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OF

SCIENCE AND ARTS.

CONDUCTED BY

PROFESSORS B. SILLIMAN, B. SILLIMAN, JR.

AND

JAMES D. DANA.

AIDED

IN THE DEPARTMENTS OF CHEMISTRY AND PHYSICS

BY

DR. WOLCOTT GIBBS.

SECOND SERIES.

VOL. XIV.—NOVEMBER, 1852.

WITH FOUR PLATES AND A MAP.

NEW HAVEN:

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ERRATA.

P. 302, 15th line from top, for 6-*articulatum*, read 1–6-*articulatum*.
P. 305, last line, for 92, read 192.
P. 306, 5 lines from bottom, for iii, read viii.
P. 307, 14th line from top, after *thoracis* insert *feminæ*.
P. 308, 25th line from bottom, for *sex*, read 1*mi* 2*dique*.
P. 315, 9th line from top, for *nudo*, read *nullo*.

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THE

AMERICAN

JOURNAL OF SCIENCE AND ARTS.

[SECOND SERIES.]

Art. I.—*Nereis Boreali-Americana; or Contributions to a History of the Marine Algæ of North America;* by Wm. Henry Harvey, M.D., &c.—Part I. Melanospermeæ. Washington, Smithsonian Institution. New York: G. P. Putnam. Jan., 1852.

This is the first part of the work announced in our January number. It is a separate issue of a Memoir (of 150 pages, with 12 plates) contained in the forthcoming third volume of the *Smithsonian Contributions to Knowledge;* and a welcome contribution it is, as well in its purely scientific bearings, as on account of the popular interest of the subject; and under both aspects well deserving the efficient furtherance of this admirably managed institution, since the heavy outlay for the needful pictorial illustration would deter any unaided author or publisher.

Algæ are especially interesting to the structural anatomist and physiologist, from their consisting either of isolated cells or series of cells in their simplest combination, often of considerable size, and developed under circumstances very favorable to microscopic investigation; therefore affording the readiest elucidation of cell-formation, and of the most universal laws of growth and reproduction, the understanding of which forms the true ground-work of physiology, whether animal or vegetable. Studied less profoundly, and in view of their infinitely varied and beautiful forms and systematic arrangement, this class of plants has attracted more popular interest perhaps than any other, at least in Great Britain, where their study has been encouraged and facilitated by the various illustrated works which the Algæ particularly require. This general interest, first incited by Dr. Greville's *Algæ Britannicæ*, has been widely extended by Dr. Harvey's own Manual of the British Algæ, especially the second edition, and his elaborate *Phycologia Britannica.* The plates of the latter are excelled only by those of the present memoir, in which Professor Harvey is doing for our country what in those works he has accomplished for his own, and what in his *Nereis Australis* he is likewise doing for the counterpart regions of the southern hemisphere. As we welcome this accomplished naturalist as a fellow-laborer on our own ground, let us hope that this first is far indeed from being the last "Contribution to knowledge" from a transatlantic source to be called forth and published by the Smithsonian Institution. Such scientific intervention is productive only of good results.

The book now before us, in the form of a thin quarto volume, is only the first part of the work, comprising the *Melanospermeæ*, or olive-colored seaweeds, with the general introduction. Two more parts, still more ample, or at least embracing a greater variety of forms, are yet to come; namely, part 2d, the *Rhodospermeæ*, or Rose-red Algæ; and part 3d, the *Chlorospermeæ* or Grass-green Algæ. Both of these, and especially rose-red series, already in a state of forwardness, will furnish more striking illustrations than the present, for the olive-colored seaweeds are not remarkable for beauty. They are however, generally, the most conspicuous for size, and the most important in their economical uses.

In speaking of the uses of seaweeds, Prof. Harvey very properly alludes, first to the general office which this class of plants discharges in the economy of nature.

"The part committed to the Algæ in the household of nature, though humble when we regard them as the lowest organic members in that great family, is not only highly important to the general welfare of the organic world, but, indeed, indispensable. This we shall at once admit, when we reflect on the vast preponderance of the ocean over the land on the surface of the earth, and bear in mind that almost the whole submarine vegetation consists of Algæ. The number of species of marine plants which are not Algæ proper is extremely small. These on the American coast are limited to less than half a dozen, only one of which, the common *Eel Grass* (*Zostera marina*), is extensively dispersed.

"All other marine plants are referable to Algæ; the wide spread sea would therefore be nearly destitute of vegetable life were it not for their existence. Almost every shore—where shifting sands do not forbid their growth—is now clothed with a varied band of Algæ of the larger kinds; and microscopic species of these vegetables (*Diatomaceæ*) teem in countless myriads at depths of the ocean as great as the plummet has yet sounded, and where no other vegetable life exists. It is not, therefore, speaking too broadly to say that the sea, in every climate and at all known depths, is tenanted by these vegetables under one phase or other.

"The sea, too, teems with animal life,—that "great and wide sea, wherein are things creeping innumerable, both small and great beasts," affords scope to hordes of animals, from the "Leviathan" whale to the microscopic polype, transparent as the water in which he swims, and only seen by the light of the phosphoric gleam which he emits. Now this exuberant animal creation could not be maintained without a vegetable substructure. It is one of the laws of nature that animals shall feed on organized matter, and vegetables on unorganized. For the support of animal life, therefore, we require vegetables to change the mineral constituents of the surrounding media into suitable nutriment.

"In the sea this office of vegetation is almost exclusively committed to the Algæ, and we may judge of the completeness with which they execute their mission by the fecundity of the animal world which depends upon them. Not that I would assert that all, or nearly all, the marine animals are directly dependent on the Algæ for their food; for the reverse is notoriously the case. But in every class we find species which derive the whole or a part of their nourishment from the Algæ, and there are myriads of the lower in organization which do depend upon them altogether.

"Among the higher orders of Algæ feeders I may mention the Turtles, whose *green fat*, so prized by aldermanic palate, may possibly be colored by the unctuous green juices of the *Caulerpæ* on which they browse. But without further notice of those that directly depend on the Algæ, it is manifest that all must ultimately, though indirectly, depend on whatever agency in the first instance seizes on inorganic matter, and converts it into living substance suitable to enter into the composition of animal nerve and muscle. And this agency is assuredly the office of the vegetable kingdom, here confined in the main to Algæ; we thus sufficiently establish our position that the Algæ are indispensable to the continuance of organic life in the sea.

"As being the first vegetables that prey upon dead matter, and as affording directly or indirectly a pasture to all water animals, the Algæ are entitled to notice. Yet this is but one half of the task committed to them. Equally important is the influence which their growth exerts on the water and on the air. The well known fact that plants, whilst they fix carbon in an organized form in extending their bodies by the growth of cells, exhale oxygen gas in a free state, is true of the Algæ as of other vegetables. By this action they tend to keep pure the water in which they vegetate, and yield also a considerable portion of oxygen gas to the atmosphere. I have already stated that whenever land becomes flooded, or wherever an extensive surface of shallow water—whether fresh or salt—is exposed to the air, *Confervæ* and allied Algæ quickly multiply. Every pool, every stagnant ditch is soon filled with their green silken threads. These threads cannot grow without emitting oxygen. If you examine such a pool on a sunny day, you may trace the beads of oxygen on the submerged threads, or see the gas collect in bubbles where the threads present a dense mass. It is continually passing off into the air while the Confervæ vegetate, and this vegetation usually continues vigorous, one species succeeding another as it dies out, as long as the pool remains. And when, on the drying up of the land, the Confervæ die, their bodies, which are scarcely more than membranous skins filled with fluid, shrivel up, and are either carried away by the wind or form a papery film over the exposed surface of the ground. In neither case do they breed noxious airs by their decomposition. All their life long they have conferred a positive benefit on the atmosphere, and at their death they at least do no injury. The amount of benefit derived from each individual is indeed minute, but the aggregate is vast when we take into account the many extensive surfaces of water dispersed over the world, which are thus kept pure and made subservient to a healthy state of the atmosphere. It is not only vast, but it is worthy of Him who has appointed to even the meanest of His creatures something to do for the good of His creation."—pp. 31, 32.

For those who, unfortunately, cannot appreciate such views, who might reply that the present supply of oxygen in the air is quite sufficient to last out their time, or even that of the whole human race, and who would ask, "what is the *use* of feeding all these animals?" our author proceeds to enumerate some of the principal uses to which the Algæ have been applied by man, showing that many are directly edible and nourishing, and some prized as delicacies, while others furnish the pasturage of turtles, and are probably needful for the formation of their much prized green fat, the use of which, in feeding the aldermanic race of animals, our objector will probably appreciate. What a pity that the botanist must now leave the famous edible birds' nests out of his list of vegetable esculents, it being lately ascertained that this costly delicacy "consists of an animal substance which is supposed to be disgorged by the swallows that build them." The various other uses to which Algæ have been applied by man, whether civilized or savage, some of them curious, are mentioned at some considerable length.

Another part of the Introduction treats, in a clear and interesting way, of the general structure and morphology of Algæ, tracing the series of vegetable development from the simplest possible vegetable organism, formed of a single cell or vesicle, such as the Protococcus or red-snow plant, which in its growth, or reproduction (for these two functions are reduced to one and the same thing) merely gives rise to other free cells like itself; up to those of considerable complexity of organization and of large or even gigantic size; such as the *Devil's Apron*, *Oar-weeds* and *Murlins* of our own Atlantic shore, and the *Macrocystis*, with "stems from five to several hundred feet in length," the curious *Thalassiophyllum*, and the strange *Nereocystis* of our Northwest coast. The latter "is said, when fully grown, to have a stem measuring 300 feet in length, which bears at its summit a huge air-vessel, six or seven feet long, shaped like a great cask, and ending in a tuft of 40 or 50 forked leaves, each of which is from 30 to 40 feet in length. The cask-like air-vessel buoys up this immense frond, which, like Milton's hero, lies

Prone on the flood, extended long and large
(And) floating many a rood.—

Here the Sea Otter (*Lutra marina*) has his favorite lair, resting himself on the vesicle, or hiding among the leaves while he pursues his fishing."—p. 82. On page 86, a fuller account of this wonderful sea-weed is given, translated from the narrative of its discoverer, Dr. Mertens. We wish to call the particular attention of travellers, and of our fellow countrymen of Oregon, to this and to the Thalassiophyllum of the Northwest coast, because they are very imperfectly known; and whoever meets with them, or has occasion to visit the shores where they abound, would confer a great favor and advantage by collecting characteristic specimens of these and also of all other Algæ, immersing smaller specimens in proof spirit or Goadby's solution, and transmitting them to the Smithsonian Institution. These great air-vessels, it appears, cannot be preserved by drying, but probably they might be packed, with their leaves, in strong brine, so as to reach us in good condition.

This leads us to remark that clear directions for collecting and preserving specimens of sea-weeds are given in the Introduction, pp. 28–30. Their *habitat*, or place of growth, and their geographical distribution, especially on our Eastern coast, which Prof. Harvey has explored in person from Halifax to the keys of Florida, are presented with considerable fullness in the Introduction. All these topics are treated in the happiest manner, and so abound with interest that it is needless to indicate particular portions; for it can hardly be that any general reader, still less one with the smallest tincture of science, who opens the Introduction, will lay it down before he has finished it. Still we cannot deny ourselves the privilege of adverting to its appropriate close, in vindication of the moral influence of science, and of the teaching of the book of nature, from the aspersions of the ignorant and the prejudiced.

"Unfortunately, it happens that in the educational course prescribed to our divines, natural history has no place, for which reason many are ignorant of the important bearings which the book of Nature has upon the book of Revelation. They do not consider, apparently, that both are from God—both are His faithful witnesses to mankind. And if this be so, is it reasonable to suppose that either, without the other, can be fully understood? It is only necessary to glance at the absurd commentaries in reference to natural objects which are to be found in too many annotators of the Holy Scriptures, to be convinced of the benefit which the clergy would themselves derive from a more extended study of the works of creation. And to missionaries, especially, a minute familiarity with natural objects must be a powerful assistance in awakening the attention of the savage, who, after his manner, is a close observer, and likely to detect a fallacy in his teacher, should the latter attempt a practical illustration of his discourse without sufficient knowledge.* This subject is too important for casual discussion, and deserves the careful consideration of those in whose hands the education of the clergy rests. These are not days in which persons who ought to be our guides in matters of doctrine can afford to be behind the rest of the world in knowledge; nor can they safely sneer at the "knowledge that puffeth up," until, like the Apostle, they have sounded its depths and proved its shallowness.

"Why should the study of the physical sciences be supposed to have an evil influence on the mind—a tendency to lead men to doubt every truth which cannot be made the direct subject of analysis or experiment? I can conceive a one-sided scientific education having this tendency. If the mind be propelled altogether in one direction, and that direction lead exclusively to analytical research, it is possible that the other faculties of the individual may become clouded or enfeebled —and then he is the unresisting slave of analysis—not more a rational being than any other monomaniac. And yet, paradoxical though the assertion seem, he may be all his life a reasoner, forming deductions and inductions with the most rigid accuracy, in his beaten track.

"I can conceive too the astronomer, conversant with the immensity of space and its innumerable systems of worlds, so prostrated before the majesty of the material creation, as not only to lose sight of himself and of the whole race to which he belongs, but of the world or even of the solar system, and be led to doubt whether things so poor, and mean, and small can have any value in the sight of the Lord of so wide a dominion. I can conceive him, too, observing the uniformity and the harmony of the laws that govern the whole system of the heavens; the undeviating course of all events among the stars coming round as regularly as the shadow on the dial; and the little evidence there is that this uniformity has ever suffered any disturbance that cannot be accounted for by the law of gravitation, and made the subject of calculation by the mathematician, who, working an equation in his closet, shall come forth and declare the cause of irregularity, though that cause may be acting at thousands of millions of miles distance—I can conceive him inferring from a uniformity like this the absence of a superintending Providence in human affairs. If the Creator, he will say, have given up the very heaven of heavens to the immutable laws of gravitation, can I believe that he interferes by his Providence to superintend the puny matters of this lower world?

"His reasons seem plausible while the mind is pointed in that one direction. But they lose all their force when, laying aside for a moment the telescope, the philosopher investigates with his microscope the structure of any *living* thing, no matter how small and how seemingly simple the organism may be. Let the object examined but have *life*, and it will soon lead him to understand a little of the meaning of God's glorious title, *Maximus in minimis*. And the further he carries his researches, the more the field of research opens, until, extending from the speck beneath his lens, it spreads wider and wider, and at length blends with infinity at the "horizon's limit." Here his boasted

* See some excellent observations on this subject in "Foot-prints of the Creator: or, the Asterolepis of Stromness," by Hugh Miller. London, 1849.

analysis can afford him no help. He has laid bare the "mechanism of the heavens;" he has weighed the sun and the planets; he has foretold with unerring certainty events which shall happen a thousand years after he shall be laid in the dust;—and yet he cannot unravel the mystery that shrouds the seat of life, even as it exists in the meanest thing that crawls. And if the life of this poor worm be thus wonderful, what is that spirit which animates the human frame? What is that humanity which, but a moment ago, seemed like the small dust in the balance compared with the multitude and the masses of the stars? His conceptions of his own true position in the scale of being become more rational. For a moment he views from a new position the distant stars, as the peasant views them in a clear night:—points of light spangling the blue vault above. And he reflects, 'How do I *know* that those shining ones are other than they seem; how do I *know* their size, their distance, the laws by which they are governed; the reins by which the 'coursers of the sun' are held in their appointed track? How?—but by the intellectual powers of that human spirit which but now I deemed so poor and mean:—so unworthy of the very thought of the Almighty—much more so unworthy of the price which He has paid for it.'

"Thus the mind, turned back upon itself, begins to discover that, after all, it is not 'of the earth, earthy,' but derived from a higher source and reserved for a higher destiny. And strange to say, this altered and bettered opinion of itself is traceable to the first check which it feels—the first baffling of its analytical powers. So long as the mind was extending the sphere of its researches into the material universe, weighing, and numbering, and tabulating, all nature seemed to move in blind obedience to a force whose influence might be calculated; every world being found to act upon its fellow in exact proportion to its position and its weight, and *our* world to be but a part, and a small part of one vast machine. And with such a view of the relation of the earth to the universe, might not unnaturally come a lower estimate of man the dweller on the earth. 'Is he too but a part in the house in which he dwells? Is his course also subject to those immutable laws which bind the universe together? And if so, where is his individuality; where the reflex of that image in which he is said to have been created?' But the moment that the mind apprehends the action of the inexplicable laws of life, and is certified of the *individuality* of every living thing however small;—and compares these microscopic 'wholes' with the 'whole' that it feels itself to be, that moment it begins to see that the human soul is a something apart from the world in and over which it is placed."

* * * "Whilst I admit that half views of natural science may lead men astray; and whilst I deplore the infidelity of scientific men, whose minds are absorbed in the material on which they work;—I deny that the study of nature has, in itself, an evil tendency. On the contrary, the study of organic nature, at least ought to be one of the purest sources of intellectual pleasure. It places before us structures the most exquisite in form and delicate in material; the perfect works of Him who is Himself the sum of all perfections: and if our minds are properly balanced, we shall not rest satisfied with a mere knowledge and admiration of these wonderful and manifold works;

but, reading in them the evidence of *their* relation to their Maker, we shall be led on to investigate *our own.*

"I do not assert that this study is, of itself, sufficient to make men religious. But as the contemplation of any great work of art generally excites in us a two-fold admiration—admiration of the work itself, and of the genius of its author—so a true perception of the wonders of nature includes a certain worship of the author of those wonders. Yet we may study natural objects, and admire them, and devote our whole life to elucidate their structure; and after all may fail to recognize the being of Him who has fashioned them. Such blindness is scarcely conceivable to some minds; yet to others, the opposite appears but the effect of a warm imagination. So inexplicable is the human mind! The moral evidence which stirs one man to his centre brings no conviction to another. Physical truths, indeed, cannot be rationally denied; but there is no metaphysical truth which may not be plausibly obscured or explained away by self-satisfied prejudice. Hence the inconclusiveness of all reasoning against infidelity. The failure is not in the reasons set before the mind, but in the non-acknowledgment of the imperative force of moral reasons. No man can be convinced of any *moral* truth against his will; and if the will be corrupt, it is possessed of a blind and deaf spirit, which none can cast out until a 'stronger than he' shall come."—pp. 38–41.

It is to be noted that this is a complete treatise, comprising descriptions of all the species of this country, those of the western as well as of the eastern coast, and from the Arctic shores to Mexico; and that it is our only work on the subject. It is therefore indispensable to all who seek for any information on the subject. To meet, therefore, the demand which there should be for such a work, the Smithsonian Institution, which incurs the whole expense of the publication, has placed this separate issue of a moderate number of copies on sale, with the well known house of Geo. P. Putnam, New York, at a price which barely covers the cost of their production. Copies of this first part bound in cloth sell, we believe, for \$3, those in paper covers for \$2.50. We trust it will find a ready sale, not only that so admirable work may be widely diffused, but also that the Institution may be encouraged by this first and costly experiment to send forth other treatises and memoirs in the same way, the cost and risk of which is too great for private enterprise to assume. Our only wonder is that the Institution can accomplish so much as it does with its limited and divided resources. But even if its means were much more ample than they are, it is evident that unless it can recover by the sale of separate copies a portion at least of the bare expense of producing them (and especially the expense of striking and coloring plates), such separate copies must cease to be issued in a way that renders them generally accessible, and the edition be nearly restricted to the collected volumes of the *Smithsonian Contributions.* We hope, therefore, that the demand for this History of the Marine Algæ of North America may be commensurate with its merits. A. G.

ART. II.—*On Kirkwood's Analogy;* by J. BRADFORD CHERRIMAN, M.A., Fellow of St. John's Coll., Cambridge, Eng., and Dep. Prof. of Math. and Nat. Phil. in the University of Toronto, U. C.

IN support of the remarks of Prof. Loomis in the American Journal, March, 1851, I beg to offer the following considerations.

The statement of Kirkwood's Analogy is that throughout the Planetary system,

$$n^2 = k \,.\, D^3$$

where n is the ratio of the sidereal period of a planet to its time of rotation about its axis,

D is the diameter of its sphere of attraction,

k is a numerical constant.

It may be observed that this law is not universal, being inapplicable in the case of the outermost planet (Neptune, so far as we know) and also of the Sun regarded as the innermost planet; in the former case, k being made to vanish by D becoming infinitely great; in the latter, by n vanishing. This failure of continuity would entitle us to reject it as a *Law of Nature:* whether it be a *physical fact*, must be examined in detail.

The Analogy breaks, as it ought to do, between Jupiter and Mars, where the asteroids occur, and this deprives us of the means of applying it in the cases of those two planets. The hypothesis of supplying a planet between them does not remove the indeterminateness; for by so doing, we introduce *three* arbitrary quantities, namely, the mass, mean distance, and time of rotation of the supposed planet, and can thus satisfy *any three* required results; in other words, we are able to make Mars, Jupiter, and the supposed planet satisfy *any formula whatever* connecting the quantities, n, k, D.

On applying the Analogy to Mercury, regarding the Sun as the next interior planet, it fails; and if we seek to remedy this by interposing a planet, it remains indeterminate as in the previous case.

On applying it to Uranus, we get a result which is confessedly contradictory to the approximate time of rotation, calculated from the observed compression. The theory of this calculation gives results in accordance with observation in the case of other planets, and there seems to be no reason why we should distrust it in this case. Moreover, the rotation thus given bears on the face of it a trustworthy look, as Prof. Loomis has most ably and strikingly pointed out in the article above quoted. At any rate, the most we can do is to consider the time of rotation unknown, and the *Analogy* in this case also to be indeterminate.

Thus out of the *ten* primary bodies (counting the Asteroids as one) there are no less than *seven*, in which the Analogy is either indeterminate or fails: and we have only *three* left, Venus, the Earth, and Saturn, from which to obtain *two* coincidences that shall establish a law universal in its claims.

The following values are those given in the *Annuaire du Bureau des Longitudes*, for 1851, being the latest authoritative table of whose publication I am aware.

Planet.	Sidereal period in mean solar days.	Mean distance.	Mass in parts of the Sun's.	Rotation.
Mercury,		0·3870985	$\frac{1}{2025810}$	
Venus,	224·70080	0·7233317	$\frac{1}{401847}$	$23^h\ 21^m$
Earth,	365·25637	1·0000000	$\frac{1}{354936}$	$23^h\ 56^m$
Mars,		1·523691	$\frac{1}{2680337}$	
Jupiter,		5·202767	$\frac{1}{1050}$	
Saturn,	10759·2198	9·538850	$\frac{1}{3509}$	$10^h\ 30^m$
Uranus,		19·1824	$\frac{1}{24000}$	

From these I deduce the following table—

Planet.	n	D	k
Venus,	230·9558	·3666685	1082025·
Earth,	366·2738	·5265920	918732·
Saturn,	24592·50	8·513061	980276·

The values of k do not, I think, agree with sufficient nearness to establish the Analogy: in fact, the difference betwen the values for the Earth and Venus would cause an error of two hours in the rotation of the latter.

Lastly, suppose that a change in density and volume of one of the planets were to take place; then, since the mass and mean distance are unaltered, D remains the same; and since the sidereal period is not affected, it would follow, if the analogy were true, that the time of rotation would remain unchanged, which is contrary to the mechanical principle of the conservation of areas.

From these reasons I feel compelled to reject Kirkwood's Analogy as "the expression of a law of nature," and must agree with Prof. Loomis in considering it *not* established as a "physical fact."

University of Toronto, U. C., April 10, 1852.

Art. III.—*Notes and Observations on the Analyses and Characters of the Soil of the Scioto Valley, Ohio, with some general considerations respecting the subject of Soil Analyses;* by David A. Wells, Cambridge, Mass.

In the spring of 1851, I was intrusted by the Secretary of the Ohio State Board of Agriculture, Prof. W. W. Mather, with the office of examining, analyzing and reporting upon the nature and composition of the soils of that State, and under his direction have since made a series of analyses of soils taken from Pike county, Scioto Valley. A few of these analyses are here submitted for the purpose of showing the composition of these fertile soils, as well as to some extent, the method followed in their examination.

The soil which I would first notice, was taken from the best bottom-land, opposite the mouth of Sun-fish Creek, about one hundred yards east of the Scioto. This ground is occasionally overflowed, and has been cleared and cultivated about eighteen years successively in corn, and yields with ordinary culture from seventy to eighty bushels of corn to the acre. The average crop has not sensibly diminished since it was first cleared. The timber growth originally upon this ground, was honey-locust, black-walnut, pawpaw, box-elder, white-ash, elm, mulberry and buckeye.

The color of this soil when dry, was dark brown, or black, of an extraordinary degree of fineness. Sample examined, entirely free from stones or pebbles. The character of this soil for the absorption and retention of moisture was carefully noted, but as the results obtained seem to me to have mainly a comparative value, they are here omitted.

The chemical analysis gave as follows.

Water, hygrometric and combined, . . .		03·636
Waxy and resinous matters extracted by alcohol,	·0030	
" " " " " " ether,	·0025	
Total extract, ...	·0055	
Total per-centage, ...		00·0164
Constituents soluble in pure water.		
Extract of earth, alkaline chlorids, with traces of lime,	·0460	
Organic matter—crenic acid, . . .	·0208	
Silica, iron, lime, with traces of sulphuric acid,	·0652	
Total water extract, ...	·1320	
Total per-centage, ...		00·395

Constituents soluble in dilute acid.

Iron, alumina with traces of manganese, .	01·995	
Organic matter in combination with the above,	01·004	
Silica, ...	00·640	
Phosphoric acid, . . .	00·041	
Potash and soda, ...	00·100	
Lime, ...	01·026	
Magnesia, ...	00·236	
Total per-centage of constituents soluble in dilute acid,		5·042
Organic matter rendered soluble by ammonia,		01·840
" " " " " soda,		04·368
Organic matter remaining in combination with the insoluble residue, and determined by ignition,		04·145
Whole amount of organic matter found in the soil, as extracted by water, acids and alkalies, and also determined by ignition from the final residue,		11·373
Whole amount of organic matter determined in another equal portion of the same soil by ignition, .		10·970
Difference, ...		00·403
Insoluble silicates and earthy residue, . .		78·842
One hundred parts of the insoluble residue gave by washing and separation, 45 parts siliceous sand, and 55 clayey matter.		
Total per-centage, of the whole analysis, . .		98·2844

Another soil examined was from the "Ree Ree Bottom," a tract of land occasionally overflowed by the Scioto River. It has been cultivated fifty-one years; forty-five crops of corn and two or three of wheat have been taken off from it; it has also been a few years in grass or clover. It has scarcely diminished fertility and now with the most ordinary culture yields on an average, one year with another, eighty bushels of corn to the acre.

The analysis of this soil gave—

Water, hygroscopic and combined, . .		3·500
Resinous and waxy matters extracted by alcohol and ether, ...		·036
Constituents soluble in pure water.		
Extract of earth, alkaline chlorids, &c. .	·032	
Organic matter—crenic acid, . .	·010	
Iron, lime and silica, ...	·012	
Total water extract, ...	·054	
Total per-centage of the same, . . .		0·190
Constituents soluble in dilute acid.		
Iron, alumina and manganese, ...		2·760
Organic matter combined with the above, .		0·860
Silica, ...		0·560
Lime, ...		0·390

Magnesia,	0·280	
Phosphoric acid,	*traces.*	
Potash and soda,	0·161	
Total acid extract,	5·011	
Organic matter rendered soluble by ammonia,		3·140
" " " " " soda,		1·030
Organic matter remaining in combination with the insoluble residue, and determined by ignition,		1·720
Insoluble silicates,		83·010
100 parts of the insoluble residue gave by washing and separation 59 parts siliceous, and 41 parts clayey matter.		
Total amount of organic matter extracted by alkalies and acids,		6·750
Total per-centage of the whole analysis,		97·637

In the separation of the organic constituents of a soil by means of alkalies, a slight loss is almost unavoidable, owing to the separation and solution of a part of the alumina and other inorganic substances in combination with the organic matter, forming salts.

The third analysis which I present, is that of a subsoil, underlying the fertile loam of the Ree Ree Bottoms. This bottom was originally prairie, at the first settlement of the country. The soil in color is yellow, and in character, coarser than any other variety examined from the Scioto valley.

Chemical analysis gave as follows:

Water, hygroscopic and combined,	00·44	
No appreciable matter extracted by either alcohol, or ether.		
Constituents soluble in pure water.		
Alkaline chlorids,	·0070	
Organic matter, with traces of silica and lime,	·0055	
Total water extract,	·0125	
Total per-centage,		00·057
Constituents soluble in dilute acid.		
Iron, alumina and manganese,		02·000
Organic matter, combined with the above,		00·440
Silica,		00·200
Lime,		02·550
Magnesia,		01·280
Phosphoric acid and alkalies,		*traces.*
Total per-centage of constituents soluble in acid,		6·470
Carbonic acid,		02·300
Organic matter rendered soluble by ammonia,		00·42
" " " " " soda,		00·05
Organic matter remaining in combination with the insoluble residue, and determined by ignition,		00·50
Insoluble silicates, &c.,		90·270
Total per-centage of the analysis,		100·507

In the examination and analysis of these soils of the Scioto Valley, several points of interest were noted by me, which I consider worthy of especial attention. Their reputation for fertility is extensively known, as well as their general character and chemical composition, but I am not aware that any extended and thorough examination of a suite of specimens, from known localities, has heretofore been made by any chemist.

The first and perhaps the most interesting fact noticed in the examination of these soils was the remarkable degree of fineness of their constituent particles. In this respect I venture to assert that they are not surpassed by any other alluvial deposits upon the surface of the earth, some of the soils being little else than impalpable powders. In commencing their examination, it was at once seen, that a mechanical division of these soils by means of the sieves ordinarily used in soil analyses, would not afford a fair indication of the minuteness of their particles. I therefore procured a sieve of the finest gauze, the largest meshes of which by accurate measurement did not exceed one-sixtieth of an inch in diameter. The soil was then broken in a porcelain mortar, care being taken that only the dried particles were crushed, without triturating any of the silicates or earthy matter. One hundred parts of six samples so treated, were sifted upon the sieve before described, and left the following small quantities of coarse residue; of this residue, it should be stated, that it was composed in part of vegetable fibres and undecomposed organic matter. Of soil No. 1, seven parts in one hundred remained upon the sieve; of No. 2, one and six-tenths parts; of No. 3, a subsoil, from twenty to thirty parts; of No. 4, six and three-tenths; of No. 5, one and five-tenths; of No. 6, eight parts in one hundred.

This remarkable comminution of the particles of these soils, gives us at once a clue to the secret of their great fertility. With this fineness an increased power is given to a soil for the absorption, retention and condensation of moisture, carbonic acid, and ammonia, an opportunity for the free permeation of atmospheric air, a facility to the rootlets of plants for extension, and a consequently increased facility for receiving and appropriating nourishment. Indeed, a soil but scantily provided with the inorganic constituents deemed necessary for the support of vegetable life, but gifted with this fineness of the elementary particles, must possess great elements of fertility. I consider the existence of a large proportion of finely divided matter in a soil, of almost as much consequence so far as regards its fertility, as its chemical constitution is. It must be also evident, that a soil composed in great part of siliceous matter (as many of the fertile western soils are), may, if the particles possess sufficient fineness, assume to a considerable extent the good properties and characteristics of an aluminous soil, without its bad ones. As an illustration of this I would state, that one of the best tobacco soils upon the Island of Cuba, some time since examined by Dr. A. A. Hayes of Boston, was found to contain ninety per cent. of the peroxyd of iron. And yet this soil, which we might suppose would be barren, without the usual proportions of siliceous and aluminous matter, is, on account of its great fineness, and the remaining ten per cent. of organic and inorganic constituents, enabled to produce the best crops upon the island.

