.8	34 52 24	20 43 12.06	35 00 15.5	6	Lalande 40277.
28 6 55 53	20 47 58.3	33 34 54	20 40 03.75	33 24 13.8	3	ε Cygni.
29 6 55 16	20 52 10.5	32 16 04	20 40 03.75	33 24 13.8	1	"
30 8 20 36	20 56 35.6	30 51 18	20 59 22.45	30 57 32.7	3	B Z. 306.
Dec. 18 7 18 45	22 04 15.3	6 13 02	22 04 19.51	6 08 58.3	3	Weisse H. XXII. No. 78.
19 7 34 09	22 07 39.0	+ 4 54 25	22 06 25.42	+ 5 01 41.0	4	" No. 124.
1849.						
Jan. 22 6 42 22	23 42 13.2	−27 10 19	23 36 34.00	−27 05 15.9	2	Lacaille 9579. Lalande 46511.

"*Nov. 25th.* The comet was first seen at $6^{h.}$ $30^{m.}$; it shows a finely marked nucleus, with a tail of 15′ or 20′.

"At $6^{h.}$ $56^{m.}$ $41^{s.}$, M. S. T., it followed a star of the 9th magnitude by $0^{m.}$ $25^{s.}.60$, and was north of it by 2′ 25″.1, by ten micrometric comparisons. The centre is so well defined that the relative places of the star and comet may be found with great nicety. The A. R. and Dec. on the 25th, 28th, and 29th are from instrumental comparisons.

"*Nov. 30th.* The nucleus passed within one second of arc of a star of the 12th magnitude; both appeared of the same magnitude, and formed a close double star, but were not in contact; at the time of nearest approach, the comet *could be seen to move.*

"*Dec. 18th.* Tail of the comet 2° in length. There are traces of a secondary tail, at an angle of 10° or 20° with the principal one.

"*Dec. 19th.* The breadth of the tail in its brightest part, at 20′ from the nucleus, is only about one minute of arc.

"*Jan. 22d.* Altitude of the comet at the observation = 8°."

5. *Moon Culminations observed at Cambridge.*

Lon. West of Greenwich, 4 h. 44 m. 32 s.

Date.	Name of Object.	Sidereal Time of Meridian Passage.	Seconds of Tabular A. R.	Diff.	Observer's Initial.
		h. m. s.	s.	s.	
1847, Sept. 17	☽'s 1st Limb	17 42 19.92			B¹ *
"	γ Draconis	17 53 04.57	04.56	— 0.01	"
"	μ^1 Sagittarii	18 04 39.82	39.82	0.00	"
28	Aldebaran	4 27 12.66	12.26	— 0.40	"
"	☽'s 1st Limb	4 42 46.55			"
"	ι Tauri	4 54 00.26	00 63	+ 0 37	"
"	Capella	5 05 27.93	27.98	+ 0.05	"
"	β Tauri	5 16 40.74	40.93	+ 0.19	"
"	α Leporis	5 26 02.21	02.24	+ 0.03	"
"	α Orionis	5 46 56.25	56.22	— 0.03	"
Oct. 3	δ Geminorum	7 11 01.60	01.56	— 0.04	"
"	α^2 Geminorum	7 24 52.64	52.64	0.00	"
"	β Geminorum	7 35 59.26	59.36	+ 0.10	"
"	☽'s 2d Limb	9 17 56.02			B²
23	ι Piscium	23 32 08.35	08.40	+ 0.05	B¹
"	e Piscium	1 00 33 28	33.58	+ 0.30	"
"	μ Piscium	1 22 14.19	14.05	— 0.14	"
"	☽'s 1st Limb	2 05 35.53			"
"	☽'s 2d Limb	2 06 57.22			"
"	ξ^2 Ceti	2 20 05.92	05.81	— 0.11	"
"	μ Ceti	2 36 45.02	44.43	— 0.59	"
Nov. 1	ε Hydræ	8 38 43.10	43.13	+ 0.03	"
"	α Hydræ	9 20 06.34	06.57	+ 0.23	"
"	ε Leonis	9 37 12.19	11.94	— 0.25	"
"	α Leonis	10 00 15.60	15.52	— 0.08	"
"	☽'s 2d Limb	10 38 07.95			"
1848, Feb. 18	ξ Leonis	9 23 45.95	46.65	+ 0.70	"
"	o Leonis	9 33 03.95	03.79	— 0.16	"
"	α Leonis	10 00 18.03	18.03	0.00	"
"	☽'s 1st Limb	10 04 17.43			"
"	☽'s 2d Limb	10 06 24.67			"
"	b^1 Leonis	10 17 15 94	15.90	— 0 04	"
"	ϱ Leonis	10 24 50.01	49.92	— 0.09	"
Feb. 25	f Libræ	15 25 53.28	53.16	— 0.12	"
"	☽'s 2d Limb	15 42 50.66			"
"	β^1 Scorpii	15 56 37.16	37.20	+ 0.04	"
"	δ Ophiuchi	16 06 23.19	23.66	+ 0.47	"
27	☽'s 2d Limb	17 27 27.92			B²
"	α Lyræ	18 31 47.01	47.08	+ 0 07	"
March 11	γ Tauri	4 11 09.26	09.25	— 0.01	B¹
"	α Tauri	4 27 12.69	12.67	— 0.02	"
"	☽'s 1st Limb	5 09 47.69			"
"	ζ Tauri	5 28 34.43	34.56	+ 0.13	"

* B¹ is the initial of *W. C. Bond;* B², that of *G. P. Bond.*

Date.	Name of Object.	Sidereal Time of Meridian Passage.	Seconds of Tabular A. R.	Diff.	Observer's initial.
		h. m. s.	s.	s.	
1848, March 11	δ Geminorum	7 11 03.83	03.74	−0.09	B[1]
14	δ Geminorum	7 11 03.74	03.69	−0.05	"
"	α^2 Geminorum	7 24 54.95	54.95	0.00	"
"	ϰ Geminorum	7 35 17.40	17.18	−0.22	"
"	☽'s 1st Limb	8 02 24.86			"
"	ϑ Cancri	8 22 56.76	56.80	+0.04	"
"	δ Cancri	8 36 03.85	03.84	−0.01	"
15	ϑ Cancri	8 22 56.68	56.79	+0.11	"
"	δ Cancri	8 36 03.89	03.82	−0.07	"
"	☽'s 1st Limb	8 56 47.74			"
"	ξ Leonis	9 23 46.77	46.56	−0.21	"
"	ο Leonis	9 33 03.78	03.71	−0.07	"
16	ξ Leonis	9 23 46.44	46 55	+0.11	"
"	ο Leonis	9 33 03.71	03.70	−0.01	"
"	☽'s 1st Limb	9 47 02.49	-		"
"	π Leonis	9 52 12.29	12.30	+0.01	"
"	α Leonis	10 00 18.00	18.01	+0.01	"
18	d Leonis	10 52 44.30	44.29	−0.01	B[2]
"	χ Leonis	10 57 12.18	12.39	+0.21	"
"	δ Leonis	11 06 02.76	02.79	+0.03	"
"	δ Hyd. et Crat.	11 11 46.96	46.67	−0.29	"
"	☽'s 1st Limb	11 24 31.44			"
"	ν Leonis	11 29 11.86	11.74	−0.12	"
April 14	δ Leonis	11 06 02.65	02.65	0.00	B[1]
"	☽'s 1st Limb	11 09 15.13			"
15	δ Leonis	11 06 02.44	02.65	+0.21	"
"	σ Leonis	11 13 19.59	19.51	−0.08	"
"	τ Leonis	11 20 08.86	08.84	−0.02	"
"	β Leonis	11 41 19.79	19.87	+0.08	"
"	π Virginis	11 53 07.05	06.96	−0.09	"
"	☽'s 1st Limb	11 55 20.73			"
"	η Virginis	12 12 09.85	09.70	−0 15	"
17	β Leonis	11 41 19.92	19.86	−0.06	"
"	β Corvi	12 26 26.72	26 95	+0.23	"
"	α Virginis	13 17 13.73	13.65	−0.08	"
"	☽'s 1st Limb	13 29 53.13			"
"	☽'s 2d Limb	13 31 56.11			"
"	ϰ Virginis	14 04 49.98	49.78	−0.20	"
May 15	m Virginis	13 33 40.42	40.56	+0.14	"
"	η Bootis	13 47 28.74	28.74	0.00	"
"	☽'s 1st Limb	14 01 42.01			"
17	α^2 Libræ	14 42 31.26	31.21	−0.05	"
"	ξ^2 Libræ	14 48 34.45	34.14	−0.31	"
"	β Libræ	15 08 52.47	52.42	−0.05	"
"	☽'s 1st Limb	15 39 23.86			"
"	☽'s 2d Limb	15 41 31.12			"
"	δ Scorpii	15 51 23.92	23.95	+0.03	"

Date.	Name of Object.	Sidereal Time of Meridian Passage. h. m. s.	Seconds of Tabular A. R. s.	Diff. s.	Observer's initial.
1848, May 17	β^1 Scorpii	15 56 38.47	39.00	+0.53	B[1]
June 10	γ Virginis	12 33 59.42	59.16	−0.26	B[2]
"	☽'s 1st Limb	12 58 30.67			"
"	ϑ Virginis	13 02 06.90	06.89	−0.01	"
12	α Virginis	13 17 13.28	13.48	+0.20	B[1]
"	$\varkappa$ Virginis	14 04 49.86	49.82	−0.04	"
"	λ Virginis	14 10 55.61	55.85	+0.24	"
"	☽'s 1st Limb	14 31 47.76			"
"	α^2 Libræ	14 42 31.49	31.21	−0.28	"
"	ξ^2 Libræ	14 48 33.81	34.16	+0.35	"
July 10	β Libræ	15 08 52.39	52.32	−0.07	B[2]
"	☽'s 1st Limb	15 03 23.70			"
"	γ Libræ	15 27 04.48	04.33	−0.15	"
"	η Libræ	15 35 34.46	34.54	+0.08	"
11	α Serpentis	15 36 49.24	49.23	−0.01	B[1]
"	☽'s 1st Limb	15 53 11.79			"
"	ν Scorpii	16 03 12.94	12.84	−0.10	"
"	δ Ophiuchi	16 06 25 46	25.54	+0.08	"
"	ψ Ophiuchi	16 15 15.74	15.68	−0.06	"
12	ψ Ophiuchi	16 15 15.80	15.68	−0.12	B[2]
"	α Scorpii	16 20 08.74	08.78	+0.04	"
"	☽'s 1st Limb	16 44 43.65			"
"	ϱ Ophiuchi	17 11 56.99	56.64	−0.35	"
14	μ^1 Sagittarii	18 04 43.55	43 55	0.00	B[1]
"	λ Sagittarii	18 18 38.30	38.69	+0.39	"
"	☽'s 1st Limb	18 32 37.92			"
"	π Sagittarii	19 00 46.26	46.35	+0.09	"
17	ν Aquarii	21 01 21.33	21.31	−0.02	B[2]
"	☽'s 2d Limb	21 21 46 94			"
"	β Aquarii	21 23 35.97	35.97	0.00	"
"	δ Capricorni	21 38 41.52	41.26	−0.26	"
18	δ Capricorni	21 38 41.36	41.28	−0.08	"
"	ι Aquarii	21 58 15.83	15.91	+0.08	"
"	☽'s 2d Limb	22 16 52.32			"
"	σ Aquarii	22 22 38.36	38.43	+0.07	"
Aug. 7	α Virginis	13 17 12.85	12.85	0.00	"
"	☽'s 1st Limb	15 32 53.81			"
9	☽'s 1st Limb	17 20 28.00			"
"	ξ Serpentis	17 28 56.17	56.00	−0.17	B[1]
10	ξ Serpentis	17 28 56.24	55.99	−0.25	"
"	D Ophiuchi	17 34 22.42	22.37	−0.05	"
"	☽'s 1st Limb	18 09 14.39			"
"	A. S. C. 2125	18 20 35.16	35.10	−0.06	"
"	ν^1 Sagittarii	18 45 02.56	02.60	+0.04	"

" The above are corrected for known instrumental errors and for the rate of the chronometer. The Seconds of Tabular Right Ascension are taken from the Nautical Almanac."

6. *Double Stars observed at Cambridge Observatory.* —1848–49.

Name of Star.	Date.	A. R.	Dec.	Pos.	Dist.	No. of Obs.	Power.	Observer.	Remarks, Magnitudes, &c.
		h m.	° ′	° ′	″				
170 P. VII.	1848.27	7 32	+ 5 36	142 40	1.3	4	140	B¹	The two components make a star of the 7th or 8th magnitude.
α^2 Geminorum	1848.30	7 24	+32 14	249 45	5.1	5	860	B¹	A = 1st, 2d, B = 3d.
"	.26			249 20	5.3	5	860	B¹	
"	.30			248 40	5.2	5	860	B²	
ζ Cancri	1848.25	8 03	+18 06	342 45	1.0	4	860	B¹	A and B.
"	.25			149 20	5.6	4	860	B¹	A and C.
ξ Ursæ Majoris	1848.45	11 09	+32 24	128 30	2.7	5	860	B¹	A = 4th, B = 5th, 6th.
"	.45			129 45	3.1	5	860	B²	
γ Leonis	1848.27	10 11	+20 37	108 20	2.9	4	860	B²	
γ Virginis	1848.45	12 33	− 0 37	179 15	2.5	10	860	B¹	
"	.45			181 30	2.7	2	860	B²	
ζ Bootis	1848.38	14 34	+14 23	130 40	1.3	5	860	B¹	Seen through dense clouds; the definition is good.
"	.38			129 30	1.3	5	860	B²	
ε Bootis	1848.38	14 38	+27 43	326 45	3.2	5	860	B¹	The images of the stars are pretty well defined, though not good.
"	.38			322 00	3.2	5	860	B²	A = 3d orange, B = 7th green.
"	.45			322 05	3.1	5	860	B²	A = 3d golden, B = 7th blue or greenish.
44 Bootis	1848.55	14 58	+48 15	237 00	4.5	5	860	B²	
"	.55			240 00	4.3	5	860	B¹	
"	.54			239 30	4.3	5	860	B¹	
η Coronæ Borealis	1848.58	15 17	+30 52	207 20	0.8	5	860	B¹	Very unsteady images.
"	.66			210 20	0.8	5	1560	B²	
μ^2 Bootis	1848.53	15 18	+37 53	282 00	0.5	5	1560	B¹	
"	.52			283 00	0.5	5	1240	B²	Pretty good vision.
"	.51			282 52	0.6	5	1240	B²	Stars well separated.
"	.51				0.7	5	1240	B¹	
"	.49			283 40		4	1560	B²	
γ Coronæ Borealis	1848.51	15 36	+26 46	294 45	0.6	5	1240	B¹	Images unsteady.
"	.49			290 30	0.3	5	1560	B²	
"	46			293 00	0.3	4	1240	B²	Not a favorable evening for close objects, but the components are separated with [certainty.
Antares	1848.28	16 19	−26 06	275 20	3.8	12	400	B¹	A = 1st, B = 10th.
"	.28			277 00	3.8	3	400	B²	

Name of Star.	Date.	A. R.	Dec.	Pos.	Dist.	No. of Obs.	Power.	Observer.	Remarks, Magnitudes, &c.
		h. m.	° ′	° ′	″				
Antares	1848.49	16 19	− 26 06	272 45	8.6	5	1560	B²	Very fine definition.
"	.58			273 10	3.6	5	860	B¹	
"	.55			272 00	3.4	5	860	B¹	Bad definition.
σ Coronæ Borealis	1848.42	16 08	+ 34 14	171 15	2.2	5	860	B¹	
"	.42			172 30	2.2	4	860	B²	
λ Ophiuchi	1848.56	16 23	+ 2 18	9 50	1.4	10	860	B¹	When the micrometer-wires are set at 1″, both wires are decidedly within the stars.
New Star	1848.40	16 51	− 12 39	212 30	115.6	5	220	B¹	A = 6th, B = 15th. A resembles Antares to the naked eye, but its red is deeper.
"	.41			211 20	115.1	5	140	B¹	[It is one of the most strikingly colored stars we remember to have seen.
"	.41			212 30	118.1	5	140	B²	{ On the 29th of June this star was seen with thirty companions of from the 15th to the 20th magnitudes, within a radius of 6′.
"	.42			212 00	114.9	5	140	B¹	
"	.44			212 08	115.0	3	140	B²	With a power of 1500 there is no sign of a planetary disk under fine definition.
"	.55			212 30	115.2	5	140	B²	A = 7th, 8th, B = 14th. A appears to have decreased in brilliancy; its ruby-red color still remains. The star is at once recognized from its neighbours by its color alone.
"	.62			211 57	115.4	3	140	B²	
"	.63			211 13	116.1	5	140	B¹	
"	.64			212 27	115.4	10	320	B²	A = 7th, 8th, B = 15th. A is sensibly less than when first seen.
"	.66			212 30	115.5	5	400	B¹	
36 Ophiuchi	1848.55	17 05	− 26 22	215 30?	4.3	5	860	B¹	The position-angle does not agree with its computed value.
α Ophiuchi	1848.55	17 07	+ 14 33	176 45	22.9	5	860	B¹	A = 3d, B = 8th.
70 Ophiuchi	1848.52	17 57	+ 2 32	118 07	6.9	5	1560	B¹	A = 4th, B = 6th. B has a reddish tinge.
"	.52			117 45	6.8	5	1560	B²	
ε Lyræ	1848.47	18 39	+ 39 30	21 04	3.1	5	860	B¹	A and B.
"	.47			172 50	207.1	5	860	B¹	A and C.
"	.47			149 00	2.5	5	860	B¹	C and D.
Ring Nebulæ	1848.41	18 48	+ 32 50	66 00	73.3	5	140	B¹	Longer axis of the ring.
"	.41				60.4	5	140	B¹	Shorter axis.
α Cygni	1848.41	20 36	+ 44 43	88 35	95.5	5	140	B¹	Companion star 12th magnitude.
β Cygni	1848.25	19 24	+ 27 39	55 55	33.5	5	140	B¹	Seeing not good.
16 ♅ Delphini	1848.56	20 24	+ 10 44	209 50	0.5	3	860	B²	
γ Virginis	1849.45	12 03	− 0 37	179 49	3.0	10	860	B¹	
"	.45			179 45	3.0	5	860	B²	
Antares	1849.52	16 19	− 26 06	270 27	3.4	10	860	B¹	

Three hundred and seventeenth meeting.

March 6, 1849. — MONTHLY MEETING.

The PRESIDENT in the chair.

The Vice-President, Mr. Everett, read a letter from Professor Schumacher, of Altona, inclosing printed copies of a communication from the Secretary of the Royal Astronomical Society at London to Lord Palmerston; also letters from M. Arago and from Baron Humboldt; touching the position of Professor Schumacher in his connection with the observatory at Altona, and as the publisher of the *Astronomische Nachrichten*, and the dangers that threaten them in consequence of the disturbed state of the relations between Denmark and the Duchies of Schleswig and Holstein. Whereupon it was unanimously

"*Resolved*, That the American Academy of Arts and Sciences entertains a high opinion of the importance of an observatory at Altona, as a convenient point of communication between countries distant from each other, and of the value of the *Astronomische Nachrichten* as a medium of intelligence for the whole scientific world; that it recognizes the great importance of Professor Schumacher's services in connection with the Altona observatory and the publication of the *Nachrichten*, and would regard as a public misfortune any event which should interrupt his labors, or discourage the generous zeal with which, during a long and honorable career, he has successfully exerted himself for the promotion of astronomical science.

"*Resolved*, That a committee be appointed to address a letter to Professor Schumacher, transmitting a certified copy of these proceedings; and that a copy of the letters this evening submitted to the Academy be sent by the committee to the other learned societies and observatories of the United States."

Mr. Everett, Professor Peirce, and J. Ingersoll Bowditch were appointed to constitute this committee.

Professor Peirce, after calling attention to a recent communication in *Silliman's Journal*, on the trisection of angles, exhibited an instrument for this purpose, which was devised many years ago, by the late B. R. Nichols, Esq. He also exhibited the model of another instrument, constructed by Mr. Nichols, for the division of an angle into any number of equal parts.

Professor Peirce also presented the computation of the orbit (elliptical) of Petersen's comet, made by young Safford, now thirteen years of age, showing its period to be 382,000 years. He stated that Safford was employed only fifteen hours in the computation.

Professor Peirce likewise made a communication, in which he gave reasons for his belief that all the comets seen by us are component parts of our solar system, drawn from the fact that their orbits are none of them decidedly hyperbolical. He showed that few comets could enter the solar system except in orbits of a manifestly hyperbolic form, derived from the motion of our system in space.

Three hundred and eighteenth meeting.

April 4, 1849. — MONTHLY MEETING.

The PRESIDENT in the chair.

Mr. Everett read a letter from M. Leverrier, in relation to the discovery of the eighth satellite of Saturn. He also exhibited the comet-medal awarded by the king of Denmark to Miss Mitchell, which had just been received, and presented a printed copy of the correspondence which had been held in relation thereto.

Professor Peirce read a letter from Mr. S. C. Walker, containing a comparison of his ephemeris of Neptune with the latest observations on that planet, showing a variation from his calculations of only the fraction of a second. He also adduced further reasons for his opinion that the known comets belong to our solar system, drawn especially from the tendency of their orbits in respect to the plane of the ecliptic. His attention had been drawn to the obvious error of Laplace's argument upon this point by Dr. B. A. Gould, Jr.; who has made a chart of the path of the orbits of the comets, which is conclusive in its exhibition of the relation of the comets to the solar system.

Dr. J. C. Warren and Dr. Channing continued a discussion which commenced at the last meeting, on the comparative merits and safety of ether and chloroform as anæsthetic agents.

Three hundred and nineteenth meeting.

May 8, 1849. — Monthly Meeting.

The President in the chair.

The Corresponding Secretary presented a memoir from William S. Sullivant, Esq., entitled "Contributions to the Bryology and Hepaticology of the United States, Part II.," comprising the descriptions of several new or little known Musci and Hepaticæ, illustrated by figures.

Professor Agassiz gave a summary account of his investigations upon Medusæ. He has ascertained that their body consists entirely of cells, preserving in all the different systems of organs their character as true cells, and nevertheless performing very different functions. He showed that there is a complete system of bundles of elongated cells, arranged in longitudinal and transverse series, acting as muscles, and disposed in several layers, one being superficial and another lining the inner surface of the disk in Discophoræ, whilst some penetrate at various depths the gelatinous mass. The nervous system consists of a circular cord of oval cells, extending along the lower margin of the disk, from one eye-speck to the other, and forming a ganglion at the base of each. He also showed that the digestive system is naturally distinct from the tubes through which the digested food, mixed with water, is circulated, though at times they communicate directly with each other. This circulation — the arrangement of which he has ascertained by artificial injection — is very complicated in

Ctenophoræ, as there are peculiar tubes for each row of combs, for the netting apparatus, for the stomach, for the mouth, and for the ocular bulb. He further showed that the walls of the digestive and circulating cavities are cellular, like the other parts of the body, and that the gelatinous mass itself is divided into large cells by partitions similar to the hyaline membrane of the vitreous body of the eye. He also illustrated the various modes of development of these animals, and described the successive changes of their alternative generations in the *Tiaropsis diademata;* the embryo of which he has seen escape from the ovary, move about free for some time, and finally attach itself and grow into a polyp-like animal with tentacles, the first stage of growth of a Campanularia, which is its other mode of existence. He finally enumerated the species of Ctenophoræ and naked-eyed Discophoræ which he has observed in Boston Bay, referring them to the modern genera to which they belong, viz. *Pleurobrachia rhododactyla*, *Bolina alita*, *Staurophora laciniosa*, *Bougainvillea superciliaris*, *Sarsia mirabilis*, and *Tiaropsis diademata*, pointing out the differences by which they are distinguished from the species already described, and the generic characteristics of the new type he has recognized among them. The discovery of a new species of Staurophora on these shores is a new instance of the remarkable analogy which exists between the fauna of the Atlantic States and that of the northeastern shores of Asia.

Dr. B. A. Gould made some remarks on the comet now visible, which had passed remarkably near the earth during the last week. He had, however, in spite of this near approach, heard of but two observers who had seen it with the naked eye, namely, Mr. Bond, in Cambridge, and a gentleman in Salem.

"The first rough elements deduced from observation, within two days after its discovery, were so strikingly similar to those deduced by Bessel (*Berliner Astronomisches Jahrbuch*, 1809, p. 99) from Klinkenberg's observations of the second comet of 1748, as to lead to strong suspicion of the identity of those two bodies. The following are the third parabolic elements computed for this comet, (originally published by S. C. Walker, Esq., in the *National Intelligencer* of April 26th,) from Cambridge observations, April 11th, 14th, and 19th, and Bessel's elements for the comet of 1748.

1848. Mean Berlin Time.	1748. Mean Paris Time.
T June $8^{d}.23220$	T $18^{d}.89401$
☊ 30° 32′ 7″	☊ 33° 8′ 29″
i 66 55 12	i 67 3 28
π 267 13 6	π 278 47 10
q 0.892703	q 0.625357
Motion direct.	Motion direct.

" The discrepancies between these two orbits are not greater than the uncertainties of the latter, except as regards the perihelion distance. Both comets were very favorably situated for determination of the perihelion distance, and on mature consideration I am convinced, that, unless it can be shown that the comet had been exposed to perturbations, by the earth or Jupiter, capable of producing a very great change in the perihelion distance, all arguments, drawn from the similarity of the elements, in favor of the identity of the two comets, must fall to the ground. In both cases, the comets approached quite near the earth, and were observed in the ecliptic ; but in 1748 the comet crossed this plane so far *inside* the earth's orbit, and in 1849 so far *outside* of the same, that all attempts to attribute the discrepancy of the perihelion distances to errors of observation or computation, in either case, must be fruitless.

" It must, nevertheless, be acknowledged that the resemblance of the two orbits is greater than exists between those of any other two comets on record. In order, therefore, to discover whether any indication of periodicity were to be found in the orbit itself, application was made to Mr. Bond, of the Cambridge Observatory, for three observations, as remote from one another as possible ; and from observations on April 11th, 19th, and 27th, I computed an orbit by Gauss's method, without any hypothesis whatever as to the nature of the conic section described. The resulting curve was no ellipse at all, but the following hyperbola.

☊	30°	11′	11″
i	67	19	39
π	266	16	36
ψ	10	6	1

"Even the magnitude of the resulting eccentricity cannnot be considered as proving the curve described to be actually a hyperbola. On the contrary, I fully coincide with the views which Professor Peirce has developed at a late meeting of the Academy, with regard to the non-hyperbolism of any of the cometary orbits on record. I can only say, that no curve but a hyperbola can be drawn *precisely* through the three places given by the observations on which my calculations were based. None of the observations had been made in the meridian, and a small change in the fundamental places would change the character of the curve very considerably. I believe, however, that the evidence is sufficient to prove that the comet was not moving in any ellipse whose eccentricity differs sufficiently from unity to enable us to deduce the period, and am convinced that no hypothesis of identity with Klinkenberg's comet of 1748 could be supported. It must moreover be observed, that, during the whole of the period comprised between the fundamental observations, the comet was approaching the earth, whose attraction must, in consequence of its proximity, have been powerful, and was to be added to that of the sun. The increased velocity thus imparted to the comet might give temporarily a hyperbolic aspect to the orbit."

Dr. Gould then spoke of the comet observations quoted in Struyck and Pingré as having been made by Kindermann in Dresden, and a Dutch navigator at the Cape of Good Hope, in the spring of 1748. He had attempted to reconcile them with the orbits of the two authentic comets of that year, but entirely in vain.

DONATIONS TO THE LIBRARY,

FROM JUNE, 1848, TO MAY, 1849.

Edward Everett. Eulogy on the Life and Character of John Quincy Adams, delivered at the Request of the Legislature of Massachusetts, in Faneuil Hall. 8vo. pamph. From the Author.

J. L. and Henry C. Lord. Defence of Dr. C. T. Jackson's Claims to the Discovery of Etherization. 8vo. pamph. From the Authors.

Dr. L. P. Yandell and Dr. B. F. Sheemard. Contributions to the Geology of Kentucky. 8vo. pamph. From the Authors.

Observations upon a Greek Vase discovered in Etruria, bearing the

Name of the Fabricator, Nicosthenes, in the Possession of the Marquis of Northampton. 4to pamph. From the Author, through Mr. Everett.

Wm. Whewell, D. D. The Philosophy of the Inductive Sciences, founded upon their History. A new Edition. 2 vols. 8vo. From the Author.

Transactions of the American Antiquarian Society. Vol. II. 8vo. From the Society.

A Catalogue of the Books in the Library of the American Antiquarian Society, in Worcester, Massachusetts. From the Society.

Nachrichten von der Georg-Augusts-Universitäts und der Königl. Gesellschaft der Wissenschaften zu Göttingen, vom Jahre 1846. — Nachrichten, etc., vom Jahre 1847. 4to. From the Royal Society of Sciences of Göttingen.

Abhandlungen der Königl. Gesellschaft der Wissenschaften zu Göttingen. Band III. 4to. 1845-47. From the Royal Society of Sciences of Göttingen.

Professor J. F. Hausmann. Bemerkungen über Gyps und Kanstenit. (Extr. Abhand. Königl. Gesellsch. Wissenschaften zu Göttingen, Band III.) From the Author.

Mémoires de la Société de Physique et d'Histoire Naturelle de Genève. Tome XI. (in two Parts). 4to. From the Society.

The American Journal of Science and Arts, for July, 1848. From the Editors.

Annual Report of the Regents of the University of the State of New York, made to the Legislature, March 2, 1848. 8vo. Albany. From the Regents.

Message of his Excellency, Governor Briggs, transmitting the Report of Benjamin Perley Poore, employed in France as Historical Agent of the Commonwealth of Massachusetts, &c. 8vo. pamph. From Mr. Poore.

Transactions of the Royal Irish Academy. Vol. XXI., Part 2. 4to. Dublin, 1848.

Charts of the Coast Survey of the United States. From the Hon. J. G. Palfrey, and from the Clerk of the House of Representatives.

Sears C. Walker. Ephemeris of Neptune for the Opposition of 1848. (Smithsonian Contributions to Knowledge.) 4to pamph. From the Smithsonian Institution.

Hon. Captain W. H Smyth, R. N. Description of an Astrological

Clock belonging to the Society of Antiquaries. 8vo. pamph. London, 1848. From the Author.

The American Journal of Science and Arts, for November, 1848. From the Editors.

B. A. Gould. Untersuchungen über die Gegenseitige Lage der Bahnen der zwischen Mars und Jupiter sich bewegenden Planeten. 8vo. pamph. Göttingen, 1847. From the Author.

Annual Report of the Regents of the University of the State of New York, on the Condition of the State Cabinet of Natural History, with Catalogues of the same. 8vo. Albany, 1848. From the Regents. Also a copy from Professor James Hall.

Reduction of Greenwich Lunar Observations, for the Years 1750 to 1830. 2 vols. 4to. From the Royal Society, London.

Greenwich Magnetical and Meteorological Observations, for 1845. 4to. From the Royal Society, London.

Magnetische und Meteorologische Beobachtungen zu Prag. Jahrg. 8. Jan. – Dec., 1847. Prague, 1848. From the Observatory of Prague.

Abhandlungen der Königlichen Gesellschaft der Wissenschaften zu Göttingen. Band III., von der Jahren 1845 – 1847. 4to. From the Royal Society of Göttingen.

Annals of the Lyceum of Natural History, New York. Vol. IV., Part 2. 8vo. New York, Sept., 1848. From the Lyceum.

Frederick Emerson. Communication to the American Academy of Arts and Sciences, relative to a late Report on the Subject of Ventilators and Chimney-Tops. 8vo pamph. Boston, 1848. From the Author.

Henry Piddington. The Sailor's Horn-Book for the Law of Storms in all Parts of the World. 12mo. New York and London, 1848. From the Author, through W. C. Redfield.

Smithsonian Contributions to Knowledge, Vol. I. Viz. Ancient Monuments of the Mississippi Valley, by E. G. Squier, A. M., and E. H. Davis, M. D. 4to. 1848. From the Smithsonian Institution.

Alexandre Vattemare. Report on the Subject of International Exchanges. 8vo pamph. Washington, 1848. From the Author.

Charles Cramer. Bescreibung der in der Grossen Knochen Höhle Tennessee gef undenenFossilen Knochen des Megalonyx laqueatus, etc. From the Author.

Flora Batava; Afbeelding en Beschrijzing van Nederlandsche Gewassen, door Jan Kops, en J. E. van der Trappen. Aflev. 147, 148, 149, 150, 151. 4to. Amsterdam. From the Netherlands Government.

F. G. W. Struve. Stellarum Duplicium et Multiplicium Mensuræ Micrometricæ per Magnum Fraunhoferi Tubum, Annis 1824–37, in Specula Dorpatensi Institutæ; Adjecta est Synopsis Observationum de Stellis Compositis Dorpati Annis 1814–24 per minora Instrumenta perfectorum. Editæ jussu et expensis Acad. Sci. Cæsar. Petropolitanæ. Petrop., 1837. From the Author.

F. G. W. Struve. Description de l'Observatoire Astronomique Central de Poulkova. St. Petersbourg, 1845. 4to. With a folio volume of Plates, &c. From the Imperial Observatory of Pulkova.

F. G. W. Struve. Expedition Chronométrique executée en 1843 entre Poulkova et Altona, &c. St. Petersbourg, 1844. From the Imperial Observatory of Pulkova.

Astronomische Ortsbestimmungen in der Europäischen Türkel, in Kaukasien und Klein-Asien, etc., in der Jahren 1828 bis 1832. Angestellten Astronomischen Beobachtungen, etc., von F. G. W. Struve. St. Petersburg, 1845. From the Imperial Observatory of Pulkova.

F. G. W. Struve. Catalogus Librorum Speculæ Pulgovensis, 1845. From the Imperial Observatory of Pulkova.

F. G. W. Struve. Table des Positions Géographiques Principales de la Russie. St. Petersbourg, 1843. From the Imperial Observatory of Pulkova.

F. G. W. Struve. Sur le Coefficient Constant dans l'Aberration des Etoiles Fixes, etc. St. Petersbourg, 1843. From the Imperial Observatory of Pulkova.

F. G. W. Struve. Catalogue de 514 Etoiles Doubles et Multiples découvertes sur l'Hémisphère Céleste Boréal par la Grand Lunette de l'Observatoire Central de Poulkova: et Catalogue de 256 Etoiles Doubles Principales où la Distance des Composantes est 32 Secondes à 2 Minutes. Publiée par l'Acad. Imp. Sci. St. Petersb. 1843. From the Imperial Observatory of Pulkova.

M. Weisse. Catalogus Stellarum ex Zonis Regiomontanis. (Edit. F. G. W. Struve.) Petrop., 1846. From Professor Struve.

Walter Channing, M. D. On Etherization in Childbirth. 8vo. Boston, 1848. From the Author.

Topographical Engineers' Papers, No. 2. Determination of the Latitude with Zenith and Equal Altitude Telescopes, by Captain T. J.

Lee, U. S. Corps Topog. Engineers. 4to pamph. Washington, 1848. From the Topographical Bureau.

Charles Martins. Instructions pour l'Observation des Trombes Terrestres. (Extr. de l'Annuaire Météorologique de la France, 1848.) From the Author.

Edward Desor. Embryology of Nemertes, with an Appendix on the Embryonic Development of Polynoë. (Extr. Jour. Bost. Nat. Hist. Society.) From the Author.

American Journal of Science and Arts. No. 19. New Series. For January, 1848. From the Editors.

Abhandlungen der Königl. Preuss. Akademie der Wissenschaften zu Berlin: aus dem Jahre 1846. 4to. Berlin, 1848. From the Berlin Academy.

Monatsbericht der Königl. Preuss. Akademie der Wissenschaften zu Berlin. July – Dec., 1847, and January – June, 1848. 8vo. From the Berlin Academy.

Denkschriften der Allgemeinen Schweitzerschen Gesellschaft für die gesammten Naturwissenschaften. Band I. 4to. Zurich, 1829 – 33. Neue Denkschriften Schweitz. Gesellsch., etc. Bände I. – IX. 4to. Neuchatel, 1837 – 47. From the Helvetian Natural History Society.

Francis Wayland, D. D. The Elements of Moral Science. Boston, 1849. — The Elements of Political Economy. Boston, 1848. — Thoughts on the Present Collegiate System in the United States. Boston, 1842. — Sermons delivered in the Chapel of Brown University. Boston, 1849. — 12mo. From the Author.

Smithsonian Contributions to Knowledge. Occultations visible in the United States during 1849, computed under the Direction and at the Expense of the Institution, by John Downes. 4to pamph. Washington, 1848. From the Smithsonian Institution.

Proceedings of the Academy of Natural Sciences, Philadelphia. Vol. IV., Nos. 3 – 7. 8vo. 1848.

Charter of the Boston and Lowell Railroad Corporation, and Report of the Directors to the Legislature, 1848. 8vo pamph. Boston, 1849.

Edward Everett. Correspondence relative to the Award of the King of Denmark's Comet-Medal to Miss Maria Mitchell of Nantucket, for the Discovery of a Telescopic Comet, on the 1st of October, 1847. 8vo pamph. [Not published.] Cambridge, 1849. From the Author.

Report of the Stockholders of the Dauphin and Susquehanna Coal Company. Philadelphia, 1848.

Dr. J. C. Flügel. Literarische Sympathien öder Industriel Buchmacherei, ein Beitrag zur Geschichte der Neueren Englischen Lexicographie von Dr. J. G. Flügel. Leipsic. With other pamphlets on the same subject. From the Author.

Edward Everett. Speech in Support of the Memorial of Harvard, Williams, and Amherst Colleges, delivered before the Joint Committee on Education, in the Hall of the House of Representatives, Boston, February 7th, 1849. 8vo pamph. From the Author.

Report on the Memorial of W. T. G. Morton, and the Remonstrance of Dr. Charles T. Jackson. 8vo pamph. Congressional Document, No. 114. From the Author.

Annals of the Lyceum of Natural History, New York. Vol. IV., No. 5. Feb., 1846. 8vo. New York, 1846. From the Lyceum.

Joseph Leidy, M. D. Observations on the Existence of the Intermaxillary Bone in the Embryo of the Human Subject. Pamph. From the Author.

Annual Report of the Trustees of the State Library of the State of New York; made to the Legislature, January 15, 1849. 8vo. Albany, 1849. From the Regents of the University of the State of New York.

Proceedings of the Friends of a Railroad to San Francisco, at a Public Meeting, Boston, April 19, 1849. Second Edition. Pamph. Boston, 1849.

Proceedings of the American Philosophical Society. Vol. V., No. 42. January to March, 1849. 8vo. Philadelphia. From the Society.

A. D. Bache. Report of the Superintendent of the United States Coast Survey. December, 1848. Congressional Document. From Hon. Robert C. Winthrop.

J. C. Fremont. Geographical Memoir upon Upper California; in Illustration of his Map of Oregon and California; addressed to the Senate of the United States. With the Map. Congressional Document. Washington, 1849. From Hon. R. C. Winthrop.

A. Guyot. The Earth and Man. Lectures on Comparative Physical Geography in its Relation to the History of Mankind. 12mo. Boston, 1849. From the Author.

Reports from the Secretary of the Treasury of Scientific Investigations in Relation to Sugar and Hydrometers, made under the Superintendence of Professor A. D. Bache, by Professor R. S. McCulloh. Congressional Document. 8vo. Washington, 1848. From the Comptroller's Office, Washington.

Samuel Geo. Morton, M. D. Additional Observations on a New Living Species of Hippopotamus of Western Africa. (Extr. Jour. Acad. Nat. Sci. Philad.) 4to. Philadelphia, 1849. From the Author.

Smithsonian Contributions to Knowledge. App. I. to Vol. II.; containing an Ephemeris of the Planet Neptune for the Date of the Lalande Observations of May 8th and 10th, 1795, and for the Oppositions of 1846, 1847, 1848, and 1849. Computed by Sears C. Walker. 4to pamph. Washington, 1849. From the Smithsonian Institution.

Annals of the Lyceum of Natural History, New York. Vol. V., No. 1. 8vo. May, 1849. From the Lyceum.

Journal of the American Oriental Society. Vol. I., No. 4. 8vo. New Haven, 1849. From the Society.

Verhandlungen der Kaisersl. Leopold.-Carol. Akademie der Naturforscher. Band XXIII. Suppl. Enthal. F. A. W. Miquél Illustrationes Piperacearum. 4to, with 92 Plates. Band XXIV. 4to. Breslau and Bonn, 1846, 1847. From the Acad. Naturæ Curiosorum.

Augustus Mason, M. D. The Cholera: Brief Hints for its Prevention, &c., &c. 8vo pamph. Lowell, 1849. From the Author.

Professor Von Boguslauski. On a New Micrometer and its Application to the Determination of the Parallax of Mars. (Ext. from the Transactions of the Royal Astronomical Society, London.) 4to pamph. From the Author.

Uranus, Synchronistisch geordenete Ephemeride aller Himmelserscheinungen des Jahr. 1849. Erstes und Zweites Quartal. 8vo. Breslau, 1849. From the Editor.

Übersicht der Arbeiten und Veranderungen der Schlesischen Gesellschaft für Vaterlandische Kultur im Jahre 1847. 4to. Breslau, 1848. From Professor Boguslauski.

Sixty-second Annual Report of the Regents of the University of the State of New York; made to the Legislature, March 1st, 1849. 8vo. From the Regents.

American Journal of Science and Arts. Second Series, No. 22. July, 1849. From the Editors.

E. B. O'Callaghan. Documentary History of the State of New

York; arranged under the Direction of the Hon. C. Morgan, Secretary of State. Vol. I. 8vo. Albany, 1849.

B. A. Gould, Jr. Account of the Observatory of Pulkova; as written for the North American Review, July, 1849. 8vo pamph. From the Author.

Jas. O. Halliwell. Rara Mathematica: or a Collection of Treatises on the Mathematics and Subjects connected with them. From Ancient inedited Manuscripts. Second Edition. London, 1841. From the Editor.

Three hundred and twentieth meeting.

May 29, 1849. — Annual Meeting.

The President in the chair.

Mr. Everett announced that the comet discovered by Mr. George P. Bond, on the 11th of April last, at nine o'clock, P. M., was observed at Moscow, on the same evening, at half past nine o'clock. It was also seen in England, by Mr. Graham, on the 14th of April.

A memoir, "On some Applications of the Method of Mechanical Quadratures," by George P. Bond, was communicated.

Professor Agassiz gave a further exposition of his observations on the structure and devolopment of the Medusæ.

A letter was read from Mr. Henry Dexter, the sculptor of the marble bust of the former President of the Academy, the late Hon. John Pickering, LL. D., recently placed in the hall, inclosing the list of the subscribers by whom this memorial was procured and presented to the Academy.

The Treasurer's Annual Report, with the auditor's certificate, was read and placed on file; and the appropriations for the current year, as proposed by the Treasurer, were voted.

Professor Charles U. Shepard, and Professor Charles B. Adams, of Amherst College, were elected Fellows of the Academy.

The annual election was held, and the following officers were chosen for the ensuing year, viz.: —

JACOB BIGELOW, M. D., . . *President.*
EDWARD EVERETT, LL. D., *Vice-President.*
ASA GRAY, M. D., ... *Corresponding Secretary.*
AUGUSTUS A. GOULD, M. D., *Recording Secretary.*
J. INGERSOLL BOWDITCH, . *Treasurer.*
HENRY J. BOWDITCH, M. D., *Librarian and Cabinet-Keeper.*

The Standing Committees were appointed as follows: —

Rumford Committee.

EBEN N. HORSFORD, JOSEPH LOVERING,
DANIEL TREADWELL, FRANCIS C. LOWELL,
MORRILL WYMAN.

Committee on the Library.

A. A. GOULD, D. H. STORER, U. A. BOYDEN.

Committee of Publication.

ASA GRAY, LOUIS AGASSIZ, W. C. BOND.

Three hundred and twenty-first meeting.

August 8, 1849. — QUARTERLY MEETING.

The PRESIDENT in the chair.

The Corresponding Secretary read letters of acceptance from Dr. Joseph Leidy, of Philadelphia, and Professor Charles B. Adams, of Amherst College.

Professor Gray gave some account of *Argyroxiphium*, a remarkable genus of Compositæ, belonging to the mountains of the Sandwich Islands; of which a second species was obtained by the naturalists of the United States Exploring Expedition under Captain Wilkes. Dr. Gray thinks that

"The genus should be referred to the division Madieæ (a group which belongs entirely to the western side of America, principally to California, and of which the radical leaves of some Californian species exhibit a somewhat similar silky covering); on account of the nearly obsolete pappus of the ray-achenia, and their inclosure in the involute scales of the involucre, and because there is an inner series of scales interposed between the ray-flowers and those of the disk. It has been remarked that, when a genus of two or more species is peculiar to a group of islands, the different islands are apt to have each their own peculiar species. In this instance, while the species on which this characteristic genus was founded belongs to Hawaii, growing on the high mountains of Mouna Loa and Mouna Kea, the second species was found only on the island of Maui, at the base of a high crater; and a plant of an allied, but very distinct, genus was gathered on the island of Kauai. The new Argyroxiphium has much larger capitula than A. Sandwicense, from which it also strikingly differs in the total absence of pappus, just as the Californian Lasthenia (Hologymne) glabrata does from the genuine species of Lasthenia, Burrielia (Baeria) chrysostoma from the other species of that genus, and Ptilomeris calva, *Nutt.*, from its congeners; adding another to a singular class of cases, all occurring in the same part of the world. The species may therefore be briefly characterized as follows: —

" A. MACROCEPHALUM: capitulis nutantibus maximis ($1\frac{1}{2}$ unc. diamet.); ligulis discum vix æquantibus; receptaculo conico; pappo nisi coronula disciformis nullo.

