PROCEEDINGS

OF THE

AMERICAN ACADEMY

OF

ARTS AND SCIENCES.

VOL. II.

FROM MAY, 1846, TO MAY, 1852.

SELECTED FROM THE RECORDS.

BOSTON AND CAMBRIDGE:

METCALF AND COMPANY.

1852.
Three hundred and eighth 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. 168, of the Proceedings.)

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" 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.
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:

"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,

"President Everett."  

"W. C. BOND."
which have been found in the United States, and which are much more numerous than is generally supposed. He showed nearly perfect skulls 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 Fendleriæ 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 cooperation 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 south-western 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 Anímos (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 *Cactee*, 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 Compositae (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 sphaero-carpm, a species with almost exactly globose sili- cles, 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. te-nella, 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 diphy-sus, 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. Enothera (Pachylophis) eximia, the largest and most striking species of the section, and apparently one of the handsomest of the genus; and O. (Salpingia) Fendleri, also a very showy species. The new Cactee are Mammillaria papyracantha, Cereus Fendleri, and Opuntia phaeacantha, described by Dr. Engelmann, who has very successfully investigated this family. Ribes leptanthum. Philadel- phus microphyllus, a charming species. Archemosa Fendleri. Cy-


"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 Federatae Duce, lexit et des- scriptsit Jacobus D. Dana. Pars II. *

Familia III. CALANIDÆ.


Genera notis sequentibus distinguenda: † —

† Membra pedalia Cyclopaceorum ordine sequentia: —
I. Pedes mandibulares duo (membra cephalothoracis, ad normam, quarta, — et iv.).
II. Maxillæ due (ct. v.).

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Antennis anticus nec angulo flexis, nec articulatio

tionem geniculatam.

Oculis inferioribus nullis.

| Pedibus anticus (ct. vi.) majoribus quam maxillipedes (ct. vi.), laterali
ter porrectis, non geniculatis. | Pedibus anticus minoribus quam maxillipedes. Maxillipede

| Pedibus posticis elongatis, subulatis, uno sub-prehensili; pedibus anticus duplo geniculatis, sub corpore gestis, apice deflexis. 2. Scribella.

| Pedibus posticis elongatis, subulatis, uno sub-prehensili; pedibus anticus duplo geniculatis, sub corpore gestis, apice deflexis. 3. Euchaeta.

| Pedibus posticis elongatis, subulatis, uno sub-prehensili; pedibus anticus duplo geniculatis, sub corpore gestis, apice deflexis. 4. Undina.

| Pedibus anticus angulo levissime flexis, nunquam articulatio

tionem geniculatam. Pedibus posticis maris prehensilibus. 5. Undina.

| Pedibus posticis elongatis, subulatis, uno sub-prehensili; pedibus anticus duplo geniculatis, sub corpore gestis, apice deflexis. 6. Cyclopsina.

| Pedibus posticis elongatis, subulatis, uno sub-prehensili; pedibus anticus duplo geniculatis, sub corpore gestis, apice deflexis. 7. Calanus.

| Pedibus posticis elongatis, subulatis, uno sub-prehensili; pedibus anticus duplo geniculatis, sub corpore gestis, apice deflexis. 8. Cephalothorax 4—5-articulatus. Rami antennarum postica-

rum subaequ, ramo breviore ad apicem 3-setis instructo, in dorso se-

tigero.*

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

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

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

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

Mandibulum articulatus pedis mandibularis primus est, et "palpi" articuli se-

quentes pedis reliqui sunt.

* Species optime distinguendae sunt: —

1. Per gestum antennarum antica; etiam per setas, præcipue apicales et sub-

apicales; per longitudinem et numerum articulorum:

2. Per maxillipedes, et pedes anticos:
OF ARTS AND SCIENCES.


I. SETAÆ ANTENNARUM ANTICARUM APICALES SUBAPICALIBUS LONGIORES.

A. STYLI CAUDALES CURTI.

1. CALANUS ROTUNDATUS. — Frons rotundata. Cephalothorax 4-articulatus, crassus, posticè obtusus. Antennæ antice corpore vix breviiores, 24-articulatæ, duplo curvatæ, apicibus fronte paulo posteriores, articulo ultimo elongato; setis apicalibus articulum æquantibus, anticus 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. austral. 32° 24', long. occident. 166°; lat. bore. 3°, long. orient. 176°; lat. bore. 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 antice tenuissimæ, cephalothorace paulo longiores, fermè 24-articulata, duplo curvatæ, apicibus fronte posteriores, articulo ultimo elongato (forsan duplice); setis apicalibus articulum fere æquantibus, anticis apice remotis, posticè penultimâ articuli longitudine, anticus penultimâ et antepenultimis minutis. Styli caudales breves; setis strictis, rectis, duobus paulum longioribus.

Long. $\frac{1}{12}$". — Hab. in mari Pacifico, lat. bore. 40°, long. occident. 157°; lat. bore. 45°, long. occident. 156°; lat. austral. 21°, long. occident. 136°. — Lect. diebus 2, 6 Jul., 1841; 13 Aug., 1839.

3. CALANUS NUDUS. — Frons rotundata, prominulus. Cephalothorax 4-articulatus, posticè subacutus. Antennæ antice 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 strictis, rectis, abdomine non longioribus.

Long. $\frac{1}{25}$". — Hab. in mari Atlantico, lat. bore. 8° - 0°, long. occident. 21° - 18°, et lat. austral. 0° - 6°, long. occident. 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 corum setas:

Articulatio cephalothoracis non valet genera distinguere. Numerus segmentorum abdominis per statum variat, et vix valet species distinguere.
4. **Calanus Magellanicus.** — Frons rotundata. Cephalothorax 4-articulatus, posticè obtusus. Antennæ antice corpore breviore, duplo curvatae, apicibus fronte valde posteriores, articulis quattuor ultimis brevibus, subaequis; setis totis perbrevibus, apicalibus articulo* brevioribus, antice apice remotis, subapicalibus posticis minutis, antice obtusis. Styli caudales perbreves, setis abdominem fere aequantibus.


5. **Calanus crassus.** — Frons rotundata. Cephalothorax crassus, 4-articulatus, postice vix subacutus. Antennæ antice corpore breviore, apicibus fronte valde posteriores, setis brevibus, apicalibus paulo longioribus, subapicalibus minutis, aut obsoletis. Styli caudales perbreves, setis subaequis abdomine paulo brevioribus.

*Long.* 1½". — Hab. in mari Atlantico, lat. aust. 9°, long. occident. 17° 30'. — Lect. die 9 Mai, 1842.

6. **Calanus furcicaudus.** — Frons triangulata. Cephalothorax 4-articulatus, capite subito angustatus, posticè obtusus. Antennæ antice corpore Paulo breviore, duplo curvatae, apicibus fronte posteriores, fermè 24 (26 ?)-articulatae; articulo ultimo paulo longiore; setis brevibus, prope basin numerosis, apicalibus articulo paulo longioribus et antice apice parce remotis, subapicalibus minutis. Styli caudales seteque latè divaricati, setis inaequis, secundis abdomine longioribus.


B. **Styli caudales valde elongati.**

8. **Calanus turbilatus.** — Frons obtusa. Cephalothorax antice crassus, posticè attenuatus (idcirco, segmentum posticum abdomine

* In his, "setæ articulo breviores" et aliis similibus, articulus ille has setas germen passim intelligentus.
parè latius) obtusiusculus. Antennæ anticea duplo leviter curvate, corpore breviore, 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.


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


Long. $\frac{1}{12}''$. — Hab. in mari “Sulu”; etiam fratro Sundæ. — Lect. die 27 Jan., et die 2 Mar., 1842.


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

II. SETE ANTENNAE ANTICÆ APICALES SUBAPICALIBUS NON LONGIORES.

A. Setæ caudales totæ mediocræ. Frons obtusa, non elongata.

a. Cephalothorax 4-articulatus.

12. CÆLANUS PAVO. — Frons subtriangulata, obtusa. Cephalothorax posticè obtusus. Antennæ anticeæ corpore dimidio longiores, duplo

* l. e. stylis exclusis, ut passim.
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curvatae, articulo ultimo longiore, setis longiusculis. Abdomen brevis-
sum. Styli caudales breves, divaricati, setis fere corporis longitudi-
dine, latis, eleganter plumiformibus, flabellatim divaricatis.

Long. 2\(\frac{1}{4}\). — Hab. in mari Atlantico, lat. bor. 12°, long. occ. 24°. —
Lect. die 9 Oct., 1838.

13. CALANUS LEVIS. — Frons obtusa. Cephalothorax medio
cris, posticè subacutus. Antennæ antice corpore vix longiores, duplo
leviter curvatae, apicibus fronte non antieriores; setis brevibus, 4 – 5
remotis longioribus, apicalibus et antice pentulmà fere articuli longi-
tudine, posticis penultimà antepenultimàque paulo longioribus, subae-
quìs, antice antepenultimà obsoletâ. Styli caudales parce oblongi, set-
is rectis, appressis, abdominis longitudine.

Long. 2\(\frac{1}{4}\). — Hab. in mari Atlantico juxta "Rio de Janeiro." —
Lect. die 7 Jan., 1839.

14. CALANUS MEDIUS. — Frons rotundata. Cephalothorax posticè ob-
tusus. Antennæ antice cephalothorace paulo longiores, duplo curva-
tæ, apicibus fronte posteriores; setis perbrevibus, 4 – 5 remotis longi-
ribus, posticà apicalis et antice pentulmà largè articuli longitudine, pos-
ticà penultimà paulo breviore, posticà antepenultimà duplo longiore.
Styli caudales breves, setis appressis, abdominis brevioribus.

Long. 2\(\frac{1}{4}\). — Hab. in mari Pacifico, lat. bor. 41°, long. occ. 153°.
— Lect. die 6 Jul., 1841.

15. CALANUS PLACIDUS. — Frons rotundata. Cephalothorax posticè ob-
tusus. Antennæ antice corporis longitudinaline, duplo leviter curvatæ,
apicibus fronte paulo posterioribus; setis apicalibus brevibus, posticis
pentulmà antepenultimàque valde elongatis, antice pentulmà dìmidi
breviore. Styli caudales breves.

Long. 2\(\frac{3}{4}\). — Hab. in mari Pacifico, prope insulas "Kingsmill";

16. CALANUS RECTICORNIS. — Frons obtusa. Cephalothorax posticè
rotundatus. Antennæ antice corpore longiores, rectissimæ, apicibus
fronte non antieriores, articulo primo (2?) crassè oblongo, ultimo pau-
lium demisso; setis brevibus, articuli secundii subelongatæ, articuli an-
tepenultimi postieæ longiore (= 4 artic.), penultimis posticà et antice
paulo brevioribus, apicalis posticà minore, articulo longiore, duabus alis
apicalibus brevibus et subuncinatis. Styli caudales breves; setis me-
diocribus, parce diffusis.

Long. 2\(\frac{3}{4}\). — Hab. in mari "Sulu." — Lect. die 1 Feb., 1842.
b. Cephalothorax 5–6-articulatus.

1. *Cephalothorax posticè obtusus aut breviter subacutus.*


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


*Long.* \(\frac{1}{4}\)".—*Hab.* in mari Atlanticō, lat. bor. 14\(\frac{1}{2}\)°, long. occ. 21°.—Lect. die 5 Oct., 1838.


*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 subaeutus. Antennae anticae corpore paulo longiores, duplo leviter curvate, apicibus fronte vix posteriores; setas *affinis* similis. Styli caudales oblongi, setis mediocribus, non diffusae. Abdomen 2-articulatum; an adultum?

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

21. **Calanus tenuicornis.**—Frons rotundata. Cephalothorax 5-articulatus, posticè obtusus, articulis posticis subaequis. Antennæ anticae sesqui corporis longitudine, tenuissimae, duplo levissimē curvate,

* Anguli postici cephalothoracis adulti sape elongati et subacuti aut acuti.
apicibus fronte vix posteriores, articulis tribus ultimis subaequis; setis brevibus, articuli tertii setà longiore, setis duabus posticis subapicalibus praetongis, antica penultima prope dimidio breviore, apicalibus brevibus. Styli caudales oblongi (latitudine duplo longiores).

— Lect. die 2 Jul., 1841.


Long. 1/14. — Hab. in mari Pacifico, lat. bor. 44°, long. occ. 154°.
C. recticorni affinis; sed cephalothorax 5-articulatus.


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

2. Cephalothorax posterior acutus, angulis posticis abdomini appressis.

25. Calanus simplicicaudus. — Frons obtusa. Cephalothorax 5-
articulatus, segmento postico angusto et posticè brevissimè acuto. Antennæ antice corpore paulo longiores, basi arcuata, aliquoe fere rectae, apicibus fronte parè posteriores; setis brevibus, duabus subapicalibus posticis longis, inaequis, anticà penultimà duplo breviore, apicalibus brevibus. Abdomen 2-articulatum: (an adultum ?). Styli caudales paulum oblongi.

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

_C. flavipes_ abdominem et angustum articulum cephalothoracis posteriori affinis; antennarum anticearum setas apicales subapicalesque _C. sanguineo_ similis.


3. _Cephalothorax posticè longè acutus, angulis posticis remotis._


_Long._ 14° = _Hab._ in mari Atlantico, inter lat. bor. 8° et lat. aust. 5°, long. occ. 23° — 15°; etiam, lat. aust. 41° — 1°, long. occ. 25° — 30°. — _Lect._ diebus 18, 20, 27, 31 Oct., 2, 3, 8, 12 Nov., 1838; 13, 16 Mai, 1842.

_C. affini_ similis; sed anguli postici cephalothoracis longè acuti. An distinctio vera ?

28. _Calanus amænus._ — _C. commun_ antenas anticas setasque caudales affinis. Cephalothorax 5-articulatus, sed articulo ultimo brevissimo; angulis posticis longè acutis.

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32. **Calanus attenuatus**. — Elongatus. Frons triangulata, acuta, rostro longè et tenuiter furcato. Cephalothorax antice valde angustatus, posticè obtusus, 5-articulatus, articulo ultimo brevi. Antennæ antice corpore valde longiores, prope basin arcuatae, alioque rectæ et
latissimè divaricatæ, apicibus fronte paulo antiores, articulo penulti- mo abbreviato; setis vix brevibus, plerumque fractis, sere æquis, api-


C. Frons valde elongata; rostro breviter valdeo furcato. Setæ caudales secundae longissimæ (?).


Long. 1/2". — Hab. in mari “Sulu.” — Lect. die 2 Feb., 1842.


Long. 1/2". — Hab. in mari Atlantico, lat. bor. 1°, long. occ. 18°. — Lect. die 3 Nov., 1838.

Genus II. SCRIBELLA. (Dana.)

Antennæ antica elongatæ, pauci-articulataæ, longè setigere, setis diffusis, maris non geniculantes. Antennæ posticae simplices (?). Maxil-
lipedes (ct. vi.) maximi, pedibus proximis majores, 4-articulati, geni-
culati et prorsum flexi. Oculi inferiores nulli. Cephalothorax 4– 5-articulatus, capite non discreto. Abdomen valde elongatum, cepha-
lothorace non brevius. Styli caudales oblongi, divaricati. [Stepius, e basi pedis biuremis, seta grandis lateralter porrecta.]

1. **Scribella scribella.** — Antennae anticae latè (130°) divaricatae, fere corporis longitudine, 7-articulatae, 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.** 23°. — **Hab.** in mari Pacifico, prope "Tierra del Fuego"; etiam lat. aust. 24°, long. occ. 175°; lat. bor. 44½°, long. occ. 153°. — Lect. die 21 Jan., 1839; die 21 Ap., 1840; die 7 Jul., 1841.

**Genus III.** **EUCIETA.** (Philippi.)


*Long. = 5/".* — *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.


Genus IV. UNDINA. (Dana.)

Antennae antice ante medium angulo leviter flexae, apicibus fronte posteriores, maris non geniculantes. Pedes postici (ct. xii.) maris grandes, dextro subcheliformi. Pedes antici (ct. vii.) elongati, maxillipedibus sape majores et valde recti, non geniculati. Oculi inferiores nulli. Cephalothorax 4-5-articulatus, capite non discreto.


Long. \( rac{1}{2} \text{cm} \). — Hab. in freto "Banca," juxta insulam "Sumatra"; etiam in mari Atlantico, lat. aest. 4°-9°, long. occ. 17\( \frac{1}{2} \)°-25°. — Lect. die 1 Mar., et diebus 9, 13 Maii, 1842.


Long. \( rac{2}{3} \text{cm} \). — Hab. in mari Pacifico, prope insulas "Kingsmill," et lat. bor. 25°, long. orient. 167°. — Lect. die 25 Mar., et die 14 Maii, 1841.


Long. \( rac{1}{2} \text{cm} \). — 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 antice regulariter et breviter setigeræ, transversæ; dextræ maris articulatione geniculante. Maxillipedes (ct. vi.) pedibus proximis majores, duplo


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giores, a basi arcuatae; articulis 13, 14, 15, 16, 17 antennae dextrae incrassulatis, articulo 17 elongato apice prominulo, partim subtilissime pectinato, sequentibus sex brevibus, et tenuissimis.

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

5. CANDACE AUCTA. — FEMINA : Cephalothorax 5 - 6-articulatus, postice subacutus aut obtusus. Antennae antice fere corporis longitudine, e basi arcuatae, apice prorsum parce flexae, articulo secundo longo et crasso. Abdomen 2 - 3-articulatum.

Long. \( \frac{1}{12}'' \). — Hab. in mari Pacifico, lat. auct. 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. — FEMINA : Cephalothorax postice truncatus. Antennae antice corporis longitudine, prope articulum, sextum flexae, deinde recte transversae et tenuissimae; articulo secundo crasso, non longiore quam articulus tertius quartusve.


Genus VI. CYCLOPSINA. (Milne Edwards.)


Long. 1/4°. — Hab. in mari Atlantico, lat. aust. 4°, long. occ. 21°. — Lect. die 7 Nov., 1838. — An Cetochnlo septentrionali (Goodsir) affinis?


Genus VII. CATOPIA.

Antennas posticas et antennarum habitum anterum Calano affinis.

Antennam anticam maris dextram Pontellae affinis. Oculi superiores nulli; oculus inferior unicus (?).

CATOPIA FURCATA. — Gracilis. Caput quadratum, non discretum. Cephalothorax 4-articulatus, posticé 4-dentatus, dentibus acutis, externis longioribus. Styli caudales oblongi, divaricati. Antennae antece corpore longiores, duplo curvatae, apicibus fronte non antieriores; setis totis brevibus.


Genus VIII. ACARTIA. (Dono.)

Antennæ antice rectiusculæ, flexiles, setis irregulariter diffusis, dextræ maris non geniculante. Maxillipes (et vi.) pedibus proximis majores, recti, setis setulosis longis instructi. Pedes postici (et xii.)
parvuli, uni-articulati, 2 setas divaricatas gerentes. Oculi duo inferiores et duo superiores. Seta caudales mediores.


Long. $\frac{1}{10}$". — Hab. prope Patagoniam. — Lect. diebus 14, 15 Jan., 1839.


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


Long. $\frac{1}{15}$". — Hab. in "Port Jackson" Novi-Hollandiae. — Lect. Mar., 1840.


Genus IX. Pontella.