These advantages of fineness, it is evident the Ohio soils will always possess, as it cannot be exhausted by any system of agriculture. To this point I wish to call especial attention, since if due regard be paid to the supplying of these soils with the necessary quantities of organic and inorganic nutriment, they must and always will be unrivalled for fertility. An examination of the silicious insoluble constituents of these soils, leads to the belief, that they have not been derived from the disintegration, or decay of any underlying or contiguous rocks, but from materials brought from a distance. The rocks of Ohio are for the most part carbonate of lime, and yet in only one of the soils examined, a subsoil, could the slightest trace of carbonic acid be detected. The method adopted for testing, was by placing the soil in a favorable light upon a watch-glass, covering with dilute warm acid, and noticing carefully for the appearance of effervescence. In this way the most minute quantity of carbonic acid could not fail of being detected. In the examination of the soils of Massachusetts by Pres. Hitchcock, the same remarkable deficiency of carbonates, even in soils resting upon carbonate of lime rocks, was noticed. The same conclusions have, I understand, been arrived at by Dr. D. D. Owen, from an examination of the soils of Iowa and Wisconsin. From these facts we believe that the alkaline and earthy carbonates are to a much greater extent wanting in arable soils than is generally supposed. This supposition, however, should perhaps be confined to the northern portions of this country, which have soils resulting mainly from materials distributed by the drift agency.

When a soil containing considerable quantities of organic matter is tested for carbonates after ignition, they will generally be found, the crenates and apocrenates passing over into carbonates, and remaining fixed except at a high temperature.

A microscopic examination of the siliceous insoluble residues of these soils, left after the extraction of all soluble organic and inorganic substances, showed that they are composed of the detritus of syenitic and porphyritic rocks, consisting of minute particles of quartz, feldspar and yellow jasper without the presence of mica. I would not, however, present these facts as wholly conclusive respecting the origin of these soils; the quartz, jasper and feldspar may have had their immediate origin in the Waverly and other sandstones of Ohio, and the carbonates may have disappeared by the action of vegetation and long continued washing and filtration. But the impression left after a careful examination of their constituents was, that the soils of this portion of Ohio, have had an origin similar to that of other soils which are known to have resulted from drift agency, and possess at present a character, different from what might have been expected had they resulted from the decomposition of underlying or contiguous rocks.

The quantity of organic matter in these soils, is generally large, ranging from two to eleven per cent. in the specimens examined. It should be stated that the estimation of this organic matter was made upon the finest portion of the soil after sifting, and in this there is not included the smallest portion of undecomposed vegetable fibre, which is not unfrequently included in the organic per-centage of other analyses. The amount of nitrogenous compounds contained in this organic matter is undoubtedly large, although not determined; the peculiar odor of these products while burning being very appreciable.

Particular attention was given to the accurate determination of the amount of waxy and resinous matters contained in these soils, and although it may not be possible to say that they enter unaltered and directly into vegetable systems, yet we know that as constituents of vegetables they re-enter to form fats in the systems of animals, I can, therefore, but consider a soil analysis, into which their careful determination is not included, as essentially deficient. In the statement of the analyses, the products extracted by alcohol and ether are given separately. At present I am not prepared to say, that bodies of a different constitution are extracted by these different solvents. There are, however, reasons which induce me to believe this is really the case, and also that the products so extracted are not mere resins and gums, as is generally supposed, but vegetable fat acids. This important point which a want of time has compelled me in great measure to overlook, will form the subject of future investigations. I would also say that this matter has engaged the attention of Dr. A. A. Hayes, of Boston, who fully coincides with me in the opinions expressed.

Among the constituents of these soils soluble in water, were found soluble organic matter (to which Berzelius has applied the term "extract of earth, or mould," and Dr. Dana of Lowell, "solution of vegetable extract,") alkaline chlorids, lime, magnesia, iron, silica, and organic matter combined with these bases. The presence of the first three of these bodies was to be expected; but the solution of the last three in water, in the absence of a mineral acid, and that too in considerable quantities, is, it seems to me, especially worthy of notice. An explanation must be sought for in the presence of organic matter, crenic, or apocrenic acid. In the later published works of Mulder, a salt of $C_{48}H_{12}O_{24}$ (apocrenic acid) $+NH_4+KO+CaO+MgO+FeO$, is given as soluble in water. It is not improbable that the extractive matter noticed, may have possessed this constitution. In all the soils examined, appreciable quantities of alkalies and phosphoric acid existed.

In these analyses, for the first time, has the amount of organic matter combined with the iron and alumina been carefully estimated by itself. This organic matter is undoubtedly combined with the above mentioned bases as an acid, and as such may have an important bearing upon the fertility of a soil. In some of the New England soils, this acid has been ascertained by Dr. Hayes of Boston to be oxalic acid, and such localities as might be expected, were adapted to the growth of sorrels and other acid plants. I have tested the soils examined by me from Ohio carefully for oxalates, but have not been able to detect them. What other acid may be present I am unable to say: the subject in this connection is new and requires careful investigation.

Manganese was present in all the soils examined. Its quantitative determination, unless present in large quantities, as well as the separate estimation of the amount of iron, and the amount of alumina, soluble in acid, I consider of little or no value in a soil analyses. Manganese appears to be a constituent in small quantities in almost all soils, and in the waters of lakes, ponds, and rivers, and must undoubtedly rank among the elementary bodies most widely distributed.

In the analyses of these soils, the separation, and estimation of the comparative value of the organic constituents has been made by means of alkalies. This plan seems to possess advantages over that of any other. A given portion of the soil, after washing with water and dilute acid, is digested with a small quantity of caustic ammonia. The organic matter rendered soluble is washed out, precipitated by an acid, dried at 250° F., and weighed. This determination it is considered shows at once the *present value* of the organic portion of the soil—in other words, how much organic matter is so far decomposed, or changed, as to be available for the present crop. The soil after digesting with ammonia and washing, is next treated with a stronger alkali, caustic soda, and the organic matter rendered soluble by this agent is collected and determined as before. This estimation, it is conceived, shows the amount of organic matter existing in a state not so sufficiently decomposed, or changed as to be immediately available for the use or nourishment of plants, but in a state preparatory for such use, or nourishment, and which at no distant period will become available. Thus if we were to represent the organic matter rendered soluble by ammonia as in the state of crenic acid, ready to be dissolved in water, or by the aid of weak alkalies, we might consider the organic matter rendered soluble by soda, as in a state of apocrenic or humic acid, insoluble in water or weak alkalies. Lastly, it is found that after digesting a soil even with strong alkalies, and after repeated washings with acids and water, a considerable quantity of organic matter will remain fixed, and completely insoluble. This portion of organic matter, generally the largest in a soil, is considered to be in a state allied to charcoal, or more properly lignite, valuable in many respects, as an absorbent of moisture, etc., but taking no active part in the production and sustinence of the plant. In ordinary soil analyses, the amount of organic matter, in these three conditions is determined as a whole, and without distinction, thus giving the agriculturalist no opportunity of judging whether this portion of his soil is in a condition resembling a peat bog, or in a state conducive to fertility.

There is one other subject connected with these analyses, which I consider of the highest importance, and to which I would direct especial attention. Dr. Dana of Lowell, in the course of many years experience, has collected and preserved the results of more than four hundred analyses of soils, from the northern portion of this country. The analyses of the soils I have made from Ohio, and the analysis of all the soils resulting from the drift agency, do not differ *materially*, so far as regards their inorganic constituents. That is to say, the soils of Ohio, yielding with little or no culture from seventy to eighty bushels of corn to the acre, are no better so far as their mineral composition is concerned, than many of the Massachusetts soils which have a reputation for sterility. Slight differences it is true, exist, but not to such an extent as might be supposed from contrasting their relative products of the different soils. In what then is there a reason for their difference in value to be found? It cannot be in the attributes in which they agree—which are their mineral constituents, but in the attributes in which they differ; and these are the amount and condition of the organic matter contained in the soils, and the fineness of their elementary particles.

These conclusions, if of any value, may show to the agriculturalists of New England, the necessity for the thorough breaking and pulverizing of the earthy particles, and for the preservation, preparation, and proper application of organic manures, the produce of the farm-yard and the muck-beds. These suggestions are not new; they are the results of the experience of ages, and of the observations and experiments of every practical farmer. The agricultural tendency of the present day is toward mineral manures;—I would not undervalue them, but at the same time I wish that the old notions respecting thorough tillage, and the value of barn-yard products, notions, the value of which experience has taught, and which all scientific investigations are now confirming, may not be underrated, or undervalued.

There is another topic in this connection to which I may be permitted to allude, as it deeply concerns the prosperity of scientific agriculture in this country—and that is, the tariff of prices paid for soil analyses. My own opinion, and the opinion of of others who are most conversant with this subject is, that a complete and thorough soil analysis cannot be made with any profit to the analyst for a less sum than twenty dollars. Yet the usual price charged is about one-fourth this sum, and in a comparatively recent instance, the editor of an agricultural paper in one of the northern states, has publicly offered to make complete and thorough soil analyses for the sum of two dollars. Such a proposition should stamp its author at once as a charlatan and a quack. It is time that this subject was rightly understood by the agricultural community, as it is not improbable that much of the ill-success and ridicule which has attended the application of science in this direction, is owing to analyses and other similar investigations which have been made and *fully paid for* according to the above mentioned rates. My excuse for introducing this subject, will I trust be found in its importance.

Art. IV.—*On the Chemical Principles involved in the Manufactures of the Great Exhibition;* by Lyon Playfair, C.B., F.R.S.*

The industrial products of the different countries represented at the Exhibition showed, as a marked feature of ascending civilization, that civilized states differ from barbarous nations in their manner of employing natural forces as aids to production. In the less advanced state, human labor, often exhibited with an endurance and patience scarcely conceivable to Europeans, attained good results, though not superior to those produced by European methods involving quick execution with little manual labor. I might refer you, as an example, to the fine blue glazed tobes worn by the higher class of Africans. This cloth, dyed with indigo, receives its gloss by the laborious process of rubbing with the shell of a snail as hard as the force of the wrist can bear. About fifty years since, our handloom weavers used a round bottle for a similar purpose, but now our calenderers give, in the same time, to miles of cloth a gloss superior to that produced by

* From the Lectures on the results of the Exhibition, delivered before the Society of Arts, Manufactures and Commerce, at the suggestion of H. R. H. Prince Albert, President of the Society.

this infinitely laborious process to a few inches of the material. It would appear that the less civilized nations attain a high degree of excellence in manufactures when they depend on mere ingenuity and labor, as in the muslins of Dacca and Chunderee, and do not involve an intimate acquaintance with natural forces. So far as regards beauty of design and the harmony of colors, European nations had little to teach, but much to learn. The rude pottery of Tunis was more elegant in form than the common pottery of modern Europe. The shawls and carpets of India, both as to design and harmony of coloring, were unequalled. So long as the manufactures involved human labor and a perception of beauty as their principal elements, the less civilized states equalled, and often excelled the productions of Europe. But when economy of time and of labor, or an enlightened comprehension of a natural force, became essential conditions, then the striking progress of European manufactures was manifested.

The progress of civilization, with its necessary increase of human wants, compelled man to invent means for their gratification. The study of natural forces then became necessary, because their employment not only added much to his power, but also materially economized his time. The cleansing of the Augean stables by manual labor was impossible even to the enduring powers of Hercules; but by the use of a natural force, in the form of the waters of the Alpheus, the work was speedily and effectually accomplished.

The position of nations in the scale of civilization depends upon their greater or less acquaintance with, and employment of, natural forces. All nations have a conception of their use, but their relative success arises from their applying them to the best advantage and under the most favorable circumstances. In the attempt to storm the fort of Arcot, the Rajah drove before him numerous elephants, armed with iron plates, in the hope that the gates would yield to these living battering-rams. But the gallant Clive met this ill-applied, by a well-applied, force. The eighth of an ounce of gunpowder, propelling an ounce of lead from an iron tube, was sufficient to alter the direction of this misused force, and to cause the huge beasts to turn and trample upon the army using them as allies.

Mechanics being a deductive science, and naturally growing from the observation of common phenomena, afforded powers which man availed himself of in an early state. The separate action of two mechanical forces being known, the result of their combined action can be predicated. But in chemistry it is very different. Two bodies, such as muriatic acid gas and ammoniacal gas being brought together, no previous reasoning could tell us that from these two gases a solid would be produced; and nothing inherent in themselves could enable us to say, that the acid character of the one and the alkaline character of the other would wholly disappear in the resultant. Chemistry, therefore, in its present state, as Mills has shown, is not so much a *deductive* as an *experimental* science. Before it could be applied to the purposes of Industry, its experience had to accumulate, and its teachings to be appreciated and systematized. This accumulation of experience has been going on from the time of Tubal-Cain until now, and every day, in adding new facts to the stores, materially augments its powers. It is not, therefore, surprising that it is one of the last of the sciences which, as a branch of systematized knowledge, has offered its services to man; yet, during its short existence as a separate science, it has increased human resources and enjoyments to a greater degree than any of its elder sisters. If I can show you this by proofs derived from the Exhibition, it will naturally follow, that the study of Chemistry is essential to those engaged in manufacturing industry.

The wants of civilization and the effects of competition require the effective application of increased power, both with regard to economy of labor and of time; and, in the gratification of these wants, there is a constant aim to render objects apparently of little value useful and productive. These, the benefits conferred upon industry by mechanical science, as shown by Babbage and others, are also afforded still more strikingly by her younger sister, Chemistry. Examining the various applications of Chemical Science to manufactures, they naturally divide themselves into the following three heads, which I therefore adopt as the basis of my Lecture.

1. Chemical appliances which have added to human power, either by furnishing substitutes for mechanical contrivances, or by affording tools and methods of arriving at results formerly impossible.

2. Methods of producing economy of time, generally resulting from a constant tendency to simplification.

3. Methods of utilizing products apparently worthless, or of endowing bodies with properties which render them of increased value to industry.

When a manufacture is already established, the results of competition not only compel an increasing attention to the economy of power or of time, but also require an increase of the industrial value of the article offered for competition. He that can replace an expensive mechanical power by a cheap chemical process, or can economize production by the happy adaptation of natural forces, must possess advantages over his less skillful competitors. Vulcan produced his works more economically than the mere mortal blacksmiths of his time, by availing himself of the fires of Mount Etna for his forges. The possibility to do what previously could not be done generally effects a moral as well as a physical result. The communication of a new power often occasions great social changes. It has been justly said, that the discovery of the Greek fire projected from the walls of Constantinople "saved Europe from desolation by the Saracens;" and it is equally true, that the personal animosity of warriors and the hostile spirit of nations have been much subdued by the new system of tactics introduced when a German monk, in deflagrating a mixture of sulphur, nitre, and charcoal, discovered gunpowder. Morality was improved and crime lessened, when the brilliant lighting of our streets by the introduction of gas made every passer-by a detective policeman; just as the cares, anxieties, and expenses of a government, will be diminished by a fuller development of the electric telegraph.

In addition to the direct communication of power, the increased economy of time resulting from chemical appliances is of immense importance in manufactures. This sometimes follows the discovery of new bodies endowed with peculiar properties, but it far more commonly arises from the reduction of a complex to a simple process. It is with chemistry as with mechanics; the progress of discovery is in the direction of simplification. The simplification of complex processes is the economy of labor, the husbanding of wealth. Industry, in its progress, continually finds more ready means of cultivating and reaping fields long in its possession. You all recollect the story of poor Ho-ti and the pig, told with such delightful vivacity by Charles Lamb. When Ho-ti's house, containing a litter of young pigs, was burned to the ground, it was natural that he should discover the delicate taste of roasted pig; and it was equally natural, as a consequence of this discovery, that the inhabitants of Pekin should introduce pigs into their houses, and burn them down, when they desired to participate in a dish so savory: but it was a great discovery when an ingenious person found that a common fire would do equally well, and that it was not absolutely necessary to burn down a house every time a pig had to be dressed. "By such slow degrees," concludes the Chinese History, "do the most useful and seemingly the most obvious arts make their way among mankind." The moral of this well-known story is of every day occurrence in the chemistry of the arts. Not a year passes without the most mature processes of manufacture being further simplified and economized. It is with industry as with nature; many of the lower animals have a repetition of organs, destined for the performance of similar functions exercised by single organs in the higher animals. Various stomachs and several eyes in the lower creatures are not more effective than one stomach and two eyes in man. The law of repetition of organs is like the complex processes of manufactures, represented by fewer but more perfect methods as civilization ascends. Argus, with his hundred eyes, was not nearly such a practical man as a Cyclops with one eye; the hundred eyes of Argus were found napping when work had to be performed, but with the one eye of the Cyclops the trident was forged which assured to Neptune the empire of the sea. The industrial position of England has been gained by her perception of this truth, and by her constant endeavors to replace complex processes of manufacture by means more simple and perfect.

The third division, into which I have divided chemical appliances to industry, is one peculiarly characteristic of advancing civilization. European nations, as they increase in wants, examine every material, to see if it be adapted to their ministration; they do not, like the African Dokos, bury their heads in the ground, and shaking their legs in the air, thank the Supreme Being that they are content with snakes, ants, and mice, for their food. Using their heads for sublimer purposes, they observe and investigate the phenomena and properties of each body, so as to ascertain how far it may be made subservient to their desires. In these investigations chemistry offers vital aid: she like a prudent housewife, economizes every scrap. The horseshoe nails, dropped in the streets during the daily traffic, are carefully collected by her, and reappear in the form of swords and guns. The clippings of the travelling tinker are mixed with the parings of horses' hoofs from the smithy, or the cast-off woolen garments of the poorest inhabitants of a sister isle, and soon afterwards, in the form of dyes of brightest blue, grace the dress of courtly dames. The main ingredient of the ink with which I now write was possibly once part of the broken hoop of an old beer-barrel. The bones of dead animals yield the chief constituent of lucifer matches. The dregs of port-wine, carefully rejected by the port-wine drinker in decanting his favorite beverage, are taken by him in the morning in the form of Seidlitz powders, to remove the effects of his debauch. The offal of the streets and the washings of coal-gas reappear carefully preserved in the lady's smelling-bottle, or are used by her to flavor blancmanges for her friends. This economy of the Chemistry of Art is only in imitation of what we observe in the Chemistry of Nature. Animals live and die; their dead bodies, passing into putridity, escape into the atmosphere, whence plants again mould them into forms of organic life; and these plants, actually consisting of a past generation of ancestors, form our present food.

The objects of the Exhibition were divided into—1. Their raw materials; 2. The machinery used in their preparation; 3. The manufactures themselves; 4. The fine art employed to adorn them. I would that I had time to take even a general chemical survey of these four divisions, and show you how everywhere chemistry is affording her aid; but as this is impossible, I must content myself with isolated examples from the manufacturing department only, adducing them, however, merely as indications of the universal presence of the science.

Iron Smelting.—Let us select the smelting of iron* as an example of the teachings of Chemistry. If practice, unaided by science, be sufficient for the prosecution of manufactures, this venerable art must be thoroughly matured, and science could scarcely expect to be of much use to it in its present state. But while we find much to admire in the triumphs of practical experience, there is yet great room for the improvement of this art. The cheapness of iron ore, and of the coal used in its smelting, has been so great, that, regardless of their capital importance to this country, we, like careless spendthrifts, use them without thought of the future.

The mode of smelting iron consists in mixing the ore with lime and coal, the former producing a slag or glass with the impurities of the ore, while the coal reduces the oxyd of iron to its metallic state. Much heat is required in the process of smelting, but the cold air blown in, as the blast, lowers the temperature, and compels the addition of fuel, as a compensation for this reduction. Science pointed to this loss, and now the air is heated before being introduced to the furnace. The quantity of coal is wonderfully economized by this application of science; for instead of seven tons of coal per ton of iron, three tons now suffice, and the amount produced in the same time is increased nearly sixty per cent. Assuredly this was a great step in advance. Could science do more?

Professor Bünsen, in an inquiry in which I was glad to afford him aid, has shown that she can. We examined the furnaces, in each portion of the burning mass, so as fully to expose the operations in every part of the blazing structure. This seemingly impossible dissection was accomplished by the simplest means; the furnaces are charged from the top, and the materials gradually descend to the bottom; with the upper charge a long graduated tube was allowed to descend, and the gases streaming from ascertained depths were collected and analyzed. Their composition betrayed with perfect accuracy the nature of the actions at each portion of the furnace, and the astonishing fact was elicited, that, in spite of the saving produced by the introduction of the hot blast, no less than 81½ per cent. of fuel is actually lost, only 18½ per cent. being realized. If, in round num-

* Although the smelting of iron is not strictly within the division of manufactures, according to the classification, its importance to this country will authorize an exception in its favor.

bers, we suppose that four-fifths of the fuel be thus wasted, no less than 5,400,000 tons are every year thrown uselessly into the atmosphere, this being nearly one-seventh of the whole coal annually raised in the United Kingdom. This enormous amount of fuel escapes in the form of combustible gases, capable of being collected and economized; yet in spite of these well ascertained facts, there are scarcely half a dozen furnaces in the United Kingdom where this economy is realized by the utilization of the waste gases of the furnace.

Large quantities of ammonia are annually lost in iron smelting, which might readily be collected. Ammonia is constantly increasing in value, and each furnace produces and wastes at the least 1 cwt. of its principal salt daily, equivalent to a considerable money loss. With the low price of iron, this subsidiary product is worthy of attention. As I write, a Welsh smelter has visited me, to say that he has adopted this suggestion with advantageous results. I might adduce other improvements introduced by chemistry in the smelting process; but these will suffice to show you that she has added to human power by increasing production, while she has also economized both the time and the materials employed.

Textile Fabrics.—Without the aid of chemistry, it would have been impossible for textile fabrics to have attained their present developement. The bleaching of cotton and linen was not much practised in England until about a century since: before that time, they were sent to Holland, where the operation of bleaching consisted in steeping them in potash for a few days, afterwards for a week in buttermilk, and then exposing them for several months on a meadow to the influence of the sun and moisture. A great improvement was made in Scotland, by substituting sulphuric acid for sour milk; and the immediate effect was, to reduce the time from eight to four months. In 1785, a French chemist suggested the use of chlorine as a means of hastening the process, and, in the last year of the eighteenth century, a compound of this gas with lime was introduced by Tennant of Glasgow. The development of the cotton manufacture now became immense. By a happy adaptation of other chemical processes, in conjunction with the bleaching power of chlorine, the time required for the whitening of cotton and linen fabrics was at once reduced from months to hours, while the miles of outstretched calico, defacing the verdure of country districts, disappeared, the whole operation being carried on within the small space of an ordinary factory. You may imagine what an impulse this gave to a trade so important to us. The bleaching of calico now consists of a chemical operation of great precision; that of silk and wool has not yet been so thoroughly comprehended by science, and consequently has not derived so many advantages from its application.

A greater acquaintance with the theory of bleaching has led to a better understanding of the very ancient practice of washing. The washing of domestic linen is by no means an operation too insignificant for the attention of the chemist. A dozen shirts may cost 3*l.* 12*s.*, this being the united interest of the producer, cotton-spinner, and shirt-maker. These shirts will last three years, with care, and supposing three to be washed each week, the cost of washing—that is, the washerwomen's interest in the dozen shirts—amounts to 7*l.* 16*s.*, or more than double that of the cotton-spinner. In fact, the cost of washing is about one-twelfth the income of a family of moderate means. Taking rich and poor together, and estimating the cost of washing at no more than 3*d.* per head weekly, the annual charge of washing to the metropolis alone is 1,535,060*l.*, which is equal to about one-twenty-fifth of the whole capital invested in the cotton manufactures of the United Kingdom. Hard water usually contains lime, and in washing that earth unites with the fatty acid of soap, producing an insoluble body of no use as a detergent. For every 100 gallons of Thames water, 30 oz. of soap are thus wasted, before a detergent lather is formed. In personal ablution, we economize this excessive waste by the uncomfortable practice, universally followed in London, of taking about an ounce of water into the hands, and converting it into a lather, the water in the basin being only employed to rinse this off, instead of aiding in the detergence. But in washing linen this plan cannot be followed, every particle of the lime being removed before the soap becomes useful; this, as a matter of economy, is frequently accomplished by carbonate of soda, as being cheaper than soap. The amount of soap and soda salt thus wasted in the metropolis has been stated to be equal to the gross water rental. Hard water, besides wasting soap, produces a great tear and wear of clothes.

All these facts are well known to manufacturers, and hence the care with which a water is selected before the seat of a manufactory is determined. Why, then, should we not attend to our domestic manufactures, considered trifling only because they are carried on with a great division of labor, unseen in its aggregate? Yet these domestic manufactures are of more importance, economically, than those carried on in large and imposing factories.

I wish I had time to refer, with sufficient detail, to the discovery of Mercer, who has shown that the immersion of cotton in soda or in sulphuric acid causes an equal contraction of the fibres, thus producing the mechanical effect of a loom. If very fine calico, containing as much as 180 picks to the inch, be thus treated, it contracts to calico of 260 picks to the inch—a fineness not yet attained by any mechanical contrivance. This calico, in addition to its acquired fineness, has also assumed powers which enable it to receive colors superior to those assumed by ordinary calico. Before leaving this important discovery of Mercer, I should allude to one other by the same chemist. The French calico-printers employ mousselines-de-laine consisting altogether of wool, while in England we use a much cheaper fabric, consisting of wool and cotton. The colors of this mixture are, however, extremely meagre when compared with the former; but Mercer has shown that the mixed fabric acquires the properties of the other, when it is treated with a bath of chlorid of lime. This, one of the most important discoveries ever made in calico-printing, has been of great value to this country.

I cannot, however, allude to all the triumphs of chemistry in calico-printing, an art which has grown with the growth of chemistry and strengthened with its strength. The knowledge of mordants and of colors, and the other results of chemical discoveries, are of every-day occurrence. Let us take one of the last examples. Lapis lazuli, long celebrated for its beautiful blue, almost ranked among the precious stones, and was sold at a price which put it quite out of the reach of the calico-printer. But chemists, ascertaining its composition by analysis, soon learned how to make it by synthesis. Artificial ultramarine is now manufactured at three or four shillings per pound. But when it was made, how was it to be fixed on cloth? From its insolubility, its fixation was a real difficulty. Chemists suggested that the ultramarine might be mixed with albumen, which, being coagulated by heat, would retain the color on the cloth to which it was applied. Whole barrels of the dried white of eggs are now to be seen at calico-print works. Yet this is an expensive process. Could common cheese not be substituted for the white of eggs? Cheese is soluble in ammonia, and the ultramarine, being mixed with this solution, is retained by the cheese, when the ammonia evaporates. Now, therefore, the ultramarine is fastened on by cheese, made from the buttermilk of Scotland, and sold under the name of lactarine.

A recent application of chemistry to the economy of dyeing deserves especial attention. Madder, the dye most commonly used for calico, after imparting its color, was considered useless. The large quantities of spent madder constantly accumulating were found exceedingly inconvenient. It was not valuable enough for the manure-heap, and the rivers became polluted in carrying away the waste material. But chemistry has shown that actually one-third of the coloring matter is thus thrown away, and that simple treatment with a hot acid again renders it available as a dye. These waste-heaps are now sources of wealth, and the dyer no longer poisons the rivers with spent madder, but carefully collects it, in order that the chemist may make it again fit for his use.

Stannate of soda is a salt largely used by calico-printers. The usual mode of preparing it was, (1), tin was reduced from its ore; (2), this tin was dissolved in muriatic acid; (3), it was oxydized by nitric acid or chlorine; (4), the oxyd thus formed was precipitated and redissolved by soda, this bulky, aqueous solution being furnished to calico-printers. Mercer simplified the process, and obtained it in the solid state by two operations: (1), the tin was obtained as before; (2), this tin was fused with a mixture of nitrate of soda and caustic soda, the former oxydizing it, and the latter forming stannate of soda with the oxyd thus formed. Young showed in the Exhibition a still further simplification. The common ore of tin is an oxyd: why, then, was it necessary to reduce it to the metallic state merely to oxydize it again? He therefore fused the ore at once with soda, the impurities remaining undissolved; and the salt was made by one operation. I quote this instance as a remarkable example of the tendency of Chemistry to simplify processes of manufacture. The history of this salt is an exact parallel to that of Ho-ti and the pig.

I might refer to the important discoveries of yellow and red prussiate of potash, the formers of Prussian blue; but this would only be to cite one out of innumerable appliances. I prefer, therefore, to finish this part of the subject, by alluding to the resists and discharges used in calico-printing. In order to preserve white patterns in the process of dyeing, the nations of the East, whence calico-printing originated, still employ the most laborious mechanical devices, each white spot being covered with sealing-wax, or by being tied up and protected from the dye. By the aid of chemistry, we either discharge the color on the cloth, or we put upon it bodies which resist the action of the mordants and prevent the color attaching to that particular part. Acids made from the lees of wine (tartaric acid) and from the lemon (citric acid) are now largely used in these operations, and hence come the beautiful paterns we enjoy in our dresses. It was found that, even when the whites were thus obtained, they became soiled in washing off the excess of mordants from the other parts of the cloth; and the only mode of preventing this was, to treat the cloth with a bath of cowdung. Large dairies were consequently necessary adjuncts of a calico-print work. Chemistry has shown that the action of the manure is due to its phosphates; and a mixture of phosphate of soda, phosphate of lime, and size, is now substituted for the filthy baths formerly indispensable. I could spend hours in discoursing to you on the triumphs of Chemistry in the dyeing of textile fabrics, whether of cotton, wool, and silk, or their mixtures; but I must content myself with these few isolated examples, and pass on to other subjects.

Leather.—The manufacture of leather has been less advanced by the application of Chemical Science than any other of the arts. If Simon, the tanner of Joppa, had been able to send leather to the Exhibition, no doubt he would have carried off a medal for leather as good, and made exactly by the same process, as that of our most eminent manufacturers of the present day. And yet the science of leather production is better understood now than then; but so many physical conditions are involved in the production of good leather, that scientific processes have been unable to satisfy them all. The hides, steeped in an infusion of oak-bark, absorb tannin and are converted into leather. Good sole leather takes about a year to tan, and even calf-skins consume a month in the operation. Chemists have certainly indicated substitutes for bark, containing a greater amount of tannin, and these, as for instance terra japonica, cutch, catechu, and dividivi, produce their effects in half the time; but the leather is said not to be so durable. With sumach, light skins may be tanned in twenty-four hours, and with the aid of alum even in one hour; but the resulting manufactures are not preferred to the old processes. Atmospheric and hydrostatic pressure have been used to hasten the absorption; the refined laws of Endosmosis and Exosmosis have been called in to accelerate the process; heavy rollers have squeezed the solution through the pores; but all these methods have had at the best but a doubtful success. Leather-manufacturers meet men of science by the well-founded assertion, that the resulting leather is too porous, too hard or too soft, or not sufficiently durable; and they revert to their old traditional modes of preparation. I allude to these failures the more especially to show that there is a wide chasm between the chemist's laboratory and the workshop,—a chasm which has to be bridged over by the united aid of the philosopher and the manufacturer. One without the other does not suffice, but both, working together, may achieve great results. Yet, in bridging over this chasm, they must act on a common plan. If the manufacturer build his half without understanding the principles of construction employed by the other, the sides of the bridge may indeed meet, but they are not constructed to receive the binding influence of the key-stone, and the arch must give way and tumble down.