" The *A. Sandwicense* has a convex or depressed-conical, not a *flat*, receptacle: the pappus is better represented by the figure of Hooker (*Icones Plantarum*, tab. 75) than by the description of De Candolle.

" The allied genus referred to has much the habit of Argyroxiphium, but in its floral characters is more nearly related to Lasthenia. As it is one of the most striking of the new plants obtained during the cruise, it may be appropriately dedicated to the commander of the expedition; I have therefore characterized it, in the Botany of the voyage, now in preparation, under the name of

" WILKESIA, *Nov. Gen.*

" Capitulum homogamum, multiflorum. Involucrum campanulatum, gamophyllum, subtri-quadrilobum, lobis apice 3–4-dentatis villoso-ciliatis. Receptaculum convexum, nudum. Flores hermaphroditæ, conformes. Corollæ tubulosæ, glabræ; limbo dilatato campanulato 5-lobo. Antheræ ecaudatæ. Styli rami cono hispidulo complanato apice subulato superati. Achenia elongata, compresso-quadrangulata, ad angulos hirtella. Pappus persistens, e paleis 8–9 lanceolatis acuminatis rigidis hispido-ciliatis. — Herba grandis crassicaulis; foliis lineari-lanceolatis nervosis coriaceis, adultis glabratis tomentuloso-ciliatis, caulinis subverticillatis basi coadunatis; capitulis in paniculam amplam digestis longe pedunculatis; floribus ut videtur albidis.

" W. GYMNOXIPHIUM. — In Montibus *Kauai*, Ins. Sandwicensium."

Mr. Bond communicated several papers from Major W. H. Emory, of the Corps of United States Topographical Engineers, and Chief Astronomer and Surveyor, on the part of the United States, of the Mexican Boundary Commission.

These papers consisted of, — 1. Astronomical Observations made at the City of Panama, New Grenada. — 2. Results of Observations for the Determination of the Latitude of the Northwest Bastion of the Fortification of the City of Panama. The station occupied by Major Emory was found to be situated 2″.75 north, and 6″.85 west, of the cathedral. The places of the adopted stars were taken from the British Association Catalogue. The computations were made by Major Emory and Professor James Nooney, one of his assistants. The following are the resulting latitudes : —

1849, April 10th,	8°	57′	11.03″	7 pairs of stars.
" " 11th,	8	57	13.31	7 " "
" " 12th,	8	57	13.19	4 " "
" " 24th,	8	57	14.85	A single pair of stars.
" " 25th,	8	57	12.27	8 pairs of stars.

3. Eclipses of Jupiter's First and Second Satellites. Observed by Major Emory and Lieutenant A. W. Whipple, United States Topographical Engineers, at the *Northeastern* Bastion of the Wall of the City of Panama, and Moon Culminations observed by Lieutenant Whipple. The result of these observations gave for the longitude of the *northwestern* bastion of the city wall, $5^{h.}$ $17^{m.}$ $57^{s.} = 79°$ 29′ 24″ west of Greenwich.

The fourth paper contains Observations of the Elements of Terrestrial Magnetism at Chagres, Gorgona, and at the City of Panama, made by Major Emory, assisted by Lieutenant Whipple. The first station at Chagres was "near the centre of the plateau, east from the village, and 94 feet east from a ruin consisting of two rows of brick pillars, there being five pillars in each row." Latitude 9° 20′ north, longitude $5^{h.}$ $20^{m.}$ $5^{s.}$ west.

The second station, at the city of Panama, "was upon the glacis, just beyond the ditch, about 300 feet outside the western gate of the city. Latitude 8° 57′ 12″ north, longitude 79° 29′ 24″.5 west.

The instrument made use of in these magnetic observations was a "Fox" magnetic circle, made by W. George, at Falmouth, England, under the immediate inspection of Mr. Fox, who determined its relative indications in regard to Falmouth. It has likewise been compared on several occasions with the instruments of the Cambridge Observatory, in 1844–45 by Colonel Graham and W. C. Bond, and in 1849 by Lieutenant Whipple and W. C. Bond. The observations are given in detail.

The fifth paper contains Meteorological Observations made at Panama.

The sixth gives the Longitude of Chagres, derived from Five Chronometers, transported in the Steam-packet "Northerner," leaving New York on the 1st of March, and arriving at Chagres on the 13th. Major Emory gives as the resulting longitude, by these five chronometers, (assuming the longitude of Columbia College, at New York, to be $4^{h.}\ 56^{m.}\ 00^{s.}$,) of the house of Don Luis Parides, $5^{h.}\ 20^{m.}\ 05^{s.}.4$, and its latitude, as determined by Espinar, 9° 10′.

Professor Gray communicated a paper by Dr. J. Deane, of Greenfield, on Fossil Footprints of the Valley of the Connecticut, with drawings.

Dr. H. J. Bigelow submitted a paper entitled Descriptions of Certain Tumors, with Remarks upon the Character of Morbid Growths, usually thus designated.

Professor Agassiz gave an account of some discoveries he had made in respect to the structure of the tracheæ and the circulation in insects. He also exhibited living specimens of *Astrangia Danæ*, a living coral which he obtained by dredging on the southern coast of Massachusetts, off Edgartown, as well as drawings illustrating their development and structure; also the curious structure of the cells which form their stinging apparatus.

The committee appointed at the Annual Meeting, to suggest some special rules in respect to the nomination of foreign members, and also to report suitable provisions for the future amendment of the Statutes, made a report, proposing the following additional Statutes, which were adopted, viz.: —

"Chap. VII. Additional Statute. Foreign Honorary Members may be chosen by the same vote as Fellows; but only at the statute meetings of May and November, and from a nomination list prepared by a Council for that purpose, and publicly read at the meeting immediately preceding that on which the balloting takes place. The Council for nominating Foreign Members shall consist of the President, Vice-President, the Secretaries, Treasurer, Librarian, and the members of the three Standing Committees; and no candidate shall be balloted for who is not recommended by the signatures of two thirds of the members of this Council.

"Chap. IX. Of Amendments of the Statutes. All proposed alterations or additions to the Statutes shall be referred to a committee during the interval between two statute meetings, and shall require for enactment a majority of two thirds of the members present, and at least eighteen affirmative votes."

The Hon. Robert C. Winthrop, and Dr. William F. Channing, of Boston, were elected Fellows of the Academy.

Three hundred and twenty-second meeting.

October 2, 1849. — Monthly Meeting.

The President in the chair.

The Corresponding Secretary read letters of acceptance from the Hon. Robert C. Winthrop, and Professor Charles B. Adams, in reply to his official notification of their election as Fellows of the Academy.

A circular from the Physical Section of the American Association for the Advancement of Science, respecting the establishment of an Astronomical Journal, was read; whereupon it was

"Resolved, That, in the opinion of this Academy, the establishment of the proposed Journal, for the publication of original researches in mathematics and astronomy, will tend materially to the advancement of these sciences; and it should receive the encouragement and support of learned societies, seminaries of learning, and scientific men throughout the United States."

By a resolution, the Committee of Publication was authorized and directed to prepare, and append to the current volume of the Memoirs, a list of the present Fellows and Honorary Members of the Academy.

Mr. Everett presented some papers from Professor Mitchell, of Cincinnati, describing his machinery for recording the observed motions of the heavenly bodies. Professor Peirce and Dr. B. A. Gould made some comments upon it.

Dr. C. T. Jackson desired a correction to be made in the printed Proceedings of the Academy, under date of January 2d, namely, that the discovery of the *almost universal presence of oxide of manganese in the water of streams, &c.*, should be ascribed to his assistant, Richard Crossley, Esq.

Dr. Jackson also exhibited specimens of tellurium, from Virginia, discovered by him in connection with the gold ores from that locality.

Dr. Pickering made a communication on the length of the year, according to the Egyptian cycle. From various sources, which were specified, he had deduced the following table of the Egyptian computation of time, viz.: —

"That 30 years make a panegyry;
" 22 panegyries make a phœnix; and
" $2\frac{1}{3}$ phœnixes make the great year, or the Sothic Cycle."

Professor Wyman exhibited some crania of the *Engé-ena* (Troglodytes Gorilla, *Savage*), and made additional observations on its structure and relations, based on the examination of two skulls recently brought from Cape Palmas, by Dr. George A. Perkins. Contrary to the views of Professor Owen, Professor Wyman would rank the animal below the Chimpanzée, on account of the greater development of the intermaxillary bones, the comparatively smaller capacity of the cranium, and the conformation of the teeth, especially of the *dentes sapientiæ.*

The subjoined communication was received from Mr. Haldeman: —

" *On some Points in Linguistic Ethnology; with Illustrations, chiefly from the Aboriginal Languages of North America.* By S. S. HALDEMAN, A. M.*

" Every fact in relation to language must be worthy of consideration in an ethnologic point of view; and as speech is the natural representative and vehicle of thought, its laws, as exhibited in comparative grammar, must afford great aid in investigating the science of reason.

" The chief points, in the phonetic examination of a language, are the number and nature of its vocal elements, their order and replacement in speech, the greater or less frequency of certain contacts, and of phases like surd and sonant, lene and aspirate. Thus we should know the proportion in a given language of *p* to *t*, *p* to *b*, to *f*, or to *m*. *T* may be taken as the typical representative and most common of the consonants, and *A* (in *far*) of the vowels.

" The classification of the elements is of great importance in the study of language, and I am convinced that a distribution of the consonants into *contacts*, as proposed by the Abbé Sicard, is the only proper mode. These, as proposed by me, in the year 1846, are essentially five, the *labial*, *dental*, *palatal*, *guttural*, and *glottal*. There are, however, some intermediate ones, or subcontacts, and the order of the whole may be represented thus: —

1. P; 2. F; 3. Th; 4. T; 5. S; 6. Sh; 7. —; 8. K; 9. —; 10. Q.

"The number of elements in each contact is usually eight, but this number may be doubled, so that, if all the contacts and subcontacts were full, there would be 160 consonants, some of which being subject to variation, (as the cerebrals,) the theoretical number may be

* This paper was intended in part as a review of a work entitled, — *The Essentials of Phonetics; containing the Theory of a Universal Alphabet, together with its Practical Application as an Ethnical Alphabet to the Reduction of all Languages, written and unwritten, to one uniform System of Writing; with numerous Examples; adapted to the Use of Phoneticians, Philologists, Etymologists, Ethnographists, Travellers, and Missionaries, in Lieu of a Second Edition of the "Alphabet of Nature."* By Alexander John Ellis, B. A., Fellow of the Cambridge Philosophical Society, and formerly Scholar of Trinity College, Cambridge. London, 1848. 250 pages. Printed in phonotype.

200. This shows the necessity of using points extensively, to prevent a superabundance of primary characters, as the missing sounds occur. Mr. Ellis has devoted a number of years, in various parts of Europe, to the study of the phonetic peculiarities of language, the results of which are given in his *Essentials of Phonetics*, and his views are worthy of attention. Unfortunately, his alphabet was primarily adapted to English alone, and being intended to replace the ordinary one, the most unjustifiable concessions were made to its corrupt orthography, apparently that the people might be as little shocked as possible, and spared a few hours' study. But whilst phonotypy is framed for the heterotypic readers of a fleeting present, it is admitted (*Phonetic News*, p. 1, §§ 5, 7) that 'most poor children leave school unable to read with ease,' 'and that one third of the population of England are unable to read.' They, at least, have no prejudices to conciliate. The common sense of Europe, Polynesia, Africa, and a great portion of America, as well as of those to whom these literary husks are specially offered, (if made acquainted with the merits of the question,) would reject them as barbarisms. Moreover, the unlettered public should not be deprived of the power to pronounce foreign words and sentences, nor the foreigner of that to pronounce English ones.* The excuse, that the powers of the *Latin* † alphabet are 'uncertain,' (p. 222,) is neutralized by his own opinion that the Latin vowel-characters had their Italian or German power,‡ and we find an English author making an adjective HIBERIANA out of the English name *Heber*.

* Phonetic writing obviously depends upon speech; Mr. Ellis, however, makes both virtually depend upon etymology (pp. 103, 104), as if to preserve the aristocratic distinction between the lettered and the unlettered public. As a consequence, his English depends upon Old English, Latin, or French orthography, so that, to write (and speak) it, one must be acquainted with these languages. Thus he takes *minor* from the French, and makes it different from *miner*. So *or* stands in *memory* (which he pronounces *mem-or-y*), and *form* in *réformation;* and the words *our*, *power*, follow the old spelling, the latter having *e* in the second syllable.

† Leaving Latin out of view, there must be uniformity somewhere, because the Sandwich-Islander spells the name of one of these islands MAUI, and an English or American missionary, a Spaniard, Portuguese, Italian, German, Choctaw, or West African Mandingo, would do the same.

‡ The "many [English] vowels and consonants which the Latin language is totally unable to represent or to suggest," should have been particularized. Among them are the vowels in *net, not, nut, fat.* The vowel in *fin* was perhaps heard in OPTIMUS, as U replaced I in a few words; a fact cited by Mr. Ellis to prove that

"When a character has several sounds, it has a *special* and an *accidental* power, the former usually found in its alphabetic name. It seems plain, that the accidental power should have a new or modified character, and not those which have always been written and recognized. Mr. Ellis assigns to the vowel O the character ω closed at the top. He should then, at least, have supplied that in *not* with a modified character. A character formed like the Greek ȣ (the Latin U) is perverted to a diphthongal power, as if to justify and perpetuate a false pronunciation of Greek.

"Mr. Ellis (in conjunction with Mr. Pitman) has proposed, it is said, fifteen alphabets, in which there is a gradual deterioration, the last being the worst. There is a certain relation between the primary vowel in *meal* and the secondary one in *mill*, which was recognized by Mr. Ellis in 1844, when the former was represented by I with a horizontal medial line, and the latter by I. The related vowels in *dale, dell*, were represented by E with the line continued across, and E without a medial line. Now, *meal* and *mill* are spelt 'mɛl, mil'; whilst *dale* and *dell* stand 'dal, del'; and A, the capital of 'a' is reserved for the rare Welsh vowel in *fat*. Having reached its lowest point of deterioration, this alphabet 'is brought to a satisfactory conclusion,' and fault is found with those who will not adopt the later changes, termed 'improvements' (p. 220, and *Phon. Journ.*). When the pure vowel in *meal* is *short* (without falling into that of *mill*), ĭ is employed; which is correct, but inconsistent.

"Mr. Ellis's ethnical alphabet contains 56 characters, including *a* with a line through it, which is omitted in the table on p. 126. Some of his analyses are very minute, as the 'middle sound' (pp. 3, 7) between the consonant and vowel of *see*. On the other hand, his ideas of the relation between the *open* (and usually long) vowels in *paw*,* *fur*, *pool*, *lo*, and their *close* (and usually short) condition in *naught*,* *worth*, *full*, *obey*, are very confused. At present, he makes

U had "undoubtedly several sounds" in Latin. He should have informed his unclassical readers, that in these words, according to the ancient grammarians, the I and U *had not their true power*, but an allied one, for which Claudius proposed a character. Consult Velius Longus, Priscian, and Donatus. The power in question was not the French *u*, as that was represented by Y. The aperture of the I in *fin* is nearer that of U than of I.

* To form the latter, a longer pipe is required than for the former, according to the experiments of Wheatstone. Herschel (*Encyc. Metrop.*) confesses himself unable "to detect any shade of difference" between them.

no distinction between the short vowel in *mutter* and the long one in *murder*, chiefly because it would be inconvenient in phonography.* He places the vowel of *fall* in the first syllable of *authority*, *although*, *water*, *fortune*, *short*. The vowel in *not* is placed in *quarter*, *god*, *John*, *hog*, *horse*, *wrong*, *long*, *beyond*, *swan*. The inconsistency is obvious which demands a different vowel in *fŏr* and *nŏt*, and an identical one in *fŭr* and *nŭt;* a different one in *conclude* and *good;* but the same one in *endŭre* and *dŭty*. In some cases Pitman and Ellis have used at different times both of the vowels in *făll*, *nŏt*, in the same words, as in *talk*, *George*, *cross*.

"The vowel in *pool*, *smooth*, is placed in *to* (as in *to do*), *into*, *truth*, *rule*, *conclude*, *Lucian*. In most of these examples, the vowel is neither long nor short, but *medial*, and the aperture is both close and open. The vowel in *rule* is closer and less labial than that in *pool* (which is short in *boat*), and when short it occurs in *pull*. It is preceded by English *y* in *endŭre*, *dŭty*, when not pronounced with the Welsh diphthong *iw*.

"The discrepancies here noticed arise in some degree from an empirical rule,† (p. 101,) requiring the orthography to represent the 'emphatic utterance of each word as it would be pronounced independently of all other words.'‡ This mode of pronouncing English is common with foreigners. But if *to*, as in the verb *to do*, or in *heretofore*, (*Phon. Journal*, 1847, p. 283,) is pronounced independently, like *too*, as when a child spells it, it is a different word, and of no more account for its legitimate purpose than a broken link detached from a chain. Mr. Ellis takes a different view of his own vernacular on page 110, where he states that French syllables upon which no stress is laid 'are not to be *hurriedly* or *indistinctly* pronounced, *as in English*.'

* This name is applied to a beautiful and useful system of stenography, which, however, is not as philosophical as is generally supposed. The vowels in *food*, *feed*, should both have been "first place," and those in *far*, *fall*, "third place," so as to form the vocal circle properly. The diphthong in *aisle* should have been "third place" by its vowel. The vowel-dots, when placed in an angle, cannot be read with certainty. The *w* and *y* should each have had an independent character for syllables like the old English *wray*, or the German *glauben* when pronounced *jlaubn*. The character for *r* (in the labial position) would have been better as *m*; *s* as *n; tsh* as *s*, &c.

† Those least skilled in analysis will insist most upon this rule.

‡ Adelung, quite as good an authority, gives a different rule: — "*Schreib wie du sprichst*, ist das höchste und vornehmste . . . . . auch das einzige Grundgesetz für die Schrift in allen Sprachen."

"We have seen that Mr. Ellis places different vowels in *water* and *quarter*, yet he considers that in *boy* and the one in *quoit* identical, admitting no vowel distinction in the diphthongs. In writing diphthongs other than English, he uses a notation which makes them dissyllables, whence it is evident that he does not understand the nature of these compounds. The Nadako, an unwritten language, is very instructive upon this point, as it contains true diphthongs, and their corresponding *quasi* diphthongs, which Mr. Ellis's theory places in English and German. In this paper it is impossible to represent an exact pronunciation, so that the words must be taken as approximately correct, unless fully described; and the notation is provisional.

"In the Nadako word for *cheek*, tánkadaus, the last syllable does not rhyme with *house*, but the vowels are pure, as in the name of the Persian poet Firdausi, both these words having four syllables. The *t* and *k* are 'indifferent,' the *n* is pure, (not *ng*,) and all the vowels short. But in behedawso, *shoulder*, the third syllable is accented, and like the second of *endow*.

"This language, besides the English diphthong in *aisle*, (ending with a *coalescent*, as explained by me in 1847,) has a *quasi* diphthong similar to it, terminating with the vowel in *feet*, and another with that in *fit*.

"The Hesperian * (North American) languages are remarkable for the extent to which they reject the labials (except *m* and English *w*), a circumstance which probably has some connection with the coldness of expression of the aborigines; emotions being less likely to affect the countenance, if the lips remain unmoved in speech. † Several Oriental languages, in which the four inner contacts are used, want some of the labials; whilst most of the European ones employ the four outer ones, excluding the glottal.

"In the Lenàpe ‡ or Delaware language, there is a sound which

* "*Hesperian*, situated at the west." *Dict.* — For scientific purposes, America north of 50° might be called *Hudsonia;* from this line to the tropic, *Hesperia* (or Vesperia); the tropical portion, *Favonia;* from the southern tropic to 50° south, *Zephyria;* and south of this, *Magellania.*

† In representing a spirit, painters reject the body, preserving a winged head; probably because it is the seat of expression, thought, and the organs of sense.

‡ The *a* as in *far*, accented; the *e* as in *pet.* Messrs. Pitman and Ellis have maintained that the vowels in *pity*, *net*, *not*, cannot be pronounced except before a consonant. The proper name *Konza* ends with the vowel in *not*, that of *Choctaw* (the *c* is a literary corruption) has it twice. Mr. Ellis, whilst he denies the

Mr. Duponceau describes as a *whistle*, citing the word '*wtehim*' as containing it initially. This consonant I have noticed in Cherokee and in Weko (*e* as in *they*), in the latter of which it is peculiar in being final as in ta῾v, *three*, the *a* as in *cart*. No grammarian or phonetician has properly analyzed the English *wh*. Of two opinions concerning it, one gives it as the English *w* preceded by *h*, according to which the word *when* is represented by *hwen*, by Noah Webster and Ellis. Others consider it a distinct whispered consonant, and Dr. Comstock perverts to its use Q (consecrated to the Oriental *qof*, at least as early as the building of the pyramids), writing qɛn for *when*. The first party is wrong in inserting *h*, and the second in giving three instead of four sounds.

"Let *sonant* be represented by a grave, and *surd* by an acute accentual; and let the Greek aspirate-mark indicate an *aspirate*, and the lenis a *lene* consonant. Let the English *w* be represented by its Latin character V, and the elements of *when* will stand ·῾v῝vɛn, or in English letters, wh-w-e-n. Mr. Ellis overlooks this sound in his account of Welsh.

"This succession depends upon a law not hitherto announced, prevailing in the more flowing consonants (the liquids * and nasals), which results in a tendency of their surd aspirates to be followed by their lene sonant power. The English interjection *hem* and German *hm* (formed with the mouth closed) afford a second example. Mr. Ellis writes it 'h'm,' as if it were *h* preceding *m*.† N and L take the same phases in Cherokee. In this language, when the ordinary *l* is not interposed, and a vowel follows the aspirate, the vowel is whispered. In Welsh, the whispered element occurs final. The two modes of its occurence have not been recognized by Mr. Ellis.

"I have found whispered vowels, and even syllables, not uncommon in several American languages, as in the two final syllables of the Comanche word for *ten*, sɛwᴀɴchut; the first syllable of which agrees with *send*, but nasal; the second with *want*; the third with the vowel in *nut*, whispered; and the fourth with that in *foot*, whispered.

vowels in *pit*, *pet*, *pat*, to the French (p. 109), inserts the characters with which he represents them in his example of this language on p. 156.

* English W and Y bear the same relation to P and K respectively, that L does to T, or R to the palatal contact.

† *Phonetic Journal*, 1848, p. 141, 5th line from below. In other cases, the interposed comma indicates a second syllable.

"A labial consonant seldom appreciated is the aspirate (or spirant) of B, the German w and Spanish *b* in certain words, as *Cordoba*, *Habana*, a sound confounded with their *v* (also a Spanish sound) by the English. Mr. Ellis spent a year in Germany without discovering the difference, (which he now admits, but usually disregards in his examples of German,) — a singular fact in a professed phonetician, when the most unlettered part of the population of Pennsylvania speaking German and English make the proper distinction. Even the savage aborigines inhabiting the frontiers of Mexico and the United States, pronounce the sound in question with perfect accuracy in words taken from the Spanish, as that for *horse*, which, in German characters, is kawajo, the *l* of the original being dropped in Mexican Spanish, as in corresponding French words. This aspirate *b* occurs naturally in Weko and Konza. The Spanish grammarians have an imperfect idea of this sound, which they insist is a *b*, because it is not the labiodental *v*. This language doubtless takes it from the Latin, of which, as well as of Greek, it seems to be the digamma (Ⅎ), the small letter of which was probably *two gammas* ($\gamma\gamma$), from which resulted w, which character, under this view, has not arisen from the repetition of v. A critical review of the Greek orthography of Latin names, and the reverse, will, I think, confirm the views here taken. I would represent this sound by B surmounted by ‘‘.

"The corresponding aspirate of P (undoubtedly the Greek *phi*) is heard in German when *f* follows *p*, as in *pfropf*, *kopfweh*, *dampfboot*.

"S is a post-aspirate of *t*, the theoretical aspirate of which is intermediate in power to *theta* and *s*. The *lene* of *th* (in *this*) is to be looked for in the Spanish *d*, in those cases where it is believed to have the power of sonant *th*. The purely English notation *sh* (which is in no case etymologic) is founded in error; as this consonant does not bear the relation to *s* which the annexed *h* indicates in other cases. *Sh* belongs to a more posterior contact than *s*, and there is an allied sound formed still farther back, with the jaw more open. It is the Arabic *sad*, (Hebrew *tsadai*,) mistaken by Mr. Ellis for an ordinary *s* strongly hissed, overlooked in his Polish and Russian, and in Sanscrit mistaken for German *ch* (p. 56) and for *sh* (p. 133). I have heard it in Polish, Chinese, and Nadako.

"The French *j* (the sonant of *sh*) I have heard in but two American languages, the Konza and Wyandot.

"Sonant *s* (as in *roses*, *has*, *is*, *his*, *wise*) should not be represented by the Latin, Italian, and German double character *z;* and here Mr. Ellis might have consulted the appearance of the English page with advantage, in using a pointed *s;* the sound in question being scarcely ever represented by *z* in English and French. In Pelham's notation, *s* is used with its sonant power, that in *hiss* having a pointed *s*.

"Mr. Ellis's ethnical alphabet, whilst it properly separates *x* into *cs*, represents the double sound of the English *tsh* by a single character, namely, *c* with a tail; and the reasoning employed to excuse this *ought* to have required the English *dzh* to be represented by G with the same tail, to make the deduced characters correspond with their originals C, G (cay, gay), which, by a great concession on the part of Mr. Ellis, he uses in their classical sense. But whilst the character for *tshi* is *etymological*,* that for its sonant *dzhi* is merely *English*, being *j*, a character which, on the correct principle of making *c cay*, should have had its Latin, Italian (as in *jeri*), German, Polish, &c. power, as in the initial of *year* (German *jahr*), the character having been made for this sound.† In Spanish, *j* ‡ stands for the Greek *chi*, and in Cherokee for *gu* (in *good*), constituting less of a corruption than to call it *dzhi* or *zhi*, because it still represents a member of the guttural contact. But if *tshi* must have a character because derived from *cay*, so must the German *ts*, *t* alone, French ç, *sh*, *t* when followed by *sad*, &c., with their sonants, forming an aggregate of about twenty useless characters, rendered necessary by Mr. Ellis's concession to etymological orthography, which in other points he ostensibly opposes. Moreover, who shall decide when *tshi* is derived from *c* or *g*, or *ng*, or *ch*, or *j*, or from neither, especially in foreign languages? — and to use it in other cases (to write *China* for example) destroys its supposed etymological value. A statement of the fact, and

* As in the change from *brig* to *bridge*, and *kist* (Latin *cista*) to *chist*, or the literary corruption *chest*.

† In the *English* alphabet of Professor Reynolds, published in 1845, J has its proper power, *yoke* being spelt like its original *jok*. E and ε are used properly, and *fowl* is spelt *faul*. English written in this alphabet, or in that of Jones, can be read by a reader of ordinary English as readily as Mr. Ellis's transcription; and a person taught with either, or with Dr. Comstock's, can subsequently learn heterography quite as easily as through Ellis's system.

‡ There is a complete parallelism between the Spanish use of J as *ch*, and the German use of the Latin V (English *w*) as *f*.

the cause, of the change from *kinn* to *chin* should have been sufficient. The cause of this phenomenon seems to be as follows.

"K and *g* being formed by the base of the tongue, where there is not much room, to form them readily, the mouth must be more open than for the palatals, which are formed where the tongue is thinner and less confined, so that the latter are *close* when compared with the former. I and E have also a close aperture; more close, indeed, than suits the ready production of *k*, but corresponding with that of *tsh*, &c. There is a tendency to place the organs in a position to form the subsequent vowel or liquid* during the formation of the preceding consonant, so that if I is intended to be formed, the previous consonant will be more likely to be a palatal than a guttural. Hence *tshi*, &c., are more readily formed than *ki*.

"Mr. Hale, (*Philol. U. S. Expl. Exp.*,) followed by Dr. Comstock, perverts J to its French power, and C to that of *sh*. One of Mr. Ellis's characters for *shi* is the long ſ terminated below like Italic *f*; the other the Greek Σ, which is a useless perversion. For *zhi* he usually employs *z* with a tail like ɔ, and Σ reversed. There is a remnant of propriety left in his use of ȷ (deprived of its dot) for the element following *l* mouillé in French, *n* circumflex in Spanish, and a number of other consonants in the Sclavonic languages. The element, however, which follows the Spanish circumflex *n* is nasal, not pure like that in the English word *onion*, which is often cited as containing the Spanish sound. The analysis which introduced this J in French should have discovered a corresponding labial in the same language, and a palatal in English.

"Dr. Rapp's 'indifferent' consonants, well known in German, are

* In *play*, *pray*, the tongue is in the position of *l*, *r*, whilst the lips are closed to form *p*. Mr. Ellis formerly wrote *bul* as the last syllable of *table;* he now writes *tab'l*, as if there *ought to be* a second vowel, as in *tabula*. In general, *r* may have the phases of *l*. The combination *pr* (as in *pray*) can, like *pl*, be pronounced and form a syllable without a vowel, notwithstanding Mr. Ellis's former opinion of such a syllable being an "orthographic monster," a monstrosity with which the Bohemians seem to be familiar. Let *l* and *r* follow the word *stop*, when we will have the English words *stopple*, *stopper*. Compare *barble*, *barber; battle*, *batter; bushel*, *brazier; hammer* with the German *hammel;* and *sugar* with its Bohemian form *cukr*. The two modes of English orthography *ter*, *tre*, when final, are equally incorrect: Mr. Ellis, however, puts the vowel in *ferry* in the finals of *letter*, *martyr*, *maker*, *alter*, *theatre*, *miner*, *power*, &c., to which the *Westminster Review* objects.

common in the American languages. They are *p*, *t*, *k*, formed by the contact of a greater surface than usual. I supposed them to require a greater stress of breath until I tested the fact mechanically with an appropriate dynamometer. I have never met with 'indifferent' *t* preceding *s* or *sh*, and there is a physical reason against their ready occurrence. The indifferents should be rigorously marked in all transcriptions of language.

"Mr. Ellis indicates nasal vowels by *n* with a dot over it, which seems more awkward than a horizontal comma point (⌢) beneath the nasal letter, somewhat as in Polish. This will appear when several nasals occur in succession. Let us represent the dotted *n* by Italic *n*, when (using German characters) the Wyandot word for *a bear* will be danj*n*o*n*j*n*ε*n*>ʿ. The first and second vowels of this word are of medial length, the third short and accented. The character > indicates the close of the glottis, and the *spiritus asper* the subsequent passage of the breath, as in the word *quick*ʿ.

"This close of the glottis is also medial in Wyandot, as in hareda>aje*hau*, my name in this language. The *a* is that in *far*, the *e* in *weigh*, *j* as in German, *r* smooth, and the final syllable like *how*, but nasal. The first, second, and final syllables are each half a second long, and the remaining three are only one sixth of a second.

"The Weko language of Texas has a clack or smack formed by the sudden separation of the closed fauces, independent of any action of the lungs; forming an exception to the maxim of Buquoy, 'Stimme nur da wo lungen vorhanden.' The word for *eye* is k7t7kɫʿ, in which the *k* is indifferent, and the vowels as in *pit*. This sound occurs medial and final. The ordinary trilled *r* occurs in this language.

"The Nadako has an allied independent dental sound in a *t* strongly held in place with a pressure of air behind it, (not from the lungs,) which is allowed to escape in a sudden explosion, like spitting, as in the word for *tooth*, tʿauh, in which the vowels are short, (the last not diphthongal, and as in *foot*,) the final element being the ordinary aspirated *h*.* The dental effect is more dull and less loud than the corresponding Hottentot clack.

"The indefatigable missionary, the Rev. P. J. de Smet, informed me that he found a corresponding labial effect in one of the languages of the Rocky Mountains, in which the repetition pʿpʿ is used.

* This final *h* is also found in Konza.

"Mr. Hale's notation *txl* for an allied independent Chinook glottal is defective, the sound in question being difficult and of a deeper contact, whilst his combination is an easy one. An author, however, who would knowingly omit or replace a letter as important as the French *u*, must have had but little inclination to analyze the peculiarities of speech which his unusual opportunities threw into his way.

"In the Teutonic languages, the nature of syllables is not appreciated, as it is in the more highly refined French, in which the rhythmic sense has attained its highest development. The English words *rock*, *hut*, *top*, would be correctly considered dissyllables in French; as the escape of the breath at their close takes the place of a vowel, or a liquid consonant. The English word *luck* is exactly the Chinese word for *six*, except that in the former it is a dissyllable (lᴗk‘) and in the latter a monosyllable (lᴗk'), the breath not being allowed to escape after *k*. The same thing takes place with *p* and *t* in Chinese.

"Unless accent and quantity are marked, a language must be known to be read, and such an omission has enabled Mr. Ellis to give *quasi* phonetic specimens of three times more languages than he received from legitimate sources.* On account of this omission, a speaking knowledge of Lenape or Delaware cannot be acquired from Zeisberger's German transcription. For example, he writes the numeral *five*, *palenach*, which, as a word in German characters, would probably be accented on the first syllable, with the vowels short. Let the reader pronounce the supposed word, and then compare it with the true one. The vowels are as in *cart* and *lay*; the second syllable takes the grave accent; the length of the syllables is respectively two, five, and three eighths of a second; the final *ch* is deeper than the German, and it is triilled, and followed by k‘.

"The want of a proper notation renders a paper of this kind unsatisfactory and difficult to print, and on this account I have limited the number of examples, and avoided diacritical marks. I communicated some remarks upon the Phonology of the Wyandots to the American Philosophical Society, which may be found in their Proceedings for 1846, Vol. IV. p. 268. I have taken oral specimens, from natives, of nine aboriginal American languages, five of which are un-

* He marks the accent in English, when it cannot be determined by the position of *fifteen* letters which he enumerates. He uses the acute accentual only, whether the co-accented consonant precedes or follows the vowel.

written, besides others, upon which I lay no stress, from persons who did not speak them vernacularly, as Russian from a Pole, and Turkish from an Armenian. The English in general confound the short A with the vowel in *fat*, an error into which Mr. Pickering, and I think Mr. Keating, have fallen. I judge the latter from his Dakota (Sioux) vocabularies, in which the vowel in *fat* is represented in words which have A short in the cognate Konza, if my analysis is correct. This confusion appears in the *London Phonotypic Journal* (1847, p. 108), where the vowel-character used in writing *am* (the key word) is placed in *as*, *far*, *apart*, *enlarge*.

"Mr. Ellis's criticisms upon the Missionary alphabet owe their force to the fact, that it employs *no new characters*, his own fault being that he employs too many, and not enough. The additions to this alphabet by Mr. Hale, and subsequently by Dr. Comstock, are partly free from these objections. The alphabet of Marsden has a few good features, but this author knew little of phonetics.

"The objections to Mr. Ellis's alphabet by the *Edinburgh Review* are perfectly valid, and this author's attempts to avert their force are very weak. Besides his unfortunate citation of the variation of the Latin U, as supposed to be proved by the orthography OPTIMUS, OPTUMUS, he refers to his tables on 'the value of Roman letters in nine modern languages,' to show 'how little truth there is in the idea that certain Latin letters are appropriated to certain sounds as *European* letters.' We here find that U represents the vowel in *fool*, *full*, in six out of the nine languages, and that in *nut* in but two, Dutch and English, in neither of which is it specially applied to this power. In English, the idea of U might have been associated with the words *rūle*, *fŭll*. The syllable *you* has a character in Russian, and sometimes in English. The conjoined 'au' is uniform in six of the examples, but in none, not even English, has it Mr. Ellis's power, according to which 'maur' spells *mayor*. The character *k* as German *ch* suits no language; J and W stand alone with their English power; and *q* is incorrectly and confusedly used for the German *g* when the sonant of *chi*, for the distinct Arabic *ghain*, the modern Greek *gamma*, and the Hebrew *gimel*. The diæresis-mark, as in some German books, is corrupted, after the *Phonotypic Journal* (1847, p. 77) had decided against 'strokes and dots' because not adapted for 'ornamental type.'

"The *Phonetic News*, (1849, p. 103,) in discussing the ability of a pupil taught with its alphabet to learn ordinary English, says that 'the whole construction of the phonetic alphabet was devoted to this end, and that to attain this great, this most important object, the siren voice of scientific analogies was steadily and systematically disregarded; not because European analogies were worthless, but because English analogies were paramount.' If this was the intention, the 'English analogies' must have been extremely difficult to discover, since the crossed I was used at different times to represent the vowel in *field*, and the consonant and diphthong in *thigh*. The character ω (nearly) replaced a less corrupt type for the vowel in *fool*, to be itself replaced by ɯ as stronger analogies appeared. In January, 1844, these were secured by using A as in *far* and A in *fat*, and there was a similar correspondence between the primary and secondary vowel-characters. In March, A had the cross line lengthened, in October it had the head of T, now shortened to a simple line. In the same month the small letter for the vowel in *field* was a dotted ɪ, finally rejected for ɛ, which, in the search for English analogies, was first assigned to the vowel in *they*, although subsequently pretended to be derived from the double English character in *fee*.

"As the *Essentials of Phonetics* contains the fullest and latest ethnical alphabet before the public, it became necessary to examine the basis upon which it is founded. The fact that it was intended to produce 'as little alteration as possible in the appearance of the printed [English] page,' (*Phon. Journ.*, 1847, p. 32; *News*, p. 32, 67''', 103,) against the corruptness of which the phonetic publications have been so eloquent, not only calls for its prompt rejection abroad, but also as far as English is concerned.

"If concessions in orthography are allowed to languages with a perverted alphabet, they can and ought to be demanded with tenfold force for the humblest language which spells correctly; as the Danish in its use of *j* and *y*. But there is little to fear, since it is not probable that nations, who have spent centuries in keeping their orthography more or less pure, would submit to a literary fraud of such magnitude.

"A singular fact in connection with the wonderful increase of phonetic works in England is the great dearth of examples of the native dialects, and the comparatively few foreign languages investigated, when London must afford such admirable opportunities. Officers in the public service, who have spent years in distant countries, might furnish much information; but, judging from the tone of these journals, nothing can be expected from such a source. Unphonetic works on the English dialects are numerous, but they are almost useless, because unpronounceable; the word 'wapse,' for example, which is a form of the German *wespe* and the English *wasp*."

Professor Horsford illustrated "the spheroidal state of water," by several experiments. He also communicated the following

" *Results of some Experiments on the Explosions of Burning-Fluids.*

"It has been maintained, that several of the various preparations, used under the general denomination of *Burning-Fluids*, are, in certain conditions, explosive. It has been asserted, on the other hand, by venders, that they are not explosive. Wherein the misapprehension lies, how the numerous accidents that have occurred in the use of these preparations are to be explained, and by what precautions such accidents may be prevented, have been subjects of experimental inquiry.

"The burning-fluids, as a class, are rectified spirits of turpentine, or turpentine with an admixture of a small percentage of alcohol, or of some other inflammable body readily mixing with or soluble in turpentine.

Turpentine, alcohol, ether, and the burning-fluids, when fired in an open vessel, burn at the surface as long as a supply of oxygen is kept up. (*a*) A slight report attends the flash of flame at the commencement of the combustion. (*b*) The accidents with burning-fluids have ordinarily occurred during the filling of lamps from the cans, when the chamber of space above the fluid within the can or lamp was large, and *always* in the presence of flame. (*b*) A mixture of hydrogen (an inflammable gas) with oxygen (an ingredient of atmospheric air), in the proportion of two volumes of the former to one of the latter, is eminently explosive. (*c*) Atmospheric air, substituted for oxygen, lessens the violence of the explosion when flame is applied. (*d*) The carbo-hydrogen, employed for city illumination, may be substituted for the hydrogen, and the explosive property, somewhat impaired, be still possessed by the mixture. (*e*) Certain proportions of the gases are better suited to produce violence of explosion. (*f*)

"It has been found that the vapor of common spirits of wine, ether, and of two varieties of burning-fluid, may severally be substituted for the hydrogen, and the explosive property remain essentially the same, though of unequal energy. (*g*)

"In these facts, *a*, *b*, *c*, *d*, *e*, *f*, *g*, lies the explanation of the phenomena that have been observed with burning-fluids.

"The following experiments were made: —

"I. A current of air was directed into the upper part of a loosely-stoppered laboratory glass spirit-lamp, while burning, causing thereby a mixture of alcohol-vapor and air to rush past the flame. After a moment or two, the jet took fire, and was instantaneously followed by explosion. This result was invariable.

"II. After permitting a drop of alcohol, in a large glass flask of small neck, to evaporate for a moment, and applying flame to the mouth, explosion resulted generally, though not invariably.

"III. Ether similarly treated yielded less uniform results, because, probably, of the greater difficulty of obtaining the proper mixture of ether-vapor and air.

"IV. A variety of burning-fluid in extensive use, said by the venders not to *explode*, was subjected to similar experiment, with still less frequent affirmative results. They were, however, sufficient to show that explosions with it are possible. Similar experiments have been made with another variety of burning-fluid, by Dr. Morrill Wyman, with like results.

"It is, then, conceivable, that, when the proper relative amounts of the vapor of burning-fluid and atmospheric air are mixed together, as they may be in the upper part of a partially filled can or lamp, and a flame is brought sufficiently near, explosion must result. If the quantity of mixed gases be large, the explosion may cause the destruction of the containing vessel, or if that remain entire, it may drive out a portion of the fluid, which, taking fire, may cause more or less injury. The course of safety has been pointed out by the dealers in these articles for illumination. It is to fill the lamps (the tops of which *screw on* and are not supplied with special air-holes) in the *absence of flame*, *by daylight*, for example; in which case no explosion can occur." *

* "Similar accidents to these have taken place in the use of the so-called air-tight stoves for burning wood. After the wood has been fired, and the supply of air for some time shut off, on reopening the draft, and sometimes without, occasional explosions of great violence have occurred, attended with the blowing out of the stove-door, and in some instances producing still greater injury to the stove.

Professor Agassiz gave additional facts respecting the circulation of insects, and showed in the larva of the mosquito how true vessels, destined for the caudal bronchiæ, arise as branches from the *main tracheal* tubes.

Three hundred and twenty-third meeting.

November 6, 1849. — MONTHLY MEETING.

The PRESIDENT in the chair.

The President exhibited a model of the great wooden dam recently erected across the Connecticut River, at Hadley, and explained the means by which it was kept from floating, or from being carried down the stream.

Professor Horsford made a further communication upon the spheroidal state of water. He illustrated, by experiment, a phenomenon occurring when water is carefully dropped into a hemispherical capsule of polished platinum. The mass having been made to rotate by directing the drops of water obliquely upon the side of the capsule, at a certain stage the irregular motions and shape were resolved into a series of vanishing and reappearing indentations in the margin of the spheroid, of wonderful regularity and beauty. This scolloped edge was occasionally replaced with a series of wave intersections, exhibiting at the surface of the water systems of lozenges flitting from the circumference to the centre, diminishing till they vanished.

Professor Horsford suggested that the phenomenon might be due to the rotation of the mass, and its motion across the bottom of the capsule from one side to the other, tending, as the mass moved outward, to its elongation, and to contraction

The probable explanation is this. After firing the wood and shutting off the draft, destructive distillation commences. Inflammable gases issue from the wood, which, mingling with air derived from the pipe or remaining still unconsumed, furnish an explosive mixture, which the first jet of flame, or perhaps the incandescent coal, causes to explode.

"As these accidents are not of frequent occurrence, it may be found that the probability of producing inflammable gases in the required quantity is less with some varieties of wood than with others."

as it returned, while the rotation served to reduce the irregular form to that of a circle. The joint action and resolution of the forces thus brought into play might, Professor Horsford conceived, account for the phenomenon observed.

Further observations on the topic were made by the President and Mr. Hayes.

Professor Horsford likewise gave an account of the phenomena attending the death of a bear from strychnine, administered for the purpose by Professor Agassiz. Rapid decomposition commenced almost immediately after death.

Professor Agassiz gave a paper on the development of the ova in insects. His observations were made by following the tubular ovary of a species of Acheta, through the portion charged with ova in different stages up towards its termination, where it contains simple structural cells. Some of the latter merely take a further and special development, and become ova.

Three hundred and twenty-fourth meeting.

November 13, 1849. — Quarterly Meeting.

The President in the chair.

Mr. James D. Dana, through the Corresponding Secretary, presented a copy of his work, *The Geology of the United States Exploring Expedition.*

Mr. E. C. Cabot exhibited plans of the former and present wooden dams across the Connecticut River at Hadley, and explained the different principles on which they were constructed.

Professor Agassiz made a verbal communication, to show that, throughout all classes of the animal kingdom, there is such a direct relation between the structure of animals and the element in which they dwell, that the circumstance of habitat will go far towards determining the relative systematic position of groups and species; the marine animals ranking lowest, those of fresh water next, and the land animals highest: also, that the series so formed corresponds to the order of appearance in time.

Samuel B. F. Morse, Esq., of New York, and Professor Wolcott Gibbs, of New York, were elected Fellows.