Rostrum furcatum. Oculi duo superiores, pigmentis sive coalitis sive remotis; duo inferiores coaliti. Antennæ antecé multiarticulatae, setis non diffusis, antennâ dextrâ maris geniculante. Cephalo-
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I. PONTELLA CALANOIDEÆ. Antennaæ Antice duplo curvatæ, ad apices fronte non anteriores. Antennaæ Postice, ad apicem rami minoris, 3-setigeræ.


II. Antennaæ Antice ad apices fronte anteriores.

A. Caput lateribus inerme.

1. Cephalothorax posticè obtusus aut brevissimè acutus.

3. Pontella plumata. — Femiae : Frons rotundata. Cephalo-

* Pontia Papilionum generis vocabulum, itaque Pontella hic scripsa.

Long. 1/2 — Hab. in mari Atlantico, lat. bor. 5°, long. occ. 21°.


Long. 1/2 — Hab. in mari Pacifico, lat. aust. 18°, long. occ. 121°.
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30; lect. die 7 Aug., 1839. An eadem species in mari Atlantico, lat. aust. 2°, long. occ. 20°; lect. die 6 Nov., 1838.


Long. \( 29' \). — Hab. in mari "Sulu"; lect. die 27 Jan., 1842.


Long. \( 2^v' \). — Hab. in mari Pacifico, prope insulas "Kingsmill"; lect. diebus 22, 26 Mar., 1841. In mari Atlantico, lat. bor. 8½°, long. occ. 23° 45'; lect. die 15 Oct., 1838.


Long. \( 1/2^v - 1/6^v \). — 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."

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

Long. \( \frac{2}{9} \). — Hab. in mari Pacifico, lat. aust. 32° 24', long. orient. 178°. — Lect. die 9 Ap., 1840.


Long. \( \frac{3}{9} \). — Hab. in mari Atlantico, lat. bor. 7\(^\circ\) 45', long. occ. 38\(^\circ\) 18'; lect. diebus 16, 24 Oct., 1838.

2. Cephalothorax postice productus et acutus.

* Seta antennarum anticae apicalis setis subapicalibus brevior.


Long. \( \frac{1}{9} \). — Hab. in mari Atlantico, lat. aust. 19\(^\circ\) 15', long. occ. 38\(^\circ\) 18'; lect. die 17 Nov., 1838: etiam (?) lat. bor. 91\(^\circ\), long. occ. 21° 18'.


Long. \( \frac{3}{9} \). — Hab. in mari Pacifico, prope insulam "El Gran Co-cal," lat. aust. 5° 40', long. orient. 175° 30'; etiam prope insulas "Kingsmill"; lect. diebus 25 Mar., 1 Ap., 1841.


Long. 1½". — Hab. prope insulam "Mindoro"; lect. die 21 Jan., 1842. In mari Sinensi; lect. die 15 Feb., 1842.

† Seta antennarum anticearum apicalis subapicalibus longior.


Long. 1½". — Hab. in mari prope Promontorium Bonæ Spei; lect. die 12 Ap., 1842.

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

Long. \( \frac{1}{2}^{\circ} \). — Hab. in mari “Sulu”; lect. die 27 Jan., 1842.


Long. \( \frac{1}{12}^{\circ} \). — Hab. in mari Atlantico, lat. austr. 0° 40', long. occ. 18°; lect. die 3 Nov., 1838. Forsan, lat. bor. 7° 25', long. occ. 20°; lect. die 17 Oct., 1838.


Long. \( \frac{1}{12}^{\circ} \). — Hab. in mari Pacifico, lat. austr. 3°, long. orient. 175°.


Long. \( \frac{1}{16}^{\circ} \). — Hab. in fretis “Banka” et “Sunda”; lect. diebus 1, 4 Mar., 1842.

B. Caput lateribus armatum.

Antennae antice fere corporis longitudine, transverse, apicibus fronte paulo anterioribus, prorsum parce curvatis, prope basin setis confertis longiisculis, et unà sublonga mobilis. Setis apicalibus articuli longitudine, posticà penultimà paulo longiore, aliis subapicalibus brevius. Styli caudales vix oblongi. [Abdomen 3-articulatum.]

Long. \( \text{1/6} \). — Hab. prope insulam “Sumatra”; lect. die 3 Mar., 1842.


Maris (an hac species?) antennæ antica dextra 9-articulata, subtræs, incrassulata, articulis 2, 3, 4, 5, 6 totis longis, 3 sequentibus (ultimis) normalibus, articulo quarto longiore et crassiore, subcylinndrico. Antennæ posticæ tenuissimæ, ramis fere æquis. Abdomen 4-articulatum, tenue; styli parce oblongis. Anguli postici cephalothoracis acuti, dextro longiore. — Long. \( \text{1/2} \). Hab. in mari “Sulu”; lect. die 28 Jan., 1842.


Long. 1/4. — Hab. prope fretum Sundæ; lect. die 4 Mar., 1842.


Long. 1/2. — Hab. in mari Pacifico, prope insulam “Tongatabu”; lect. die 29 Mar., 1840.


Long. 1/4. — Hab. in mari Pacifico, lat. aust. 11° –12° 45'; long. occ. 170° – 171°; lect. diebus 1, 5 Feb., 1840.
Familia IV. CORYCÆIDÆ.


Genus I. CORYCÆUS.


1. Antennæ Posticae macrodactyle, digito non breviore quam carpus.*

A. Sæta caudales stylis valde breviore. [Cephalothorax posticus (ad segmentum tertium) acutus, segmento quarto minore.]


Long. 30". — Hab. in mari Atlantico, lat. bor. 1° 30', long. occ. 18° 20', et lat. aust. 2° 20', long. occ. 20°.


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

3. Corycæus deplumatus.—Consipicilla remotiuscula. Antennæ antice brevissimè setulosæ, 7-articulatae. Antennarum posticarum car-

* Carpus est articulus elongatus antennarum posticarum secundus (aut primus et secundus simul sunt). Digitus articulorum tertio quartoque compositus, plus minusve discretis. Carpus setà longà sive nudâ sive setulosâ ad basin ornatus, et sæpe una duabusve laterallis 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'.


_Long._ 2½'. — _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."


_Long._ 1⅓'. — _Hab._ in mari Sinensi.

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

* Cephalothorax posticè obtusus.


_Long._ 3½'. — _Hab._ in mari Pacifico, prope insulam "El Gran Cocal."

† Cephalothorax posticè acutus.


_Long._ 2½'. — _Hab._ in mari "Sulu," prope insulam "Panay."

Long. \(\frac{3}{2}''\). — Hab. in mari Atlantico, lat. bor. 4°—5°, long. occ. 19°—22°, et lat. aust. 0°15'—1°, long. occ. 18°30', et 31°.


Long. \(\frac{1}{2}''\). — Hab. in mari Pacifico, lat. aust. 18°, long. occ. 124°30'.


Long. \(\frac{3}{2}''\). — Hab. in mari Pacifico, prope insulam “Tongatabu.”


Long. \(\frac{1}{2}''\). — Hab. in mari “Sulu,” prope insulam “Panay.”

2. Antennae Postice microdactyle, digitus carpo brevior.

A. Seta carpi antennarum posticarum nuda.

* Styli caudales abdomen non breviores.

Digitus carpo paulo brevior.


Long. 15°. — Hab. in mari Pacifico, prope insulas “Kingsmill.”

Digitus carpo valde brevier, uncinatus.


Long. 16°. — Hab. in mari Atlantico, lat. bor. 5° – 7°, long. occ. 21° – 22°.


Long. 14°. — Hab. in mari Atlantico, lat. austr. 11°, long. occ. 29°.

† Styli caudales abdomen breviore. [Cephalothorax posticè (ad segmentum tertium) longè acutus.]


Long. 17°. — Hab. in mari Atlantico, lat. bor. 3° 45′ – 4° 20 ′, long. occ. 19° 30′ – 18° 30′; etiam lat. austr. 6° 20′, long. occ. 24°.


Long. 18°. — Hab. in mari Pacifico, prope insulas “Kingsmill.”

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

17. Corycæus pellucidus. — Cephalothorax gracilis, ventre max-
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Long. \( \frac{2}{5}^{60} \). — Hab. in mari Atlantico, lat. bor. 4° - 7°, long. occ. 19° 30' - 21° 30'; quoque lat. aust. 2° 20', long. occ. 20°.


Long. \( \frac{2}{5}^{60} \). — Hab. in mari Pacifico, lat. aust. 15° 35', long. occ. 138° 30'; quoque leucas 80 ab insulâ "Tongataba" versus austrum.


Long. \( \frac{1}{3}^{60} \). — Hab. in mari Atlantico, lat. bor. 8° 35', long. occ. 23° 40'.


Long. \( \frac{1}{3}^{60} \). — Hab. in mari Atlantico, lat. bor. 5° - 0° 50', long. occ. 18° - 20°; quoque lat. aust. 2° 20', long. occ. 20°.

Genus II. ANTERIA.


Long. $\frac{3}{4}^\circ$. — Hab. in mari Atlantico, lat. bor. 1°, long. aust. 18°.


Long. $\frac{2}{3}^\circ$. — Hab. in mari Atlantico, lat. bor. 5° - 7°, long. occ. 21° - 22°; lat. aust. 2° 20', long. occ. 20°.


Long. $\frac{3}{4}^\circ$. — Hab. in mari “Sulu,” prope insulam “Panay.”

Genus III. COPILIA.

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


Long. $\frac{1}{6}^\circ$. — Hab. in mari Pacifico, prope insulam “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 excavav. 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 similis, et abdomen, pedesque antici (vel maxillipedes, ct. vii.) dissimiles. Antennæ posticae pediformes, digito tenui, 2-articulato, ad apicem unguiculato. Abdomen feminae 5 - 6-articulatum, thorace subito angustius, appendices breves ad basin latere gerens; maris 4 - 5-articulatum, thorace subito non angustius, appendicibus nullis.
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Pedes antici maris digitum elongati, feminae breves. Styli caudales laminati. — Mares sepe lacte opalini aut fulgidè metallini, interdum caerulei. Feminae saepius incoloratae, plus minusve pellucidæ; interdum opacæ et azuleae.

1. Conspicilla conjuncta.


Long. 41°. — Hab. in mari Pacifico, lat. aust. 41°, long. occ. 76° 24'.

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

Long. 43°. — Hab. in mari Pacifico, lat. aust. 43°, long. occ. 78° 45'; etiam ad syrtas "Laguallas," lat. aust. 35° 50', long. orient. 23°.


Long. 179°. — Hab. in mari Pacifico, lat. bor. 15°, long. orient. 179°.

4. SAPPHIRINA METALLINA. — Lamellæ caudales fere rectangulatae, apice subtruncatae, setis quatuor apicalibus subæquis, parcè breviaribus quam lamellæ. — Maris: Corpus valde depressum, angustato-ellipticum, 9-articulatum, segmento ultimo tecto, primo oblongo, quarto dimidio breviore quam quintum.

Long. 16°. — Hab. in mari Pacifico, prope insulas "Kingsmill."

5. SAPPHIRINA CORUSCANS. — Digitus antennarum posticarum paulo
brevior quam carpus, tenuis, unguiculo elongato. Lamellae caudales subovatae, ad apicem rotundatae, apice interno setam brevem gerente, setis alis quatuor, totis brevibus (lamellae fere quadruplo brevioribus).

— *Maris* : Corpus depressum, elongato-ovatum, posticè angustatum, segmento primo (fere duplice) parce oblongo, alis segmentis fere similibus. Conspicilla fronte insita, prominentia.

*Long.* 1\(\frac{1}{6}\)".— *Hab.* in mari Pacifico, lat. aust. 18° 10', long. occ. 125° 30'.


*Long.* 1\(\frac{1}{2}\)".— *Hab.* in mari Pacifico, lat. aust. 43°, long. occ. 78° 45'.


*Long.* 1\(\frac{1}{2}\)".— *Hab.* in freto "Balabac," prope insulam "Borneo."


*Long.* 1\(\frac{1}{5}\)".— *Hab.* in mari Pacifico, prope insulam "Assumption," lat. bor. 19° 30', long. orient. 144° 30'.

9. **Saphhirina ovalis.** — Digitus antennarum posticarum erassus, carpo fere longior, articulis digitig valde inæquis, unguiculo dimidium digitig longitudine æquante. Lamellae caudales ovatæ, setis quinque, unà

_Hab._ in mari Pacifico, prope insulam "Tongatabu," versus Australium.


_Long._ 1½". — _Hab._ in mari Pacifico, lat. aust. 15°, long. oec. 138° 45′.


_Long._ 1½". — _Hab._ in mari Pacifico, lat. bor. 28°, long. orient. 177°.


_Long._ 1½". — _Hab._ in mari "Sulu."
2. Conspicilla non contigua.


Hab. in mari Atlanticó, prope "Rio de Janeiro"; quoque lat. aust. 29°, long. occ. 41°.


Long. \( \frac{1}{2} \). — Hab. in mari Australis, ad syrtas "Lagullas." — An Sapphirina indicatori pertinet?


Long. \( \frac{1}{3} \). — Hab. in mari Pacifico, prope insulas "Kingsmill."

*Long. \( \frac{1}{2} ^\circ \).* — Hab. in mari Atlantico, lat. bor. 1° – 0°, long. occ. 17° – 18°; quoque lat. aust. 4° 30', long. occ. 25°.


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


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

19. Sapphirina obesa. — Lamellae caudales late, subellipticas latitudine non duplo longiores, setis brevissimis, fere obsoletis, una ad apicem internum vix dispiciendâ. — Femina: 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. Consipilla remotiuscula, fronte insita.
— Brunnescens.

_Long._ $1_6^{1/6}$. — _Hab._ in mari Pacifico, prope insulas "Kingsmill."

20. _SAPPHIRINA OBTUSA._ — Lamellae caudales elongate, non divaricate, setis dimidio lamellae valde brevioribus. — _Feminae._ Cephalothorax convexus, 4-articulatus, ad frontem subtruncatus, segmento antico oblongo, lateribus fere parallelis, angulis posticos rotundatis, segmentis alis dissimilibus, secundo ad latus truncato, quarto (vel ultimo) medium ad latus angulato. Abdonem angustum, 5-articulatum, segmento primo parvulo, tribus sequentibus sublunatis. — Rubescens.

_Long._ $1_5^{1/5}$. — _Hab._ in mari Pacifico, lat. aust. 43°, long. occ. 78° 45'.

_Familia V. MIRACIDÆ._

_Oculi_ duo conspiciliis maximis constructi. _Antennae postice_ ad apicem setigeræ. _Pedes mandibulares_ maxillaresque brevissimi. _Abdonem feminae_ (an maris quoque?) 6-articulatum. _Sacculus ovigerus_ unicus.

_Genus MIRACIA._

_Corpus_ elongatum, non depressum, ad frontem duas appendices falciiformes subitus gerens. _Antennae anticae_ appendiculate, flexiles et non geniculantes. _Pedes antici_ (ct. vii.) mediores, uni-unguicalecti; _pedes_ duo sequentes biremes, lateraliter porrecti. _Pedes abdominis_ longi setigeri. _Setae caudales_ elongate. — _Setellæ_ affinis, sed conspicilla oculorum diverse.

1. _MIRACIA EFFERATA._ — _Corpus_ 10-articulatum, segmento antico valde latiore, alis sensim attenuatis. Consipilla fronte insita, maxima, valde prominentia, contigua. _Antennae anticae_ mediores, 7-articulatae, articulis tertio quinto septimoque brevibus. _Styli caudales_ oblongi, setis duplo longioribus. — _Cyanea._

_Long._ $1_6^{1/6}$. — _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 posticoe attenuatum, 10-articulatum, segmento antico non latiore. Consipilla maxima, paulo prominentia, fronte insita. _Antennæ anticae_ tenuissimae, articulis secundo, quarto, duobusque ultimis brevibus. _Styli_ caudales oblongi, setis quadruplo longioribus, fere corporis longitudine. — _Cyanea et viridis._

_Long._ $1_6^{1/6}$. — _Hab._ in mari Pacifice, lat. aust. 32° 21', long. orient. 177°; quoque prope insulam "Sunday."
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Tribus 2. DAPHNIACEA (vel Cladocera).


Tribus hujus familie sunt: —


Familia I. P E N I L I DÆ.

Genus PENILIA. (D.)

Caput discretum, longe rostratum. Antenna postice grandis, ramis duobus 2-articulatis. Abdomen non inflexum, stylis duobus corneis confectum.

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


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


Familia II. D A P H N I DÆ.

Genus I. DAPHNIA.

Abdomen inflexum. Antenna antice obsolescentes. Antenna postice biremanæ, ramis 3 - 4-articulatis. Intestina non convoluta.

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

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 subtillisissimè denticulato. Caput breve, supernè visum triangulatum, obtusum. Rami antennarum posticarum subaequ, setis longiusculis. Testa reticulata, areolis longè angustissimèque linearibus, obliquis, prope marginem valde latioribus.

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


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

Genus II. SIDA.


Hab. in stagnis ad insulam "Vanua Lebu."

Genus III. LYNCEUS.


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

Hab. in stagnis ad insulam "Vanua Lebu."
Família IV. POLYPHEMIDÆ.

Pedes octo. Oculus maximus.

Genus POLYPHEMUS.

Caput discretum, magnum. Antennæ birameæ, validæ.

POLYPHEMUS BREVICAUDIS. — Testa posticè tumida rotundata. Caput oblongum (pauilo brevius quam testa reliqua), conoideum, anticiè latius et globulare. Rami antennarum subœqui 3-articulati, parce setigeri. Pedes crassi. Abdomen non inflexum, breve, crassum, parce exsertum, furcatum, ad apicem acutum.


Tribus 3. CYPRIDACEA (vel Ostracoda).


Genus I. CYPRIS. (Müller.)


1. CYPRIS SPECIOSA. — Oblonga, subovata, anticiè angustior, subitus fere recta, vix excavata, alioque bene arcuata, altitudine latior et plus duplo longior; ad marginem antennæ pubescens, posticum breviter ciliata. Flava et latè viridis, arcis flavis paucis imperfectis viridi circumdata.


2. CYPRIS ALBIDA. — Latreæ visa, breviter subelliptica, extremitates fere æqua, latè rotundata, subitus recta, supra obsolètæ gibbosa; triplus longior quam latitudo, non duplo longior quam altitudo, margine pubescente. Oculus margine superiore remoto. Albido-margaritacea, posticè et suprèm paulo brunnea.

Long. 3° 41′. — Hab. in stagnis prope “Valparaiso.”

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

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

4. Cypris Pubescens. — Brevis; latere visa, latissime fabiformis, subtus recta, extremitatis latè et æque rotundatis, dorso bene arcuato; suprænë visa, latè ovata, fronte subacuta; ad totam superficiem pubescens. Antennæ antice 7-articulatæ, setis vix longioribus quam 5 articuli ultimi simul sunti. Antennæ postice crassiusculæ, articulo ultimo fere dimidiï penultiìi longitudine, setam longam ad apicem gerente, penultiìmo ad apicem longè setigero. — Pallidè olivacea.

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

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

Long. $\frac{3}{16}$". — Hab. in stagnis prope portum "Nailoa," ad insulam "Vania Lebu," in archipelago "Viti."