Having thus shown the comparative failure of chemistry in revolutionizing this important manufacture, let me take one or two instances from it to prove that, in the details of the working, it has been of use in economizing time and labor, and in affording new uses to comparatively valueless objects. In removing the hair from the hides, previous to tanning, it was customary to shave it with a knife. This process was tedious and imperfect, and the following simple one is now used. Lime-water dissolves the bulbous root of the hair, when the hides are immersed in it for some time, and the hair may then be readily removed by a blunt instrument. By this simple process one man can remove the hair from a hundred kid-skins in about an hour. Still the immersion requires several weeks, while the addition of red orpiment to the lime, as practised by the sheep-skin manufacturers of France, reduces the time to a few hours.

When goat-skins are tanned for morocco leather, it is necessary, in order to adapt them for dyeing, to remove the lime absorbed by the last operation. A solution of *album græcum* cleanses the pores effectually, leaving them so spongelike, that air can readily be forced through them. Hence the process of tanning is rendered much easier, being in fact completed within twenty-four hours; while the leather is rendered fit to assume the colors so characteristic of morocco. About fifty persons are employed in London to collect the sweepings of dog-kennels for this purpose, and many more in applying them; and I am informed, by Mr. Bevington, that the sum annually paid to the collectors and workmen employed in using this apparently worthless substance, is not less than 5000*l.* in the metropolis alone.

The currier shaves leather to render it of equal thickness, and the shavings are treated as waste, scarcely fit for the manure-heap, but chemistry has shown that they contain much nitrogen, which renders them well adapted for the formation of the beautiful color known as Prussian blue.

Mineral and Metallic Manufactures.—The mineral and metallic manufactures are those which obviously have derived most advantages from chemistry. Glass and pottery are in fact chemical manufactures. The hard-won experience of two thousand years in China has been given to Europeans by a few years' application of chemistry. Glass, made by the ancients from the ashes of ferns and other plants, is now formed by soda artificially produced from sea salt. The Exhibition showed that this manufacture, far advanced as it is, may still be susceptible of improvement; for, in the French department, glass was shown in which zinc and barytes were substituted for lead. The hardening and production of steel, the discovery of many new alloys endowed with properties most important to the arts, and the electrotyping of metals, are familiar examples of chemical appliances; but this very familiarity renders it unnecessary that I should dwell upon them. I, therefore, from want of time, leave these important manufactures, and pass on to others, in which the influence of chemistry may be less palpable to the general observer.

Soap.—Soap is probably not older than the Christian era, for the soap of the Old Testament seems to have been merely alkali. Profane history, previous to Christ, does not allude to soap, and, in all the detailed descriptions of the bath and of washing, it is never mentioned. Pliny describes its manufacture, but ascribes to it as singular a use as that given to the potato by Gerarde, who, in his "Herbal," assures us that it "is a plant from America, which is an excellent thing for making sweet sauces, and also to be eaten with sops and wines;" so Pliny, in regard to soap states, that its main purpose was to dye the hair yellow, and that men used it for this purpose much more than women. Gradually its use became more extensive, and its manufacture considerable. Soap generally consists of a fatty acid, combined with the alkali of soda. This soda was imported from Spain under the name of barilla, itself the ashes of plants grown near the sea. As these plants derived their soda from the sea, near which they flourished, chemistry, though singularly enough in the person of Napoleon Bonaparte, suggested that it might be artificially made from sea salt. A process for this was perfected, and soda derived from salt has now replaced barilla. From 1829 to 1834 the average annual import of barilla was 252,000 cwt.; it is now almost nothing. But besides this substitution, the cheapness and comparative purity of the soda made from salt is so great, that the manufacture of soap, and consequently of soda, is enormously increased, and probably exceeds ten times the largest quantity of barilla ever imported in one year into this country. Its cheapness and excellence have also had a prodigious effect on the manufacture of glass.

Chemistry has thus produced great economy and increased power of production to the manufacturers of soap by furnishing them with soda prepared directly and artificially from salt, instead of through the organism of plants. This, however, is only one of the benefits conferred on the manufacture of Chemical Science. The fiscal regulations of foreign countries rendered their tallow and fats expensive to British industry. Russia, with almost a monopoly of tallow and linseed oil, thought it good policy to sell them at high prices. But Chemistry pointed out that vegetables, as well as animals, produce similar fats. The fat of beef and mutton exists in cocoa beans; human fat in olive-oil; that of butter in palm-oil; and horse fat and train-oil are in many oily seeds. Was it, then, necessary to submit to the high prices of Russian tallow? Now, palm and cocoa-nut oil largely replace the fat of the Russian oxen and sheep, although the cheap importation of similar fats from Australia and South America has rendered the substitution less necessary.

Perfumery.—Much aid has been given by chemistry to the art of perfumery. It is true that soap and perfumery are rather rivals, the increase of the former diminishing the use of the latter. Costly perfumes, formerly employed as a mask to want of cleanliness, are less required now that soap has become a type of civilization. Perfumers, if they do not occupy whole streets with their shops, as they did in ancient Capua, show more science in attaining their perfumes than those of former times. The Jury in the Exhibition, or rather two distinguished chemists of that Jury, Dr. Hoffman and Mr. De la Rue, ascertained that some of the most delicate perfumes were made by chemical artifice, and not, as of old, by distilling them from flowers. The perfume of flowers often consists of oils and ethers, which the chemist can compound artificially in his laboratory. Commercial enterprise has availed itself of this fact, and sent to the Exhibition, in the form of essences, perfumes thus prepared. Singularly enough, they are generally derived from substances of intensely disgusting odor. A peculiarly fœtid oil, termed "fusel oil," is formed in making brandy and whisky. This fusel oil, distilled with sulphuric acid and acetate of potash, gives the oil of pears. The oil of apples is made from the same fusel oil by distillation with sulphuric acid and bicromate of potash. The oil of pine-apples is obtained from the product of the action of putrid cheese on sugar, or by making a soap with butter, and distilling it with alcohol and sulphuric acid, and is now largely employed in England in the preparation of pine-apple ale. Oil of grapes and oil of cognac, used to impart the flavor of French cognac to British brandy, are little else than fusel oil. The artificial oil of bitter almonds, now so largely employed in perfuming soap and for flavoring confectionary, is prepared by the action of nitric acid on the fœtid oils of gas-tar. Many a fair forehead is damped with eau de millefleurs, without knowing that its essential ingredient is derived from the drainage of cowhouses. The winter green oil, imported from New Jersey, being produced from a plant indigenous there, is artificially made from willows and a body procured in the distillation of wood. All these are direct modern appliances of science to an industrial purpose, and imply an acquaintance with the highest investigations of organic chemistry. Let us recollect that the oil of lemons, turpentine, oil of juniper, oil of roses, oil of copaiba, oil of rosemary, and many other oils, are identical in composition, and it is not difficult to conceive that perfumery may derive still further aid from Chemistry.

*Candles.**—The manufacture of candles has recently been much improved by the aid of chemistry. Tallow candles, or

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* I have had the advantage of seeing the admirable Report of Jury XXIX, and have availed myself, with permission of its author, of some new information contained in it.

their more expensive substitute, wax, were generally used till within the last twenty years. The tallow itself was long very impure, containing cellular tissue, which was only partially removed in the form of a scum, known as "cracklings." This impurity rendered the light unsteady, and obstructed the wick. The old method of purification still largely used in this conntry, though superseded on the continent and in Dublin, whence such good tallow candles were exhibited, has been displaced by a process of treating with sulphuric acid the tallow melted by steam. Much of the smell is thus removed, and a larger amount of purer tallow is obtained. The researches of Chevreul had shown that fats consist of fatty acids, combined with a kind of sugar named glycerin, which it was important to remove; this glycerin, removed in candle-making, is now used for liniments in cutaneous affections, and is employed as a remedy in deafness and rheumatism. By boiling with lime, an insoluble soap is formed, while the glycerin remains dissolved in the water. This lime-soap, decomposed by a stronger acid, yields the fatty acids in a pure state. But there are generally two solid acids mixed with the fluid one; and the latter is easily removed by pressure, the solid fats remaining. The solid acids are made into the beautiful candles erroneously called "stearine." Various difficulties occurred in this manufacture. The solid acids, crystallizing rapidly, were ill adapted for candles; but the introduction of arsenic in small quantity prevented the crystallization. The public were justly alarmed at this dangerous practice, and the manufacture was threatened with extinction, when it was found that a small percentage of wax produced the same effect, and that large crystals might even be prevented by a careful regulation of the temperature. This evil was therefore avoided; but a more serious one arose. The ashes of the wicks, becoming heated, cause the fatty acids to splutter; and this was a grave inconvenience. These ashes, however, form a fusible glass with borax; so the wicks are dipped into a solution of this salt, and the difficulty is removed; a salt of bismuth is also used for this purpose. Snuffers, however, are always troublesome, and a self-snuffing candle was an important want. Chemists have told us that flame is hollow, its centre containing no oxygen capable of supporting combustion; and the wick being in the hollow part, excluded from the air by its fiery prison, is charred, and diminishes the light. If the wick could be made to turn outwards, it would reach the exterior air and be consumed, whilst the glass formed by the action of the borax on its ashes would also be removed. This beautiful scientific fact was attained by the introduction of plaited and twisted wicks, the tension of the threads forcing the wick to curl outwards to the exterior of the flame, where it is rapidly burned.

Another great improvement now took place. In preparing the commercial stearine from palm-oil or tallow, it is essential to remove the glycerin, and this had been accomplished by saponifying them with alkalies. Sulphuric acid, acting on fats, unites with the oily acids and with glycerin; the former compounds are decomposed by water and become insoluble, while the latter, from being soluble, is removed; the oily acids, blackened with the destroyed organic impurities, are now distilled, and it is found that a jet of steam, heated somewhat in the manner of the hot blast, aids their distillation, the fatty acids passing over in a comparatively pure form, while the residual black resinous matter is made into black sealing wax. Candles may now be made from the distilled fatty acids at once, or they may be pressed to remove the oleic acids.

The oleic acid, both from this mode of manufacture and from that by alkaline saponification, is principally exported to France, where it is made into a hard soap. In this country we have yet to acquire the method of doing this. The excellence of the acid saponification is, that it is applicable to palm-oil and to the most impure and fœtid fats; by its means, the finest candles may be made from the waste of the glue-maker and from the oily residues obtained by the decomposition of the waste lyes of the woollen manufacturer and the bleacher. As the first beautiful process of saponification sprang from the abstract researches of Chevreul, so has the last elegant method arisen from the scientific investigations of Frèmy, although both of them have been reduced to practice, with many improvements, by the manufacturers themselves. The importance of the manufacture may be understood when I state that one company (Price's Candle Company) possesses cocoa-nut plantations in Ceylon, and employs eight hundred workmen in its five manufactories in London, using a capital of nearly half a million, and dividing profits to the extent of 40,000*l.* per annum.

Chemistry has not yet done so much for the manufacture of wax candles as might have been anticipated. Wax is still bleached by exposure to air and light, and the operation has been hastened more by mechanical than by chemical contrivances; the bleaching of wax is a tedious and often a difficult process, and demands greater attention from chemists than it has received; the Brazilian mahogany-colored wax, produced by a black bee hiving under ground, has not yet been bleached by the sun, and might be imported in considerable quantity if Chemistry offered means for removing its color. I do not allude to what Chemistry offers to do, but it would appear that paraffin and oil from coal, and possibly from peat, may dispense, to a certain extent, with the necessity for sperm-whale fishing.

Coal-Gas.—The manufacture of coal-gas is an admirable example of the benefits conferred by Chemistry in all the three divisions of its uses; for it not only has economized human power and time, but it has utilized all the products employed in removing its impurities. Coal-gas was only introduced to use at the beginning of this century, and the public prejudice which had to be overcome, and the difficulties to be surmounted in its actual manufacture, may still be remembered by many of my hearers. It was no mean innovation to replace tallow candles and oil lamps by an air streaming through pipes, but the difficulties attending its purification from noxious ingredients appeared even more insuperable than to reconcile the public to the innovation: the gas had an insupportably fœtid odor, and certainly injured health when burned; it discolored the curtains, tarnished the metals, eat off the backs of books, and covered everything with its fuming smoke. It required a man of courage, as indomitable as Winsor, its great advocate, to persuade the public to continue its use until means were found for the removal of these noxious qualities. Here Chemistry, itself the father of the manufacture, was called in consultation. The impurities in the gas are sulphuretted hydrogen, which tarnished the metals, and with sulphuret of carbon produced sulphurous fumes; ammoniacal compounds, which changed the colors of dyes and acted on leather; tarry vapors, which caused the deposition of soot; and all these had to be removed. The ammonia and the tar were partially condensed in tubes kept cool, the sulphuretted hydrogen and carbonic acid were removed by lime, and the ammonia by washing the gas with water. This last operation was the least effective, and new substitutes had to be devised, one of which I may mention; superphosphate of lime, consisting of bones dissolved in sulphuric acid, only required ammonia to make it a powerful and excellent manure; trays of this superphosphate were therefore placed in a chamber through which the gas passed, and thus the ammonia was removed, while the phosphate became enriched. A new method is now extensively employed, and shows the tendency to simplification resulting from discovery. By this method almost all the conditions of purification are satisfied by one process; the gas, after cooling, is at once taken into a chamber containing carbonate of lime and sulphate of iron; these, reacting upon each other, produce oxyd of iron and sulphate of lime. The gas, streaming through this mixture, gives up its sulphuretted hydrogen to the oxyd of iron, while the carbonate of ammonia, decomposing the lime salt, forms sulphate of ammonia and carbonate of lime, the lime thus being reconverted to its original state; the gas before being passed into this mixture is occasionally led through chlorid of calcium in order to aid the removal of the ammoniacal salt. When the mixture has done its work it is exposed to air, and the sulphide of iron absorbing oxygen is converted into a basic sulphate of iron; hence the mixture is similar in its purifying character, except that it contains sulphate of ammonia, which may be washed out and preserved, while the residue is employed over and over again. By this elegant process the noxious sulphur compounds are utilized in the fabrication of sulphate of ammonia, and the mixture seems never weary of performing its duty; hence not only is the purification performed at one process, but the noxious ingredients are converted into compounds of much value. The waste and badly-smelling products of gas-making appeared almost too bad and fœtid for utilization, and yet every one of them, Chemistry, in its thriftiness, has made almost indispensable to human progress; the badly-smelling tar yields benzole, an ethereal body of great solvent powers, well adapted for preparing varnishes, used largely for making oil of bitter almonds, of value for removing grease-spots, and for cleansing soiled white kid gloves. The same tar gives naphtha, so important as a solvent of Indian rubber and gutta percha; similar tar, when made from wood, yields creosote, a powerful preservative of animal matter, and much employed as a medicinal agent. Coal tar furnishes the chief ingredient of printer's ink, in the form of lampblack; it substitutes asphalte for pavements; it forms a charcoal when mixed with red-hot clay, that acts as a powerful disinfectant. When the tar is mixed with the coal-dust, formerly wasted in mining operations, it forms by pressure an excellent and compact artificial fuel; the water, condensed with tar, contains much ammonia, readily convertible into sulphate of ammonia, a salt now recognized as being of great importance to agriculture, and employed in many of the arts. Cyanids are also present among the products of distillation, and these are readily converted into the beautiful color known as Prussian blue. The naphthaline, an enemy to the gas-manufacturer by choking the pipes, may be made into a beautiful red coloring matter, closely resembling that from madder. This, by its transformation, promises an important, though hitherto not yet realized useful product. Coal, when distilled at a lower temperature than that required to form gas, produces an oil containing paraffin, largely used as an antifrictional oil for light machinery.

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Art. V.—*Abstract of a Memoir on Polymerous Isomorphism, by* Th. Scheerer.*

This important paper covers nearly 100 pages in Poggendorff's Annalen and presents a review of the subject of polymerous isomorphism as developed by Scheerer, together with numerous new analyses of minerals, especially the magnesian. The two great points which the author considers as established are—

1. That 1 atom of $\dot{Mg}$ may be replaced by 3 atoms of $\dot{H}$.
2. That 2 atoms of $\dddot{Si}$ may be replaced by 3 of $\overline{\overline{Al}}$.

We present our readers with an abstract of his paper, citing in its illustration the new analyses.

I. Amphibolic Talc and Amphibole.

1. *Foliated Talc.*

	$\dddot{Si}$	$\overline{\overline{Al}}$	$\overline{\overline{Fe}}$	$\dot{Mg}$	$\dot{Fe}$	$\dot{Ni}$	$\dot{H}$	
1. Fol. talc, Tyrol,	62·38	...	...	31·19	1·42	0·20	4·73= 99·92	G.=2·69
2. " "	62·12	...	...	31·15	1·58	0·24	4·73= 99·82	
3. " " Yttre-Sogn,	61·54	...	...	30·56	2·35	0·31	4·93= 99·69	G.=2·70
4. " " "	61·69	...	...	30·62	2·33	0·29	4·94=100·14	
5. " " Röraas,	61·98	0·04	...	30·41	1·59	....	5·04= 99·06	G.=2·78
6. " " "	62·03	0·03	...	30·62	1·57	0·32	5·04= 99·61	
7. " " Raubjerg,	61·85	0·13	...	31·61	1·18	0·36	5·13=100·26	G.=2·79
8. " " "	61·63	0·16	...	31·37	1·20	0·39	5·13= 99·88	
9. " " Tyrol, slaty,	60·95	0·48	...	31·26	1·43	0·35	5·29= 99·76	G.=2·76
10. " " "	61·16	0·46	...	31·17	1·40	0·39	5·31= 99·89	
11. Potstone, Zöblitz,	60·14	0·75	0·45	30·17	2·05	0·28	5·71= 99·55	G.=2·80
12. "	60·31	0·79	0·45	29·94	2·11	0·30	5·87= 99·77	
13. Scaly talc, Canton-Wallis,	62·34	0·35	...	31·96	0·61	....	4·82=100·08	G.=2·79
14. " " "	62·55	0·44	...	32·00	0·73	....	4·84=100·56	Rr.†
15. " " Styria,	62·37	0·32	...	32·02	0·65	....	4·81=100·17	
16. " " Fahlun,	56·95	4·92	0·72	30·09	0·94	....	6·07= 99·69	
17. " " "	57·10	4·69	0·81	30·11	1·07	....	6·07= 99·85	
18. Fol. talc, white, St. Goth.	60·85	1·71	...	32·08	0·09	....	4·95, $\dot{Ca}$ *trace*=99·68	
19. Col. fol. talc, "	62·85	1·44	...	30·76	0·20	....	4·55, $\dot{Ca}$ 0·42=100·22	
20. " " "	62·15	1·01	...	33·04	0·38	....	3·21, " 0·07= 99·86	

The oxygen relation for the silica, protoxyds and water of the first four of these analyses is 32·00 : 12·80 : 4·72=15 : 6 : 2. This ratio corresponds to the formula, according to the Berzelian method, $\dot{R}^6\,\dddot{Si}^5 + 2\dot{H}$ or $3\dot{R}\,\dddot{Si} + \dot{R}^3\,\dddot{Si}^2 + 2\dot{H}$.
which corresponds to $\dddot{Si}$ 62·61, $\dot{Mg}$ 32·51, $\dot{H}$ 4·88=100.

On the ground that $3\dot{H}$ replace $1\dot{Mg}$, the ratio becomes 15 : $6\frac{2}{3}$= 45 : 20=9 : 4, the oxygen ratio of hornblende.

Scheerer also reviews the analyses 5 to 20 in which alumina exists, substituting $2\dddot{Si}$ for $3\overline{\overline{Al}}$, and brings out the same ratio 9 : 4.

2. *Asbestiform Talc.*

	$\dddot{Si}$	$\overline{\overline{Al}}$	$\dot{Mg}$	$\dot{Ca}$	$\dot{Fe}$	$\dot{H}$
21. St. Gothard,	61·51	0·83	30·93	3·70	0·12	2·84=99·93

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* Pogg. Ann., lxxxiv, p. 321.

† Analysis made by Hrn. Richter.

The oxygen ratio is 31·94 : 0·39 : 13·46 : 2·52, giving according to Scheerer's theory of substitutions, 32·20 : 14·30=9 : 4, the hornblende ratio. The same locality affords tremolite and foliated talc, and this ratio is common to both.

3. *Columnar Talc.*

Includes hydrous anthophyllite.

4. *Sparry Crystalline Talc.*

	$\overline{Si}$	$\overline{Al}$	$\dot{Mg}$	$\dot{Fe}$	$\dot{H}$	
23. Fenestrelles, Piedmont,	61·96	...	31·02	1·47	4·92= 99·37	G.=2·79
24. " "	62·29	0·15	31·55	1·22	4·83=100·04	
25. Indur't'd Talc, Gloggnitz,	62·47	0·13	32·08	0·47	4·78= 99·93	G.=2·78
26. " "	62·69	0·12	32·41	0·39	4·70=100·31	Rr.

The oxygen ratio is the same as for the *first* group 15 : 6 : 2, and the hornblende ratio 9 : 4 is deducible in the same way.

5. *Massive Crystalline Talc.*

	$\overline{Si}$	$\overline{Al}$	$\dot{Mg}$	$\dot{Fe}$	$\dot{H}$	
27. Steatite, Wunsiedel,	62·03	....	31·44	1·88	4·96=100·31	Rr.
28. " "	61·98	*trace*	31·17	1·48	4·81= 99·44	
29. " pseudom.	62·07	0·39	31·13	1·69	4·83=100·11	
30. " "	62·35	*trace*	31·32	1·34	4·78= 99·79	
31. " Parma.	62·18	....	30·46	2·53	4·97=100·14	Rr.
32. Agalmatolite, China,	61·48	....	31·27	1·65	4·86= 99·26	
33. " "	62·30	0·06	31·32	1·62	4·89=100·19	

The oxygen ratio of No. 27, is 32·21 : 0·00 : 12·99 : 4·41, (and the others are nearly the same) giving the ratio again 15 : 6 : 2, or the hornblende ratio 9 : 4. The older analyses are also reviewed.

6. *Amorphous Talc.*

	$\overline{Si}$	$\overline{Al}$	$\dot{Mg}$	$\dot{Ca}$	$\dot{Fe}$	$\dot{H}$	$\ddot{C}$	
34. Meerschaum, Turkey,	61·17	...	28·43	...	0·06	9·83	0·67=100·16	
35. " "	61·49	...	28·13	0·60	0·12	9·82	0·67=100·83	Rr.
36. " Greece,	61·30	...	28·39	...	0·08	9·74	0·56=100·07	
37. " doubtful loc.,	58·20	...	27·73	1·53	...	9·64	2·73= 99·83	Rr.
38. " "	60·45	0·11	28·19	...	0·09	9·57	1·74=100·15	

Considering the $\ddot{C}$ and $\dot{Ca}$ combined as carbonate of lime, the oxygen ratio for No. 34 is 31·76 : 11·14 : 8·74; for No. 36, 31·83 : 11·17 : 8·66; for No. 37, 30·22 : 10·54 : 8·57. Substituting $3\dot{H}$ for $1\dot{Mg}$, the first corresponds to 31·76 : 14·05, which equals (and so with the others) the ratio 9 : 4.

7. *Hornblende.*

The two analyses of Crocidilite by Stromeyer, afford the mean oxygen ratio for the silica, protoxyds and water, 26·60 : 10·40 : 4·26, whence the formula $4\dot{R}\,\overline{Si} + \dot{R}^3\,\overline{Si}^2 + 3\dot{H}$. But adding one-third of 4·26 to 10·40, the ratio becomes 26·60 : 11·82, or 9 : 4, which is that of hornblende. A tremolite from Reichenstein afforded—

	$\overline{Si}$	$\overline{Al}$	$\dot{Mg}$	$\dot{Ca}$	$\dot{Fe}$	$\dot{H}$
39.	58·89	0·67	23·37	9·57	3·79	3·60=99·89, Rr.

giving the oxygen ratio, 30·58 : 0·31 : 12·92 : 3·20, which becomes by the author's theory 30·79 : 13·99, or 9 : 4 nearly. We pass by Scheerer's review of some earlier analyses.

II. Augitic Talc and Augite.

1. *Foliated Talc.*

	S⃛i	A̶l	F̶e	Ḟe	Ṁg	Ḣ
40. Gastein,	51·06	5·37	3·13	4·68	28·46	7·28=99·98, Rr.
42. "	49·74	5·72	3·20	6·12	27·32	7·85, Ċu 0·30=100·25

These analyses give the ratios 26·51 : 3·45 : 12·42 : 6·47, and 25·83 : 3·63 : 12·22 : 6·98, equivalent nearly to 8 : 1 : 4 : 2. The author by his theory deduces the ratios 28·81 : 14·58, and 28·25 : 14·54, each very nearly 2 : 1, or the *augite ratio.*

2. *Sparry Crystalline Talc.*

	S⃛i	A̶l	Ṁg	Ċa	Ḟe	Ṁn	Ḣ
44. Talc Diallage, Presnitz,	58·46	0·09	32·83	0·61	1·09	...	6·56=99·64
45. " "	58·60	0·06	32·07	0·81	1·01	0·39	6·56=99·50

Mean oxygen ratio, 30·40 : 0·04 : 13·46 : 5·83, becoming by Scheerer's theory 30·43 : 15·40, or nearly 2 : 1. Some old analyses are reviewed and a like result deduced.

3. *Massive Talc.*

	S⃛i	A̶l	Ṁg	Ċa	Ḟe	Ṁn	Ḣ
46. Neolite, Arendal,	52·28	7·33	31·24	0·28	3·79	0·89	4·04=99·85
47. " "	47·35	10·27	24·73	...	7·92	2·64	6·28=99·19

These give the oxygen ratios 27·15 : 3·42 : 13·62 : 3·59, and 24·58 : 4·80 : 12·24 : 5·58, equivalent approximately to 8 : 1 : 4 : 1 or 10 : 2 : 5 : 2. Scheerer deduces by his method, the ratios 29·43 : 14·82 and 27·78 : 14·10, or nearly 2 : 1, the augite ratio. [It may be observed that, throwing out the alumina and water, the remaining ratio is 27·15 : 13·62 for the first, and 24·58 : 12·24 for the second, each very closely 2 : 1.]

	S⃛i	A̶l	Ṁg	Ċa	Ḟe	Ḣ
48. Neolite of Eisenach,	51·16	9·61	29·65	1·91	0·82	6·50= 99·65
49. " "	51·35	9·02	30·19	1·93	0·79	6·50= 99·78
50. " "	51·44	8·79	31·11	2·00	F̶e 0·88	6·50=100·72 Rr.

Oxygen ratios, 26·56 : 4·49 : 12·59 : 5·78, 26·66 : 4·21 : 12·80 : 5·78, and 26·71 : 4·40 : 13·02 : 5·78, giving by the new theory 29·56 : 14 : 51, 29·47 : 14·73, 29·64 : 14·94, each =2 : 1.

4. *Nephrite.*

	S⃛i	A̶l	Ṁg	Ċa	Ḟe	Ḣ
51. Nephrite, Turkey,	57·49	0·67	25·86	12·01	1·34	2·55= 99·92
52. " "	57·28	0·68	25·91	12·39	1·37	2·55=100·18
53. " N. Zealand,	57·10	0·72	23·29	13·48	3·39	2·50=100·48

Oxygen ratios, 29·85 : 0·31 : 14·07 : 2·27.—29·74 : 0·32 : 14·21 : 2·27.—29·65 : 0·34 : 13·92 : 2·22

Scheerer's ratios, 30·06 : 14·83 — 29·95 : 14·96 — 29·87 : 14·66

approaching in each case 2 : 1.

5. *Augite.*

	$\dddot{\text{Si}}$	$\dot{\text{Mg}}$	$\dot{\text{Ca}}$	$\dot{\text{Fe}}$	$\dot{\text{H}}$
54. Rock Cork, Zillerthal,	57·20	22·85	13·39	4·37	2·43=100·24
55. Asbestus, Tyrol,	57·50	23·09	13·42	3·88	2·36=100·25
56. " Reichenstein,	55·85	23·99	11·66	5·22	2·15, $\dddot{\text{Al}}$ 0·56, $\dot{\text{Cu}}$ 0·40=99·83, Rr.
57. Diopside, Reichenstein,	54·50	18·96	21·41	3·00	1·19, $\dddot{\text{Al}}$ 1·10=100·16, Rr.

Oxyg'n ratios, (1) 29·70 : 13 94 : 2·16, (2) 29·86 : 13·93 : 2 10, (3) 29·00 : 0·26 : 14·09 : 1·91, (4) 28·30 : 0·51 : 14·37 : 1·07.

A rock leather analysed gave the composition of serpentine, $(\dot{\text{Mg}})^3 \dddot{\text{Si}}$.

III. Talc not Augitic or Hornblendic in type.

	$\dddot{\text{Si}}$	$\dddot{\text{Al}}$	$\dot{\text{Mg}}$	$\dot{\text{Fe}}$	$\dot{\text{H}}$
58. Hydrotalc, Presnitz,	67·81	...	26·27	1·17	4·13= 99·38
60. " "	68·47	0·12	26·31	1·19	4·11=100·20
62. Sub-columnar,	67·95	0·24	25·54	1·59	4·14= 99·46, Rr.

Ox. ratios, (1) 35·21 : 0·00 : 10·77 : 3·67. (2) 35·55 : 0·06 : 10·79 : 3·65. (3) 35·28 : 0·11 : 10·57 : 3·68
Scheerer's ratios, 35·21 : 11·99 35·59 : 12·01 35·26 : 11·80

The first set of ratios correspond to 10 : 3 : 1; Scheerer's set, to 3 : 1, and the formula $(\dot{\text{R}})\dddot{\text{Si}}$.

Conclusion.—The three general rations deduced by Scheerer for the species reviewed, are 9 : 4, 4 : 2, 3 : 1, corresponding, the first to hornblende, $\dot{\text{R}}\dddot{\text{Si}}+\dot{\text{R}}^3\dddot{\text{Si}}^2$; 2d to augite $\dot{\text{R}}^3\dddot{\text{Si}}^2$; 3d to $\dot{\text{R}}\dddot{\text{Si}}$.

From the alleged isomorphism of $1\dot{\text{Mg}}$ and $3\dot{\text{H}}$, and of $2\dddot{\text{Si}}$ and $3\dddot{\text{Al}}$, the following formulas are equivalents and the substances presenting them should be isomorphous—

$(a)\ \dot{\text{R}}^3\dddot{\text{Si}}^2$, $(b)\ \dot{\text{R}}^2\dddot{\text{Si}}^2+3\dot{\text{H}}=2\dot{\text{R}}\dddot{\text{Si}}+3\dot{\text{H}}$, $(c)\ \dot{\text{R}}\dddot{\text{Si}}^2+6\dot{\text{H}}$, $(d)\ \dddot{\text{Si}}^2+9\dot{\text{H}}$.

The minerals of the *Augitic* series whose composition is given, are compounds according to Scheerer, of (*a*) and (*b*) in different proportions. In a like manner, those of the *Hornblendic* series are considered as composed of the compounds $\dot{\text{R}}\dddot{\text{Si}}+\dot{\text{R}}^3\dddot{\text{Si}}^2$ (*a*), and $3\dot{\text{R}}\dddot{\text{Si}}+3\dot{\text{H}}$ (*b*) in different proportions: and those of the *Hydrotalc* series, of the compounds $2\dot{\text{R}}\dddot{\text{Si}}$ (*a*), and $\dot{\text{R}}\dddot{\text{Si}}^2+3\dot{\text{H}}$ (*b*) in different proportions. His paper contains a table of the results, in which the ratios of the two constituent portions are given, with the calculated and found results, in accordance with the ratios. We give a few examples, (referring to the paper for the complete table.)