From the list reported by the Council appointed for this purpose, the following persons were chosen Foreign Honorary Members, viz.: —

Robert Brown, Esq., London.
Prof. Elias Fries, Upsal, Sweden.
Leopold von Buch, Berlin.
Sir Henry de la Bèche, London.
Prof. Elie de Beaumont, Paris.
Prof. P. A. Hansen, Seeberg, Denmark.
Prof. Jens Christian Oersted, Copenhagen.
Prof. Henry Rose, Berlin.
Prof. Jean Baptiste Dumas, Paris.
Prof. Milne Edwards, Paris.
Prof. Johann Müller, Berlin.
Prof. Christ. Gottfried Ehrenberg, Berlin.
Prof. Karl Ritter, Berlin.
Prof. Friedrich Tiedemann, Heidelberg.
Prof. Theod. Ludwig Wilhelm Bischoff, Giessen.
Prof. Johann Friedrich Encke, Berlin.
Prof. Karl Ernst von Baer, St. Petersburgh.
Prof. Theod. Schwamm, Louvain, Belgium.
Robert Stephenson, Esq., London.
M. Benoit Fourneyron, Paris.
Prof. Macedonie Melloni, Pisa.
M. Andral, Paris.
Prof. P. C. A. Louis, Paris.

Three hundred and twenty-fifth meeting.

December 4, 1849. — MONTHLY MEETING.

The PRESIDENT in the chair.

The occasion was rendered peculiarly interesting from the circumstance that the meeting was convened in the library of Dr. Bowditch, formerly President of the Academy. The arrangements of the apartment remain precisely as they were in his day. His chair and table occupy their usual position, his bust is placed on the wall as near as possible to the place where he used to sit, and all the papers on his desk remain just as he left them. Many incidents respecting his early life and his subsequent habits, and especially his scientific labors, were related, and several memorials were shown, — such as medals; a bust of Laplace, presented by his widow; the manuscript of an Almanac, constructed by him at the age of fifteen; his abstract of the mathematical papers in the Transactions of the Royal Society; his portfolios, on the covers of which were numerous mottoes in various languages, characteristic of the philosopher; and, lastly, the fragment of his translation of the fifth volume of the *Mécanique Céleste*, as far as he had proceeded.

Letters were read from Samuel B. F. Morse, Esq., and Professor Wolcott Gibbs, of New York, accepting the fellowship of the Academy.

Dr. H. I. Bowditch gave the result of the microscopic examination of the accumulations on the teeth of healthy persons, near the gums, in forty-nine individuals, most of whom were very particular in their care of the teeth. Animalcules and vegetable products were found in every instance except two. In those cases the brush was used three times a day, and a thread was passed between the teeth daily. Windsor soap was also used by one of these two persons, with the brush. Dr. Bowditch had tried the effects of various substances in destroying the animalcules, and especially of tobacco, by which they seemed to be in no wise incommoded. Soap-suds and the Chlorine Tooth-wash invariably destroyed them.

Professor Agassiz made some remarks on the egg in vertebrate animals, as a means of classification. What is their structure, and is there any thing specific in the eggs of the different classes of Vertebrata? In the eggs of them all is found a generation of cells in the germinative dot, as may be readily seen in eggs of turtles, rabbits, squirrels, &c. The eggs of Mammals are very minute, and surrounded by epithelium; and they begin at once their subdivision within the parent. In those of birds, a large bulk of vitellus is developed in the ovary, and afterwards the albumen and shell are added. The same is the case in turtles, lizards, and serpents; but the eggs of Batrachians are different, and are small, elastic, and dilatable, like those of fishes. He thought, therefore, that there was a closer affinity between the first-mentioned reptiles and birds than between them and the Batrachians; and that the turtles, lizards, and serpents might be incorporated with birds, while the Batrachians were classed with fishes.

Professor Horsford exhibited several specimens of vermilion which varied very essentially in color from adulteration. Some of the articles used for that purpose are chromate of lead, sulphate of lime, and carbonate of magnesia.

Mr. Desor mentioned some facts relating to the distribution of animals in the region of Lake Superior, and specified some of the animals found on Isle Royale, whose presence he was at a loss to account for, except on the supposition that the island was once continuous with the continent.

Three hundred and twenty-sixth meeting.

January 8, 1850. — Monthly Meeting.

The President in the chair.

Dr. C. T. Jackson, from the committee raised at a former meeting to suggest a practicable mode for recording by coast-marks the present mean sea-level on the Atlantic shore of this country, made a report, in the form of a memorial to the Secretary of the Treasury. The draft was recommitted, in order that a proper resolution, expressing the sense of the Academy, might be appended.

Mr. Paine presented a communication from Professor Augustus W. Smith, of Middletown, Connecticut, containing

Occultations of Fixed Stars, &c., at the Wesleyan University, Middletown, Connecticut. Latitude, 41° 33′ 10″. *Assumed Longitude,* 4h. 50m. 36s..

Date.		Name.	Sidereal Time.		
1845.			h. m. s.		
April	15	A^2 Cancri	9 27 01.38	Im.	Good observation.
May	9	62 Orionis	11 26 45.55	"	" "
"	9	Unknown	11 24 23.50	"	2s. (?)
"	9	"	12 20 16.40	"	1s. (?)
July	16	58 Sagittarii	17 03 39.92	"	Good observation.
"	17	29 "	17 45 33.95	"	Pretty good observation.
Sept.	12	ν Piscium	1 44 49.92	"	" " "
"	15	λ "	18 40 36.09	"	1s. (?)
"	15	λ "	19 29 50.00	Em.	1s. (?)
Nov.	10	δ "	20 54 04.48	Im.	Pretty good.
1846.					
Feb.	4	74 Tauri	3 56 21.11	"	1s. (?)
"	6	71 Orionis	6 06 41.87	"	Pretty good.
May	3	2 Leonis	11 29 43.35	"	" "
1847.					
Jan.	25	61 Tauri	5 00 56.61	"	" "
Sept.	16	Unknown	18 51 18.33	"	" "
"	16	29 Ophiuchi	19 03 50.83	"	" "
1848.					
Feb.	12	α Tauri	2 22 30.08	"	*
"	16	29 Cancri	7 02 50.55	"	Pretty good.
Mar.	8	750 B. A. C.	6 05 41.19	"	" "
"	10	75 Tauri	8 30 29.26	"	" "
"	10	Unknown	8 21 02.26	"	" "
"	11	111 Tauri	7 23 21.40	"	" "
"	11	Unknown	7 20 31.40	"	" "
"	13	λ Geminorum	7 35 41.90	"	" "
"	16	3,398 B.A.C.(?)	9 05 01.19	"	Saw a bright spot in the dark part of the [Moon.
May	6	26 Geminorum	11 33 42.08	"	
"	6	"	11 52 44.00	Em.	1s. (?)
June	6	3,418 B. A. C.	13 43 53.86	Im.	
Nov.	8	Mercury	14 53 39	Em.	2d internal contact with Sun's limb.
"	8	"	14 55 19	"	2d external " " " "
"	11	54 Tauri	21 59 40.60	Im.	Good observation.
1849.					
Jan.	5	75 "	3 35 44.80	"	" "
"	5	1,391 B. A. C.	4 46 12.20	"	Thin clouds. Observation fair.
"	5	α Tauri	7 36 35.70	"	" " " good.
"	5	α "	8 42 27.70	Em.	Recognized the star by its form, not by its brightness. Appeared projected on the disk slightly.
"	6	111 "	0 22 18.20	Im.	
Feb.	7	31 Leonis	7 05 31.27	"	Pretty good.
Mar.	1	1,517 B. A. C.	8 32 02 40	"	1s. (?)
April	6	38 Virginis	10 29 27.04	"	Pretty good.
June	25	21,678 Lalande	13 25 54.85	"	" "
July	22	59 Leonis	15 48 17.50	"	" "
Oct.	24	7,263 B. A. C.	23 47 11.72	"	" "

* This observation was supposed to be good at the time, and no error can be found by referring to the original entry in my book of rough records. But a reduction of the observation for this longitude leads to the supposition that it ought to be 2h. 20m. 30.08s..

Professor Lovering read the following communication, viz.: —

" *Remarks on the Aneroid Barometer, by* Professor J. Lovering, *of Harvard University.*

" Most of the scientific journals of Europe and America have published descriptions of the new French barometer, as it is called. For the construction of the instrument, and the history of its invention, I may refer to them; and particularly to that contained in *Silliman's Journal* for September, 1849.

" The two ordinary statical ways of measuring forces are, first, by means of gravity, and, second, by means of elasticity. Our common balances to measure weight employ, either the gravity of a known counterpoise, or the elasticity of a spring. In like manner, the weight of a column of the atmosphere is determined by ascertaining the height of a similar column of some known fluid, which it is able to support, or the elasticity of some familiar substance with which it is in equilibrium. The barometer with which we are most familiar employs the first method: the aneroid barometer, which, as its name implies, contains no liquid, is based on the last principle, namely, that of measuring weight by elasticity.

" This new instrument is already manufactured, in large numbers, in France and Great Britain; and its adoption is recommended on the ground of economy, as well as of its great compactness. The barometer is now extensively used, not only for tracing out the grand laws of meteorology, but also as a practical guide to the mariner to forewarn him of approaching storms, and an indispensable auxiliary to the man of science in studying the geography of the solid parts of our planet. It is highly important that the meteorologist, the navigator, and the student of general science, should know what degree of accuracy may be claimed for the new barometer, and to what extent they are allowed to trust themselves to its indications. With the hope of assisting those who desire to form an opinion on this subject, I present the following experiments and observations, undertaken originally at the suggestion of Professor A. D. Bache, Superintendent of the United States Coast Survey. The instrument employed in this research was furnished by Professor Bache. It bears the number 1265, and came from the establishment of Lerebours and Secretan, Paris.

"A series of experiments was first made with this aneroid barometer, to determine the whole range of the instrument. It was placed for this purpose, first under the receiver of a common air-pump, and afterwards under the receiver of a condensing pump. In this way, it was found capable of indicating a change of atmospheric pressure, which would move the column of mercury in an ordinary barometer from about twenty inches up to about thirty-one inches. From the nature of its construction, the index is incapable of moving beyond the point which corresponds to twenty inches of the mercurial barometer, or beyond that which corresponds to thirty-one inches of the same. How accurately its march between these limits agrees with that of the mercurial barometer will appear from an examination of Table I. The pressure of the air in the receiver of the pump was derived from the pump-gage, which was supplied with common mercury, and corrected for level and capillarity. This table shows that, while the index of the aneroid barometer continues to move, it moves farther than the column of mercury. As it approaches its lower limit, it will begin, of course, to move more slowly, and afterwards the differences between its indications and those of the mercury change sign. It is obvious that, in this instrument at least, and with large ranges, similar changes of pressure are not marked by equal quantities of motion in the index, in all parts of the scale. This might be expected in an instrument where no consideration is given to the distinction between the potential and the apparent leverage. Besides this error, which we may call the instrumental error, there appears to be an irregularity in the motion of the index, arising from friction, bending, or some other cause, which would interfere seriously with the accuracy of this barometer, even if the arc over which the index moves were so graduated as to indicate the true pressure.

"At the meeting of the British Association, in 1848, it was stated by Mr. Lloyd, that one of his friends had made a similar experiment to that I have described, and that the indications of the aneroid barometer agreed with those of the pump-gage to within .01 of an inch. Such is the statement in the *London Athenæum*, although no mention is made of the subject in the Report of the Association for that year. As we are not informed to what amount of diminished pressure the aneroid barometer was subjected in this case, and whether the difference above mentioned was the result of a single observation or the mean of many, I am not able to say how far my own experiments are at variance with those to which Mr. Lloyd refers. Neither am I able to say how much of the error manifested by my comparisons is fairly to be charged to the general character of the new barometer, and how much is peculiar to the single instrument with which I experimented. I intend, as soon as an opportunity offers, to subject other specimens of the aneroid barometer, both of French and English construction, to the same trial.

" My next series of experiments consisted in a comparison of the aneroid barometer, day by day, with the common barometer, under the ordinary changes of atmospheric pressure. The mercurial barometer used for this purpose was made by W. and S. Jones, of London, and is the same as that used by Professor Farrar in the barometric observations published by him in Volume III. of the Memoirs of this Academy. This instrument is furnished with an adjustment for level, an attached thermometer, and a scale of corrections for temperature. This correction, as well as that for capillarity, has been applied to my observations. In this series of experiments it was necessary to know how much the aneroid barometer was affected by a change of temperature. Only a partial compensation is aimed at in the construction of the instrument. An increase of temperature will make the air in the reservoir expand, in the same way as a diminution of pressure. The same increase of temperature, by enlarging the metallic surfaces of the reservoir and increasing its capacity, may sometimes even over-compensate for the increased elasticity of the contained gas. In the instrument which I used, the compensation was deficient, and the amount of the deficiency was determined by exposing the barometer, side by side with a thermometer, to a temperature of 32° Fah., and reading the index, and then exposing it to a high temperature (in some instances as high as 140° Fah.), and then again reading the index. The difference of the two readings divided by the difference of the two temperatures was adopted as the correction for one degree, and was applied to the daily observations. The value of this correction, as obtained from the mean of five experiments, was .0021 of an inch, with the same sign as in the mercurial barometer. To accommodate the scale of the mercurial barometer, the standard temperature adopted was 55° Fah. The aneroid barometer which I used was not provided (as is sometimes the case) with an attached thermometer. A thermometer by the side of it, and not under the same inclosure as the air-chest, does not indicate the exact temperature of the working parts of the instrument. The slowness with which the index returned to its old mark after the barometer had been subjected to excessive heat or cold, and was then restored to the temperature of the room, manifests the importance of having the thermometer inclosed as the test of the instrument. The result of this series of comparisons is given in Table II. Although the agreement is much better than with low ranges, it falls far below the requirements of nice scientific investigations.

"Mr. David Purdie Thompson, in his very recent work on Meteorology, has the following paragraph:—'Upon comparison of indications made with the aneroid barometer — not corrected for the particular temperature — and a very perfect mercurial barometer, given by Mr. Dent, we find that, from forty-nine observations made between the 6th of January and the 23d of February, 1848, the mean difference was 0.037 of an inch, the *aneroid* being in excess; and from sixty similar observations made with a standard barometer, during December, 1848, and between the 3d and 31st of January, 1849, the mean difference amounted to 0.026 of an inch, the *mercurial* being in this case in excess over the aneroid barometer. Combining these observations (109 in number), a mean difference amounting to 0.0025 inch is found to exist, the indications of the aneroid being in excess. For general use, the instrument is thus shown to be well suited; for the measurement of heights, it is peculiarly adapted, from its portability and comparative strength; and for nautical purposes we know of no better instrument.' — p. 448.

"Now it will be observed that the mean difference in the twenty-eight comparisons which I have given of the two barometers amounts to only 0.040 of an inch. So far as can be known from such means, the comparison was as satisfactory as in the first set given by Mr. Thompson. Still, the differences in single comparisons are large: whether larger or smaller than in Mr. Dent's observations, I am not able to say, as Mr. Thompson has not given the individual differences. Provision has been made in the construction of the instrument for diminishing the mean difference, as we may alter the rate of the chronometer. This mean difference has been eliminated from my comparisons, and the differences which are given in the last column manifest, by the signs of plus and minus, the irregularities of the instrument, and the error to be expected from these irregularities in single observations. I have arranged the same observations in Table III. according to the sign and the value of the differences. From the sign of the differences it appears that, when the barometers fall, the aneroid falls most, and when the barometers rise, the aneroid rises most. In other words, the aneroid index, moving either way from the place where it agrees with the reading of the mercurial barometer, moves too fast. The experiments with the air-pump indicate the same tendency more unequivocally. For, in those experiments, where the two barometers were moving in a direction which corresponds to a depression of the common barometer, the aneroid always moved the most, so that when the motion of the mercury in the pump-gage is subtracted from the motion of the aneroid index, the sign is always plus; at least, until we approach the lower limit of range. Although this is the general character of the differences, a nice examination of the observations shows that here, as well as in the experiments with the air-pump, there are errors and fluctuations which cannot be traced to any law of the instrument, and against which no provision can be made. Table IV. contains a series of observations made with the view of ascertaining the stability of the levers in the aneroid barometer, and the firmness of other parts of the instrument. The instrument was first read off; and then, after being exposed to diminished pressure, it was noticed with what fidelity and despatch the index returned to its original position when the original pressure was restored.

"It must not be forgotten that it is single observations, indicating momentary changes of atmospheric pressure, on which the navigator most relies. In some of the hurricanes to which he is exposed, the barometer occasionally sinks so low as to come within the range of those experiments made with the air-pump. And yet here, if anywhere, the aneroid barometer finds its appropriate sphere. In meteorology, the barometer is the most important instrument of research. The barometer alone, of all the instruments employed in this research, is independent of merely local changes, and gages the atmosphere to its upper limit. But the range of atmospheric pressure is so limited, that laborious series of observations, with the nicest barometers that can be constructed, are necessary in order to develop the harmonies of nature. No observer would be willing to risk the value of this long labor by trusting to the new barometer, until its peculiarities are better understood than at present. It may possibly happen, that a long series of observations which eliminates irregularities of weather will eliminate instrumental irregularities at the same time. The same objection applies with greater force to the application of the aneroid barometer to the measurement of heights above the level of the sea. An elevation of eighty-seven feet depresses the barometer by about .1 of an inch only ; hence, a small error in the barometer will entail a large error on the estimated elevation. Moreover, a long series of observations in this case will generally be impracticable. I would make one farther remark in this connection. The mercurial barometer is liable to be broken when exposed to the perils of mountain travel. In this case the damage, though great, is known and appreciated, and no error is introduced into science. Unless the barometer is broken, it is so simple in its construction that it is not likely to be injured at all. It is otherwise with the aneroid barometer. To appearance it is stronger, and can bear a greater strain without being broken. On the other hand, we can easily foresee that it may be materially injured without attracting the notice of the observer at the time, and in this way may conceal its own infirmities under its apparent strength. It should be added, in justice to the aneroid barometer, that it is far from having been carried as yet to that degree of perfection in its mechanical execution which the principle on which it is based will allow. When it shall have received, at the hands of the artist, that amount of skill and delicacy in its construction which is expended on the chronometer, a more impartial comparison can be made between its claims and those of the best mercurial barometers."

TABLE I.

1849.	Fall of the Aneroid Barometer under the Receiver.	Rise of the Mercury in the Pump-gage, corrected for Capillarity and Level.	Difference.	1849.	Fall of the Aneroid Barometer under the Receiver.	Rise of the Mercury in the Pump-gage, corrected for Capillarity and Level.	Difference.
Sept. 24,	4.27	4.258	.012+	Sept. 27,	10.42	20.721	10.301—
Thermometer not observed. Barometer, 29.760.	7.78	7.673	.107+	Thermometer, 66. Barometer, 29.940.	10.40	19.338	8.938—
	10.10	15.830	5.730—		10.38	18.236	7.856—
	10.07	16.030	5.960—		10.38	17.294	6.914—
	9.78	10.150	.370—		10.36	16.282	5.922—
	9.44	9.268	.172+		10.30	15.030	4.730—
	8.46	8.216	.244+		10.02	10.140	.120—
	7.52	7.264	.256+		9.60	9.268	.332+
	6.48	6.232	.248+		8.68	8.246	.434+
	5.48	5.240	.240+		7.72	7.224	.496+
	4.45	4.388	.062+		6.79	6.332	.458+
	3.38	3.256	.124+		5.61	5.270	.340+
	2.32	2.214	.106+		4.49	4.208	.282+
					3.50	3.256	.244+
Sept. 26,	10.13	18.537	8.407—		2.36	2.254	.106+
Thermometer, 72.5. Barometer, 29.690.	10.11	17.294	7.184—				
	10.11	16.382	6.272—	Sept. 29,	10.63	23.035	12.405—
	10.07	15.280	5.210—	Thermometer, 66.5. Barometer, 30.170.	10.59	16.262	5.672—
	9.75	10.220	.470—		10.23	10.220	.010+
	9.36	9.268	.092+		9.75	9.328	.422+
	8.71	8.316	.394+		9.02	8.426	.594+
	7.67	7.274	.396+		7.95	7.294	.656+
	6.67	6.262	.408+		6.93	6.332	.598+
	5.53	5.120	.410+		5.80	5.270	.530+
	4.67	4.238	.432+		4.63	4.238	.392+
	3.34	3.206	.134+		2.45	2.224	.226+
	2.30	2.154	.146+				

Dec. 4. The aneroid barometer was placed under the receiver of a condensing-pump, when it was observed that it would only move up to thirty-one inches (corresponding to thirty-one inches of a common barometer).

TABLE II.

1849.	Aneroid, corrected for Temperature.	Mercurial, corrected for Level, Capillarity, and Temperature.	Difference.	Difference after eliminating Mean Difference of Instruments.
Dec. 10,	29.932	29.977	.045—	.005—
11,	30.089	30.107	.018—	.022+
12,	30.439	30.507	.068—	.028—
13,	30.267	30.237	.030+	.070+
14,	30.122	30.117	.005+	.045+
15,	30.378	30.397	.019—	.021+
16,	30.148	30.147	.001+	.041+
17,	29.870	29.907	.037—	.003+
18,	30.327	30.327	.000	.040+
19,	30.519	30.537	.018—	.022+
20,	29.703	29.787	.084—	.044—
21,	30.119	30.127	.008—	.032+
22,	30.012	30.067	.055—	.015—
23,	29.353	29.447	.094—	.054—
24,	29.595	29.667	.072—	.032—
25,	29.488	29.597	.109—	.069—
26,	30.212	30.310	.098—	.058—
27,	30.087	30.160	.073—	.033—
28,	30.407	30.447	.040—	.000
29,	30.025	30.090	.065—	.025—
30,	30.200	30.197	.003+	.043+
31,	30.115	30.147	.032—	.008+
1850.				
Jan. 2,	30.360	30.407	.047—	.007—
3,	30.156	30.207	.051—	.011—
4,	29.890	29.937	.047—	.007—
5,	30.125	30.137	.012—	.028+
6,	30.464	30.517	.053—	.013—
7,	30.340	30.367	.027—	.013+
Mean,	30.098	30.138		
		30.098		
	Difference,	.040—		

Table III.

Observations in Table II., *arranged according to the Amount and the Sign of the Differences.*

29.597	.069—	30.237	.070+
30.310	.058—	30.117	.045+
29.447	.054—	30.197	.043+
29.787	.044—	30.147	.041+
30.160	.033—	30.327	.040+
29.667	.032—	30.127	.032+
30.507	.028—	30.137	.028+
30.090	.025—	30.537	.022+
30.067	.015—	30.107	.022+
30.517	.013—	30.397	.021+
30.207	.011—	30.367	.013+
30.407	.007—	30.147	.008+
29.937	.007—	29.907	.003+
29.977	.005—	Mean, 30.212	.029+
Mean, 30.048	.029—	" 30.048	
		Difference, .164	

Table IV.

1849, Sept. 10. The aneroid stood at 30.39. It was placed under the receiver of an air-pump, and the atmospheric pressure diminished by five inches. When the air was admitted, the index moved forward to 30.35. It rose to 30.375 in two or three minutes. The following table embraces similar experiments, with their results.

1849.	Original Reading of the Aneroid Barometer.	Reading after the Air was admitted.	Difference.	Degree of Rarefaction as measured by the Pump-gage.
Sept. 10,	30.390	30.375	.015—	5 inches.
	30.480	30.530	.050+	5 "
	30.375	30.360	.015—	5 "
	30.360	30.460	.100+	9 "
	30.480	30.500	.020+	5 "
	30.530	30.530	.000	9 "
Sept. 24,	29.760	29.720	.040—	16 "
26,	29.690	29.680	.010—	18 "
27,	29.940	29.930	.010—	20 "
29,	30.170	30.050	.120—	22 "

Dr. C. T. Jackson exhibited some specimens of native copper, and gave a verbal account of some of the evidences of ancient Indian mining at Lake Superior. Dr. A. A. Hayes stated that the occasion of these samples being on the table was a proper one for him to take, in communicating the fact,

"that, from extended observations, embracing more than five hundred specimens of the Lake Superior native copper, no instance occurred in which the slightest indication was presented of this copper having been fused in its present condition. I have investigated its internal structure, by a new method of analysis, which permits all alloys and foreign matters to fall on one side, while the pure copper is separated and weighed as such on the other. In this way, and by little modifications, the highly crystallized structure is exposed to view, the less regularly polarized portions being removed. Whether we subject the solid thick masses, or the thinnest plates, to the operation, one constant result is obtained; — *that this copper has taken its present varied forms of crystallized masses, more or less flattened, laminated, or grooved, by the movements among the parts, composing the rocks in which it is found.* If we select a mass which has entered a cavity, we find the crystals with their angles sharp and uninjured, while the mass mainly may have been compressed into a plate. Dissecting this, the crystals are seen to be connected with and form parts of the original system of crystallization. Flattened and grooved specimens often present on their edges arrow-head-shaped forms, derived from regular crystals, crushed and laminated."

Dr. Hayes, having alluded to a new method, a kind of proximate analysis of metals and alloys, further stated, that it is one which admits of almost universal application. Operating on irons of commerce, he has demonstrated that phosphorus and sulphur, usually found to be present, are not united to the iron, but with more highly electro-positive metals, such as potassium, sodium, and calcium, the latter most commonly. And in all alloys thus far examined, the compound is a metal in a pure homogeneous state, while one, two, or three definite alloys are distributed, often unequally, throughout the mass. In some tough metals, brittle substances like iron ores, quartz, &c., are found, rendering the method of research one of great interest and importance.

Dr. Hayes called the attention of the Fellows to the fact, that

"The urinary deposition called red sand, which presents such well-defined crystals, is a compound body, having generally a large quantity of oxalate of lime crystallized with it. Crystals of various forms and colors were shown under the microscope. Lithic acid, ammonia, coloring matter, and oxalate of lime are the most common and obvious ingredients assuming a crystalline form. Oxalate of lime, as inferred from more than twenty-five analyses of different urine samples, is always present, and may be detected both by spreading a layer of aqua ammonia on the surface of recent urine, when the salt crystallizes, and by adding hydrochlorate of lime to recent urine, washing the precipitate and subsequent analysis. Recent healthy urine is always acid; but this state is not produced by carbonic acid, united to the phosphates, as has been supposed. When salts of lead, lime, baryta, or magnesia are added, the acidity is preserved unchanged. The carbonic acid usually present is disengaged by a powerful acid, with the effervescence due to its gaseous form, but, independently of this, there exists an acid reaction. It has been assumed that oxalic acid is absent in cases where no crystals of oxalate of lime separated from samples of urine preserved. If the acid action is very marked, such cases are no exceptions, for in *urine* we do not expect unfailing chemical decompositions of salts. Besides, it can be shown that, even in alkaline urines, oxalate of lime separates as red sand, and covers the surface after several days of exposure for deposition. These, with other observations, lead to the conclusion, that we are far from possessing a true knowledge of the composition of this important secretion. A true analysis can only be made by operating on recent urine, by precipitations and evaporations, without loss of time and aid of heat; the more important constituents are otherwise converted into secondary products of the steps of the analysis."

Professor Horsford read a paper from Mr. Breed of the Lawrence Scientific School, giving an account of a series of experiments on the nature of vesication, and showing that the process was totally independent of evaporation.

Professor Horsford also exhibited a Daguerreotype of the moon, taken in front of the eye-glass of a telescope, by Mr. Wells of the Scientific School.

Three hundred and twenty-seventh meeting.

February 6, 1850. — Monthly Meeting.

The President in the chair.

Professor Gray, from the Publishing Committee, announced the publication of a new half-volume of the Memoirs of the Academy, namely, Vol. IV. Part I. (new series), and laid a copy on the table.

Professor Peirce made a communication on a new method of computing the constants of the perturbative function of planetary motion.

"The researches of Laplace and Legendre left the theory of these constants, and of their mutual relations, in a state which seems to require no farther development. But their methods of computation consisted in formulæ, by which the constants were derived from each other in such a way, that the defects of imperfect approximation were aggravated at each step, and finally became intolerable in the more remote constants and their higher differential coefficients. The labors of Pontecoulant varied in some degree the form, but not the nature or extent, of these difficulties. In his theory of Mercury, Leverrier has discussed the defects of the old form of computation, and proposed a new method, by which each constant and differential coefficient is determined directly, either from the usual series in the case of the constant itself, or from a very ingenious transformation of the series in the case of the differential coefficients. Leverrier has proposed and executed the exact determination, once for all, of the coefficients of these series, but has not yet published them. I was also permitted, several months ago, to examine a table of Leverrier's coefficients, which was calculated with the greatest care by Mr. Sears C. Walker. Leverrier's transformations were derived from observing that the successive terms of the original series differ very little in the values of their coefficients. A recent examination of the forms of these coefficients has led me to make the computation of the constants and of their differential coefficients depend upon certain auxiliary series, which approximate as much more readily than Leverrier's as his transformed series do in comparison with the original series. The principle of this new approximation consists in the very small difference which may be observed between the corresponding terms of different series, instead of between those of the same series. In the new method, the different constants are not computed independently of each other, but by such successive steps, that any error or defect of approximation continually diminishes in its effect, and gradually dies out. This want of independence of computation may sometimes be regretted, but since the whole series of constants is usually needed at the same time, it will oftener be a gain, for it will give the means of verifying the whole series by a few independent computations corrected by Leverrier's tables. The two methods are not, therefore, to be regarded as antagonistic, but rather as complementary.

"I have the honor of laying upon the table my formulæ, and a table of the coefficients of my fundamental auxiliary series, computed with great care by Mr. J. D. Runkle, who is an assistant in the preparation of the *Nautical Almanac.*"

Mr. Teschemacher read a paper on two minerals, *Struvite* and *Gahnite*, giving an historical account of them, and showing their identity. He also exhibited specimens of native bicarbonate of ammonia, taken from a deposit, said to be of great extent, found on the shore of Terra del Fuego.

Professor Guyot gave a verbal account of the method formerly pursued, and the instruments employed, in the meteorological observations made throughout the State of New York; also of the system now adopted by the Regents of the University of that State, to be carried on uniformly at a great number of stations, established under his supervision, in conformity with the plan recommended by the Secretary of the Smithsonian Institution. He hoped that this system would be adopted in all the States, and thus uniformity, and a ready mode of comparing the results, be secured. He concluded by offering a preamble and resolutions, with a view of obtaining the coöperation and aid of the Legislature of Massachusetts in establishing such meteorological observations in Massachusetts, in connection with the contemplated sanitary survey of the State; and moved that a committee be appointed to take the subject into consideration. Messrs. Guyot, Peirce, Lovering, Treadwell, and Bowen were appointed the committee.

Mr. Guyot also described the apparatus employed at the Observatory at Toronto, by which the variation and the minute oscillations of the magnetic needle are self-registered photographically; and exhibited several specimens of such records.

Mr. Paine briefly recapitulated some of the results of the thermometrical observations he had carried on, in Boston and its vicinity, during the last twenty-six years.

He also moved the appointment of a new committee on the Rumford Observations, of which the late Dr. Hale was formerly chairman, but from which there had been no report since his death.

Messrs. Treadwell, Peirce, and Charles Jackson, Jr., were constituted the committee.

Dr. A. A. Hayes presented for examination, specimens of *Stereoptene*, or the camphor derived from crude oil of valerian, in the forms of solid, clear crystals and elongated porous prisms.

"This oil, which is manufactured by the society of Shakers, at Enfield, New Hampshire, from the roots of the English valerian, contains, with the volatile oil of the root, all the valerianic acid. It is well known that the oil as usually obtained contains *valerole, valerianic acid, and borneole.* By repose for several months, imperfectly guarded from the atmosphere, a crystalline aggregate withdraws from the compound oil, in an impure state. These crystals are readily purified by the usual processes. In the most regular form, they were measured by J. E. Teschemacher, Esq., who refers them to the rhombic system, — 'form, a right rhombic prism, with angles M on M' $121\frac{2}{10}$, and $58\frac{4}{10}$, while M on e, the terminal plane, is $134\frac{3}{10}$.' Its general form is that of thin elongated prisms; cooled from a fluid, it gives a crystalline mass; sublimed, it forms snow-like flakes, or stellæ. The crystals have a high lustre, and a clear white color, with a slight, but peculiar odor. Masses suddenly cooled have the specific gravity 1.030, and crystalline fragments float indifferently in sulphuric acid, specific gravity 1.076, at 60° F. This substance melts at 198° F., remains fluid at 195° F.; its fusing-point, as determined, is between 196.7° and 197.2° F.

"Mr. Adolph Schlieper performed the analysis, after attempts with oxide of copper, by means of chromate of lead, as the oxidizing body. The crystals by fusion lose the elements of water, but when dried in warm air over sulphuric acid,

1. 0.304 grm. gave 0.851 grm. carbonic acid, and 0.305 grm. water.

2. 0.2513 grm. substance gave 0.705 grm. carbonic acid, and 0.2503 grm. water.

3. 0.290 grm. substance gave 0.811 grm. carbonic acid, and 0.293 grm. water.

"Calculated for 100 parts, we have for the empirical formula, C 8, H 7, O, or,

Calculated,	I.	II.	III.
C 8 = 48 = 76.19	76.34	76.51	76.26
H 7 = 7 = 11.11	11.14	11.05	11.22
O = 8 = 12.70	12.52	12.44	12.52

"All attempts on the part of Mr. Schlieper and myself to form compounds with chlorine, hydrochlorine, or other acids, failed; but the deductions of Mr. Schlieper which follow show clearly that this new body belongs to the large class of Stereoptenes, or camphors of the volatile oils.

"As a valerian camphor, its probable formula is obtained by multiplying the empirical formula by the number 5, or,

C 40, H 35, O 5, = Valerian Camphor.

"Under this view, it appears to be derived from borneole, C 10, H 8, by the process of oxidation, in presence of water and atmospheric air; thus, 4 equiv. borneole + 3 equiv. water + 2 equiv. oxygen, form the crystallized body.

$$\begin{array}{lr} 4\ (\mathrm{C}\ 10,\ \mathrm{H}\ 8) = & \mathrm{C}\ 40,\ \mathrm{H}\ 32 \\ 3\ \mathrm{H,O} = & \mathrm{H}\ 3,\ \mathrm{O}\ 3 \\ 2\ \mathrm{O} = & \mathrm{O}\ 2 \\ \hline & \mathrm{C}\ 40,\ \mathrm{H}\ 35,\ \mathrm{O}\ 5 = \text{Valerian Camphor.''} \end{array}$$

Mr. Dana communicated, through the Corresponding Secretary, a continuation of his account of the Crustacea collected in the cruise of the United States Exploring Expedition, viz.: —

Conspectus Crustaceorum quæ in Orbis Terrarum circumnavigatione, CAROLO WILKES *e Classe Reipublicæ Fœderatæ Duce, lexit et descripsit* JACOBUS D. DANA. Pars III.*

Subtribus I. GAMMARACEA.

Familia I. ORCHESTIDÆ.

Palpus mandibularis obsoletus. *Corpus* compressum, epimeris latis. *Styli caudales* duo postici breviores.

Genus I. TALITRUS. (*Latreille.*)

Pedes primi styliformes, secundi vel non subcheliformes vel manu debilissimâ confecti. *Antennæ* primæ basi inferiorum breviores.

1. TALITRUS NOVI-ZEALANDIÆ. — Epimera grandia, nuda, spinulis minutis marginem armata. Antennæ 2dæ dimidii corporis longitudine, setis brevissimis, (latitudine antennæ duplo brevioribus); flagello vix longiore quam basis, articulis transversis. Antennæ 1mæ basi 2darum non duplo breviores. Pedes 1mi validiusculi, elongati; 2di paulo breviores, articulo ultimo obtuso, fere breviore quam penultimus, digito obsoleto(?). Pedes 10 postici densè setosi, 6 postici valde inæqui, 7mis duplo longioribus quam 5ti, articulo primo latissimo.

Long. 10‴. — *Hab.* in portu "Bay of Islands" Novi-Zealandiæ.

2. TALITRUS GRACILIS. — Epimera grandia. Antennæ 2dæ dimidio corporis valde longiores, setis brevissimis (latitudine antennæ duplo brevioribus); flagello multo longiore quam basis, articulis paulo oblongis. Antennæ 1mæ basi secundarum triplo breviores. Pedes 1mi validiusculi, ungue parvulo, articulis 2do 3tio 4to 5to subæquis. Pedes 2di paulo breviores, articulo penultimo posticè triangulato; ultimo lamellato, fere nudo, apicem rotundato, margine antico parce excavato et versus apicem digitum minutum gerente. Pedes 3tii 4tis valde longiores. Pedes 6 postici paulo graciles, fasciculatim setulosi, articulo primo anguste elliptico; pedibus 7mis multo longioribus quam 5ti.

Long. 5‴ – 6‴. — *Hab.* in sabulis litoralibus insulæ freti "Balabac."

3. TALITRUS ORNATUS. — Segmenta corporis lævia. Epimera lata, per sulcos subtiles areolata. Antennæ 2dæ dimidio corporis paulo

* Vide supra, p. 61.

breviores, flagello vix longiore quam basis, articulis parce oblongis, setis brevissimis. Antennæ 1mæ basi secundarum fere triplo breviores, 5–7-articulatæ. Pedes 1mi validiusculi, secundis multo longiores, ungue valido. Pedes 2di debiles, manu parvulâ subellipticâ, apice subacutâ, digito dorsali, minuto, apicem non attingente. Pedes sequentes subsetosi, 4ti 5ti subæqui, 7mi 6tis longiores, articulis primis pedum sex posticorum scalpturis.

Long. 6‴–9‴. — *Hab.* in sabulis litoralibus prope "Valparaiso."

Genus II. TALITRONUS. (*Dana.*)

Pedes secundi manu valido prehensili confecti. Alias *Talitro* similis.

1. Talitronus insculptus. — Segmenta corporis glabra, lineis elevatis granulisve seriatis transversim notata. Epimera lata sparsim sculpto-granulosa. Antennæ 2dæ dimidio corporis non breviores, fere nudæ, articulo basis ultimo fere duplo longiore quam penultimus, flagello non longiore quam basis. Antennæ 1mæ dimidio basis 2darum breviores. Pedes 1mi subgraciles, ungue fere recto. Pedes 2di validi, manu latâ, subtriangulatâ, palmâ obliquâ rectiusculâ medium emarginatâ, digito perlongo (dimidio manus valde longiore). Pedes 3tii quartis longiores, 6ti 7mique subæqui.

Long. 9‴. — *Hab.* in sabulis litoralibus prope "Valparaiso."

Genus III. ORCHESTIA. (*Leach.*)

Pedes primi, secundique subcheliformes, manu debili aut validâ confecti. *Antennæ primæ* basi secundarum breviores. *Maxillipedes* apicem obtusi.

1. Orchestia sylvicola. — Epimera sat angusta. Antennæ 2dæ tenues, dimidii corporis longitudine; flagello longiore quam basis, articulis oblongis, setis articulo parce brevioribus. Antennæ 1mæ basi 2darum dimidio breviores. Pedes 4 antici debiles; 2di paulo grandiores, manu oblongâ, subellipticâ, antrorsum reflexâ, apicem rotundatâ, digito minuto, marginem inferiorem versus medium affixo. Pedes 4 sequentes subæqui, ungue parvulo. Pedes 6 ultimi paulo inæqui, setis brevibus, articulo primo 5torum oblongo, 7morum latissimo.

Long. 6‴–8‴. — *Hab.* in cratere extincto "Taiamai" Novi-Zealandiæ.

2. Orchestia tenuis. — Epimera sat angusta. Antennæ 2dæ tenues, dimidii corporis longitudine; flagello tenuissimo, valde longiore

quam basis, articulis oblongis, cylindricis, setis articulo vix brevioribus. Antennæ 1mæ basi 2darum vix breviores. Pedes 4 antici debiles; primi minimi; secundi parvuli, manu minutâ, oblongâ, retrorsùm inflexâ, extremitate dimidio truncatâ, apice postico producto et obtuso, digito minuto, non laterali. Pedes 4 sequentes parvuli, 4tis brevioribus. Pedes 6 postici valde inæqui, 7mis fere duplo longioribus quam 5ti ; setis brevibus.

Long. 6‴. — *Hab.* apud oras sinus "Bay of Islands" Novi-Zealandiæ.

3. ORCHESTIA RECTIMANUS. — Epimera sat lata, marginem minutè setulosa, quinta perangusta. Antennæ 2dæ dimidii corporis longitudine, setis minutis (latitudine articuli non longioribus); flagello parce longiore quam basis, articulis paulo oblongis, setis perbrevibus. Antennæ 1mæ, basi 2darum breviores. Pedes 4 antici debiles, 1mis subtilissimè unguiculatis; 2dis paulo longioribus, manu parvulâ rectâ, spatulatâ, apicem rotundatâ, digito minuto laterali prope apicem affixo. Pedes 4 sequentes subæqui. Pedes 6 ultimi non multo inæqui, setis perbrevibus, articulo primo latissimo, margine postico setuloso.

Long. 3‴–4‴. — *Hab.* in humidulis, insulæ Tahiti, ad altitudinem ped. 1500, mari remotis.

4. ORCHESTIA SPINIPALMA. — Epimera sat angusta, quintis parce angustioribus quam quarta. Antennæ 2dæ dimidii corporis longitudine, setis minutissimis; flagello basin longitudine æquante, articulis plerumque paulo oblongis. Antennæ 1mæ minutæ, basi secundarum quadruplo breviores. Pedes 1mi parvuli, debiles, manu oblongâ, minutâ, breviore quam articulus precedens, apicem rectè truncatâ. Pedes 2di validi, manu subovatâ, margine inferiore (palmâ) versus apicem parce excavato, spinulis armato, digito elongato, paulo breviore quam manus. Pedes sequentes tenues; 4 proximis subæquis; 4 ultimis subæquis; setis perbrevibus.

Long. 6‴. — *Hab.* apud oras insulæ "Tongatabu."

5. ORCHESTIA SCUTIGERULA. — Epimera sat lata, quintis angustioribus quam quarta. Antennæ 2dæ breves, corpore triplo breviores; flagello moniliformi, parce longiore quam basis. Pedis 7mi articulus primus ellipticus et *laminam crassam grandem latè ellipticam posticè gerente;* setis perpaucis perbrevibus. Pedes 1mi parvuli, manu subtriangulatâ, apice transversâ. Pedes 2di validi, manu latâ, subtriangulatâ, anticè arcuatâ, palmâ obliquè transversâ, fere rectâ, angulo

infero acuto; digito longo. Pedes 4 sequentes sat longi, subæqui, 6 ultimi sensim increscentes.

Long. 9‴ – 11‴. — *Hab.* ad oras sinus "Nassau," Fuegiæ, inter Algas rejectas.

6. Orchestia nitida. — Epimera mediocria, quinta quartis minora. Antennæ 2dæ dimidio corporis breviores; flagello longiore quam basis, moniliformi. Antennæ 1mæ dimidio basis secundarum parce longiores. Pedes 1mi parvuli, manu subsecuriformi, apice truncato, latiore. Pedes 2di validi, manu subovatâ, palmâ rectâ dimidio manus longiore, digito longo (palmam longitudine æquante). Pedes 4 sequentes subæqui; reliqui breviusculi, sensim increscentes, articulo primo lato, margine subtilissimè serrulato.

Long. 4‴. — *Hab.* in mari prope oras sinus "Nassau," Fuegiæ, inter Algas natantes.

7. Orchestia dispar. — Epimera mediocria, quinta valde angusta. Antennæ 2dæ vix dimidii corporis longitudine; flagello longiore quam basis, articulis vix oblongis, setis brevissimis. Antennæ 1mæ basi secundarum breviores. Pedes 1mi parvuli, manu apicem latiore, obliquè truncatâ et excavatâ. Pedes 2di validi, manu subobovatâ, obliquè truncatâ, palmâ paulo sinuosâ, pubescente. Pedes 3tii 4tis parce longiores; 7mi 6tis paulo breviores, *articulis tertio quartoque incrassatis, et valde compressis.*

Long. 6‴ – 7‴. — *Hab.* ad oras Illawarræ, Australiæ.

8. Orchestia quadrimanus. — Epimera sat lata, 5ta 4tis minora. Antennæ 2dæ dimidio corporis paulo breviores, bene setulosæ; flagello parce longiore quam basis, articulis non oblongis, cylindricis. Antennæ 1mæ basi 2darum fere dimidio breviores. Pedes 1mi parvuli, manu fere triangulatâ, apicem truncatâ, paululo excavatâ. Pedes 2di validi, manu subquadratâ, paulo oblongâ, palmâ apicali, transversâ, paulo excavatâ. Pedes 3tii 4ti debiles subæqui; 5ti 6ti 7mi similes, valde inæqui (7mis duplo longioribus quam 5ti), sensim increscentes, breviter setosæ.

Long. 7‴. — *Hab.* ad oras Illawarræ, Australiæ Orientalis.

9. Orchestia serrulata. — Epimera lata, quinta anticè quartis non angustiora. Antennæ 2dæ fermè dimidii corporis longitudine; flagello vix longiore quam basis, articulis non oblongis, setis fere obsoletis. Pedes 1mi parvuli, manu subtriangulatâ, paulo oblongâ, apicem latiore transversâ parce excavatâ. Pedes 2di validi, manu

grandi, subelliplicâ, palmâ infero-subapicali, excavatâ, subtilissimè spinulosâ, angulo infero rotundato. Pedes 3tii 4ti tenues, subæqui; 5ti 6ti 7mi sensim increscentes, articulo primo latissimo, margine postico serrulato, antico 2–3 setis minutis armato.

Long. 9‴–10‴. — *Hab.* ad oras insularum "Black Rocks" in sinu "Bay of Islands" Novi-Zealandiæ.