Genus II. CYPRIDINA. (Milne Edwards.)


1. Cypridina Luteola. — Compresso-ovoidea; latere visa, latè elliptica, antice breviter rostrata, fronte non prominula, marginibus allis arctuis, posticè non gibbosò; suprænë visa, angusto-ovata, antice acuta,
posticè rotundata. Digitus pedis mandibularis ad basin crassus, sensim attenuatus. Antennæ antice ad apicem 4-5-setigere, setis antennâ non longioribus. — Luteola.

Long. \( \frac{1}{12} \). — Hab. in mari “Sulu.”

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

Hab. in mari “Sulu.”


— Olivacea.

Long. \( \frac{1}{10} \). — Hab. in mari “Sulu.”


Long. \( \frac{2}{10} \). — Hab. in mari Pacifico, lat. aust. 15° 20', long. occ. 148°. — Lect. die 10 Sept., 1839.


Long. \( \frac{1}{10} \). — Hab. in mari Pacifico, prope insulam “Upolu.” — Lect. die 26 Feb., 1841.

Genus III. CONCILÆCIA. (Dana.)

Testa interdum breviter rostrata, corpus omnino tegens, fronte apertâ. Oculi simplices. Antenna antice 3-4-articulata, apicem longè setigere. Spiculum inter antennas sarcosem, simplex, exsertile. Antenna postice 5-7-articulata, articulis brevissimis longè setigeris confectæ, ramo altero brevi. Pedes mandibulares fermè 5-articulati,
non unguiculati, apice interno articuli primi sepius etiam basi interno secundii simul cornis (instar mandibulæ) et denticulatis. Maxille quattuor. Pedes quattuor, tenues. Abdomen spinulis biseriatis confectionem.


Long. $\frac{19}{20}$°. — Hab. in mari Atlantico, lat. bor. 0° – 4°, long. occ. 17° 30' – 20° 10'; lat. aust. 0° – 6°, long. occ. 17° 30' – 21°. — Lect. diebus 25, 26, 27, 29 Oct., et 2, 3, 5, 8 Nov., 1838.


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


Long. $\frac{19}{20}$°. — Hab. in mari Atlantico, lat. aust. 23°, long. occ. 41° 10'. — Lect. die 19 Nov., 1838.

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Long. 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:


II. *Caligacea.* — Corpus saxipius depressum. Maxillae pedesque toti numero 12—14, octo pedes ultimi plerumque natatorii, plurimi testâ tecti.


IV. *Nymphacea.* — Corpus breve, araneiforme, abdomine obsolescente.

**Tribus I. *Monstrillacea.***

Genus *Monstrilla.* (Dana.)


*Long. 1° 15′.* — Hab. in mari “Sulu.” — Lect. die 3 Feb., 1842.

**Tribus 2. *Caligacea.***

Familiae quinque sequentes:


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

Familia II. CALIGIDÆ.

Subfamiliae Caligidarum nobis sunt:


Caligaceorum segmenta corporis auctoribus sepe malè data. Segmentum abdominis anticum, ovarium externum gestans, thoracis posticum sepe vocatum. In Cyclopaceis Caligaceisque ovarium externum ad segmentum secundum abdominis normalè semper pertinet. Si hæc animalia Cyclopaecis Crustaceisque aliis comparantur, affinitates veras educemus. Tabula sequens, membris ordine enumeratis, hæc comparationem exhibit.

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vergiformes, bifidi;* duo proximi sequentes subprehensiles digito acuto confecti; sex sequentes natatorii; duo reliqui simplices, vergiformes. Venter furcula parvula armatus. *Abdomen 2-3-articulatum, appendicibus caudalibus sublamellatis, marginem setigeris. [Sexus, antennas posticas, pedes paris secundi, et formam abdominis, valde dissimiles.]


*Long. 3/8.*—*Hab.* in corpus *Thymni pelamys* mari Atlantico; lat. bor. 27°, long. occ. 19° 30'.—Lect. die 27 Sept., 1838.


*Long. 1/2.*—*Hab.* intus operculum *Thymni pelamys*, in mari Atlantico; lat. bor. 27°, long. occ. 19° 30'.—Lect die 27 Sept., 1838.


*Long. 1/4.*—*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 suctoriis non munitus: segmentum secundum fere oblongum. Abdomen 3-articulatum, segmento primo valde latiore; segmentis duo-
bus posticis simul sumtis oblongis, ano prominenti. Styli caudales parvuli ad angulos abdominis posticos insiti, anum vix superantes. Antennae posticae spinâ extus basin non munitae. Furcula simplex, bra-
acuto setâque internâ armato, margine manús interno fere recto, pol-
lice 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.

Trebic affinis, ced cephalothorax non 3-articulatus et maxille nec lamellares, nec ad truncum buccalem appressae.

Calistes Trigonis. — Feminae: Cephalothorax subrotundatus, discis suctoriis nullis. Segmentum secundum parvum, lateribus rotun-
datis. Abdomen 3-articulatum, segmento primo lato, sequentibus li-
neatis, ano vix prominente. Styli caudales styliformes, oblongi. An-
tenae posticae spinâ cornea longâ extus basin munitae. Furcula sim-
plex, brachiiis parallelis. Maxille posticè aculo-furcatae. Pedes pos-
tici natatorii, ramis 3-articulatis, parce subæquis, setis longis. — Seg-
mentum abdominis primum subquadratum, angulis rotundatis, duo-
bus sequentibus fere æquís 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 natatorii.

Caligiera Bella. — Feminae: Cephalothorax rotundatus, discis sucto-
ririis nullis. Segmentum secundum transversum, angulos posticos alatum, alis latis, approximatis, margine toto arcuato. Abdomen 3-

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articulatum, segmento primo lato, tertio posticè truncato, lamellis caudalibus latis, paulo oblongis, contiguis, setis lamellâ brevioribus, fere aquis. Furcula simplex, tenuis, basi angustissimo, brachiis divergentibus. Pedes postici tenues, ramis valde inaequis, 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 branchiis speciei Thynnii, 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 arcuata, segmento secundo ad latera posticè producto, duobus sequentibus non alatis. _Abdomen_ stylos brevibus sublammellatis setigerisque confectum. _Oculi_ simplices, remotiusculi; (an quoque oculus subtilissimus intermedius ?). _Pedes_ paris secundi crassè cheliformes; pedes natatorii octo, grandes.

_NOGAGUS VALIDUS._ — _Feminae?_ 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 antice subquadrato, angulis posticis prominulis; segmento postico brevi, transverso, angulis posticis truncatis. _Styli_ caudales latè lamellati, paulo oblongo, setis tribus plumosis.


Genus II. SPECILLIGUS. (Dana.)

_Nogago_ segmenta cephalothoracis pedesque affinis. _Oculi_ duo remotiusculi, et _conspicillis_ grandibus instructi, eisque Saphirinae similes.

_SPECILLIGUS CURTICAUDUS._ — _Feminae?_ Carapax oblongo-ellipticus, anticè arcuatus, discis suctoriis post antennam anticom 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-articu-
latum, segmento antico paulo oblongo, angulis posticis truncatis et se-
tam minutam gerentibus, segmento postico brevi, ano prominenti; stylis
parvulis, triangulatis, ad angulos inuitis, unum non superantibus, setis
tribus, plumosus.

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 posticé
alatis, et bilobatis. Abdomen 2—3-articulatum, segmento ultimo tec-
to, secundo posticé rotundato et utrinque stylis caudalis suis 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, posti-
cè truncatus et dentatus, angulis posticis paululo elongatis, obtusis.
Segmentum secundum brevissimum, alis divaricatis, subrectangu-
latis, angulis posticis subaequato. Segmenta duo sequentia transversa,
subequa, lobis rotundatis acutè sejunctis. Abdomen 3-articulat-
um, 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, posticé sensim la-
tior, angulis posticis parce prominentibus, margine postico integro, ant-
tico obsoletè denticulato. Segmentum secundum brevissimum, alis di-
varicatis, oblongo-ellipticis. Segmenta cephalothoracis sequentia trans-
versa, primo minore, lobis rotundatis acutè sejunctis. Abdomen 3-arti-
culatum, articulo antico grandi, posticè angusto-excavato, lateribus fere
rectis, parce deinde subito angustioribus et angulis posticis internis
acuis; 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. Seg-
menta sequentia tria transversa. Alae segmenti secundi non divaricatae,
posticè obtusae. Segmenta tertium quartumque abdomen 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-Zelandiam.

Genus IV. DINEMATURA. (Latreille.)

**Cephalothorax** 3-articulatus, segmento secundo parvo, testâ tertii dorsali posticè valde expansâ et profundè bilobâtâ, eoque elyroideâ. **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, dimidiâ 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.)


**LEPIDOPUS ARMATUS.** — Corpus oblongum, posticè sensim latius. Carapax subquadra tus, posticè paulo latior, margine postico vix arcuato. Segmenta duo sequentia subequa, alis grandibus, fere rotundatis. **Abdomen** oblongum, carapace valde longius, posticè non angustius, paulo bilobatum, lobis rotundatis. *Antennæ posticae* ad apicem longè falciformes et denticulis biseriatis armatæ, articulo penultimo subquadra tus.
Pedes paris secundi grandes, articulo penultimo ad apicem spinigero, ultimo crassissimo, superficie terminali oblongâ, squamatâ, squamulis spinulâ armatis.

\[ \text{Long. } \frac{3}{4} \text{.} \quad \text{Hab. in corpus speciei Musteli (Squalorum familie).} \]

— Lect. ad urbem "Rio de Janeiro."

**Tribus 4. NYMPHACEA.**

**Genus ASTRIDIUM.** (Dana.)


\[ \text{Long. } \frac{1}{3} \text{.} \quad \text{Hab. in mari "Sulu."} \quad \text{Lect. die 11 Feb., 1842.} \]

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 verà 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, or 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-

* Lead 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 Bredecke, 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 \text{\(\frac{1}{79}\)}th to \text{\(\frac{1}{50}\)}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-

§ 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 excitments 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-
mitted to him by the Water Commissioners, in 1815, 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.

"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 0.0108gr.

"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, 0.1880gr.; 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 0.0040gr. 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, 0.0503gr.; 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 experi-
ments. 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.

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Distilled water,</td>
<td>0.0000</td>
<td>0.0000</td>
<td>0.0000</td>
<td>0.0000</td>
</tr>
<tr>
<td>Albany &quot;</td>
<td>0.0924</td>
<td>0.0198</td>
<td>0.0726</td>
<td>...</td>
</tr>
<tr>
<td>Cambridge &quot;</td>
<td>0.3918</td>
<td>0.0900</td>
<td>0.2028</td>
<td>0.0676</td>
</tr>
<tr>
<td>Cambridge water {</td>
<td>0.1380</td>
<td>0.0540</td>
<td>0.0840</td>
<td>...</td>
</tr>
<tr>
<td>that acts on lead, {</td>
<td>0.0267</td>
<td>0.0122</td>
<td>0.0145</td>
<td>0.0050</td>
</tr>
<tr>
<td>Cochituate water, &quot;</td>
<td>0.0267</td>
<td>...</td>
<td>...</td>
<td>...</td>
</tr>
<tr>
<td>&quot;</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Croton &quot;</td>
<td>0.2175</td>
<td>0.1496</td>
<td>0.0679</td>
<td>...</td>
</tr>
<tr>
<td>Fairmount &quot;</td>
<td>0.3007</td>
<td>0.1032</td>
<td>0.1975</td>
<td>0.0239</td>
</tr>
<tr>
<td>Jamaica &quot;</td>
<td>0.0268</td>
<td>0.0115</td>
<td>0.0153</td>
<td>0.0070</td>
</tr>
<tr>
<td>Troy &quot;</td>
<td>0.0593</td>
<td>0.0181</td>
<td>0.0412</td>
<td>0.0278</td>
</tr>
</tbody>
</table>

"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.

<table>
<thead>
<tr>
<th>Days</th>
<th>Cochituate</th>
<th>Croton</th>
<th>Fairmount</th>
<th>Jamaica</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>5.000</td>
<td>2.000</td>
<td>7.000</td>
<td>10.000</td>
</tr>
<tr>
<td>3</td>
<td>0.500</td>
<td>0.500</td>
<td>2.000</td>
<td>0.000</td>
</tr>
<tr>
<td>4</td>
<td>1.000</td>
<td>0.500</td>
<td>2.000</td>
<td>0.000</td>
</tr>
<tr>
<td>5</td>
<td>10.000</td>
<td>2.000</td>
<td>5.000</td>
<td>1.000</td>
</tr>
<tr>
<td>6</td>
<td>0.100</td>
<td>0.100</td>
<td>0.100</td>
<td>0.500</td>
</tr>
<tr>
<td>7</td>
<td>0.100</td>
<td>0.100</td>
<td>0.100</td>
<td>0.100</td>
</tr>
<tr>
<td>8</td>
<td>0.200</td>
<td>0.200</td>
<td>0.200</td>
<td>3.000</td>
</tr>
<tr>
<td>11</td>
<td>0.100</td>
<td>0.100</td>
<td>0.100</td>
<td>1.000</td>
</tr>
<tr>
<td>12</td>
<td>0.100</td>
<td>0.100</td>
<td>0.200</td>
<td>0.500</td>
</tr>
<tr>
<td>13</td>
<td>0.000</td>
<td>0.000</td>
<td>0.100</td>
<td>0.500</td>
</tr>
</tbody>
</table>
"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.

<table>
<thead>
<tr>
<th>Days</th>
<th>Cochituate</th>
<th>Croton</th>
<th>Fairmount</th>
<th>Jamaica</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>5.000</td>
<td>5.000</td>
<td>1.000</td>
<td>10.000</td>
</tr>
<tr>
<td>3</td>
<td>3.000</td>
<td>2.000</td>
<td>1.000</td>
<td>2.000</td>
</tr>
<tr>
<td>4</td>
<td>0.500</td>
<td>0.500</td>
<td>1.000</td>
<td>0.000</td>
</tr>
<tr>
<td>5</td>
<td>0.100</td>
<td>0.100</td>
<td>0.100</td>
<td>0.100</td>
</tr>
<tr>
<td>6</td>
<td>0.100</td>
<td>0.100</td>
<td>0.100</td>
<td>0.010</td>
</tr>
<tr>
<td>7</td>
<td>0.100</td>
<td>0.100</td>
<td>0.010</td>
<td>0.200</td>
</tr>
<tr>
<td>8</td>
<td>0.100</td>
<td>0.100</td>
<td>0.100</td>
<td>3.000</td>
</tr>
<tr>
<td>11</td>
<td>0.100</td>
<td>0.100</td>
<td>0.100</td>
<td>1.000</td>
</tr>
<tr>
<td>12</td>
<td>0.100</td>
<td>0.200</td>
<td>0.100</td>
<td>5.000</td>
</tr>
<tr>
<td>13</td>
<td>0.100</td>
<td>0.200</td>
<td>0.200</td>
<td>5.000</td>
</tr>
</tbody>
</table>

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

<table>
<thead>
<tr>
<th>Days</th>
<th>Cochituate</th>
<th>Croton</th>
<th>Fairmount</th>
<th>Jamaica</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1.000</td>
<td>0.500</td>
<td>0.500</td>
<td>10.000</td>
</tr>
<tr>
<td>3</td>
<td>10.000</td>
<td>2.000</td>
<td>1.000</td>
<td>4.000</td>
</tr>
<tr>
<td>4</td>
<td>5.000</td>
<td>0.500</td>
<td>3.000</td>
<td>40.000</td>
</tr>
<tr>
<td>5</td>
<td>0.000</td>
<td>0.500</td>
<td>1.000</td>
<td>15.000</td>
</tr>
<tr>
<td>6</td>
<td>1.000</td>
<td>0.200</td>
<td>0.100</td>
<td>10.000</td>
</tr>
<tr>
<td>7</td>
<td>0.500</td>
<td>0.100</td>
<td>0.100</td>
<td>8.000</td>
</tr>
<tr>
<td>8</td>
<td>0.100</td>
<td>0.100</td>
<td>0.100</td>
<td>4.000</td>
</tr>
<tr>
<td>11</td>
<td>0.100</td>
<td>0.200</td>
<td>0.200</td>
<td>2.000</td>
</tr>
<tr>
<td>12</td>
<td>0.100</td>
<td>0.100</td>
<td>0.100</td>
<td>5.000</td>
</tr>
<tr>
<td>13</td>
<td>0.100</td>
<td>0.200</td>
<td>0.100</td>
<td>3.000</td>
</tr>
</tbody>
</table>

"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.

<table>
<thead>
<tr>
<th>Days</th>
<th>Cochituate</th>
<th>Croton</th>
<th>Fairmount</th>
<th>Jamaica</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>15.500</td>
<td>1.500</td>
<td>0.280</td>
<td>80.000</td>
</tr>
<tr>
<td>2</td>
<td>0.012</td>
<td>0.012</td>
<td>0.012</td>
<td>2.750</td>
</tr>
<tr>
<td>3</td>
<td>0.012</td>
<td>0.001</td>
<td>0.000</td>
<td>0.027</td>
</tr>
<tr>
<td>4</td>
<td>0.000</td>
<td>0.000</td>
<td>0.000</td>
<td>0.000</td>
</tr>
</tbody>
</table>

"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.

<table>
<thead>
<tr>
<th>Days</th>
<th>Cochituate</th>
<th>Croton</th>
<th>Fairmount</th>
<th>Jamaica</th>
<th>Distilled Water</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
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<td>0.500</td>
<td>0.000</td>
<td>0.050</td>
<td>25.000</td>
</tr>
<tr>
<td>3</td>
<td>0.050</td>
<td>0.010</td>
<td>0.000</td>
<td>0.050</td>
<td>15.000</td>
</tr>
<tr>
<td>5</td>
<td>0.010</td>
<td>0.000</td>
<td>0.000</td>
<td>0.050</td>
<td>15.000</td>
</tr>
<tr>
<td>7</td>
<td>0.000</td>
<td>0.000</td>
<td>0.000</td>
<td>0.000</td>
<td>15.000</td>
</tr>
<tr>
<td>9</td>
<td>0.000</td>
<td>0.000</td>
<td>0.000</td>
<td>0.000</td>
<td>15.000</td>
</tr>
<tr>
<td>12</td>
<td>0.000</td>
<td>0.000</td>
<td>0.000</td>
<td>0.000</td>
<td>15.000</td>
</tr>
<tr>
<td>17*</td>
<td>0.020</td>
<td>0.010</td>
<td>0.000</td>
<td>0.000</td>
<td>30.000</td>
</tr>
<tr>
<td>24*</td>
<td>0.050</td>
<td>0.000</td>
<td>0.000</td>
<td>0.000</td>
<td>0.500</td>
</tr>
<tr>
<td>39*</td>
<td>0.500</td>
<td>0.000</td>
<td>0.100</td>
<td>0.100</td>
<td>3.000</td>
</tr>
</tbody>
</table>

"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.