1. *Hornblendic Series.*

		Oxygen ratios.	Combinat'n of Stochiometric elements.
1. Colum. talc, St. Got., (11) (1·44 $\dddot{\text{Al}}$, 3·21 $\dot{\text{H}}$)	Found	32.59 : 13·32 : 2·85	=3*a*+*b*
	Calc.	32·59 : 13·58 : 2·72	
2. Asbest. talc, ibid, (12) (10·83 $\dddot{\text{Al}}$, 2·84 $\dot{\text{H}}$) (3·70 $\dot{\text{Ca}}$)	Found	32·20 : 13·46 : 2·52	=3*a*+*b*
	Calc.	32·20 : 13·42 : 2·68	
3. Talc, Tyrol, (1) (0·0 $\dddot{\text{Al}}$, 4·73 $\dot{\text{H}}$)	Found	32·26 : 12·86 : 4·20	=3*a*+2*b*
	Calc.	32·26 : 12·90 : 4·30	
21. Meerschaum, (21) (0·11 $\dddot{\text{Al}}$, 9·57 $\dot{\text{H}}$)	Found	31·43 : 10·66 : 8·51	=3*a*+9*b*
	Calc.	31·43 : 11·35 : 7·86	
22. Nephrite, Turkey, (27) (0·68 $\dddot{\text{Al}}$, 2·55 $\dot{\text{H}}$) (12·39 $\dot{\text{Ca}}$)	Found	29·95 : 14·21 : 2·27	=6*a*+*b*
	Calc.	20·96 : 14·26 : 2·14	

2. Augitic Series.

34. Asbest., Tyrol (30) (0 $\ddot{A}l$, 2·36 $\dot{H}$, 13·42 $\dot{C}a$)	Found	29·86 : 13·93 : 2·10	$=6a+b$
	Calc.	29·86 : 14·21 : 2·13	

3. Hydro-talc Series.

41. Talc, Presnitz (33) (0·12 $\ddot{A}l$, 4·11 $\dot{H}$)	Found	35·59 : 10·97 : 3·65	$=4a+b$
	Calc.	35·59 : 10·68 : 3·56	

A second table presents the series of species under the hornblendic and augitic divisions, in the order of their variation in form and composition from the typical species, hornblende and augite; and the tendency to foliated crystallizations, as the species become hydrous is illustrated. Anthophyllite is placed as intermediate between true hornblende and hornblendic talc, while diallage, in the augitic series, is intermediate between true augite and augitic talc.

ART. VI.—*Remarks on* MENODORA, *Humb. & Bonpl., and* BOLIVARIA, *Cham. & Schlecht.*; by ASA GRAY.

HAVING been requested to report upon a collection of plants made last year, *en route* from Texas to El Paso, New Mexico, by Mr. Wright, while attached to Col. Graham's surveying party, I have been led, in anticipation of the regular study of the *Monopetalæ* of various collections now in my hands, to inquire whether *Bolivaria* is or is not generically distinct from *Menodora.* The latter genus was established on a Mexican plant, by Humboldt and Bonpland, in their *Plantes Æquinoctiales*, 2, p. 98, t. 110, and is re-described by Kunth, in the *Nova Genera et Species Plantarum*, 7, p. 199, from a specimen not in fruit. The former was founded by Chamisso and Schlechtendal, in the first volume of the *Linnæa* (1826), on two Buenos Ayrean species. The question of the order to which these plants should be referred, has, perhaps, been sufficiently discussed by Lindley,* who says they are genuine Jasminaceous plants; by Grisebach,† who created for them a distinct family, Bolivariaceæ; and by Alphonse De Candolle,‡ who again refers them to Jasmineæ. He does not admit them to form a separate tribe in that small order, although he corrects Grisebach's character of the æstivation of the corolla (which is not contorted, as in Jasminum, but imbricative), and considers the remaining and more important character of the four ovules in each cell of Bolivaria to be invalidated by the single pair in each cell, attributed to Menodora.

* Natural System of Botany, ed. 2, (1836) p. 239.
† Genera et Species Gentianearum, (1839) p. 20.
‡ Prodromus Syst. Veg., 8, p. 300, note.

It is on this latter ground, mainly, that De Candolle distinguishes the two genera, *Menodora* having, according to Bonpland, only two ovules in each cell, a *two-valved* capsule, and a 10–13-cleft calyx; while *Bolivaria* has four ovules in each cell, a circumscissile dehiscence of the capsule, and, as to the original species, a five-parted calyx. The bivalvular dehiscence of Menodora rests wholly on the statement of Bonpland (the fruit being unknown to Kunth and to Grisebach), which I have some reason to think is not correct. At least, the ovary in a Coulterian specimen of what I take to be *Menodora helianthemoides*, shows manifest indications of the transverse dehiscence of Bolivaria. The character of the ovulation would seem to be confirmed by Kunth (*Nova Genera & Spec., l. c.*); but Grisebach may have found it different in the specimen he examined, as he gives the character "loculis 4-ovulatis" to his Bolivariaceæ, without exception. There are certainly four ovules in each cell, superposed in pairs, in No. 937 of Coulter's Mexican collection, which agrees so minutely with the description that I do not hesitate to consider it as Humboldt's species; especially as the ovules stick together a little, so that the mistake as to their number might easily have occurred. If it was examined, the same mistake must have occurred in respect to De Candolle's second species, *Menodora heretophylla;* in which the cells are equally 4-ovulate, both in wild and in cultivated specimens. On the other hand, the Patagonian *Bolivaria robusta* of Bentham, in *Lond. Jour. Bot.*, 5, p. 190, t. 5, (of which indeed the fruit is unknown, but which has only a 5–6-lobed calyx,) is said to have only a single pair of ovules in each cell. As the last mentioned species has frequently six lobes to the calyx, and one of our new Texan species has sometimes as few as seven, it is evident that this remaining character is of no generic consequence.

The genus *Bolivaria* must therefore be merged in *Menodora*, as Sir Wm. Hooker proposed, when publishing his *M. Africana*.*

One Texan species, *M. heterophylla* of Moricand, has already been published. It was gathered by Berlandier, Drummond, and all later collectors in that country. An allied New Mexican species, with narrow and entire leaves, was collected by Wislizenus, Fendler, and Gregg, and has been named by Dr. Engelmann, *Bolivaria scabra.* Another, found in Texas by Lindheimer and by Wright, and appropriately called by Dr. Engelmann, *Bolivaria longiflora*, is remarkable for the prolonged tube of the corolla; differing from the genuine species just as Lithospermum longiflorum, L. canescens, &c., differ from L. officinale. These three

* Icones Plantarum, 6, (1843) t. 586. The æstivation of the lobes of the corolla of this plant is described as "contorto-imbricated," but figured (fig. 8) as if regularly contorted.

have been cultivated by Dr. Engelmann and myself for the last three years, and Dr. Engelmann sent me characters of them in the autumn of 1850. He noticed that, while the *Breviflorœ* (his *Bolivaria heterophylla* and *B. scabra*) open their flowers in the morning, and are inodorous; the *Longiflorœ* (*B. longiflora*) expand their blossoms, which are fragrant, at or towards evening. He also remarked that the anthers of B. longiflora are almost sessile, and included within the summit of the narrow tube, which is glabrous; while in the others, the anthers are exserted on slender filaments, and the throat of the corolla is more or less hairy within. The style, moreover, is less exserted in B. longiflora, and the lobes of the corolla are rather conspicuously pointed. All these characters are confirmed by a second species, if such it be, which I find in Mr. Wright's collection of 1851. Perhaps it is no more than a hairy variety of the last. These are far the most showy plants of the genus, their pure yellow corollas being from an inch and a half to two inches long; and they continue to blossom for a long time, though not so long as M. heterophylla, which flowers through the whole growing season.

The known species may be thus disposed.

MENODORA, *Humb. & Bonpl.*

Menodora & Bolivaria, *Cham. & Schlecht., Griseb., D C. ll. cc.*

§ 1. Bolivaria, *Cham. & Schlecht.* Calyx 5-lobus, raro 6-lobus. Corolla campanulata seu infundibuliformis, lobis acutiusculis. Filamenta filiformia corollam subæquantia; antheris muticis.

* *Lobi calycis lineares tubo longiores.*

1. M. integrifolia, *Steud.* Bolivaria integrifolia, *Cham. & Schlecht., Linnæa,* 1. *p.* 207, *t.* 4, *f.* 1; *Hook. & Arn., Jour. Bot.*, 1, *p.* 284; *DC. Prodr.*, 8, p. 315. Buenos Ayres.

2. M. trifida, *Steud.* Bolivaria trifida, *Cham. & Schlecht., l. c.; Hook. & Arn., l. c.; DC.* l. c. Buenos Ayres, Mendoza.

* *Lobi calycis triangulares tubo subduplo breviores.*

3? M. robusta. Bolivaria robusta, *Benth. in Lond. Jour. Bot.*, 5, *p.* 190, *t.* 5. Patagonia.—Ovarii loculi dicitur biovulati!

§ 2. Menodora, *Humb. & Bonpl.*—Calyx 10–14-lobus, rarius 7–9-lobus; lobis linearibus setaceisve tubo corollæ breviter infundibuliformis vel subrotatæ (fauce pl. m. barbatæ, limbo 5-partito, lobis obovatis oblongisve vix mucronulatis) longiores. Filamenta filiformia; antheris muticis.

* *Stigma obtusum parvum. Folia bipinnatisecta..*

4. M. Africana, *Hook. Ic. Pl.* 6, *t.* 586. Africa Australis.

* * *Stigma discoideum vel depresso-capitatum subbilobum.*

† Corollæ majusculæ lobi oblongo-lanceolati (ex auct.)

5. M. decemfida. Bolivaria decemfida, *Gill. in Hook. Jour. Bot.*, 1, *p.* 284; *DC.* l. c. Mendoza.

†† Corollæ lobi sæpius obovati. Caules diffusæ vel decumbentes. Pedunculi solitarii, nunc pseudo-laterales, fructiferi recurvati.

‡ Foliis integerrimis.

6. M. helianthemoides (*Humb. & Bonpl. Pl. Æq.*, 2, *p.* 98, *t.* 110): hirtello-pubescens; foliis ovalibus seu elliptico-oblongis in petiolum angustatis; corollæ lobis late obovatis calycis lacinias anguste lineares plus duplo superantibus.—Mexico, *Humboldt & Bonpland*, Coulter (No. 937).—A thin annular disk adheres to the very base of the ovary: its edge marks the line where the pod will evidently dehisce transversely. The fruit is not known.

7. M. Coulteri (sp. nov.): glabra, vix puberulo-scabra; foliis linearibus basi attenuatis, infimis sublanceolatis; corollæ lobis obovato-oblongis calycis lacinias setaceas plusduplo superantibus. —Mexico, *Coulter* (No. 938).—The lobes of the corolla are half an inch in length, about as long as in the foregoing species but narrower, and also more pointed. Lobes of the calyx not longer than the ripe pod, which is on a recurved peduncle.

‡‡ Foliis plerisque 3–5-fidis.

8. M. heterophylla (*Moricand in DC. Prodr.* 8, *p.* 316): glabella; foliis caulinis præsertim inferioribus oblongis cuneatisve 3–5-fidis segmentis vel integerrimis vel 2–3-lobatis, summis seu paucis intermediis linearibus integerrimis; corollæ lobis obovatis calycis lacinias lineari-subulatas duplo superantibus.—Texas, *Berlandier*, *Drummond*, *Lindheimer*, *Wright*, etc. Camargo, Mexico, *Gregg*.—Flowers light yellow, externally often tinged with purple.

††† Corollæ lobi obovati. Caules erecti apice plerumque corymbosi; pedunculis floriferis et fructiferis erectis.

9. M. scabra: foliis inferioribus oblongo-lanceolatis superioribus lineari-lanceolatis integerrimis (rarissime 2–3-dentatis) caulibusque scabrellis; corollæ lobis late obovatis calycis lacinias 7–10 setaceas duplo superantibus; calyce fructifero coccos haud excedentibus.—Bolivaria scabra, *Engelm., Mss.* New Mexico, *Wislizenus, Fendler* (No. 693), *Wright* (No. 563). Saltillo, Mexico, *Gregg* (No. 527).—Corolla small, its lobes only 3 or 4 lines long. Lobes of the calyx 2 or 3 lines long.

10. M. Mexicana. Bolivaria Mexicana, *Alph. DC. Prodr.* 8, *p.* 315. Oaxaca, Mexico, *Andrieux.* "Corolla calyce sublongior. Calycis lobi semipollicares." *DC.*—From the length of calyx-lobes and the size of the corolla, this can scarcely be No. 7 or No. 9.

§ 3. Menodoropsis. Calyx 10-lobus, lobis setaceis. Corolla longe tubulosa, hypocraterimorpha, intus glabra; lobis subovatis mucronato-acuminatis. Antheræ fauce inclusæ subsessiles, oblongo-lineares, mucrone apiculatæ.—Flores vespertinæ, odoratæ.

11. M. longiflora: glabra; caulibus erectis subsimplicibus; foliis lanceolatis vel inferioribus oblongis integerrimis (infimis rarissime trilobatis); pedunculis terminalibus confertis subcymosis erectis; tubó corollæ sesqui-bipollicari lobis suis laciniisque calycis setaceis pluries longioribus.—Bolivaria longiflora, *Engelm. Mss.* Texas, *Lindheimer* (No. 652, &c.), *Wright* (No. 564).—Stems 12–18 inches high, rather strict. Leaves one to two inches long. Flowers bright yellow. Cocci of the capsule 3 or 4 lines in diameter, shorter than the calyx-lobes.

12. M. pubens (sp. nov.): pube molli brevi patente subcinerea; foliis oblongis superioribus oblongo-lanceolatis: cæt. ut in præcedente.—New Mexico, *Wright*, 1851.

Art. VII.—*Chemical Examination of a few Minerals associated with Serpentine;* by T. H. Garrett.*

1. Chrome Ore.

Massive Chrome Iron.—This mineral, as is well known, is found in large quantities in the serpentine range which extends through Delaware, Chester and Lancaster counties, Pa., occurring as a sand, derived from the disintegration of the serpentine, or in a few instances in well-defined veins of nearly pure ore. The most remarkable vein, perhaps in the world, is that known as Wood's Pit in Chester county, a short distance from the village of Texas, where it is so compact as to require blasting for its extraction. Thousands of tons of rich ore have already been extracted from this mine.

Among other minerals which are found with chromic iron, is the hydrated carbonate of nickel or emerald nickel, which occurs in a thin coating lining interstices and joints in the ore, and sometimes disseminated through the whole mass.

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* Communicated for this Journal by Prof. J. C. Booth.

To ascertain whether nickel was contained in the ore where it was not visible, as well as to determine the richness of the ore in chrome, I selected a specimen for analysis which had a slight coating of emerald nickel upon one side. This coating having been carefully removed, the rest was broken into minute pieces, and those rejected on which a trace of nickel was visible. The ore itself was jet black, shining and submetallic, very compact, rather brittle, with uneven fracture. Hardness 5·5; streak brown; specific gravity 4·568.

The specimen, having been finely pulverized, was analyzed in the usual manner, by fusion first with bisulphate of potassa, and afterwards with a mixture of carbonate of soda and nitrate of potassa. The chromic acid thus obtained in combination with the alkalies, was deoxydized by alcohol and precipitated as chromic oxyd by ammonia. The nickel was separated from the iron by hydrosulphuret of ammonia and dilute hydrochloric acid. The several constituents were carefully reëxamined, and the absence of alumina determined. The following was the result of the examination:

Cr_2O_3	- - - -	63·384
Fe_2O_3	- - - -	38·663
NiO	- - - -	2·282

The analysis calculated into the formula RO, R_2O_3, excluding the nickel, gives $FeO\,Cr_2\,O_3$ 93·164 + $FeO\,Fe_2O_3$ 5·298 + NiO 2·282 = 100·744. If the nickel be included in the calculation it gives $FeO\,Cr_2O_3$ 93·164 + $FeO\,Fe_2O_3$ ·591 + $NiO\,Fe_2O_3$ 7·150 = 100·905. This specimen approaches nearer to the pure chromic iron ($FeO\,Cr_2O_3$) than is indicated by any analysis that I have yet seen. As the minute fragments exhibited not the slightest appearance of nickel, it is evident that the metal is either present as sesquioxyd, and therefore mechanically mingled with the ore, which is unlikely, or it belongs to the formula, as a replacement of protoxyd of iron, which I regard as the most probable view.

Chrome Sand.—A large proportion of the chrome ore that is exported from this country, is obtained by washing the deposits of sand which form in the beds of streams flowing from the serpentine. The method of washing employed is similar to that used for washing deposit gold, and depends upon the same principle, viz., that the metalliferous portions are much heavier than the siliceous, and consequently remain when the latter are washed away. The deposit being first sifted in water with hand sieves, to separate the coarse gravel, the finer sand is then thrown into sloping troughs, through which a stream of water is made to pass, and constantly raked up against the current until all the lighter matter is removed. The chrome sand on account of its superior gravity remains at the bottom of the trough. The washing process is carried on at numerous points along the serpentine range in the three counties already mentioned.

At the washings situated about six miles west of the town of Chester, the sand in which the chrome occurs, contains a large amount of bright green *actinolite* of which good specimens may be obtained. As the chrome sand itself in this locality consists almost entirely of small but very perfect octohedra, it might be supposed to be richer in chrome than the massive ore which I had examined. The pure sand, separated from all foreign matter, was analyzed by Mr. Isaac Starr in Prof. Booth's Laboratory with the following results:

SiO_3	0·619
Cr_2O_3	60·836
Fe_2O_3	38·952
Al_2O_3	0·928
NiO	0·100

The proportions calculated according to the formula are, $FeO\,Cr_2O_3$ 89·419 + $FeO\,Fe_2O_3$ 6·254 + $FeO\,Al_2O_3$ 1·578 + SiO_3 ·619 + NiO ·100 = 97·970.

The specimen being perfectly pure, proves the substitution of alumina for chromic oxyd. The analysis further shows that the pure crystallized sand is not richer in chrome than the pure massive ore. The association of nickel with the sand is interesting, although present in small quantity, for the locality is some thirty or forty miles from that of the massive chrome containing emerald nickel.

Magnetic Chrome Sand.—Having observed that most if not all chrome sands contain more or less that is magnetic, I thought it a question of sufficient interest to determine whether the magnetic portion contained chrome. For this purpose a quantity of the sand was extracted by a magnet, and this magnetic part treated several times successively by the magnet to free it entirely from adhering chrome sand. The sand thus obtained consisted entirely of magnetic grains. Being then analyzed by the process indicated above, it yielded the following result:

SiO_3	1·25
Cr_2O_3	41·55
Fe_2O_3	62·02

Calculated, as before, into the formula RO, R_2O_3, it gives, $FeO\,Cr_2O_3$ 61·07 + $FeO\,Fe_2O_3$ 38·64 + SiO_3 1·25 = 100·96. From which we may infer that the presence of as small a proportion as 38 pr. ct. of magnetic iron is sufficient to render the whole magnetic. It is moreover clear, that, although the magnetic portion of chromic iron contains a smaller per-centage of oxyd of chrome than the non-magnetic portion, yet it contains a large proportion available for the manufacture of the chromates, and that therefore a magnet will not reveal the property of a chrome ore. The larger contact of oxyd of iron is only so far detrimental, as it impedes the action of the alkalies and oxygen to form a chromate, and hence, within reasonable limits, the economic value of a chrome ore is almost in direct proportion to the per-centage of oxyd of chrome. The most serious injury to the value of chrome ore lies in the per-centage of silex which consumes a proportionally large amount of costly alkali.

Art. VIII.—*On Remingtonite, a new Cobalt Mineral;* by James C. Booth.

Remingtonite occurs as a rose-colored coating, one-hundredth of an inch in thickness, very soft and earthy, opake, with a pale, rose-colored streak.

In a mattrass it yields water and darkens; gives with borax and microcosmic salt, first a feeble reaction of iron, and finally, when the bead cools, a deep blue color of cobalt. It dissolves in muriatic acid with a slight effervescence, and a nickel-green color, the latter property indicating iron associated with it; for pure oxyd of cobalt dissolves with a blue color, and requires but a small quantity of iron to change the blue to green. The solution, neutralized by ammonia, precipitated by sulphide of ammonium, and then treated with muriatic acid, left a large amount of black sulphide of cobalt; while the muriatic solution yielded a small amount of sulphide of iron. The metal is, therefore, almost wholly cobalt. Since a little arsenic is associated with carollite, this mineral was tested for arsenic, but yielded not a trace of it.

Although the above experiments were performed on about $\frac{1}{10}$th of a grain, yet the mineral is clearly proved to be a hydrocarbonate of cobalt. The quantity was, however, much too small to determine its formula.

Remingtonite coats thin veins of serpentine, which traverse hornblende and epidote, and its association with serpentine, containing both magnesia and lime, reminds us of the beautiful emerald nickel, (also a hydrocarbonate) discovered by Silliman on the chrome ore, in the serpentine, of Lancaster county, Pa.

The immediate associates of Remingtonite are serpentine, hornblende, epidote, carbonate of lime, and carrollite. The copper mine in which it occurs, is near Finksburg, Carroll county, Maryland, and is under the immediate supervision of Mr. Edward Remington, after whom the species is named.

Philadelphia, May 15th, 1852.

Art. IX.—*Post-Pliocene of the Southern States and its relation to the Laurentian of the North and the Deposits of the Valley of the Mississippi;* by E. Desor.

The geologists of the southern United States have designated as Post-pliocene, certain deposits of detrital materials which are seen overlying the tertiary along the coast of Georgia and South Carolina, where they form low and level plains, the average height of which does not exceed twenty feet. According to Mr. Lyell, this formation has an extent of at least 400 miles, it having been traced from the mouth of the Altahamah to that of the Neuse in North Carolina. How much farther it extends to the south along the coast of Florida, has not yet been ascertained.*

As far as their composition goes, these deposits are very homogeneous, generally composed of sand and clay, in regular stratification, so as to convey at once the idea of a prolonged and quiet deposition. In this respect they are essentially different from the coarse drift, and from many of the stratified deposits at the north, which frequently contain scattered boulders, the transportation of which becomes an interesting subject of enquiry.

Here at the south the materials are generally so homogeneous that the question as to their origin does not present itself to the mind, their leading features being derived from their arrangement in layers and from the fossil remains they contain, rather than from the nature, size or form of the materials.

Thus far no attempt has been made to parallelize these deposits with any of the subdivisions of the northern quarternary. Geologists seem in general to have felt satisfied when they could make out that such a deposit was more recent than any tertiary formation; hence the name *Post-pliocene.* Now that we have been enabled to point out several periods in the quarternary epoch, the question arises, to which of these periods the Post-pliocene of the southern states is to be referred, whether to the drift, to the Laurentian, or to the alluvium.

It is not my intention to enter into an elaborate investigation of this problem, which would require more time and labor than I have been able to bestow upon the subject. I shall therefore limit myself to a few suggestions based upon the similarity of the strata and the identity of the fossil shells contained in them.

* From what we know of the structure of Anastasia Island opposite St. Augustine, on the eastern coast of Florida, it appears probable that it belongs to the same formation, the island being composed, according to M. Dietz, of horizontal layers, of a semi-indurated rock consisting wholly of fragments of shells, belonging, as far as examined, almost exclusively to species inhabiting the adjacent coast. The shells are principally of the genus Arca; they are *Arca pexata*, Say, *A. ponderosa*, Say, *A. incongrua*, Say, *A. transversa*, Say; also *Lutraria canaliculata*, Say, besides a *Mactra*, a *Donax*, a *Crepidula* and a *Lucina*. *Natica, Oliva* and *Buccinum trivittatum*, are also mentioned.

The main features of the Post-pliocene of South Carolina are thus defined by Mr. Tuomey.* It is confined to a belt along the coast of about eight or nine miles in breadth. The fossils are nearly all referable to living species now inhabiting the coast; a few however belong to the fauna of Florida and the West Indies. As to its elevation, M. Tuomey† is of opinion that along the whole line of the coast of South Carolina it does not exceed eight feet. "There is no sudden break any where separating it from the beds now in progress of deposition, for it dips gently under the waves of the ocean, and the fossils are often found mingled with living species. So life-like indeed do the shells appear, that it requires the presence of forms no longer inhabitants of the coast, to satisfy one that he is not looking at a recent shell-bed." Like the fossils of the Laurentian along the Kennebec, the shells have even retained their specific colors and markings.

We have already stated, on Sir Charles Lyell's authority, that this formation extends uninterruptedly to the mouth of the Neuse in North Carolina. There indeed, Mr. Conrad long since described a deposit of Post-pliocene, with thirty-four species of marine shells, all identical with those of South Carolina. He found here also the *Gnathodon cuneatus*, a species inhabiting brackish water, together with remains of terrestrial animals.‡

The portion of the coast north of the Neuse, between it and the Chesapeake Bay, bordering on Albemarle Sound and James River, has not as yet been sufficiently examined to allow us to indicate the precise boundaries of the various tertiary and quarternary formations. There is, however, little doubt that the Pine-barrens belong to the most recent deposits; and it would seem that the Post-pliocene occupies here a much wider belt than it does farther south beyond the Neuse.

As to Chesepeake Bay itself, it has been ascertained that the deposits upon its borders belong, partly at least, to the Post-pliocene. As early as 1830, Mr. Conrad called attention to a remarkable deposit of this description at the mouth of the Potomac, which he designated then as upper tertiary.§ The same naturalist published in 1842, in the proceedings of the National Institute, the following list of shells collected there.‖

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* Report on the Geology of South Carolina, p. 212.

† Ibid., p. 188.

‡ Am. Journ. of Arts and Sciences, Proc. of the National Institution, 1842, p. 190.

§ Journal of the Academy of Natural Sciences of Philadelphia, 1830.

‖ It has been a matter of much controversy whether the oyster beds which occur in a sub-fossil state on the Patuxent and in many other places upon the low level plains adjacent to the creeks and rivers along the coast of the middle states, belong to the same formation, as it is supposed by Mr. Conrad, or whether they are due to human agency. As a proof that they were not collected by Indians, it is stated that at the mouth of the Potomac they are covered by the diluvium, which if true would at once settle the question. It is moreover stated by Mr. Conrad that the character and position of these oyster beds is such as to correspond with those of the Gnatho-

Arca transversa, *Say.*
Arca ponderosa, *Say.*
Corbula contracta, *Say.*
Gnathodon cuneatus, *Gray.*
Cytherea Sayâna, *Conrad.*
Mactra lateralis, *Say.*
Mya arenaria, *L.*
Mytilus hamatus, *Say.*
Nucula limatula, *Say.*
Nucula acuta, *Conrad.*
Pandora trilineata, *Say.*
Petricola pholadiformis, *Lam.*
Pholas castata, *Lam.*
Sanguinolaria fusca, *Say.*
Tellina lusaria (Psammobia lusaria,) *Say.*
Solecurtus caribæus, *Lam.*
Solen ensis, *Lam.*
Venus mercenaria, *Lam.*

Actæon melanoides, *Conrad.*
Crepidula convexa, *Say.*
Crepidula glauca, *Say.*
Fusus cinereus, *Say.*
Buccinum obsoletum, *Say.*
Buccinum trivittatum, *Say.*
Natica duplicata, *Say.*
Ranella caudata, *Say.*

There is some probability that the regularly stratified beds of dark-blue clay at Baltimore and along the Chesapeake and Delaware Canal, with its beds of lignite and decayed trees, together with the mingled mass of diluvium which reposes upon it, belong to the same formation. We are also inclined to refer to this group the various beds of brilliant sands and dark and white clays which form the banks of the Delaware at and about Bordentown, although we have not as yet heard of any of the characteristic shells having been found in them. The same may be said of the superficial deposits between the Chesapeake and Delaware, which extend over the State of Delaware and a great part of Maryland and New Jersey.

It is not until we reach Long Island that we again meet with fossil remains, (at Brooklyn near New York.) And although the deposits which contain them are somewhat irregular, still the identity of the fossils with others occurring in regular layers both to the north and to the south seems to settle the question of their synchronism.* Indeed we need only to proceed a little farther north, to the Island of Nantucket, to find the same species in an undisturbed condition, forming regular beds and oyster-banks among the stratified layers of clay and sand, as for instance in the cliffs of Sancoti head, where the oysters, the Venus mercenaria, the Serpula and others occur exactly in the same position in which they lived and and died.

On comparing the species from the bluffs of Sancoti head on the island of Nantucket with the above mentioned list from the Potomac or with the list of the Post-pliocene fossils of South Carolina as given by Mr. Tuomey, I find that among the seventeen species which I collected at Sancoti head,† there are but six which do not occur there, viz., *Astarte castanea, Cardita borealis, Ostrea*

don on the Potomac, which might with just as much reason be referred to Indian agency. Oyster beds of that description occur in Cumberland county, at Egg Harbor on the Severn, at Easton in Maryland, upon the York river in Virginia, and upon various other rivers of the southern states.

* Among the species which I collected at Brooklyn are Venus mercenaria, Mya arenaria, Ostrea borealis, Buccinum undatum, Buccinum trivittatum, all of which occur in the Post-pliocene of South Carolina.

† See the list of the fossils of Sancoti Head, farther below.

borealis, *Buccinum undatum*, *Buccinum plicatum* and *Scalaria groenlandica*, so that it may be fairly assumed as palæontological evidence that the same ocean extended from Georgia and Florida to Cape Cod.

Along this whole coast the Post-pliocene shells, as has already been stated, belong exclusively to recent species, such as now inhabit the neighboring shore. There is, consequently, no proof whatever that the climate was colder than that of the same region at the present day. On the contrary there are positive indications of a milder climate, as was already noticed by Mr. Conrad, who remarked with regard to the Post-pliocene fossils on the Potomac, "the fossils of this locality with two exceptions, are common recent species of the Atlantic coast, and in some instances the original colored markings remain upon the shells. Were it not for the occurrence of *Gnathodon cuneatus*, *Mytilus hamatus* and *Arca ponderosa*, the group would not vary much from that now inhabiting the coast, as far north as Massachusetts; but the presence of these three bivalves indicate that a climate equivalent to that of Florida prevailed, when the shells of this locality were living in the sea."* Mr. Conrad was led to make a similar remark in relation to the fossils of the Neuse, which, with two exceptions, are likewise such as now exist on the coast of the southern Atlantic states and in the Gulf of Mexico. The two exceptions are again *Gnathodon cuneatus* and *Arca ponderosa*.

The island of Nantucket does however not by any means mark the northern boundary of the Post-pliocene fauna. The same species occur farther north, in the vicinity of Boston. A glance at the list of species collected at Sancoti Head (Nantucket) by Mr. Edw. C. Cabot and myself, compared with the list of the species of Point Shirley (Boston harbor) as given by Mr. Stimpson,† will show how clear the resemblance is.