Genus IV. ALLORCHESTES. (*Dana.*)

Pedes primi secundique subcheliformes. *Antennæ primæ* breviores, basi secundarum longiores. *Maxillipedes* apicem unguiculati.

1. Allorchestes compressa. — Epimera latissima, quarta maxima, quinta perangusta. Antennæ 2dæ crassiusculæ, basi fere quadruplo longiore quam flagellum. Antennæ 1mæ 2dis paulo breviores, flagello fere duplo longiore quam basis. Pedes 1mi parvuli, manu vix oblongâ, apicem obliquè truncatâ et paulo excavatâ. Pedes 2di validi, manu subovatâ, palmâ rectâ, fere nudâ, digito longo. Pedes 3tii 4ti longi, subæqui; sex sequentes paulo inæqui, breviusculi, sensim increscentes, articulo primo latissimo, setis sparsis, minutissimis.

Long. 7‴–8‴. — *Hab.* ad oras Illawarræ, Australiæ Orientalis.

2. Allorchestes verticillata. — Epimera sat angusta, quinta perangusta. Antennæ 2dæ 1mis fere duplo longiores, plus dimidio corporis breviores, flagello fermè duplo longiore quam basis, 14-articulato, articulis parce oblongis, setis densè verticillatis, brevibus. Pedes 1mi parvuli, manu oblongâ, dorsum fere rectâ, infra versus apicem obliquâ. Pedes 2di validi, manu ovatâ, palmâ rectiusculâ, pubescente, digito longo. Pedes 3tii 4ti sat longi, subæqui; 5ti 6ti 7mi subæqui, 5tis paulo brevioribus, articulo primo lato, setis sparsis, brevibus.

Long. 4‴. — *Hab.* apud oras prope Valparaiso.

3. Allorchestes hirtipalma. — Epimera lata, quinta perangusta. Antennæ 2dæ corpore plus dimidio breviores; flagello plus duplo longiore quam basis, infra densè breviter villoso, articulis non oblongis. Antennæ 1mæ 2dis paulo breviores. Pedes 1mi parvuli, manu oblongâ, apicem oblique truncatâ. Pedes 2di validi, manu subovatâ, infra subtruncatâ et hirtâ, palmâ paulo depressâ, rectiusculâ, digito longo. Pedes 4 ultimi subæqui, quinti breviores.

Hab. apud oras prope Valparaiso, et insulæ "San Lorenzo."

4. Allorchestes gracilis. — Epimera mediocria, quinta perangusta. Antennæ tenuissimæ: 2dæ dimidii corporis longitudine;

flagello multo longiore quam basis, articulis oblongis, setis perbrevibus, paucis : 1mæ dimidio breviores, basi 2darum paulo longiores. Pedes 1mi parvuli, manu trapezoidali, obliquè truncatâ, palmâ rectâ, pubescente. Pedes 2di validi, manu subovatâ, palmâ rectiusculâ, breviter sparsim hirsutiusculâ, angulo infero obsoleto; digito longo; articulo tertio brevi, infra acutè producto. Pedes 3tii 4ti subæqui ; 6 ultimi sat breves sensim increscentes, articulo primo lato, setis sparsis brevissimis.

Long. 6‴ – 8‴. — *Hab.* in mari prope oras insulæ "Tongatabu."

5. Allorchestes peruviana. — Epimera sat lata, quinta perangusta. Antennæ 2dæ dimidii corporis longitudine; flagello duplo longiore quam basis, fermè 14-articulato, articulis parce oblongis, setis perbrevibus. Antennæ 1mæ 2dis paulo breviores, flagello 10 – 12-articulato, fere nudo. Pedes 1mi sat parvi, manu oblongâ, dorsum rectâ, apicem obliquè truncatâ. Pedes 2di validiusculi, manu angustâ, dorsum rectâ, apicem valde obliquè truncatâ ; margine infero omnino hirsutâ ; digito brevi. Pedes 3tii 4ti sat longi, subæqui ; 6ti 7mi subæqui, non perlongi, 5ti parce breviores.

Long. 4‴. — *Hab.* ad oras prope Valparaiso, inter Algas rejectas.

6. Allorchestes humilis. — Epimera sat lata, quinta perangusta. Antennæ breves : 2dæ corpore fere triplo breviores, flagello breviore quam basis, 9 – 10-articulato, setis totis brevissimis : 1mæ 2dis paulo breviores, flagello 6 – 8-articulato. Pedes 1mi parvi, manu oblongâ, angustâ, dorsum fere rectâ, apicem obliquâ. Pedes 2di validiusculi, manu angustâ et versus basin angustante, apicem obliquè truncatâ et hirsutiusculâ, margine infero versus basin nudo, ad medium subemarginato et hirtello ; digito brevi. Pedes 3tii 4ti tenues, subæqui ; 6 sequentes sat breves, subæqui, 5ti breviores, articulo primo fere orbiculari, setis paucis brevissimis.

Long. 4‴. — *Hab.* in mari apud oras portus "Jackson" Australiæ Orientalis.

7. Allorchestes australis. — Epimera grandia, quinta perangusta. Antennæ sat breves : 2dæ corpore plus duplo breviores ; flagello paulo longiore quam basis, 12 – 14-articulato, articulis vix oblongis, setis fere obsoletis : 1mæ 2dis paulo breviores, flagello fermè 14-articulato. Pedes 1mi parvuli, manu apicem paulo latiore, rectè truncatâ. Pedes 2di validi, manu subovatâ, palmâ paulo excavatâ, nudâ, angulo infero minutè setuligero. Pedes sequentes breves : 3tii

4ti tenues: 5ti 6ti 7mi sensim increscentes, setis brevissimis; articulo primo perlato.

Long. 6‴. — *Hab.* ad oras Illawarræ, Australiæ Orientalis.

8. Allorchestes brevicornis. — Epimera mediocria, quinta perangusta. Antennæ breves: 2dæ corpore triplo breviores; flagello longiore quam basis, articulis vix oblongis setis brevissimis: 1mæ breviores. Pedes 1mi parvuli, manu rectangulatâ, apicem rectè truncatâ. Pedes 2di sat parvi, manu perangusto-ovatâ, infra fascibus setarum parvulis paucis ornati, palmâ brevi, paulo impressâ, rectâ. Pedes 3tii 4ti debiles; 5ti 6ti 7mi sat breves; 4 ultimi subæqui, setis minutis, paucis.

Long. 5‴. — *Hab.* ad oras sinus "Bay of Islands" Novi-Zealandiæ.

9. Allorchestes Novi-Zealandiæ. — Corpus valde compressum, epimeris latissimis. Antennæ fere æquæ, tenuissimæ: 2dæ fere dimidii corporis longitudine; flagello duplo longiore quam basis, 12–14-articulato, articulis oblongis, setis brevissimis, paucis: 1mæ parce breviores, flagello fermè 16-articulato. Pedes 4 antici parvuli (an feminæ tantum?) manu primâ apicem paulo latiore, truncatâ, digito brevissimo; secundâ parce majore obliquè truncatâ, trapezoidali, marginibus fere rectis; articulo precedente apicem inferiorem valde producto, processu angusto manum appresso. Pedes 6 ultimi sat breves, 5tis paulo brevioribus.

Long. 5‴. — *Hab.* ad oras sinus "Bay of Islands" Novi-Zealandiæ.

10. Allorchestes intrepida. — Corpus valde compressum, epimeris 8 latissimis, 6 posticis angustissimis. Antennæ 2dæ dimidii corporis longitudine; flagello tenuissimo, parce longiore quam basis, articulis oblongis tenuibus, setis fere obsoletis: 1mæ multum breviores, flagello plus duplo longiore quam basis. Pedes 1mi parvuli, manu apicem transversâ et non latiore, emarginatâ, digito valde longiore quam margo apicalis (vel palma), articulo precedente infra producto et acuto. Pedes 2di validi, manu subovatâ, dorso fere recto, palmâ parce impressâ hirsutiusculâ, digito longo: *feminæ* manu angustâ apicem rectè truncatâ, digito brevi; articulo precedente infra longe acuto. Pedes 3tii 4ti subæqui; 6 ultimi sensim increscentes.

Long. 3‴ – 4‴. — *Hab.* ad oras portus "Parua" in sinu "Bay of Islands" Novi-Zealandiæ.

11. Allorchestes orientalis. — Epimera lata. Antennæ 2dæ dimidii corporis longitudine; flagello fere duplo longiore quam basis,

moniliformi, 14-articulato, articulis oblongis, setis brevibus. Antennæ 1mæ paulo breviores, flagello moniliformi, 7-articulato. Pedes 1mi parvuli, manu subellipticâ. Pedes 2di validiusculi, manu subovatâ, palmâ parce excavatâ, minutè sparsim setulosâ; digito longo; articulo precedente angusto, proximo infra subacuto, non producto. Pedes 6 postici sensim increscentes, setis paucis, minutis.

Long. 3‴. — *Hab.* in mari "Sulu."

12. Allorchestes? graminea. — Epimera mediocria. Antennæ 2dæ corpore plus duplo breviores; flagello moniliformi, multo longiore quam basis, setis minutis. Antennæ 1mæ 2dis breviores, flagello ferme 14-articulato. Pedes 1mi parvuli; manu angustâ; digito crasso, styliformi. Pedes 2di validi, manu angustè subovatâ, infra fere rectâ, palmâ non excavatâ, digito longo; articulo precedente infra non producto. Pedes 3tii 4ti sat longi, subæqui; 5tii 6ti 7mi paulo inæqui, sensim increscentes, fere nudi.

Long. 6‴ – 7‴. — *Hab.* in portu "Rio de Janeiro."

Familia II. GAMMARIDÆ.

Mandibulæ palpigeræ. *Corpus* sæpius compressum. *Antennæ* flagello confectæ, non pediformes. *Styli caudales* duo postici sive longi sive breves. *Animalia saltatoria vel natatoria.*

Subfamilia I. LYSIANASSINÆ.

Antennæ primæ basin crassæ. *Epimera* grandia. Pedes sex postici non prehensiles.

Genus I. LYSIANASSA.

Pedes subcheliformes nulli secundis interdum exceptis, sex posticis directionem similibus. *Antennæ* primæ appendiculatæ.

1. Lysianassa Brasiliensis. — Corpus valde compressum, epimeris latissimis. Oculi reniformes. Antennæ 1mæ breves, corpore quadruplo breviores; flagello duplo longiore quam basis, fermè 10-articulato, appendice 7-articulato. Antennæ 2dæ dimidio corporis valde longiores, sæpe epimeris celatæ, basi brevi et geniculante. Pedes 4 antici similes, tenues; 3tii 4tis longiores; 5ti 6ti 7mi similes, sensim increscentes, articulo primo marginem posticum serrulato.

Long. 3‴. — *Hab.* ad oras portus "Rio de Janeiro."

Genus II. URISTES. (*Dana.*)

Pedes primi subcheliformes; *secundi* articulo styliformi confecti; *tertii quartique* brevissimi; reliqui non prehensiles; similes. *Antennæ primæ* non appendiculatæ.

Uristes gigas. — Corpus compressum, epimeris latissimis. Antennæ subæquæ, crassiusculæ, dimidio corporis breviores: 1mæ parce breviores, flagello processubus obtusis infra breviter fimbriato, articulis transversis: 2dæ paulo graciliores, flagello fere triplo longiore quam basis, processubus minutis triangulatis supra ornato, articulis non oblongis. Pedes 1mi 2dis breviores, manu parvulâ, angustâ, oblique truncatâ, digito brevi. Pedes 2di 5-articulati, articulo ultimo elongato, styliformi, acuto. Pedes 7mi 6tis paulo breviores. Segmentum abdominis antepenultimum posticè acutum.

Long. 9‴. — *Hab.* in mari Antarctico: tubo cibario piscis lecta.

Genus III. STENIA. (*Dana.*)

Pedes primi secundique subcheliformes; reliqui non prehensiles. *Antennæ primæ* non appendiculatæ. *Corpus* compressum.

Stenia Magellanica. — Corpus valde compressum. Oculi reniformes. Antennæ 2dæ 1mis plus duplo longiores, dimidii corporis longitudine, fere nudi, basi brevi. Antennæ 1mæ nudæ, flagello longiore quam basis. Pedes 4 antici parvuli, similes, 1mi parce minores, manu parvulâ, angustâ, apicem obliquâ, digito minuto. Pedes 3tii 4tique æqui; 6ti 7mique æqui, articulo primo lato et posticè serrulato. Abdominis segmentum ultimum oblongum, emarginatum.

Long. 4‴ – 6‴. — *Hab.* in mari portus "Good Success" Fuegiæ.

Subfamilia II. GAMMARINÆ.

Antennæ primæ basin tenues. *Epimera* sive grandia, sive angusta. *Pedes sex postici* non prehensiles.

Genus I. GAMMARUS.

Pedes primi secundique subcheliformes, digito uni-articulato, reliqui non prehensiles, sex posticis similibus. *Antennæ* secundæ sub primas insitæ, primæ appendiculatæ.

I. Manus pedum 2dorum pollice elongato non armata.

1. *Abdominis segmenta dorsum plus minusve spinulosa aut denticulata.*

1. Gammarus asper. — Epimera lata. Segmenta abdominis tota

dorsum inæque denticulata. Oculi subrotundati. Antennæ 2dæ dimidio corporis parce longiores, tenues, flagello breviore quam basis, articulis oblongis, setis conspicuis, divaricatis. Antennæ 1mæ æque setulosæ, articulo primo paulum crasso, oblongo, appendice 3-articulato. Manus 1ma parvula, oblonga, attenuata. Manus 2da validiuscula, angusta, versus apicem sensim angustior, dorsum recta, infra supraque valde hirsuta, digito dimidio breviore.

Long. 6'''. — *Hab.* in mari "Sulu."

2. Gammarus Suluensis. — *Feminæ:* Segmenta abdominis primum secundumque in marginem posticum dorsalem 2–3-dentata, quartum etiam 2-acutum. Oculi subrotundati. Antennæ 1mæ corporis longitudine; flagello longiore quam basis, articulis oblongis, setis non brevioribus, appendice brevissimo, 3-articulato. Antennæ 2dæ fere dimidio breviores, flagello plus duplo breviore quam basis, basi parce breviore quam antennarum basis 2darum. Pedes 4 antici subæqui, parvi; manu 1mâ parvulâ, apicem latiore, truncatâ; 2dâ paulo majore, oblongâ, apicem truncatâ, non latiore. Pedes sex postici paulo inæqui, setis paucis remotis, apicalibus longiusculis.

Long. 4''' – 5'''. — *Hab.* in mari "Sulu" prope oras insulæ, inter Algas natantes.

3. Gammarus albidus. — Epimera latiuscula. Abdominis segmenta primum secundum quartumque dorso uni-spinosa. Antennæ 1mæ dimidio corporis valde longiores, flagello longiore quam basis, fere 21-articulato, articulis oblongis, setis vix brevioribus, appendice brevi, 3-articulato. Antennæ 2dæ tenuissimæ, fere dimidio breviores, flagello breviore quam basis, fermè 8-articulato. Pedes *feminæ* 4 antici subæqui, parvi; manu 1mâ parvulâ, oblongâ, apicem fere rotundatâ, non latiore; 2dâ parce longiore, fere lineari, infra hirsutâ; *maris* 2dâ crassâ, latè oblongâ, versus basin sensim paulo angustiore, infra parce hirsutiusculâ apicem obliquè truncatâ, palmâ apicali, paulo excavatâ. Pedes 6 postici subæqui, hirsuti.

Long. 5'''. — *Hab.* in lacu insulæ "Tongatabu."

2. *Abdomen non dentatum nec spinulosum.*

a. Margo frontis lateralis ophthalmicus saliens.

4. Gammarus hirsuticornis. — Epimera lata. Antennæ infra setosæ; 1mæ dimidio corporis breviores, flagello basis longitudinem fere æquante, appendice 3-articulato: 2dæ paulo breviores, articulis ba-

salibus quatuor subæquis, flagello breviore quam basis. Pedes 4 antici parvuli, 6 postici sensim increscentes, setis brevibus sparsis. An femina ?

Long. 3‴ – 4‴. — *Hab.* ad oras insulæ " Enchados," in portu " Rio de Janeiro."

5. GAMMARUS EMISSITIUS. — Gracilis, epimeris mediocribus. Caput oblongum, lateribus anticè productum. Antennæ setosæ, 1mæ dimidio corporis vix longiores, articulis primo tertioque subæquis ; flagello breviore quam basis, fermè 7-articulato, appendice 3-articulato. Antennæ 2dæ breviores, basi vix breviore quam basis 1marum ; flagello breviore quam basis, fermè 7-articulato. Manus 1ma parvula angustissima ; secunda valida, subovata, sparsim setosa, dorso parce arcuato, palmâ non excavatâ, digito mediocri. Pedes 6 postici sensim increscentes, setis paucis ; quinti quartis breviores.

Long. 4‴. — *Hab.* in mari " Sulu."

b. Margo frontis lateralis ophthalmicus non prominentes.

6. GAMMARUS TENUIS. — Gracilis, epimeris angustis. Caput utrinque obsoletè prominulum. Antennæ 1mæ corpore paulo breviores, teretes, tenuissimæ, flagello parce longiore quam basis, 14-articulato, setuloso, appendice brevissimo. Antennæ 2dæ valde breviores, setis longioribus ; basi valde longiore quam basis 1marum, articulis 2 ultimis longis subæquis ; flagello 5-articulato, non longiore quam articulus basis ultimus. Manus 1ma valida, lata et oblonga basin paulo angustior, apicem obliquè truncata, palmâ non excavatâ, digito mediocri. Manus 2da parvula (an feminæ ?) ovata. Pedes 7mi 6tis valde longiores, sparsim setosi.

Long. 3‴. — *Hab.* in mari " Sulu."

7. GAMMARUS FURCICORNIS. — Gracilis, epimeris angustis ; sparsim pubescens. Caput fere oblongum. Antennæ 1mæ corpore breviores, articulo primo crasso, oblongo ; flagello terete, parce longiore quam basis, fermè 14-articulato, sparsim setuloso ; appendice dimidio breviore, 5-articulato. Antennæ 2dæ valde breviores, basi vix breviore quam basis 1marum, flagello brevi, parce longiore quam articulus tertius, 7 – 10-articulato. Manus 1ma parvula, subovata. Manus 2da valida, lata et oblonga, trapezoidea, apicem parce latior, fere rectè truncata, infra setuligera, palmâ apicali, non excavatâ. Pedes 6 postici subæqui, 7mis paulo longioribus, setis numerosis.

Long. 3‴. — *Hab.* ad oras insulæ in mari " Sulu."

8. Gammarus tenellus. — Gracilis, epimeris angustis. Oculi orbiculati, parvuli. Antennæ 1mæ dimidii corporis longitudine, articulo primo tenui, flagello parce longiore quam basis, setis perbrevibus, appendice fere dimidio breviore. Antennæ 2dæ tenuissimæ, breves, basi paulo breviore quam basis 1marum, flagello non longiore quam articulus basis ultimus. Manus 1ma parvula, subovata, dorsum rectiuscula. Manus 2da valida, lata, oblonga, subrectangulata, basin paulo angustior, apicem fere rectè truncata, sparsim setulosa, palmâ non excavatâ. Pedes 6ti 7mis longiores, quinti valde breviores, setis paulo sparsis.

Long. 4‴. — *Hab.* in Archipelagine "Viti."

9. Gammarus orientalis. — Gracilis, epimeris angustis. Oculi orbiculati. Antennæ validiusculæ, basi longo, flagello brevi (an adulto?). Pedes 1mi validiusculi, manu mediocri, subellipticâ, dorsum fere rectâ, infra arcuatâ, hirsutâ, digito longo. Manus 2da valida, subovata, palmâ erosâ vel 2–3 dentatâ remotè hirsutâ, digito longo. Pedes sex postici sensim paulo increscentes, setis paucis.

Long. $2\frac{1}{2}$‴–3‴. — *Hab.* in mari prope fretum Sundæ.

II. Manus una paris secundi validissime cheliformis, pollice valde elongato; altera parvula. (*Gen.* Mæra, *Leachii.*)

1. *Dorsum abdominis nudum.* [Palma 3-dentata.]

10. Gammarus (Mæra) quadrimanus. — Gracilis, epimeris perangustis. Antennæ 1mæ dimidii corporis longitudine, basi longiore quam flagellum, articulis primo secundo subæquis, longis, flagello pubescente, appendice parce longiore quam dimidium flagelli. Antennæ 2dæ breviores, basi breviore quam basis 1marum, flagello perbrevi. Manus 1ma parvula oblonga, infra hirsuta, basin angusta, palmâ obliquâ. Manus 2da validissima, subquadrata, palmâ apicali, transversâ, tridentatâ, pollice acuto, tenui, digito acuto. Pedes 7mi 6tis parce breviores, articulis apicem posticum densè pilosis.

Hab. in Archipelagine "Viti."

2. *Dorsum abdominis armatum.* [Manus major subtriangulata, palmâ 2-dentatâ, dentibus obtusis.]

11. Gammarus (Mæra) validus. — Gracilis, epimeris angustis. Oculi rotundati. Antennæ tenuissimæ: 1mæ corporis longitudine, articulo secundo longiore, flagello vix longiore quam basis, appendice

brevi, 3 – 5-articulato: 2dæ paulo breviores, basi parce longiore quam basis 1marum, flagello dimidio breviore. Manus 1ma parvula. Manus secunda *dextra* validissima, basin latè rotundata, apice superno non prominente, rectangulato; *sinistra* parvula, angusta, acuminata, infra pubescens. Pedes 6 postici subsetosi.

Long. $2\frac{1}{2}'''$ – $3'''$. — *Hab.* in mari juxta "Singapore."

12. Gammarus (Mæra) setipes. — Gracilis, epimeris perangustis. Oculi orbiculati. Antennæ corporis longitudine: 1mæ paulo majores, articulo secundo longiore, flagello longiore quam basis, appendice 5-articulato: 2dæ longæ, basi multo longiore quam basis 1marum, articulo primo infra producto, flagello breviore quam basis. Manus secunda *dextra* validissima, basin angusta, apicem non prominens, fere rectangulata; *sinistra* parvula, basin angustior, apicem truncata. Pedes 6 postici subæqui, 6tis parce longioribus, articulis breviter et sparsim setosis, tertio postice serrato.

Long. $4'''$. — *Hab.* in portu "Rio de Janeiro."

13. Gammarus (Mæra) pilosus. — Gracilis, epimeris angustis. Antennæ subæquæ, corpore breviores; 1mæ paulo longiores, flagello longiore quam basis; 2dæ graciliores, basi longiore quam basis 1marum, flagello breviore quam suus basis. Manus secunda *sinistra* validissima, basin rotundata, apice superno prominulo; *dextra* parvula, apicem obliquè truncata. Pedes 6 postici subæqui, longè pilosi, articulo tertio posticè fere integro.

Long. $6'''$. — *Hab.* in portu "Rio de Janeiro."

Genus II. AMPHITOË.

Gammaro affinis. *Antennæ* superiores non appendiculatæ.

A. Antennæ superiores longiores.

I. Margo frontis lateralis ophthalmicus saliens.

1. Amphitoe peculans. — Gracilis, epimeris angustis, marginem sparsim ciliatis. Antennæ subæquæ; flagellis non longioribus quam bases, teretibus, articulis oblongis, setis inferioribus longiusculis. Manus prima validiuscula, breviter subtriangulata, carpo non minore, inversim triangulato, (formâ carpi manusque simul sumtorum ellipticâ,) anticè et posticè hirsuta. Manus secunda valida, oblonga, elliptica, palmâ non excavatâ, hirsutâ, carpo hirsuto, triangulato infra anguste producto, hoc processu manum non appresso, digito longiusculo. Pedes 3tii 4ti

æqui, breves, articulo primo fere orbiculato; 5ti vix longiores; 6ti 7mi subæqui, 7mis longioribus, setis sparsis, articulo primo oblongo.

Hab. in mari "Sulu."

II. Margo frontis lateralis ophthalmicus saliens.

a. Oculi reniformes.

2. Amphitoe fissicauda. — Corpus compressum, epimeris latis. Abdominis segmentum ultimum fere usque ad basin fissum. Antennæ subæquæ; 1mæ parce longiores, dimidii corporis longitudine, basi multo breviore quam flagellum et parce breviore quam basis 2darum, setis inferioribus longiusculis. Pedes 1mi parvuli, manu parce oblongâ, apicem obliquâ et non latiore. Manus secunda mediocris, angusta, infra ciliata, digito perbrevi. Pedes 6 postici subæqui, non longi, setis brevibus.

Hab. in mari juxta oras prope urbem "Valparaiso."

3. Amphitoe pubescens. — Corpus compressum, sparsim pubescens, epimeris latis. Abdominis segmentum ultimum brevius, emarginatum. Antennæ 1mæ dimidio corporis valde longiores, flagello vix breviore quam basis, setis numerosis; 2dæ dimidio fere breviores, dense hirsuti, basi fere duplo longiore quam flagellum. Manus 1ma parvula, angusta, apicem angustior. Manus 2da versus apicem angustior, dorsum recta, infra hirsuta, palmâ non impressâ, digito longiusculo. Pedes 6 postici longi, subæqui, setis rigidis, articulo primo lato.

Long. 4‴. — *Hab.* apud insulam "Pitt" Archipelaginis "Kingsmills."

b. Oculi non reniformes, fere orbiculati.

1. Palma manus secundæ lateralis. (*Gen.* Melita, *Leachii.*)

4. Amphitoe (Melita) inæquistylis. — Epimera mediocria. Antennæ 1mæ fere corporis longitudine, setis brevibus, divaricatis, verticillatis, flagello paulo longiore quam basis, terete, articulis cylindricis. Antennæ 2dæ valde breviores, basi longiore quam basis 1marum, flagello multo breviore. Pedes primi parvuli, manu brevi, apicem latiore, truncatâ; secundi validiusculi, manu oblongâ, subobovatâ, apicem paulo obliquâ, digito brevi, in latus manus claudente. Pedes 6 postici sensim parce increscentes, 6ti 7mi fere æqui, articulo primo angusto. Styli postici longiores.

Long. 4‴. — *Hab.* in sinu "Bay of Islands" Novi-Zealandiæ.

2. Palma manus secundæ marginalis.

* *Epimera quinta quartis valde angustiora.*

5. Amphitoe Peruviana. — Corpus compressum. Antennæ 1mæ corpore parce breviores, articulis tribus basalibus subæquis, flagello paulo longiore quam basis, setis perbrevibus, non divaricatis. Antennæ 2dæ basi 1marum parce longiores, basi longiore quam flagellum. Manus 1ma parva, apicem oblique truncata, parce latior. Manus 2da validiuscula basin latior, apicem angusta, palmâ vix excavatâ, digito breviusculo. Pedes 6 postici sensim parce increscentes, non longi, setis brevibus, articulo primo latissimo. Styli caudales 2di 3tiis non longiores.

Long. 5‴–6‴. — *Hab.* apud oras insulæ "San Lorenzo," Peru.

6. Amphitoe tenuicornis. — Epimera latiuscula. Antennæ pertenues: 1mæ dimidio corporis longiores, articulo secundo multo longiore, flagello paulo longiore quam basis, setis parce longioribus quam articuli: 2dæ parce breviores, basi longiore sive quam flagellum sive quam basis 1marum, articulis 3tio 4to subæquis. Manus 1ma parvula, oblonga, obovata, pubescens, apicem rotundata, digito sub apicem infixo. Manus 2da validiuscula oblonga, subelliptica, dorsum rectiuscula, infra dense hirsuta, palmâ non excavatâ, digito majusculo. Pedes 3tii 4tique perbreves. Pedes 5ti 6ti 7mi subæqui. Styli ultimi perbreves.

Long. 4‴–5‴. — *Hab.* in sinu "Bay of Islands" Novi-Zealandiæ.

7. Amphitoe Indica. — *Feminæ:* Corpus crassiusculum, epimeris mediocribus, segmento abdominis 4to apicem acuto. Antennæ 1mæ dimidio corporis longiores, articulo primo longiore, flagello longiore quam basis, setis breviusculis. Antennæ 2dæ dimidio breviores, tenues, flagello vix breviore quam basis. Manus prima parvula, oblonga, acuminata; 2da formam similis, parce major, palmâ non excavatâ, digito dimidii manus longitudine. Pedes 3tii 4tique tenues, non breviores, 6ti 7mi subæqui, 5ti breviores, articulo primo lato. Styli postici elongati.

Long. 4‴. — *Hab.* apud oras insulæ in freto "Balabac" juxta Borneo.

8. Amphitoe rubella. — Corpus crassiusculum, epimeris latis. Antennæ 1mæ dimidio corporis longiores, articulo secundo multo longiore, flagello fere duplo longiore quam basis, articulis longis, setis perpaucis, brevibus. Antennæ 2dæ 1mis breviores, basi multo longiore

quam basis 1marum, flagello articulum precedentem fere æquante. Manus 1ma parvula, oblonga, angusta, apicem angustiore. Manus 2da valida, lata, subrectangulata, apicem transversa, palmâ apicali, excavatâ, angulo infero acuto, digito mediocri. Pedes 3tii 4ti breves; 6ti 7mi subæqui, 5ti multo breviores, setis sparsis, articulo primo latiusculo.

Long. 3‴. — *Hab.* in Archipelagine "Sulu."

9. Amphitoe fucorum. — Antennæ longiusculæ, 2dæ paulo breviores, basi fere duplo longiore quam basis 1marum, flagello non longiore quam suus basis. Manus 1ma parva, apicem latior, obliqua; 2da fere elliptica, marginibus arcuatis, digito duplo breviore quam manus. Pedes 4 sequentes non breviores, subæqui; 5ti breviores; 6ti 7mi subæqui.

Hab. in mari Atlantico inter Algas natantes.

* * *Epimera quinta quartis vix angustiora.*

10. Amphitoe Tongensis. — Corpus compressum nudum, epimeris latis, 5tis magnis. Antennæ 1mæ corpore breviores, articulo secundo longiore, flagello fere duplo longiore quam basis, fermè 40-articulato. Antennæ 2dæ paulo breviores, basi longiore quam basis 1marum, flagellum suum fere æquante, setis flagelli paris secundi longioribus. Manus 1ma parva, subelliptica, dorsum fere recta. Manus 2da oblonga, infra arcuata, hirsuta, supra rectiuscula, digito brevi, carpo infra producto sed non acuto. Pedes 6 postici valde inæqui, sensim increscentes.

Long. 6‴. — *Hab.* apud oras insulæ "Tongatabu."

11. Amphitoe peregrina. — *Feminæ?* Corpus gracile, epimeris latiusculis, 5tis magnis, margine sparsim ciliato. Antennæ 1mæ fermè dimidii corporis longitudine, articulo primo longiore, flagello duplo longiore quam basis, 12-articulatis, setis brevibus numerosis. Antennæ 2dæ fere dimidio breviores, basi longiore quam basis superiorum, flagello 6-articulato, subulato, paulo breviore quam basis. Manus 1ma 2da subæquæ, parvulæ, oblongæ, infra arcuatæ, digito minuto. Pedes 3tii 4ti non breviores, subæqui; 5ti 6ti 7mi non longi, sensim parce increscentes, setis minutis, articulo primo lato.

Long. 3‴. — *Hab.* inter Algas natantes maris alti prope "Valparaiso."

12. Amphitoe brevipes. — Corpus compressum, epimeris latis, quintis maximis, subquadratis. Antennæ 1mæ dimidio corporis paulo

longiores, articulo primo longiore, flagello plus duplo longiore quam basis, fere nudo. Antennæ 2dæ dimidium 1marum longitudinem parce superantes, basi longiore quam basis 1marum, flagello brevi (multo breviore quam basis), subulato, infra hirsuto. Manus 1ma 2da *feminæ* subæquæ, parvulæ, breves, apicem rectè truncatæ et non latiores; palmâ apicali, digito, minuto; 2da *maris* valida, subovata, dorsum rectiuscula, prope apicem internum unidentata, digito longo. Pedes 3tii 4ti subæqui; 5ti 6ti 7mi breviusculi, sensim increscentes, articulo primo lato.

Microcheli, generi non vero, ut mihi videtur, femina *A. brevipedis* forsan pertinet.

B. Antennæ superiores breviores. (Genus Iphimedia, *Rathke.*)

13. Iphimedia simplex. — Corpus compressum, nudum, epimeris latis, quintis angustis. Antennæ 2dæ dimidii corporis longitudine, basi brevi, flagello fere nudo, plus duplo longiore, articulis perbrevibus. Antennæ 1mæ paulo breviores, basi vix breviore quam basis 1marum. Pedes toti breves: manus 1ma mediocris, angusto-ovata, apicem subacuta; 2da (feminæ?) minor, formam similis. Pedes 3tii 4ti subæqui, 2dis longiores; reliqui 6 subæqui, setis brevissimis, articulo primo latissimo, margine postico obsoletè serrulato.

Long. 4‴ – 5‴. — *Hab.* apud oras insulæ "Hermite" Fuegiæ.

14. Iphimedia (Acanthosoma, *Owen*) nodosa. — Corpus crassiusculum, testâ subcalcareâ, fronte minutè rostratâ, abdomine dentato-carinato, segmentis corporis 4 anticis marginem integris, quinto sinuoso, sequentibus plus minus spinoso-dentatis aut acuto-nodosis segmentis quatuor ultimis exceptis; epimeris tribus anticis integris, obtusis, 4tis latis, posticè 2-dentatis, tribus sequentibus angustis, posticè acutis. Articulus primus pedum posticorum grandis, subquadratus postice uni-dentatus, angulum posticum acutus. Antennæ 2dæ dimidio corporis breviores, nudæ; 1mæ paulo breviores. Pedes nudi; 4 antici (feminæ?) parvuli, manubus minutis subæquis; 6 postici subæqui, articulo tertio triangulato, apice postico producto et acuto.

Long. 4‴. — *Hab.* apud oras insulæ "Hermite" Fuegiæ.

Genus III. ŒDICERUS. (*Kröyer.*)

Amphitoe pedes 4 anticos membraque buccalia affinis. Pedes septimi valde elongati, tenues, fere filiformes. Epimera mediocria.

Œdicerus Novi-Zealandiæ. — Parvulus. Antennæ 1mæ dimidio corporis breviores, teretes, articulis oblongis; 2dæ fere duplo longiores, flagello fermè 21-articulato, fere duplo longiore quam basis. Pedes 7mi corporis longitudine, extremitate styliformi, minutè pubescente: 4 antici inæqui, manubus ovatis, manu 1mâ parvulâ, 2dâ validiusculâ, palmâ paulo excavatâ, digito sat longo. Pedes 3tii 4ti tenues, parvuli; sequentes articulum primum angusti.

Long. 2‴. — *Hab.* in sinu "Bay of Islands" Novi-Zealandiæ.

Genus IV. ERICHTHONIUS? (*M. Edwards.*)

Antennæ elongatæ. *Pedes* primi plus minusve cheliformes, secundi valde cheliformes, digito biarticulato, pollice prominente. *Epimera* sat angusta aut latiuscula. *Cauda* subsaltatoria.

Erichthonii gressorii (caudâ non saltatoriâ), M. Edwardsio auctoritate, et epimera carentes. Forsan genus hic descriptum Erichthonio discrepat et novum. Hoc credente, genus Pyctilus (a πύκτης, *pugil*) in manuscriptis auctore institutum est.

1. Erichthonius (Pyctilus?) macrodactylus. — Corpus gracilis, epimeris mediocribus, capite oblongo, margine frontis ophthalmico producto. Antennæ elongatæ; 2dæ corpore breviores, articulis 3tio 4toque subæquis, longis, flagello paulo breviore quam basis, fermè 10-articulato, setis perbrevibus. Manus 1ma elliptica, 2-articulata, (articulo primo majore) digito brevi. Manus 2da validissima, paulo $<$ forma, pollice prælongo, acuto, digito longiore quam manus, articulis duobus subæquis, utroque pollicis longitudinem æquante, apicem acuto, sparsim breviter hirsuto. Pedes 3tii 4ti subæqui; 5ti breves, articulo primo posticè acutè producto; 6ti 7mi paulo inæqui, postici longiores.

Hab. in mari Indiæ Orientalis.

2. Erichthonius (Pyctilus?) pugnax. — Antennarum basis 1marum flagello vix longior. Manus secunda validissima oblonga, marginibus antico posticoque fere parallelis, pollice brevi, bifurcato; digito elongato, articulis duobus inæquis primo crassiore et longiore, intus parce eroso et sparsim hirsutiusculo, duplo longiore quam pollex.

Hab. in mari Indiæ Orientalis.

Familia III. COROPHIDÆ.

Corpus plus minusve depressum, lineare, abdomine recto, articulos normali, epimeris angustissimis vel obsoletis. *Mandibulæ* palpigeræ. *Antennæ* pediformes. *Animalia gressoria.*

Genus I. COROPHIUM.

Pedes secundi non subcheliformes digito nullo 2-articulato. *Antennæ* 2dæ flagellis carentes.

Corophium quadriceps. — Caput quadratum. Abdomen posticè rotundatum. Pedes 4 antici similes, primis minoribus. Pedes 5ti 4tis breviores, articulo primo non setoso; 7mi tenues, articulo primo setoso, setis longiusculis, plumosis. Antennæ (an adultæ?) subæquæ; 1mæ parce breviores, 7-articulatæ, articulo primo longiore; 2dæ crassiusculæ, 7-articulatæ, quartam partem corporis longitudine vix superantes, articulo 3tio longiore, tribus ultimis parvulis subæquis.

Long. 1‴. — *Hab.* in portu "Rio de Janeiro."

Genus II. CLYDONIA. (*Dana.*)

Corpus elongatum, paulo depressum. Abdomen 6 – 7-articulatum. Antennæ quatuor; duæ elongatæ, styliformes, rectæ et rigidæ, articulo basali brevi, reliquâ parte longissimè subulatâ obsoletè multi-articulatâ. Pedes tenues, 6 postici longè filiformes, quintis longissimis.

1. Clydonia gracilis. — Antennæ longæ fere corporis longitudine, subulatæ. Oculi parvi, lenticulis 9. Styli caudales tenues, 1mi 3tiique 2dis longiores, 3tiis ramum brevem acutum ad medium ferentibus. Pedes 5ti corpore non breviores, articulo primo longissimo infra minutè spinoso, apice spinoso-producto; 7mi 5tis plus dimidio breviores. Abdominis segmenta 3 antica latere acuta, angulo postico subtruncato.

Long. 3‴. — *Hab.* in mari Atlantico, lat. bor. 1°, long. occ. 18°. — Lect. die 31 Oct., 1838.

2. Clydonia longipes. — *C. gracili* similis. Antennæ longæ fere corporis longitudine, subulatæ, parce crassiores. Pedes 7mi 5tis non dimidio breviores. Segmenta abdominis duo antica angulos posticos acuta et non truncata.

Long. 4‴ – 5‴. — *Hab.* in mari Pacifico, lat. aust. 18° 10′, long. occ. 126°. — Lect. die 8 Aug., 1839.

Familia IV. ICILIDÆ.

Corpus valde compressum, latum, vix lineare, abdomine articulos normali, valde inflexo. *Pedes* plerumque latè expansi instar Aranei.

Antennæ quatuor flagellis confectæ, non pediformes. *Animalia gressoria.*

Genus ICILIUS.

Antennæ elongatæ, secundæ longiores. *Pedes* non prehensiles, toti vergiformes, apicem unguiculati. *Styli caudales* sex, furcati.

Icilius ovalis. — Cephalothorax ellipticus, capite brevi latè triangulato, frontem lateraque obtuso. Oculi remotissimi. Segmentum thoracis primum angustius et brevissimum. Abdomen 7-articulatum, segmentis tribus anticis ad marginem posticum medianum acutis, segmento ultimo parvulo ovato. Antennæ subteretes: 2dæ corpore longiores, flagello fere duplo longiore quam basis, tenuissimo: 1mæ fere dimidio breviores, flagello non duplo longiore quam basis. Pedes 4 antici infra densè hirsuti; 6 postici inter sese similes; 7mi 6tis valde longiores, tenues, fere nudi.

Long. 2‴. — *Hab.* in freto " Balabac," juxta Borneo.

Three hundred and twenty-eighth meeting.

February 13, 1850. — Quarterly Meeting.

[This statute meeting was held in virtue of an adjournment from January 30th, on account of the accidental omission of the usual circular notice to the Fellows.]

The President in the chair.

Professor Guyot, from the committee on the resolutions in behalf of the establishment of a system of meteorological observations in the State of Massachusetts, reported in favor of their adoption. The report was accepted, and the resolutions adopted.

Professor Peirce, Professor Guyot, and Dr. H. I. Bowditch were appointed a committee to bring the subject to the consideration of the Legislature now in session.

The Librarian brought to the notice of the Academy a chart of the ancient mounds, or earth-works, at Marietta, by Winthrop Sargeant, addressed in the year 1788 to Governor Bowdoin, President of the Academy. The Librarian found this among the manuscript papers in his custody, and considers it as very interesting from its being an earlier survey than that which is published in the first volume of the *Smithsonian Contributions to Knowledge*, with which it corresponds in most particulars, while it exhibits some parts which do not appear in the later chart, showing that some changes may have taken place during the interval.

Mr. Desor made some remarks on the columnar crystallization of ice in gravel or clay, and offered an explanation of the phenomenon, differing in some respects from that of a writer in a late number of *Jameson's Journal.*

Further remarks on the subject were made by Professor Rogers, Dr. C. T. Jackson, Mr. Treadwell, and others.

Dr. C. T. Jackson, from the committee on coast marks, submitted the following report: —

"The committee appointed to consider the subject of permanent coast marks for the determination of the future changes of level of the coast of the United States, have attended to their duty, and beg leave to present the following report.

"It is now more than a century since the great Swedish philosopher, Celsius, announced that, from observations made on the coast of Sweden, he had arrived at the conclusion that the relative level of the land and sea was not fixed, but that undoubted changes took place, which he, at that time, ascribed to the subsidence of the waters of the Baltic Sea.

"It was not until the beginning of this century, that it was discovered that the change, instead of being the result of a subsidence of the waters, was due, on the contrary, to a gradual rise of the land. The bearing of this discovery was too obvious to be overlooked. It not only afforded the means of explaining many geological phenomena, but it seemed also to involve the future destinies of all coasts undergoing similar changes. Surveys, accordingly, were ordered by the Swedish government, as long ago as the year 1820, to discover the amount of change in a given time; and we are already in possession of records, which enable us to estimate with accuracy the amount of upheaval in many places.

"The example set by the Swedish government has been followed by others, not along the coasts of Europe merely, but even in the southern hemisphere, marks having been established by order of the British government on the coast of Van Diemen's Land, for the same purpose. Were it necessary to urge the paramount importance of such examinations, both in a scientific and practical point of view, your committee would simply recall the words of that illustrious naturalist, Alexander von Humboldt, who says, 'If similar measures had been taken in Cook's and Bougainville's earliest voyages, we should now be in possession of the necessary data for determining whether secular variation in the relative level of land and sea is a local phenomenon, and whether any law is discoverable in the direction of the points which rise and sink simultaneously.' If such a law exists, it can be demonstrated only by a sufficient number of observations made on the several continents.

"Your committee deem the establishment of similar land-marks on the American continent the more important, because the whole eastern coast of the United States exhibits evidence of a gradual rise of the land during the most recent geological periods, in the deposits of recent marine shells, which are to be seen, undisturbed in their natural position, many feet above the highest tides. There are, moreover, direct indications of a gradual rise of the land actually in progress on and around the island of Newfoundland, and, according to one of your committee, similar indications may be traced along the coast of Maine.

"A system of land-marks established at measured heights above mean sea-level on both shores of North America, within the limits of the United States, would eventually determine whether any changes in the relative level of sea and land take place, and whether such changes, if they do take place, are general or local, and whether there is any thing like a balance movement in this continent, whereby one coast rises while another sinks.

"The preliminary step to be taken is to cause a series of careful tidal observations to be made at the places where the marks are to be established, in order to determine the mean sea-level at those places, to serve as a fixed plane of reference. These observations might, as your committee suppose, be made under the direction of the Superintendent of the Coast Survey, whose well-known regard for science warrants the belief that he would cheerfully lend his aid to accomplish that important object. Your committee, therefore, propose that the aforesaid system of operations be recommended, by the Academy, to the Secretary of the Treasury of the United States, with the request that he would instruct the Superintendent of the Coast Survey to cause suitable observations to be made to effect the objects herein recommended, by the establishment of permanent marks or monuments at ascertained heights above the mean sea-level, at suitable intervals, along the eastern and western coasts of the United States; and also that he be requested to cause a record of the observations and marks or monuments to be made and furnished to the various scientific institutions in this country.

"All of which is respectfully submitted, by

CHARLES T. JACKSON,
E. DESOR,
EDWARD C. CABOT,
CHARLES H. DAVIS."

This report was accepted, and the Corresponding Secretary was instructed to forward an authenticated copy to the Secretary of the Treasury.

Judge Shaw paid a feeling tribute to the memory of the late Dr. Martin Gay, for many years a distinguished Fellow of the Academy. He spoke of his attainments as a chemist, and especially as an adept in medical jurisprudence, and of the peculiar faculty he had of rendering scientific principles and processes intelligible to a jury. In conclusion, he offered the two following resolutions, to which a third was added by Mr. J. Hale Abbot.

"*Resolved*, That the Academy have received, with the deepest feelings of sorrow, intelligence of the decease of our lamented associate, Dr. Martin Gay, in the vigor of life, and in the midst of his usefulness.