<table>
<thead>
<tr>
<th>Days</th>
<th>Distilled Water</th>
<th>Albany</th>
<th>Cambridge</th>
<th>Cochituate</th>
<th>Croton</th>
<th>Fairmount</th>
<th>Jamaica</th>
<th>Troy</th>
</tr>
</thead>
<tbody>
<tr>
<td>3</td>
<td>8,000</td>
<td>1,000</td>
<td>2,000</td>
<td>1,000</td>
<td>1,000</td>
<td>10,000</td>
<td>10,000</td>
<td>25,000</td>
</tr>
<tr>
<td>7</td>
<td>10,000</td>
<td>0,010</td>
<td>0,010</td>
<td>0,010</td>
<td>0,010</td>
<td>0,019</td>
<td>0,500</td>
<td>0,000</td>
</tr>
<tr>
<td>9</td>
<td>2,000</td>
<td>0,000</td>
<td>0,000</td>
<td>0,000</td>
<td>0,000</td>
<td>0,000</td>
<td>0,000</td>
<td>0,000</td>
</tr>
<tr>
<td>11</td>
<td>0,000</td>
<td>0,000</td>
<td>0,000</td>
<td>0,000</td>
<td>0,000</td>
<td>0,000</td>
<td>0,000</td>
<td>0,000</td>
</tr>
<tr>
<td>20</td>
<td>0,100</td>
<td>0,100</td>
<td>0,100</td>
<td>0,000</td>
<td>0,000</td>
<td>0,010</td>
<td>0,100</td>
<td>0,000</td>
</tr>
<tr>
<td>30</td>
<td>1,000</td>
<td>0,100</td>
<td>0,500</td>
<td>0,500</td>
<td>0,500</td>
<td>0,500</td>
<td>0,500</td>
<td>0,100</td>
</tr>
<tr>
<td>48</td>
<td>0,100</td>
<td>0,095</td>
<td>0,100</td>
<td>0,010</td>
<td>0,050</td>
<td>0,000</td>
<td>0,010</td>
<td>Lost</td>
</tr>
</tbody>
</table>

"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.

<table>
<thead>
<tr>
<th>Days</th>
<th>Distilled Water</th>
<th>Albany</th>
<th>Cambridge</th>
<th>Cochituate</th>
<th>Croton</th>
<th>Fairmount</th>
<th>Jamaica</th>
<th>Troy</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>0,500</td>
<td>0,500</td>
<td>0,500</td>
<td>0,500</td>
<td>0,500</td>
<td>0,500</td>
<td>0,500</td>
<td>0,500</td>
</tr>
<tr>
<td>3</td>
<td>0,000</td>
<td>0,000</td>
<td>0,000</td>
<td>0,000</td>
<td>0,000</td>
<td>0,000</td>
<td>0,000</td>
<td>0,000</td>
</tr>
<tr>
<td>7</td>
<td>0,000</td>
<td>0,000</td>
<td>0,000</td>
<td>0,000</td>
<td>0,000</td>
<td>0,000</td>
<td>0,000</td>
<td>0,000</td>
</tr>
<tr>
<td>16</td>
<td>0,010</td>
<td>0,010</td>
<td>0,100</td>
<td>0,010</td>
<td>0,010</td>
<td>0,010</td>
<td>0,010</td>
<td>0,010</td>
</tr>
<tr>
<td>26</td>
<td>0,500</td>
<td>0,100</td>
<td>0,010</td>
<td>0,010</td>
<td>0,010</td>
<td>0,010</td>
<td>0,010</td>
<td>0,010</td>
</tr>
<tr>
<td>44</td>
<td>3,000</td>
<td>0,050</td>
<td>0,100</td>
<td>0,100</td>
<td>0,100</td>
<td>0,100</td>
<td>0,100</td>
<td>Lost</td>
</tr>
</tbody>
</table>

"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.

<table>
<thead>
<tr>
<th>Days</th>
<th>Distilled Water</th>
<th>Albany</th>
<th>Cambridge</th>
<th>Cochituate</th>
<th>Croton</th>
<th>Fairmount</th>
<th>Jamaica</th>
<th>Troy</th>
</tr>
</thead>
<tbody>
<tr>
<td>3</td>
<td>10,000</td>
<td>6,000</td>
<td>6,000</td>
<td>6,000</td>
<td>1,000</td>
<td>10,000</td>
<td>7,000</td>
<td>7,000</td>
</tr>
<tr>
<td>12</td>
<td>...</td>
<td>1,000</td>
<td>Lost</td>
<td>1,000</td>
<td>1,000</td>
<td>1,000</td>
<td>1,000</td>
<td>2,000</td>
</tr>
<tr>
<td>17</td>
<td>30,000</td>
<td>0,000</td>
<td>0,050</td>
<td>0,010</td>
<td>0,500</td>
<td>0,000</td>
<td>0,500</td>
<td>0,000</td>
</tr>
</tbody>
</table>

"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.

<table>
<thead>
<tr>
<th>Days</th>
<th>Distilled Water</th>
<th>Albany</th>
<th>Cambridge</th>
<th>Cochitute</th>
<th>Croton</th>
<th>Fairmount</th>
<th>Jamaica</th>
<th>Troy</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>5.000</td>
<td>2.000</td>
<td>0.500</td>
<td>0.800</td>
<td>25.000</td>
<td>0.100</td>
<td>1.000</td>
<td>5.000</td>
</tr>
<tr>
<td>3</td>
<td>8.000</td>
<td>2.000</td>
<td>1.500</td>
<td>1.500</td>
<td>2.000</td>
<td>1.500</td>
<td>1.500</td>
<td>8.000</td>
</tr>
<tr>
<td>7</td>
<td>20.000</td>
<td>0.800</td>
<td>10.000</td>
<td>10.000</td>
<td>2.000</td>
<td>1.500</td>
<td>20.000</td>
<td>7.000</td>
</tr>
<tr>
<td>33</td>
<td>10.000</td>
<td>0.100</td>
<td>7.000</td>
<td>0.200</td>
<td>0.100</td>
<td>0.100</td>
<td>4.000</td>
<td>7.000</td>
</tr>
<tr>
<td>37</td>
<td>20.000</td>
<td>0.800</td>
<td>10.000</td>
<td>2.000</td>
<td>10.000</td>
<td>1.000</td>
<td>8.000</td>
<td>5.000</td>
</tr>
<tr>
<td>38</td>
<td>12.000</td>
<td>—</td>
<td>—</td>
<td>0.800</td>
<td>0.500</td>
<td>—</td>
<td>0.400</td>
<td>—</td>
</tr>
<tr>
<td>39</td>
<td>2.000</td>
<td>—</td>
<td>—</td>
<td>0.800</td>
<td>0.300</td>
<td>—</td>
<td>0.400</td>
<td>—</td>
</tr>
<tr>
<td>40</td>
<td>1.250</td>
<td>—</td>
<td>—</td>
<td>0.400</td>
<td>0.600</td>
<td>—</td>
<td>0.400</td>
<td>—</td>
</tr>
<tr>
<td>41</td>
<td>1.500</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>0.250</td>
<td>—</td>
<td>0.800</td>
<td>—</td>
</tr>
<tr>
<td>43</td>
<td>2.000</td>
<td>—</td>
<td>—</td>
<td>1.200</td>
<td>0.500</td>
<td>—</td>
<td>0.500</td>
<td>—</td>
</tr>
</tbody>
</table>

"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.

<table>
<thead>
<tr>
<th>Days</th>
<th>Distilled Water</th>
<th>Cochitute</th>
<th>Croton</th>
<th>Fairmount</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>5.000</td>
<td>0.500</td>
<td>0.500</td>
<td>0.100</td>
</tr>
<tr>
<td>3</td>
<td>1.500</td>
<td>8.000</td>
<td>0.150</td>
<td>0.500</td>
</tr>
<tr>
<td>7</td>
<td>20.000</td>
<td>2.500</td>
<td>1.000</td>
<td>1.000</td>
</tr>
<tr>
<td>14</td>
<td>25.000</td>
<td>7.000</td>
<td>1.000</td>
<td>1.000</td>
</tr>
<tr>
<td>39</td>
<td>10.000</td>
<td>1.000</td>
<td>1.000</td>
<td>1.000</td>
</tr>
<tr>
<td>40</td>
<td>1.500</td>
<td>1.000</td>
<td>1.000</td>
<td>1.000</td>
</tr>
<tr>
<td>44</td>
<td>1.200</td>
<td>0.500</td>
<td>0.500</td>
<td>1.500</td>
</tr>
<tr>
<td>45</td>
<td>2.000</td>
<td>0.200</td>
<td>0.300</td>
<td>2.000</td>
</tr>
<tr>
<td>46</td>
<td>5.000</td>
<td>0.800</td>
<td>0.800</td>
<td>3.000</td>
</tr>
<tr>
<td>47</td>
<td>3.000</td>
<td>0.050</td>
<td>0.020</td>
<td>1.500</td>
</tr>
<tr>
<td>49</td>
<td>2.300</td>
<td>0.010</td>
<td>0.800</td>
<td>2.000</td>
</tr>
</tbody>
</table>

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

<table>
<thead>
<tr>
<th>Days</th>
<th>Distilled Water</th>
<th>Albany</th>
<th>Cambridge</th>
<th>Cochitute</th>
<th>Croton</th>
<th>Fairmount</th>
<th>Jamaica</th>
<th>Troy</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>40.000</td>
<td>0.500</td>
<td>0.500</td>
<td>0.500</td>
<td>0.500</td>
<td>0.500</td>
<td>0.500</td>
<td>0.500</td>
</tr>
<tr>
<td>8</td>
<td>60.000</td>
<td>0.100</td>
<td>0.100</td>
<td>0.100</td>
<td>0.200</td>
<td>0.500</td>
<td>0.800</td>
<td>0.500</td>
</tr>
<tr>
<td>32</td>
<td>50.000</td>
<td>1.500</td>
<td>4.000</td>
<td>0.500</td>
<td>0.100</td>
<td>1.500</td>
<td>2.000</td>
<td>—</td>
</tr>
<tr>
<td>36</td>
<td>12.000</td>
<td>—</td>
<td>—</td>
<td>0.050</td>
<td>0.050</td>
<td>—</td>
<td>1.500</td>
<td>—</td>
</tr>
<tr>
<td>38</td>
<td>1.500</td>
<td>—</td>
<td>—</td>
<td>0.500</td>
<td>1.500</td>
<td>—</td>
<td>3.000</td>
<td>—</td>
</tr>
<tr>
<td>39</td>
<td>2.000</td>
<td>—</td>
<td>—</td>
<td>0.500</td>
<td>0.300</td>
<td>—</td>
<td>0.400</td>
<td>—</td>
</tr>
<tr>
<td>40</td>
<td>0.500</td>
<td>—</td>
<td>—</td>
<td>0.500</td>
<td>0.500</td>
<td>—</td>
<td>0.700</td>
<td>—</td>
</tr>
<tr>
<td>41</td>
<td>2.000</td>
<td>—</td>
<td>—</td>
<td>0.010</td>
<td>0.010</td>
<td>—</td>
<td>0.010</td>
<td>—</td>
</tr>
<tr>
<td>43</td>
<td>3.000</td>
<td>—</td>
<td>—</td>
<td>0.010</td>
<td>0.020</td>
<td>—</td>
<td>0.700</td>
<td>—</td>
</tr>
</tbody>
</table>
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.**

<table>
<thead>
<tr>
<th>Days</th>
<th>Cochituate</th>
<th>Cochituate and $\frac{1}{100}$ of Tannin</th>
<th>Cochituate and $\frac{1}{1000}$ of Tannin</th>
<th>Cochituate and $\frac{1}{10,000}$ of Tannin</th>
<th>Distilled Water</th>
</tr>
</thead>
<tbody>
<tr>
<td>3</td>
<td>1.000</td>
<td>0.800</td>
<td>0.400</td>
<td>0.600</td>
<td>0.600</td>
</tr>
<tr>
<td>5</td>
<td>0.000</td>
<td>20.000*</td>
<td>0.500</td>
<td>0.250</td>
<td>0.250</td>
</tr>
<tr>
<td>6</td>
<td>0.500</td>
<td>2.000</td>
<td>0.500</td>
<td>0.100</td>
<td>0.100</td>
</tr>
<tr>
<td>7</td>
<td>0.000</td>
<td>2.000</td>
<td>0.200</td>
<td>0.000</td>
<td>0.000</td>
</tr>
<tr>
<td>8</td>
<td>0.050</td>
<td>0.500</td>
<td>0.100</td>
<td>0.000</td>
<td>0.000</td>
</tr>
<tr>
<td>10</td>
<td>0.000</td>
<td>0.500</td>
<td>0.000</td>
<td>0.000</td>
<td>0.000</td>
</tr>
<tr>
<td>11</td>
<td>0.000</td>
<td>0.000</td>
<td>0.000</td>
<td>0.000</td>
<td>0.000</td>
</tr>
<tr>
<td>12</td>
<td>0.100</td>
<td>0.000</td>
<td>0.000</td>
<td>0.000</td>
<td>0.000</td>
</tr>
<tr>
<td>13</td>
<td>0.050</td>
<td>0.000</td>
<td>0.000</td>
<td>0.000</td>
<td>0.000</td>
</tr>
</tbody>
</table>

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 $\frac{1}{100}$ 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 full 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.

<table>
<thead>
<tr>
<th>Days</th>
<th>Cochitute</th>
<th>Croton</th>
<th>Jamaica</th>
<th>Distilled Water</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0.100</td>
<td>0.200</td>
<td>3.000</td>
<td>3.000</td>
</tr>
<tr>
<td>2</td>
<td>0.250</td>
<td>1.500</td>
<td>2.000</td>
<td>2.000</td>
</tr>
<tr>
<td>3</td>
<td>0.100</td>
<td>0.400</td>
<td>2.000</td>
<td>1.000</td>
</tr>
<tr>
<td>4</td>
<td>0.050</td>
<td>1.000</td>
<td>1.500</td>
<td>2.000</td>
</tr>
</tbody>
</table>

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 hydrochloric acid. The precipitate was collected on a filter, previously dried at 100° C., and gave 0.0225 gr. of sulphide of lead, equal to 0.0196 gr. of lead; which is equivalent to 0.8095 gr. 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 Cochitute 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.

<table>
<thead>
<tr>
<th>Days</th>
<th>Pure Cochitute</th>
<th>Cochitute and ( \frac{2}{3} ) of Chloride of Sodium</th>
<th>Cochitute and ( \frac{1}{2} ) of Chloride of Sodium</th>
<th>Cochitute and ( \frac{1}{3} ) of Chloride of Sodium</th>
<th>Cochitute and ( \frac{1}{4} ) of Chloride of Sodium</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2.00</td>
<td>.20</td>
<td>.30</td>
<td>1.60</td>
<td>2.00</td>
</tr>
<tr>
<td>2</td>
<td>1.80</td>
<td>.10</td>
<td>.15</td>
<td>.60</td>
<td>1.20</td>
</tr>
<tr>
<td>3</td>
<td>.20</td>
<td>.10</td>
<td>.08</td>
<td>.08</td>
<td>.30</td>
</tr>
<tr>
<td>8</td>
<td>.30</td>
<td>2.50</td>
<td>1.20</td>
<td>.30</td>
<td>.50</td>
</tr>
</tbody>
</table>

* 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.

<table>
<thead>
<tr>
<th></th>
<th>Volume</th>
<th>Hours Exposed</th>
<th>Reduced Volume</th>
<th>Sulphide of Lead</th>
</tr>
</thead>
<tbody>
<tr>
<td>a</td>
<td>100cc.</td>
<td>36</td>
<td>10cc.</td>
<td>0.000</td>
</tr>
<tr>
<td>&quot;</td>
<td>200</td>
<td>36</td>
<td>10</td>
<td>0.000</td>
</tr>
<tr>
<td>&quot;</td>
<td>300</td>
<td>36</td>
<td>10</td>
<td>0.000</td>
</tr>
<tr>
<td>b</td>
<td>500</td>
<td>12</td>
<td>16</td>
<td>0.000</td>
</tr>
<tr>
<td>c</td>
<td>100</td>
<td>12</td>
<td>10</td>
<td>Precipitate.</td>
</tr>
<tr>
<td>&quot;</td>
<td>50</td>
<td>12</td>
<td>10</td>
<td>&quot;</td>
</tr>
<tr>
<td>&quot;</td>
<td>40</td>
<td>12</td>
<td>10</td>
<td>0.000</td>
</tr>
<tr>
<td>&quot;</td>
<td>30</td>
<td>12</td>
<td>10</td>
<td>0.100</td>
</tr>
<tr>
<td>d</td>
<td>gallon</td>
<td>12</td>
<td>10</td>
<td>0.000</td>
</tr>
<tr>
<td>e</td>
<td>500cc.</td>
<td>12</td>
<td>5</td>
<td>Precipitate.</td>
</tr>
<tr>
<td>f</td>
<td>gallon</td>
<td>12</td>
<td>5</td>
<td>0.0004</td>
</tr>
<tr>
<td>g</td>
<td>300cc.</td>
<td>12</td>
<td>5</td>
<td>Precipitate.</td>
</tr>
<tr>
<td>h</td>
<td>gallon</td>
<td>12</td>
<td>5</td>
<td>0.0005</td>
</tr>
<tr>
<td>i</td>
<td>gallon</td>
<td>12</td>
<td>10</td>
<td>0.0013</td>
</tr>
<tr>
<td>j</td>
<td>gallon</td>
<td>12</td>
<td></td>
<td>0.0009</td>
</tr>
<tr>
<td>k</td>
<td>gallon</td>
<td></td>
<td></td>
<td>0.0136</td>
</tr>
</tbody>
</table>

"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 0.000003gr. = 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 510 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.

<table>
<thead>
<tr>
<th>Bottles</th>
<th>Volume</th>
<th>Volume</th>
<th>Sulphide of Lead</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>500cc.</td>
<td>10cc.</td>
<td>00</td>
</tr>
<tr>
<td>2</td>
<td></td>
<td></td>
<td>00</td>
</tr>
<tr>
<td>3</td>
<td></td>
<td></td>
<td>00</td>
</tr>
<tr>
<td>4</td>
<td></td>
<td></td>
<td>00</td>
</tr>
<tr>
<td>5</td>
<td></td>
<td></td>
<td>00</td>
</tr>
<tr>
<td>6</td>
<td></td>
<td></td>
<td>00</td>
</tr>
<tr>
<td>7</td>
<td></td>
<td></td>
<td>trace</td>
</tr>
</tbody>
</table>

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.

<table>
<thead>
<tr>
<th>April 13th</th>
</tr>
</thead>
<tbody>
<tr>
<td>No. 6 Hudson Street, 200cc., 12 hours, reduced to 20cc.</td>
</tr>
<tr>
<td>No. 10</td>
</tr>
<tr>
<td>No. 98</td>
</tr>
<tr>
<td>No. 800 Washington Street,</td>
</tr>
<tr>
<td>No. 10 Tyler Street,</td>
</tr>
</tbody>
</table>

"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.*

\[= 0.00018\text{gr. in a gallon.}\]

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., 0.00015gr.,† —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 laminae 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. 321-333.
§ 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 Chimie 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 tenth 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 porcelain 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.**

<table>
<thead>
<tr>
<th>Days</th>
<th>Well-water</th>
<th>Cochituate</th>
<th>Fairmount</th>
</tr>
</thead>
<tbody>
<tr>
<td>3</td>
<td>1.00</td>
<td>1.00</td>
<td>.15</td>
</tr>
<tr>
<td>5</td>
<td>.20</td>
<td>.00</td>
<td>.60</td>
</tr>
<tr>
<td>6</td>
<td>.30</td>
<td>.50</td>
<td>.00</td>
</tr>
<tr>
<td>7</td>
<td>.10</td>
<td>.00</td>
<td>.09</td>
</tr>
<tr>
<td>8</td>
<td>.00</td>
<td>.05</td>
<td>.00</td>
</tr>
<tr>
<td>10</td>
<td>.50</td>
<td>.00</td>
<td>.00</td>
</tr>
<tr>
<td>11</td>
<td>.00</td>
<td>.00</td>
<td>.00</td>
</tr>
</tbody>
</table>

"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.