Sancoti Head (Nantucket).	*Point Shirley (Boston).*
Balanus rugosus.	Balanus rugosus.
Pagurus pollicaris (claws).	Mya arenaria.
Serpula.	Solen ensis.
Mya arenaria.	Mactra solidissima.
Solen ensis.	Venus mercenaria.
Arca transversa.	Astarte sulcata.
Venus mercenaria.	Astarte castanea.
Astarte castanea.	Cardita borealis.
Cardita borealis.	Mytilus edulis.
Ostrea borealis.	Modiola modiolus.
Cumingia tellinoides.	Ostrea borealis.
Crepidula fornicata.	Fusus decemcostatus.
Buccinum undatum.	Buccinum plicosum.
" plicosum.	Buccinum trivittatum.
" trivittatum.	
" obsoletum.	
Scalaria groenlandica.	

* Proceedings of the National Institution, 1842, p. 190.
† Proceedings of the Boston Soc. of Natural History, vol. iii.

A glance at these two lists will be sufficient to show that the formations which contain these shells cannot but belong to the same epoch, however different they may be in structure and materials. Moreover, the fossils of Point Shirley, like those of the Neuse and the Potomac, seem to indicate that the climate was by no means colder, but on the contrary rather warmer than at the present day. There indeed we find in considerable quantity the *Venus mercenaria*, whereas at the present day it occurs but scantily in Massachusetts Bay. So likewise do we find *Buccinum plicosum* among the fossils of Point Shirley, whereas its natural habitat now is south of Cape Cod.

On the other hand, we have shown elsewhere that the resemblance is almost as close between the fossils of Nantucket and Point Shirley on one hand, and those of the valleys of Maine, Lake Champlain and the St. Lawrence on the other. The leading species in both regions are the same, except that a few of the Nantucket species, such as *Venus mercenaria*, *Cumingia tellinoides* and some of the Buccina have disappeared, or are replaced on the St. Lawrence by species which do not occur south of Cape Cod, as for instance, *Cyprina islandica*, *Mytilus edulis*, *Pecten islandicus*, *Saxicava rugosa*. But on the whole the difference is not greater than that which usually occurs between recent species from corresponding latitudes, for instance between a collection of shells from the coast of Maine and one from Long Island or Cape Cod.

As far as palæontological evidence goes, there seems to be sufficient reason to consider the Post-pliocene of the south as the equivalent of the Laurentian of the north. There is moreover evidence enough to warrant the conclusion that at the time of their deposition, the climate, far from being colder, was *throughout* warmer than at the present day.

There are nevertheless some striking differences between the Post-pliocene of the south and the Laurentian of the north, which deserve to be considered.

First, the Laurentian deposits of the north occur at much higher levels than the pliocene of the south. We have stated before on Mr. Tuomey's authority, that on the whole coast of South Carolina the average height of the pliocene does not exceed eight feet; and, according to Mr. Lyell, its elevation along the whole coast from Georgia to North Carolina is less than twenty feet. At Nantucket, on the contrary, the fossil oyster bank occurs at a height of thirty feet; which is also the elevation at which the Venus mercenaria and other species are found at Point Shirley. At Brooklyn near New York, they exceed 100 feet in height. Their elevation at Augusta on the Kennebec is about 70 feet. At Lake Champlain they occur at 200 feet. At Moira on the Northern railroad they are found at 310 feet; at the mouth of the

St. Lawrence they reach a height of 390, and at Montreal as much as 470 feet. It is evident therefore, that the changes of level by which the shells were raised to their actual position in these various localities must have embraced a much wider range at the north than at the south.

Another and more striking difference between the two deposits is afforded by the erratic boulders. It is well known that over all New England and the greater part of New York, including Long Island, there occur a quantity of boulders scattered over the surface or buried within the detrital formations; and moreover these boulders can all be traced back to some northern origin more or less remote, showing that they have travelled from north to south. But in proceeding farther south, they vanish gradually. There are very few in the vicinity of Philadelphia and Baltimore, or if they occur occasionally, as for instance along the Potomac at Washington and in the neighborhood, they are of a different kind and can be traced to some rock within the Alleghanies. Some of them contain even fossils characteristic of formations which occur beyond the Blue Ridge.

Proceeding still farther south, to North and South Carolina, we lose sight of the boulders entirely; Mr. Conrad states that he never saw a single boulder on the surface of the state of Alabama. But the stratified deposits with which they are associated at the north continue uninterruptedly. It is indeed not a little remarkable that the only difference which M. Tuomey recognizes between the Post-pliocene and the diluvium consists in the absence of boulders in the former. "I have," says he, "nowhere in the state (South Carolina) seen one (boulder) a foot in diameter, nor have I met with a single bed that I could refer to this formation (diluvium) along the tertiary plane from the Mississippi to the Potomac."* The same author adds that, as we proceed southwards, the "materials become finer and finer. The large pebbles are succeeded by gravel and coarse sand, and towards the coast they are replaced by the fine sands blown about by the winds."

The question then will be asked how it happens, that both formations (Laurentian and Post-pliocene) being contemporaneous, the one contains boulders, whilst the other contains none? Was there some barrier which prevented the northern boulders from proceeding farther south than New York and New Jersey? And if such a barrier existed, why do we not find any trace of it? Or do the last boulders about New York indicate that the agency by which they were transported had exhausted its power? But in that case they ought to decrease in size from north to south whereas we know that the boulders on Long Island are as voluminous and heavy as those occurring farther north through-

* Ibid, p. 189.

out New England and Canada. Geologists have proposed various solutions of this great problem. To examine them all would lead us far beyond our limits. I shall therefore merely allude to some of the theories, and point out the characteristic features of each.

The most ancient theory, and at first sight the most simple, is that which ascribes the transportation of the boulders to a violent action of the waters, progressing from north to south either in form of currents (according to Sefström, von Buch, Elie de Beaumont) or in form of earthquake waves (according to Profs. Rogers), such as are sometimes known to sweep over the islands of the Pacific and to cover them with debris. In each of these hypotheses it is assumed that the momentum of the current or earthquake wave went on decreasing gradually and that the limits of the boulders mark the place where its power of transportation became exhausted. This explanation appears indeed to be borne out in various localities of the interior of the country, as was pointed out by us elsewhere.* But there is this objection to its application to the littoral regions under consideration. It must be assumed, in accordance with the well known facts, that wherever a transportation by water takes place, there is a constant relation between the size of the materials and the momentum of the transporting current or wave; the former decrease in size and weight in proportion as the force by which they are impelled decreases. Now such is not the case on Long Island, Martha's Vineyard, Nantucket and along the coast of New Jersey. There the materials are generally finely comminuted and regularly stratified, indicating at the first glance that they have been deposited in a quiet manner. On the surface of these strata of fine sand we find the boulders scattered here and there, generally on the prominent points, as for instance on the island of Nantucket, and generally as large if not larger than those farther north. In such cases, it is obvious that no theory depending on aqueous currents can be sufficient to account for the phenomena.

Another theory which has had some currency, is that which ascribes the transportation of boulders to the former existence of gigantic glaciers, covering the northern hemisphere and extending as far south as the latitude of New York. It is supposed in this theory that the boulders were transported on the surface of the glaciers, and the underlying masses of sand and gravel were considered as the remains of the bottom moraines. The circumstance that the southern limit of the large boulders coincides pretty nearly with that of the ground and polished rocks seemed at first to confirm this view, and it seemed fair to assume on that

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* Foster and Whitney's Report on the Geology of the Lake Superior Land District.

ground that the boulders did indeed indicate the limits of the ancient glaciers. On closer examination it was found, however, that the glacier theory could not apply to the region under consideration, in as far as the materials which underly the boulders are not only stratified, but moreover contain a quantity of fossil remains, which indicate that a considerable amount of time must have elapsed between the furrowing of the rocky floor and the transportation of the surface boulders. Now if the furrows and scratches have been made by glaciers, it is evident that the boulders resting on the surface of the stratified sand must have been transported at a much later period. In the glacier theory of M. de Charpentier (which is also advocated by M. Agassiz) it is assumed on the contrary that the furrowing of the rock and the transportation of the boulders are simultaneous, that they are the result of the same agency.*

The third and most popular theory is that which ascribes the transportation of the boulders to the agency of ice rafts. When we consider the striking contrast which exists between the size of the boulders and the minuteness of the materials on which they rest, which excludes all idea of their having been assorted, and consequently of all violent action, there is indeed sufficient reason to look upon this theory as the best adapted to solve the problem. Supposing the boulders to have been packed in ice which was driven by wind and current from north to south along the coast, it seems natural that these rafts should have been stranded upon the prominent points of the coast and adjacent islands which at that time were shoals, dropping there their burden of boulders.

There is, however, a difficulty even in this theory, viz., the circumstance that the ice-rafts must have reached frequently as far south as New York, whereas at the present day it is very seldom that they are driven as far south.† To assume that the boulders on Long Island and the coast of New Jersey were transported on ice-rafts would therefore be tantamount to assuming that the climate was colder than at the present day. And yet we have the testimony of the shells buried underneath the boulders to show that far from being colder, the climate was rather warmer. An explanation of this difficulty may perhaps be found in the fact that the greater part of the boulders overlie the fossils

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* Whether the furrowing and polishing of the rocks is really the result of glacier action, and whether the materials of the stratified clay, sands and gravel-deposits were *first* transported by glacier and *afterwards* merely displaced and rearranged, are questions which I do not intend to discuss at present. My object here is merely to prove that the boulders could not have been brought into their *actual* position by glaciers.

† A few icebergs have been seen as far south as New York, but, as far as I know, no field-ice.

and are therefore referable to a later period in which the climate may actually have been colder. This however is a mere hypothesis.*

The foregoing remarks apply more especially to the boulders along the sea-shore from New England to Long Island and part of New Jersey. From all the evidence we possess it seems highly probable that they were transported on ice-rafts along the sea-shore and stranded on the ridges and eminences which were then shoals along the coast. The next question then is, whether this mode of transportation applies likewise to the boulders occurring in the interior of New York and Pennsylvania, or whether we have to look for another agency?

It has been stated before that the last boulders of northern origin occur in New Jersey, a little south of New York. But according to Prof. H. D. Rogers, they are chiefly limited to the sea-shore, and it would appear as if the highlands of New Jersey had acted as a barrier, preventing them from spreading south, except through the channels of the rivers. Indeed there can be no doubt that the few boulders in the neighborhood of Philadelphia are confined to the valleys, and on ascending the uplands in the neighborhood of the city we find that they disappear. The valley of the Delaware was such a channel by which a few northern boulders were conveyed farther than they would otherwise have reached.

The valleys of the Susquehanna and the Potomac contain also a great many boulders, but those of the latter, it seems, are without exception derived from the Appalachian chain itself, whereas among those of the Susquehanna, there may be some of northern origin intermingled with those of the neighboring mountain. According to Prof. H. D. Rogers, there are evidences in each of these valleys of a violent rush of waters, which is supposed to have carried along with it the boulders which the valleys contain. But whether the same can be said of the boulders occurring at a distance from the mountains, as for instance those in the neighborhood of Washington, seems to us rather doubtful; for in leaving the gap of the Blue Ridge, the current would necessarily have abated and it is difficult to conceive how it could have borne along the same boulders over an almost level country as far as Washington. Indeed we need only to look at the position in and about the last named city, to be convinced that they cannot but have been transported by the same agency which transported those of Long Island, viz., by floating ice. The materials accompanying them moreover confirm this.

* It might perhaps be assumed on hygrometric principles, that the area of water being greater at the time of the transportation of the boulders, there was a greater amount of evaporation causing more moisture and consequently more snow and ice.

The absence of boulders constitutes, however, not the only difference between the Post-pliocene of the South and the Laurentian of the North. Whilst the latter is an exclusively marine formation, the Post-pliocene is said to contain besides remains of land and freshwater animals. M. Tuomey mentions in the Post-pliocene of South Carolina some bones (in a bed of mud on Edding's island) which he is inclined to refer to the Megatherium. M. Conrad, speaking of the deposits on the Neuse of North Carolina, says that they are "of more than common interest in consequence of the quantity of bones of land animals which are mingled with the shells."* According to Sir Ch. Lyell, the Post-pliocene of Georgia contains, besides the marine shells, some beds filled with freshwater shells which are said to be identical with species living actually in the neighborhood. It is farther stated that the same freshwater beds contain remains of many land animals, among them, bones of Mastodon,† Elephas, Mylodon, Megatherium, horse, ox and Harlanus, a peculiar genus allied to Lophiodon. It is moreover stated by Sir Ch. Lyell that the bones, especially those of Megatherium, are by no means injured and their position is such as to convey the idea that whole skeletons must have been floated by a river to the place where they are found buried. On the strength of these statements it has been taken for granted that the above named quadrupeds must have lived *during the Post-pliocene period.*

Now if it be true, as we have endeavored to prove, that the Post-pliocene and Laurentian are parallel formations, it would follow that the mastodon and its kindred existed on this continent at the time of deposition of the Laurentian of the North. Such an inference, however, would conflict with our knowledge of the position of mastodon remains throughout the northern states, where they have never been found in the Laurentian, but occur invariably in deposits of a more recent date, such as river terraces, peat-bogs, &c.

Before taking it for granted that the deposits containing bones of mastodons and elephants in Georgia are really Post-pliocene, it might be well to inquire whether they may not belong to a later epoch, as the very suggestion of Lyell, "that the skeletons must have been floated by rivers," seems to imply. We might, in like manner, point out various localities at the north where mastodons were said to occur *in the drift*, but which, after closer examination, were found to belong invariably to a more recent epoch.

The remarks of M. Tuomey respecting the bones mentioned by him among the Post-pliocene fossils of South Carolina, "that

* Proceedings of the National Institution, 1842, p. 191.
† M. Tuomey mentions also the same elephant in the pliocene of South Carolina.

they occur in a bed of mud," seems also to justify the supposition that they may belong to a later period.

On the other hand, we know that the remains of mastodon and elephants are found associated with land and freshwater shells in the bluffs of the lower Mississippi, and that on that account these bluffs have been parallelized by geologists with the river terraces of the North which we know to be more recent than the Laurentian and to belong to the alluvium. Should it be proved that the deposits with mastodon bones throughout the states of Georgia and South Carolina do not belong to the true Post-pliocene, but are, like those of the North, of a more recent origin, there would no longer be any difficulty in the way of identifying the Laurentian and the Post-pliocene as one and the same formation, whereas the beds containing mastodons at the South, together with the river terraces of the North and the valley drift of the West, including the loam bluffs of the Lower Mississippi and the celebrated deposits of Big-Bone Lick, would represent another more recent period, *that of the alluvium,* which passes gradually into the historical period, if it does not actually belong to it.

But should it ever be shown that the mastodon remains of the state of Georgia are really associated with true Post-pliocene shells, it does not by any means follow that it would contradict our views as to the parallelism between the Laurentian of the North and the Post-pliocene of the South. The question might then be asked whether the absence of remains of land animals at the North could not be accounted for, merely by supposing that the changes of level which were going on at that time were too considerable, and the extent of dry land at the time of the greatest depression of the Laurentian sea too small to support such huge animals, whereas the extensive tertiary plains of the southern states, which were then dry land, might well have afforded a convenient home for them. In this case it would appear that they subsequently migrated to the North, where at the beginning of the alluvial period, the area of dry land began to be sufficiently extensive.

These are problems which are well worthy the attention of American geologists.

Art. X.—*Mineralogical Notices;* by Prof. Meneghini of Pisa.*

* * * Professor C. Bechi, one of my friends, is about publishing some analyses of Tuscan minerals in our official report, and as they will be nearly lost to science in the large volume, I take the liberty of transcribing for you in brief, our observations. The analyses are by Prof. Bechi.

Galena.—Of the following galenas, No. 1, is a coarse granular variety from Bottino near Seravezra; 2, 3, fine granular, from the same locality; 4, fine granular from Argentiera in Val di Castello; 5, octahedral crystals (Jargionite of M. Bechi) from the same locality.

	S	Pb	Sb	Fe	Cu	Zn	Ag		
1.	12·840	80·700	3·307	1·377	0·440	0·024	0·325	=	99·013
2.	15·245	78·238	4·431	1·828	trace	——	0·485	=	100·227
3.	15·503	78·284	2·452	2·811	——	——	0·560	=	99·610
4.	16·780	72·440	4·308	1·855	4·251	——	0·650	=	100·284
5.	15·62	72·90	5·77	1·77	1·11	1·33	0·72	=	99·22

The last variety appears to resemble Bleischweif and is probably identical with *Steinmannite.* Its specific gravity is actually 6·932.

Fahlerz in fine crystals is found at Angina, Val di Castello. Analysis (agreeing closely with that by Kersten),

S	Sb	Cu	Zn	Hg	Fe	Ag		
24·1413	26·5240	37.7172	6·2311	3·0313	1·6360	0·4500	=	99·7309

Feather ore (*Heteromorphite*), *Boulangerite, Jamesonite* and *Meneghinite* from *Bottino.* Analyses:

	S	Sb	Pb	Cu	Zn	Fe	
1. Capillary Heteromorphite,	18·395	30·186	47·681	1·110	1·085	0·255	= 98·712
2. Acicular "	19·250	29·244	49·311	2·000	0·211	——	= 100·016
3. Massive Boulangerite,	17·994	26·085	53·154	1·242	1·407	0·350	= 100·232
4. Acicular "	17·822	26·740	55·390	1·250	0·085	0·230	= 101·517
5. Capillary Jamesonite,	20·5335	32·1576	43·3830	1·2453	1·7356	0·9450	= 100
6. Meneghinite,	17·522	19·284	59·214	3·540	——	0·344	= 99·904

A third variety of the *Boulangerite* is fibrous compact. These three forms are very distinct, and the last perfectly resembles Zinkenite; the analyses conduct closely to the Boulangerite formula, $3PbS+SbS^3$. The external characters of the *Jamesonite* are those of Heteromorphite, but the analysis gives the formula of Jamesonite $3PbS+2SbS^3$, as deduced by M. Bechi.

The *Meneghinite* is a new species, established by M. Bechi. It occurs in compact fibrous forms, very lustrous: H.=2·5. The analysis leads to the formula $4PbS+SbS^3$, a compound hitherto unnoticed.

* From a letter, to J. D. Dana, dated Pisa, March 10, 1852.

Copper glance (Chalkosine, *Beud*).—Analyses:—

	S	Cu	Fe	
1. Monte Catini,	20·50	76·54	1·75	= 98·79
2. "	17·631	63·864	2·426,	F̶e 15·750, = 99·671
3. Monte Vaso,	15·734	58·500	1·450	" 24·125, gangue 0·125=99·934
4. "	15·480	57·785	1·333	" 25·000
5. S. Biagio,	24·5249	40·8925	15·8282	—— gangue 17·9350=99·1806
6. "	15·9771	31·4370	8·8559	—— " 42·1195=98·3895

The last two analyses are only of metallurgical interest, as the copper glance was mixed with copper pyrites. The oxyd of iron in the three preceding, is evidently a mechanical mixture.

Chalcopyrite or Copper pyrites, and Erubescite.—Analyses:

	S	Cu	Fe,	Gangue.	
1. Chalcopyrite, Castellina Marit.,	30·072	27·540	38·800	3·450	= 99·862
2. " Les Capanne Vecchie,	30·348	18·008	43·336	8·624	=100·316
3. " Val Castrucci,	35·617	34·091	30·292	——	=100·000
4. " Ferriccio,	41·306	15·960	38·484	4·250	=100·000
5. " Mt. Catini,	36·155	32·788	29·750	0·863	= 99·556
6. " Riparbella,	30·092	27·540	38·832	3·250	= 99·714
7. " Campiglia,	34·030	31·300	34·670	——	=100·000
8. Erubescite, Mt. Catini,	24·926	55·880	18·028	——	= 98·834
9. " "	23·363	59·472	13·868	0·750, F̶e 1·500	=98·953
10. " "	23·415	59·672	13·868	2·687	= 99·642
11. " Miemo,	23·983	60·160	15·088	——	= 99·231
12. " Ferriccio,	24·700	60·007	15·889	——	=100·596
13. " Castagno,	24·108	52·288	18·192	4·748	= 99·336
14. " Rocca a Sillano,	20·015	46·700	13·700	18·350	= 98·765
15. " L'Impruneta,	21·044	46·300	15·600	16·500	= 99·444
16. " Mnte Castelli,	22·031	58·276	12·134	7·560	=100·001
17. " Les Capanne Vecchie,	18·088	45·130	11·125	25·750	=100·093

The analyses of chalcopyrite appear to lead to the formula in which the proportions of the two sulphurets are variable, e. g. $4Cu^2 S+5Fe^2 S^3$, $Cu^2 S+3Fe^2 S^3$, etc. Those of Erubescite seem to establish for the species the single formula (Fe, Ꞓu)S, instead of several formulas containing the two sulphurets in various proportions.

Zigueline.—Analyses:

	O	Cu	
1. From Les Capanne Vecchie,	11·22	88·78	
2. " Elba,	10·88	86·12	mixed with native cop. 3·00=100

The Elba zigueline is crystallized in cubes, and frequently with pseudomorphs of malachite.

White Antimony.—It occurs at Pereta with Stibine in small acicular crystals. Analysis:—

O	Sb	Fe	Gangue.
19·470	78·830	1·250	0·750=100

Marmatite.—Found at Bottino near Serravezza, well crystallized in tetrahedrons and also massive.

1. In tetrahedrons,	S 32·117	Zn 50·901	Fe 11·441	Cd 1·226	Fe S^2 0·750=96·435
2. massive,	33·653	48·110	16·232	Cu and Cd *traces*	=97·995

The formula is 4(Zn, Cd) S+Fe S, or (Zn, Cd, Fe) S.

Oxyd of Zinc.—Occurs on the marmatite. Composition,

Zn O 31·725 $\quad \dddot{\overline{\text{Fe}}}$ 47·450 $\quad \dot{\text{H}}$ 20·825=100

It is evidently a mechanical mixture, and the oxyd of iron may be derived from the Franklinite mixed with the oxyd of zinc.

Braunite.—A compact variety from the island of Elba afforded:

$\acute{\text{O}}$ 3·080, $\dot{\text{M}}\text{n}$ 88·310, $\dddot{\overline{\text{Fe}}}$ 4·750, $\dot{\text{Ba}}$ 1·025, $\dddot{\text{Si}}$ 0·751, $\dot{\text{H}}$ 2·084=100, $=\text{Mn O}+\text{Mn O}^2$

Chromic Iron from near Volterra. Analysis:—

$\dddot{\overline{\text{Cr}}}$ 42·130 $\quad \dot{\text{Fe}}$ 33·933 $\quad \dddot{\text{Si}}$ 4·750 $\quad \dddot{\overline{\text{Al}}}$ 19·835=100·648

Silicated Chrome (Wolchonskoite?):

$\dddot{\text{Si}}$ 28·357 $\quad \dddot{\overline{\text{Cr}}}$ 8·112 $\quad \dddot{\overline{\text{Al}}}$ 41·333 $\quad \dot{\text{H}}$ 22·750=100·552

An argillaceous earth containing oxyd of chrome occurring near Volterra afforded,

$\dddot{\overline{\text{Al}}}$ 63·158 $\quad \dddot{\overline{\text{Fe}}}$ 8·183 $\quad \dddot{\overline{\text{Cr}}}$ 5·770 $\quad \dddot{\text{Si}}$ 5·925 $\quad \dot{\text{H}}$ 19·266=102·302

The point of especial interest connected with these three minerals is, that they have originated from the decomposition of the diallage of Euphotide. All the transitions from the diallage to the chromic ochre may be traced out. The chromic iron forms seams which thin out downward. The metamorphosis seems to have been due to ancient sulphur exhalations, ("Soffione,") traces of which are still seen in places even now emitting vapor and incrusted about with chalcedony.

I am also indebted to my friend, Prof. Bechi, for several analyses of silicates from the Gabbro rosso.

Caporcianite.—Monoclinic; the forms are referable perfectly to Heulandite and are very near that species in the angles; M : T= 131°, M : T on ā =150°. Cleavage extremely easy parallel to P and T, and easy also parallel to M: with a light shock the crystals fall to acicular fragments. Also in macles, and imperfectly radiated foliaceous. H.=3·5. G.=2·470. Color flesh-red; lustre pearly. Faces M minutely striated. Only the smallest fragments transparent. Composition:

$\dddot{\text{Si}}$	$\dddot{\overline{\text{Al}}}$	$\dot{\text{Ca}}$	$\dot{\text{Mg}}$	$\dot{\text{K}}$	$\dot{\text{Na}}$	$\dot{\text{H}}$
52·015	22·833	9·675	1·114	1·112	0·250	13·168=100·197

Formula, $2\dot{\text{Ca}}\,\dddot{\text{Si}}+\dddot{\overline{\text{Al}}}^2\,\dddot{\text{Si}}^3+6\dot{\text{H}}$. The analysis agrees quite nearly with that by Anderson, and we might deduce from it the other formula, $\dot{\text{Ca}}^2\,\dddot{\text{Si}}^3+2\dddot{\overline{\text{Al}}}\,\dddot{\text{Si}}+6\dot{\text{H}}$, which, however, is much less accordant with analogies. Dissolves easily in acids and forms a jelly even in the cold. The solution gives a precipitate with oxalate of ammonia. Heated in a glass tube, yields water. B.B. fuses to a white enamel without intumescence. It occurs in geodes incrusted with crystals of calcite in the Gabbro rosso of Mt. de Caporciano at L'Impruneta and several other places; and sometimes it is accompanied by native copper.

Picranalcime.—Monometric; trapezohedral and cubo-trapezohedral. Cleavage cubic, very distinct. H. = 5. G. = 2·257.

Lustre vitreous; colorless to flesh-red and colophonite-red. Composition:

	$\overline{Si}$	$\overline{Al}$	$\dot{Mg}$	$\dot{Na}$	$\dot{K}$	$\dot{H}$
1.	59·347	22·083	10·250	0·450	0·015	7·650=99·795
2.	58·875	22·083	10·000	0·450	0·015	7·688=99·111

Oxygen ratio 1 : 3 : 8 : 2, like analcime. Formula, $(\dot{Mg}, \dot{Na}, \dot{K})^3 \overline{Si}^2 + 3\overline{Al}\,\overline{Si}^2 + 6\dot{H} =$ (supposing the protoxyds magnesia alone) $\overline{Si}$ 57·96, $\overline{Al}$ 24·14, $\dot{Mg}$ 9·41, $\dot{H}$ 8·22 = 99·73. The formula $2\dot{R}^3\,\overline{Si}^2 + 5\overline{Al}\,\overline{Si}^2 + 10\dot{H}$ would correspond to $\overline{Si}$ 58·43, $\overline{Al}$ 23·05, $\dot{Mg}$ 10·71, $\dot{H}$ 8·08=100·27; but the preceding is to be preferred. Dissolves in the acids, and the solution gives with potash a flocculent precipitate which moistened with nitrate of cobalt and heated, becomes of a blue color. In a closed tube gives water. B. B. fuses with difficulty. Covers the interior of geodes in the Gabbro rosso, or the surfaces of contact between the Gabbro and the Ophiolite, sometimes having a metallic nucleus and enveloped in the steatitic paste of the metalliferous dyke. Often accompanied with Calcite, Caporcianite and Picrothomsonite.

Picrothomsonite.—Trimetric. Mass radiated in one direction, and in a direction normal to this laminated according to two cleavage directions equally easy parallel to $\bar{M}$ and $\breve{M}$. H. = 5. G. = 2·278. Lustre pearly; white; transparent in small fragments; very fragile. Composition:

$\overline{Si}$	$\overline{Al}$	$\dot{Ca}$	$\dot{Mg}$	$\dot{Na}, \dot{K}$	$\dot{H}$
40·356	31·251	10·993	6·265	0·285	10·790=99·940

Formula $2(\dot{Ca}, \dot{Mg})^3\overline{Si} + 5\overline{Al}\,\overline{Si} + 9\dot{H} = \overline{Si}$ 40·08, $\overline{Al}$ 31·83, $\dot{Ca}$ 10·55, $\dot{Mg}$ 7·58, $\dot{H}$ 10·00=100·04. It differs a little from that of Thomsonite, in having the ratio of the protoxyd and peroxyd silicates 2 : 5 instead of 2 : 6, and in the proportion of water also being a little smaller. Dissolves even in cold acids and gelatinizes, and the solution is precipated by oxalate of ammonia. In a tube yields water. B. B. fuses to a white enamel with intumescence. Occurs with Picranalcime and Caporcianite in the Gabbro rosso.

Portite, (a new species dedicated to M. Porte, "qui a fait renaitre l'art minéraire en Toscane").—Trimetric; in radiated masses, with cleavage very distinct parallel to the faces of a rhombic prism of about 120°. H=5. G=2·4. White; opaque; lustre vitreous. Composition:—

$\overline{Si}$	$\overline{Al}$	$\dot{Ca}$	$\dot{Mg}$	$\dot{Na}$	$\dot{K}$	$\dot{H}$
58·125	27·500	1·759	4·873	0·157	0·100	7·917=100·431.

Formula $(\dot{Mg}, \dot{Ca})^3\overline{Si}^2 + 4\overline{Al}\,\overline{Si}^3 + 7\dot{H} = \overline{Si}$ 58·36, $\overline{Al}$ 25·95, $\dot{Mg}$ 7·71, $\dot{H}$ 7·95. The resemblance of this formula to that of Harmotome will be noticed, and also to that of Phillipsite. We might almost consider it a magnesian harmotome; yet there is too large a difference in the proportion of water, which, I believe, justifies giving it a different name. Dissolves in acids even in the cold, and gelatinizes. The solution whitens slightly when gently heated with oxalate of ammonia and affords but a very small precipitate with potash. In a closed tube yields water. B. B. intumesces much and affords a milk-white enamel.

Sloanite.—Occurs with the preceeding. Trimetric; and in radiated masses with very distinct cleavage parallel to all the faces of a rhombic prism; M : M=75° and 105°. H=4·5. G=2·441. White; opaque; pearly; transverse fracture irregular, but frequently in a plane at right angles to the radiation of the prisms. Composition:—

$\bar{\bar{\text{Si}}}$	$\bar{\bar{\text{Al}}}$	$\dot{\text{Ca}}$	$\dot{\text{Mg}}$	$\dot{\text{Na}}$	$\dot{\text{K}}$	$\dot{\text{H}}$
42·187½	35·000	8·119	2·670	0·250	0·030	12·500=98·756½

Formula $(\dot{\text{Ca}}, \dot{\text{Mg}})^3\bar{\bar{\text{Si}}}^2+6\bar{\bar{\text{Al}}}\,\bar{\bar{\text{Si}}}+12\dot{\text{H}}=\bar{\bar{\text{Si}}}$ 42·47, $\bar{\bar{\text{Al}}}$ 35·41, $\dot{\text{Ca}}$ 9·69, $\dot{\text{H}}$ 12·41. The formula is analogous to that of the other zeolites (Mesole, Brevicite, Liebnerite, etc.;) and also to species out of this group, excepting the water, such as Rosite and Polyargite. I have named this species after Mr. Sloane, proprietor of the mine of Mt. Catini. Dissolves in the acids, even in the cold, and gelatinizes, and the solution is precipitated by oxalate of ammonia. In the closed tube yields some water. B. B. fuses without intumescence to a white enamel.

Schneiderite.—Occurs with the preceding, in the Gabbro rosso, along with Humboldtite (?). Mass confusedly laminato-radiate; white; opaque. H=3. Composition:—

$\bar{\bar{\text{Si}}}$	$\bar{\bar{\text{Al}}}$	$\dot{\text{Ca}}$	$\dot{\text{Mg}}$	$\dot{\text{K}}$ & $\dot{\text{Na}}$	$\dot{\text{H}}$
47·794	19·382	16·765	11·029	1·621	3·409=100.