"*Resolved*, That, regarding our late associate as a man of learning, ardently devoted to the pursuit of useful science, as a member of society and of a learned profession, of singularly pure and elevated principles, and of undeviating integrity, as a friend, amiable and beloved in all the relations of life, we shall ever cherish the recollection of his virtues, and hold his memory in the highest respect.

"*Resolved*, That the Fellows of the Academy sincerely sympathize with the family of the deceased in their bereavement; and that a copy of these resolutions be transmitted to them, in token of respectful condolence."

These resolutions were unanimously adopted.

The following gentlemen were elected Fellows of the Academy: —

Professor Henry L. Eustis, of Cambridge.

Samuel L. Abbot, M. D., of Boston.

S. Stehman Haldeman, Esq., of Columbia, Pennsylvania.

The Council of Nomination reported certain nominations for the list of Foreign Honorary Members.

Three hundred and twenty-ninth meeting.

March 5, 1850. — MONTHLY MEETING.

The PRESIDENT in the chair.

The Corresponding Secretary read a letter from S. S. Haldeman, Esq., of Columbia, Pennsylvania, signifying his acceptance of his election as a Fellow of the Academy.

The Council reported a list of candidates, duly recommended, to be ballotted for as Foreign Honorary Members at the ensuing Annual Meeting.

Mr. Teschemacher gave a brief account of a recent treatise by James D. Dana, Esq., on the isomorphism and atomic volume of minerals.

Dr. B. A. Gould, Jr., gave a detailed account of a series of experiments he had recently witnessed, made at Washington, under the direction of the United States Coast Survey, by means of the electric telegraph, which were thought to furnish important data respecting the velocity of the electric current through the wire. This gave rise to an animated discussion.

Professor Peirce made some remarks on the theory of vibrating dams, and stated that these vibrations were beautifully exhibited at the great dam just erected at Holyoke, upon the River Connecticut. They were plainly not vibrations of the dam, and he had no doubt of the correctness of the explanation which had been prepared by a gentleman of great practical judgment. The air confined between the dam and the sheet of water was constantly carried forward with the downrushing stream, and burst out at short intervals below the sheet of water. At each outbreak of air, there is a strong inward puff at the ends of the dam, accompanied with a waving back of the sheet towards the dam.

Professor Peirce announced that he had found quite simple forms for the differential coefficients, relatively to the elements of a planet's orbit, of the coefficients of the sine and cosine of the eccentric anomaly in Gauss's formulæ for the equatorial rectangular coördinates of the planet. Mr. J. E. Oliver has obtained a very near geometrical demonstration of these results.

Three hundred and thirtieth meeting.

May 7, 1850. — MONTHLY MEETING.

The PRESIDENT in the chair.

The Corresponding Secretary read a letter from the Hon. W. M. Meredith, Secretary of the Treasury, acknowledging the reception of the report made at the February meeting by a committee of the Academy appointed for that purpose, recommending the establishment of permanent marks to record the present mean sea-level; and stating that, "the object being deemed important by the Department, and the fitness of its connection with the Coast Survey recognized, authority will be given to the Superintendent to cause the necessary observations to be made, and the results communicated to the Academy."

Dr. Pickering offered some further remarks on the Egyptian Astronomical Cycle.

On motion of Mr. Eliot, the committee formerly appointed to memorialize the Legislature of the Commonwealth, in behalf of the establishment of meteorological observations at certain stations in Massachusetts, was authorized to apply to his Excellency the Governor for the appropriation recently made for that purpose, and to superintend its expenditure in furtherance of the object for which it was appropriated.

Mr. Eliot also gave an account of an organ with perfect intonation, the octave being divided into thirty-seven parts, which has recently been constructed, and is now on exhibition in Boston.

Dr. Locke, of Cincinnati, at his own request, made to the Chairman of the Rumford Committee, had leave to withdraw his communication on the Electro-Chronograph, &c., and to substitute another, if he shall think proper to do so.

DONATIONS TO THE LIBRARY,

FROM JUNE, 1849, TO JUNE, 1850.

Kops and Trappen. Flora Batava: Fasc. 137, 152, 153, 154, 155, 156, 158, 159. Also, Title and Index to Vol. X. 4to. Amsterdam, 1849. From the Netherlands Government, through W. S. Campbell, Esq., U. S. Consul at Rotterdam.

W. W. Greenough. The Conquering Republic, an Oration delivered before the Municipal Authorities of the City of Boston, July 4th, 1849. 8vo pamph. 1849. From the Author.

B. A. Gould, Jr. Review of Herschel's Outlines of Astronomy. 8vo pamph. Cambridge, 1849. From the Author.

The American Journal of Science and Arts. Second Series, Vol. VIII., Nos. 23, 24, 25, 26. From the Editors.

S. Lovén. Index Molluscorum Litora Scandinaviæ Occidentalia Habitantum. Faunæ Prodromum. (Öfversigt af K. Vet. Akad. Förh. 1846, 13 Maji, 10 Junii.) — Malacozoologi. (Öfversigt af K. Vet. Akad. Förh. d. 9 Juni 1847.) Holmiæ, 1846 – 47. 8vo pamph. From the Author.

Öfversigt af Kongl. Vetenskaps-Akademiens Förhandlingar. Årg. 4. 1847. No. 7, 8, 9, 10. Årg. 5. 1848. No. 1, 2, 3, 5, 6. Stockholm. 8vo pamph. From the Royal Academy of Sciences of Stockholm.

J. H. Maedler. Tabula Generalis Stellarum Duplicium Indicationem

Motus Gyratorii Exhibentium. Dorpati, 1849. folio pamph. From the Author.

Prof. R. S. McCulloh. Report from the Secretary of the Treasury, of Scientific Investigations in Relation to Sugar and Hydrometers. Made under the Superintendence of Professor A. D. Bache. Revised Edition. Washington, 1848. 8vo. From the Hon. R. C. Winthrop.

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N. D. Wailly. Elements de Paleographie. Paris, 1838. 2 vols. folio. From the French Minister of Public Instruction, through Mr. Alexander Vattemare.

The Report of the British Association for the Advancement of Science, for the Year 1848. 8vo. London, 1849. From the British Association.

Prof. Mitchell. Manner of Observing and Recording the Celestial Phenomena by a Machine. (A newspaper published at Cincinnati, 19th Sept., 1849. With a Plate.) From Prof. Mitchell.

Prof. C. B. Adams. Monograph of Stoastoma, a new Genus of new Operculated Land Shells. Amherst, Mass., Sept., 1849. 4to pamph. From the Author.

Victor Jubien. Poesies, Vaudevilles, &c. Maurice, 1842. From the Author.

Victor Jubien. Precis de Rhetorique, suivi des Règles auxquelles sont assujettis les differents Ouvrages de Litterature. Maurice, 1843. From the Author.

James D. Dana. Geology of the United States Exploring Expedition. 1 vol. 4to. With an Atlas of Plates. folio. Philadelphia, 1849. From the Author.

Prof. C. B. Adams. Contributions to Conchology, Nos. 1, 2, 3, 4, 5. 8vo pamph. Amherst, Massachusetts, 1849–50. From the Author.

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M. Tuomey. Report on the Geology of South Carolina. 4to. Columbia. 1848.

Robert W. Gibbes, M. D. New Species of Myliobates from the Eocene of South Carolina, with other Genera, not heretofore observed in the United States. 4to pamph. From the Author, through Dr. Warren.

Transactions of the Zoölogical Society of London. Vol. III., Parts 2, 3, 4, 5, 6. From the Zoölogical Society.

Annuaire Magnetique et Métérologique du Corps des Ingenieurs des Mines, ou Recueil d'Observations Métérologique et Magnetique Faites dans l'étendue de l'Empire de Russie et publiées par A. T. Kupffer, Directeur, etc. Annee 1845. Nos. 1, 2. 4to. St. Petersburg, 1848. — Resumé des Observations Métérologique Faites dans l'Empire de Russie, etc. 1er Cahier. St. Petersburg, 1846. From the Imperial Academy of St. Petersburg.

Occultations visible in the United States during the Year 1850. 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. 4to. Washington, 1849. From the Hon. R. C. Winthrop.

Astronomical Journal, Nos. 1 to 9. From the Editor, Benjamin A. Gould, Jr.

Magnetical and Meteorological Observations at the Magnetic and

Meteorological Observatory at the Girard College, Philadelphia. Made under the Direction of Prof. A. D. Bache. 1840–45. 3 vols. 8vo. Plates, 1 vol. Washington, 1847. (Pub. Doc.) From the Hon. R. C. Winthrop.

Annual Report of the Commissioner of Patents for the Year 1848. 8vo. Washington. From H. I. Bowditch.

Joseph Leidy, M. D. 1. History and Anatomy of the Hemipterous Genus *Belostoma* (Art. 6, in Jour. Acad. Natural Sciences, Philadelphia). — 2. Descriptions of Two Species of *Distoma*, with a Partial History of one of them. Plate. (Art. 26, Vol. I., N. S., Jour. Acad. Nat. Sc.) From the Author.

F. C. Zantedeschi. Annali di Fisica. Fasc. 2, 3, 4. 8vo pamph. Padova, 1849–50. From the Author.

Report of the Select Committee of the Legislature of 1849, on the Publication of the Natural History of the State of New York. 8vo. Albany, 1850.

Prof. C. B. Adams. Monograph of Vitrenella, a new Genus of new Species of Turbinidæ. Amherst, 1850. From the Author.

James D. Dana. On the Isomorphism and Atomic Volume of some Minerals, with a Table of Atomic Weights. (From the American Journal of Science and Arts.) 8vo pamph. March, 1850. From the Author.

Descriptions of the Instruments and Process used in the Photographic Self-Registration of the Magnetical and Meteorological Instruments at the Royal Observatory, Greenwich (extracted from the Introduction to the Greenwich Magnetical and Meteorological Obs., 1847). 4to pamph. London.

Letters on Certain Passages in the Life of Admiral Sir John Hawkins. (Temp. Elizabeth.) From John Paine Collier, Esq., and Captain W. H. Smyth. 4to pamph. London, 1850.

Boston Journal of Natural History. Vol. IV., No. 1. 8vo. Boston, 1850. From Soc. Nat. Hist.

U. S. Coast Survey. Maps of Huntington Bay, Harbours of Captains Island East, and Captains Island West, and Mouth of Chester River. From Prof. A. D. Bache, Superintendent of U. S. C. S., by request of Hon. R. C. Winthrop.

Catalogue of the New York State Library, January, 1850. 8vo. Albany, 1850. From the Regents of the University of the State of New York.

Proceedings of the Royal Astronomical Society. Vol. X., No. 2. Dec. 14, 1849. From the Royal Astr. Soc.

Astronomical Observations made at the Royal Observatory, Greenwich, in the Year 1847. 4to. London, 1849.

Message from the Governor of Pennsylvania, transmitting the Reports of the Joint Commissioners, and of Col. Graham, U. S. Engineers, in Relation to the Boundary Lines between the States of Pennsylvania, Delaware, and Maryland. 8vo pamph. Harrisburg, 1850. From Col. J. D. Graham.

B. A. Gould, Jr. Report to the Smithsonian Institution, on the History of the Discovery of Neptune. 8vo pamph. Washington, 1850. From the Author.

Prof. C. B. Adams. Contributions to Conchology. Nos. 6 and 7. 8vo pamph. From the Author.

Proceedings of the American Philosophical Society. Vol. V., No. 44. From the Society.

Proceedings of the Academy of Natural Sciences of Philadelphia. Vol. IV., Nos. 9, 10, 11, 12. Vol. V., No. 1. 8vo pamph. 1849–50. From the Academy.

Journal of the Academy of Natural Sciences, Philadelphia. Vol. I. 8vo. Vol. I., New Series, 4 Parts. 4to. Philadelphia, 1848–49. From the Academy.

Third Annual Report of the Regents of the University, of the Condition of the State Cabinet of Natural History, and the Historical and Antiquarian Collections annexed thereto. (State Document.) 1850. 8vo. From the Regents of the New York University.

Mémoires de la Société de Physique et d'Histoire Naturelle de Genève. Tom. XII., 1re Partie. Geneva, 1849. 4to. From the Society.

Premier Supplement au Tome XII. des Mém. Soc. Phys. et d'Hist. Nat. Genèv. — Observations Astronomiques Faites à l'Observatoire de Genève dans l'Année 1846, par E. Plantamour. VIe. Serie. Geneva, 1848. — Second Suppl. au Tome XII., etc., etc. Geneva, 1849. 4to. From the Society.

Tables des Comptes Rendus des Séances de l'Academie des Sciences. Deuxième Semestre, 1847. Tom. XXV. — Comptes Rendus Hebdominaires des Séances de l'Academie des Sciences; par MM. les Secretaires Perpetuels. Tom. XXVI. 1848. Premier Semestre, Nos. 1–25. From the Academy of Sciences.

Twenty-ninth Annual Report of the Board of Direction of the Mercantile Library Association, Clinton Hall, New York. Jan., 1850. 8vo pamph.

Neu Denkschriften der Allg. Schweizerischen Gesellschaft fur die gesammten Naturwissenschaften. Band. VII.–XIX. 4to. Neuchatel, 1845.

On the Regio Cinnamomifera of the Ancients. By W. Desborough Cooley. With Maps. Read before the Royal Geol. Soc. of London, April, 1849. 8vo pamph. From the Hon. Edward Everett.

On the Tertiary and more recent Deposits in the Island of Nantucket. By E. Desor and E. C. Cabot. (In a Letter to Sir Charles Lyell, Pres. Geol. Soc.) 8vo pamph. 1849.

Edward Jarvis, M. D. Production of Vital Force. A Discourse delivered before the Massachusetts Medical Society, at their Annual Meeting, May 30th, 1849. 8vo. Boston, 1849. From the Author.

Three hundred and thirty-first meeting.

May 28, 1850. — Annual Meeting.

The President in the chair.

The Treasurer presented his annual report on the finances of the Academy, accompanied by the certificate of the Auditor.

Dr. Gould, from the Library Committee, and Dr. Gray, from the Committee of Publication, made verbal reports.

Mr. Everett moved resolutions of respect to the memory of the late William Vaughan, Esq., of London, an Honorary Member of the Academy, which were unanimously adopted.

Professor Treadwell, from the Committee on Meteorological Observations, read the following report: —

"The committee appointed, in February last, to consider the subject of meteorological observations, respectfully ask leave to report, that there are now in the possession of the Academy journals of observations, more or less complete, for the following periods: —

"Professor Winthrop's Journal, from December 11th, 1742, to April 29th, 1779.

"Professor Wigglesworth's Journal, from August 1st, 1780, to December 31st, 1789. Also for the year 1793.

"Dr. Holyoke's Journal, from January 1st, 1754, to February 28th, 1829, except only the year 1759. A period of 75 years and 2 months, of which the observations are complete for 74 years and 2 months!

"Dr. Hale's Journal, from January 1st, 1818, to November 30th, 1818.

"Making a continued series for 106 years and 7 months, of which there are duplicate observations for 46 years and 3 months. Of these observations, 65 years of Dr. Holyoke's and Dr. Hale's have been reduced to tables, and various means of years and seasons computed and published in the Academy's Memoirs, by Dr. Hale. The original journals have been bound in volumes, and are now in a good state of preservation. As these papers were confided to the Academy, in most cases, by the heirs of the observers, it is manifestly the duty of the Academy to adopt every means for their preservation, that the object of the patient and persevering labor of their authors may be attained. The committee find that they contain a record of many phenomena not noticed in the printed abstracts, and which may hereafter be found highly useful in explaining the laws of meteorology, if science should ever be able to discover the order and relations of those laws, and reduce them to a rational and connected system. With a view, therefore, to the preservation of these journals from fire and other hazards to which they are now exposed, the committee have subjoined a vote for the purchase of a fire-proof safe, in which they may be deposited.

"Since the lamented death of Dr. Hale, no observations have been made under the direction of the Academy. It will be recollected that that gentleman several years since extended his original private observations, at the request of the Academy, for which he received a small compensation from the Rumford fund. The committee deem it highly important that these observations should be resumed as soon as a competent observer can be found who will undertake the trust. The committee think it desirable, moreover, that the instruments used by Dr. Hale, which were his private property, should be in the possession of the Academy, that they may be referred to and compared with such other instruments as may be used hereafter.

"Under these views of the whole subject, the committee recommend the following votes: —

"*Voted*, That the Librarian be authorized and requested to purchase an iron safe, in which shall be kept the various manuscript meteorological journals in possession of the Academy; and that the same officer be authorized to purchase of the heirs of Dr. Hale any instruments which were used by him in his Meteorological Observations, and that the sum of one hundred dollars be appropriated from the income of the Rumford fund for these purposes.

"*Voted*, That it is expedient to continue the meteorological observations, as made by Dr. Hale, at the expense of the Rumford donation, and that for this purpose an observer be appointed at the next meeting of the Academy.

"All of which is respectfully submitted, by order of the Committee.

"DANIEL TREADWELL, *Chairman*.

"*Boston*, *May* 28, 1850."

Professor C. G. J. Jacobi of Berlin, Professor Adrien de Jussieu of Paris, and Professor Rokitansky of Vienna, were chosen Foreign Honorary Members.

Mr. Jonathan P. Hall and Mr. Thomas T. Bouvé, of Boston, were elected Fellows of the Academy.

The annual election was held, and the following officers were chosen for the ensuing year, viz.: —

JACOB BIGELOW, M. D., . . *President*.
HON. EDWARD EVERETT, . . *Vice-President*.
AUGUSTUS A. GOULD, M. D., . *Corresponding Secretary*.
JOSEPH HALE ABBOT, . . . *Recording Secretary*.
J. INGERSOLL BOWDITCH, . . *Treasurer*.
HENRY I. BOWDITCH, M. D., *Librarian*.

The following gentlemen were appointed on the several Standing Committees, viz.: —

Rumford Committee.

EBEN N. HORSFORD, JOSEPH LOVERING,
DANIEL TREADWELL, HENRY L. EUSTIS,
MORRILL WYMAN.

Committee of Publication.

A. A. GOULD, LOUIS AGASSIZ, W. C. BOND.

Committee on the Library.

A. A. GOULD, D. H. STORER, S. L. ABBOT.

The thanks of the Academy were voted to Professor Gray for his efficient services as Corresponding Secretary.

Professor Peirce proposed that special meetings of the Academy should be holden on the first Tuesdays in June and July, at four o'clock, P. M.

Voted, that such meetings be holden.

Three hundred and thirty-third meeting.

June 4, 1850. — Monthly Meeting.

The President in the chair.

Dr. A. A. Gould declined serving as a member of the Committee of Publication, and Professor Joseph Lovering was nominated by the chair, and unanimously chosen, to fill the vacancy.

Professor Agassiz presented some new views respecting the coloration of animals. He stated that the coloration of the lower animals living in water depends upon the condition, and particularly upon the depth and transparency, of the water in which they live; that the coloration of the higher types of animals is intimately related to their structure; and that the change of color which is produced by age in many animals is connected with structural changes. He stated that coloration is valuable as an indication of structure; that it is a law universally true of vertebrated animals, that they have the color of the back darker than that of the sides; and that the same system of coloration prevails in all the species of a genus, — partially developed in some, but recognizable when a large number of species is examined.

Professor Peirce expressed the opinion, that there are errors in the lunar theory that still remain to be investigated; that occultations cannot be relied on as a means of accurately determining longitude; and that they are of little use for any purpose, except when whole groups of stars, as the Pleiades or Hyades, are taken.

He made some remarks upon the orbit of the comet of 1843, considered as a straight line directed through the sun's centre.

Three hundred and thirty-fourth meeting.

July 2, 1850. — MONTHLY MEETING.

The PRESIDENT in the chair.

The Corresponding Secretary communicated letters of acceptance from Professor Elias Fries of Sweden, and M. Macédoine Melloni of Naples, recently elected Foreign Members. The latter gentleman states that he has sent to the Academy the first volume of his work, "Sur la Coloration Calorifique," in which he has demonstrated, as he believes, the identity of light and heat.

The Corresponding Secretary also communicated letters from the Secretary of the Royal Institution, the Secretary of the Linnæan Society, the Librarian of the British Museum, and the President of the Academy of Breslau, acknowledging the receipt of various publications of the Academy; and two letters from Petty Vaughan, Esq., recently deceased.

Professor Peirce stated, that Mr. Schubert had discovered that Spica is a double star, one of the component parts of which is invisible. This conclusion was deduced by Mr. Schubert from observations made from 1764 to 1847 inclusive, and was said by Professor Peirce to rest on much stronger grounds than the similar conclusions of Bessel in regard to certain other stars. Spica has an irregular motion in right ascension, and it revolves in fifty years at the distance of one second and a half from the common centre of gravity of the two. This discovery Professor Peirce considered a most remarkable step in the progress of stellar astronomy.

Mr. S. C. Walker exhibited to the Academy a drawing illustrative of the results of experiments made by him on the 4th of February last, to determine the velocity of electricity, through the telegraphic circuit between Washington and St. Louis, seventeen hundred miles in length. His experiments gave a velocity of a little less than ten thousand miles a second. This result he proposes to test by further experiments on telegraphic lines, in which chemical changes of colors are used, instead of markings made by an electro-magnet. Mr. Walker found that pauses and syllables could be simultaneously transmitted in opposite directions, without interference, in the telegraphic circuit, in the same manner as they are in air.

Professor Agassiz stated that he had ascertained that there are certain animals, capable of performing all the great functions of animal life, which consist entirely of cells. He referred, in illustration of his remark, to the genus Coryne of the Polypoid Medusæ, found in Boston harbor. He distinguished the cells of which the tentacles of these animals are composed into three kinds, — epithelian, lasso, and locomotive cells. The tentacles, which consist of two cylindrical bodies, one within the other, tapering to a point, and without any cavities, are composed entirely of such cells. The epithelian cells cover the whole surface of the tentacles. The individual lasso cells throwing out their inner cylindrical body, the tentacles are converted into stems, with long, lateral threads, for catching small animals. By the contraction of their inner or locomotive cells, they are reduced to one tenth of the length they have when elongated. The locomotive cells were stated by Professor Agassiz to undergo endosmosis and exosmosis, accompanied by a change of form in the individual cells which constitute the inner cylinder of the tentacle, and in that change, to become organs of locomotion. The apparent fibres, described by some writers, were said by Professor Agassiz to be merely elongated cells.

Professor Peirce and Dr. Walter Channing made some further remarks in regard to the cause of the elongation of the cells.

After a discussion of considerable length, in which Mr.

Guyot, Mr. B. A. Gould, Jr., Professor Agassiz, and the President took part, on the importance and practicability of introducing a uniform system of thermometrical and barometrical notation in all countries where science is cultivated, it was, on motion of Mr. Guyot, —

" *Voted*, That a committee be appointed to consider the expediency of recommending the adoption of the centigrade thermometrical scale, and the metrical barometrical scale at the meteorological stations in Massachusetts.

" *Voted*, That Mr. Guyot, Professor Agassiz, Professor Peirce, Professor Lovering, and Mr. B. A. Gould, Jr. be that committee."

Professor Agassiz made some remarks respecting the structure of the egg. He stated that no two portions of the egg between the centre and the periphery have the same structure; that the yolk does not consist of homogeneous cells; and that it is not a store of nutritious matter to feed the young animals, but that it is a living, organized being.

On motion of Professor Peirce, it was voted that a monthly meeting of the Academy be held on the first Tuesday in August, at four o'clock, P. M.

On motion of Mr. B. A. Gould, Jr., it was

" *Voted*, That a committee be appointed to address a memorial to the Senate and House of Representatives of the United States, on the subject of attaching a corps of scientific men to the commission for running the boundary line between the United States and Mexico."

Professor Agassiz, Professor Peirce, and Mr. B. A. Gould, Jr., were appointed a committee for that purpose.

Three hundred and thirty-fifth meeting.

August 6, 1850. — MONTHLY MEETING.

The PRESIDENT in the chair.

The Corresponding Secretary read a letter of acceptance from Professor Bischoff of Giessen, recently elected a Foreign Member of the Academy.

Professor Agassiz communicated a paper on Spermatozoa by Dr. Burnet, of which he gave a brief abstract. He highly commended the paper, as establishing new and important views, and evincing uncommon qualifications on the part of its author for such researches.

On motion of Professor Agassiz, it was referred to the Committee of Publication.

Professor Agassiz stated that he had ascertained that cat-fishes, and the whole family of Siluridæ, to which they belong, have a sub-cutaneous cavity behind the humerus, and outside of the peritoneum and the muscular walls of the abdomen, into which protrude portions of the liver, and sometimes the air-bladder and kidney. He also stated that these animals have lateral holes for the admission of water into the interior of their bodies.

Professor Agassiz exhibited a part of the skin of a Bonito, caught off Nahant, which presented a remarkable peculiarity in the form of its scales. At first sight, the animal seemed to offer the anomalous phenomenon of ctenoid and cycloid scales occurring upon the same individual ; but, on further examination, the scales were found to be a new type, intermediate between the ctenoid and the cycloid, the serratures being merely marginal, and not extending over the posterior surface. He also called attention to some dark, longitudinal stripes, which at first appeared to militate with the views he had brought before the Academy at a late meeting, respecting the connection between the coloration and the structure of animals. On examining them more carefully, however, each stripe was found to originate at the base of one of the finlets of the tail.

Professor Agassiz, in reply to a question of the President, stated that the shrill noise heard on suddenly drawing a cat-fish out of the water is occasioned by the escape of air from the air-bladder through the pharynx ; and, in reply to a remark of Dr. Gould, he stated that a somewhat similar explanation is applicable to the noise made by the drum-fish when taken from the water, a fact recently ascertained by Dr. Holbrook.

Three hundred and thirty-sixth meeting.

August 14, 1850. — QUARTERLY MEETING.

The PRESIDENT in the chair.

The Corresponding Secretary read a letter of acknowledgment from Professor Karl Ritter of Berlin, in reply to a notification of his election as a Foreign Member of the Academy.

On motion of Mr. Treadwell, it was voted, that Jonathan P. Hall be appointed Meteorological Observer of the Academy on the Rumford foundation.

The nomination list was taken up, and the following gentlemen were elected Fellows of the Academy: —

Josiah D. Whitney, United States Geologist.

Hon. John C. Fremont, of California.

Prof. Stephen Alexander, of Princeton, N. J.

Prof. J. S. Hubbard, of Washington, D. C.

On motion of Professor Peirce, it was voted, that the next statute meeting be held in the evening.

Three hundred and thirty-seventh meeting.

October 1, 1850. — MONTHLY MEETING.

The PRESIDENT in the chair.

The Corresponding Secretary laid before the Academy letters from Professor Encke of Berlin, and Professor Müller, also of Berlin, signifying their acceptance of the honor conferred upon them by the Academy in electing them Foreign Honorary Members.

Professor Horsford presented a communication upon the spheroidal state of bodies. He proposed to show that temperature is not essential to the production of the phenomenon in some cases, and that no new law is required for its explanation in any case. He referred to the act of plunging the moistened hand into masses of molten metal as coming under this head, and as having been repeatedly performed in this country more than twenty years ago. The explanation he gave of the safety of the hand in this exposure was, that the moisture, volatilizing, rendered a part of the heat latent, and encased the hand in a sheath of aqueous vapor, so that only radiant heat acted upon it, and that only for the instant the hand was immersed.

As proof of the occurrence of the spheroidal state in the absence of temperature, Professor Horsford instanced the form mercury assumes on glass, that of oil and ether on water, and the bead upon acohol when agitated. The explosion at the close of the experiment of burning potassium or sodium on water, especially where the piece is large, he ascribed to the same cause as the explosion in the Leidenfrost experiment, where the cooling of the highly heated surface permits contact. The explosion attending the contact of fused saltpetre and water he classed with the Leidenfrost experiment. That which sometimes takes place when potassium is thrown into water or nitric acid, but an instant after the contact, he ascribed to another cause, — the mixture of hydrogen from the decomposed water, and oxygen from the air or acid, in such proportions as to be explosive.

Professor Horsford expressed a doubt whether any explosions of steam-boilers were to be ascribed to the Leidenfrost phenomenon, alleging that the temperature of 300°, which is about the temperature permitting contact, cannot produce sufficient steam from within the boiler to effect an explosion.

Professor Horsford concluded his paper with a series of experiments illustrating the general subject.

Professor Peirce stated that he had obtained from some investigations connected with the turbine wheel the following result: — that the curve along which a material point should move so as to compel this curve to raise weights to which it is attached, must be the cycloid. He exhibited a drawing of a bucket of a turbine wheel, constructed by Mr. U. A. Boyden, experiments upon which, conducted with the most scrupulous care, had shown it to produce an effect equal to eighty-eight per cent. of the power expended; and stated that some of Mr. Boyden's wheels had given the astonishing result of ninety-two per cent. of the power.

Professor Peirce made some remarks in regard to the fraction which expresses the law of vegetable growth, which he compared with the ratio of the mean motions of the planets, and found to express more nearly the arrangement of these bodies than Bode's law. For this purpose, Neptune's period of revolution must be multiplied by $\frac{1}{1} \times \frac{1}{2}$ to obtain that of Uranus. The period of Uranus must be multiplied by $\frac{1}{2} \times \frac{2}{3}$ to obtain that of Saturn. Saturn's period must be multiplied by $\frac{2}{3} \times \frac{3}{5}$ to obtain that of Jupiter, and so on. If this law is true, there can be only one planet within the orbit of Mercury, and no planet beyond Neptune. This law or harmony seems to be that to which successive development in general tends to conform, and is manifested when other forces opposed to it are not too powerful. The atomic laws are opposed to it, in crystallizing and other chemical processes; and also the higher laws of organization, such as those of bilateral division in the higher animals.

Professor Peirce remarked that the perturbative function of planetary motion had been developed by Hansen, according to the eccentric anomaly of one of the planets, in a numerical form; and exhibited the first terms of a literal development of this function, which is more simple than the usual form of development according to the mean anomaly. He thought there were reasons for believing that some other form of development will be discovered better adapted to cases of great inclinations and eccentricities; inasmuch as, in case the two orbits do not approach each other within a small distance, the development of this function should not contain any term capable of becoming infinite.

Dr. C. T. Jackson laid before the Academy a number of specimens of native phosphate of lime, or apatite, from a large vein discovered by Mr. Alger and himself in Hurdstown, New Jersey, during the month of June last, and offered the following remarks : —

" These specimens exhibit, in a striking manner, the various colors and forms of this interesting mineral, justifying the name given to it by mineralogists, in allusion to its deceptive appearance. Specimens of the crystallized mineral from Bolton, Massachusetts, St. Lawrence Co., New York, Murcia in Spain, and Hungary, were also shown, in illustration of its variable external appearance. The New Jersey specimens were crystallized, massive, and granular, and possessed various colors, such as olive-green, rosin-yellow, brown, and dingy white, and some of them were covered with iridescent films of oxide of iron. The peculiar resinous lustre of the broken surface may be pointed out as most generally characteristic of the mineral. By chemical tests its nature is readily proved, it being at once dissolved in nitric acid, and giving, when neutralized by ammonia, the characteristic yellow precipitate of phosphate of silver when tested with nitrate of silver. The presence of fluorine may also be demonstrated by decomposing the pulverized mineral by sulphuric acid, and allowing the fluohydric acid to act upon glass.

" Chlorine may be proved to be present by adding nitrate of silver to the nitric solution of the mineral. From these experiments, it appears that this mineral has the usual composition of apatite. Although crystals of this mineral have before been observed in the magnetic pyrites of this locality, the nature of the great vein of massive phosphate of lime had not been detected ; its dead white appearance on the surface, and its structural changes into rhombic prisms of 80° and 120°, giving no idea of its true nature."

Dr. Jackson stated that he had advised Mr. Alger to obtain a lease of this locality, and to work the phosphate of lime for agricultural use, and that mining operations had since been begun, and thirteen tons of the mineral were now on their way to Boston, and would be converted into prepared phosphates.

He then spoke of the importance of augmenting the proportions of phosphates in our soils, and showed that they are essential to the healthy growth of both plants and animals. In reply to a remark of Dr. Holland of London, Dr. Jackson gave some account of the researches of Professor Daubeny of Oxford, England, who had been employed by the British government to investigate the economical value of the phosphate of lime of Estremadura, Spain. Prof. Daubeny found that the mineral phosphate of lime answered as well as bones in prepared phosphates for agriculture, but that the supply in Spain was too limited to be of much importance.

Three hundred and thirty-eighth meeting.

November 5, 1850. — MONTHLY MEETING.

The PRESIDENT in the chair.

Professor Guyot, in behalf of the committee appointed to consider the expediency of recommending the adoption of the centigrade thermometrical scale, and the metrical barometrical scale, made a report, to which was appended a series of resolutions. A discussion of considerable length ensued, in which Messrs. Horsford, Lovering, B. A. Gould, Jr., Paine, Guyot, W. F. Channing, Peirce, Agassiz, Everett, and Treadwell took part; and the resolutions were amended and passed as follows: —

"1. *Resolved*, That the American Academy earnestly recommend the adoption of the metrical scale for the barometer destined for the observations made in behalf of the State of Massachusetts and of the Smithsonian Institution, not only for the sake of convenience, but also as a first step leading to a general adoption of the metrical system of weights and measures in scientific matters.

"2. As regards the thermometer, that the scale of Fahrenheit, in actual use in this country, be retained for the present.

"3. That a committee be appointed to consider the propriety and the practicability of introducing the modified Fahrenheit's scale mentioned in the report, or some other possessing similar advantages, as a universal scale, and to correspond with eminent meteorologists and scientific societies.

"4. That notice be given to the Smithsonian Institution of the opinion of the Academy on the subject of this report."

The Academy then

" *Voted*, That the committee to be appointed in pursuance of the foregoing resolutions consist of the gentlemen who reported them; viz. Messrs. Guyot, Agassiz, Peirce, Lovering, and B. A. Gould, Jr."

Professor Agassiz made an oral communication of considerable length upon the classification and homologies of radiated animals.

Professor Lovering read a part of a letter from Captain Lefroy, of the Toronto Observatory, to Mr. W. C. Bond, representing that there is danger that the magnetic observations at that place may be discontinued after next March, and expressing a desire that the Academy would use its influence in promoting their continuance for a further period of three years. He then offered the following resolutions, which, after some remarks by Mr. Guyot in their support, were adopted: —

" 1. That, in the opinion of this Academy, it is highly desirable that the magnetical and meteorological observatory at Toronto should be sustained for another period of three years.

" 2. That a committee be appointed to correspond with the American Minister at London, or with the Royal Society, as they may think best, with the view of urging upon the British government the scientific importance of prolonging their magnetical and meteorological operations in British America, and thus coöperating with similar observations to be made more or less extensively at different stations in the United States."

Hon. Edward Everett, Mr. W. C. Bond, Mr. Guyot, Professor Lovering, and Mr. J. P. Hall, were appointed a committee to carry the foregoing resolutions into effect.

Professor Lovering made some remarks upon the advantages of the French system of weights and measures over all others, and offered the following resolutions, which were adopted: —

" 1. That the decimal system of weights and measures, based upon the French metre, possesses advantages which belong to no other system that has been adopted or proposed; that it is the only existing system which is symmetrical in its parts, simple in its reductions, and which maintains in its various denominations that invariable and recoverable value which adapts the observations and experiments recorded in it for ready and permanent use over all the world.

"2. That the Academy authorize the use of the system in their own publications, and recommend its adoption for scientific purposes wherever it is practicable."

On motion of Professor Agassiz, it was

"*Voted*, That these resolutions be communicated to other scientific bodies of a similar character to that of the Academy."

On motion of Professor Agassiz, it was

"*Voted*, That the Recording Secretary be authorized, with the concurrence of the President, to call a semi-monthly meeting of the Academy at their hall, whenever any Fellows shall have such an amount of scientific matter prepared for communication, as to render a special meeting expedient."

Three hundred and thirty-ninth meeting.

November 13, 1850. — QUARTERLY MEETING.

The PRESIDENT in the chair.

The President laid before the Academy two letters, written in the year 1796, by Count Rumford, to the late John Adams, then President of the Academy; among whose papers they were recently found by Hon. C. F. Adams, and by him transmitted to the President.

The following gentlemen were elected Members of the Academy: —

Professor Alexis Caswell, of Brown University.

Professor William Chauvenet, of the U. S. Naval Academy, Annapolis.

Professor Lovering stated that Part II. of Vol. IV. of the Memoirs of the Academy would be printed in a week or two, and that two papers of the fifth volume were already printed.

In accordance with an arrangement made by Dr. Bowditch, the children represented to be Aztecs, from Central America, were exhibited to the Academy. They excited much interest. The boy presented, in the form of his head and the expression of his countenance, a striking resemblance to an engraving of a piece of sculpture, found near Palenque in Central America, to which Dr. Bowditch had previously called the attention of the Academy.

Three hundred and fortieth meeting.

December 3, 1850. — MONTHLY MEETING.

The PRESIDENT in the chair.

Mr. Everett, chairman of the committee appointed at the last monthly meeting to address a letter on the subject of sustaining the Toronto Observatory, either to the American Minister or the Royal Society, as they should deem most expedient, stated that the committee had addressed a letter to the Royal Society, recommending the continuance of the meteorological and magnetical observations at the Toronto Observatory, for another period of three years.

Dr. Pierson exhibited to the Academy a large and valuable specimen of gold recently brought from California.

Mr. Alger exhibited several very remarkable crystals of gold from California, and offered the following remarks in illustration of them: —

"The largest were octahedral crystals, simple or modified, and were as perfectly formed as similar crystals of pleisto-magnetic iron, or octahedral spindle. The most striking examples were three isolated crystals, which without exhibited no portion of the usually adhering quartz matrix. Their exact locality was not known, but the very worn appearance presented by several of them indicated their erratic or transported origin. The largest was *three fourths of an inch* across the base, and the smallest one quarter of an inch. This last presents four regular faces, with three of its solid angles extending out to points, which, however, have become somewhat rounded by attrition. It exhibits no modifications; but two of its faces are depressed or hollowed out, one of them by a very deep cavity, which extends not quite to the edges of the planes, but so near to them as to leave a narrow ridge or border all around the cavity, and parallel with its edges; thus giving the same triangular outline to each. It appeared as if the crystal had been in a melted state, and that, soon after the outside had congealed, the inner and yet fluid portion, or a part of it, had run out, leaving the surrounding consolidated edge just referred to. Appearances quite similar may sometimes be observed among artificial crystals, as for instance alum, and, more strikingly, metallic lead (which takes the form of the octahedron and has become partially desulphurized), in cases where the metal was allowed to flow off slowly, just as the outer crust had formed over the surface of the crystals. The large crystal presents only one half of the octahedron, its base blending with the massive gold, or only indicating the incipient planes of the lower pyramid. Three of its planes are perfectly smooth, excepting along the edges, which are prominently marked by the same projecting border or ridge observed on the smaller crystal. This border may have been produced in the same manner by the shrinking away of the metal, or it may be the result of that kind of crystallization which is dependent on a greater intensity of molecular attraction in one direction or axis than another. It would seem in this case as if the molecules arrived at the points of contact along the edges of the crystal faster than they could be appropriated, and thus have accumulated in these little ridges. This peculiarity is not confined to the large crystals, for it is observed even among the smallest. In one instance, as shown on a crystal of a half-inch in diameter, there had been produced a double series of these parallel ridges, extending around the edges of one of the planes of the octahedron, the inner ridge representing, apparently, the commencement of another crystalline face within the cavity of the larger one.*

" The great size of these crystals, and the fact that some of the cavi-

* The two large crystals above described were obtained from the very choice and beautiful collection of specimens, made with great care, and at no small expense, by Mr. Platt. This gentleman, during a most prosperous residence of two years in San Francisco, and while occupying a situation which brought him into daily and almost hourly contact with persons returning from the mines, has evinced his good taste by purchasing the most interesting specimens obtained by them. He has consequently been rewarded by the finest amateur collection hitherto brought from California. It comprises a great variety of ramified, arborescent, dendritic, and other imitative forms, here and there showing crystalline faces, all of them being sometimes most fantastically joined together in the same specimen. He informs me that, in obtaining this collection, he had examined gold of the value of more than four millions of dollars.

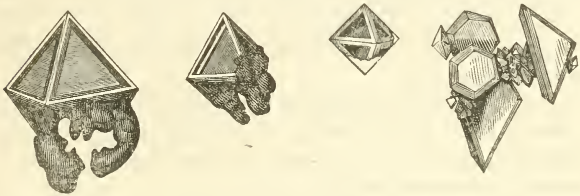
ties contained portions of oxide of iron, probably derived from the decomposition of iron pyrites, have led some to regard them as pseudomorphs of sulphuret of iron. But there seems to be no good reason for ascribing any such forced and unnatural origin to these beautiful productions. On the contrary, they seem to have been formed under the ordinary circumstances of crystallization, either in open space, or while surrounded by a matrix so soft and accommodating, as to allow them full freedom to take the form it was intended they should take. Were the crystals cubes, there might be some reason for regarding them in the light of pseudomorphs of iron pyrites, because this is the most common form of pyrites, and, moreover, all the pyrites hitherto brought from California have been in that form. But, we may well ask, who has ever seen even a cubic pseudomorph of gold? Crystals of gold are rare, cubes particularly so, and yet this form, on account of its simplicity, is made the primary form; whereas it would seem as reasonable, in cases of the regular system, to select that form as the primary which is most commonly and perfectly presented by the mineral, provided there is no cleavage to guide us in the determination; and there does not appear to be any, well made out, among most of the native metals. By assuming those which most commonly occur in nature, we seem to recognize a sort of inherent disposition, a preference, as it were, which is shown by the mineral itself; and we avoid what seems to be a palpable inconsistency, namely, the establishing of a cube as the primary form of minerals which have never been known to occur under such form, and which even present a distinct octahedral cleavage. This is the case with two at least. If we take the simplest form, the cube should be made the primary of native iron, copper, lead, silver, and mercury; and so of some others, which occur in octahedrons and are not determined by any certain cleavage. In the case of copper, some authors have made the cube its primary.* Haüy (*Traité*, 1808) even expressed his doubts as to the existence of cubic gold, while he cites examples of the octahedron; and Beudant (*Min.*, 1832) says they are very rare.† Mohs implies the contrary, for he says (*Min.*, ed.

* They differ in regard to silver and iron, some adopting the cube, and others the octahedron, as the primary.

† Cronstedt, in his Mineralogy, says, "I have procured in Transylvania a specimen of cubic native gold, but I have never seen it anywhere else." In Levy's enumeration of the splendid Turner collection formed by Henry Heuland, eight examples are given of the regular octahedron, and only two of the cube, one of these being from the very locality Cronstedt speaks of.

by Haidinger) they are often hollow, while the octahedrons are smooth. Cleaveland describes the crystals in general as small and imperfect, and Nichol, in his late work, in like manner, observes, 'They are small, and very small.' It is more than probable that we may yet be able to say of our California gold crystals, they are large, and very large, as much for the benefit of mineralogists, as for a reward to the industry and hard toil of the diggers.

"The first three of the following figures give a pretty correct idea



of the size and appearance of the specimens above referred to. The fourth is a group of rare modified forms or hemitrope combinations, such as have occasionally been brought from Brazil and Siberia. There is an example somewhat similar to it in the School of Mines (Paris), and described by M. Dufrénoy in his late treatise on Mineralogy. The crystals exhibited have been very fully described in the *American Journal of Science*, Vol. X., 1850.

Two additional crystals recently received present still more remarkable modifications, one of them being a hemitrope. Some description of these will be given at another meeting of the Academy."

Dr. C. T. Jackson added some remarks on the beautiful crystals of native gold from California, exhibited by Mr. Alger, and stated that crystals of this magnitude were unknown in the public collections of Europe, where those of one eighth of an inch in diameter were regarded as very rare and valuable specimens. He also observed, that the octahedral crystals belonging to Mr. Alger appeared like what are called dissected crystals, the centres of the triangular planes of the octahedron being depressed, while the edges were presented in bold relief, and a series of striæ, parallel to the edges of the planes, indicated a remarkable decrement from those edges towards the centre of the planes, such as is exhibited in crystals of alum partially dissolved by elevation of the temperature of the mother solution in which the crystals were originally formed.

He stated that he had examined and assayed some remarkable specimens of native gold from California, one single mass examined by him weighing 265 ounces, and containing 235 ounces of California gold, or 200 ounces of fine gold, and 35 ounces of silver. This single specimen is worth $3,885, and is the largest that has been brought from California to this city.

Dr. J. C. Warren exhibited to the Academy some large and valuable casts of fossils from the Sivâlik Hills, situated in the northern part of Hindostan, which he described and remarked upon at considerable length.

Mr. J. D. Whitney gave an account of the progress of the geological survey of the United States mineral lands in Michigan, and of its results; and exhibited several geological maps of that region executed for the United States.

Three hundred and forty-first meeting.

January 7, 1851. — Monthly Meeting.

The President in the chair.

Professor Peirce made some remarks respecting the uncertainty existing in regard to the masses of the planets. They vary when determined by different satellites, and should be taken as determined by actions upon planets, rather than upon satellites. The observations of Mr. Bond upon the satellite of Neptune give a less mass to that planet than those of the Pulkova Observatory, or those of Mr. Lassell; but the accuracy of Mr. Bond's observations is confirmed by the perturbations of Uranus. Professor Peirce stated the amount of discrepancy, as to the masses of several of the planets, between observation and theory. He said that theoretical errors could sometimes be detected by empirical means, and gave an empirical correction of the theory of Saturn. He further stated, that there are some indications of the secular action of a planet within the orbit of Mercury.