<table>
<thead>
<tr>
<th></th>
<th>Of Solid Residue</th>
<th>Of Organic Matter</th>
<th>Of Inorganic Matter</th>
</tr>
</thead>
<tbody>
<tr>
<td>Well water</td>
<td>0.1380gr.</td>
<td>0.0510gr.</td>
<td>0.0840gr.</td>
</tr>
<tr>
<td>Cochituate</td>
<td>0.0267</td>
<td>0.0122</td>
<td>0.0145</td>
</tr>
<tr>
<td>Fairmount</td>
<td>0.3007</td>
<td>0.1032</td>
<td>0.1975</td>
</tr>
</tbody>
</table>

"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

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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.*

<table>
<thead>
<tr>
<th></th>
<th>Total.</th>
<th>Nitrates</th>
<th>Chlorides</th>
<th>Sulphates</th>
<th>Carbonates</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wells,</td>
<td>6455</td>
<td>1701</td>
<td>650</td>
<td>1394</td>
<td>2291</td>
</tr>
<tr>
<td>Springs,</td>
<td>3344</td>
<td>86</td>
<td>77</td>
<td>365</td>
<td>2336</td>
</tr>
<tr>
<td>Rivers,</td>
<td>1949</td>
<td>65</td>
<td>38</td>
<td>157</td>
<td>1185</td>
</tr>
</tbody>
</table>

"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.**

<table>
<thead>
<tr>
<th>Days</th>
<th>Pure Coochitate</th>
<th>Coochitate and 1/100 of Saltpetre</th>
<th>Coochitate and 1/1000 of Saltpetre</th>
<th>Coochitate and 1/10000 of Saltpetre</th>
<th>Coochitate and 1/100000 of Saltpetre</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1.00</td>
<td>2.25</td>
<td>0.75</td>
<td>0.50</td>
<td>0.50</td>
</tr>
<tr>
<td>2</td>
<td>0.00</td>
<td>2.00</td>
<td>1.00</td>
<td>0.50</td>
<td>0.10</td>
</tr>
<tr>
<td>3</td>
<td>0.50</td>
<td>2.00</td>
<td>0.25</td>
<td>0.10</td>
<td>0.10</td>
</tr>
<tr>
<td>4</td>
<td>0.00</td>
<td>2.50</td>
<td>1.00</td>
<td>0.30</td>
<td>0.20</td>
</tr>
<tr>
<td>5</td>
<td>0.05</td>
<td>2.50</td>
<td>0.50</td>
<td>0.30</td>
<td>0.00</td>
</tr>
<tr>
<td>6</td>
<td>0.00</td>
<td>2.00</td>
<td>0.80</td>
<td>0.05</td>
<td>0.00</td>
</tr>
<tr>
<td>7</td>
<td>1.00</td>
<td>1.80</td>
<td>0.70</td>
<td>0.00</td>
<td>0.00</td>
</tr>
</tbody>
</table>

† Sulphate of lead is soluble in not less than 15000 parts of water. Gmelin. — Carbonate of lead requires 56551 parts of water. Fresenius, J. der Chem. und Pharm., 1.1.1., S. 117–125. — 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.
§ This fact has been noticed by Berzelius in Europe. 'I,' says Dr. Dana, 'have
"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 Tunquerel, 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 Tunquerel. — Experiments with graduated solutions of common salt were made. See p. 71.
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 protosulphates 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 bouillir 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: \( -4 \text{(Fe}_2\text{O}_3\text{S}_2\text{O}_3) + 20 = \text{Fe}_2\text{O}_3 + 3\text{S}_2\text{O}_3 + \text{Fe}_2\text{O}_3\text{S}_2\text{O}_3. \) The latter compound is insoluble in water. Gmelin.—The constitution of the precipitate, according to Mitscherlich and Scheerer, is \( 2\text{Fe}_2\text{O}_3\text{S}_2\text{O}_3 + 3\text{H}_2\text{O}. \) Wittstein (Buch. Rep., 3 R., Bd. I., S. 182–189) gives it as \( 2\text{Fe}_2\text{O}_3 + 3\text{S}_2\text{O}_3 + 8\text{H}_2\text{O}. \) 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 6½ 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

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. Chris- tison 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, cider-down, hare’s fur, cotton-wool, ravelings 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 (Journ. 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 animaculæ 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 Dabl. 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 re-
placed with quicksilver, the upper surface of which, after the original
temperature had been re-established, was marked. Now, if any decom-
position of common salt occurred by the agency of lead, the chlorine
would be freed from the sodium, the sodium would decompose the wa-
ter, hydrogen would be set free, and the column of mercury depressed.
Instead of any such result, the column of mercury regularly rose in ev-
every instance. An apparatus of this description, several months in ac-
tion, 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 bright-
ness, and is but very faintly dimmed at this late day, February 1, 1849.

"5. Action of Organic Matter. — It has been conceived that or-
ganic 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, pre-
cipitates 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 re-
searches of Dr. Smith† upon the air and water of towns, it is men-
tioned 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 (com-
mon salt) in distilled water was the subject of experiment. The ac-
tion, it will be seen, was more vigorous in distilled than in the impure
waters.

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

<table>
<thead>
<tr>
<th>Days</th>
<th>Distilled Water</th>
<th>$\frac{1}{100}$ of Epsom Salt</th>
<th>$\frac{1}{1000}$ of Epsom Salt</th>
<th>$\frac{1}{10000}$ of Epsom Salt</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>5,000</td>
<td>2,500</td>
<td>2,000</td>
<td>1,750</td>
</tr>
<tr>
<td>3</td>
<td>20,000</td>
<td>1,500</td>
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<td>1,800</td>
</tr>
<tr>
<td>5</td>
<td>4,000</td>
<td>2,500</td>
<td>2,000</td>
<td>1,800</td>
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<td>2,000</td>
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<td>2,000</td>
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<td>1,500</td>
<td>3,000</td>
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<td>1,200</td>
<td>2,000</td>
<td>0,800</td>
</tr>
<tr>
<td>13</td>
<td>2,000</td>
<td>1,200</td>
<td>1,200</td>
<td>0,800</td>
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</tbody>
</table>

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

<table>
<thead>
<tr>
<th>Days</th>
<th>Distilled Water</th>
<th>$\frac{1}{100}$ of Salt</th>
<th>$\frac{1}{1000}$ of Salt</th>
<th>$\frac{1}{10000}$ of Salt</th>
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<td>2,000</td>
<td>1,500</td>
</tr>
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<td>3</td>
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</tr>
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<td>2,000</td>
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<td>1,800</td>
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<td>7</td>
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<td>2,000</td>
<td>2,000</td>
<td>1,800</td>
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<tr>
<td>8</td>
<td>3,000</td>
<td>2,500</td>
<td>2,250</td>
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<td>12</td>
<td>2,000</td>
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<td>1,200</td>
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"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.*

<table>
<thead>
<tr>
<th>Days</th>
<th>Distilled Water</th>
<th>Albany</th>
<th>Cambridge</th>
<th>Cohocton</th>
<th>Croton</th>
<th>Fairmount</th>
<th>Jamaica</th>
<th>Troy</th>
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<td>0,500</td>
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<td>2,500</td>
<td>2,000</td>
<td>12,000</td>
<td>2,000</td>
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<td>0,010</td>
<td>0,010</td>
<td>0,020</td>
<td>8,000</td>
<td>1,000</td>
<td>15,000</td>
<td>0,500</td>
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<tr>
<td>8</td>
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<td>0,010</td>
<td>0,500</td>
<td>0,800</td>
<td>10,000</td>
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<td>3,000</td>
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<td>0,100</td>
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<td>0,700</td>
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<td>1,000</td>
<td>3,000</td>
<td>0,100</td>
<td>0,100</td>
</tr>
</tbody>
</table>

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 grammé 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.

<table>
<thead>
<tr>
<th>Quantity Present</th>
<th>0.05gr. of lead</th>
</tr>
</thead>
<tbody>
<tr>
<td>After separation</td>
<td>0.0005</td>
</tr>
</tbody>
</table>

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.

<table>
<thead>
<tr>
<th>Quantity Present</th>
<th>0.005gr. of lead</th>
</tr>
</thead>
<tbody>
<tr>
<td>After separation</td>
<td>0.0004</td>
</tr>
</tbody>
</table>

"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 fifteenths of the lead.

Originally in solution, 0.05 gr. 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, 0.005 gr. 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.

<table>
<thead>
<tr>
<th>Days</th>
<th>Distilled Water</th>
<th>Albany</th>
<th>Cambridge</th>
<th>Cochituate a</th>
<th>Cochituate b</th>
<th>Cochituate c</th>
<th>Croton</th>
<th>Fairmount</th>
<th>Jamaica</th>
<th>Troy</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0.000</td>
<td>0.500</td>
<td>0.000</td>
<td>0.001</td>
<td>0.002</td>
<td>0.000</td>
<td>0.000</td>
<td>0.000</td>
<td>0.001</td>
<td>0.000</td>
</tr>
<tr>
<td>11</td>
<td>0.005</td>
<td>0.500</td>
<td>1.000</td>
<td>0.500</td>
<td>1.000</td>
<td>0.000</td>
<td>0.010</td>
<td>0.050</td>
<td>0.010</td>
<td>0.500</td>
</tr>
<tr>
<td>17</td>
<td>0.005</td>
<td>0.001</td>
<td>0.002</td>
<td>0.050</td>
<td>0.080</td>
<td>0.002</td>
<td>0.001</td>
<td>0.050</td>
<td>0.001</td>
<td>0.001</td>
</tr>
<tr>
<td>25</td>
<td>0.000</td>
<td>0.000</td>
<td>0.005</td>
<td>0.050</td>
<td>0.050</td>
<td>0.000</td>
<td>0.001</td>
<td>0.050</td>
<td>0.001</td>
<td>0.001</td>
</tr>
<tr>
<td>37</td>
<td>0.000</td>
<td>0.000</td>
<td>0.000</td>
<td>0.050</td>
<td>0.050</td>
<td>0.000</td>
<td>0.000</td>
<td>0.000</td>
<td>0.010</td>
<td>-</td>
</tr>
</tbody>
</table>

"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 from 3 to 5cc. Precipitates
with hydrosulphuric acid and oxide of tin are both represented in the numbers below.

<table>
<thead>
<tr>
<th>Days</th>
<th>Cochitute</th>
<th>Croton</th>
<th>Fairmount</th>
<th>Jamaica</th>
<th>Distilled Water</th>
<th>Albany</th>
<th>Cambridge</th>
<th>Troy</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>100</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>0.100</td>
<td>0.100</td>
<td>0.000</td>
<td>0.000</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>0.020</td>
<td>0.010</td>
<td>0.000</td>
<td>0.000</td>
<td>0.100</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>0.010</td>
<td>0.010</td>
<td>0.000</td>
<td>0.000</td>
<td>0.030</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>0.001</td>
<td>0.000</td>
<td>0.000</td>
<td>0.000</td>
<td>0.001</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>0.005</td>
<td>0.000</td>
<td>0.000</td>
<td>0.000</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>12</td>
<td>0.005</td>
<td>0.001</td>
<td>0.001</td>
<td>0.001</td>
<td>0.500</td>
<td>0.500</td>
<td>0.500</td>
<td></td>
</tr>
<tr>
<td>17</td>
<td>1.000</td>
<td>1.000</td>
<td>1.000</td>
<td>1.000</td>
<td>0.050</td>
<td>2.000</td>
<td>2.000</td>
<td></td>
</tr>
<tr>
<td>26</td>
<td>8.000</td>
<td>15.000</td>
<td>10.000</td>
<td>8.000</td>
<td>0.010</td>
<td>0.000</td>
<td>50.000</td>
<td>0.010</td>
</tr>
<tr>
<td>38</td>
<td>10.000</td>
<td>25.000</td>
<td>8.000</td>
<td>10.000</td>
<td>3.000</td>
<td>7.000</td>
<td>100.000</td>
<td></td>
</tr>
<tr>
<td>75</td>
<td>10.000</td>
<td>15.000</td>
<td>15.000</td>
<td>10.000</td>
<td>4.000</td>
<td>4.000</td>
<td>7.000</td>
<td>20.000</td>
</tr>
</tbody>
</table>

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

A portion of Cochitute 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 Cochitute and the various other waters upon the impure tin, were identical in appearance.

Lehman remarks of the solubility of tin in solutions of sal-ammoniaca, 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-ammoniaca, and bisulphate of potassa. Without dissolving the oxide, but merely depositing it, chlorides of baryum 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

* Tauschenbuch 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.

<table>
<thead>
<tr>
<th>Days</th>
<th>Distilled Water</th>
<th>Cochituate</th>
<th>Croton</th>
<th>Jamaica</th>
<th>Fairmount</th>
<th>Albany</th>
<th>Cambridge Hard Water</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>15 000</td>
<td>20 000</td>
<td>10 000</td>
<td>20 000</td>
<td>20 000</td>
<td>20 000</td>
<td>20 000</td>
</tr>
</tbody>
</table>

"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 unfit 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, 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 oxidized in dry air, or (b.) in pure water deprived of air. (c.) It is oxidized 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 animaletc. 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 pendent 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.
OF ARTS AND SCIENCES.

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 falls 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.
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 indi-
cate, 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 stational 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 feeblcr 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 re-
marked, "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.

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\(^{a}\) 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 $-11^\circ 11' 44.4$

Challis finds $-11^\circ 11' 33.0$

Rümker " $-11^\circ 11' 41.6$

"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" 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,

$$\Delta_1 = -3.1, \quad \Delta_2 = 6.6$$

"The right ascension of the Cambridge observation of May 16 (A. S. Notices, p. 177) is given $14^h 33^m 47.46$, 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 $14^h 28^m 42.1$.

"Is there not a mistake of 1" 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.

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<th>II.</th>
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<td>963° 2.272</td>
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"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.**

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The comparison of this ephemeris with observation is contained in the following table.

**Comparison of Orbit III with Observation.**

C. — O.

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</table>

For this orbit the perturbations by Jupiter, since the opposition of 1818, 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.
118 PROCEEDINGS OF THE AMERICAN ACADEMY

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<th>$\Delta \psi$</th>
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**"Hence result the following osculating elements for April 6.5:"**

**"METIS."**

1849. April 6.5, Mean Equinox 1849.0. M. B. T.

\[
\begin{align*}
\mu &\quad 234^5 45' 32^\prime 9 \\
L &\quad 306 27 46.5 \\
Q &\quad 68 28 38.5 \\
H &\quad 71 42 13.7 \\
i &\quad 5 35 31.9 & \text{Log. } \mu &\quad 2.9836193 \\
\varphi &\quad 7 6 25.18 & \text{Log. } a &\quad 0.3775915 \\
\nu &\quad 962^5 985 & \text{Log. } e &\quad 0.0924492 \\
\end{align*}
\]

**"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."**

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"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 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 sim-

plicity 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 Levering, 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 thereof 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 impor-
tant 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 sur-
vey 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 ac-
curate, that the whole amount of possible error in this distance would
not exceed half an inch. This beautiful apparatus, which is incom-
parably 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 de-
scription 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 exam-
Proceedings of 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

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<thead>
<tr>
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<tbody>
<tr>
<td>213°</td>
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<tr>
<td>216°</td>
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<tr>
<td>228°</td>
<td>1630</td>
<td>4740</td>
<td>3110</td>
</tr>
</tbody>
</table>

"The results for higher, intermediate, and lower temperatures are... vol. ii.
given in the accompanying table. The whole expansion of the steam, when heated from $212^\circ$ to $228^\circ$, was a little more than one thirtieth of its volume at $212^\circ$. 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 24½ 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."

<table>
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<th>Centigrade</th>
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<th>Centigrade</th>
<th>Fahrenheit</th>
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<td>93</td>
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<td>1610</td>
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<td>103.5</td>
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<td>90</td>
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<tr>
<td>103</td>
<td>217.4</td>
<td>1604</td>
<td>70</td>
<td>158.0</td>
<td>000</td>
</tr>
</tbody>
</table>

"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-

† 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 tranquility."
"In 1823, 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

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 tranquility. 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

†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.:


<table>
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<tr>
<th>Cambridge Mean Solar Time</th>
<th>Angle of Position</th>
<th>Distance</th>
<th>%</th>
<th>Observ. err.</th>
<th>Power</th>
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<td>16.2</td>
<td>8</td>
<td>B²</td>
<td>1200</td>
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<tr>
<td>10 10 10</td>
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<td>3</td>
<td>B¹</td>
<td>860</td>
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<tr>
<td>9 54</td>
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<td>B²</td>
<td>860</td>
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<td>5</td>
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<td>860</td>
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<tr>
<td>23 7 35</td>
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<td>5</td>
<td>B¹</td>
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<tr>
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<td>f²</td>
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<td>221.5</td>
<td>16.5</td>
<td>4</td>
<td>B²</td>
<td>860</td>
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</table>

 Remarks:  
- Neither the angle of position nor the distance is well determined.
- The satellite is seen without difficulty, and the observations are supposed to be good.
- Very fine definition. Obs. uncertain from dense fog. Satellite faint. (clouds)
- Satellite occasionally obscured by clouds; otherwise it is well seen.
- Fine definition. Obs. interrupted by daylight.
- Measures very difficult, from haze and moonlight.
- Satellite well seen.
- Bad seeing.
- Observations difficult.
- 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.

<table>
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<tr>
<th>Date</th>
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<th>Periodic Obs.</th>
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<th>Inclination Obs.</th>
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"The corresponding mass of Neptune is = \( \frac{1}{15405} \)"

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21 at 15 17 02 ½ A.R. — Comet's A.R. = + 7° 29 35 by two comparisons.

18 05 36 ½ Dec. — Comet's Dec. = + 5° 44.3 by one comparison.

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. 30th. A slight elongation is suspected in the direction south-preceding, position 240°.'

'Aug. 31st. 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. 26th. 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 α² Librae, 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°.7, and in Dec. by 13′′."


<table>
<thead>
<tr>
<th>Cambridge Mean Solar Time</th>
<th>Distance from Saturn's Centre</th>
<th>Cambridge Mean Solar Time</th>
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<td>Oct. 21.42</td>
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<td>21.52</td>
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<tr>
<td>20.31</td>
<td>-187</td>
<td>Jan. 12.29</td>
<td>-132</td>
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"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 Hy-
perion 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.

<table>
<thead>
<tr>
<th>Cambridge Mean Solar Time</th>
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<th>Star of Comparison, A.R.</th>
<th>No. of Comps.</th>
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<tr>
<td>27 6 58 34 20</td>
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<td>34 52 24.29</td>
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<td>28 6 55 33 20</td>
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<td>29 6 55 16 20</td>
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<td>39 8 59 39 29</td>
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<td>Dec. 18</td>
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<td>1849.</td>
<td>6 42 22 32</td>
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"Nov. 25th. The comet was first seen at 6° 30′; it shows a finely marked nucleus, with a tail of 15′ or 20′.