Formula, $3(\dot{\text{Ca}}, \dot{\text{Mg}})^3\bar{\bar{\text{Si}}}^2+\bar{\bar{\text{Al}}}^3\,\bar{\bar{\text{Si}}}^2+3\dot{\text{H}}=\bar{\bar{\text{Si}}}$ 45·98, $\bar{\bar{\text{Al}}}$ 19·16, $\dot{\text{Ca}}$ 31·49, $\dot{\text{H}}$ 3·35. I have proposed this formula with much hesitation, finding no like compound among the known zeolites; the species is named after M. Schneider, director of the mine of Mt. Catini. Dissolves in acids, even in the cold, and gelatinizes, and the solution is precipitated by oxalate of ammonia. In a closed tube yields water. B. B. fuses with intumescence to a blue enamel.

Savite.—Dimetric. In acicular rectangular prisms, a centimeter long, very slender, terminating in pyramids or truncated; radiating; colorless; transparent. H=3·2. G=2·450. Composition:—

$\bar{\bar{\text{Si}}}$	$\bar{\bar{\text{Al}}}$	$\dot{\text{Mg}}$	$\dot{\text{Na}}$	$\dot{\text{K}}$	$\dot{\text{H}}$
49·167	19·663	13·500	10·520	1·230	6·575=100·675.

Formula, $(\dot{\text{Mg}}, \dot{\text{Na}})^3\,\bar{\bar{\text{Si}}}^2+\bar{\bar{\text{Al}}}\,\bar{\bar{\text{Si}}}+2\dot{\text{H}}=\bar{\bar{\text{Si}}}$ 49·555, $\bar{\bar{\text{Al}}}$ 18·364, $\dot{\text{Mg}}$ 14·564, $\dot{\text{Na}}$ 11·079, $\dot{\text{H}}$ 6·438. We might deduce $(\dot{\text{Mg}}, \dot{\text{Na}})^3\,\bar{\bar{\text{Si}}}+\bar{\bar{\text{Al}}}\,\bar{\bar{\text{Si}}}^2+2\dot{\text{H}}$, and there are some analogies for it as well as for the other. The oxygen ratio for the protoxyds, peroxyds, silica and water, 1 : 1 : 3 : $\frac{2}{3}$, is new; and I trust the species may prove to be well-grounded, and worthy to bear the name, justly famous, of M. Savi. Soluble in the acids; the solution gives with potash a flocculent precipitate, which affords a blue color when moistened with nitrate of cobalt and heated. In a closed tube yields water. B. B. fuses with great difficulty. Occurs with Picranalcime in the Gabbro rosso.

Humboldtite, (Datholite.)—Monoclinic, and apparently like the figures of Levy. Composition:—

$\dddot{Si}$	$\bar{\bar{A}}l$	$\dot{C}a$	$\dot{M}g$	$\ddot{B}$	$\dot{H}$
37·500	0·852	35·341	2·121	22·033	1·562=99·413.

Formula, $2(Ca^3\,\dddot{Si}^4+3\dot{C}a\,\ddot{B})+\dot{M}g\,\dot{H}^2=\dddot{Si}$ 38·75, $\dot{C}a$ 35·36, $\ddot{B}$ 21·93, $\dot{H}$ 1·87, $\dot{M}g$ 2·09. The mineral of the Seisser Alp gives the same composition. Dissolves in the acids, forming a jelly, and oxalate of ammonia gives an abundant precipitate, which dried, dissolved in alcohol, and inflamed, affords a flame colored green on the borders. B. B. fuses very easily. Occurs with Schneiderite, in the same manner as at the Seisser Alp, associated with Apophyllite in geodes in the Gabbro Rosso.

Art. XI.—*Notice of A. Quekett's Practical Treatise on the use of the Microscope.**

The first edition of Mr. Quekett's work appeared at a time when there was a general dearth of books on practical microscopy. With the exception of the small works of Chevalier, Dr. Goring and Mr. Pritchard, all of which were written with a view to praise and sell the microscopes of their own construction, and in which the least possible amount of practical information was introduced, no book of any note or character had been for a long time published. In this lapse of time it was evident that microscopy had made considerable progress, and some work was needed, in which this progress would be faithfully detailed, as an assistance to those who were already workers in the field and as a guide to those who desired a practical acquaintance with the subject, and were unable to obtain the necessary information.

Mr. Quekett's work, evidently the result of much practical knowledge, was therefore warmly welcomed, and the rapid sale of the entire edition, has proved abundantly that the book was both needed and appreciated.

With all its value however, it had, as a general practical work, some important faults: many of omission and some of commission; these it was hoped and believed would be rectified in the second edition, which comes to us "with numerous additions,"

* A Practical Treatise on the use of the Microscope, including the different methods of preparing and examining animal, vegetable and mineral structures; by John Quekett, Assistant Conservator of the Museum, and demonstrator of minute anatomy at the Royal College of Surgeons of England. Second edition, with additions, illustrated with 12 plates, and 270 wood engravings. London: H. Ballière, 219 Regent St., and 290 Broadway, New York. 8vo, pp. 515. 1852.

and the hope on the author's part that the present volume "will be found more worthy of notice."

In the brief space to which we are limited we can only examine the points of difference in the two editions.

The second edition contains fifty-one pages, three plates, and twenty-nine wood engravings not in the former one. The general plan of the book is unchanged.

To the history of the microscope, and the chapter on the simple microscope, nothing has been added. The chief part of the chapter on compound microscopes is devoted to the description of the instruments made by Ross, Powell and Lealand, and Smith and Beck. These descriptions have the same fault as was generally complained of in the first edition: the author does not proffer any advice, as to which form he has found to have the most advantages and fewest defects. In this chapter we have mention of a new London maker, Mr. Pillischer; also of Mr. King of Bristol and Mr. Abrahams of Liverpool. These three, however, receive but faint praise, though "report speaks well" of Mr. Abrahams.

Following this we have a description of "foreign microscopes," occupying nine pages, including five large figures. The want of information about other instruments than those of London make, was justly complained of as a prominent fault in the first edition. This seems to have been represented to Mr. Quekett, who however does not admit that it was a fault, if we may judge from the preface to the present volume. "It having been objected, that no mention was made of foreign microscopes in the first edition, this seeming omission is remedied by the description of all the best instruments now manufactured by our continental neighbors." This description however, so unwillingly given is miserably meagre, and we believe by no means does justice to the opticians whose instruments are noticed. We can here only allude to two of them, M. Oberhauser, and M. Nachet of Paris.

The instrument of M. Oberhauser, "for general purposes," figured at page 107, is a deformed little microscope, with a compound body of about five inches in length, if the figure be rightly proportioned, and the fine adjustment placed on the top of the arm which supports the compound body. This is described as a sample of the Oberhauser microscope. The figure is little less than a libel, and we venture to assert that Oberhauser has not made such an instrument within the last five years. We have seen many of his microscopes in private hands and on sale, and we never saw one answering to the description here given. In a foot-note we are informed, as the latest information in regard to Oberhauser's microscopes, that he "has placed the fine adjustment at the bottom of the support of the compound body instead of at the top. He has also increased the length of the compound body." This is as he has made them for the last five years to our certain knowledge, and perhaps longer. Not a word about his improvements within the last year or two, of his new "horse-shoe stand," moveable mirror for obtaining oblique light, &c., and yet some instruments of this form have reached this country.

So with regard to Nachet's microscopes: the one figured and described (p. 108) is one of Nachet's more common and cheaper forms. No allusion to his inclined microscope, which allows, even when inclined, the body and stage to be revolved on their support, and not a single word of commendation for his objectives, which will favorably compare with those of London make, and are furnished at about one-fourth the price. These descriptions are therefore both imperfect and unjust.

Under the head of foreign instruments we should have been justified in expecting to find some notice of American microscopes, particularly those of Mr. Spencer's construction, and this especially as the first edition of Mr. Quekett's work contained a slighting notice of Mr. Spencer, and an imputation upon the correctness of his description of the then new test, Navicula Spencerii, which we should have thought Mr. Quekett would have been glad to have corrected. But Mr. Spencer's name has been altogether suppressed, the full-length imaginary portrait of the Nav. Spencerii as "faithfully delineated" by Mr. Warren De la Rue, who discovered "depressions or perforations" where none existed, is omitted, and were it not that in the list of test-objects furnished by Mr. Topping, the N. Spenceri appears, shorn of its Latinity, we should have no knowledge that any such optician ever existed. And yet it is a matter of record that the humble little shell which bears his name, from his having first resolved it with his own lenses, puzzled the bravest of the English microscopists for several weeks, after it had been thoroughly resolved on this side the Atlantic. We say that we might have expected some notice of Mr. Spencer in the list of the "principal foreign" microscope makers, but the meagre account given of other principal makers reconciles us to the omission.—Mr. Spencer has been guilty of the unpardonable fault of teaching English opticians something—that 135° was not the "largest angular pencil that can be passed through a microscopic object-glass," (1st ed. p. 431,) but that it might be increased to 160°, and lately even to 174½°; that there were more difficult test-objects than the Podura scales and Nav. angulata, the latter of which is still recommended as a good test for "an $\frac{1}{8}$th or $\frac{1}{12}$th" (2d ed. p. 394) and then "generally mounted dry"! (p. 411)—and that lines closer than the $\frac{1}{48.608}$ of an inch apart, were by no means "near to the utmost limit that the position of a line can be ascertained." (1st ed. p. 442.) For these and similar offences, Mr. Spencer's name and occupation have been suppressed.

The chapter on magnifying powers closes the first part of the book, which we cannot pass over without congratulating Mr. Quekett on the correction of the egregious blunder contained in the 1st edition in two places, pp. 73 and 160, that when the Ramsden eye-piece is used, "the image of the object is not reversed as in the Huyghenian form: hence it has received the name of a positive eye piece." We observe it stated that "the whole of the former edition" has been revised by Mr. Lister and Mr. Jackson.

The several chapters on the Use of the Microscope, we are obliged to pass over entirely, merely remarking that they seem to be more complete, than the corresponding chapters in the first edition: we are glad to see that Mr. Goadby justly receives more credit for his methods of preparing and mounting objects, than was previously accorded to him.

Mr. Hett's name appears also with just commendation as a preparer of objects in human and comparative anatomy. We consider his preparations as superior to those of other London anatomists.

No new information is furnished in regard to obtaining or mounting fossil infusoria. The same complicated directions are given for the preparation of infusorial earth, (that from Richmond is taken as an instance,) by digesting it in hydrochloric acid, then boiling it in nitric acid, then washing it, a process which requires several days. If Mr. Quekett had read Professor Bailey's published directions for obtaining the silicious shells from this or almost any infusorial earth, by simply placing the earth in a conical vessel, an ordinary wine-glass for example, adding a little water, stirring it briskly for a few seconds, when the shells will rise to the surface and adhere to the sides of the glass,—he might have spared his readers who consult him on this head, much trouble.

The localities out of England in which infusoria may be found, are given with a remarkable degree of vagueness. Thus we are informed that recent infusoria are found "in America, in seven localities." If the number had been stated at *seven thousand*, it would still have fallen much below the real number, for there is hardly a pond or stream in the country, which will not at some season yield beautiful and remarkable species.

So in the localities of fossil infusoria, we have in both editions "Rapp*en*hanock-cliff, America," and "Richmond, North America." Considering that the infusorial deposit at Richmond is one of the most extensive and richest in beautiful forms of any in the world, and as such is generally known to all microscopists, we should have thought that in the lapse of time between the two editions, Mr. Quekett might have arrived a little nearer the precise locality of Richmond, than North America. We would suggest that should Mr. Quekett's work reach a third edition, he may safely affirm Richmond to be in the United States of North America, leaving the particular State in which it is located, to be determined by future geographical researches.

The chief advances made in microscopical apparatus, since the former edition of the work before us, seem to be in an immense number of condensers and illuminating prisms. No less than eight new forms of this kind of apparatus are described and figured, and some more complicated than the microscope itself. Many of these pieces of mechanism are for obtaining oblique light, for ever since Mr. Spencer demonstrated how much better certain lined-objects could be defined by very oblique light, opticians have not been slow to act upon the information; and the stages of English miscroscopes are usually so thick that it is impossible to obtain any great amount of obliquity from the mirror.

The most faulty chapter in the whole book is the one on test-objects. This is common ground on which all microscopists meet, and no better evidence can be offered of the improvements in microscopes of late years, than the gradual adoption of more difficult tests, for the same focus object-glasses. Only a few years ago, the Navicula Hippocampus was sent to this country from England as the test *par excellence*, and within the last six months we have seen an advertisement of a Dublin optician, whose $\frac{1}{12}$th "will shew that severe test, the Nav. Hippocampus, perfectly well," and yet many gentlemen who were present last August at the Scientific Convention in Albany, will remember to have seen that "severe test" thoroughly defined by one of Mr. Spencer's *half-inch* objectives.

Mr. Quekett has not only furnished no description of any new test, but as before stated, he has omitted the account of the Nav. Spencerii, which was a severer test than any he has described; not that we object to the omission of that description, or the plate, for both were grossly erroneous as to measurements and general structure. To be sure, in the appendix we are informed in a short paragraph, that two new tests, the Nav. Amicii and the Grammatophera subtilissima "from America," have been employed, both of which "Mr. Ross' object-glasses of $\frac{1}{12}$th of an inch focal length, and 152° angular aperture, exhibit satisfactorily." If so, why not have described and figured them for the benefit of those who have passed beyond the Podura, and N. angulata, and wish to know what they must look for in the new tests, both of which have now been before the microscopic world for more than two years. Such a plate might well have taken the place of Mr. De la Rue's "Scale of Amathusia Horsfieldii," which, in addition to its being altogether inappropriate to such a work, had been already elsewhere published: besides, after the "faithful delineation" of the N. Spencerii in the first edition, we are not inclined to attach much value to any drawing Mr. De la Rue has the "kindness to furnish."

In conclusion, while we cordially recommend Mr. Quekett's work as by far the best to be obtained on practical microscopy, yet we must protest that it by no means furnishes a complete exposition of this branch of microscopical science. The second edition continues to be what the first emphatically was, *an account of the state of microscopy in London.* As such we believe it to be faithful and correct. H. V. A.

Art. XII.—*On the Resinous Nature of Coal.*

Read before the Boston Society of Natural History, 7th April, 1852, by J. E. Teschmacher.

The paper I last read before the Society, advanced the proposition that, the Stigmaria so abundantly and so universally found in the coal formations, was a resinous plant, identical with the genus Picea. I will now support this by evidence tending to show the existence of other Coniferous plants at this period, as well as the general resinous nature of coal of all descriptions. The following specimens are produced for this purpose.

1st. A slice of southern pine (Pinus Australis) in which, owing to its resinous nature, the glandular vessels of the coniferous tribe are very clearly visible.

2d. A slice of the same carbonized, in order to show the appearance of these glands when changed by this action.

3d. A specimen of anthracite, and one of Cumberland coal, in which these glandular vessels are extremely distinct. Such specimens are quite common in the Pictou and other coal.

4th. Impressions in the shale, from Carbondale, Pa., of the leaves of a species of Pinus.

5th. A specimen of the same shale, showing an impression of the base of a bunch of leaves and its sheath at the junction, with the stem.

On comparing the latter with the accompanying specimen of the Pinus australis of the present day, its close resemblance is very evident, fitting the impression almost as if moulded from it.

On the side of the recent specimen adjacent to the axis of the branch, is a protuberance formed by the vessels which penetrate the bark, and depressions on each side thereof; the impressions of these in the shale although faint, bear a close resemblance. In many of the leaves of the recent fir tribe, there are rows of glands extending from the base to the summit, and in some, very minute spines on each edge: it cannot be expected that these microscopic characters should be visible in impressions on so coarse a material as the shale, but no doubt they will be found when similar impressions are discovered in the coal itself. Other impressions of leaves of Coniferæ are in my collection, some in the anthracite, but although I have little doubt of their being leaves, they are not so undeniable as to be exhibited as proofs.

I pass on to chemical evidence.

Lehman, in his Physiological Chemistry states that, *formic acid* is found in coal during the process of decay (eremacausis), and also that it is found in the berries of the Juniperus, and in the cones of several of the fir tribe. Redtenbacher finds formic acid in the leaves and twigs of the fir tribe during the fermentation (incipient eremacausis). A few years ago Pelletier and Walther examined the products of the distillation of resin tar, and found therein two substances which they named *retinnaphtha* and *retinnyle*, and then the well-known *naphthaline.* The progress of organic chemistry has since shown the former substances to be the *Toluole* and *Cumole* of the present day. In 1849, Mansfield, at the instigation of Dr. A. W. Hoffman, investigated the products of the distillation of coal-tar from gas works, chiefly, however, with the view of ascertaining the boiling points of the various educts.

He tabulates the neutral results of his distillation as follows:

1st.	Benzole	$C^{12}H^{6}$		
2d.	Toluole	$C^{14}H^{8}$	the retinnaphtha	of Pelletier and
3d.	Cumole	$C^{18}H^{12}$	" retinnyle	Walther.
4th.	Cymole	$C^{20}H^{14}$		
	and then Naphthaline.			

I will now simply advert to the opinion of Göppert, in his prize essays. He supposes the origin of the coal to be from a fermentation, and consequent eremacausis of vegetable matter. Others suppose this vegetable matter to have been chiefly mosses, such as form the large accumulation of peat. My view is that coal is chiefly composed of resinous trees (conifers) and oleaginous trees (palms), these latter being in excess in the cannel coal.

I now wish to show that all coal has been formed from nearly the same original materials, and probably nearly under the same circumstances, from the anthracite to the most bituminous. This I propose to do by exhibiting these specimens selected from many hundreds in my possession, of anthracite coal from Pennsylvania, of cannel and bituminous coal from the Cumberland basin, and from Hillsboro'; specimens from Pictou and other localities might have been added. The comparison of these, the exact similarity in their structure, marks of organisms, and peculiar fracture, can leave but little doubt on the subject; they exhibit, however, but a small portion of the resemblances manifest on a minute and extended examination.

From what cause, then, can arise the difference in various coals? At present only three characters of diversity are apparent: specific gravity, quantity of carbon, and quantity of hydrogen. To show this the following descending scale may be used.

	Hydrogen.	Carbon.	Specific gravity.
Asphaltum,	9 per cent.	78·10	1·063
Hillsboro' Coal,	———	———	1·09 to 1·12
Cannel, "	5·66 to 6·00	81·00	1·28
Bituminous " various,	4·80 to 5·60	81 to 86	1·29 to 1·32
Anthracite, "	2·40 to 4·20	89 to 92	1·34 to 1·47
Graphite,	none	99	2 to 2·27

The difference in specific gravity and carbon seems to depend on the diminution of the hydrogen. How this has been separated, whether by a process of time, of pressure, of heat, or as is most probable, by a process of which we are entirely ignorant, must be a subject for future investigation.

It must be obvious that the foregoing is but a very faint outline of some of the results of my yet imperfect examination of this subject, imperfect, mainly because the means of a more perfect one are yet out of reach. The chemical analyses of coal have hitherto been undertaken chiefly with commercial views, and altogether to obtain ultimate principles. But the daily operations of the gas works exhibit products, showing that much has yet to be done in these analyses, to satisfy the increased progress in the science of organic chemistry. My own experience has also led me to the conclusion that much more remains to be accomplished in the study of the internal structure and contents of coal*, and that the vast and varied coal formations of this immense continent, are chiefly to be relied on as the fields of this study.

The consequences to geology, should the truth of my views be finally sustained, are obviously of importance, with respect to the present opinion on central heat, on the atmospheric state of these early periods, and on other points, on which this is not the proper time to enlarge.

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* On the application of heat many anthracites separate into laminæ as thin as paper. These are alternate layers of hardened resinous hydrocarbon, and of vegetable matter, often retaining in its state of ashes its original forms; this last is the first burned out, leaving the laminæ of the former exposed. A chemical comparison of the ashes of the vegetable layers, selecting only that part where form permits no doubt, with the ashes of recent plants, particularly of Coniferæ and Equisita, would be very interesting.

Art. XIII.—*Description of a Slide on Mount Lafayette, at Franconia, New Hampshire;* by President Edward Hitchcock.

In August, 1851, in company with S. C. Carter, Esq., of Amherst, Mass., and Mr. Daniel Bliss, of the senior class in Amherst College, I visited the White Mountains of New Hampshire. We first went to Franconia Notch, and from thence we ascended La Fayette Mountain, which, without attempting great accuracy, I made, by the aneroid and syphon barometers, 5,164 feet above the ocean. It can be ascended only by a very wretched foot-path, among vast quantities of detritus, with most of the surface covered with low evergreens, whose thick-set branches make it almost impossible to force our way through them, if not previously cut out. The ascent is about three miles, and the view from the summit as grand, for aught I could see, as that from Mount Washington, which is about 2,000 feet higher.

In our descent from the mountain, I noticed a hundred rods to the right of the path, and perhaps a thousand feet below the summit, the commencement of a slide; and the large amount of rock laid bare at its upper end, incited a desire to visit the spot. From thence the slide took a southerly direction, passing down a deep ravine, which, within a mile, seemed to approach near to the path by which we ascended, and still farther down, we thought it could not be very distant from the Notch House Hotel, from whence we started. With great difficulty we clambered over the angular blocks, and through the tangled bushes, to the head of the slide. Having taken courses a little diverse, we lost sight of one another; and it was with great difficulty that we at length formed a reunion again, at the head of the slide. There we saw a mass of naked gneiss rock, many rods wide, mostly denuded of soil, and much of it also of several layers of the rock, which had slid downwards, and were strewn along the sides of the ravine, for at least two miles. This naked surface, at its upper part, had a slope of about 38°. Lower down, however, it was much less, for the most part, and at its termination the descent was slight. A brook commenced quite as high I think as the slide, and this increased rapidly as we descended, until it became a streamlet of considerable size within five or six miles.

But I will first describe some of the unexpected perils we met in our descent, as a caution to those who traverse mountainous regions covered with unbroken forests. At first the rock in the bed of the slide was so steep and smooth that it was with difficulty we worked our way downward. And then, if we tried to walk along the bank, so irregular and loose was the detritus piled up in ridges, and so tangled the brush a little beyond, that to get along was still more hazardous and difficult. We went safely forward, however, till we reached that part of the ravine nearest the footpath, through which we had ascended. But we found ourselves several hundred feet below it, and the spruces so thick and matted together, that to make our way through them seemed a formidable undertaking, and so we concluded to follow down the stream till we should come to the mouth of a brook, which we knew passed the tavern and emptied into this ravine. Onward we went, stepping from stone to stone in the bottom of the creek, until we began to suspect something wrong; and my pocket-compass showed me that the ravine was turning gradually to the right, so as to carry us towards the mountain-range, and away from the hotel. The stream was from one to two rods wide, and the banks covered with trees from eighty to one hundred feet high, so that we could see only a short distance on either hand. We passed the mouth of the brook, which we meant should be our guide, without observing it. It was impossible over such a road to judge of the distance we had travelled, but it seemed very long; yet we did not dare to leave the stream, lest we should lose our way in the vast forest. A commencing rain towards night made the prospect the more gloomy, as we had no means of making a fire.

On we still went, and the stream finally was so much enlarged, that we could no longer step from stone to stone, along its bed, so that we were obliged to get on as we could through the brushwood, and among the rocks on the shore. At length, turning my eye towards the top of a steep hill, that formed the bank, I thought I saw through the forest, a single stump bearing the marks of an axe. One of our number ascended the hill and announced a cleared field and a farm-house in sight. Cheered by the discovery we pushed forward, and ere long were resting in a farmer's kitchen, before a good fire. We ascertained, on inquiry, that we had followed the stream six miles from its source, and had advanced three miles beyond the hotel. The farmer's wagon conveyed us thither, in the early part of the evening, and though excessively fatigued, sleep restored us, so that on the morrow we went on our way.

But though we met with such unexpected difficulties in this case, as geologists we were amply repaid for all our anxieties and fatigue. It was just such an example as I had long wished to find. An enormous mass of detritus, probably from ten to twenty feet thick, and in some places two or three rods wide, composed of irregular fragments of all sizes, from twenty feet diameter down to sand, had deen driven forward, over a rocky surface two miles long. What now was the effect upon the rocky floor? Did it score and striate that floor as was done by the drift agency, as some suppose would be done by the crowding forward of detritus by the power of water? I found it was not so. The rock in place was smoothed, but not striated; except in a few places, perhaps, in the slightest manner. The fundamental rock passed over, is gneiss, but it is traversed occasionally by veins of granite, and towards the upper part by dykes of trap several rods wide. They are such rocks, indeed, as in various places retain distinct markings of the drift action. I conclude, therefore, that the drift agency must have been somewhat different from that which produced this slide.

The beds of detritus, produced along this slide, are so closely like those of glacier origin, that we may call them *moraines*. They are larger and more distinct than I have seen on any other slide. All along the borders of the ravine, are ridges of blocks, gravel, and sand, sometimes twenty feet high, lying in as much confusion as is possible, and making it difficult, and even dangerous, to go into, or out of, the ravine over the loose and crumbling ridges. At the lower end of the slide is a large terminal moraine, by which the river has been forced, to seek a new channel. This terminal moraine is in fact double, that is, an old moraine lies in advance of that produced by the slide of 1850. The blocks of the two being easily distinguished by the appearance of recent of more ancient erosion. In short, the appearances along this gulr are almost precisely what they would be, if a glacier in one of the valleys of the Alps should melt away. And when examining it, I had no doubt that the slide was produced by the advance of a mass of ice. Yet I noticed that in some places, the lateral moraine was driven in among the trees, without affecting them, and subsequently I learned, that the slide took place in June, 1850, in consequence of a powerful shower of rain.

In some places near the bed of the slide, I noticed the stumps of trees, perhaps six inches diameter, that had been broken off by the descending mass.

We were so struck with the perfection of these moraines, that we ventured to call this hitherto nameless stream, *Moraine Brook;* and we entered it as such on the register at the hotel. If any wish to get an idea of the moraines of the Alps without the glaciers, I would advise them to visit this spot.

A little below the terminal moraine, we found springs issuing, strongly impregnated with iron, which, with a little fitting up, might be serviceable to the numerous visitors of the Franconia hotel, where so many objects of interest are clustered together.

Some of the trap that has been denuded by this slide, is columnar. I saw none such in place, but one or two very distinct examples of hexagonal joints lay along the bed of the stream.

I learnt at the hotel that Moraine brook lies at the best possible route for a horse-path, to the summit of La Fayette. No such path now exists; but I understood it to be the intentions of the proprietor of the hotel to construct one. If he will do this, so as to lead the traveller along this slide, and past the mineral spring, and thence to the summit, it will be a most interesting route. At present, ladies, unless very robust and courageous, will hardly venture to scale this mountain. But with such a path they would find it much more accessible than Mount Washington, because the distance is little more than half as great; and as the view from the summit of La Fayette is equal in my opinion to that from Washington, I think the former would be the chief centre of attraction, to visitors to the White Mountains. Since these mountains afford scenery of unusual interest, and as an excursion thither is eminently conducive to health, I am anxious to see inducements multiplied for making this summer excursion more frequent.

Art. XIV.—*On Coral Reefs and Islands*; by James D. Dana. Part Eighth.—With a Map.

Geological Conclusions from the Sturcture and Composition of Coral Reefs and Islands.

The geological bearing of the facts that have been detailed, has probably been already perceived by our readers. A brief recapitulation, however, may afford a convenient review of the subject. The following are the points of more special interest.

I. The *coral reef-rock* has been described as solid limestone of coral origin. In some parts it is a coral conglomerate, or breccia, made up of fragments firmly cemented. Over much larger areas it is a fine white limestone, as compact as any secondary marble, and as homogeneous in texture. It is often free from any traces of organic life, or proofs of an organic origin. Only now and then an imbedded shell or some other relic evinces that animals of any kind were living in the seas. This white limestone breaks with a conchoidal fracture, a splintery surface, and rings under the hammer. These facts are of great importance in deciding upon the origin of the older limestone strata. Other portions of the rock, of less extent, are made of standing corals with the intervals filled in by reef-debris, and the whole cemented solid. The latter variety here mentioned prevails in the inner patches growing in quiet waters. The former kind is common about outer reefs, since large areas in the coral plantation are mere sand. It is still more abundant, forming the bottom among the inner patches, or in the lagoons, where the finer detritus is washed by the sea. A glance at the chart of the Feejees or at the Kingsmills, (a copy of which, from Capt. Wilkes's Narrative is inserted in this volume,*) will show how large a portion of the reef increases from these fine accumulations. The exterior of a coral island, for a few hundred yards, excepting some islets within, is the only part which is the proper growth of the living reef. Within the exterior reef the coral structure may consist almost wholly of the compact homogeneous white limestone we have described. The elevated island of Metia was for a long time after elevation exposed to the ravages of the sea, before the present shore-reefs accumulated to give it protection. Proofs of degradation along the coast have been referred to. There is much reason, therefore, for believing that the Metia now existing, exposes on its eastern and southern sides at least (where particularly examined by us) the interior of the original structure; and this view is supported by the compact character of the rock.

These reef-rocks receive also large contributions of sand or fragments from shells, which unite with the coral debris.

Besides the coral rocks formed beneath the waters surface, the beach or drift sands and gravel form stratified deposits of considerable extent, either bordering the shores within the range of the tides, or raised some distance above them. These drift-sand formations may cover the forming island and contribute largely to its progress; and sometimes they accumulate into drift hills forming when consolidated, hills of rock occasionally 60 or 80 feet in height. The rock is often loose and friable, but sometimes quite solid. The layers of the beach rock have a nearly constant dip of a few degrees, not exceeding eight, towards the water. The rock of the drift-hills or accumulations is more finely laminated, less firmly cemented, and dips whichever way the accumulating sandhill sloped, the layers being the successive sheets of sand which were drifted over it.

II. Coral reefs, though they may stretch along a coast for scores of miles, are seldom a single mile in width at the surface: and if elevated above the sea, they would stand as broad ramparts separated by passages mostly 20 to 200 feet deep, and often of great width. The substratum, however, is continuous coral-rock; and if these more elevated parts were removed by any process, after an elevation, they would leave an area of coral limestone often as extensive as the whole reef-grounds. This is at once seen from the figures of the Kingsmill chart and others on a preceding page. In an island like Deans's, one of the Paumotus, these reef-grounds are 1000 square miles in extent. It is true that the reefs at the surface gradually widen if the land is undergoing no subsidence. But when situated on a sloping bank, as usual, this

* This chart presents to the eye a map of one of the most remarkable reef-grounds in the world; and the whole theory of coral islands is illustrated in its different parts, in the fullest and clearest manner.

widening gradually renders the bank steeper, and the rate of increase in width is rapidly diminished. And if the bank were not sloping, there is still reason to believe that the patches would not attain a great width at the surface of the sea, owing to the currents sweeping over them, occasioned partly by the position of a growing reef; and that therefore there would be unoccupied intervals or channels, as above alluded to, between the several reefs of a reef-ground.

The bearing of these facts upon the character and origin of ancient limestones, and the formation of channels, or valleys in such rocks, is apparent without particular explanation.

III. The occurrence of coral sand forming the exposed beaches, while the finer coral mud exists on the shores of the smaller lagoons, or at the bottom of the larger, affords an interesting illustration of the result produced by a triturating sea, as compared with that from more gently agitated waters. The rude seashore waves give rise to sand or pebbles; while the gentle undulations or ripplings of inland waters produce mud by their finer trituration. In the latter case the finely comminuted matter is retained beneath the quiet waters, in the former the rude action washes it away.