Professor Lovering described an experiment in electricity, and continued: —

"It is hardly necessary to remind the Academy of the two theories devised more than a century since to explain the phenomena of electrostatics. One of these theories, known as the theory of Dufay, attributes the two electrical states of a body to an excess of one or the other of two distinct electrical fluids. The other theory, known as the theory of Franklin, admits the existence of only a single electrical fluid, and refers the two electrical states of a body to an excess or a deficiency of this fluid.

"The imponderability of the electrical fluid, the transcendent velocity with which it moves, the facility with which it changes the direction of its motion when in full speed, and the absence of all visible signs of inertia in its swift flight, are not easily to be reconciled with the hypothesis of its materiality. To assert that electricity is matter, and in the same breath to deny to it all the universal properties of matter, is a plain confession of our ignorance.

"Nevertheless, these theories are convenient artifices for symbolizing the phenomena of electrical activity, and furnishing simple expressions for laws which otherwise could be described only by intricate algebraical formulæ. That protracted struggle between the two theories, the issue of which is still so uncertain, has no longer reference to the question which of these theories expresses a physical reality; but to this other question, which of these theories may be considered as the best artifice for grouping together phenomena, the dynamical relations of which are not yet distinctly understood.

"The exclusive advocates of one or the other theory, not being able to find an *experimentum crucis* among the statical facts of electricity, have made their strong appeal to certain appearances observed in current electricity. These are all of the same general character, but I desire at this time to call attention to only a single one, namely, the direction in which the little wheel, with pasteboard vanes, moves when exposed to the electricity which circulates from arm to arm of the universal discharger. Those who have opposed the conclusion in favor of Franklin's theory drawn from this experiment, have been contented with showing that the direction of motion is not always in correspondence with a current passing from the positive to the negative arm, and that trifling modifications in the experiment are sufficient to change the direction of the motion. I have been able to satisfy myself that the motion is not produced either by the electrical current (a supposition which probably few would adopt), or by the current of air which accompanies the passage of the electricity; and that, therefore, the direction of the motion, even if it were always the same, would justify no inference in regard to the direction of the electrical current. This motion is another instance of that numerous class which depends on alternate attractions and repulsions. This we can show by the following experiments: — 1. By substituting a ball for the pointed extremity of the discharging-wire, the motion continues and its velocity is increased. 2. If the wheel is insulated, no motion can be produced either with a pointed or blunt discharging-rod.

"Where the wheel is exposed between the arms of the universal discharger to a similar action on both sides, the direction of the motion will be determined by the relative tension of the two arms, and this relative tension will depend on the shape and mass of the metal connected with the prime conductor, as compared with the shape and mass of the metal connected with the rubber. Ordinarily, the negative mass is small, imperfectly insulated, and not communicating freely with the inside of the rubber, where the electricity is generated. These remarks apply with equal force to all those test experiments analogous to the one I have particularly discussed."

Mr. J. H. Abbot communicated some additional electrical facts, among which he described the effects produced by lightning upon a savin or red-cedar tree, the *Juniperus Virginiana* of botanists, in the eastern part of Beverly, in the summer of the year 1845. The course of the lightning could be traced by displaced stones, and several discontinuous furrows radiating from the trunk of the tree, one of which extended to the distance of two or three rods, while the tree itself was uninjured. These effects Mr. Abbot contrasted with the effects produced by lightning, during the same summer, upon a large chestnut-tree, in the northern part of Mason, New Hampshire, a large part of which was shivered into fragments, and scattered over an area more than a dozen rods in diameter. The great difference in the effects produced by lightning in these two instances Mr. Abbot attributed to a remarkable conducting power possessed by the red-cedar, and perhaps by other evergreens.

Mr. Bouvé remarked that those present were probably aware that a substance has been at times taken from the iron furnaces of England and Scotland, appearing in minute cubic crystals, having the color and more than the lustre of metallic copper, and which mineralogists had hitherto considered the pure metal titanium.

"Having in my possession the finest specimen perhaps ever obtained, which I received from one of the furnaces of Scotland, I would, in exhibiting it, call the attention of those interested to the remarkable fact lately made known by Wohler, that, instead of this substance being pure titanium, as has been believed, it is in fact a nitruret and cyanuret of titanium.

"Considering the nature of nitrogen, that it is one of the most evanescent of known elements, it is certainly a matter that may well surprise chemists, that it should be found a constituent part of a body formed under circumstances of such intense heat as exists in a blast furnace.

"The specimen just presented exhibits crystals of great beauty, having the color of copper and a brilliant lustre. Some of them are nearly one eighth of an inch in size."

Professor Horsford referred to a compound of nitrogen and boron, as nearly allied to the crystals exhibited by Mr. Bouvé. He announced the discovery of iodine in the ammoniacal liquor of gas-works, by Mr. Storer of the Lawrence Scientific School; and also the discovery of manganese in urine and in the tea-plant.

Mr. James Hall gave some account of his investigations, during the past summer, on Drummond's Island, and the north shore of Lake Huron and Lake Michigan, in connection with the geological survey under the direction of Messrs. Foster and Whitney.

"These investigations show that the strata recognized in the State of New York can be traced over this entire extent, and everywhere recognized by their lithological and fossil characters. On St. Joseph's Island, in the St. Mary's River, I have recognized the Chazy and Birdseye limestones; the Black River limestone, by its fossils, in a thin band above the Birdseye; and the Trenton limestone, preserving, to a great extent, the same lithological characters, and containing the same fossils, as in New York. I have traced the same strata, particularly the Birdseye and Trenton limestones, across to the Mississippi River, everywhere characterized by the same fossils.

"The 'blue limestone' of Cincinnati and other Western localities, I have already proved to be a continuation of the Hudson River Group of New York, and to be always above the Trenton limestone when occurring at all. The Niagara limestone can be traced along the entire distance, and across to the Mississippi River. At Milwaukie and other places, it is characterized by numerous fossils identical with those found in the same rock in New York.

"After a more critical examination, I have satisfied myself that the lead-bearing rock of Wisconsin and Iowa is not a part of the Niagara limestone, as I had supposed, but a member of the Lower Silurian series, which, in the absence of the shales of the Hudson River Group, succeeds the Trenton limestone proper, — as that rock is known in New York and elsewhere, — and is a member of the series which I had failed to recognize east of the Escanaba River. The fossils this rock contains are of Lower Silurian types. The name Galena limestone has been adopted for this rock.

"I have also satisfied myself that the sandstones of the Upper Mississippi are of the same age as the Potsdam sandstones, and that the lower magnesian limestone of the Western geologists is identical with the calciferous sandstone of New York, the next member of the series above the Potsdam sandstone. The thin bed of sandstone succeeding this rock cannot be identified as the Potsdam sandstone by itself, but must be regarded as a repetition of the arenaceous deposits below, which likewise alternate with the calciferous sandstone near its base.

"All these investigations have proved the continuity and identity of many of the most important formations, while others are wanting, and thus allow two widely separated formations of the East to come in contact, and apparently form one rock, at the West."

Three hundred and forty-second meeting.

January 29, 1851. — QUARTERLY MEETING.

The PRESIDENT in the chair.

The nomination list was taken up, and the following gentlemen were chosen Fellows of the Academy: —

Hon. George P. Marsh, of Vermont;

Rev. William Jenks, D. D., of Boston;

Prof. William A. Norton, of Brown University, R. I.;

Prof. Charles B. Hadduck, of Dartmouth College.

Professor Peirce stated that he had found the empirical correction of the theory of Saturn, which he communicated at the last meeting, to be confirmed by theory; and that the theoretical correction corresponded precisely in all its features with the empirical correction. This correction reconciles completely the discrepancy between the mass of Jupiter, as it is determined from its action upon its own satellites, and that which is derived from its action upon Saturn; and it now appears that this discrepancy did not arise from any error in the great inequality, but from one in the largest term of the periodical inequalities.

Mr. B. A. Gould, Jr. announced the death of Professor Schumacher, Director of the Altona Observatory, and Foreign Honorary Member of the Academy, and, on his motion, it was

"*Voted*, That a committee be appointed to prepare suitable resolutions, and address a letter of condolence to the family of the deceased.

"*Voted*, That Messrs. B. A. Gould, Jr., Peirce, and Bowen be that committee."

Three hundred and forty-third meeting.

February 4, 1851. — MONTHLY MEETING.

The PRESIDENT in the chair.

Professor Peirce, in behalf of the committee appointed at the last meeting on the occasion of the death of Professor Schumacher, a Foreign Honorary Member of the Academy, offered a series of resolutions expressive of the feelings of the Academy in relation to that event, which resolutions were unanimously adopted.

Professor Lovering stated that Part II. of Vol. IV. of the Memoirs of the Academy was published, and ready for delivery to the Fellows of the Academy, at their Library Hall.

Dr. C. T. Jackson communicated some interesting facts, showing that charcoal takes fire at a remarkably low temperature, which, when the charcoal is powdered and dry, he stated to be but little above that of boiling water. Dr. A. A. Hayes confirmed Dr. Jackson's statement, and referred to other similar facts. Dr. Holmes and Dr. W. F. Channing made further remarks on the same subject. The President spoke of the practical importance of an investigation of the subject; and, on motion of Mr. J. H. Abbot, made at his suggestion, it was

"*Voted*, That a committee be appointed to investigate the subject and report to the Academy.

"*Voted*, That Dr. C. T. Jackson, Dr. Hayes, and Dr. W. F. Channing be that committee."

Professor Peirce gave an argument, which he thought to be new, against the principle which is usually adopted in theoretical works, that the force of a body in motion is its *vis inertiæ*. He believes, on the contrary, that the time is at hand when the *vis viva* will be universally recognized as the force of a moving body. His new argument is derived from the effect of a force in causing rotation, as well as translation. By the old theory, no additional force is required to produce rotation; whereas, by the theory of the *vis viva*, just as much force is required as is actually exhibited in the resulting rotation. The same argument may be derived in another form from the vibrations of elastic bodies.

Mr. Peirce also gave some new views upon the subject of friction, and especially discussed the theory of rolling friction. This theory is of very little practical importance, but it is annoying to a scientist not to have it correctly established.

The careful consideration of this subject seems also to be well adapted to throw light upon some of the more hidden questions of practical mechanics The principles upon which his theory was based are, that the whole amount of resistance is measured by the amount of change of form, of compression, or of vibration with which the rolling surfaces are left; and these are themselves dependent upon the nature of the surfaces as yielding or hard, elastic or inelastic, and upon the amount of pressure and the extent of the surface of contact.

The subject was further discussed by Mr. C. Jackson, Jr., Mr. Treadwell, and the President. Mr. Treadwell concurred with Professor Peirce in his views, except that he was inclined to attribute the loss of force, in the case of elastic bodies, rather to the slow recovery by the particles of their previous position, than to their vibrations.

Dr. Holmes exhibited the peculiar bone corpuscles shown and described by him to the Boston Society for Medical Improvement in the year 1847, together with one of the drawings of them taken at the same period, by Mr. McIlvaine, under his direction. These corpuscles, remarkable for their regular, sharply defined, and often yellowish nucleus, are found in the cancellated structure of human bones. They are identical with those described by M. Robin in the *Gazette Médicale* for December 22, 1849, under the name of medullary cells.

Professor Peirce referred to a paper on the subject of heat, formerly prepared by Mr. U. A. Boyden, and expressed a desire that it might receive the attention of the Rumford Committee.

Three hundred and forty-fourth meeting.

March 4, 1851. — MONTHLY MEETING.

The PRESIDENT in the chair.

Professor Peirce made some remarks respecting the name to be assigned to the new planet, and thought it should be called Clio, rather than Victoria.

Mr. W. C. Bond expressed his preference for the latter name, because it had already been given to the new planet by the English astronomers.

Professor Peirce continued his remarks on the subject of the loss of force in friction, which he attributed in great part to vibration. He thought that the rising and falling of the moving body, occasioned by superficial asperities, could produce but a very small part of the loss that actually occurs.

The President stated that the rising and falling of the moving body would cause loss of force by increasing the space traversed by it.

Mr. Bowen suggested that heterogeneous attraction must take place in friction, and be one source of this loss of force.

Professor Lovering remarked that adhesion would increase with smoothness, and friction with asperities of surface.

Professor Treadwell concurred with Mr. Bowen in attributing a loss of force to incipient or partial cohesion.

Mr. Whitney communicated some statistical facts respecting the increased annual products of silver and gold. He thought that the relative value of those metals is destined to undergo a great change.

Mr. W. C. Bond communicated a letter from Colonel Sabine, and an extract from a letter sent by Dr. Holland, both addressed to Mr. Everett, and giving information that the British government had decided on continuing the Observatory at Toronto.

Colonel Sabine having requested specific information as to the wishes of the Academy in regard to the observations to be made, it was

"*Voted*, That the subject be referred to the committee formerly appointed to take charge of it, and that that committee be empowered to conduct the necessary correspondence.

Mr. W. C. Bond communicated a letter from Hon. William Mitchell of Nantucket, giving an account of the occultation of Aldebaran on July 16, 1849, of which the following is an extract: —

" On the 16th ultimo, I was prepared with a five-foot equatorial instrument of four-inch aperture, and an excellent chronometer by Parkinson and Frodsham. My assistant was furnished with a forty-two-inch Dolland, of three-inch object-glass, and a chronometer by Robert Roskell. The error and rate of my chronometer were obtained by the sun's meridian passage at the previous and the succeeding noon, and confirmed by the meridian passage of Antares on the following evening. With this chronometer that used by my assistant was compared before and after the occultation, and no change detected. The immersion, as observed by myself, occurred at $9^{h.}\ 30^{m.}\ 49^{s.}$. The time noted by my assistant was $9^{h.}\ 30^{m.}\ 50^{s.}$, and the mean of these results, namely, $9^{h.}\ 30^{m.}\ 49^{s.}.5$ may be deemed the true mean time at the meridian of my observatory.

" At this immersion of Aldebaran, I witnessed for the third time the singular phenomenon of the projection of the star on the bright limb of the moon. The other instances occurred, first on the 16th of July, 1830, and again on the 30th of August, 1831. In the present case the appearance of the star between my eye and the moon was so decided, that a thread of the moon's disc was manifest east of the star, and the star seemed to plunge into the surface of the moon. But this position was assumed by the star instantaneously, and not progressively, as sometimes supposed. The star occupied this position nearly two seconds, strictly one second and seven tenths.

" This illusion, for such it must be called for the want of a better explanation, is well worthy of the consideration of astronomers. In the immersion of other stars of the first magnitude, I have not witnessed it, nor have I met with it in the observations of others.

" Is this unaccountable appearance peculiar to this star? Whether it be so or otherwise, no inquiry can interest astronomers more than the solution of this mystery."

Mr. W. C. Bond also communicated a letter from Colonel J. D. Graham, giving an account of the transit of Mercury on the 8th of May, 1845, at Castle William, on Governor's Island, in New York harbor.

" The observations of Major Graham, in which he was assisted by Lieutenant Thom, were made with a forty-six-inch achromatic telescope constructed by Simms, having an aperture of two inches and three fourths, with a power of sixty, shaded by an orange glass. This telescope was mounted on an equatorial stand obtained from the Messrs. Blunt of New York. The instrument was mounted in the parapet of the castle, and was placed for shelter against the wind under the lee of the north wall of the upper tier. The interior contact of the planet at ingress had passed before the instruments were ready for use, on account of some unexpected difficulties which delayed the preparation. An observation was taken of the time when the second limb of the planet had passed within the sun to an extent equal to its own diameter, as nearly as the eye could judge. The correct or reduced sidereal time, as noted by the sidereal chronometer (No. 2419), was $2^{h.}\ 35^{m.}\ 25^{s.}$. The correct or reduced mean time, as noted by the mean solar chronometer (T. Dallas 158), was $11^{h.}\ 29^{m.}\ 59^{s.}.9$, civil account. The transit, at the egress of the planet, was observed with great satisfaction. For this purpose the instrument was removed from the parapet, and placed on a large flat slab of granite standing on the ground. It was first observed when the planet was within the sun's disc by a space equal to its own diameter. The time by the sidereal chronometer was $8^{h.}\ 51^{m.}\ 26^{s.}$, and by the solar chronometer, $5^{h.}\ 47^{m.}\ 58^{s.}.4$ P. M. The next observation was on the interior contact. The time was satisfactorily observed to be $8^{h.}\ 57^{m.}\ 30^{s.}.7$ sidereal time, and $5^{h.}\ 51^{m.}\ 3^{s.}.2$ solar time. Immediately after this observation, perhaps two seconds of time, the whole disc of Mercury, appearing perfectly round, seemed to be within the sun's disc again. There was an apparent connection between the limbs of the sun and Mercury by a little black stem of the same color as the planet. This stem appeared, when first seen, as long as one fifth or one sixth of Mercury's diameter. It remained distinct for thirty-three seconds of mean time, when, by a gradual diminution, it disappeared; thus forming a second apparent internal contact, at $8^{h.}\ 58^{m.}\ 6^{s.}.4$ sidereal time, and $5^{h.}\ 51^{m.}\ 38^{s}.4$ solar time. The disappearance of the planet from the sun's disc was watched with great satisfaction and distinctness, until it became like the finest black dot hanging on the exterior edge of the sun. The total disappearance took place at $9^{h.}\ 0^{m.}\ 59^{s.}.6$ sidereal time, and $5^{h.}\ 54^{m.}\ 31^{s.}.4$ mean solar time.

"The chronometers were regulated by equal altitudes of the sun, taken on the 7th and 8th of May, with an eight-inch sextant made by Troughton and Simms, and an artificial horizon sheltered by a glass roof in the usual way."

The Corresponding Secretary read a letter from the Assistant Secretary of the Smithsonian Institution, offering to transmit for the Academy, free of expense, to any part of Europe, publications delivered at Washington; and also to deliver, free of expense, at Washington, any publications intrusted to its agents in Europe.

On motion of Mr. Treadwell, it was

"*Voted*, That the Corresponding Secretary be directed to present the thanks of the Academy to the Smithsonian Institution for its obliging offer."

Dr. C. T. Jackson communicated the results of his analysis of a crystal of phosphate of lime from Hurdstown, New Jersey: —

"This crystal has a pale lemon-yellow color, and possesses a resplendent lustre on the surface, resembling the glazing produced by heat on a semi-fused mineral. Its specific gravity is 3.205. By analysis it was found to consist of

Phosphate of lime	92.405
Chloride of calcium	0.540
Peroxide of iron	0.040
Oxide of manganese	0.003
Fluoride of calcium, by difference,	7.012
	100.000

"It is, therefore, identical with apatite, and nearly of the same composition as that from Capo de Gata in Spain. Its formula will be $3\ Ca_3\ P + Ca\ (Cl\ F)$.

"This mineral occurs in large quantities at Hurdstown, and is now extracted from the mine for use in agriculture; it has been also employed in England in the manufacture of earthen-ware. The presence of fluorine in most, if not all, native phosphate of lime, was remarked upon at a former meeting of the Academy, and its agricultural importance was then indicated."

Three hundred and forty-fifth meeting.

April 1, 1851. — MONTHLY MEETING.

The PRESIDENT in the chair.

Lieutenant Davis presented a paper, relating to the deterioration which, he stated, has been taking place in Boston harbor for a considerable period of time, and mentioned several striking facts in illustration of his statement.

Professor Eustis remarked that he could corroborate Lieutenant Davis's statement, from former personal observation.

Professor Peirce spoke of the great importance of the subject, and, on his motion, it was

"*Voted*, That Lieutenant Davis's paper be referred to a committee of five."

"*Voted*, That Messrs. Treadwell, Eustis, Peirce, M. Wyman, and Lovering be that committee."

Professor Peirce offered the following resolutions, which were unanimously adopted: —

"*Resolved*, That Professor A. D. Bache, President of the American Association for the Advancement of Science, be requested and empowered to correspond, in the name of the Academy, with such foreign scientific bodies as may appear to him advisable, with a view to the union of scientific men of different nations, for the purpose of taking such steps as may best show their respect for the memory of the late Professor Schumacher, and their sense of the services which he has rendered to the science of the world.

"*Resolved*, That, in the opinion of the Academy, the foundation of a Schumacher medal and prize would be most appropriate to the memory of our honored associate, — though the Academy, on its part, will of course concur in any plan that may be determined on."

Professor Peirce presented a paper by Mr. U. A. Boyden, giving an account of a fall of rain at a temperature much below the freezing-point of water; and also a paper by Rev. Thomas Hill, on the catenary curve.

Professor Agassiz communicated, at considerable length, the results of some of his observations, during the past winter, on the Florida Coral Reefs. He described their topographical features, structure, and mode of formation, and pointed out some striking differences between them and all other kinds of reefs hitherto observed. He stated that the present barrier reef succeeds to two others, more elevated, contained within it; and that the foundation on which they are built has not, like that of the reefs described by Darwin and Dana, been undergoing a process of subsidence or of elevation. He further stated, that a free generation of coral animals detach themselves from the parent stem, move through the water, and select new situations, favorable for building, on the dead corals. He exhibited a small mangrove-tree, and called attention to its very long and numerous roots, by which it strongly attaches itself to the coral sands, and thus confines them.

Mr. Desor made some remarks on the first appearance of the Vertebrata in geological strata. From the absence of the remains of Vertebrata in the Trenton limestone, which contains the remains of a variety of invertebrate animals, and also in two fossiliferous formations below the Bala limestone in England, he argued that Invertebrata must have existed long before the appearance of Vertebrata. Mr. Desor further remarked, that, inasmuch as the remains of reptiles have been found in the coal measures of Germany, fishes could not be regarded as the only representatives of vertebrate animals in the paleozoic series, unless we remove from this group the carboniferous formations.

Professor Agassiz stated, that he was satisfied, from an examination of the figures in Professor Burmeister's paper, that the fossils found in the coal measures of Germany, and described by him as the remains of reptiles, are the remains of fishes.

Mr. Whitney exhibited a specimen of iron, manufactured at Springfield, out of ore brought from Lake Superior, which, he stated, had been found on trial to possess uncommon strength.

Mr. Alger exhibited a remarkable specimen of fossil Sigillaria from the sandstone of the coal formation of Nova Scotia. It is fourteen inches in diameter, and three feet long; the lower part bulging out, as if approaching the lower portion of the stock from which the roots proceeded. The flutings or longitudinal furrows upon its exterior, of an inch in width, and parallel with each other, are so perfect as to produce the effect of a regularly fluted column wrought with a chisel. In some parts of these grooves, there are carbonized remains of the original plant. It is otherwise a perfectly silicified fossil of a grayish-white color. Mr. Lyell, who has visited the spot (South Joggins) from which the specimen came, has satisfactorily determined that the strata of sandstone, in which the Sigillaria and other coal fossils of Nova Scotia are found, form altogether a mass of 2,500 feet in thickness. As these fossils are dispersed through every part of this immense mass, at the lowest depth as well as near its surface, Sir Charles Lyell concludes that many forests which grew here must have been successively submerged, and changed to the condition in which we now find them. The fossil trees are in an erect position, and perpendicular to the planes of stratification of the sandstone; but as this rock is now inclined at an angle of twenty-four degrees, we have proof of its subsidence or change of position.*

Three hundred and forty-sixth meeting.

April 15, 1851. — Semi-monthly Meeting.

The President in the chair.

Professor Peirce presented a paper on Saturn's rings, by Mr. George P. Bond, in which the latter gentleman has carefully investigated the structure of those rings, and arrived at the result, that they are fluid, and variable in number. Professor Peirce also stated, as some of the results of his own researches upon the same subject, that no ring can exist around a planet which has not satellites; that a ring surrounding such a planet would fall into it; and that a fluid ring surrounding Saturn might at the maximum become subdivided into twenty rings.

Professor Agassiz communicated some new views upon the special homologies of Echinoderms; and pointed out, at considerable length, homologies in the structure of several speci-

* See Lyell on American coal plants, in his *Travels in North America*, Vol. II. p. 159.

mens which he exhibited to the Academy. He also, in reply to inquiries proposed by Professor Henry B. Rogers, stated the result of his observations in regard to the different depths inhabited by Echinoderms in the ocean.

Three hundred and forty-seventh meeting.

May 6, 1851. — Monthly Meeting.

The President in the chair.

Mr. Everett read a part of a letter from Sir John Herschel, expressing a high opinion of the power of the astronomical telescope belonging to the Cambridge Observatory, and of Mr. Bond as a skilful observer; and ascribing to him priority in the discovery of the new ring of Saturn.

Mr. Guyot gave an account of some recent discoveries relating to the geography of the interior of Africa, and expressed his views at considerable length in regard to the general configuration of the African continent. Remarks upon the same subject were made by the President, Mr. Everett, Judge Shaw, Professor Horsford, and Professor Caswell. Mr. Guyot presented to the Academy a pamphlet in the German language by C. Ritter, relating to the same matter.

Dr. W. F. Channing offered some remarks respecting Foucault's pendulum experiment, and suggested the idea of supporting the pendulum by magnetic attraction or upon an agate in an exhausted receiver, as a means of obviating the effects of friction and the resistance of the air.

Mr. J. H. Abbot communicated and explained the results of a new experiment in Hydraulics. He stated that, — while water flowing from a cistern through a straight, horizontal, cylindrical tube, escapes, if small lateral holes are made in it, through those holes in jets, contrary to a proposition laid down by Bossut, — the opposite effect takes place, if the end of the tube is made conically divergent, and small glass tubes descend from the holes into vessels containing water. In this case, water ascends and is discharged into the horizontal tube, not only, as shown by Daniel Bernouilli, through the holes in the divergent part, but also through holes in the contiguous portion of the cylindrical part. In the experiment performed, the angle of divergency from the axis of the tube was four degrees and a half.

Three hundred and forty-eighth meeting.

May 28, 1851. — Annual Meeting.

The President in the chair.

Mr. B. A. Gould, Jr., laid before the Academy a letter from the widow of the late Professor Schumacher, gratefully acknowledging the receipt of the letter of condolence, on account of the recent death of her husband, addressed to her by the committee of the Academy appointed for that purpose.

It was then voted to proceed to the choice of officers for the ensuing year. The following gentlemen were chosen officers of the Academy, viz.: —

Jacob Bigelow, M. D., . . *President.*
Hon. Edward Everett, . . *Vice-President.*
Augustus A. Gould, M. D., . *Corresponding Secretary.*
Joseph Hale Abbot, . . . *Recording Secretary.*
J. Ingersoll Bowditch, . . *Treasurer.*
Henry I. Bowditch, M. D., *Librarian.*

The following gentlemen were chosen members of the several Standing Committees, viz.: —

Rumford Committee.

Eben N. Horsford, Joseph Lovering,
Daniel Treadwell, Henry L. Eustis,
Morrill Wyman.

Committee of Publication.

Joseph Lovering, Louis Agassiz, W. C. Bond.

Committee on the Library.

A. A. Gould, D. H. Storer, S. L. Abbot.

Mr. Everett, from the committee on the Toronto Observatory, made an oral report of the doings of the committee. He also made some remarks on the importance of a system of more extended scientific observations than can be carried on by the coöperation of private individuals or of scientific bodies; and, on his motion, it was

"*Voted*, That a committee of five be appointed by the chair to present a memorial to Congress at the ensuing session, praying that an appropriation may be made to defray the expense of scientific observations, to be taken under the direction of the Secretary of the Smithsonian Institution, or otherwise, as may be deemed expedient by Congress."

Messrs. Everett, Agassiz, Peirce, Bond, and Lovering were appointed a committee to carry the above vote into effect.

The following gentlemen were chosen Fellows of the Academy: —

Professor Benjamin Silliman, Jr., of New Haven;

Professor John P. Norton, of New Haven.

Rev. Dr. Jenks exhibited a copy of an inscription on a rock in the small island of Manānas, near the island of Monhegan, and offered the following remarks: —

"The great simplicity of the strokes, their resemblance to marks for merely scoring articles, often made in the delivery of bulky merchandise; and the supposition, also, that they might have been the occupation of some idle hour, had led me to undervalue them, and speak of them but slightingly. Since, however, mentioning them the last time, before a meeting of the Antiquarian Society, I have had opportunity of seeing the elaborate report on the subject of the American Indians, made by Mr. Schoolcraft, in which he gives an index to the meaning of the celebrated Dighton Inscription. This had been dilated on by Professor Rafn, copiously. But Mr. Schoolcraft has apparently proved that there are two inscriptions of widely differing origin, — that the one may be Runic, and certainly is not Indian, since nothing of an alphabetic character appears in any of their rock-paintings; and that the other is decidedly Indian, as testified by Chingwauk, his assistant examiner and expert in Indian picture-narratives.

"On reading this opinion, which appeared to me more reasonable than any I had seen, I reviewed my transcript, and, comparing it with the various Runic alphabets of various ages exhibited by Hickes in his

Thesaurus, and by Professor Rafn and his coadjutors in their various publications, I found that all the characters or combinations of them, except one, were decidedly Runic, or could be so supposed on good grounds; and even that one might possibly be accounted for in some of the known variations of the alphabet or its contractions. The last two of the characters are precisely similar to the last two of the Runic motto chosen by the Royal Society of Northern Antiquaries, and printed on some of their volumes.

"In the Dighton Inscription not more than six or seven characters are claimed as Runic, or even Phœnician, Punic, or foreign. Here are eighteen at least. They are on the side of a ledge of rock near the middle of the little island Manānas, or, as Williamson writes it, Menannah, which is separated from Monhegan island only by a narrow strait that forms the harbor of the latter.

"The island of Monhegan is only about three leagues from the nearest shore of the continent, and was very early and long frequented after the English began to colonize the country. It consists of one thousand acres, and has nearly one hundred inhabitants; the little island containing the inscription consists of but two acres.

"The characters themselves were reported to me as being about six inches in length, and from a quarter to half an inch deep. On the top of the rock, also, are three excavations, made about one foot apart, triangularly, from two to three inches in diameter, and about one inch deep, as if for receiving a tripod.

"My object, Mr. President, in making this communication, is, as I have said, that, if any gentleman should feel disposed during the summer to visit that vicinity, either for health or pleasure, and has it in his power, he may be induced to make a more accurate and minute copy, or, what is better, take an impression either in *papier maché*, as has been suggested to me by the Librarian of the Athenæum, or in plaster of Paris, clay, or some other substance, so that we may have a certainty of possessing what yet remains of the inscription itself, and that a communication may be made to the Royal Society of Northern Antiquaries at Copenhagen."

Professor Horsford exhibited a globe, having a series of parallel lines drawn upon it, to illustrate Foucault's pendulum experiment, upon which he made some remarks. Further comments upon the same subject were made by Professor Peirce and Dr. B. A. Gould, Jr.

Three hundred and forty-ninth meeting.

August 13, 1851. — Quarterly Meeting.

The President in the chair.

The Corresponding Secretary laid before the Academy a letter of acceptance from Professor Carl Rokitansky, of Vienna.

The following gentlemen were elected Fellows of the Academy : —

Professor John H. C. Coffin, of Washington;

Waldo J. Burnett, M. D., of Boston ;

Nathaniel B. Shurtleff, M. D., of Boston.

Professor Agassiz exhibited some specimens of a new type of Echinoderms; one of Holothuridæ of the genus Orcula, discovered on the coast of Maine, near Eastport, which he called *Orcula punctata ;* one of the genus Synapta, which he called *Synapta coriacea ;* a gigantic Holothuria from Florida, which he called *Holothuria heros ;* and a new species of Ophiura, from Eastport, which he called *Ophiura acufera.*

Three hundred and fiftieth meeting.

October 7, 1851. — Monthly Meeting.

The President in the chair.

On motion of Professor Peirce, it was

" *Voted*, That every communication to the Academy shall, before being made, be entered by its title in a book to be kept by the Recording Secretary for that purpose, and numbered at the discretion of its author, with any number not previously appropriated.

" *Voted*, That communications shall be made to the Academy in the order of their numbers.

" *Voted*, That members shall be requested to note the time their communications will probably require."

After some introductory remarks by Professor Peirce, Mr. Blasius communicated to the Academy the results of a very laborious investigation and analysis of the phenomena of the late destructive tornado in the eastern part of Middlesex County. He had discovered, in the track of the tornado, a series of points of greatest destruction, which succeeded each other at constantly increasing distances. He endeavored to account for the ascertained facts, by referring them to the collision of a northwest and a southwest wind, of which he thought there was satisfactory evidence.

Dr. A. A. Gould stated some additional observations made by him at the time of the occurrence of the tornado.

Mr. Guyot, who had examined a part of the track of the tornado with Mr. Blasius, testified to the accuracy of his observations, but did not coincide with him in his theoretical views.

Professor Peirce thought that some of the phenomena of the tornado were incompatible both with Espy's and with Redfield's theory of storms, and offered some objections to the explanations of Mr. Blasius.

Three hundred and fifty-first meeting.

November 4, 1851. — MONTHLY MEETING.

The PRESIDENT in the chair.

Professor Agassiz gave an account of two families of fishes not before observed in the United States, the Myxinoids and the Erythrinoids, and described a new genus, Phyllobranchus.

Professor Agassiz also communicated some new views in regard to the geological position of the coal at Mansfield, Massachusetts, which led to an animated discussion, in which Mr. Bouvé, Dr. C. T. Jackson, and Professor Horsford took part. He advanced the opinion, that the slate rocks at Nahant are metamorphosed shales of the Mansfield coal formation; that the sienite which overlies them is not the cause of the metamorphic change, and is not an intruded rock, but is itself a metamorphic sandstone of the coal period.

Mr. Bouvé remarked, that, if these views were correct, heat must have been transmitted through the coal-bearing rocks sufficient to melt down and render liquid or semi-liquid the strata superincumbent on them, and enable their elements to rearrange themselves and crystallize, while, at the same time, the shales were not essentially changed in structure. He could not conceive of so intense a heat passing through the shales without annihilating every trace of organic life in them; he should certainly not expect to find any carbon except in the form of graphite.

Professor Agassiz replied to the last observation of Mr. Bouvé, that the coal in these rocks is partly graphite, very similar to that found in Worcester.

Dr. Jackson stated several facts which he considered irreconcilable with the views maintained by Professor Agassiz. He said that no trace had ever been observed of sandstone passing into sienite, and that sandstone contains no potash or soda, while these substances exist abundantly in sienite. He dissented from the opinion formerly advanced by Mr. Agassiz, that the nodules found in the rocks at Nahant are the remains of corals; and stated that they had been found, by microscopic examinations, not to be organic remains.

Professor Agassiz endeavored to account for the presence of potash and soda in the sienite, by supposing them to have been derived through the agency of heat, from the coal included within the slate. He also stated, that he had found one of the nodules to possess the structure of an Astræa.

Dr. Jackson replied, that sandstone is an exceedingly poor conductor of heat, and may be heated to a white heat without undergoing chemical change; and he thought it impossible that it should have been changed through its entire thickness into sienite by heat, — potash and soda transmitted through slate from underlying coal.

Professor Peirce remarked, that the recent solar eclipse of July 28, 1851, had proved quite a triumph for the new lunar tables employed in the construction of the Nautical Almanac, in comparison with those of Burckhardt, with which the European ephemerides were computed. Both in this country and in Europe the errors of theory had been reduced, from

40, 50, or even 65 seconds, to 10, 15, or 20 seconds. He stated that some additional corrections had been received from Mr. Longstreth, which reduce the errors still further, generally to less than 10 seconds, and sometimes to a fraction of a second. Mr. Longstreth's corrections have been adopted in the computation of the Nautical Almanac, which is in preparation for the government of the United States.

Professor J. Wyman made a communication on the metamorphosis of the nervous system in frogs.

Professor Horsford presented a paper, entitled "A Theory explanatory of Internal Fire in the Heavenly Bodies, and of Light and Heat in the Case of Luminous Bodies," by the Rev. Edmund B. Cross.

On motion of Professor Horsford, it was voted, that the paper be referred to the Rumford Committee.

Three hundred and fifty-second meeting.

November 12, 1851. — Quarterly Meeting.

The President in the chair.

The Corresponding Secretary laid before the Academy letters of acceptance from Professor Johann Müller and Professor Johann Friedrich Encke, both of Berlin, Professor Benjamin Silliman, Jr., of New Haven, and John Le Conte, M. D., of New York, in reply to notifications of their election as Fellows of the Academy.

The Academy then took up the nomination list.

Mr. T. S. Hunt, of Montreal, Lower Canada, was elected a Fellow of the Academy.

" *Voted*, That when the Academy shall adjourn, it adjourn to meet in three weeks from this time."

DONATIONS TO THE LIBRARY,

FROM JUNE, 1850, TO DECEMBER, 1851.

United States Government, through Hon. R. C. Winthrop.

Letter of the Secretary of the Treasury, transmitting the Report of the Superintendent of the Coast Survey, showing the Progress of that Work during the Year ending November, 1849. 8vo pamph. Washington, 1850. (Pub. Doc.)

Report of Professor A. D. Bache, Superintendent of the Coast Survey, showing the Progress of that Work for the Year ending October, 1850. 8vo pamph. Washington, 1851. (Pub. Doc.) (Through Professor A. D. Bache.)

Maps of Cat and Ship Island, Hyannis Harbor, and Pasquotank River, by the United States Coast Survey. (Presented by A. D. Bache, by Request of Hon. R. C. Winthrop.)

Report of the Secretary of the Treasury on the State of the Finances. December, 1849. 8vo. (Pub. Doc.)

Report of the Secretary of the Treasury, transmitting a Report from the Register of the Treasury of the Commerce and Navigation of the United States, for the Year ending the 30th of June, 1849. 8vo. (Pub. Doc.)

Message from the President [with accompanying documents]. December, 1849. 3 vols. 8vo. (Pub. Doc.)

Report of the Commissioner of Patents, for the Year 1849. Part I. Arts and Manufactures. 8vo. Washington, 1850. (Pub. Doc.)

Report of the Secretary of War, communicating the Report of an Exploration of the Territory of Minnesota, by Brevet Captain Pope. 8vo. Washington, 1850. (Pub. Doc.)

Report of the Secretary of War, communicating Information in Relation to the Geology and Topography of California. 8vo. Washington, 1850. (Pub. Doc.)

Reports of the Secretary of War, with Reconnoissances of Routes from San Antonio to El Paso. Also the Report of Captain R. B. Marcy's Route from Fort Smith to Santa Fé; and the Report of Lieutenant J. H. Simson, of an Expedition into the Navajo Country; and the Report of W. H. C. Whiting's Reconnoissances of the Western Frontier of Texas. 8vo. Washington, 1850. (Pub. Doc.)

Historical and Statistical Information respecting the History, Condition, and Prospects of the Indian Tribes of the United States: collected and prepared under the Direction of the Bureau of Indian Affairs, by Act of Congress of March 3d, 1847. By Henry Schoolcraft, LL. D., illustrated by S. Eastman, Capt. U. S. A. Part. I. Folio. Philadelphia, 1851.

Smithsonian Institution.

Smithsonian Contributions to Knowledge. Vol. II. 4to. Washington, 1851.

Smithsonian Contributions to Knowledge. The Classification of Insects from Embryological Data, by Professor Louis Agassiz. 4to pamph. Cambridge, 1850. (Through the Author.)

Notices of Public Libraries in the United States of America, by C. C. Jewett. 8vo pamph. Washington, 1851. (Through the Author.)

Fourth Annual Report of the Board of Regents of the Smithsonian Institution for 1849. Washington, 1850.

Academy of Natural Sciences of Philadelphia.

Journal of the Academy of Natural Sciences of Philadelphia. New Series. Vol. II. Part. I. 4to. Philadelphia, 1850.

Boston Society of Natural History.

Proceedings of the Boston Society of Natural History. Vols. I.–III. 8vo. Boston, 1844–51. (Through Dr. Nathaniel B. Shurtleff.)

Boston Journal of Natural History. Vol. VI. No. 2. 8vo. Boston, 1850.

Lyceum of Natural History of New York.

Annals of the Lyceum of Natural History. New York. Vol. V. Nos. 2, 3. 8vo pamph.

American Antiquarian Society.

Transactions and Collections of the American Antiquarian Society. Vol. III. Part I.

Proceedings of the American Antiquarian Society. Annual Meeting, October 23, 1849; and the Meetings in Boston, May 29, and at Worcester, October 23, 1850. 8vo pamph.

American Oriental Society.

Journal of the American Oriental Society. Vol. II. 8vo. New York and London, 1851.

New York University.

Fourth Annual Report of the Regents of the University, on the Condition of the State Cabinet of Natural History, and the Historical and Antiquarian Collection annexed thereto. 8vo. Albany, 1851.

Sixty-third and Sixty-fourth Annual Reports of the Regents of the University of the State of New York. 8vo. 2 vols. Albany, 1850–51.

Association of American Geologists and Naturalists.

Reports of the First, Second, and Third Meetings of the Association of American Geologists and Naturalists, at Philadelphia in 1840 and 1841, and at Boston in 1842. 8vo. Boston, 1843.

New York Mercantile Library Association.

Annual Report of the Board of Directors of the Mercantile Library Association, Clinton Hall, New York, January, 1851. 8vo. New York.

Astor Library.

Alphabetical Index to the Astor Library, or Catalogue with Short Titles of the Books now collected, and of the Proposed Accessions, as submitted to the Trustees of the Library for their Approval. January, 1851. 8vo. New York.

Samuel Swett, Esq.

Who was the Commander at Bunker Hill? With Remarks on Frothingham's History of the Battle. 8vo pamph. Boston, 1850.

Nathaniel B. Shurtleff, M. D.

A Perpetual Calendar for Old and New Style; prepared for the Use of those engaged in Antiquarian and Historical Investigations. 8vo. Boston, 1848.

Another copy. Second edition. 4to. Boston, 1851.

Professor Robb.

Journal of the New Brunswick Society for the Encouragement of Agriculture, Home Manufactures, and Commerce. 8vo. Fredericton, N. B., 1850.

Report on the Agricultural Capabilities of the Province of New Brunswick. By J. F. W. Johnston, F. R. S., &c. 8vo. Fredericton, 1850.

American Medical Association.

Report of the Committee on Medical Sciences, presented at the Third Annual Meeting of the American Medical Association, Cincinnati, May, 1850. By Usher Parsons, M. D., Chairman. 8vo pamph. Philadelphia, 1850. (Through the Author.)

Edward Jarvis, M. D.

On the Comparative Liability of Males and Females to Insanity, and their Comparative Curability and Mortality when Insane. By Edward Jarvis, M. D. Read before the Association of Medical Superintendents of American Institutions for the Insane, at Boston, June, 1850. 8vo pamph. Utica, 1850.

Joseph Leidy, M. D.

Description of some Annelida Abranchia. (Article III., Journal of the Academy of Natural Sciences, Vol. II. N. S.)

Special Anatomy of the Gasteropoda of the United States. By J. Leidy, M. D. 8vo. Plates.

Samuel G. Morton, M. D.

Letter to the Rev. John Bachman, D. D., on the Question of Hybridity in Animals, considered in Reference to the Unity of the Human Species. By S. G. Morton, M. D., &c. 8vo pamph. Charleston, 1850.

Additional Observations on Hybridity in Animals, and on some Collateral Subjects. 8vo pamph. Charleston, 1850.

Notes on Hybridity, designed as a Supplement to the Memoir on that Subject. 8vo. Philadelphia, 1850.

Ibid. Second Supplement. January, 1851.

Professor C. B. Adams.

Contributions to Conchology.

J. W. Foster and J. D. Whitney.

Report on the Geology of a Portion of the Lake Superior Land District, in the State of Michigan. By J. W. Foster and J. D. Whitney, U. S. Geologists. Part I. Copper Lands. 8vo. Washington, 1850.

C. T. Jackson, M. D.

Report on the Geology of the Mineral Lands of the United States in Michigan. By C. T. Jackson, M. D., U. S. Geologist. 8vo. Washington, 1849.

Mrs. Binney.

The Terrestrial Air-breathing Mollusks of the United States and the adjacent Territories of North America. Described and illustrated by Amos Binney. Edited by Augustus A. Gould, M. D. 4to. 2 vols. Boston, 1851.

N. I. Bowditch, Esq.

A History of the Massachusetts General Hospital. By N. I. Bowditch. 8vo. Boston, 1851.

Hon. Josiah Quincy.

The History of the Boston Athenæum, with Biographical Notices of its Deceased Founders. By Josiah Quincy. 8vo. Cambridge, 1851.

B. A. Gould, Jr., P. D.

On the velocity of the Galvanic Current in Telegraph Wires. By B. A. Gould, Jr., in a Report to A. D. Bache, LL. D., &c. 8vo pamph.

Astronomical Journal, Nos. 2 and 4 to 28. 4to. Cambridge, 1849 – 1851.

Charles Girard.

Essay on the Classification of Nemertes and Planariæ : preceded by some General Considerations on the Primary Divisions of the Animal Kingdom. 8vo. (Ext. Ann. Sci. Nat., 3d Ser., Vol. IV. 1845.)

Royal Irish Academy.

Transactions of the Royal Irish Academy. Vol. XXII. Part II. 4to. Dublin, 1850.

Proceedings of the Royal Irish Academy. Vol. IV. 8vo. Dublin, 1850.

The Royal Society of London.

Philosophical Transactions of the Royal Society of London, for 1849 (Part II.), 1850 (Parts I. and II.), and 1851 (Part I.). 4to.

Proceedings of the Royal Society of London. Nos. 73 – 75, and Nos. 77, 78. 8vo pamph.

Lists of the Royal Society for 1849 – 50. 4to.

Magnetical and Meteorological Observations made at the Royal Observatory, Greenwich, in the Year 1847, under the Direction of G. B. Airy, Esq., M. A. 4to. London, 1849.