"At 6° 56′, 41°, M. S. T., it followed a star of the 9th magnitude by 0° 25′.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 more.*

"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.

<table>
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<tr>
<th>Date</th>
<th>Name of Object</th>
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<th>Seconds of Tabular A.R.</th>
<th>Diff.</th>
<th>Observer’s Initial</th>
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* B¹ is the initial of W. C. Bond; B³, that of G. P. Bond.
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"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.

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<td>The two components make a star of the 7th or 8th magnitude.</td>
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<td>1848.30</td>
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<td>860</td>
<td>B</td>
<td>A = 1st, B = 2d, B = 3d.</td>
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<td>α¹ Geminorum</td>
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<td>+32 14</td>
<td>249 45</td>
<td>5.1</td>
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<td>860</td>
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<td>+18 06</td>
<td>142 45</td>
<td>1.9</td>
<td>4</td>
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<td>A and B.</td>
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<td>+32 24</td>
<td>128 30</td>
<td>2.7</td>
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<td>860</td>
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<td>A and C.</td>
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<tr>
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<td>10 11</td>
<td>+20 37</td>
<td>128 30</td>
<td>2.7</td>
<td>5</td>
<td>860</td>
<td>B</td>
<td>A = 4th, B = 5th, 6th.</td>
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<td>179 15</td>
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<td>130 40</td>
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<td>Seen through dense clouds; the definition is good.</td>
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<td>The images of the stars are pretty well defined, though not good.</td>
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<td>A = 3d golden, B = 7th blue or greenish.</td>
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**Remarks, Magnitudes, &c.**

- **Remarks:** Various observations about the visibility and separation of the stars.
- **Magnitudes:** The magnitude values indicate the brightness of the stars, with lower numbers generally indicating brighter stars.
- **Power:** The power required to observe the stars.
- **Observer:** The observer who made the observations.

---

*Note:* The table details the observed double stars, including their positions, magnitudes, and remarks on their visibility and characteristics.
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</thead>
<tbody>
<tr>
<td>Antares</td>
<td>1848.49 16 19</td>
<td>58</td>
<td>-26 06 272 45</td>
<td>8.6</td>
<td>5</td>
<td>1560 B²</td>
<td>Very fine definition.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>α Coronæ Borealis</td>
<td>1848.42 16 05</td>
<td>42</td>
<td>172 30 2.2</td>
<td>4</td>
<td>860 B³</td>
<td>Bad definition.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>λ Ophiuchi</td>
<td>1848.56 16 23</td>
<td>.41</td>
<td>211 20 15.1</td>
<td>5</td>
<td>140 B³</td>
<td>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.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>New Star</td>
<td>1848.40 16 51</td>
<td>-12 39 212 30</td>
<td>115.6</td>
<td>5</td>
<td>140 B³</td>
<td>With a power of 1500 there is no sign of a planetary disk under fine definition.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>β Ophiuchi</td>
<td>1848.55 17 05</td>
<td>+14 33 176 45</td>
<td>22.9</td>
<td>5</td>
<td>1560 B³</td>
<td>λ = 7th, 8th, B = 14th. A appears to have decreased in brilliancy; its red color still remains. The star is at once recognized from its neighbors by its color alone.</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>70 Ophiuchi</td>
<td>1848.52 17 57</td>
<td>+2 33 18 07</td>
<td>6.9</td>
<td>5</td>
<td>140 B³</td>
<td>λ = 7th, 8th, B = 15th. A is sensibly less than when first seen.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ω Lyrae</td>
<td>1848.47 18 39</td>
<td>+39 30 21 04</td>
<td>3.1</td>
<td>5</td>
<td>860 B³</td>
<td>The position angle does not agree with its computed value.</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Ring Nebula</td>
<td>1848.41 18 45</td>
<td>+32 50 66 00</td>
<td>73.3</td>
<td>5</td>
<td>140 B³</td>
<td>A and B.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ζ Cygni</td>
<td>1848.41 20 36</td>
<td>+44 43 88 53</td>
<td>35.5</td>
<td>5</td>
<td>140 B³</td>
<td>A = 3d, B = 8th.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>γ Cygni</td>
<td>1848.25 19 21</td>
<td>+2 39 35 55</td>
<td>33.5</td>
<td>5</td>
<td>140 B³</td>
<td>A = 4th, B = 9th. B has a reddish tinge.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>16 ς Delphini</td>
<td>1848.56 20 24</td>
<td>+1 43 29 50</td>
<td>0.5</td>
<td>3</td>
<td>860 B³</td>
<td>Companion star 12th magnitude.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>γ Virginis</td>
<td>1849.45 12 03</td>
<td>-0 37 17 49</td>
<td>3.0</td>
<td>10</td>
<td>860 B³</td>
<td>Seeing not good.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Antares</td>
<td>1849.52 16 19</td>
<td>-26 06 270 27</td>
<td>3.1</td>
<td>10</td>
<td>860 B³</td>
<td></td>
<td></td>
<td></td>
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</table>
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 ex-
hibited 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 anaesthetic 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 Discophorae, 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
Ctenophora, 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 Ctenophora and naked-eyed Discophora 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.


<table>
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<tr>
<th>T</th>
<th>June 8h.23220</th>
<th>T</th>
<th>15h.59401</th>
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<tbody>
<tr>
<td>Ω</td>
<td>30° 32' 7''</td>
<td>Ω</td>
<td>33° 8' 29''</td>
</tr>
<tr>
<td>i</td>
<td>66 55 12</td>
<td>i</td>
<td>67 3 28</td>
</tr>
<tr>
<td>π</td>
<td>267 13 6</td>
<td>π</td>
<td>278 47 10</td>
</tr>
<tr>
<td>q</td>
<td>0.892703</td>
<td>q</td>
<td>0.625357</td>
</tr>
<tr>
<td>Motion direct.</td>
<td>Motion direct.</td>
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</table>

"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.

<table>
<thead>
<tr>
<th>Ω</th>
<th>30° 11' 11''</th>
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<tbody>
<tr>
<td>i</td>
<td>67 19 39</td>
</tr>
<tr>
<td>π</td>
<td>266 16 36</td>
</tr>
<tr>
<td>ψ</td>
<td>10 6 1</td>
</tr>
</tbody>
</table>
"Even the magnitude of the resulting eccentricity cannot 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.


The American Journal of Science and Arts, for July, 1848. From the Editors.


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.


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.


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.


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.


Charles Cramer. Beschreibung der in der Grossen Knochen Hohle Tennessee gefundenen Fossilien Knochen des Megalonyx laqueatus, etc. From the Author.

Flora Batava; Afbeelding en Beschrijzing van Nederlandsche Ge-

vol. II. 20
wassen, 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._ 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.


_F. G. W. Struve._ Catalogus Librorum Speculae 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.


Topographical Engineers’ Papers, No. 2. Determination of the Latitude with Zenith and Equal Altitude Telescopes, by Captain T. J.

Charles Martins. Instructions pour l'Observation des Trombes Terrestres. (Extrait de l'Annuaire Méteorologique de la France, 1848.) 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.


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.

Dr. J. C. Flügel. Literarische Sympathien oder Industriel Buchmacherci, 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.


Reports from the Secretary of the Treasury of Scientific Investiga-
tions in Relation to Sugar and Hydrometers, made under the Super-
tendence of Professor A. D. Bache, by Professor R. S. McCul-
the Comptroller's Office, Washington.

Samuel Geo. Morton, M. D. Additional Observations on a New Liv-
ings Species of Hippopotamus of Western Africa. (Extr. Jour. Acad.

Smithsonian Contributions to Knowledge. App. I. to Vol. II.; con-
taining an Ephemeris of the Planet Neptune for the Date of the La-
lande 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.

New Haven, 1849. From the Society.

Verhandlungen der Kaisersl. Leopold.-Carol. Akademie der Natur-
forscher. Band XXIII. Suppl. Enthal. F. A. W. Miquel Illustra-
tiones Piperacearum. 4to, with 92 Plates. Band XXIV. 4to.
Breslau and Bonn, 1846, 1847. From the Acad. Naturæ Curios-
sorum.

Augustus Mason, M. D. The Cholera: Brief Hints for its Preven-
tion, &c., &c. 8vo pamph. Lowell, 1849. From the Author.

Professor Von Boguslauski. On a New Micrometer and its Ap-
plication 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 Himmels-
erscheinungen des Jahr. 1849. Erstes und Zweites Quartal. 8vo.
Breslau, 1849. From the Editor.

Übersicht der Arbeiten und Veränderungen der Schlesischen Gesell-
schaft für Vaterländische 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
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 development 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, L.L. 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.


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 Compositae, belonging to the mountains
of the Sandwich Islands; of which a second species was ob-
tained by the naturalists of the United States Exploring Ex-
pedition under Captain Wilkes. Dr. Gray thinks that

"The genus should be referred to the division Madce (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-aehenia, 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 (Hologymnec) glabrata does from the genuine species of Lasthenia, Burrielia (Baeria) chrysostoma from the other species of that genus, and Pilomeris 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 nutantisibus maximis (1½ unc. diamet.); ligulis discum vix aquantium; 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.


"W. GYMNOXIPHUM. — 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 Cullimations observed by Lieutenant Whipple. The result of these observations gave for the longitude of the northwestern bastion of the city wall, 5h. 17m. 57s. = 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 5h. 20m. 5s. 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 4h 56m. 00",.) of the house of Don Luis Parides, 5h 20m. 05.4", 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 tracheae and the circulation in insects. He also exhibited living specimens of Astrangia Daneae, 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 panegyrics make a phoenix; and"
" 2½ phoenixes 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 Chimpanzee, 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 sapientiae*. 
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: —


"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 Philologists, Etymologists, Ethnographers, 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, fit. 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 τ (the Latin v) 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 'mel, 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), i 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, liis ideas of the relation between the open (and usually long) vowels in pav,* fur, pool, lo, and their close (and usually short) condition in naught,* worth, full, obey, are very confused. At present, he makes

υ had "undoubtedly several sounds" in Latin. He should have informed his unclassical readers, that in these words, according to the ancient grammarians, the ı and υ 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 (Emcee. 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 *for* and *not*, and an identical one in *für* and *nüt*; a different one in *conclude* and *good*; but the same one in *endüre* and *düty*. In some cases Pitman and Ellis have used at different times both of the vowels in *fall, nöt*, 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 *endüre, düty*, when not pronounced with the Welsh diphthong *iə*.

"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.'

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* 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 *für, 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 *e* and *y* should each have had an independent character for syllables like the old English *eray*, or the German *glauben* when pronounced *glaubn*. The character for *r* (in the labial position) would have been better as *w*; *s* as *n*; *tsch* 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 sprichtst, 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*, tankadaus, 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 Lenâpe‡ 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, *Furonia*; 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 *e* is a literary corruption) has it twice. Mr. Ellis, whilst he denies the

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Mr. Duponceau describes as a whistle, citing the word 'utethim' 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 qn 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 jv'wen, 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 occurrence 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, sewanchut; 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. 111, 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 Pennsylavnia 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 (Ϝ), the small letter of which was probably two gammas (ϝϝ), 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 φι) is heard in German when f follows p, as in pfropf, kopfsee, 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 represent-
ed 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 es, 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 e with the same tail, to make the deduced characters correspond with their originals c, e (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 i, a character which, on the correct principle of making c cay, should have had its Latin, Italian (as in peri), 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 dsh 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 eista) 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 s are used properly, and jowl is spelt jowl. 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 u) 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 f 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 3, and Σ reversed. There is a remnant of propriety left in his use of j (deprived of its dot) for the element following l mouillé in French, n circumflex in Spanish, and a number of other consonants in the Slavonic 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 but as the last syllable of table; he now writes tabl, 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 barley, barber; battle, batter; bushel, brazier; hammer with the German hammet; 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 re-
quire a greater stress of breath until I tested the fact mechanically
with an appropriate dynamometer. I have never met with 'indiffer-
ent' 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 danjronjna." 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'.

"This close of the glottis is also medial in Wyandot, as in bare-
dar>ajshau, 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, 'Stim-
me nur da wo lungen vorhanden.' The word for eye is krtik', 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 lan-
guage.

"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, t'auh, in which the vowels are short, (the last not
diphthongal, and as in foot,) the final element being the ordinary aspi-
rated k.* The dental effect is more dull and less loud than the cor-
responding 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 p'p' is used.

* This final k is also found in Konza.
OF ARTS AND SCIENCES.

"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 a, 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 (*l-k') and in the latter a monosyllable (*l-k'), 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 eights of a second; the final ch is deeper than the German, and it is trilled, 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 vermacularly, 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, optimus*, 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 *rule, full*. 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 diacresis-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.1 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 o (nearly) replaced a less corrupt type for the vowel in fool, to be itself replaced by u 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 i, finally rejected for e, 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\textsuperscript{w}, 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 jour-
nals, 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 substi-
tuted 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 vendors 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 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 airtight 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 bronchia, 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 scollop-ed 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.:

Prof. Elias Fries, Upsal, Sweden.
Leopold von Buch, Berlin.
Sir Henry de la Beche, London.
Prof. P. A. Hansen, Seeberg, Denmark.
Prof. Jens Christian Oersted, Copenhagen.
Prof. Henry Rose, Berlin.
Prof. Jean Baptiste Dumas, Paris.
Prof. Johann Müller, Berlin.
Prof. Friedrich Tiedemann, Heidelberg.
Prof. Theod. Ludwig Wilhelm Bischoff, Giessen.
Prof. Johann Friedrich Encke, Berlin.
Prof. Karl Ernst von Baer, St. Petersburg.
Prof. Theod. Schwamm, Louvain, Belgium.
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 incommode. 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 vermillion 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" N. Assumed Longitude, 4° 50°. 36°.

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<thead>
<tr>
<th>Date</th>
<th>Name</th>
<th>Sidereal Time</th>
<th>Details</th>
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<tr>
<td>1845</td>
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<tr>
<td>April 15</td>
<td>A² Cancri</td>
<td>9h 27m 01s 38m</td>
<td>Good observation</td>
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<tr>
<td>May 9</td>
<td>62 Orionis</td>
<td>11h 26m 45s 55m</td>
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<td>&quot; 9</td>
<td>Unknown</td>
<td>11h 31m 23s 50m</td>
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<tr>
<td>July 16</td>
<td>58 Sagittari</td>
<td>17h 03m 39s 92m</td>
<td>Good observation</td>
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<tr>
<td>&quot; 21 &quot;</td>
<td></td>
<td>17h 45m 33s 95m</td>
<td>Pretty good observation</td>
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<tr>
<td>Sept. 12</td>
<td>r Piscium</td>
<td>1h 44m 49s 92m</td>
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<td>&quot; 15 &quot;</td>
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<td>1h 29m 50s 09m</td>
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<td>Nov. 10</td>
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<td>20h 54m 04s 48m</td>
<td>Pretty good</td>
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<td>1846</td>
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<tr>
<td>Feb. 4</td>
<td>74 Tauri</td>
<td>3h 56m 21s 11m</td>
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<tr>
<td>&quot; 6</td>
<td>71 Orionis</td>
<td>6h 06m 41s 57m</td>
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<tr>
<td>Mar. 3</td>
<td>2 Leonis</td>
<td>11h 29m 43s 35m</td>
<td>&quot;</td>
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<tr>
<td>1847</td>
<td></td>
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<tr>
<td>Jan. 25</td>
<td>61 Tauri</td>
<td>5h 00m 56s 61m</td>
<td>&quot;</td>
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<tr>
<td>Sept. 16</td>
<td>Unknown</td>
<td>18h 51m 12s 33m</td>
<td>&quot;</td>
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<tr>
<td>&quot; 16 &quot;</td>
<td>29 Ophiuchi</td>
<td>19h 03m 50s 83m</td>
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<tr>
<td>1848</td>
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<tr>
<td>Feb. 12</td>
<td>a Tauri</td>
<td>2h 22m 30s 08m</td>
<td>&quot;</td>
</tr>
<tr>
<td>&quot; 16 &quot;</td>
<td>29 Cancri</td>
<td>7h 02m 50s 55m</td>
<td>&quot;</td>
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<tr>
<td>Mar. 8</td>
<td>750 B. A. C.</td>
<td>6h 05m 41s 19m</td>
<td>&quot;</td>
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<tr>
<td>&quot; 10 &quot;</td>
<td>75 Tauri</td>
<td>8h 30m 29s 26m</td>
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<tr>
<td>&quot; 10 &quot;</td>
<td>Unknown</td>
<td>8h 21m 02s 26m</td>
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<tr>
<td>&quot; 11 &quot;</td>
<td>111 Tauri</td>
<td>7h 23m 21s 40m</td>
<td>&quot;</td>
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<td>&quot; 11 &quot;</td>
<td>Unknown</td>
<td>7h 20m 31s 40m</td>
<td>&quot;</td>
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<tr>
<td>&quot; 13 &quot;</td>
<td>δ Geminiorum</td>
<td>7h 35m 41s 90m</td>
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<tr>
<td>&quot; 16 &quot;</td>
<td>3,386 B. A. C. (?)</td>
<td>9h 05m 01s 19m</td>
<td>&quot;</td>
</tr>
</tbody>
</table>
| May 6      | 26 Geminiorum               | 11h 33m 42s 08m| Saw a bright spot in the dark part of the [Moon.]
| " 6 "     |                             | 11h 52m 44s 00m| 1s. (?)                  |
| June 6     | 3,415 B. A. C.             | 13h 43m 53s 86m| "                        |
| Nov. 8     | Mercury                    | 14h 53m 39m 53m| 24 internal contact with Sun's limb. |
| " 8 "     |                             | 14h 55m 19m 59m| 24 external " " " " " " " |
| " 11 "    | 54 Tauri                    | 21h 59m 40s 60m| Good observation         |
| 1849       |                             |               |                          |
| Jan. 5     | 75 "                        | 3h 35m 44s 80m| Thin clouds. Observation fair. |
| " 5 "     | 1,391 B. A. C.             | 4h 46m 12s 20m| "                        |
| " 5 "     | a Tauri                     | 7h 36m 35s 70m| "                        |
| " 5 "     | a "                        | 8h 42m 27s 70m| "                        |
| " 6 "     | 111 "                      | 0h 22m 18s 29m| Pretty good             |
| Feb. 17    | 31 Leonis                   | 7h 05m 31s 27m| 1s. (?)                  |
| Mar. 1     | 1,517 B. A. C.             | 8h 32m 02s 40m| Pretty good             |
| April 6    | 38 Virginis                 | 10h 29m 27s 04m| "                        |
| June 25    | 21,678 Lalande              | 13h 25m 54s 85m| "                        |
| July 22    | 59 Leonis                   | 15h 48m 17s 50m| "                        |
| Oct. 24    | 7,263 B. A. C.             | 23h 47m 11s 72m| "                        |

* 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. 30.0s.

VOL. II. 24
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 com-
parisons, and the differences which are given in the last column mani-
manifest, by the signs of plus and minus, the irregularities of the instrument, 
and the error to be expected from these irregularities in single ob-
servations. 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 ba-
rometer 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 ba-
rometer 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.