IV. The almost total absence of fossils from many parts of the coral reef-rock, and generally from the shore sandrocks, is one of the most striking facts here exemplified. These rocks are formed in the midst of life, and out of the enduring remains of animals; yet fossils, (as shown at Metia and other elevated reefs,) are often rare.

This absence of organic remains characterizes almost invariably the *drift* sandrock. On Oahu, where this rock forms hills thirty or forty feet in height above the reef-rock, not a fossil nor a fragment of one was distinguished by us, neither of shells nor corals. This fact had been previously remarked by some of the intelligent residents, and it was a matter of dispute whether one or two shells had not been found. These formations are but a few rods from waters prolific with the productions of the sea, and were made from them.

An explanation of this peculiarity, is obvious on the principle already discussed—the action of a triturating sea. Everything washed towards the shores, is ground down by this action and reduced to sand; and a large part of the sand is worn out and carried off by the sea; or, being thrown up by the reef, is blown inward by the winds.

It is a natural inference from these facts, that the non-fossiliferous sandstones of our continents are no good evidence of the absence or sparing diffusion of animal life in the seas about whose shores they may have been formed. If this destruction of fossils is so complete when the sands are of limestone, much more rapid and thorough should it be when they are siliceous. As the sea by its action bears off the finer material, and leaves only what is in the condition of sand or a coarser material, the lime of fossils might be almost wholly removed from among siliceous sands, and hardly a trace remain which the chemist could detect.

V. The formation of *chalk* from coral is known to be exemplified at only one spot among the reefs of the Pacific. The coral mud described appears to be a fit material for its production; and when dried it takes much the appearance of chalk. This fact was pointed out by Mr. Darwin, and was suggested to the writer by the mud in the lagoon of Honden Island. Still it does not explain the main point; for under all ordinary circumstances, this mud solidifies into compact limestone, instead of chalk. This appears, moreover, to be the result which should be expected. What condition then is necessary to vary the result, and set aside the ordinary process?

The bed of chalk referred to was not found on any of the coral islands, but in the elevated reef of Oahu, of which reef it formed a constituent part. It is twenty or thirty feet in extent, and eight or ten feet deep. The rock could not be distinguished from much of the chalk of England: it is equally fine and even in its texture, as earthy in its fracture, and so soft as to be used on the blackboard in the native schools. Some imbedded shells look precisely like chalk fossils. It consists, according to an analysis by Prof. B. Silliman, Jr., of

Carbonate of lime,	92·800
Carbonate of magnesia,	2·385
Alumina,	0·250
Oxyd of iron,	0·543
Silica,	0·750
Phosphoric acid and fluorine,	2·113
Water and loss,	1·148

The locality is situated on the shores just above high tide level, near the foot of Diamond Hill. This hill is an extinct tufa cone, near seven hundred feet in height, which rises from the water's edge, and in its origin must have been partly submarine. It is one of the lateral cones of eastern Oahu, and was thrown up at the time of an eruption through a fissure, the lavas of which appear at the base. There was some coral on the shores when the eruption took place, as is evident from imbedded fragments in the tufa; but the reef containing the chalk appeared to have been subsequent in formation. There is no certain proof yet ascertained of any connection between the fires of the mountain and the formation of the chalk.

The facts leave the subject of the origin of chalk still in uncertainty. Its fine earthy texture is evidence that the deposit was not subaerial seashore accumulation, as only sandstones and conglomerates, with rare instances of more compact rocks, are thus formed. Sandrock making is the peculiar prerogative, the world over, of shores exposed to waves, either marine or fresh water. We should infer, therefore, that the accumulations were produced either in confined areas, into which the fine material from a beach may have been washed, or on the shores of shallow, quiet seas: in other words, under the same conditions nearly as are required to produce the calcareous mud of the coral island. But, although the agency of fire in the result cannot be proved, it is by no means improbable, from the position of the bed of chalk, that there may have been a hot spring at the spot occupied by it. That there were some peculiar circumstances distinguishing this from other parts of the reefs, is evident; and this appears to be the only probable supposition. If this be admitted, the existence of an elevated temperature might be suggested for certain areas during the deposition of the chalk strata. It is well known that heated waters dissolve lime much less readily than cold; and this might be a reason for its inferior hardness and earthy texture. The character of the cretaceous deposits presents many interesting points bearing upon this subject; but a discussion of them would be out of place here, as our object is simply to state such inferences as the facts observed among existing reefs may have suggested.

This coral chalk has been examined microscopically by Professor Bailey, for infusoria and polythalamia, without detecting anything of this kind. It appeared to contain nothing organic.

VI. The analyses have shown that ordinary corals consist mainly of carbonate of lime. There is a small proportion of fluorids and phosphates, with some silica, alumina, and oxyd of iron. These fluorids and phosphates, existing in the coral, must exist also in the limestone rock made from coral. It is probable from some trials made by Prof. Silliman, Jr., that these constituents may be found also in many shells.

From the several analyses of corals by Mr. Silliman, we infer that the fluorids and phosphates amount, on an average, to about ¼th per cent., or 0·25 parts in a hundred of coral: and the amount in the same manner of the phosphates, is 0·05 per cent. A cubic foot of coral, as deduced from the average specific gravity, weighs one hundred and fifty-seven pounds, and consequently, in each cubic foot, there must be full six and one-fourth ounces of fluorids, and one and one-fourth ounces of phosphates: and in each cubic rod seventeen hundred pounds of fluorids, and three hundred and forty pounds of phosphates. These fluorids are fluorids of calcium and magnesium, and the phosphates, phosphates of lime and magnesia. To obtain the amount of these ingredients in a reef a mile long, half a mile wide and a hundred feet deep, the estimate for a cubic rod should be multiplied by 320,000; which will give for the fluorids more than five hundred millions of pounds.

Late geological researches have placed it beyond doubt that the various limestones consist mainly, like coral limestone, of animal remains, among which, in many instances, corals have a conspicuous place. These limestones often contain crystallizations of fluorid of calcium (fluor spar); and in other beds which have been acted upon by heat, and thus rendered crystalline, there are, besides this mineral, crystallizations of apatite, (phosphate of lime,) and chondrodite (consisting of fluorine, magnesia and silica). Moreover, these are among the most common minerals of such limestones. The above facts supply us with a full explanation of their origin. The fluorine, phosphoric acid, magnesia, and silica present, are adequate for all results, without looking to other sources for the elements of these disseminated minerals. Instead, therefore, of being extraneous minerals introduced into the limestone rock, they are (or may be in some instances) an essential part of its constitution. And they have been separated from the general mass by a segregation of like atoms, under well-known principles, while the rock was subjected to an elevated temperature. The fluorid of calcium appears to crystallize without much heat; but apatite and chondrodite are found mainly in *granular* limestones, which show, by their crystalline texture, that they have been subjected either to a very high temperature, or to one long continued of more moderate degree.

Lord Byron, of the Blonde, states that specimens of *phosphate of lime* (apatite,) were actually collected on Mauki, of the Hervey Group, one of the elevated coral islands.

VII. The cementation of coral sand along shores and beneath the sea is illustrated among all reefs, and is the process by which reef-rocks are formed. The sea-water receives some carbonate of lime into solution, and again deposits it among the deposited sand and fragments which lie compacted together. The same process takes place among the beach sands and the drift heaps. The eminences of drift sandrock at the Sandwich islands were covered in part by a smooth, solid crust, two or three lines thick, and made of layers like stalagmite, which was formed by the solution of lime from the surface by the rains, and its deposition again on evaporation.

The waters of the sea have been found to contain a small proportion of free carbonic acid, which is sufficient to enable it to dissolve the carbonate of lime of the corals.

Analyses of the coral limestone of the elevated coral island Matea, by Prof. B. Silliman, Jr., have determined the singular fact that although the corals themselves contain very little carbonate of magnesia, this salt is largely present in some specimens of the rock. The rock is hard (H. = 4·25), and splintery in fracture, with the specific gravity 2·690.

Carbonate of lime, . . .	61·93
Carbonate of magnesia, . .	38·07*

Another specimen from the same island, having the specific gravity 2·646, afforded 5·29 per cent. of carbonate of magnesia. The first was a compact, homogeneous specimen, and the other was partly fragmentary. Recent examinations of coral sand, and coral mud from the islands, give no different composition, as regards the magnesia, from that for corals. The coral sand from the straits of Balabac afforded carbonate of lime, 98·26, carbonate of magnesia, 1·38, alumina, 0·24, phosphoric acid and silica, a trace.

We cannot account for this supply of magnesia except by referring to the magnesian salts of the ocean. It is an instance of dolomization, during the consolidation of the rock beneath sea-water, and throws light on this much vexed question.

This subject is illustrated, and the view we sustain confirmed, by an article on the formation of dolomite from carbonate of lime, published in the Naturwissenschaftliche Abhandlungen edited by W. Haidinger, (4to. Vienna, 1847.) According to von Morlot, in this paper, Haidinger has recently shown both by the frequent association of gypsum with dolomite, and by chemical experiment, that carbonate of lime and sulphate of magnesia, when together, undergo a double decomposition, the magnesia taking the place of part of the lime, and the excluded lime combining with the sulphuric acid set free. The result is *magnesian carbonate of lime*, (dolomite,) and *hydrous sulphate of lime*, (gypsum,) the latter being separated, and either continuing in solution or solidifying, according to the amount formed or the proportion in the water. Von Morlot gives figures of specimens from different localities in which gypsum and dolomite are intimately associated; and among them are some of fossil corals.

According to Haidinger, however, some heat is required for this result. Yet in the case of the coral rock and the *compact* magnesian limestones of our Western States, there is no evidence of the action of such heat; the subject therefore requires farther investigation.

The circumstance of a chemical change going on between the carbonate of lime and magnesian salt, (for such a change, under

* The *magnesia* in this analysis was directly determined, the lime being inferred from the loss.

some circumstances, must have taken place,) is especially favorable for consolidation. When the coral is a fine mud, and the grains are therefore extremely fine, the dolomisation might extend to the grains themselves, as well as the infiltrating material acting as a cement. But when the grains of coral are large, or there are pebbles, the infiltrated material that might be magnesian would constitute but a small part of the whole bed. Hence it is obvious that such formations in cold waters should not always in the mass have the proportions of a true dolomite, (54·2 of carbonate of lime, to 45·8 of carbonate of magnesia;) they would probably attain such proportions under an ocean during that action of heat required alike for crystallization and chemical combination.*

VIII. It is an inquiry of some interest, whether, in an archipelago like the Paumotus, coral debris is not carried from the coral islands, and distributed over the bottom of the ocean; and whether limestones thus originating, are not in process of formation. I venture no positive assertion on this subject, yet would express strong doubts. The fact that soundings off some islands, as we recede from the reef-growing depths, lose more and more in the proportion of coral sand, till we finally reach a bottom of earth, like the material of the island, bears against any such hypothesis. This was found to be the case off Upolu, where the reefs are extensive.

The action of the waves tends to throw back the material washed into the sea by fresh water streams and other currents, and in this manner extensive shore or shallow-water accumulations have been formed in all ages of the world. The formation from land debris of deep sea deposits, outside of soundings, is an hypothesis of geologists, yet to be proved. Such results may perhaps take place off the mouths of large rivers like the Amazon,

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* Prof. Horsford, in a paper on the consolidation of coral reef-rock, read before the last meeting of the American Association at Albany, (August, 1851), attributes this consolidation to the presence of organic matter which undergoes decomposition, as follows:—the sulphur present produces sulphuretted hydrogen; this changes to sulphuric acid, whence results sulphate of lime and a soluble carbonate of lime; then ammonia (resulting from the nitrogen) carries off the sulphuric acid as sulphate of ammonia and leaves the lime as a soluble hydrate, which remains united with the carbonate of lime, forming a compound like that indicated as existing in mortar by Fuchs; the final removal of the water by evaporation leaves the rock in a crystallized state.

In the first place, his paper only alludes to the rock formed above low-tide level, which I have called the coral sand-rock. Again, the amount of organic matter in corals, as found by analyses, does not exceed 5 per cent.; and the sulphur present in this organic matter is not over *one-tenth of one* per cent. It hence appears that the amount of sulphur is altogether inadequate for such changes.

But as the sands of the beach (which have a peculiarly white and clean appearance) are washed by the breakers, and the animal matter they contain is either undecomposed within the several grains, or is borne off by the waters, even the animal matter present cannot contribute to the consolidation. The waters of the tides along a sand beach on the open ocean have certainly not been proved to carry in dissolved animal matter for dissemination among the sands.

the force of whose currents carries their transported material far to sea; but not, it would seem, in any case where the streams are small, or where the river current can not be traced out to sea much beyond soundings.

IX. It remains still to speak of the proofs of elevation or subsidence presented by coral islands throughout the Pacific, and of the former extent of Pacific lands compared with the present. But these topics relating to the dynamics of the ocean, form a separate chapter, following our geological descriptions of the several groups of islands in the Pacific.

We might dwell also on the formation of caverns by the rains becoming subterranean waters; on the illustration of the action of marine currents afforded by this subject; on the agency of polyps in rock-making. But the deductions are too obvious to require farther remark.

Art. XV.—*Remarks on the proposed Geographical Survey of New York.*

A memorial was recently addressed to the Governor of New York, by a committee of the American Association for the Advancement of Science, appointed for that purpose at its Albany meeting, urging the speedy commencement of a Trigonometrical and Topographical Survey of this State. This memorial was sent to the Senate with a favorable message by the Governor, and referred to the Committee on Literature. It may, therefore, be interesting and useful to present somewhat fully the history of the kind of survey proposed. In doing this, the writer would profess himself a decided advocate of the measure, but one who has no personal purposes to serve.

At the outset, it may be well to know what has been done by other civilized nations, for this will indicate how highly minute topographical surveys are esteemed by those having most experience of their uses. It should be remembered that topography is a new art. A century since, topographical geography scarcely existed at all. Slowly emerging from its nebulous age—shedding its puerilities and unveracities by experience of better things, as it has now become systematic, eminently accurate in its field work, and spirited and trustworthy in its representations. Its capacities are equal to representing all cases of surface in a manner unmistakeable by a moderately practised eye. It pictures a country in all its detailed accidents of ground with so much unity of effect and due relation of parts, that the whole rests on the mind as a picture, all the parts of which are in true similitude and relation.

The last half century has seen the governments of Europe, almost with one accord, embarking their resources of mind and wealth in topographical surveys of their respective territories.

In these labors, France deserves the place of pioneer. Prolific in great geometers, and keenly sensitive to the magnificent, both in country and in fame, she has applied, with peculiar liberality, her wealth and the talents of men like Cassini, Delambre, La Place, Mechain, Biot, Arago, and Puissant, to a Survey and Topographical map of France, noble in conception, scrupulously correct in execution, and embodying all important accidents of ground. The scale of the final map is $\frac{1}{80,000}$, and it will contain 250 large engraved sheets, of which 149 are now published. This map really gives a better idea of the surface of France than could be derived from any travels. The map of Corsica, on a scale of $\frac{1}{100,000}$ makes an additional French contribution to topography. French geographical enterprise has also been exhibited by numerous costly explorations and voyages, by the valuable maps and battle fields of the "*Depot de la guerre,*" and by the hydrographic labors of the "*Depot de la Marine.*" From each of these, hundreds of sheets have been issued, covering Turkey, Russia, Algeria, and furnishing charts of ports in all lands. These are mainly of a high style, though deficient in accuracy from the imperfection of surveys.

Great Britain has, with deep sagacity, applied lavish means to forming a correct geography of her wide-spread dominions. The ordnance surveys of England, Ireland, and Scotland, now severally in progress, are of the most elaborate nature and afford results unsurpassed in fidelity and minuteness. The Trigonometrical survey of East India occupies a high rank among geodetic operations, and has been steadily prosecuted, fearless of expense, forty sheets of topography being now published, twelve more in hand, and the triangulation well advanced. By a comparison of the Government Survey and map of Canada with the best New-York map extant, we shall see cause for wonder, if not for shame. The very numerous and expensively prepared charts from the English Admiralty Office, show what geographical zeal, when stimulated by commercial enterprise and forecast, can accomplish. These noble geographical labors of Great Britain, both internal and external, are intimately allied with that profound commercial policy which has made her so preëminent. A keen scent for mercantile opportunity has guided her explorers to the earth's end, and a judicious perception of the value of local knowledge to every pithy undertaking, has led to systematic liberality in shaping and publishing the results of exploration.

Germany, the labyrinth of geography, has throughout her petty principalities, exhibited a proficiency and refinement in the field and record work of Geodetic Surveys, a steady determination in prosecuting them to the end, and a copiousness of scientific resource every way honorable to herself and instructive to other nations. In Holland, Bavaria, Baden, Wirtemburg, Hesse Darmstadt, Hanover and Brunswick, Topographical Surveys, based on systematic triangulations, are either made or in progress. Some of the magnates of modern science have liberally bestowed their energies and abilities on these great works, giving them a monumental and ever-enduring character.

Switzerland has thought it due to herself and the world, that her stupendous Alps and peaceful lakes should be mirrored in a topographical picture. That land of scenic grandeur and patriotic struggle, by concurrent action of its Cantons, has, under General Dufour's guidance, been busy gatherihg the drapery of her magnificence into a map miniature, of thorough accuracy and finish. We cannot wonder at any great achievement of a nation, so rich in intellect as of her superfluity to give us an Agassiz and a Guyot.

The sunny, vine-clad hills and fields of Italy have sent forth to the world a topographical likeness of their varied surface, such as to stimulate the imagination to a realization of her myriad homes of history and song. Carlini gave to the survey of Upper Italy, a high excellence, and the map of Piedmont may, perhaps, challenge the world in its finish of style.

A Prussian survey of the highest character is now in active progress, its publications being already much advanced. Its geodesy, under the illustrious Bessel, became a very model for such undertakings.

Austria, displaying a munificence which has long characterized her deportment towards scientific enterprises, has lavished on the geographical illustration of her own territory, whatever was necessary to the most complete results. The Institute of Vienna is a systematic contributor on a large scale to the world's geographical resources. During the last year, it has, besides other important works, published a map of Italy, in 27 large sheets, on a scale of $\frac{1}{288,000}$.

A government survey of Denmark has been progressing under the direction of the late lamented Schumacher, whose name is a voucher for everything excellent in scientific operations.

The "Topographical Survey of Sweden," to consist of 260 sheets, is rapidly advancing, being zealously prosecuted in spite of climate rigors. The liberal scale of this work, when we consider the restricted resources of the government conducting it, is alike honorable to the national intelligence and patriotism. The Swedish Admiralty charts bear additional testimony to that zeal for science which belongs to the country of Linnæus and Berzelius.

In Russia, the government trigonometrical survey, under the eminently able guidance of the world-known Struve, assumes a character of gigantic magnitude, proportionate to the territorial expansion of that over-shadowing empire. Embracing twenty-one large provinces between the Baltic and Black Seas, only about one-fourth of European Russia is yet surveyed. A meridional arc of over 20° between Ismail, near the Black Sea, and Torneo on the Gulf of Bothnia, with an extension of $4\frac{1}{2}°$ in Sweden, links hyperborean and sunny climes by a triangulation chain the most stupendous on the earth. There is something almost appalling in an undertaking so nearly impossible to any but the great Autocrat.

Turning from this rapid view of foreign surveys to our own country, an oppressive sense of the littleness of our geodetic and topographical achievement fills the mind. The amplitude of our domain, its highly varied and beautiful features, the grand sweeps of our rivers, our fair lakes, strewn in tasteful profusion, are well nigh all unrecorded in that pictorial language of topography common to civilized nations. Engrossed in the great labors, incident to founding a nation, our people have scarcely had time to canvass the demands of science, art and international comity, or even of liberal home administration. That leisure is now slowly dawning on us which will permit us to enter on the duties and privileges of national maturity. The first great geographical fruit of this our maturity is the U. S. Coast Survey. Our Atlantic Gulf and Pacific coasts are divided into eleven distinct sections, within which independent operations are going on, and furnishing sound bases for topography and hydrography, Limited as this is to a narrow belt along the shore line, the interior of our country cannot look to this organization for a topographical survey, but the states, as such, must either survey and map their own territories, or remain in the same category as Turkey and Egypt, unsurveyed except by invaders.

In the work of interior surveys, Massachusetts, with her wonted enterprise and liberality, has been the first state to act. The result of her geographical survey has been a map, which though below the European standard of topographical accuracy and minuteness, enjoys a signal preëminence over the crude scrawls called maps of her sister States. The triangulation, conducted by Mr. Simeon Borden, is excellent, and will endure with the granite hills bearing its monuments. Thus, by the judicious expenditure of about $71,000, the Bay State has conferred on her citizens and neighbors a great benefit, and on herself a new title to renown. The convenience of this map has been and will be felt in a thousand nameless ways; in her intercommunication, in developing her manufacturing and industrial capacities, and as a means of instructing its users in the physiognomy and special features of Massachusetts.

Here we must end our enumeration of good works performed, and it is not without the feeling that New-York will soon vindicate her claim to civilization, by enrolling herself among those States whose portraits have been taken. E. B. H.

Art. XVI.—*On the Electrical Properties of Flame;* by H. Buff, *Professor of Natural Philosophy in the University of Giessen.*[*]

Professor Buff commences his memoir with a review of the divergent notions at present existing as to the electricity of flame; Becquerel finds electric opposition in all directions in flame, which depends upon the difference of the temperature of the metals immersed in it; Pouillet recognizes a motion of electricity only from the interior to the exterior, and hence also from the base to the summit of the flame; according to Hankel[†], however the motion of the electric fluid, at least in flames obtained by the ignition of spirit, is exactly opposite, and independent of the temperature of the immersed conductor. To solve these contradictions was the object of the present investigation.

Two small strips of platinum were introduced into a glass tube closed at one end; they were separated by an interval of 1·5 line of air. The air within the tube could *not* be heated to a degree sufficient to permit the electricity of two of Daniell's cells to pass through it. When the glass became soft by heating, and both pieces of platinum were permitted to touch it, a strong deflection of the needle of a galvanometer was the consequence.

A porcelain tube two feet long and six lines wide was encompassed with glowing coals, and air was drawn slowly through it; this air could not be heated so as to allow the passage of the electricity from the source abovementioned, although the two platinum wires sunk in the air were less than a line apart, and were glowing red.

A metal web was placed over the flame of a spirit-lamp; the flame did not pass through; over the web the platinum strips were held a line apart—there was no passage of electricity.

The galvanometer used in these experiments was extremely sensitive. When two persons who were connected simply by the wooden floor, touched the ends of the wire which formed the helix of the instrument with different metals, a deflection of sev-

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* Annalen der Chemie und Pharmacie, lxxx, 1.—Cited here from the Phil. Mag. [4], iii, 145.

† Ibid. [4], ii, p. 542.

eral degrees was obtained. The two cells before mentioned, when connected by the floor, caused a deflection of 25°. The wooden floor was thus proved to be an incomparably better conductor than air heated to 400° C.

When the strips of platinum were exposed to the direct action of the flame of a spirit-lamp, the first notice of the passage of electricity was obtained, when they were placed at about three inches above its extreme point, and began to show signs of redness. The deflection increased as the strips were lowered into the flame, and attained its maximum at a small distance beneath the point of the cone into which the flame shaped itself. When the flame was strongest, there was a permanent deflection of 75°.

In these experiments, care was taken to preserve the strips of platinum as nearly as possible at the same temperature. The two cells were removed, and the electrity of the flame itself was exhibited when the two strips were placed, the one above the other, within the flame, with their flat surfaces horizontal, so that they assumed different temperatures. The flame current passed always from the hottest platinum strip through the separating interval of gas to the other strip.

Another attempt was made to ascertain the point at which heated gas permitted the passage of electricity. In the centre of the flame, from a Berzelius's lamp, is a cone-shaped obscure mass of air as yet unburned, but strongly heated by its vicinity to the flame; into this two platinum wires connected with the two cells were introduced from beneath; they were not heated to redness, but the gas nevertheless possessed a weak capacity of conduction. An approximation to the blue rim of the flame showed an increase of conductive power, and a deflection of several degrees was obtained.

When in this case one of the wires was caused to approach the blue edge of the flame, while the other remained at a distance, a deflection of 1° to 2° was obtained after the removal of the two cells; the deflection indicated the passage of a current from the hotter to the cooler wire.

The aperture through which the air passed upwards into the flame was stopped, and thus the dark interior of the flame became formed of the vapor of alcohol and the products of its decomposition; two isolated platinum wires were introduced through the stopping-cork into the central space, but as long as they were kept at some lines distant from the inflamed portion, no trace of electricity passed from one to the other. When they were caused to approach the burning portion, the described phenomena exhibited themselves. In this case also a current was observed to pass from the warmer to the less warm wire through the intervening space of gas.

The author concludes from these experiments, that air and other gases, when heated, and thus rendered conductible, excite electrically bodies plunged in them. Gases thus range themselves in the same list as other conductors of electricity. When two metallic wires, or other conductors which are connected at one end, are brought into contact with a sufficiently heated gas, we have, properly speaking, a closed circuit. If one of the places of contact with the gas be more strongly heated than the other, a thermo-electric current is the necessary consequence.

There is, however, another source of electrical excitation in the flame, as is proved by the following experiment:—One platinum wire was introduced into the obscure centre of the flame, the other was brought near its outer surface; a current immeditely exhibited itself, which passed through the flame from the interior to the exterior wire. It continued to pass in the direction even after the outer wire had attained a bright red heat, while the inner one glowed but feebly. It is evident that the thermo-current which would have passed from the hotter to the cooler wire, was in this case overcome by a current, the source of which was the place of contact of the flame and the air. The electricity here developed is so feeble, that the condensing electronometer is better suited to its examination than the multiplying galvanometer. It is easy to see, observes the author, how experimenters who have neglected to separate these two sources of excitation may have arrived at contradictory results.

By properly connecting a platinum wire, which was dipped into the *centre* of the flame, with a condensing plate, the latter became charged with negative electricity, and hence the author concludes that positive electricity is given off by the *outer* surface of the flame. The charging here is exceedingly slow, and can be greatly accelerated when a second wire, which is connected with the other plate of the condenser, is held over the flame.

One end of the galvanometer wire was connected with the platinum wire which dipped into the centre of the flame, the other end of the same was connected with the earth. The current thus obtained was too feeble to cause the slightest motion of the galvanometer needle. But when a spacious platinum dish containing water was brought over the flame and connected with the other end of the galvanometer wire, it required no very sensitive instrument to demonstrate the existence of a current.

"Hence," observes the author, "as the strength of the flame-current by an equal chemical activity and equal conduction of the inner portion of the flame is essentially dependent on the nature of the conduction from its upper portion, it must be conjectured that the formation and carrying away of carbonic acid exercises only a subordinate influence in the matter."

Two pieces of charcoal, one of which is less heated than the other by the flame, deport themselves exactly as a pair of platinum wires under the same circumstances. Silver, copper, brass, and zinc, have also been examined, all of which exhibited the same electrical deportment as platinum when brought into contact with heated air.

The following conclusions are drawn from the experiments above described:—

1. Gaseous bodies which have been rendered conductible by strong heating, are capable of exciting other conductors, solid as well as gaseous, electrically.

2. When a thermo-electric circuit is formed of air, hydrogen or carburetted hydrogen, alcohol vapor, charcoal, or finally a metal, whether combustible or incombustible, an electric current is developed, which proceeds from the hottest place of contact through the air to the less warm place.

3. The development of electricity which has been observed in processes of combustion, and particularly in flame, is due to thermo-electric excitation, and stands in no immediate connection with the chemical process.

4. The products of combustion do not therefore by any means occupy the relation to the burning body which has been assumed by Pouillet; if positive electricity rises with the ascending gases, it is only in the degree in which the burning body and the air exterior to the place of combustion, or rather exterior to the place of hottest contact, are connected by a proper conductor.

Art. XVII.—*Comparison of the modifications of the Osseous structure of the Megatharium with that in other known existing and extinct species of the class Mammalia:* being an abstract of a Memoir read by Professor Owen, to the Royal Society of London.*

Having completed the description of the skeleton of the Megatherium, which was illustrated by an extensive series of accurate and highly finished drawings, the Professor compares the modifications of the osseous structure of this gigantic extinct animal, with that in other known existing and extinct species of the class Mammalia, in the following terms:—

Osseous Structure of the Megatherium, compared with that in other known existing and extinct species of Mammalia.—The teeth agree in number, kind, mode of implantation and growth, with those of the sloth, and their structure is a modification of that peculiar to the sloth tribe. All the modifications of the

* Cited from Jameson's Edinb. Jour., li, 350.

skull relating to the act of mastication, especially the large and complex malar bone, repeat the peculiarities presented by the existing sloths. There are the same hemispheric depressions for the hyoid bone in the Megatherium as in the sloth. In the number of cervical vertebræ the Megatherium, like the two-toed sloth, agrees with the Mammalia generally. In the accessory articular surfaces afforded by the anapophyses and parapophyses of the hinder dorsal and lumbar vertebræ, the Megatherium resembles the ant-eaters (*Myrmecophagæ*); but it does not resemble the armadillos (*Dasypus*) in having long metapophyses, the peculiar development of which, in those loricated *Bruta*, has a direct relation to the support of their bony dermal armor. In the mesozygapophyses of the middle dorsal vertebræ, the Megatherium is peculiar. In the small extent of the produced and pointed symphysis pubis, it resembles the sloths; and in the junction of both ilium and ischium with the sacrum, it manifests a character common to the Edentate order; but in the expanse and massiveness of the iliac bones, it can only be compared with other extinct members of its own peculiar family of Phyllophagous Edentata. Its habits necessitating a strong and powerful tail, we find this resembling, in its bony structure, that of other Edentata with a similar appendage, especially in the independency of the two hæmapophyses of the first caudal, a character which obtains in the great ant-eater and in some armadillos; but this is no evidence of direct affinity to either of these families; the habits of the small arboreal sloths render their eminently prehensile limbs sufficient for their required movements, and the tail is wanting. Had that appendage been proportionally as large as in the Megatherium, we cannot suppose that the caudal vertebræ would have materially differed from those of other Edentata.