Catalogue of 2156 Stars, formed from the Observations made during Twelve Years, from 1836 to 1847, at the Royal Observatory, Greenwich. 4to. London, 1849.

Cancels for the Introduction to the Reductions of the Greenwich Lunar Observations. 4to. London.

Address of the Right Honorable the Earl of Rosse, the President, read at the Anniversary Meeting of the Royal Society, on Friday, November 30, 1849. 8vo. London, 1850.

Astronomical, and Magnetical and Meteorological Observations, made at the Royal Observatory, Greenwich, in the Years 1848 – 49. 4to. 2 vols. London, 1850.

Observations made at the Magnetical and Meteorological Observatory at Hobarton, in Van Diemen's Island, and by the Antarctic Naval Expedition. Vol. I., commencing with 1841. With Abstracts of the Observations from 1841 to 1848. 4to. London, 1850.

Observations on Days of Unusual Magnetic Disturbance, made at the British Colonial Magnetic Observatories. Vol. I. 1840 to 1844. 4to. London.

G. B. Airy, Astronomer Royal.

Fallow's Cape Observations. 4to. (Ext. Mem. R. Ast. Soc., Vol. XIX.) London, 1850.

Lieutenant-Colonel Edward Sabine.

On the Means adopted in the British Colonial Magnetic Observatories for determining the Absolute Values, Secular Change, and Annual Variation of the Terrestrial Magnetic Force. By Lieutenant-Colonel Edward Sabine, F. R. S., &c. 4to pamph. London, 1850.

Charles Brooke, Esq., F. R. S., &c.

On the Automatic Registration of Magnetometers and Meteorological Instruments by Photography. By Charles Brooke, F. R. S., &c. 4to pamph. London, 1850.

Royal Institution of Great Britain.

List of Members, Officers, &c., with the Report of the Visitors of the Royal Institution of Great Britain, for the Year 1849. 8vo pamph. London, 1850.

John Kinnersley Smithies.

Essay on the Theory of Attraction. By John Kinnersley Smithies. 4to pamph. London, 1850.

Henry Raper, R. N.

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Professor William R. Hamilton, LL. D.

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Three hundred and fifty-third meeting.

December 2, 1851. — MONTHLY MEETING.

The PRESIDENT in the chiar.

Professor Peirce communicated a mathematical paper, entitled " A Case in the Theory of Probabilities."

Mr. Desor made some remarks upon the origin of the contorted strata of sand and clay in the diluvial deposits, which had recently been the subject of some discussion in the Geological Society of London. Instances of similar strata occur frequently in the neighborhood of Boston, and throughout New

England. They have been ascribed by Professor Hitchcock and others to the action of icebergs pressing laterally against the strata. This theory, however, is no longer admissible, since it is not uncommon to find such curved and looped strata alternating with others that are perfectly horizontal both above and below; besides, these peculiar loops and curves are traceable for too great a distance (several hundred feet) to be the result of a mere lateral action. It has been suggested by Mr. Trimmer, that they are probably the result of masses of ice stranded on the shores, and afterwards buried under sand and mud. In consequence of subsequent melting, the overlying sand and mud would necessarily subside, and, by their subsidence, cause such curved outlines as we witness in the drift. This theory is unquestionably the correct one; and, moreover, its correctness has been experimentally demonstrated. Mr. Edward C. Cabot several years ago buried pieces of ice in the sand of the beach at Beverly. When he came to examine the superincumbent strata after the melting of the ice, he found them contorted and looped in a manner resembling very much the curvatures of the drift strata. It is to be hoped that Mr. Cabot will, at some future meeting, communicate to the Academy the results of his experiments.

Dr. W. F. Channing exhibited to the Academy two discs of paper from the Boston and New York and Boston and Burlington lines of the Bain Telegraph, being the record of the great aurora of the 29th of September. On the evening of that day, the sky was overcast in Boston, but the attention of the telegraph operators on all the lines was early drawn to a remarkable display of electric phenomena. All of the telegraphic instruments were overpowered by currents of atmospheric electricity coming in over the wires, lasting, unlike the usual atmospheric disturbances, for several minutes at a time, and in opposite directions in the early and later part of the evening. The strength of the atmospheric current was generally estimated as about equal to one hundred Grove's elements.

The instruments of the Morse and House Telegraphs were merely locked by the atmospheric current, without furnishing means of observing its direction. Fortunately, the current gives opposite results on Bain's prepared paper when traversing it in different directions. In the specimens exhibited, the paper was seen to be marked with deep blue lines, where the wire pen-point had been the negative pole of the atmospheric current, and the slightly blue paper was seen to be bleached when it had been the positive pole.

The most remarkable exhibition, however, was in the burning of the paper in several places in the track of the pen-point, and for distances corresponding to several minutes of time. This is probably the most continuous and extensive exhibition of atmospheric electricity in connection with the aurora on record. The aurora itself, on the 29th of September, was a very remarkable display. It is to be regretted that precise and comparative observations were not made upon the Bain wires proceeding in different directions from this city. The phenomena, however, on the New York and Burlington lines seem to have been identical.

Dr. A. A. Gould, exhibited a specimen of a new method of electrical telegraphic recording.

Professor Guyot exhibited an interesting experiment, devised by Professor Snell, to show the motions of water contained in a tall glass jar, when made to rotate with various degrees of velocity, by means of four flat metallic radii attached to the lower extremity of a vertical axis, and situated a little above the middle of the jar. Assuming the motions of the water in this experiment to be essentially similar to those of the air in a tornado, he proceeded to explain many of the phenomena of the late tornado in Middlesex County. He was of opinion that a whirlwind was produced by the conflict of opposite winds at a considerable height above the ground, and that warm air from below and cold air from above, rushing towards the centre of the vortex, caused by their mixture the formation of snow and hail.

He also stated reasons for supposing that the apex of the vortex would alternately approach to, and recede from, the ground, and hence, possibly, the series of points of excessive destruction observed in the track of the late tornado.

Mr. J. H. Abbot thought, that, instead of air descending from above, the rarefied air in the centre of the vortex would ascend, in consequence of its diminished specific gravity; and in proof of the existence of strong ascending currents of air within and above cumulus clouds, he referred to the fact that a dog connected with a parachute, having been dropped from a balloon by M. Blanchard in 1787, was borne above the clouds by a whirlwind, and there sustained till Blanchard had descended almost near enough to take it into the car again!

The further discussion of the subject was postponed till the next monthly meeting.

Three hundred and fifty-fourth meeting.

December 3, 1851. — Adjourned Quarterly Meeting.

The President in the chair.

Professor Peirce, in behalf of the committee appointed to consider the arrangement into classes, and the restriction of the numbers, of the Fellows and Members of the Academy, presented the following report: —

"The present number of the Fellows and Members of the Academy is about two hundred and eighty, of whom one hundred and thirty are inhabitants of Massachusetts, about eighty reside in other portions of the United States, and about seventy are Foreign Honorary Members. They are quite unsystematically and disproportionably distributed through the various departments of science, and they have not, apparently, been selected in all cases with sufficient regard to legitimate scientific claims. The committee are of opinion, that the true remedy of this difficulty consists in the proper limitation of the number of members. For when nominations are exclusively to vacancies, and the election of one member prevents, at least temporarily, that of opposing candidates, a strong interest will be excited in the society to enroll upon their list the worthiest names, and obtain for the Academy a higher reputation for sound judgment in this respect.

"In order to give a general basis for the equal distribution of members, and prevent the collision of claims too remote for comparative measurement, a proposition is offered for limiting the number of members in the several departments of learning. It is not, however, proposed to render this limitation so minute and special in its character, as to embarrass the action of the Academy, and clog the freedom of selection by an unyielding chain of details. But it is thought, that, if a classified list of all the members is constantly kept, in which they are arranged under the special sciences to which they are devoted, it will prove to be a judicious restraint in the choice of candidates, and an effectual safeguard against their unequal distribution in the different departments.

"The views of the committee are definitely embodied in the following proposed additions to Chapter VII. of the Statutes, the title of which shall be, 'Of Fellows and Foreign Honorary Members.' It will be observed that no provision is made for limiting the number of Fellows resident in Massachusetts, because it is already provided by the charter that this number shall not be less than forty, nor exceed two hundred.

"'2 *a.* Fellows residing out of the State of Massachusetts shall be known and distinguished as Associate Fellows. Associate Fellows shall not be liable to the payment of any fees or annual dues, and shall not vote at meetings of the Academy, but on removing within the State, shall be admitted to the privileges, and subject to the obligations, of Resident Fellows.'

"'2 *b.* The nomination and election of Associate Fellows shall take place in the manner and under the conditions prescribed in the first article, for Resident Fellows; and moreover, each nomination shall be publicly read and referred to the Council designated in the third article, at a statute meeting previous to that of the election; and a written approval, authorized at a meeting of said Council by a vote of a majority of its members then present, signed by at least *seven* of said Councillors, and read at the time of the election, shall be requisite to entitle the candidate to be balloted for. The Council may, in like manner, originate nominations of Associate Fellows, which must be read at a statute meeting previous to that of the election, and exposed upon the nomination list during the interval.'

"'4. The number of Foreign Honorary Members shall not exceed *seventy-five*, and they shall be chosen from among those most eminent in foreign countries for their discoveries and attainments in either of the three great departments of knowledge, viz.: — 1st. The Mathematical and Physical Sciences; 2d. The Natural and Physiological Sciences; 3d. The Moral and Political Sciences. And there shall not be more than *thirty* members in either of these three departments.'

"'5. The number of Associate Fellows shall not exceed *one hundred*, of whom there shall not be more than *forty* in either of the three departments of knowledge designated in the fourth article.'

"'6. It shall be the duty of the Council designated in the third article to nominate, on due consideration, at meetings convened for the purpose, and as vacancies occur, the most suitable candidates for Foreign Honorary Members, to prepare and keep a list of the Fellows, of the Associate Fellows, and of the Foreign Honorary Members, classified according to the general departments of knowledge indicated in the fourth article, and arranged in subdivisions in respect to the special sciences in which they are severally proficient. It shall also be the duty of the Council to exercise a discreet supervision over all the nominations and elections, and to exert their influence to obtain and preserve a due proportion in the number of Fellows and Members in each of the special subdivisions.'"

The committee also recommended the adoption of the following votes: —

"*Voted*, That the Council be, and hereby are, directed to report to the next statute meeting of the Academy a list of all the actual Fellows and Members, arranged in the following divisions, with a statement of the number of each division.

"FIRST CLASS. — MATHEMATICAL AND PHYSICAL SCIENCES.

First Division.	Mathematics.
Second Division.	Practical Astronomy and Geology.
Third Division.	Physics and Chemistry.
Fourth Division.	Technology and Engineering.

"SECOND CLASS. — NATURAL AND PHYSIOLOGICAL SCIENCES.

First Division.	Geology, Mineralogy, and Physics of the Globe.
Second Division.	Botany and Vegetable Physiology.
Third Division.	Zoölogy and Animal Physiology.
Fourth Division.	Medicine and Surgery.

"THIRD CLASS. — MORAL AND POLITICAL SCIENCES.

First Division.	Moral and Intellectual Philosophy.
Second Division.	Philology and Ethnology.
Third Division.	Politics, Political Economy, and Jurisprudence.
Fourth Division.	Æsthetics."

"*Voted*, That the Secretaries be authorized and directed to cause to be prepared a suitable diploma or form of notification of election for the Foreign Honorary Members."

Dr. B. A. Gould, Jr. presented to the Academy, in behalf of its author, a volume entitled "The Exposition of 1851, or Views of the Industry, Science, and Government of England, by Charles Babbage, Esq.," and called attention to a new and uniform system of lighthouse signals, recommended by Mr. Babbage for universal adoption.

Three hundred and fifty-fifth meeting.

January 6th, 1852, — MONTHLY MEETING.

The PRESIDENT in the chair.

Professor Peirce, in behalf of the committee to whom was referred Lieutenant C. H. Davis's paper on the subject of the deterioration of Boston harbor, read the following report: —

"The committee to whom was referred the memoir of Lieutenant C. H. Davis upon the state of Boston harbor, have examined the same, and ask leave respectfully to report, that the memoir contains an enumeration of several changes that appear, by a comparison of the charts made at various times, and by other evidence, to have taken place in some of the most important channels of the upper harbor. This part of the memoir embraces a subject entirely local in its character; yet its importance, as affecting the prosperity of a great maritime city, our birthplace and home, may well compensate for the absence of that general interest which belongs to many other subjects of our transactions. The memoir, furthermore, contains an examination of the various causes by which the changes of the harbor have been brought about, influenced, or modified, and by which further changes may be produced. These causes are intimately connected with those general hydraulic forces which are at work wherever tides and streams are known upon the earth's surface, and have thus a character as general as most subjects of geology or physical geography. The examination of these hydraulic forces, constantly at work in all tidal harbors, has led the author of the memoir to a general specification of the principles which ought always to govern constructions for the improvement of such harbors ; and many rules are laid down, the understanding of which must be useful to the hydraulic engineer.

"The committee trust that this short summary of the contents of the memoir will enable the Academy to make a proper disposition of it. They abstain from expressing any opinion upon the accuracy or completeness of the memoir, as they hold to the wisdom of the rule, that the Academy will not, by itself or its committee, become responsible for the accuracy of any facts or opinions expressed by the authors of any memoirs.

"The committee recommend that the memoir of Lieutenant Davis be referred to the Committee on Publications. All of which is respectfully submitted.

"DANIEL TREADWELL,
BENJAMIN PEIRCE,
JOSEPH LOVERING,
HENRY L. EUSTIS,
MORRILL WYMAN.

"*Boston, January 6th*, 1852."

Voted, to refer the paper to the Committee on Publications.

The discussion of the subject of Mr. Guyot's communication at the last monthly meeting was continued by Professor Peirce, Dr. W. F. Channing, Mr. J. H. Abbot, Professor Lovering, Professor Eustis, Dr. B. A. Gould, Jr., Professor Horsford, and Dr. Jacob Bigelow.

Professor Peirce expressed his dissent from the opinion advanced by Professor Guyot, in respect to the amount of elevating force possessed by any whirlwind, which could be generated by the conflict of opposite winds. He computed the amount of this force in the case of a rotating body of air, extending the full height of the atmosphere, and demonstrated that it was insufficient to account for the phenomena to be explained. He also computed the elevating force possessed by a column of air extending to the upper regions of the atmosphere, the temperature of which he supposed to have been raised, according to the principles of Espy's theory, forty degrees Fahrenheit, by the condensation of the aqueous vapor previously contained in it; and he inferred the existence, in this case, of a force capable of elevating bodies of considerable weight.

He stated that he had not been able to test the electrical theories by a similar process of computation, for want of sufficiently definite ideas of their nature. He thought, however, that indications of electrical action in tornadoes were so strong, as to make it very desirable that electricians should investigate the data requisite for such a computation.

Dr. W. F. Channing was satisfied that the causes usually assigned were insufficient to account for the mechanical effects of tornadoes, and was glad that a calculation of the forces of various theories had been undertaken by Professor Peirce. "The rotation in these storms is insufficient to produce a vacuum in the axis of the whirl, adequate to the elevation of heavy bodies by the means of the in-rushing and ascending air. In a water-spout which he had observed on Narraganset Bay, in 1845, the rotation of the trunk was obviously too slow to account for the elevation of the water which took place in the axis. An observer at Somerville had distinctly seen the rotation of the column of the tornado at West Cambridge, a mile and a half or two miles distant. When the smallness of the diameter of this revolving column (a few hundred feet) was considered, the velocity of rotation was at once reduced to a rate insufficient to account for the mechanical effects produced.

"In the beautiful experiment exhibited by Professor Guyot at the last meeting of the Academy, there was a permanent cause of rotation in the upper strata of the revolving fluid; that fluid was inelastic, and it was confined within the walls of a cylinder, which prevented the dispersive effect of the centrifugal force. In the case of the tornado, there is no known intense and persistent cause of rotation at a given point in the upper atmosphere, and the effect of that rotation could hardly be propagated downwards through an elastic fluid by a narrow trunk, and without an adequate resisting agency to the centrifugal force. From both observation and theory, Dr. Channing was therefore disposed to regard the rotation as incidental to these phenomena, rather than their primary cause.

"It was necessary to have an axial cause which should continue to operate during the existence of the tornado, and confine these energetic phenomena within the limits of the trunk where the most powerful action takes place. The effect of rotation was to produce dispersion rather than this intense axial action so peculiarly restricted.

"Tornadoes are described usually as preceded or followed by electric phenomena, but rarely as accompanied at the same time with active electrical discharges. In the tornado, however, which crossed Providence River, in 1838, the trunk was seen to descend from the cloud, and the water to be agitated and raised beneath it. Successive flashes of electricity then passed through the trunk, apparently from the water to the cloud above. After each discharge, the agitation of the water appeared immediately to subside for a moment. Here was the common phenomenon of the spark drawn from the prime conductor, and the falling of the pith balls. The disturbance and elevation of the water under the point of the descending trunk, long before the completion of the column or any visible mechanical connection exists, is a fact of common observation in water-spouts. There is, therefore, reason from observation to infer a silent discharge of electricity by means of these trunks during a tornado. Such a discharge is, indeed, always a necessity of the case, the trunk of the tornado serving as a partial conductor between the clouds and earth. The tornado seems to exist, as a general rule, precisely when the moisture of the air or some other cause determines a silent discharge of electricity, instead of a discharge in the common form of the flash.

"When a trunk reaches down from a cloud, electrically excited, the discharge of electricity must resemble in character that from a point. With our small machines, the electricity, escaping from a pointed rod attached to the prime conductor, electrifies the air, and produces a blast sufficient to turn a small wheel. Yet Faraday estimates that several hundred thousand, or even million, turns of such a machine, are required to give the amount of electricity contained in a single flash of lightning; and the clouds from which the trunk of the tornado descends may perhaps furnish many hundred such flashes. On the scale of nature, therefore, this may become an intense axial force, producing powerful currents of air and other convective effects. If a silent electrical discharge between a great mass of clouds and the earth should be excited at a given point, the formation and descent of the trunk would almost necessarily follow, and a cause of permanent axial action would be established.

"The clouds, also, are huge floats, having a certain buoyancy, and liable to be drawn down towards the earth by electrical attraction. They must exert an equal reaction upon bodies on the surface of the earth. With our small machines, light bodies are raised in opposition to gravity, by an excited body held at some distance above them. On the immense scale of nature, this may also become a powerful cause antagonistic to the gravity of bodies, especially near the axis of convective discharge, where the inductive power of great masses of clouds is concentrated.

"These electrical causes are not presented as a theory of the tornado, to the exclusion of other active forces. They are, however, primary in their character, and based on familiar facts and analogies. They should therefore be subjected to mathematical calculation before they are set aside as insufficient to produce powerful mechanical effects."

Mr. J. H. Abbot, in addition to the theoretical objections which had been urged against the whirlwind theory, stated several observed facts, and referred to various forms assumed by the tornado cloud as figured in Peltier's work, "Sur la Formation des Trombes," which he considered as utterly irreconcilable with that theory. He objected to the electrical theories of tornadoes as unsatisfactory, inasmuch as they refer the elevating force to the *attraction* between the cloud and subjacent bodies on the earth's surface. "The cloud with its cone is not a fixed, coherent mass, but is composed of free, disconnected, and mutually repellent parts, which are situated at unequal distances from the earth, and are therefore unequally attracted by its oppositely electrified surface; so that the only obstacle to the descent of the lower parts, in obedience to the electrical attractions, is their inferior specific gravity, compared with that of the underlying air. Any attraction, therefore, exerted by the cloud, sufficient to raise into the air men, wagons, and other heavy bodies, must necessarily, it should seem, cause the lowest and most strongly attracted portions of the cloud to rush with immense velocity to the earth, to be followed by others in their turn; a phenomenon which has never been observed."

The principal elevating agency of electricity in tornadoes had, he thought, been entirely overlooked by those who had written on the subject. This agency consisted, as he conceived, in augmenting the mutual repulsion of the particles of air and water composing the cloud, and thereby expanding it, and diminishing its specific gravity to an indefinite extent. "Hence must result great elevating force. The contiguous portions of the underlying air being acted upon by powerful attraction from above, and superior pressure from beneath, must rush up into the cloud with great velocity, and be followed by other portions in their turn. As this effect accumulates and is greatest in the cone where the electrical repulsion and consequent rarefaction are the greatest, the ascending currents of air must constitute a force capable of raising very heavy bodies. The cold that will result from this great expansion may account for the hail that usually accompanies the tornado."

Professor Lovering observed, that the vast disproportion between the quantity of electricity occasionally collected in the atmosphere, and that which could be held by the conductor of the largest electrical machine, had not, certainly, been exaggerated in the remarks already made. "It should not be forgotten, however, that the conductor, no less than the cloud, might be raised by the feeblest electromotive power to its state of maximum electrical tension, and that this maximum was higher for the conductor than for the cloud, on account of the diminished density of the air at the place where the cloud existed. If, therefore, the electrical attraction between a cloud and the earth is great, it must be the result, not of the surpassing tension of atmospherical electricity, but of the large surface which this tension covers; and the extent of surface must be sufficient to overcompensate for the unusual distance through which the electrical forces act. Although it may be questioned whether the forces thus considered are adequate to produce the terrible mechanical movements which accompany the tornado, they are doubtless competent to draw down the cloud in the form of an inverted pyramid towards the earth's surface. Here the agency of the electrical tension may be supposed to terminate, and that of the quantity to begin to play its part; and as this quantity may be exceedingly great, the effects of its discharge from this cone of cloud pointing to the earth may, in the same proportion, surpass the feats of the electrician in his experiments with the machine of his own invention. In whatever way the motion of the air which is observed at the time of the brush discharge from the pointed conductor is explained, that motion, we may admit, will be multiplied into the force of a hurricane, if it corresponds with the great amount of electricity which has accumulated in the prime conductor of our planet. A reason for the fact that the electricity seeks its way to its resting-place in the solid earth by the *thunderbrush*, and not by the *thunderbolt*, may be found, in one instance at least, in the extraordinary aridity of the earth's surface, in consequence of which that surface could not receive and distribute the charge from one point, but each spot drank its own portion from the inverted cup as it was handed along."

Professor Eustis remarked, that he had carefully surveyed the track of the tornado, and had made a plan of it, in which he had laid down the prostrate trees and other important objects in their exact positions, as determined by an accurate survey. Having formed no theory upon the subject, he had made his observations without bias from that cause. He compared the general appearance of the track to that which would be produced by a heavy body of enormous size, moving forward with great momentum, so as to throw down every obstacle in its path. In one or two places only, the position of the prostrate trees indicated the action of a rotating force. In one place a tree was twisted 180° at the height of ten feet from the ground. Professor Eustis mentioned another fact, which he referred to the direct agency of electricity; namely, that a hole as large as a silver half-dollar, with its edge well defined and free from cracks, though slightly fused, had been made in a pane of glass in an inner window. A considerably smaller hole was found in the window curtain, opposite to the large hole in the glass.

Professor Horsford presented a paper, "On the Permeability of Metals to Mercury," in which, after remarking on the researches of Daniel and Henry, he gave an account of a series of original experiments, with a view to the elucidation of the laws of this phenomenon. The following is a summary, in his own language, of the results at which he arrived: —

1. The specific gravity of lead is increased by saturation with mercury.

2. The velocity of the mercury diminishes as the length of a saturated bar increases, and in a kind of geometrical ratio.

3. The progress is more rapid in cast than in drawn lead.

4. The total height to which the mercury attains is greater in cast than in drawn lead.

5. Gravity facilitates the flow of mercury from above downwards.

6. The mercury which passes through a siphon-shaped bar of lead contains lead in solution.

7. This lead is derived from the interior of the bar.

8. After the transmission of a certain amount of mercury, and the return of this mercury to be passed again, the amount transmitted in a given time attains a maximum.

9. The amount passed in a given time with a given length of the shorter leg of the siphon is dependent on the extent of absorbing surface exposed to the mercury.

10. The siphon action is limited by the same law that determines the height or length of bar through which mercury will pass.

11. Mercury saturated with lead passes through leaden bars.

12. The saturated bar is eminently brittle.

13. The saturated bar contains 3.55 per cent. of mercury, and 96.45 per cent. of lead.

14. The bar saturated with, and afterwards withdrawn from the mercury, lost in seven months, by atmospheric diffusion, 2.75 per cent. of mercury, leaving only .80 per cent. in the bar.

15. In this condition the bar had nearly recovered its original texture.

16. After the loss of a certain amount by diffusion, the surface becomes coated with crystallized amalgam, and the diffusion ceases.

17. The liquid amalgam contains 2.52 per cent.

18. The saturated bar, long in contact with mercury, assumes a crystalline texture, and cracks open.

19. After crystallization commences, the progress of the mercury is impeded.

20. The specific gravity of tin is increased by saturation with mercury.

21. The saturated bar soon opens by numerous fissures presenting crystalline angles and surfaces.

22. The specific gravity of the crystalline amalgam is greater than that of the bar nearly saturated with mercury.

23. The velocity of transmission of mercury through tin is at first slower than that through lead, but it differs in

being uniform, while the velocity in lead diminishes very rapidly.

24. The siphon action with a tin bar cannot be long maintained, on account of the crystallization and consequent brittleness of the bar.

25. The crystalline amalgam has a constitution of $Hg\ Sn_3$.

26. The liquid amalgam contained 1.55 per cent. to 1.73 per cent. of tin.

27. The crystalline amalgam loses nothing by atmospheric diffusion.

28. Quicksilver permeates gold and silver, but very slowly.

29. Zinc and cadmium are permeable to mercury, but dissolve in it.

30. Iron, platinum, palladium, and copper bars are not at common temperatures permeable to mercury.

Three hundred and fifty-sixth meeting.

January 28, 1852. — Adjourned Statute Meeting.

Professor Peirce in the chair.

The Recording Secretary reported a list of the Members of the Academy, arranged in classes and sections by the Council, agreeably to the vote of the Academy at its last statute meeting.

The Academy then proceeded to consider the amendments to the statutes reported by Professor Peirce at the last statute meeting. After some discussion, it was

Voted, That the amendments to the statutes, proposed at the adjourned statute meeting held December 3, 1851, be adopted.

Dr. B. A. Gould, Jr. stated several reasons, which he thought rendered it desirable that the nomination of Foreign and Associate Members should be vested, as far as practicable, in those sections of the Academy, to which, if elected, they would belong. After a long discussion, he offered the following amendment to the statutes: —

"The Council for nomination shall consist of the President, Vice-President, and the two Secretaries, together with three Fellows from each of the three classes of the Academy, to be elected by ballot at the annual meeting: and it shall be the duty of the Council, in nominating Foreign and Associate Members, to consult the wishes of that section of the Academy to which, if elected, the candidate would belong."

On motion of Mr. Gould, it was

Voted, That this proposed amendment be referred to a special committee, with instructions to report it, with such modifications as they may deem expedient, for the action of the Academy at their annual meeting in May.

Voted, That Professor A. Gray, Professor Horsford, Dr. B. A. Gould, Jr., Dr. W. F. Channing, and Mr. J. D. Whitney be that committee.

Three hundred and fifty-seventh meeting.

February 3, 1852. — Monthly Meeting.

The President in the chair.

Professor Peirce made an oral communication of considerable length, on the "Surface of Least Extent."

Professor Eustis exhibited to the Academy a very elaborate and beautifully executed plan, on a large scale, of three miles and a quarter of the track of the late tornado in Middlesex County, beginning at Wellington Hill in Waltham, and extending north 70° east to Mystic River. He commenced the survey ten days after the occurrence of the tornado, and completed it in eleven days, with the help of twenty assistants. In describing his method of conducting the survey, he stated that he first determined a central line, and then divided the track into sections, by transverse lines at intervals of one hundred feet. He measured the exact position and direction of every important object with reference to these lines. He pointed out some of the more striking features of the tornado as indicated by his plan.

On motion of Professor Peirce, it was

Voted, That Professor Eustis's plan be referred to a special committee.

Voted, That Hon. R. C. Winthrop, Professor Peirce, J. I. Bowditch, Esq., Mr. G. B. Emerson, and Professor Lovering be that committee.

Dr. C. T. Jackson exhibited a specimen of cannel coal from the Peyton coal mine, situated on a tributary of the Kenhawa, in Virginia. He stated that the coal-bed is horizontal, and from six to eight feet in thickness; and called attention to the electrical attraction which is developed in the coal by friction, a property which he had observed in a few instances in coal taken from other mines.

Dr. W. F. Channing remarked, "that the arrangement of the Municipal Fire Telegraph, now approaching its completion in Boston, presents a very close analogy with the nervous system of the individual. This was the result of no theory, but a practical necessity, in order to unite the various parts of the Municipal system by an intelligent and coöperative law.

"Thus in the Fire Telegraph there is a centre which is the *brain*, the common reservoir of nervous or electric force for the whole system, presided over by an intelligent will (the watchman of the central station). From this centre radiate two classes of electric conductors or nerves. The first of these, the 'Signal Circuit,' conveys impressions *to* the centre, and is '*afferent*,' '*sensitive*.' The second of these, the 'Alarm Circuit,' conveys impressions *from* the centre, and is '*efferent*,' '*motor*.' When any disturbance occurs at the circumference of the system, it is signalized from the 'Signal Boxes,' which are the '*sensitive extremities*' of the sensitive conductors to the centre; from which, after an act of intelligence and volition, an impulse to appropriate or corresponding action is instantly sent over the motor nerves or conductors to the various belfries, where the electric or nervous agent animates the *iron limbs*, by means of the contraction of *electro-magnetic muscles*, thereby releasing powerful machinery to strike a single blow upon each of the bells. By a combination of such blows, by the act of the intelligent will at the centre, district signals, or any others, may of course be struck.

"The perfection of this analogy is a guarantee, in addition to the various ends of security and intelligent action which are thus obtained, that the arrangement is in conformity with a natural law."

Professor Eustis called attention to an optical illusion which takes place when an isometric drawing is seen in a vertical position from a certain point of view, but which fails when the drawing is horizontal or much inclined, namely, the apparent convergence of the parallel lines.

Dr. C. T. Jackson stated "that he had lately had an opportunity of examining the specifications and drawings accompanying the patent for an apparatus, invented by Dr. Gorry, for making ice by compression of air, abstraction of the heat by a jet of cold water, and by a sudden expansion of this condensed air by means of an air-pump worked by steam; the heat being suddenly absorbed by the expanding air. This method has been employed for the production of large blocks of ice, one of which, in a single piece, is said to have weighed 600 pounds. It is stated by Professor Renwick, that the cost of making three tons of ice will not be more than ten dollars.

"It is now proposed to employ this machine for the freezing of water for the production of fresh from sea-water; the fresh water only freezes, and the brine is to be drawn off. Three successive freezings will make sea-water fresh and drinkable. Dr. Jackson thinks this method worthy of trial on board the ocean steamers, which have an abundance of steam-power always ready. The machine is described as not cumbersome, and capable of being worked easily on board ship.

"The principal difficulty is in preventing the effects of expansion of freezing water in the apparatus, which is liable to be burst thereby."

Three hundred and fifty-eighth meeting.

February 24, 1852. — Special Meeting.

The President in the chair.

J. I. Bowditch, Esq., in the absence of the chairman of the committee appointed to confer with the Trustees of the Boston Athenæum, on the subject of obtaining a room for the use of the Academy in the Athenæum, made a report. After much discussion, it was *voted*,

1. That the report of the committee be accepted.

2. That the contract entered into by the committee, in behalf of the Academy, for the use of the northeast room on the lower floor of the Athenæum, for the period of ten years, on the terms specified in the committee's report, be ratified.

3. That the same committee be empowered to complete the arrangement with the Trustees of the Athenæum.

4. That the same committee be empowered to effect the removal of the books belonging to the Academy, and to dispose of the book-cases in such manner as they may see fit.

Three hundred and fifty-ninth meeting.

March 2, 1852. — Monthly Meeting.

The President in the chair.

Mr. Winthrop, in behalf of the committee on the subject of Professor Eustis's plan of the late tornado, submitted the following report: —

"The committee of the Academy, to whom was referred a plan exhibiting the ravages of the tornado of August, 1851, by Professor H. L. Eustis, beg leave to report, —

"That they have examined this map with great interest, and are unanimously of the opinion, that it forms a very valuable contribution to the cause of meteorological science.

"In meteorology, as in every other science, much more depends on the fidelity and accuracy of observations and experiments, than on the multiplicity of them. A single tornado, carefully and thoroughly surveyed, is worth a hundred of which the track has only been galloped over by the observer.

"Any theory which cannot explain a tornado which has been impartially and rigidly investigated throughout an extensive sweep, may be fairly rejected as insufficient. Those facts which relate to position and direction admit most easily of this rigid investigation, and, by being placed on a map, they may be preserved in a compact and available form for future reference, and may serve as the touchstones of future or of existing theories.

"The map of the late tornado now under consideration is probably without example both in the completeness and minuteness of its details, and in the great length of track which it covers, — larger than the whole track of many tornadoes. It may well deserve consideration, whether, in the history of other tornadoes, the area which has been specially studied was large enough to insure the separation of the leading features of the phenomena from what was merely local and accidental. The present map includes an extent of not less than three miles and a quarter in length, and was the result of a survey of eleven days by Professor Eustis himself, aided by an average number of twenty assistants, in the field during the whole time, from among the pupils of the Engineer Department in the Lawrence Scientific School at Cambridge.

"The committee are unanimously of the opinion, that the Academy will subserve the cause of science by ordering this map to be printed, and they have accordingly made some inquiries, and obtained some estimates as to the cost and manner of publication. As the result of these inquiries, they propose the following resolutions: —

"'*Resolved*, That the map of the late tornado presented to the Academy by Professor Eustis be lithographed, under the direction of the Committee on Publications, on its present scale, and at an expense not exceeding $500 for five hundred copies; to be paid by subscription.

"'*Resolved*, That Professor Eustis be requested to superintend the publication, and to prepare a memoir or explanation to accompany the map.

"'*Resolved*, That a subscription paper be opened to defray the expense of publication.'"

These resolutions were adopted by the Academy.

Professor Lovering called the attention of the Academy to a beautiful corona seen about the moon, on the evening of December 3d, 1851, and remarked, that, "in phraseology at least, a distinction was not always observed between the various classes of phenomena which relate to optical meteorology. 1. There are those which depend on reflection alone. 2. There are those which depend on refraction alone. 3. There are those which result from the combined effect of reflection and refraction. 4. There are those which depend on diffraction, or the interference of light. Rainbows belong to the third class. Halos, properly so called, belong generally to the second; but in their more complicated forms, when accompanied with streams of light and mock suns or moons, they belong to the third class. Coronæ, properly so called, belong to the fourth class. *Halos* and *coronæ* are frequently confounded together, although they have each its own very decided characteristics. Halos are produced by refractions, either with or without reflection. The ordinary value of the diameter of these circles, which is either 47° or 94°, has suggested the theory that they are produced by refraction in prisms of snow or ice, in which the refracting angle is 60°. The arrangement of the colors is prismatic, the red occupying the place of the smallest circle. Experiments with a polariscope show that the light of the halo is polarized by refraction. The crystals which produce the refraction are supposed to exist in the region of the *cirrus* cloud, so that the halo is often taken as evidence of the first approach of that cloud, even when the cloud itself cannot be distinctly seen. Mr. Lovering exhibited various specimens of plates of fibrous crystals, cut perpendicular to the fibre, which produce upon light changes very analogous to those wrought on a larger scale by the atmosphere in the production of halos, and which serve, therefore, to give an idea of the structure of those clouds which develop these extraordinary optical phenomena of the air. Volume XVIII. of the Journal of the Royal Polytechnic School, published at Paris in 1847, was also exhibited. M. A. Bravais has occupied the whole of this volume in an analytical discussion of halos, and has enriched his work with copies of the most distinguished appearances of this kind on record, selected from all the journals of Europe and America.

"The characteristics of the corona are as decided as those of the halo. The arrangement of the colors, in which the red occupies the outside and the violet the inside, points to interference, and not to refraction, as the physical cause of these colors. It is an exhibition of diffraction on a large scale, similar to the experiment of looking at a small flame through a piece of thin glass, which has been sprinkled over with lycopodium powder, or which is covered with minute particles of smoke or moisture. In all these cases we see the flame surrounded by colored rings, which are larger as the particles of powder, which pave the way for the interference of the light which passes through their interstices, are smaller. The corona is produced by the *cumulus* cloud, in which the water exists in a vesicular state; not unlike in structure to a piece of network, which is known to occasion interferences in light similar to those which are here attributed to the cloud. Coronæ are much smaller than halos. They are between 3° and 12° in diameter. From the size of the corona in any case, it is possible to calculate the size of the vesicles in the cloud. According to the indications above mentioned, the appearance of the 3d of December is to be classed among coronæ, and not among halos. Mr. Lovering had proposed to illustrate the subject by scattering lycopodium powder on glass, and looking through it at a flame. But the number and the size of the gas-burners with which the room where the Academy assembled was lighted were not propitious for such an experiment, which requires a single and small source of light."

Mr. G. P. Bond gave the results of observations recently made at the observatory of Harvard College, upon two of the inner satellites of Saturn, Tethys and Enceladus. "The permanence of the mean motions of the latter over a period of several thousands of its years was mentioned as an interesting fact. Its mean distance also agreed nearly with that derived from the periods and distances of the outer satellites. Should this be sustained by further observations upon the two nearest satellites, an argument might be derived from the fact for the smallness of the mass of the ring, — since, for bodies so near to it, its attraction will differ considerably from what it would be were all its mass collected in the centre.

"The method employed by Bessel, in which the mass is derived from the motion of the line of apsides (a constantly accumulating quantity), is a better one."

Professor Peirce made further remarks upon the same subject.

Dr. B. A. Gould, Jr. exhibited to the Academy an admirable model, to represent the orbits of the sixteen asteroids, which was recently made by Chamberlain and Ritchie for the Lowell Institute, under his directions.

Three hundred and sixtieth meeting.

April 6, 1852. — MONTHLY MEETING.

The PRESIDENT in the chair.

On motion of Mr. J. I. Bowditch, who stated that the Librarian was sick, it was

Voted, That the charge of removing the Academy's books to their new room in the Athenæum be transferred to the Committee on the Library.

Dr. J. C. Warren gave an account of his visit to Darmstadt, in the year 1851, to see the Eppelsheim fossils, and exhibited a considerable number of casts of fossil bones of the Dinotherium giganteum, together with an excellent colored drawing, of the natural size, of the head.

"Having become much interested in the Eppelsheim fossils, I took the opportunity while in Europe in 1851 to visit Darmstadt, where this collection is, and its able and excellent Professor, M. Kaup.

"Darmstadt, the capital of the Grand Duchy of Hesse, is situated at a short distance from the Rhine, and near to Frankfort. The town contains about eight thousand inhabitants. It is built of stone, with wide streets, has many public ornaments, and is surrounded by gardens and groves, which extend in some directions for miles, and contribute to make it a desirable residence.

"The collection is placed in the Castle, so called, and is rich in objects of natural history. Professor Kaup, as soon as I called on him, conducted me to the Castle, and, having exposed to view the objects of my research, left me to examine them as long as I thought proper.

" My attention was first directed to the Mastodon relics. Professor Kaup had instituted a new species of Mastodon, under the name of M. longirostris, thus separating it from M. angustidens, with which it had formerly been confounded. The name *longirostris* is derived from the length of its jaw compared with that of other Mastodons. Another distinction is in the form of its teeth, the number of eminences on most of them being greater than in other animals of the same family. The number of teeth is also greater than in the M. giganteus, the latter having twenty-four teeth, to which are added in the former two germs in the upper, and possibly two in the lower jaw ; which last, however, I believe, have not been ascertained. A very fine collection of teeth, both in and out of place, serves to illustrate some of the most important points of Mastodon odontology.

" From the examination of these valuable fossils, my attention was next attracted to one of the most remarkable relics of the ancient world, the Dinotherium. This is thought to have been the largest of terrestrial quadrupeds. The first remains of this animal were found in France during the last century. Fragments of skeletons continued to be discovered during the early period of the present, when, in 1829, Professor Kaup obtained from the Eppelsheim deposit a sufficient number of bones to satisfy him that this was a new genus, to which he gave the name Dinotherium, from δεινός, *terrible*, and θηρίον, *animal.*

" Before this time, it had been thought by some writers to belong to a marine family, such as the Manatus or the Dugong, from the form of the occipital condyle ; by others to the Pangolin, a kind of hedgehog, from an ungual phalanx, now considered to have been the relic of some other animal. And by Cuvier it was thought to be allied to the Tapir, from the form of its pre-molar teeth ; the outer ridges of which are united by a connecting wall, as in the corresponding teeth of the Tapir.

" A remarkable instance is afforded by the last circumstance of the sagacity and science of this celebrated person, who, from so small a piece of mechanism, could imagine the whole structure and habits of the animal. Professors De Blainville and Kaup have justly remarked, however, that the pretension of being able to construct a skeleton from a single bone will not hold good in regard to the Dinotherium and many other animals. The true character of this genus, for example, so anomalous was its structure, could not be made out until after many bones had been discovered.

"These obscure surmises were ultimately cleared away by the labors of Professor Kaup. He came to the conclusion, that the Dinotherium was a pachydermatous animal, connected on one side with the Mastodon by the form of its head, and by a great aperture for a proboscis; on the other, with the Tapir, by a peculiarity in the premolar teeth.

"In 1836, Dr. Klipstein completed the anatomy of the head by the discovery of a cranium. This magnificent fossil, the only known specimen of a cranium, has served to supply various scientific cabinets with casts of the head. The head itself lies in the cellars of the British Museum; the owner, Dr. Klipstein, not being able to obtain the price he has thought right to demand for it. It was intimated to me, by a friend of Dr. Klipstein, that I might purchase it on favorable terms.

"*Anatomy.* — The head of the Dinotherium giganteum is nearly four feet long and about a foot and a half high; the distance from the orbitar fossa to the posterior edge of the temporal fossa is a foot and a half; the depth of the temporal fossa is about a foot; the angle of the os frontis and occiput is from thirty-nine to forty degrees. The summit of the head is divided into two parts by the occipital ridge, an arrangement different from that in the Mastodon, which has the occipital ridge at the posterior termination of this summit. Behind this ridge is the occipital surface, which is not vertical, as in the Mastodon, but oblique, and presenting a large space for the attachment of muscles. At its posterior termination is the occipital condyle, which has a globular form, as in the Manatus and Dugong. In front of the occipital ridge is seen the large nasal aperture, corresponding with that of the Elephant and Mastodon, and affording strong evidence that the Dinotherium belongs to the Mammalian order Pachydermata. This surface terminates anteriorly in the rostrated beak of the upper jaw. A large part of the lateral surface of the head is occupied by the temporal fossa, containing a space for the eye and for the immense temporal muscles.

"The lower jaw is remarkable for the circular curve downwards of its two projecting tusks. When discovered, the jaw was broken across, and the anterior fragment, separated by a space of a number of feet, was supposed to have had its curve directed upwards, as in the Elephant, Mastodon, &c., presenting an unusual and grotesque appearance. In this position they were first represented by Professor Kaup, who tells us, that, while a friend of his was handling this anterior fragment of the lower jaw containing the curved tusks, he accidentally turned it downwards, and found it corresponded exactly with the other fragment.

"Then, for the first time, it was seen that this was the true natural direction of the tusk, and that it probably served the purpose of a pick to dig up food. Dr. Buckland suggests, that it might also be employed to anchor the head to the river-shore while the animal slept. The curved tusk with the bone in which it is socketed forms a hook about three feet in length, and the degree of curvature thus formed is the fourth of a circle.

"*Teeth.* — There are two sets of teeth; — first, the primary or milk teeth, twelve in number, three on each side of each jaw; second, the permanent, twenty in number, five on each side of each jaw. The latter are divided into pre-molars and true molars; the pre-molars are the two in front, as the name indicates, making the whole number of pre-molars to be eight. The true molars are twelve in number, three on each side of each jaw, placed behind the pre-molars. These teeth resemble the Mastodon teeth in having two or three transverse ridges, but differ from them in this, that they are all square excepting the first true molar, which has three ridges and an oblong form. In the Mastodon, all the true molars possess an oblong form, particularly the last. The middle permanent tooth of the Dinotherium, however, is sometimes distinguished with difficulty from the third or fourth tooth of the M. giganteus.

"The teeth of the Dinotherium are developed vertically, as in man and most Mammalia. In this respect they differ from the Elephant family, which, on account of the great size and weight of these organs, have them developed horizontally.

"*Trunk.* — Many bones of the trunk and extremities of this animal have been discovered, but nothing like a complete skeleton. Some of these bones are said to be of great size, exceeding corresponding bones of the Mastodon and Elephant even by one fifth. The head of the Dinotherium giganteum of Klipstein is, however, scarcely equal in dimensions to that of the great Mastodon skeleton in Boston, or that of the head in my possession, called, from the river near which it was found, the Shawangunk head. The body is represented by learned authors to be eighteen feet long, which is two feet longer than our largest

Mastodon ; and fourteen high, or two feet higher than the Mastodon. The animal next in size after the Mastodon, the Megatherium, known, like the two preceding, in a fossil state only, has the height of eight feet and the length of twelve, although some of its parts are enormous.

" The bones of the extremities generally are not of great size, but there are some large bones, particularly the thigh-bone in the Darmstadt collection, more than five feet long. The thigh-bone of the great Mastodon is only three and a half feet; this would make the Dinotherium bone not quite a third longer than the Mastodon, and the skeleton about a third higher.