<table>
<thead>
<tr>
<th>Date</th>
<th>Fall of the Aneroid Barometer under the Receiver</th>
<th>Rise of the Mercury in the Capillary and Level</th>
<th>Difference</th>
<th>Date</th>
<th>Fall of the Aneroid Barometer under the Receiver</th>
<th>Rise of the Mercury in the Pump-gage, corrected for Capillary and Level</th>
<th>Difference</th>
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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.

<table>
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<th>Date</th>
<th>Aneroid, corrected for Temperature</th>
<th>Mercurial, corrected for Level, Capillarity, and Temperature</th>
<th>Difference</th>
<th>Difference after eliminating Mean Difference of Instruments</th>
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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, $0.040$
Table III.

Observations in Table II., arranged according to the Amount and the Sign of the Differences.

<p>| | | | |</p>
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<tr>
<td>Difference,</td>
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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.

<table>
<thead>
<tr>
<th>1849.</th>
<th>Original Reading of the Aneroid Barometer</th>
<th>Reading after the Air was admitted</th>
<th>Difference</th>
<th>Degree of Rarefaction as measured by the Pump-gage.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sept. 10,</td>
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<td>30.450</td>
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<td>.080</td>
<td>5 &quot;</td>
</tr>
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</tbody>
</table>
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 dif-
ferent 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 cooperation 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°, and 58°, while \( M \) on \( e \), the terminal plane, is 131°.' 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.

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<tr>
<td>C 8 = 48</td>
<td>76.19</td>
<td>76.34</td>
</tr>
<tr>
<td>H 7 = 7</td>
<td>11.11</td>
<td>11.14</td>
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<tr>
<td>O = 8</td>
<td>12.70</td>
<td>12.52</td>
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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.

4 (C 10, H 8) = C 40, H 32

3 H, O = H 3, O 3

2 O = O 2

C 40, H 35, O 5 = Valerian Camphor."

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 Crustaceaorum quae in Orbis Terrarum circumnavigatione, Carolo Wilkes et Classe Reipublicae Federatæ Duce, lexit et descriptis Jacobus D. Dana. Pars III.*

Subtribus I. GAMMARACEA.

Familia I. ORCHESTIDÆ.

Palpus mandibularis obsoletus. Corpus compressum, epimoris latis. Styli caudales duo postici breviores.

Genus I. TALITRUS. (Latreille.)

Pedes primi styliiformes, secundi vel non subcheliformes vel manu debilissimá confecti. Antennae primæ basi inferiorum breviores.

1. TALITRUS Novi-ZEALANDIÆ. — Epimera grandia, nuda, spinulis minutis marginem armata. Antennæ 2dae 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 breviores quam penultimus, digitó obsoleto(?). Pedes 10 postici densè setosi, 6 postici valde inaequivi, 7mis duplo longioribus quam 5ti, articulo primo latissimo.

Long. 10". — Hab. in portu "Bay of Islands" Novi-Zealandiae.

2. TALITRUS gracilis. — Epimera grandia. Antennæ 2dae dimidii 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, 2do parvulo, articulis 2do 3tio 4to 5to subaequibus. Pedes 2di paulo breviores, articulo penultimo posticè triangulato; ultimo lamellato, fere nudo, apicem rotundato, margine antice parce excavato et versus apicem digitum minutum gerente. Pedes 3ti 4tis velae longiores. Pedes 6 postici paulo graciles, fasciculatim setulosi, articulo primo anguste elliptico; pedibus 7mis multo longioribus quam 5ti.

Long. 5"—6". — Hab. in sabulis litoralis insulæ freti "Balabac."

3. TALITRUS ornatus. — Segmenta corporis laevia. Epimera lata, per sulcos subtiles areolata. Antennæ 2dae dimidii corporis paulo

* Vide supra, p. 61.

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breviores, flagello vix longiore quam basis, articulis parce oblongis, setis brevissimis. Antennae Imae basi secundarum fere triplo breviores, 5 - 7-articulatae. Pedes 1mi validiusculi, secundis multo longiores, ugue valido. Pedes 2di debiles, manu parvulâ subellipticâ, apice subacutâ, digito dorsali, minuto, apicem non attingente. Pedes sequentes subsetosi, 4ti 5ti subæqui, 7mi 6îs longiores, articulis primis pedum sex posticorum sculpturis.

Long. 6‴ - 9‴. — Hab. in sabulis litoralis prope "Valparaiso."

Genus II. TALITRONUS. (Dana.)

Pedes secundii manu valido prehensili confecti. Alias Taliter similis.


Long. 9‴. — Hab. in sabulis litoralis prope "Valparaiso."

Genus III. ORchestia. (Leach.)

Pedes primi, secundique subcheliformes, manu debili aut validâ confecti. Antennae primae basi secundarum breviores. Maxillipedes apicem obtusi.


Long. 6‴ - 8‴. — Hab. in craterane extincto "Taimai" Novi-Zealandic.
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quam basis, articulis oblongis, cylindricis, setis articulo vix brevioribus. Antennæ 1mæ basi 2darrum vix breviores. Pedes 4 antici debiles; primi minimi; secundi parvuli, manu minutâ, oblongâ, retrorsum 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-Zelandiae.

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 subovata, 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 increcentes.

Long. 9"—11". — Hab. ad oras sinus “Nassau,” Fuegiae, inter Algas rejectas.


Long. 4". — Hab. in mari prope oras sinus “Nassau,” Fuegiae, inter Algas natantes.


Long. 6"—7". — Hab. ad oras Illawarræ, Australiæ.


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 latiorem transversâ parce excavatâ. Pedes 2di validi, manu
grandi, subellipticà, palmâ infero-subapicali, excavatâ, subtilissimè spinulosâ, angulo infero rotundato. Pedes 3ii 4ti tenues, subaequì; 5ti 6ti 7mi sensim increcentes, 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.)


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 fere quadruplo longiore quam basis, 11-articulato, articulis parce oblongis, setis densè verticillatis, brevisbus. Pedes 1mi parvuli, manu oblongâ, dorsum fere rectâ, infra versus apicem obliquâ. Pedes 2di validi, manu ovatâ, palmâ rectiusculâ, pubescente, digito longo. Pedes 3ti 4ti sat longi, subaequì; 5ti 6ti 7mi subaequì, 5tis paulo brevioribus, articulo primo lato, setis sparsis, brevibus.

Long. 4". — Hab. apud oras prope Valparaiso.


Hab. apud oras prope Valparaiso, et insulae “San Lorenzo.”

4. ALLORCHESTES GRACILIS. — Epimera mediocria, quinta perangusta. Antennae tenuissimæ: 2dæ dimidii corporis longitudine;
flagello multo longiore quam basis, articulis oblongis, setis perbrevibus, paucis: 1mae dimidio breviore, 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 3iii 4ti subaequi; 6 ultimi sat breves sensim increscentes, articulo primo lato, setis sparsis brevissimis.

Long. 6'′—8"′.—Hab. in mari prope oras insulâ "Tongatabu."

5. ALLORCHESTES PERUVIANA. — Epimera sat lata, quinta perangusta. Antennae 2dae dimidii corporis longitudine; flagello duplo longiore quam basis, fermè 14-articulato, articulis parce oblongis, setis perbrevibus. Antennae 1mae 2dis paulo breviore, 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 3iii 4ti sat longi, subæqui; 6ti 7mi subæqui, non perlongi, 5ti parce breviores.

Long. 4"′.—Hab. ad oras prope Valparaiso, inter Algas rejectas.


Long. 4"′.—Hab. in mari apud oras portus "Jackson" Australiæ Orientalis.


Long. 5°. — Hab. ad oras “Bay of Islands” Nova-Zelandiae.


Long. 5°. — Hab. ad oras sinus “Bay of Islands” Nova-Zelandiae.

10. Alloorchestes intrepida. — Corpus vale comprosum, epimeris 8 latissimis, 6 posticis angustissimis. Antennae 2dæ dimidii corporis longitudine; flagello tenuissimo, parce longiore quam basis, articulis oblongis tenuibus, setis fere obsoletis: 1mæ multum breviore, flagello plus duplo longiore quam basis. Pedes 1m parvuli, manu apicem transversâ et non latiore, emarginatâ, digito valde longiore quam margo apicalis (vel palma), articulo precedente infra producto et acuto. Pedes 2dī validi, manu subovatâ, dorso fere recto, palmâ parce impressâ hirsutiusculâ, digito longo: femine manu angustâ apicem rectè truncatâ, digito brevi; articulo precedente infra longe acuto. Pedes 3tī 4tī subæqui; 6 ultimi sensim increcentes.

Long. 3° – 4°. — Hab. ad oras portus “Parua” in sinu “Bay of Islands” Nova-Zelandiae.

11. Alloorchestes orientalis. — Epimera lata. Antennae 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 1mì
parvuli, manu subellipticâ. Pedes 2dì validusculi, manu subovatâ,
palmâ parce excavatâ, minutè sparsim setulosa; digito longo; articulo
precedente angusto, proximo infra subacuto, non producto. Pedes
6 postici sensim increscentes, setis paucis, minutis.

Long. 3". — Hab. in mari "Sulu."

2dæ corpore plus duplo breviores; flagello moniliformi, multo longiore
quam basis, setis minutís. Antennæ 1mæ 2dis breviores, flagello
fermo 14-articulato. Pedes 1mì parvuli; manu angustâ; digito
crasso, styliformi. Pedes 2dì validi, manu angustè subovatâ, infra fere
rectâ, palmâ non excavatâ, digito longo; articulo precedente infra
non producto. Pedes 3tìi 4tì sat longi, subæqui; 5tìi 6ti 7mi paulo
inequi, sensim increscentes, fere nudi.

Long. 6"—7". — Hab. in portu "Rio de Janeiro."

Familia II. GAMMARIDÆ.

Mandibulae 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 præmæ basin crassæ. Epimera grandia. Pedes sex postici
non prehensiles.

Genus I. LYSIANASSA.

Pedes subcheliformes nulli secundis interdum exceptis, sex posticis
directionem similibus. Antennæ præmæ appendiculatae.

1. Lysianassa Brasiliensis. — Corpus valde compressum, epimeris
latissimis. Oculi reniformes. Antennæ 1mæ breves, corpore quadruplo breviores; flagello duplo longiore quam basis, fermè 10-articu-
lato, appendice 7-articulato. Antennæ 2dæ dimidio corporis valde
longiores, sæpe epimeris celatae, basi brevi et geniculante. Pedes
4 antici similès, tenues; 3tìi 4tìs longiores; 5tìi 6ti 7mi similès, sen-
sim increscentes, articulo primo marginem posticum serrulato.

Long. 3". — Hab. ad oras portus "Rio de Janeiro."
Genus II. URISTES. (Dana.)

Pedes primi subcheliformes; secundi articulo styli formi confecti; tertii quartique brevissimi; reliqui non prehensiles; similis. Antennae primae non appendiculæ.

URISTES GIGAS. — Corpus compressum, epimeris latissimis. Antennae subæque, crassiusculæ, dimidio corporis breviores: 1mæ parce breviores, flagello processubus obtusus 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 parvulæ, angustâ, oblique truncatâ, digito brevi. Pedes 2di 5-articulati, articulo ultimo elongato, styli formi, acuto. Pedes 7mi 6is paulo breviores. Segmentum abdominis antepenultimum posticum acutum.

Long. 9". — Hab. in mari Antarctica: tubo cibario piscis lecta.

Genus III. STENIA. (Dana.)

Pedes primi secundique subcheliformes; reliqui non prehensiles. Antennae primæ non appendiculæ. Corpus compressum.


Long. 4" — 6". — Hab. in mari portus "Good Success" Fuegiae.

Subfamilia II. GAMMARINÆ.

Antenna 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. Antennaæ secundæ sub primas insita, primæ appendiculæ.

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

Long. 6". — Hab. in mari "Sulu."

2. GAMMARUS SULUENSIS. — Feminea: Segmenta abdominis primum secundumque in marginem posticum dorsalem 2-3-dentata, quartum etiam 2-acutum. Oculi subrotundati. Antenne 1mae corporis longitudine; flagello longiore quam basis, articulis oblongis, setis non brevioribus, appendice brevissimo, 3-articulato. Antenne 2dae fere dimidio breviore, flagello plus duplo breviore quam basis, basi parce breviore quam antemarum basis 2darum. Pedes 4 antici subaequi, parvi; manus 1mae parvula, apicem latiore, truncata; 2dae paulo majore, oblonga, apicem truncatam, non latiore. Pedes sex postici paulo inaequi, setis paucis remotis, apicalibus longiusculis.

Long. 4" — 5". — Hab. in mari "Sulu" prope oras insulæ, inter Algaes natantes.

3. GAMMARUS ALBIDUS. — Epimera latiuscula. Abdominis segmenta primum secundum quartumque dorso uni-spinosa. Antenne 1mae dimidio corporis valde longiores, flagello longiore quam basis, fere 21-articulato, articulis oblongis, setis vix brevioribus, appendice brevi, 3-articulato. Antenne 2dae tenuissimae, fere dimidio breviore, flagello brevior quam basis, ferme 8-articulato. Pedes feminea 4 antici subaequi, parvi; manus 1mae parvula, oblonga, apicem fere rotundatam, non latiore; 2dae parce longiore, fere lineari, infra hirsuta; maris 2dae crassa, latæ oblonga, versus basin sensim paulo angustiore, infra parce hirsutiusecula apicem obliquè truncata, palmæ apicali, paulo excavatæ. Pedes 6 postici subaequi, hirsuti.

Long. 5". — Hab. in lacu insulae "Tongatabu."

2. Abdomen non dentatum nec spinulosum.

a. Margo frontis lateralis ophthalmicus saliens.

4. GAMMARUS HIRSUTICORNIS. — Epimera lata. Antenne infra setosæ; 1mae dimidio corporis breviore, flagello basis longitudinem fere æquante, appendice 3-articulato: 2dae paulo breviore, articulis ba-
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salibus quatuor subæquis, flagello breviore quam basis. Pedes 4 antici parvuli, 6 postici sensim increcentes, 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 setose, 1mae dimidio corporis vix longiores, articulis primo tertioque subæquis; flagello breviore quam basis, fermè 7-articulato, appendice 3-articulato. Antennæ 2dae breviores, basi vix breviore quam basis Imarum; 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 increcentes, 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 1mae corpore paulo breviores, teretes, tenuissimæ, flagello parce longiore quam basis, 14-articulato, setuloso, appendice brevissimo. Antennæ 2dae 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 femina ?) ovata. Pedes 7mi 6tis valde longiores, sparsim setosi.

Long. 3". — Hab. in mari "Sulu."

7. GAMMARUS FURCICORNIS. — Gracilis, epimeris angustis; sparsim pubescentis. Caput fere oblongum. Antennæ 1mae corpore breviores, articulo primo crasso, oblongo; flagello terete, parce longiore quam basis, fermè 14-articulato, sparsim setuloso; appendice dimidio breviore, 5-articulato. Antennæ 2dae 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, trapezidea, 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."

**Long. 4**". — *Hab. in Archipelagine "Viti."*


**Long. 2½"–3½". — Hab. in mari prope fretum Sundæ.**

II. *Manus una Paris secundi validissime cheliformis, pollice valde elongato; altera parvula.* (Gen. *Mëra*, Leachii.)

1. **Dorsum abdominis nudum.** [Palma 3-dentata.]

10. **Gammarus (Mëra) quadrimanus.** — Gracilis, epimeris perangustis. Antennæ Imæ dimidii corporis longitudine, basi longiore quam flagellum, articulis primo secundo subaequis, longis, flagello pubescente, appendice parce longiore quam dimidium flagelli. Antennæ 2dæ breviore, basi breviore quam basis 1marum, flagello perbrevi. Manus 1ma parvula oblonga, infra hirsuta, basin angusta, palmæ obliquæ. Manus 2da validissima, subquadrata, palmæ apicale, transversâ, tridentatâ, pollice acuto, tenui, digito acuto. Pedes 7mis 6ti parce breviore, articulis apicem posticum densè pilosis.

*Hab. in Archipelagine "Viti."*

2. **Dorsum abdominis armatum.** [Manus major subtriangulata, palmæ 2-dentatâ, dentibus obtusis.]

11. **Gammarus (Mëra) validus.** — Gracilis, epimeris angustis. Oculi rotundati. Antennæ tenuissimæ: Imæ corporis longitudine, articulo secundo longiore, flagello vix longiore quam basis, appendice

**Long. 2½"—3½". — Hab. in mari juxta “Singapore.”**

12. **Gammarus (Mera) setipes.** — Gracilis, epimeris perangustis. Oculi orbiculati. Antennæ corporis longitudine: Imae paulo majores, articulo secundo longiore, flagello longiore quam basis, appendice 5-articulato: 2dæ longæ, basi multo longiore quam basis Imarum, 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 subaequi, 6tis parce longioribus, articulis breviter et sparsim setosis, tertio postice serrato.

**Long. 4½". — Hab. in portu “Rio de Janeiro.”**

13. **Gammarus (Mera) pilosus.** — Gracilis, epimeris angustis. Antennæ subaequi, corpore breviore; Imae paulo longiores, flagello longiore quam basis; 2dæ graciliores, basi longiore quam basis Imarum, flagello breviore quam suus basis. Manus secunda sinistra validissima, basin angusta, apice superno prominulo; dextra parvula, apicem obliquè truncata. Pedes 6 postici subaequi, longè pilosi, articulo tertio postice fere integro.

**Long. 6½". — Hab. in portu “Rio de Janeiro.”**

**Genus II. AMPHIITOÆ.**

**Gammaro affinis. Antennæ superiores non appendiculatae.**

**A. Antennæ superiores longiores.**

1. **Amphitoe peculans.** — Gracilis, epimeris angustis, marginem sparsim ciliatis. Antennæ subaequæ; 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 summorum ellipticâ,) antice et posticè hirsuta. Manus secunda valida, oblonga, elliptica, palmâ non excavatâ, hirsutâ, carpo hirsuto, triangulato infra anguste producto, hoc processu manum non appresso, digitò longiusculo. Pedes 3tii 4tii
sequi, 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._


_Hab._ in mari juxta oras prope urbem "Valparaiso."


_Long. 4"._ — _Hab._ apud insulam "Pitt" Archipelaginis "Kings-mills."

_b. Oculi non reniformes, fere orbiculati._

1. Palma manus secundæ lateralis. (Gen. Melita, Leachii.)


_Long. 4"._ — _Hab._ in sinu "Bay of Islands" Novi-Zealandiae.
5. AMPHITOE PERUVIANA. — Corpus compressum. Antennae 1mae corpore parce breviores, articulis tribus basibus subaequis, flagello paulo longiore quam basis, setis perbrevibus, non divaricatis. Antennae 2dae 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, digitâ 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.


Long. 4"—5". — Hab. in sinu “Bay of Islands” Novi-Zelandiae.

7. AMPHITOE INDICA. — Femina: Corpus crassiusculum, epimeris mediocribus, segmento abdominis 4to apicem acuto. Antennæ 1mae dimidio corporis longiores, articulo primo longiore, flagello longiore quam basis, setis breviusculis. Antennæ 2dae dimidio breviores, tenues, flagello vix breviore quam basis. Manus prima parvula, oblonga, acuminata; 2da formam similis, parce major, palmâ non excavatâ, digito dimidiis manus longitudine. Pedes 3ti 4tique tenues, non breviores, 6ti 7mi subaequi, 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 1mae dimidio corporis longiores, articulo secundo multo longiore, flagello fere duplo longiore quam basis, articulis longis, setis perpaucis, brevibus. Antennæ 2dae 1mis breviores, basi multo longiore
quam basis 1marum, flagello articulum precedentem fere æquante. Manus 1ma parvula, oblonga, angusta, apicem angustiorem. Manus 2da valida, lata, subrectangulata, apicem transversa, palpæ apicali, excavata, angulo infero acuto, digito mediocri. Pedes 3īī 4ī breves; 6ī 7mi subæqui, 5īi 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 suas basis. Manus 1ma parva, apicem latior, obliqua; 2d fere elliptica, marginibus arcuatis, digito duplo breviore quam manus. Pedes 4 sequentes non breviores, subæqui; 5ī breviores; 6ī 7mi subæqui.

Hab. in mari Atlantico inter Algas natantes.

* * Epimera quinta quartis vix angustiora.


Long. 6". — Hab. apud oras insulae "Tongatabu."

11. AMPHITOE PEREGRINA. — Feminae. Corpus gracile, epimeris latiusculis, 5īs magnis, margine sparsim ciliato. Antennæ 1mæ ferme dimidii corporis longitutinde, 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 2dā subæqua, parvula, oblonga, infra arcuata, digito minuto. Pedes 3īī 4īi non breviores, subæqui; 5īi 6īi 7mi non longi, sensim parce increcentes, setis minutis, articulo primo lato.

Long. 3/4. — Hab. inter Algas natantes maris alti prope "Valparaíso."

12. AMPHITOE BREVIPS. — 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 2dae dimidium 1marum longitudinem parce superantes, basi longiore quam basis 1marum, flagello brevi (multo breviore quam basis), subulato, infra hirsuto. Manus 1ma 2da femina subequae, parvulae, breves, apicem rectè truncatae et non latiores; palmà apicali, digito, minuto; 2da maris valida, subovata, dorsum rectiuscula, prope apicem internum unidentata, digito longo. Pedes 3ti 4ti subaequi; 5ti 6ti 7mi brevisculi, sensim increcentes, articulo primo lato.

Microcheli, generi non vero, ut mihi videtur, femina A. brevipes forsan pertinet.

B. ANTENNAE SUPERIORES BREVIORUM. (Genus Iphimedia, Rathke.)


Long. 4". — Hab. apud oras insulae "Hermite" Fuegia.


Long. 4". — Hab. apud oras insulae "Hermite" Fuegia.

Genus III. CEDICERUS. (Kröyer.)


CEDICERUS NOVI-ZEALANDI. — Parvulus. Antennae Imæ dimidio vol. II. 28
corporis breviores, teretes, articulis oblongis; 2dæ fere duplo longiores, flagello femnæ 21-articulato, fere duplo longiore quam basis. Pedes 7mi corporis longitudine, extremitate styliformi, minùtè pubescente: 4 antici inaæqui, manubus ovatis, manu 1mâ parvulâ, 2dâ validiusculâ, palmâ paulo excavată, digito sat longo. Pedes 3tii 4ti tenues, parvuli; sequentes articulum primum angusti.

Long. 2". — Hab. in sinu “Bay of Islands” Novi-Zelandiæ.

Genus IV. ERICHTHONIUS! (M. Edwards.)


1. ERICHTHONIUS (PYCTILUS?) MACRODACTYUS.— Corpus gracilis, epimeris mediocribus, capite oblongo, marginis frontis ophthalmoïdes producto. Antennæ elongatae; 2dæ corpore breviiores, articulis 3tio 4tio subsequis, longis, flagello paulo breviore quam basis, fermè 10-articulato, setis perbrevisibus. Manus 1mâ elliptica, 2-articulata, (articulo primo majore) digito brevi. Manus 2da validissima, paulo < forma, pollice praolongo, acute, digito longiore quam manus, articulis duobus subsequis, utroque pollicis longitudinem æquante, apiceem acute, sparsim breviter hirsuto. Pedes 3tii 4ti subsequi; 5ti breves, articulo primo postice acutè producto; 6ti 7mi paulo inaequì, postici longiores.

Hab. in mari Indie Orientalis.

2. ERICHTHONIUS (PYCTILUS?) PUGNAX.— Antennarum basis 1mârum flagello vix longior. Manus secunda validissima oblonga, marginibus antico posticoque fere parallelis, pollice brevi, bifurcato; digito elongato, articulis duobus inaequís primo crassiore et longiore, intus parce eroso et sparsim hirsutiusculo, duplo longiore quam pollex.

Hab. in mari Indie Orientalis.

Familia III. COROPHIDÆ.

Genus I. COROPHIUM.

Pedes secundi non subcheliformes digito nullo 2-articulato. Antenne 2de flagellis carentes.

COROPHIUM QUADRICEPS. — Caput quadratum. Abdomen postice rotundatum. Pedes 4 antici similis, primis minoribus. Pedes 5th breviores, articulo primo non setoso; 7mi tenues, articulo primo setoso, setis longiusculis, plumosis. Antennae (an adultae ?) subsegmentae; 1mæ parce breviores, 7-articulate, articulo primo longiore; 2de crassiusculæ, 7-articulate, quartam partem corporis longitudine vix superior, articulo 3io longiore, tribus ultimis parvulis subsegmentis.

Long. 1". — Hab. in portu "Rio de Janeiro."

Genus II. CLYDONIA. (Dana.)


Long. 3". — Hab. in mari Atlantico, lat. bor. 1°, long. occ. 18°. — Lect. die 31 Oct., 1838.


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, abdomen articulos normalis, valde inflexo. Pedes plerumque latè expansi instar Aranei.
Antennae quatuor flagellis confectae, non pediformes. Animalia gressoria.

Genus ICILIUS.

Antennae elongatae, secundae 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 anticus ad marginem posticum medianum acutis, segmento ultimo parvulo ovato. Antennae subteretes: 2ae corpore longiores, flagello fere duplo longiore quam basis, tenuissimo: 1ae 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 down-rushing 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 formulae for the equatorial rectangular coordinates 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. Svo pamph. 1849. From the Author.


J. H. Maedler. Tabula Generalis Stellarum Duplicium Indicationem
OF ARTS AND SCIENCES.

Motus Gyratorii Exhíbentium. Dorpati, 1849. folio pamph. From the Author.


The Report of the British Association for the Advancement of Science, for the Year 1848. 8vo. London, 1849. From the British Association.


Victor Jubien: Precis de Rhetorique, suivi des Règles auxquelles sont assujettis les différents Ouvrages de Litterature. Maurice, 1843. 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.


Alfred Sme. Elements of Electro-Biology; or the Voltaic Mechanism of Man; of Electro-Pathology, especially of the Nervous System; and of Electro-Therapeutics. 8vo. London, 1849. From the Author.

Col. Edward Sabine. Directions for the Use of a Small Appa-
ratus to be employed with a Ship's Standard Compass, for the Purpose of ascertaining at any Time, whether at Sea or in Harbour, the changing Part of the Deviation, which is usually different in different Parts of the Globe. 8vo pamph. London, 1849. From the Royal Society of London.

Proceedings of the Royal Society, for 1847 and 1848. Nos. 69, 70, 71, 72. From the Society.

Philosophical Transactions of the Royal Society for 1848. Do. for 1849, Part First. 4to. — Catalogue of the Members of the Royal Society, 1847, and Do. for 1848. From the Society.

George Ticknor. History of Spanish Literature. New York, 1849. 3 vols. 8vo. From the Author.


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.


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


Prof. C. B. Adams. Monograph of Vitrenella, a new Genus of new Species of Turbinidae. 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.


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.


Prof. C. B. Adams. Contributions to Conchology. Nos. 6 and 7. 8vo pamph. From the Author.


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.


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, 1848.

"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.

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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 held 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 Linnaean 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 catfishes, and the whole family of Siluridae, 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 catfish 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 alcohol 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\(^\circ\), 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 $\frac{1}{4} \times \frac{2}{3}$ 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 $\frac{2}{3} \times \frac{3}{3}$ 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 Ox-
ford, England, who had been employed by the British govern-
ment 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 pre-
pared 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 resolu-
tions. 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 fol-
lows:

"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 men-
tioned 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 opin-
on 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 cooperating 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."

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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 expres-
sion 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 cav-
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 Boudant (Min., 1832) says they are very rare.† Mohs implis 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 striae, 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 Sivalik 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.

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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 formulae. 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 con-
ducting 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 ob-
tained, 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 *inertiae*. 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 9h 30m 49s. The time noted by my assistant was 9h 30m 50s, and the mean of these results, namely, 9h 30m. 49s.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 2h. 35m. 25s. The correct or reduced mean time, as noted by the mean solar chronometer (T. Dallas 158), was 11h. 29m. 59s. 9, civil account. The transit, at the ingress 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 8h. 54m. 26s., and by the solar chronometer, 5h. 47m. 58s. 4 P. M. The next observation was on the interior contact. The time was satisfactorily observed to be 8h. 57m. 30s. 7 sidereal time, and 5h. 51m. 3s. 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 8h. 58m. 6s. 4 sidereal time, and 5h. 51m. 38s. 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 9h. 0m. 59s. 6 sidereal time, and 5h. 51m. 31s. 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 As-
sistant 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

<table>
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<tr>
<th>Component</th>
<th>Percentage</th>
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<tbody>
<tr>
<td>Phosphate of lime</td>
<td>92.405</td>
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<tr>
<td>Chloride of calcium</td>
<td>0.510</td>
</tr>
<tr>
<td>Peroxide of iron</td>
<td>0.010</td>
</tr>
<tr>
<td>Oxide of manganese</td>
<td>0.003</td>
</tr>
<tr>
<td>Fluoride of calcium, by difference</td>
<td>7.012</td>
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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 Ca₃ 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."

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Three hundred and forty-fifth meeting.

April 1, 1851. — Monthly Meeting.

The President in the chair.

Lieutenant Davis presented a paper, relating to the deterio-
ration 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 Levering 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 with-
in 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 Vertebrata 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.
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 cooperation 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 slightly. 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 Mananans, or, as Williamson writes it, Manannah, 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 mache, as has been suggested to me by the Librarian of the Athenaeum, 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.
OF ARTS AND SCIENCES.

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 Holothuridae 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 Coun-
ty. 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.

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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.)


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.)


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.)

Academy of Natural Sciences of Philadelphia.

Boston Society of Natural History.

Lyceum of Natural History of New York.

American Antiquarian Society.

American Oriental Society.

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.

Association of American Geologists and Naturalists.


Astor Library.


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.


Professor Robb.


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. Svo 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.)


Samuel G. Morton, M. D.


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.


Professor C. B. Adams.

Contributions to Conchology.

J. W. Foster and J. D. Whitney.


C. T. Jackson, M. D.


Mrs. Binney.


N. I. Bowditch, Esq.


Hon. Josiah Quincy.

B. A. Gould, Jr., P. D.


Charles Girard.


Royal Irish Academy.


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.


Lists of the Royal Society for 1849–50. 4to.


Catalogue of 2156 Stars, formed from the Observations made during Twelve Years, from 1836 to 1847, at the Royal Observatory, Greenwich. 4to. London, 1849.


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.


G. B. Airy, Astronomer Royal.


Lieutenant-Colonel Edward Sabine.


Charles Brooke, Esq., F. R. S., &c.


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.


Henry Raper, R. N.


Professor William R. Hamilton, LL. D.


Professor Owen, F. R. S.

On the Development and Homologies of the Molar Teeth of the Wart Hogs (Phacochoerus), with Illustrations of a System of Notation for the Teeth of the Class Mammalia. By Professor Owen, F. R. S., &c. (Extract of the Phil. Trans. R. S., Pt. II., 1850.) 4to.

Adam Sedgwick, F. R. S., &c.


British Museum.

British Association.
Report of the Nineteenth Meeting of the British Association for the Advancement of Science, held at Birmingham, in September, 1849. 8vo. London, 1850.
Report of the Twentieth Meeting of the British Association for the Advancement of Science, held at Edinburgh, in August, 1850. 8vo. London, 1851.

Académie des Sciences de l'Institut de France.

Museum d'Histoire Naturelle de Paris.
Archives. Tomes I. – V. 4to. (From the Professors Administrators.)

Macedoine Melloni.
La Thermochrose ou la Coloration Calorifique. 1 Partie. 8vo.
Naples, 1850.

Jules Thurman.
Essai de Phytostatique appliqué à la Chaine du Jura. 8vo. 2 vols. Berne, 1849. (Through Professor Agassiz)

Emile Blanchard.
Mémoire sur l'Organisation d'un Animal appartenant au sou- embranchement des Annelés.
Seconde Mémoire sur l'Organisation des Malacobdelles.
De l'Appareil Circulatoire et des Organes de la Respiration dans les Arachnides.
(Extracts from the "Annales des Sci. Nat.") 8vo.

Guerin Menevill.
Revue et Magasin de Zoologie pure et appliquée. 2 Ser. Tome II. No. 1.
Analyse des Experiences sur la Muscardine et les autres Maladies des Vers à Soie en 1849.
Sur les Maladies des Vers à Soie et sur la Recherche des Moyens d'améliorer leur Races.
De la Culture de la Cochenille en Algerie.
Essai sur les Insectes Utiles et Nuisibles. 5 pamphlets. 8vo. Paris.
(Extrait des Annales de la Société Sericicole.)

Prof. A. Quetelet.

Leon Foucault.
Note sur l'Experience communiquée par M. Leon Foucault, le 3 Fev. à l'Acad. des Sci. de Paris, par Jean Plana. 4to. Turin, 1851.

Emanuel Liais.
Théorie Mathematique des Oscillations du Barometre et Recherche de la Loi de la Variation Moyenne de la Temperature avec la Latitude. 8vo. Paris, 1851.


Mémoires. Tomes VI. – X., et Tom. XII. Part II.

Royal Prussian Academy.


Doctor J. G. Flügel.
Magnetische und Geographische Ostbestimmungen im Österreichischen Kaiserstaate. 2º und 3º Jahrgang. 1847, 1848. 4to. 2 vols. Prag, 1850.

Beobachtungen der Kaiserlichen Universitäts-sternwarte Dorpat von Dr. J. H. Madler. 12º Band. 4to. Dorpat, 1850.


Ueber den Einfluss der Alpen auf die Auerserungen der Magnetischen Erdkraft. Von Karl Kreil. 4to pamph. Wien, 1849.

Uranus .... Ephemeride Synchronistisch geordnete aller Himmelserscheinungen. 1850, Nos. 2, 3, 4. 1851, No. 1. 8vo pamph. Breslau, 1850 – 51.

Prof. Hausmann.


Pamph. Göttingen, 1850.

Royal Society of Sciences, Göttingen.


Nachrichten. 1849, Nr. 1 bis 14, und 1850, Nr. 1 bis 17. 16mo. Göttingen.

Karl Ritter.


Imperial Academy of Sciences, Vienna.


Sitzungsberichte.


8vo pamph. Wien, 1850.

Das “Stiftungen-Buch” des Cistercienser-Klosters Zwetl. 8vo. Wien, 1851.

B. A. Gould, Jr., P. D.


Netherlands Government.

Flora Batava. Nos. 161, 162, 163, 164. 4to. Amsterdam.

Society of Sciences, Harlem.

Three hundred and fifty-third meeting.

December 2, 1851. —MONTHLY MEETING.

The President in the chair.

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 disproportionately 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. 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 Mathe-
matical 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 depart-
ments.'

"5. The number of Associate Fellows shall not exceed one hun-
dred, 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 ar-
ticle to nominate, on due consideration, at meetings convened for the
purpose, and as vacancies occur, the most suitable candidates for For-
ign 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 fol-
lowing 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 Fel-
lows and Members, arranged in the following divisions, with a state-
ment 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.
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 repellant 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 be-
tween 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 atmospheric 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 \( \text{Hg Sn}_3 \).

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.

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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.

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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. Boweditch, 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. Coronae, properly so called, belong to the fourth class. Halos and coronae 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 polarscope 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 $3^\circ$ and $12^\circ$ 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.

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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 ἄνθρωπος, 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 Dino-
therium 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 pre-
molar 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 Brit-
ish 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 occipi-
tal 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 be-
longs to the Mammalian order Pachydermata. This surface termi-
nates 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. australis 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 paleologicus, 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 Lucke, 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
OF ARTS AND SCIENCES.

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 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.
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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.

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"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 Violacea, 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 Violae, 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 Agatea will be deemed sufficiently different from Agathèa and Agati to be retained.

"AGATEA, Nov. Gen.

"Calyx 5-phyllus, subæqualis, basi haued productus, deciduus. Petala 5, erecta, inæqualia; postica lateralibus paullo minora; anticum majus, labelliforme, spatulatum, basi dilatatum gibboso-saccatum. Stamina 5, diadelpha, nempe; filamenta brevia, plana, antica (glandula carnosa aucta) et lateralia marginibus connata, posticum angustius distinctum: antheræ introrsum adnatae, loculis appositis apice liberis mucronatis; connectivo in appendicem petaloideam latam producto. Ovarium globosum; placentis parietalibus 3 plurirovulatis. Stylus apice clavatus,
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curvatus: stigma laterale. Fructus baccatus? — Frutex sarmentosus; foliis oblongis subintegerrimis ramisque glabris; stipulis minimis caducis; racemis paniculissve 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.


"Isodendrion pyrifolium: foliis membranaceis ovalibus seu ovato-ellipticis crenato-serratis petiolatis, junioribus subbus ramulisque pubescentibus; stipulis sepalisque isevibus; floribus pendulis. — Kaala Mountains, Oahu, Sandwich Islands.

"Isodendrion longifolium: glabrum; foliis subcoriaceis obovato-lanceolatis seu cuneato-oblongis in petiolum angustatis subrepandis; sepalis ovatis stipulisque laxevis; 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 Violareæ 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 Anonaceae from the Feejee Islands, dedicated to Mr. Rich, the official botanist of the Exploring Expedition, viz.:

"RICHELLA, Nov. Gen.


"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:

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<tr>
<th>Instrument</th>
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<tr>
<td>Achromatic telescope of 2 feet focus, magnifying 20 times,</td>
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<tr>
<td>Achromatic telescope of 3 feet focus, magnifying 28 times,</td>
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<td>Achromatic telescope of 4 feet focus, magnifying 40 times,</td>
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<tr>
<td>Gregorian reflector of 1 foot focus, magnifying 55 times,</td>
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<td>3 58 20</td>
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<tr>
<td>Gregorian reflector of 4 feet focus, magnifying 290 times,</td>
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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 Spenceri 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 Phillip 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 Quackett.

"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 arrange-
ments, 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 in-
dependent 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 achor-
matic condenser as to give light enough without heating it to any ex-
tent 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 adjust-
ment 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 advan-
tages over a carefully constructed one of the cheaper materials, which,
however, would do good service. I hope to have the opportuni-
ty 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 ap-
probation 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 hori-
zontal stage, unless various precautions are taken, which I shall not
here stop to indicate. I have found no practical difficulty in examin-
ing 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.

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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.
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