" The Eppelsheim thigh-bone, it has been suggested, might have been that of an Elephant. Professor Kaup did not appear to be settled in the opinion that it appertained to the Dinotherium ; so that we must consider this bone not to be fairly claimed by the animal in the present state of our information. Further, we must confess that we have not seen a bone of the Dinotherium, which entitles this animal to a higher estimation among gigantic quadrupeds than the Mastodon.

" The lower jaw, attached to the cast of the head, discovered by Dr. Klipstein, is indeed longer than any Mastodon jaw ; but this peculiar prolongation is destined for the support of the curved tusks, and its other proportions are generally smaller than those of the Mastodon. Thus the circumference of its medial portion is in the Dinotherium twenty inches, in the Mastodon twenty-two. The breadth of the ramus in the former is five inches just below the condyloid process, while that of the latter is at the same point ten and a half inches ; the height of the ramus is two inches less in the former than in the latter.

" The cranium has already been shown to be decidedly smaller than either the Shawangunk head or that of the great skeleton. There may be, and probably are, other Dinotherium bones in existence, greater than any we have had an opportunity of seeing.

" In the comparison made above, we have considered only the largest species, the Dinotherium giganteum. There are, however, other smaller species, but their number and distinctions are not well established. The D. Cuvieri, D. medium, and D. australe of Professor Owen, found in New Holland, are pretty well understood ; the others are more doubtful.

" Dr. Buckland was of opinion that this animal was aquatic in its habitation and modes of living ; that it slept in the rivers, anchored by its hook-like trunk to a tree on the river-bank. If, as the hook-like tusks would seem to indicate, it lived partly upon roots which were torn up by these instruments, we must allow it the privilege of passing a part of the time on shore. In short, we should be much disposed to consider the animal as very analogous in habit and residence to the Hippopotamus.

"While the bones of the Dinotherium are widely scattered through the continent of Europe, and even in Australia, the most remarkable deposit is found in the sands of Eppelsheim. This celebrated locality forms a part of the Rhine basin, belonging to the upper tertiary or pliocene formation. It is constituted by layers of loess, of calcareous and ossiferous conglomerate, of sand, of clayey marl, and, finally, of fragmentary ossiferous and marine conglomerate, arranged in layers from one to several feet in thickness. In the last of these are found the remains of the Dinotherium. The whole depth from the surface is about forty feet. They lie in great confusion, intermixed with the bones of other animals, among which we find those of Mastodon longirostris, Rhinoceros Schleiermacheri, Acerotherium incisivum, Arctomys primigenia, Spermophilus superciliosus, Tapirus priscus, Sus palæologicus, cervus, &c. Of these and other bones from the same place we have fine casts, made under the direction of Professor Kaup.

"How these vast collections were formed in the London, Paris, Rhine, and other basins, is a matter of deep interest. The more common opinion has been, that this conglomeration was formed by some great deluge. In many cases, however, the bones lie in their natural position, as if the animal had died quietly on the spot, and their remains were gradually accumulated during a course of countless ages.

"How should so many species and families have been exterminated? The march of geology and paleontology will no doubt lead us to wonderful discoveries in these new sciences, and thus afford some answer to this question; but probably there will always remain many inexplicable phenomena to keep alive the curiosity of future generations."

Professor Peirce communicated the results of his investigations relating to Foucault's experiment with the pendulum. In the course of his remarks, he referred to a mathematical discovery by Encke, which had been anticipated by Mr. G.

P. Bond, and to Airy's plate apparatus, which was similar in principle to such as had been previously contrived and used by Mr. Treadwell and by Mr. Boyden.

Dr. Peirson referred to an explosion of "burning-fluid," which caused the death of Miss Mary F. Choate of Salem, on the twenty-fourth day of last February; and read an article communicated to the Salem Gazette by Dr. E. L. Peirson, which contained a very particular account of the circumstances connected with the explosion, as investigated by that gentleman and himself. The disaster occurred in an unfinished pantry, about ten feet long and nine feet wide; in one corner of which, on a shelf at the end of a sink, and on a level with the top of it, which was three feet above the floor, there stood a can of the capacity of one gallon, partly filled with "burning-fluid." The can was screened in a great measure from the direct heat of the stove by two water-buckets, which stood on the same shelf. The mouth of the can was stopped with a plug of white-pine, and the nozzle with a small rag. A few seconds before the explosion, the girl was seen pouring water from the tea-kettle upon some meal with her right hand, and stirring the meal with her left; and was, without doubt, thus employed, when a very loud explosion occurred, and enveloped her and various other objects in the room in flames. The bottom of the can was blown out and thrown to one part of the room, and the body of it, with the plug still in the mouth, to another. The mother did not recollect what became of the nozzle. The girl survived the accident about twelve hours. Dr. Peirson invited an expression of opinion respecting the cause of the explosion.

Professor Horsford stated that he had visited the scene of the explosion. After illustrating with a diagram the position of the various articles of furniture in the apartment where the accident occurred, he remarked, "that the Salem case presented several difficulties, among the most important of which he enumerated the following: —

"1. How fire could have been communicated to the mixed vapor and atmospheric air in the can, at a distance of six feet from the stove, the only source of fire in the room.

"2. How an explosion could occur by which burning-fluid should be thrown on the outside and corresponding inside of the water-pail nearest the can, and not on the shelf or the boards in the corner.

"3. How this could take place (if produced by the explosion) with no opening on the side of the can nearest the water-pail.

"4. How, fire having been communicated to the contents of the can in its proper place, explosion should not have thrown at least the empty pail from the shelf.

"5. And how, since the pails were neither of them moved by the shock, an explosion could cause the can to leap over the pails and fall, not back into its place, but upon the floor, some four or five feet distant.

"These are among the apparently contradictory phenomena which any attempt at an explanation must reconcile.

"The communication of fire has seemed to be the principal difficulty in the case. It has been suggested that the rag stopper, saturated with the burning fluid, might have taken fire, as cotton-waste (cotton more or less saturated with oil) has been known to take fire. This explanation cannot be sound. Burning-fluid vaporizes at a low temperature. In vaporizing it absorbs heat. The purer varieties absorb so much heat, that a low wick is but slightly charred after an evening's burning. It is quite obvious, therefore, that heat enough to inflame a body so volatile could not be derived from the spontaneous oxidation of the body itself. Nevertheless, I made several experiments upon the fluid, thinking that exposure might, by oxidation, produce so much resin in the burning-fluid, and the rapidity of volatilization be thereby so much reduced, that the conditions of the rag stopper and waste cotton would more nearly approximate, and spontaneous ignition occur. The result, however, has been a negative one. It could not have been otherwise. With the reduced volatility came diminished oxidation, so that what was gained by the process in one way was lost in another.

"The impression that the wooden stopper fitted closely, has barred an attempt at the natural explanation. This impression was based upon two circumstances; — first, that in the explosion the plug and neck were not separated; and second, that no smell of burning-fluid was ever noticed in the room. In regard to the first, it is easy to see that a four-sided stopper might be driven into a cylindrical neck so tightly, as to be extracted only with great effort; and in regard to the second, very considerable quantities of burning-fluid vapor may be in a room without its being observed, as I have ascertained by placing small quantities in a number of vessels permitting ready evaporation, and by sprinkling it on the floor. The space between the pine plug and the neck I have found to be of at least twice the diameter required to transmit flame. It will be recollected that the fire was of shavings and pine-wood, and that the mother observed, a minute or two before the explosion, that it burned well, and that a portion of the stove was red-hot. Upon inquiry, she told me that the pine-wood used would snap. It is conceivable, that, when the daughter inclined the tea-kettle, as she did just before the explosion, a bit of coal was thrown through the open passage to the neck of the can; that the increasing warmth of the apartment had driven a little of the mixed vapor and atmospheric air through the space between the plug and neck to the air above, increasing somewhat the area of the target against which the shaft was aimed; and that this explosive mixture was fired and ran back into the can.

"The expansion attendant upon the explosion would press outwards in all directions the walls of the can. If all could not yield alike, the least firm would obey the impulse. The conical top is not constructed to yield without rupture to pressure from within. The vertical sides are alike unable to give increased space without rupture. The neck and plug, offering less resistance, would be blown off. The bottom, being a plane, can be pressed downwards, so as to form an obtuse cone. As the shelf, however, is firm, the depression of the centre of the bottom must be attended with the elevation of the whole body of the can, and the sudden downward movement of the bottom would cause the can to spring into the air. The shelf was inclined toward the sink, and the outer half inclined also a little outward. This inclination would give the upward movement of the can a direction from the perpendicular, and, if the can were seated on the outer half, an inclination outward from the shelf and sink. The latter supposition is a little more favorable to the view taken, but not essential. With a velocity that would carry the can to the inclined roof, it is easy to see how the nose could have been broken (the neck and plug having been separated by the explosion), and, with the momentum acquired, how a quantity of fluid would rush out upon the rafter or inside of the roof, and some of it fall. The can, as the resultant of the collision of its irregular form with the inclined inner surface of the roof, would acquire more or less of a whirling motion, and, scattering fluid in its way, would ultimately reach the floor. A jet of it falling upon the stove would instantly enshroud it and the girl by its side in flames. The heat of the burning fluid about the can would melt the solder, release the bottom, and such portions of the soldered seams as were not protected by the fluid. The line of attachment of the conical top to the sides, the opened seam of the top itself, the undisturbed ear, to which the pail was on one side secured, and the gathering of the molten solder in the same region, all are in keeping with the idea, that the can lay partially immersed, and so far protected, by the fluid on the floor. To return to the point of collision of the can with the roof. What point on the shelf would a small quantity of fluid reach, thrown from the neck of the can at the instant of its collision with the roof, and falling perpendicularly? A point manifestly lower on the inclined shelf than that occupied by the can; and although it may not now be susceptible of absolute demonstration by admeasurement, since the exact position of the article is not known, it is obvious, upon an inspection of the premises, that the point a liquid would reach, falling from the intersection of a line drawn from the can's place perpendicular to the shelf with the roof, must have been very near the edge of the pail. Indeed, it is difficult, if not impossible, to see how just liquid enough to have fired the outside and inside of one of the pails, and not the shelf or surrounding surfaces, could have come from any other point than one above.

"This view leaves no statement of the surviving inmates, or fact of the appearances as presented after the accident, without a legitimate explanation. It is, perhaps, difficult to believe that a coal would have sprung from the stove, through a space of six feet, with such precision as to inflame the fluid about the nose of the can. But six feet is not an unusual flight for a fragment of coal from snapping wood. Nothing intervened to obstruct its course. The kettle was tipped so as to give it a ready passage, and even presented a reflecting surface that would aid in sending some indirect sparks in the required direction. The bit of coal would be glowing from its friction with the air, and in the precise condition to insure explosion on its arrival at the neck. It is, therefore, no more wonderful that the spark should take the precise direction it did, than that the can should have been placed in its pathway.

"In conclusion, then, it may be stated in regard to the Salem case, —

"1. That the evidence does not require us to believe in the spontaneous explosion of burning-fluid; or

"2. That the explosion was any thing else than one of a mixture of burning-fluid vapor and atmospheric air, by bringing in contact with it an incandescent body."

Professor Peirce referred to Faraday's investigations respecting the ignition and subsequent explosion of explosive gases, induced by their adhesion to clean plates of platinum and other metals, and inquired whether the explosion at Salem might not have originated from the same cause.

Professor Horsford thought that the surface of the can could not have been sufficiently clean to produce that effect.

Dr. W. F. Channing had formerly experimented with camphene and other chemical burning-fluids, and he was satisfied that they do not spontaneously explode, and that they do not form an explosive mixture with atmospheric air, without the odor of the fluid becoming perceptible to the sense of smell.

Dr. J. Bigelow remarked, "that the condition of a canister having one of its apertures stopped with a porous body, was like that of a common camphene lamp with a tube and wick. An explosion would not be likely to be communicated through the porous body, nor would it take place unless some open aperture communicated with an explosive mixture within. He mentioned a remarkable case, which occurred some years ago, in the chemical laboratory of the old Medical College. The iron pipe of a stove, containing a fire, passed within a foot of a shelf on which were deposited some bottles containing different volatile oils. In the night the whole took fire, and in the morning the shelves and side of the apartment were found deeply charred, and the room filled with smoke. The fire, however, was spontaneously extinguished. On examination, it was found that a lead pipe, communicating with a water-cistern above, had been melted off, and the water had flowed down upon the fire. The bottles which contained the oil were found in their places, some broken, others with their stoppers blown out, with appearances indicating combustion rather than violent explosion."

Dr. C. T. Jackson said "he had listened to the ingenious explanation of Professor Horsford, and would take occasion to remark, that he could not conceive how a spark from pine-bark tan could set fire to the vapor of burning-fluid, even allowing the spark should have passed near the slightly stoppered can. It is well known that a red-hot coal will not kindle a flame in camphene or burning-fluid vapor, and that actual flame or incandescent heat is required to inflame vapors of volatile hydro-carbonaceous fluids.

"If there was no other way to account for the combustion of the vapor from this burning-fluid, he would suggest that a train of the vapor might have extended from the can to the stove, and have been inflamed by the fire, into which the vapor might possibly have been drawn. Dr. Jackson stated that he knew of several instances of the inflammation of ether, by flame distant from six to eight feet from the vessel containing the fluid, a train of explosive vapor, heavier than air, having formed a stratum from one end of the table to the other, and a flash having been seen to run from the lamp to the bottle of ether which was set on fire. This accident had happened in the laboratories of Dr. Hare of Philadelphia, of Mr. Hallowell of Alexandria, and in his own. Dr. Jackson did not think, however, that we knew the facts relating to the explosion of burning-fluid described by Dr. Peirson and Professor Horsford with sufficient accuracy to decide as to the true cause of the explosion in question."

Chief Justice Shaw made the following remarks on the subject: —

"I am very glad, Mr. President, to find that scientific and practical men are turning their attention to a subject which, in some of its aspects, seems to me a very important one. I was not aware that any such subject would be before the Academy this evening; but as it has been brought to your notice, if not too late, I should be glad to ask the attention of gentlemen to some of the views in which, it appears to me, it ought to be regarded.

"I do not profess to know any thing of the material character or chemical properties of this substance, nor can I pretend to say any thing respecting its mode of action, in forming gas, producing light, or causing explosion. But I feel that I am in the presence of those who are capable of applying all the science and skill necessary to a full understanding of this part of the subject, and it is to show the importance and value of these thorough and persevering investigations, that I am desirous of submitting these remarks.

"We often see an account published, headed, in attractive capitals, 'Another Accident from Burning-Fluid,' and often stating a case of gross carelessness, or perhaps of pure accident, concluding with an exclamation of surprise that people will wilfully continue to use so dangerous an article.

"This may be a very wise, or it may be a hasty and false conclusion. Gunpowder is a most dangerous article, and in the hands of the ignorant or imprudent, unacquainted with its properties and the precautions necessary to its safe keeping and use, may cause the destruction of human life; and sometimes, from unforeseen causes, not attributable to carelessness, it may unexpectedly ignite and cause great damage. Is this a reason why we should come to a hasty conclusion, that gunpowder ought never to be made and never to be used, notwithstanding its vast utility in the arts of war and peace, — supplying the most efficient arms in time of war, and acting as an indispensable agent in all the processes of quarrying and mining? No. But it is a reason why all the causes of danger should be investigated, ascertained, and made known, and why every precaution should be taken to guard against these causes.

"It is often suggested, I am aware, that, in using burning-fluid in preference to oil, the only object is to save a little expense in the cost, and this is an object too trifling and unimportant to warrant the running of any risk. This, it strikes me, is a very narrow and superficial view of the subject. It has been stated here this evening, that the light from camphene is whiter and purer, and the use of it more cleanly than that of oil, and the cost somewhat less. In answer to the latter fact, however, it is suggested that spermaceti oil has been much higher for a few years past than formerly, in consequence of its extensive use in manufactures. This may be the cause of a temporary rise in the price of an article, when the demand has increased faster than the supply; and that may be especially true in regard to an article like sperm oil, when so long a time elapses between the outfit and return, and when, of course, the increase of the supply is slow in following the increase of demand. But in general, when there are no intrinsic causes to cut off or diminish the supply, the supply will, in the long run, be adequate to the demand, and then the price will be regulated by the cost of production. But it appears to me that the cause of the increased price of sperm oil lies much deeper than this. It arises from the increased length and precariousness of sperm whale voyages. I understand that voyages are greatly increased in length, and in still greater proportion in expense, from the necessity of getting supplies and repairs abroad; and the chance of falling in with the sperm whale is much rarer and more precarious; so that vessels, after a long voyage, come home either not full, or filled with whale oil of inferior quality. The actual cost of importation, therefore, being increased, the price at which it can be sold, must increase proportionally. If this be correct, whilst the use of artificial light is necessarily increasing rapidly, the resources from sperm oil are diminishing and likely to diminish still more, and the time must soon come when some other source must be resorted to, to meet this extensive and increasing want.

"But it seems to me that this is not the most important aspect of the question. There is another, affecting the labor, the industry, all the great interests of the country, more especially the great interest of agriculture, in which it deserves to be considered. Agriculture, which employs the great proportion of the entire labor of the country, which is essential to every other industrial pursuit, and forms therefore the basis of the wealth of the country, demands all the encouragement and support which the country can give it.

"Without knowing any thing in detail of the composition and chemical qualities of burning-fluid, I take it for granted, — I think it has been stated here this evening, — that by far the most considerable and costly ingredient in it is alcohol or distilled spirit. Other substances may be combined with it, to fit it for its purpose of giving a brilliant light, and perhaps to check or prevent its explosive tendency, and thus guard it from danger; of this chemists and scientific men will inform us. But distilled spirit is the substance of it.

"If this is to be the principal, or even a very considerable, source of the artificial light of the country, it is hardly necessary to remark upon the immense quantity of alcohol which will be required. In a northern climate like ours, with a long night a part of the year, the quantity of artificial light required for manufactories, shops, stores, public buildings, and especially for domestic use, must be very large.

"Alcohol, distilled spirit, is produced from many species of grain, — wheat, rye, oats, barley, and Indian corn. We should then produce our own material for light from our own fields, — create a home demand and a home market for the products of our own farms. It is easy to perceive what an active spring this must give, what a firm and steady support it must afford, to the agriculture of the country.

"But perhaps I may be told, that, in proportion as you use grain for distillation, you diminish the quantity appropriated for the food of the people, and render bread scarce. If it were so, it would certainly be a grave, if not a decisive, objection to this use of grain. The con-constant, full, and steady supply of grain to a country, at moderate, steady, and uniform prices, is its most important interest in an industrial point of view.

"But if I am right in my views, the argument leads to a directly contrary conclusion; and I think it is demonstrable, that the appropriation of a considerable proportion of all the grain raised in the country to distillation, will tend to make the supply of bread more constant, regular, and uniformly cheap.

"Ours is essentially an agricultural country. There are not only very large tracts of land still unoccupied; but the lands settled upon are not cultivated to a half, probably not a quarter, of their capacity to produce grain. This is a case, therefore, where, the source of the supply being unlimited, and the supply being able so soon to follow the demand, however large that demand may be, at remunerating prices, that supply will be met.

"To illustrate this, taking numbers merely to designate proportions, and not absolute quantities: Supposing the ordinary demand for the purposes of food is 1,000,000 bushels of grain, and a fair remunerating price for labor and the use of land is 60 cents a bushel, then $ 600,000 would be paid the farmer for the crop. Then, supposing that by a change of habit, by which light is to be supplied from alcohol, and alcohol from grain, a demand has been established for 500,000 bushels more, and the burning-fluid distiller can afford to pay the same remunerating price, as the case supposes, then there will be a regular and steady demand in ordinary years for 1,500,000 bushels, and the farmer is paid $ 900,000 instead of $ 600,000 for his annual crop. The $ 300,000 a year goes steadily and regularly to the payment for labor, home labor, and the use of land.

"This supply of grain for light, not occasional or precarious, not depending upon foreign commerce, the policy of other countries, or the contingencies of war and peace, and not depending on fancy or fashion, but being a constant, ever-recurring, and ever-increasing want for an absolute necessary of life, for which all who need it must pay a remunerating price, according to the cost of production, the demand would be as constant and steady for distillation as for consumption in bread. Indeed, the grain-market would know no difference.

"It is obviously for the interest of a country to produce annually a quantity of grain considerably beyond the average demand for consumption as food. It tends to maintain and equalize prices, and to prevent the bad effects both of short crops and superabundant harvests.

An average quantity planted does not necessarily yield an average supply. Experience shows, that although an average quantity is sown, yet from the effect of drought in seed-time, of rains in harvest, and the grubs, and worms, and Hessian flies, the crop will fall below the average ; whereas, with favoring sunshine and showers, in other years, the product will be beyond the average. If the demand is for food only, so that an average crop is necessary to supply the average demand, in case of a short supply, the people will feel the ill effects in scarcity and high prices ; and in case of an abundant harvest, the supply exceeding the demand, the farmer feels the ill effects in reduced prices. And if grain does not, on an average, yield a remunerating price, the tendency is to discourage production and cause scarcity. But where there is a steady demand for a supply beyond what is necessary for food, and a quantity is produced in average years to meet that supply, even in case of short crops, there is corn enough in the country to supply the country with food, the shortness of the crop will be felt in the increased price, it will be used more economically, both for food and for distillation, and no desolating scarcity will be perceived. So, in a year of production considerably beyond the average of years, the effect will be felt in some reduction of price, affecting the whole product ; the distiller of burning-fluid, finding the price low, knowing that there will be a demand for his alcohol, which may be perfectly preserved without loss, except the slight one of interest, is induced to come into the market and purchase freely, thus maintaining and equalizing prices, to the benefit both of farmer and consumer, and causing the superabundant product of one year to supply the deficiencies of another.

" In looking at the magnitude of this interest to the whole country, and for future time, in an industrial and economical point of view, I am unwilling to give up the hope of deriving the artificial light of the country from this source, until the resources of science and skill have been exhausted in vain in finding means to keep and use it with safety. If, with all reasonable precautions, it cannot be used without danger to life, in the name of humanity let it be abandoned. But all useful agents are attended with some danger. A common lamp or candle may set fire to a dress or a curtain and destroy a life or a dwelling. All that can be hoped is to produce an article which, with reasonable care and prudence, and knowledge of its qualities, may be used with reasonable safety.

" It appears to me, that there are two modes in which scientific research and investigation may tend to prevent or lessen the danger in using this article. One is, by a thorough knowledge of the chemical qualities of these ingredients, so to mix and combine them, as to render them less explosive; and the other to ascertain and point out the mode of action and operation of these fluids, and show the causes and modes of sudden and unexpected ignition, so that those who use them may easily learn, and with ordinary prudence practise, the necessary means of avoiding danger. In the hope that something of this sort can be done, I commend the subject to the continued attention of our scientific friends."

Dr. C. T. Jackson, in illustration of the views of Judge Shaw, observed, " that the use of alcohol was of the greatest importance to the agriculture of the Western States, for it was the most valuable product of Indian corn in many of those States. If corn could not be converted into alcohol and oil, it would in many places cease to be a profitable crop. Indian corn, when fermented, yielded first fifteen gallons of *oil of corn* (a fixed oil) per hundred bushels of corn.

" The next product was a fermented one, which on distillation yielded corn-whiskey, and the corn-whiskey passed into our Eastern States for manufacturing purposes.

" This was, in part, rectified into alcohol of ninety per cent., and that was used for the manufacture of burning-fluid, of cologne, spirits or tinctures of various kinds, &c. The ordinary whiskey was used for making white vinegar by fermentation in tuns filled with beach shavings, and this vinegar was employed in the manufacture of white-lead and sugar of lead. This vinegar was also extensively sold for making pickles and for domestic uses, and, when colored by burnt sugar, passed ordinarily for cider-vinegar, though it was not so pleasant to the taste as the true cider-vinegar.

" The oil from Indian corn has thus far been profitably separated only by the process of fermentation. It is of sufficient value to repay the cost of raising corn in the Western States, the oil being worth on the spot where made about one dollar per gallon, which is fifteen cents' worth of oil per bushel of corn. The alcohol or whiskey was also a valuable product.

"Dr. Jackson had separated from six to eleven per cent. of pure corn oil from the eastern varieties of Zea mays, and had found most oil in the Canada and rice corn. It is contained in the gluten-cells of the grain, and is set free by decomposition of those cells by fermentation."

Three hundred and sixty-first meeting.

May 4, 1852. — Monthly Meeting.

The Vice-President, Mr. Everett, in the chair.

Professor Agassiz made an oral communication at considerable length, "On the Foundation of Symmetry throughout the Animal Kingdom."

Dr. Asa Gray communicated the characters of two new genera of plants of the order *Violaceæ*, discovered by the naturalists of the United States Exploring Expedition.

"One of these genera, of a single species, was discovered in the Feejee Islands. It belongs to the tribe *Violeæ*, having an irregular corolla, which is not unlike that of Ionidium; but the fruit is probably baccate, and the stamens are diadelphous, the posterior one being distinct from the four others. Something like this structure occurs in Corynostylis; but the corolla of that genus is very different. The genus is named in memory of the botanical draughtsman of the expedition, the late Alfred T. Agate. I trust that the name Agàtea will be deemed sufficiently different from Agathèa and Agati to be retained.

"AGATEA, Nov. Gen.

"Calyx 5-phyllus, subæqualis, basi haud productus, deciduus. Petala 5, erecta, inæqualia; postica lateralibus paullo minora; anticum majus, labelliforme, spathulatum, basi dilatatum gibboso-saccatum. Stamina 5, diadelpha, nempe; filamenta brevia, plana, antica (glandula carnosa aucta) et lateralia marginibus connata, posticum angustius distinctum: antheræ introrsum adnatæ, loculis appositis apice liberis mucronatis; connectivo in appendicem petaloideam latam producto. Ovarium globosum; placentis parietalibus 3 pluriovulatis. Stylus apice clavatus, curvatus: stigma laterale. Fructus baccatus? — Frutex sarmentosus; foliis oblongis subintegerrimis ramisque glabris; stipulis minimis caducis; racemis paniculisve axillaribus multifloris; pedicellis 2–3-bracteolatis infra apicem articulatis; floribus parvis viridulis.

"AGATEA VIOLARIS, sp. nov. — Feejee Islands.

"The other genus is from the Sandwich Islands, where three species were collected by the naturalists of the Expedition. It belongs to the section *Alsodineæ*, having a regular corolla. Indeed, it differs from Alsodeia, Paypayrola, *Aubl.*, and Pentaloba, *Lour.* (if these are distinct genera), chiefly in the entirely separated stamens, with narrow filaments and normal anthers, destitute of any dilated or prolonged connective, and in the unilateral stigma, which, in a flower otherwise perfectly regular, vindicates its relationship with the genuine Violeæ. The following are the characters of the genus and species.

"ISODENDRION, Nov. Gen.

"Calyx 5-phyllus, æqualis, persistens. Corolla regularis; petala 5, lineari-spathulata, longe tubuloso-conniventia, apice dilatata patentia. Stamina 5, discreta: filamenta angusta, inappendiculata, apice haud producta, antheram basifixam nudam gerentia. Ovarium uniloculare; placentis 3 parietalibus 2-ovulatis. Stylus elongatus, subclavatus, apice decurvus: stigma punctiforme laterale. Ovula collateralia, horizontalia. Capsula coriacea, 3-sperma, 3-valvis. Semina Violæ. — Arbusculæ vel frutices Sandwicenses; foliis alternis confertis; stipulis triangulatis appressis diu persistentibus; floribus axillaribus solitariis breviter pedicellatis parvis.

"ISODENDRION PYRIFOLIUM: foliis membranaceis ovalibus seu ovato-ellipticis crenato-serratis petiolatis, junioribus subtus ramulisque pubescentibus; stipulis sepalisque dorso sericeis margine scariosis; floribus pendulis. — Kaala Mountains, Oahu, Sandwich Islands.

"ISODENDRION LONGIFOLIUM: glabrum; foliis subcoriaceis obovato-lanceolatis seu cuneato-oblongis in petiolum angustatis subrepandis; sepalis ovatis stipulisque lævibus; floribus in ramos crassos brevissime pedicellatis. — Kaala Mountains, Oahu, Sandwich Islands.

"ISODENDRION LAURIFOLIUM: glabrum; foliis coriaceis oblongo-lanceolatis subrepandis basi obtusis brevissime petiolatis; sepalis lanceolatis. — With the preceding.

"The other Violaceæ of the Sandwich Islands which occur in the collection are the shrubby *Viola Chamissoniana* of Gingins, from which

V. trachelifolia of the same author is not to be distinguished, and a new species from the island of Kauai, *V. Kauensis*, which has the habit of V. sarmentosa of Oregon, and nearly the structure of the Australian V. hederacea."

Dr. Gray also communicated the characters of a new genus of *Anonaceæ* from the Feejee Islands, dedicated to Mr. Rich, the official botanist of the Exploring Expedition, viz.: —

"RICHELLA, Nov. Gen.

"Calyx subtrilobus, persistens. Corolla e petalis 6 ovatis, internis dimidio brevioribus. Torus acetabuliformis. Stamina indefinita Guatteriæ. Ovaria plura, libera, 2-ovulata: styli intus longitudinaliter stigmatosi. Ovula suturæ ventrali juxta basim inserta, adscendentia, superposita. Fructus e carpellis paucis, obovoideis, subcarnosis (siccate coriaceis), indehiscentibus, breviter stipitatis, monospermis. Semen magnum, samaroideo-nuciforme; nempe, testa coriacea marginibus alato-productis. Albumen, embryo, etc. ordinis. — Arbor Uvariæ facie.

"RICHELLA MONOSPERMA. Ovolau, Feejee Islands. — According to Blume's arrangement of the order, this genus would stand next to Polyalthia, from which it is distinguished, as from all the others, by its winged seed."

At the suggestion of Professor Lovering, the Academy referred to the Committee on Publications an account by Mr. John Farrar, formerly Professor at Cambridge, of his observations of the solar eclipse of September 17, 1811. As these observations do not appear to have been published, the committee have made the following extracts for the Proceedings: —

"The place of observation is about five hundred feet southwest of Harvard Hall in Cambridge. Several gentlemen assisted me in observing the eclipse, and the following are the times, — *in mean solar time*, — with the instrument used in the observation in each case: —

	BEGINNING. h. m. s.	END. h. m. s.
Achromatic telescope of 2 feet focus, magnifying 20 times,	0 54 14	3 58 20
Achromatic telescope of 3 feet focus, magnifying 28 times,	0 54 20	3 58 19
Achromatic telescope of 4 feet focus, magnifying 40 times,	0 54 20	3 58 20
Gregorian reflector of 1 foot focus, magnifying 55 times,	0 54 30	3 58 20
Gregorian reflector of 4 feet focus, magnifying 260 times,	0 54 32	3 58 19

" In making use of single altitudes for the above times, it became necessary to determine the error of collimation of the astronomical quadrant, the diameter of the wires and the distance between them, which occasioned a delay that prevented the observations being seasonably forwarded to Mr. Bowditch, to be inserted in his valuable memoir on this eclipse."

Dr. O. W. Holmes presented the following communication " On the Use of Direct Light in Microscopic Researches," and exhibited at the same time a model of a new horizontal microscope.

" Three points require attention in constructing a compound microscope. First, the lenses; secondly, the illuminating apparatus; thirdly, the mechanical arrangements for insuring stability in the requisite positions, and accuracy, ease, and convenience in the necessary movements.

" The lenses have been brought to great perfection by the opticians of Europe, especially of England. In our own country, Mr. Spencer of Canastota has entered into successful competition with the most eminent among them. The extraordinary merits of his lenses have been manifested in various comparative trials, the results of some of which have been made public. In a short visit I recently made to Canastota, I carried with me the one-eighth and one-twelfth objectives belonging to the instrument made by Ross for the Lowell Institute, the use of which objectives had been kindly allowed me by the Curator. In a careful comparison of them with a one-fourth and one-eighth made by Mr. Spencer, especially on the delicate tests *Navicula Spencerii* and *Grammatophora,* the superiority of Mr. Spencer's glasses was unquestionable.

" Next in importance to the perfection of the lenses, and even more important, in Sir David Brewster's opinion, is that of the illuminating apparatus. The greater number of recently attempted improvements relate to this part of the instrument. Many of the new contrivances are expensive, complicated, and somewhat difficult of management. If the same or better results can be obtained by easier means, it would be a movement in the right direction, which is always from complexity towards simplicity.

" The common mode of examining *opaque* objects is to receive the light directly upon them as it comes from its source, or concentrate it upon them by a lens. The use of a reflector for examining is less frequently resorted to.

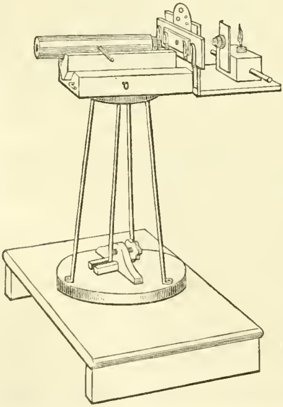
"But in examining *transparent* or *translucent* objects, which are to be seen by transmitted light, and which constitute by far the most important class of objects for study with the higher powers, it is usual to employ reflected light; a mirror, plane or concave, being commonly used for this purpose. The earlier microscopists often used direct light, sometimes pointing their tubes to the sky, sometimes employing a lamp, as in the instrument of Phllip Bonnani, figured by Chevalier and by Quekett, in their Treatises on the Microscope. Both these authors mention the use of direct light, and give figures of the method of employing it; Chevalier representing a candle, and Quekett an Argand lamp, as the source of illumination. Many very delicate objects are said by the latter author to be seen to the greatest advantage by this kind of light. A late writer in Silliman's Journal recommends its use in instituting comparisons between different lenses. It was used by Mr. Spencer in the trial of instruments I have referred to, he holding in his hand a common lamp, with one wick picked down, behind the stage, while we examined various objects with the higher powers.

"The fact, that so simple a method of illumination proved sufficient to define very delicate tests, led me to make trial of direct light as a substitute for other methods. But none of the instruments made at present being well adapted for its employment, I was led to contrive the new model, which I now offer for the examination of the Academy, and a figure of which accompanies this communication. This instrument is constructed with particular reference to dispensing with all reflectors, but can be used with excellent effect with a prism, when the light of the sky cannot be otherwise conveniently reached, as at a window opening on a narrow street. The mirror, with its two reflecting surfaces, glass and quicksilver, is got rid of, and with it several sources of error and imperfection are removed.

"The points I kept in view in the construction of this instrument were these: a fixed horizontal position; to dispense with machinery as far as possible; to employ the cheapest material.

"Direct light requires a vertical stage; a vertical stage implies a horizontal tube, and permits the use of a horizontal support for all illuminating contrivances. The power of *gravity* is therefore substituted for the ordinary adjustments of the parts above and below the stage. It is an easy matter to arrange a service of plate in all positions and relations on a table, as it commonly stands, but not so if it is inclined at an angle of forty-five degrees, or placed vertically. In this model every thing is kept in its place by gravity, except the object, which is very easily supported and adjusted without any particular mechanism. The moment the *fixed* horizontal position is given up, the simplicity of the instrument is gone. Thus the second principle, dispensing with machinery, is carried out by adhering to the first. To fulfil the third condition, that of employing the cheapest materials, it was necessary to make use of various substances for the different parts of the instrument. A piece of leaden pipe was fitted to hold the eye-glass and objectives; the latter being adapted by the bayonet joint of Chevalier. Its weight was of advantage in keeping it in its place. The rest of the instrument was made of wood, except the tripod, which was of iron, and the lever, diaphragm, screw, and springs, which were of brass. All the details will be described in connection with the figure.

"The following considerations determined some of the principal dimensions. When a person sits before a common table, the eye, when directed straight forward, is about eighteen or nineteen inches above it. This determines the height of the eye-piece and tube. To bring the hands to the height of the eye, with the elbows resting, the elbows must be raised about three inches above the table. This determines the height of the platform on which the whole rests. Eighteen inches will give width enough for the separation of the elbows. The tube being about eight inches long, which is a common length for microscopic bodies, the pieces on which it rests may be each of them an inch shorter. The common length of the English glass slides being three inches, the stage must be five inches wide, to admit of their moving about freely. From these dimensions several of the others are naturally derived.



On looking at the woodcut, it will be seen that the whole instrument is supported on an oblong square platform, the dimensions of which are $18 \times 10 \times 3$. On this is placed a revolving disk, eight inches in diameter, fitting upon a pin in the centre of the frame. A tripod, the legs of which are screwed to this disk, rises from it; the two together giving a height of twelve inches from the top of the platform. The upper portion of this tripod is a flat ring, four inches in diameter. To this is screwed an oblong square of wood, seven inches in length by four in breadth and one and a half in thickness, which we may call the *bed*. In the middle of this *bed* is an angular groove, to which a lining of thick tinfoil is accurately pasted or glued. In this angular groove slides a piece of pine of the same length, with a rounded groove on its upper surface, carrying the tube, and which may be called the *cradle*. Its width is an inch and a half, and its upper surface one inch above that of the piece on which it rests. The stage is five inches broad by four in height and one fourth of an inch thick, secured firmly to the end of the *bed*. A round hole in its centre, three fourths of an inch in diameter, is centred with the end of the tube, and bevelled half an inch outward on the side toward the light, to allow greater obliquity of illumination. The shelf supporting the lamp is five inches square, and is supported by two stout pins received in two holes passing through the lower part of the stage into the end of the *bed*, so as to be easily removed for packing. A strong wire, two inches and a half long, is soldered to the middle of each side of the tube at right angles. By these wires the tube is slid backward and forward in the *cradle*, forming the *coarse adjustment*. A brass spiral spring is fastened in the anterior end of the groove in the *bed*. The short arm of the lever, (the long arm of which, seen in the woodcut, is moved by the screw below,) passing through a hole in the middle of the *bed* into a notch in the under part of the *cradle*, presses the cradle against the spiral spring. The whole length of the lever is twelve inches, that of the short arm three fourths of an inch, giving a ratio of one to fifteen in the two arms. The screw, which plays in a brass nut, has sixteen threads to the inch, so that one revolution moves the cradle and tube one two-hundred-and-fortieth of an inch. This is the *fine adjustment*. The head of the screw, two inches in diameter, is not milled, but scalloped, so that the forefinger lies easily in the hollows, and turns it either way. The stage being an inch wider than the bed, gives room on each side for the attachment of a flat brass spring, serving to hold the object-plate against the stage, at the same time permitting it to be moved freely in every direction. The object-plate itself is of brass, *eight inches long* by an inch and three quarters wide, with a hole three fourths of an inch in diameter in its centre, and below the hole a ledge two inches long, with two small springs to hold the glass slide on which the object is placed. The diaphragm is three inches in diameter, and is let into the stage, so as to be close behind the object-plate without touching it.

" The lamp is of an oblong square form, three inches in length, one and a half in width, one in depth, and fits snugly in a square box, with two wires, each three inches long, projecting from its extremities. The wick-tube, which is made small, to insure a bright flame, is close to the edge at the middle of one side ; opposite to it is a slide, running up and down, and receiving an objective, by means of the common bayonet joint, to be used as an achromatic condenser. If the lamp flickers, it is guarded by a piece of tin four inches in height, bent to form three fourths of a circle three inches in diameter, and blackened on the inside. Two bent pieces of wire, driven into the end of the *bed* next the observer, serve to hold a hood or shade made of four pieces of thin board covered with black velvet, the top and sides turning down so as to shut out the light, the central piece cut in such a way as not to touch the tube or the cradle, which is its principal difference from that of Mr. Lister, as described by Quekett.

" To use the instrument, the elbows are rested on the platform, when all the preliminary arrangements are found close to the hands. The coarse adjustment is made, the object brought into position, the light arranged, with a precision that no machinery can surpass, because both the arms and hands are perfectly steadied. If the diaphragm is wanted, it may be easily reached with the fingers. Lastly, the fine adjustment is made by dropping one hand to the screw, and twirling its head back or forward with a single finger. If achromatic light is wanted, it is always ready ; it is only necessary to turn the lamp half round, and bring the objective so as to illuminate the object to the best advantage. The intensity and obliquity both of common and achromatic light are variable to any extent with the same facility, by moving the lamp back and forward, or from side to side. None of the ordinary arrangements of microscopes admit of using *oblique* achromatic light efficiently and conveniently, if they allow it at all.

" If it is required to use this microscope by daylight, a small prism is placed directly before the hole in the stage, or the achromatic condenser, and turned until the proper illumination is obtained. To make the light oblique, the disk carrying the tripod is revolved on the platform.

" The following explanations will account for some of the arrangements, the reasons for which are not obvious at first sight. It is very difficult to make wood slide on wood without adhesion and consequent jerking. After many unsuccessful experiments, I found white-pine would run smoothly over a surface covered with tinfoil. The unusual length of the object-plate renders it much more manageable than the ordinary ones. The arrangement of the lever not only gives extreme accuracy and delicacy to the fine adjustment, but, the screw being independent of the rest of the instrument, the focus does not change when the hand is lifted from it, as it does in many microscopes. The wick-tube of the lamp is so placed that it can be brought close to the object, and is at the same time at such a distance from the achromatic condenser as to give light enough without heating it to any extent which might injure the glasses. The wires by which the tube is moved are a little above the level of the cradle, so as to admit of a slight rocking motion of the tube. The delicacy of the coarse adjustment is such, that the use of the fine adjustment may very often be dispensed with.

" This instrument cost between three and four dollars. I have been so well pleased with its performance, that I have ordered one to be made of brass and iron, with a hollow pillar instead of the tripod, with several modifications, but the same general arrangements. Such an instrument may cost about ten dollars, and would offer some advantages over a carefully constructed one of the cheaper materials, which, however, would do good service. I hope to have the opportunity of showing a more nicely executed instrument, of the same general form with this, at a future meeting of the Academy, and if it meets the approbation of microscopists, I shall request a competent workman to make them at the lowest rate he can afford, for those who are disposed to try a new and somewhat peculiar piece of mechanism.

" Many will at first object to the vertical stage, in the belief that fluids cannot be conveniently examined in the position this requires. I believe this objection is of little importance. Capillary attraction, which holds mercury suspended in a fragment of thermometer-tube, is surely enough to support any watery fluid and its contents between two plates of glass, if the film of fluid is thin enough. Currents there will often be, and currents there constantly are on a perfectly horizontal stage, unless various precautions are taken, which I shall not here stop to indicate. I have found no practical difficulty in examining any fluid I have tried, with its contents, whatever they might be. At the same time, neither this nor any other bulky instrument can be a substitute for a simple, portable, vertical instrument, with a horizontal stage, and mirror below it, to be employed with the *low powers*. It is an *adjunct* to it, performing all the difficult tasks which the small "comet-seeker" indicates and leaves unfinished. The new instrument *can* be employed with the lowest powers; most conveniently by using a secondary stage, consisting of a piece of sheet brass bent at right angles, and carrying two springs on its outer vertical surface to hold the object-plate; this secondary stage being placed on the lamp-shelf. But every microscopist requires a portable instrument which will be sufficient for all powers below the one-fourth inch objective or its equivalent. For twenty dollars or a little more, he can get such an instrument with two eye-glasses and two objectives. Let him add twelve dollars to this, and he can obtain, in addition, the highest objective of the French makers. With the addition of an instrument like that I have shown, he will have at his command a sufficiently complete series of powers, and the means of employing common and achromatic light in every degree of intensity and obliquity, with a brilliancy of effect and a convenience in application which I will venture to compare with those of much more costly instruments. If he can obtain the more perfect and expensive objectives of Mr. Spencer or the best London makers, he will be able to bring out all their powers, and need not fear to subject them to the trial of defining the most difficult test objects."

Professor Horsford made some additional remarks on the subject of the late explosion of burning-fluid at Salem. On further consideration, he was of opinion that the ascent of heated air above the stove would cause currents of air to descend by the sides of the pantry, and flow towards the stove; and that the vapor of burning-fluid would be thus carried towards the fire, and ignition consequently ensue. He also offered an explanation of several other cases of explosion of burning-fluid to which he referred.

NOTE.

The statutes of the Academy authorize the Corresponding and Recording Secretaries "to publish in an octavo form such of the proceedings of the Academy as may seem to them calculated to advance the interests of science." As the matter to be published in this volume consisted in part of papers referred by votes of the Academy to the Committee on Publications, the duty of publication seemed to have devolved in part upon that committee. This volume has accordingly been published by the Corresponding and Recording Secretaries and the chairman of the Committee on Publications.

The abstracts of remarks made at the meetings of the Academy, which are printed in small type, or included within quotation-marks, have not been copied from the records of the Academy's proceedings, but furnished, at the request of the Recording Secretary, by the Fellows respectively by whom the remarks were made. The following abstracts should also have been included within quotation-marks: — Professor Horsford's, pp. 238, 239, and pp. 295, 296; Professor Peirce's, pp. 256, 257; Mr. Alger's, pp. 263, 264; Mr. Desor's, p. 282; and Dr. W. F. Channing's, pp. 282, 283.

An Index to Volume I. follows the Index to Volume II.; but it is printed so that it can be easily separated from this volume and bound up with the volume to which it belongs.

May 24, 1852.

ERRATA.

Insert "as observed" before "at Castle William," sixth line from the bottom of page 259.

Instead of a dash before "potash," page 271, eighth line from the bottom of the page, substitute a comma after that word.

Substitute a period for the note of admiration on page 285, twelfth line.

The experiment exhibited by Mr. Guyot, and described on page 284, where it is credited to Professor Snell, is identical with that performed by M. de Maistre in 1832, of which an account is given in Peltier's work, "Des Trombes," page 11.

INDEX TO VOL. II.

N. B. *New* genera and species are in *Italics.*

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THE END.