In the coalescence of the anterior vertebral ribs with the bony sternal ribs, the Megatherium resembles the sloths. This essential affinity is still more marked in the peculiarities of the scapula and of the carpus. In the *Myrmecophaga jubata* the scaphoid is distinct: in the *Manis* it coalesces with the lunare: in the *Dasypus gigas* the trapezoides is anchylosed to the second metacarpal: in the *Das. sexcinctus* it has coalesced with the trapezium. Not any of these characteristics are manifested by the Megatherium; its carpus repeats the peculiarities of that in the sloths, viz., the reduction of the number of carpal bones to seven, by the coalescence of the scaphoid with the trapezium. The first digit (pollex) which is retained in the ant-eaters and armadillos, is obsolete in the Megatherium, as in the sloths and Orycteropus: three digits are fully developed and armed with claws, as in the *Bradypus tridactylus*; and the fifth, though incomplete in the Megatherium, is better developed, because it was required in the ponderous terrestrial sloth, for its progression on level ground. In no existing ground-dwelling Edentate is the fifth digit deprived of its ungual phalanx, as in the Megatherium. The bones of the fore foot of that extinct animal are thus seen to be modified mainly after the type of the *Bradypodidæ.*

The long bones of all the limbs are devoid of medullary cavities, as in the sloths. The femur lacks the ligamentum teres, as in the sloths. The fibula is anchylosed to the tibia at both ends in Megatherium, as in *Dasypus;* but this is not the case in the closely allied extinct Megatherioids called *Mylodon, Megalonyx,* and *Scelidotherium,* a fact which diminishes the force of the argument which Cuvier deduced from the coalesced condition of the bones in the Megatherium in favor of its affinities to the armadillos. The semi-inverted but firm interlocking articulation of the hind foot to the leg shows the peculiarities of that joint in the sloths exaggerated, and departs further from its characteristics in other Edentata. In all the existing *Edentata,* save the sloths, the hind foot is pentadactyle, and four of the toes have a long claw, even in the little arboreal *Myrmecophaga didactyla;* the departure by degradation from the pentadactyle type is a peculiar characteristic of the sloth tribe in the order. It is carried further in the same direction in the great extinct terrestrial sloths. In these the mutilation of the foot has commenced on the outer side by the removal of the ungual phalanx from the fifth and fourth toes; but this accompanied by modifications, which adapt these toes to the important office of support and progression of the body on level ground. In the scansorial sloths, the three middle digits being equally developed for prehension, one toe on the outer and one on the inner side of the foot are reduced to their metatarsal basis. In the Megatherium, the mutilation of the foot on the inner side is carried to a greater extent; the innermost toe, or hallux, with its entocuneiform bone, is wholly removed; the second toe is represented, like the first in the sloths, by its cuneiform bone, and a coalesced rudiment of the metatarse; and it is only the third toe, or medius, that repeats the condition of the claw-bearing toes in the climbing sloths.

Habits and food of the Megatherium.—Finally, the Professor enters upon the question of the habits and food of the Megatherium. Guided by the general rule that animals having the same kind of dentition have the same kind of food, he concludes that the Megatherium must have subsisted, like the sloths, on the foliage of trees; but that the greater size and strength of the jaws and teeth, and the double-ridged grinding surface of the molars in the Megatherium, adapted it to bruise the smaller branches as well as the leaves, and thus to approximate its food to that of the elephants and mastodons. The existing elephants and the giraffe are specially modified to obtain their leafy food; the one being provided with a proboscis, and the entire frame of the lofty giraffe adapting it to browse on branches above the reach of its largest ruminant congeners. If the Megatherium possessed, as Cuvier conjectured, a proboscis, it cannot, judging from the suborbital foramina, have exceeded in size that of the Tapir, and could only have operated upon branches brought near its mouth. Of the use of such a proboscis in obtaining nutritious roots, on the prevalent hypothesis that such formed the sustenance of the Megatherium, it is not easy to speculate; the hog's snout might be supposed to be more serviceable in obtaining those parts of vegetables; but no trace of the prænasal bone exists in the skull. A short proboscis would be very useful in rending off the branches of a tree prostrated and within reach of the low and broad-bodied Megatherium, and it would be aided in this act by the tongue, of which, both the hyoid skeleton, by its strength and articulation, and the foramina for the muscular nerves by their unusual area, attest the great size and power.

As regards the limbs, the Megatherium differs from the giraffe and elephant in the unguiculate character of certain of its toes, in the power of rotating the bones of the fore arm, in the corresponding development of supinator and entocondyloid ridges in the humerus, and in the possession of complete clavicles. These bones are requisite to give due strength and stability to the shoulder-joint for varied actions of the fore-arm, as in grasping, climbing, and burrowing; but they are not essential to scansorial or fossorial quadrupeds; the bear and the badger have not a trace of clavicles, and the mere rudiments of these bones exist in the rabbit and the fox. We must seek, therefore, in the other parts of the organization of the Megatherium, for a clue to the nature of the actions by which it obtained its food. In habitual burrowers the claws can be extended in the same plane as the palm, and they are broader than they are deep. In the Megatherium the depth of the claw-phalanx exceeds its breadth, especially in the large one of the middle finger; and they cannot be extended in a line with the metacarpus, but are more or less bent. Thus, although they might be used for occasional acts of scratching up the soil, they are better adapted for grasping; and the whole structure of the fore foot militates against the hypothesis of Pander and d'Alton, that the Megatherium was a burrowing animal. The same structure equally shows that it was not, as Dr. Lund supposes, a scansorial quadruped; for in the degree in which the foot departs from the structure of that of the existing sloths, it is unfitted for climbing; and the outer digit is modified, after the ungulate type, for the exclusive office of supporting the body in ordinary terrestrial progression. It may be inferred from the diminished curvature and length, and from the increased strength and from the inequality of the claws, especially the disproportionately large size of that weapon of the middle digit, that the fore foot of the Megatherium was occasionally applied by the short and strong fore limb in the act of digging; but its analogy to that of the ant-eaters teaches that the fossorial actions were limited to the removal of the surface soil, in order to expose something there concealed; and not for the purpose of burrowing. Such an instrument would be equally effective in the disturbance of roots and ants; it is, however, still better adapted for grasping than for delving. But to whatever task the partly unguiculate hand of the Megatherium might have been applied, the bones of the wrist, fore-arm, arm and shoulder, attest the prodigious force which would be brought to bear upon its execution. The general organization of the anterior extremity of the Megatherium is incompatible with its being a strictly scansorial or exclusively fossorial animal, and its teeth and jaws decidedly negative the idea of its having fed upon insects; the two extremes in regard to the length of the jaws are presented by the phyllophagous and myrmecophagous members of the Edentate order, and the Megatherium in the shortness of its face agrees with the sloths.

Proceeding then to other parts of the skeleton for the solution of the question as to how the Megatherium obtained its leafy food, the author remarks that the pelvis and hind limbs of the strictly burrowing animals, *e. g.*, the mole, are remarkably slender and feeble, and that they offer no notable development in the rabbit, the Orycterope, or other less powerful excavators. In the climbing animals, as *e. g.*, the sloth and orang, the hind legs are much shorter than the fore legs, and even in those Quadrumana in which the prehensile tail is superadded to the sacrum, the pelvis is not remarkable for its size or the expansion of the iliac bones. But in the megatherium the extraordinary size and massive proportions of the pelvis and hind limbs arrest the attention of the least curious beholder, and become eminently suggestive to the physiologist of the peculiar powers and actions of the animal. The enormous pelvis was the centre whence muscular masses of unwonted force diverged to act upon the trunk, the tail, and the hind legs, and also by the "latissimus dorsi" on the fore limbs. The fore foot being adapted for scratching as well as for grasping, may have been employed in removing the earth from the roots of the tree and detaching them from the soil. The fore limbs being well adapted for grasping the trunk of a tree, the forces concentrated upon them from the broad posterior basis of the body may have co-operated with them in the labor, to which they are so amply adapted of uprooting and prostrating the tree. To give due resistance and stability to the pelvis, the bones of the hind legs are as extraordinarily developed, and the strong and powerful tail must have concurred with the two hind legs in forming a tripod as a firm foundation for the massive pelvis, and affording adequate resistance to the forces acting from and upon that great osseous centre. The large processes and capacious spinal canal indicate the strength of the muscles which surrounded the tail, and the vast mass of nervous fibre from which those muscles derived their energy. The natural co-adaptation of the articular surfaces shows that the ordinary inflection of the end of the tail was backwards as in a *cauda fulciens*, not forwards as in a *cauda prehensilis*. Dr. Lund's hypothesis, therefore, that the Megatherium was a climber, and had a prehensile tail, is destroyed by the now known structure of that part.

But viewing, as the Professor conceives, the pelvis of the Megatherium as being the fixed centre towards which the two legs and fore part of the body were drawn in the gigantic leaf-eater's efforts to uprend the tree that bore it sustenance, the colossal proportion of its hind extremities and tail lose all their anomaly, and appear in just harmony with the robust claviculate and unguiculate fore limbs with which they combine their forces in the Herculean labor.

The Professor then referred to the *Mylodon robustus*, a smaller extinct species of the same natural family of phyllophagus *Bruta*, and to the additional arguments derivable from the skeleton of that animal in favor of the essential affinity of the Megatherium to the sloths; and the light which the remarkable healed fractures of the skull of a specimen in the Museum of the College of Surgeons threw upon the habits and mode of life of the species.

Hypothesis of the Degeneration of the ancient Megatherioids of South America into modern Sloths, erroneous.—Finally, with reference to the hypothesis of the German authors and artists of the degeneration of the ancient Megatherioids of South America into the modern sloths, the author remarked that the general results of the labors of the anatomists in the restoration of extinct species, viewed in relation to their existing representatives of the different continents and islands, commonly suggested the idea that the races of animals had deteriorated in point of size. Thus, the palmated Megaceros is contrasted with the fallow deer, and the great cave bear with the actual brown bear of Europe. The huge Diprotodon and Nototherium afford a similar contrast with the kangaroos of Australia, and the towering Dinornis and the Palapteryx with the small Apteryx of New Zealand. But the comparative diminutive aboriginal animals of South America, Australia, and New Zealand, which are the nearest allies of the gigantic extinct species, respectively characteristic of such tracts of dry land, are specifically distinct, and usually by characters so well marked as to require a sub-generic division, and such as no known or conceivable outward influences could have progressively transmuted. Moreover, as in England, for example, our moles, water-voles, weasels, foxes, and badgers, are of the same species as those that co-existed with the mammoth, tichorrine, rhinoceros, cave hyæna, bear, &c., so likewise the remains of small sloths and armadillos are found associated with the Megatherium and Glyptodon in South America; the fossil remains of ordinary kangaroos and wombats occur together, with those of gigantic herbivorous Marsupials; and there is similar evidence that the Apteryx existed with the Dinornis; and the author offered the following suggestions as more applicable to, or explanatory of, the phenomena than the theory of transmutation and degradation. He observed that in proportion to the bulk of an animal is the difficulty of the contest which, as a living being, it has to maintain against the surrounding influences which are ever tending to dissolve the vital bond, and subjugate the organized matter to the ordinary chemical and physical forces. Any changes, therefore, in the external circumstances in which a species may have been created to exist, will militate against that existence, in probably a geometrical ratio to the bulk of such species. If a dry season be gradually prolonged, the large mammal will suffer from the drought sooner than the small one; if such alteration of climate affect quantity of vegetable food, the bulky Herbivore will first feel the effects of the stinted nourishment; if new enemies are introduced, the large and conspicuous quadruped or bird will fall a prey, whilst the smaller species might conceal themselves and escape. Smaller quadrupeds, are usually also, more prolific than larger ones. The actual presence, therefore, of small species of animals in countries where the larger species of the same natural families formerly existed, is not to be ascribed to any gradual diminution of the size of such larger animals, but is the result of circumstances which may be illustrated by the fable of the "oak and the reed,"—the small animals have bent and accommodated themselves to changes under which the larger species have succumbed.

SCIENTIFIC INTELLIGENCE.

I. Chemistry and Physics.

1. *Transmission of Radiant Heat through Crystals.*—Knoblauch has studied the transmission of heat through crystals in different directions with respect to the crystallographic axes. The radiant heat employed was that of the solar rays which were introduced into the room by means of a heliostat; a thermo-multiplier, a Nicol's prism, and cubes cut from various crystals, constituted the only apparatus employed. The principal results obtained were as follows.

(1.) Radiant heat is transmitted through certain crystals, as smoky quartz, beryl, tourmalin, and dichroite, in unequal proportions in different directions, and after transmission exhibits different properties (with respect to diathermanous bodies), according as it has traversed the crystal in one or another direction. These differences are connected with the polarization of heat, and in this respect it is found that

(2.) The transmission of rays of heat perpendicular to the crystallographic axis of rock crystal, beryl or tourmalin, is in a very different proportion from their transmission parallel to the axis, when the plane of polarization makes an angle of 90° with the axis of the crystal. When however the plane of polarization coincides with the crystallographic axis, the rays traverse the crystal in equal proportion in every direction.

(3.) In the former case the qualitative differences are strongly marked; in the latter no such differences are exhibited.

(4.) The rays of heat which traverse the crystal parallel to the axis exhibit no differences, either in respect to their quantity or to their properties, whatever be the position of the plane of polarization, which, with an infinite diversity of position, always passes through the axis of the crystal.

(5.) The rays which have traversed the three last named crystals in different directions perpendicular to the axis, exhibit no difference with respect to each other.—*Pogg. Ann.*, lxxxv, 169.

2. *Mean density of the Earth.*—Reich has published the results of a second series of experiments on the mean density of the earth, undertaken principally with a view of determining the cause of the difference between his own previous results and those of Baily. (It will be remembered that Cavendish found 5·48, Reich 5·45, Baily 5·66.) Three series of experiments, making in all 70 single determinations, were made. The first gave as a mean 5·5712 with a probable error of 0·0113, the second gave 5·6173 with a probable error of 0·0181, the third gave 5·5910 with a probable error of 0·0149. The general result of these three series is 5·5832 with a probable error of 0·0149. The third series was made with a bifilar suspension wire, but the results did not correspond better than those obtained by the single wire. To determine whether magnetic or diamagnetic action interfered with the results, two series of experiments were made, one with a magnetic sphere of iron, the other with a diamagnetic sphere of bismuth. The sphere of iron gave 5·6887 with a probable error of 0·0312; the sphere of bismuth gave 5·5266 with a probable error of 0·0402. It would appear probable that the magnetism of the iron exerted some influence, but none could be attributed reasonably to the diamagnetism of the bismuth.—*Pogg. Ann.*, lxxxv, 189.

3. *Preparation of pure Methylic Alcohol.*—Wöhler has given a very simple and elegant method of preparing pure wood-spirit from the raw material of commerce, which is of interest both to the chemist and pharmaceutist. Raw wood-spirit is to be mixed with an equal weight of sulphuric acid, avoiding an elevation of temperature. The mixture is to be allowed to stand a day, then distilled from two parts by weight of binoxalate of potash. A volatile fluid at first passes over, after which the oxalate of methyl condenses in the neck of the retort. The receiver is now to be changed and the distillation continued as long as the ether comes over. The neck of the retort is then to be gently warmed and the oxalate allowed to flow into the receiver when

it is to be strongly pressed between folds of bibulous paper, and then freed from volatile products by long fusion. In this way it is obtained directly perfectly colorless. The liquid which passes over first contains also oxalate of methyl which is readily obtained by evaporation and crystallization. The pure oxalate of methyl prepared in this manner is now to be distilled with water; pure wood-spirit passes over and oxalic acid remains in the retort. [This method obviously presents great advantages over the tedious processes of Dumas and Kane.]—*Ann. der Chemie und Pharmacie*, lxxxi, 376.

4. *Formation of Sulphuric Acid from Sulphurous Acid and Oxygen.*—WÖHLER has published a few observations relating to the formation of sulphuric acid, which, although involving no new principle, promise to be of great importance in a manufacturing point of view. The action of spongy platinum at a high temperature upon a mixture of sulphurous acid and air or oxygen, has long been known. A patent was even granted to Peregrine Phillips for the manufacture of sulphuric acid by this process, the anhydrous acid formed being condensed and united to water in an appropriate receiver. The method was however abandoned as a more extended experience showed that the platinum speedily lost its power of condensation. Wöhler has now found that various metallic oxyds possess in a high degree the property of causing the union of mixed gases. When the oxyds of copper, iron, or chromium, are heated to a low redness in a glass tube and a mixture of sulphurous acid and air or oxygen is caused to pass over them, thick white vapors of anhydrous sulphuric acid are formed. A mixture of the oxyds of chromium and copper prepared by precipitation was found to be particularly efficient; the same quantity of oxyd appeared capable of converting an unlimited quantity of the mixed gases into sulphuric acid, and the production of sulphuric acid was so easy and rapid as to lead to the idea of practical application on a large scale. Metallic copper in a state of powder produces sulphuric acid in a similar manner, but only when heated and when its surface has become converted into oxyd. No hydrate of sulphuric acid is formed by passing the vapor of water over the oxyd at the same time with the gaseous mixture. Platinum foil polished and cleaned acts upon the gaseous mixture like spongy platinum, but not at ordinary temperatures. A mixture of the oxyds of copper and iron prepared by precipitation and ignited, becomes and remains incandescent when warmed and held in a current of hydrogen gas.—*Ann. der Chemie und Pharmacie*, lxxxi, 255.

5. *Constitution of Tannic Acid.*—STRECKER has discovered that tannic acid is a copulate of sugar and gallic acid. Tannic acid was boiled with dilute sulphuric acid, the solution was neutralized with carbonate of lead and then precipitated with acetate of lead: after the removal of the lead by sulphydric acid and evaporation, a residue was obtained which proved to be sugar. Strecker considers it probable that the true formula of tannic acid is $C_{40}H_{18}O_{26}$; the resolution of tannic acid into gallic acid and sugar is then represented by the equation,

$$C_{40}H_{18}O_{26}+10HO=2(C_{14}H_{8}O_{12})+C_{12}H_{12}O_{12}.$$

—*Ann. der Chemie und Pharmacie*, lxxxi, 248.

6. *Products of the decomposition of Hippuric Acid.*—Socoloff and Strecker have studied the action of nitrous acid (NO_3) upon hippuric acid. Nitric and hippuric acids are to be rubbed together in a mortar, the mixture introduced into an appropriate vessel, and a current of deutoxyd of nitrogen passed through till the liquid assumes a greenish hue. Water added in large quantity to the liquid precipitates a crystalline substance, which when purified by recrystallization is represented by the formula $C_{18}H_8O_8$. The authors term this substance benzo-glycolic acid, its formation is represented by the equation.

$$C_{18}H_9NO_6+NO_3=C_{18}H_8O_8+HO+2N.$$

Benzo-glycolic acid is slightly soluble in cold water; hot water dissolves it more easily, but decomposes it gradually. Alcohol and ether dissolve it readily. The analysis of several salts gave the formula of the acid $C_{18}H_7O_7+HO$; it is consequently monobasic like its primitive. In this respect hippuric acid is analcgous to malic and salicylic acids, the amide acids of which are also monobasic. When benzo-glycolic acid is boiled with water containing a small quantity of sulphuric acid, it is decomposed into benzoic acid, and a new acid homologous with lactic acid and which the authors term glycolic acid. The action is represented by the equation

$$C_{18}H_8O_8+2HO=C_{14}H_6O_4+C_4H_4O_6.$$

In its pure state glycolic acid is a syrupy liquid, which does not crystallize. It has a strongly-marked acid taste, and does not give a precipitate with any metallic salt. In its general relations it strongly resembles lactic acid; when however acetate of lead is poured into a solution of glycolic acid and excess of ammonia is added, a white flocky precipitate is thrown down; this is not the case with lactic acid. Glycolic acid may also be obtained by the action of nitrous acid on glycosin (glycocoll), since $C_4H_5NO_4+NO_3=C_4H_4O_6+HO+2N$. Socoloff and Strecker consider it probable that benzo-glycolic acid may be regenerated by the direct union of its constituents. The experiment was not tried from want of material. On the other hand, however, lactic and benozic acids when heated together for some time at 180° till water is no longer disengaged, form a resinous mass which contains an acid, $C_{29}H_{10}O_8$, which the authors call benzo-lactic acid, and which is the homologue of benzo-glycolic acid; the reaction is

$$C_{14}H_6O_4+C_6H_6O_6=C_{20}H_{10}O_8+2HO.$$

7. *New Alcaloid derived from Piperine.*—Cahours has found that when piperine is distilled with from $2\frac{1}{2}$ to 3 times its weight of potash-lime, the product of the distillation consists not merely, as Rochleder and Weitheim have stated, of picoline, but of a mixture of two distinct volatile bases. The most volatile product which forms more than $\frac{9}{10}$ths of the basic liquids boils at exactly 100° C., toward the close of the distillation the thermometer rises, and at 210° again becomes stationary. The more volatile base is a colorless liquid having a strong ammoniacal odor which at the same time recalls that of pepper. It changes vegetable colors from red to blue, has a very caustic taste, and neutralizes the strongest acids. In water it is soluble, and the solution has many of the properties of water of ammonia, with reference to saline solutions; it does not appear, however, to re-dissolve the oxyds of copper and of

zinc. With acids the new base forms numerous perfectly crystallized salts. The constitution of the new base is represented by the formula $C_{10}H_{11}N$, its equivalent volume is 4: Cahours terms it *piperidine.* When iodid of ethyl is brought into contact with piperidine, great heat is evolved, and care must be taken to add but small portions of the ether at a time, and to cool the mixture. A mass of beautiful white crystals is formed, which, when decomposed by potash, yield a new base in the form of a colorless oil, boiling at 128° C., and represented by the formula $C_{14}H_{15}N$ or $C_{10}H_{10}(C_4H_5)N$, an equivalent of ethyl replacing an equivalent of hydrogen. The author terms this base ethyl-piperidine. The iodids of methyl and amyl yield similar compounds with piperidine. Methyl-piperidine boils at 117° C., amyl-piperidine at 186° C. When ethyl-piperidine is mixed with iodid of ethyl, and the mixture maintained for some days at 100° C., a hard crystalline substance is obtained, which may be obtained in beautiful crystals by the evaporation of its solution in alcohol. This compound is the iodid of a new base corresponding to tetra-methyl-ammonium, and tetrethyl-ammonium. Iodid of amyl gives similar results. From the above it appears that piperidine is an imide base, or ammonia in which 2 equivalents of hydrogen are replaced by two equivalents of other radicals. It is possible that these radicals are ethyl and allyl, so that piperidine is represented rationally by NH, C_4H_5, C_6H_5. With bisulphid of carbon piperidine unites to form a crystalline compound: with the chlorid of benzoyl and cumyl the alcaloid gives beautiful crystalline compounds, corrresponding to benzamid and cuminamid. Sulphate of piperidine boiled with cyanate of potash gives piperidinurea; the same compound is obtained by passing moist chlorid of cyanogen into piperidine. With chlorine and bromine piperidine gives oily products, which are destitute of basic properties. Cahours does not give the composition of the other base obtained by him in the distillation of piperine. Its boiling point, 210°, does not correspond with that of picoline.—*Comptes Rendus*, xxxiv, 481.

8. *Chemical properties of Electrified Bodies.*—Fremy and Becquerel have published the results of an investigation of the modification of oxygen gas, produced by the action of electricity. These results in the main confirm those of Schönbein, Marignac, and De la Rive, and are as follows:

1st. The decomposition of water by the galvanic battery cannot be successfully employed to investigate the nature of the so-called zone, because the active principle is only produced in very small quantity.

2d. The galvanic arc does not appear to modify oxygen, like the ordinary electric spark, because the elevation of temperature probably destroys the effect which the electricity might produce.

3d. The sparks produced by means of induced current act, like the sparks from the common electrical machine.

4th. Pure oxygen enclosed in glass tubes with paper dipped in starch and iodid of potassium, can be electrized by a succession of sparks, passing over the external surface of the tube.

5th. Oxygen prepared by various methods acquires an odor and very marked oxydizing properties when submitted to the action of electricity. These properties are exhibited in oxygen as pure as it can be obtained.

Electrized oxygen loses its properties when placed in contact with iodid of potassium, but resumes them when again electrized.

These facts demonstrate that the oxydizing power of electrized oxygen, is not due to the presence of any foreign body contained in the gas.

6th. When pure and dry oxygen is enclosed in a series of tubes, and submitted to the action of electricity, it is found that the quantity of gas which becomes absorbable by the alcaline iodid increases during several hours in proportion to the time of electrification, but subsequently appears to diminish, the spark probably destroying the effect which it at first produced.

7th. When small eudiometer tubes were filled with oxygen, and contained at the same time a substance capable of absorbing the electrized gas, as moist mercury, silver, or iodid of potassium, the oxygen was seen to diminish uniformly under the action of the electric spark, and frequently to be completely absorbed.

8th. Tubes containing portions of moist iodid of potassium and of silver, were filled wtth pure oxgen, and then sparks passed through them during several days. The sparks at first very brilliant, became paler and paler, and finally almost invisible. At this moment the tubes were opened beneath the surface of water, when the water instantly rushed in and completely filled the tubes, proving that the oxgen had become completely absorbable in the cold by silver and the alkaline bodies. It was proved that water was not necessary to develop the activity of the oxygen, but only to cause the oxygen to act upon the metal or iodid; also, that the electric spark does not decompose iodid of potassium.—*Comptes Rendus*, xxxiv, 399.

9. *New organic Acid.*—Cloez has separated from the mother liquor of fulminating mercury, a new organic acid, homologous with lactic acid, and to which he gives the name of homolactic acid. Its formula is $C_4H_4O_6$, the general formula of its salts $C_4H_3O_5+RO$. It is a colorless syrupy liquid, and appears to be identical with the glycolic acid of Strecker (vide p. 100, § 6). The distilled products in the preparation of the fulminate contain, according to Cloez, aldehyde, formic, acetic, and nitrous ethers.—*Comptes Rendus*, xxxiv, 363. W. G.

10. *Donarium identical with Thorium*, (L'Institut, No. 957.)—Damour addressed a note to the French Academy at their session of May 3d, stating the results of his investigation of Bergemann's proposed new metal *donarium*.* This substance was extracted by Bergemann from the mineral named *orangite* by Krantz its discoverer, and which mineral was found near Brevig in Norway, the same locality, it will be remembered, which furnished Berzelius with his thorite. Bergemann states that in the orangite, donarium exists with oxygen as a hydrous silicate. He gives 997·4 as the atomic weight of *donarium*, and deduces for its oxyd, with the formula Dr^2O^3, the number 2294·8. The characters ascribed to donarium, and especially the behavior of its oxyd with acids, led Damour to suspect that it might be identical with thorium, and he accordingly made a quantitative analysis of the *orangite*.

* See vol. xii, pp. 280, 387 and 433, of this Journal.

The specimens analyzed were procured from Dr. Krantz of Bonn. The color of this species is orange yellow and its fresh fracture has the resinous lustre and general appearance of the colophonite of Norway. Its density is higher than that of any other silicate at present known. According to Damour, G.=5·19, which is a little less than 5·39, the density given by Bergemann.

The qualitative analysis of orangite indicated that it was essentially a hydrous silicate of *thoria* with small portions of the oxyds of lead, uranium and iron, with lime, alumina, magnesia, potassa and soda. The thoria separated from the orangite presented all the characters which Berzelius in his treatise has assigned to this rare earth. The characters of *donarine*, as given by Bergemann, differ only in two points from those of thoria, viz.: 1st, the smaller density of donarine which M. Bergemann states to be =5·576, while thoria has, according to Berzelius, the specific gravity =9·402; and 2d, the red color which the donarine assumes when calcined. On these two points the results of M. Damour are at variance with those of Bergemann. The density of the earth from orangite, as determined with the greatest care by Damour is 9·366 sufficiently close to 9·402, the density of thoria. The red color is easily accounted for by the presence of the oxyds of uranium and lead which by the methods of Bergemann would remain in the earth extracted from the orangite. Prepared with precaution this earth is obtained perfectly white and has then precisely the same characters as thoria. M. Damour concludes that donarium and thorium are the same, and that the former must be struck from the list of elements.

[It is probable that orangite is identical with thorite: but in the absence of the details of Damour's analysis we can only give the formula deduced from Bergemann's, (this Journal, xii, 433,) viz., $\dot{T}h^3 \dddot{S}i+2\dot{H}$, which assumes the oxyd to be $\dot{T}h$ in accordance with the results of Berzelius. The thorite contains more water than orangite which may be owing to some change in the former, as its lustre is more dull and its density is less, indicating such a change. We speak from the comparison of authentic specimens of the two species obtained from Dr. Krantz.—B. S., JR.]

II. MINERALOGY AND GEOLOGY.

1. *Mines of Sulphurets of Arsenic and Sulphur in Koordistan*, (communicated by Prof. O. P. HUBBARD.)—In vol. iii of this Journal (2d series) is a general notice of the existence of sulphurets of arsenic, &c., in Koordistan, ores, which can be purchased in the market of Oroomiah, Persia, and in the bazaars of Constantinople. Dr. Wright of the Oroomiah mission, in a recent letter, gives the following account of the mines.

"We started from Gawar, with the bishop of Gawar for our guide, in the direction of the mines, which are between Bashkullah and Julamerk, about five hours north of the latter place. The second day we crossed the Zab, which here flows through a very deep ravine, and in about two hours from the river reached the little village of Nestorians, called *Goranis*. This is on the mountain side, facing the east, and the mines are on the same mountain, only ten minutes walk from the village.

Leaving our horses we called upon a young Turk, who superintends the mines in behalf of the Turkish government, and drank coffee with him. He and his attendants live in a solitary house on the mountain side.

Accompanied by one of his men we proceeded to the opening of this mine, which is worked by the Koords, in the employ of the Turks. As we reached the place, an old Koord, the head workman, shut the door that closed the entrance and looked as if he would say, 'Here are vast treasures; you cannot enter, or if you enter you must pay me for it.' Having been told that the passage in was so narrow in some places that none could pass except on their hands and feet, creeping through the mud, we turned our backs on the old man and followed a young Greek a few rods down the steep mountain side to the mouth of a mine which had been worked for two years by him and his companion.

On arriving at the entrance we took off our shoes and put on the heavy stout boots of the workmen. Two men entered with us, each one carrying a torch, one before and one behind. We proceeded to the head of the mine, stopping every now and then to examine a rich vein of *sulphuret of arsenic* enclosed in a hard, black rock.

The two sulphurets *realgar* and *orpiment* are usually intermingled, and it is rare that a specimen of either is found alone. The veins vary in thickness from that of a pane of glass to several inches, but the amount in the mine is not large, it being worked mainly with the expectation of reaching a rich deposit farther in the mountain. Since the Turks have subjected Koordistan to their rule, they have taken possession of these mines and are working them at the expense of the government. Some twenty men, Koords and Greeks, are employed in them. The purest sulphurets are put up in loads and sent off to Constantinople, and the inferior kinds are sold to dealers from Persia, where large quantities are used in the baths, combined with lime, to depilate the body.

Sulphur.—A large deposit of sulphur exists about five miles from *Goranis*. There is a large number of sulphur springs where the water gushes out of the ground in a state of violent ebullition.

The sulphur gases (?) are exhaled in abundance, and on holding my face over one of the springs for a moment I was almost suffocated.

While in the mountains we visited Jeeloo, a Nestorian district lying south of Gawar. No part of Koordistan surpasses or equals it in the beauty and grandeur of its scenery. Its lofty peaks and deep ravines and grand gorges are unequalled. One of the peaks is seen in a clear day from the plain of Mosul with the naked eye.

One way led us through a certain gorge, formed as if by the splitting open of a mountain of rock for the passage of the small stream of water.

We were thirty-five minutes in riding through it. Its sides are nearly perpendicular or projecting over our heads, and from 200 to 600 feet in height. The widest place is not more than twenty feet, and in others I could almost touch both sides by reaching out my arms as I rode along. In some parts the sun never shines, and on our return we passed through it between noon and one o'clock, and most of the way we were in the shade."

2. *Mineralogical Notices*; by W. T. Blake.—*Apatite.*—During the past winter a shaft has been sunk upon the vein of crystalline phosphate of lime at Hurdstown, Essex Co., N. Y., and large blocks of massive apatite have been raised; some of the largest of these masses weighed not less than 200 pounds, and were nearly pure apatite,—the specimens have very little color, portions of the masses being translucent and nearly transparent, and resembling the "asparagus-stone" variety of the mineral. The more compact and opaque masses frequently cleave into hexagonal prisms, some of them having lateral planes three inches wide. Rhombohedrons resulting from cleavage are not uncommon.

Brown Tourmaline.—Beautiful transparent crystals of brown tourmaline occur disseminated in the massive and concretionary phosphorite at the "eupyrchroite" locality, Crown-point, Essex Co., N. Y.; terminated crystals are rare, but the few found are highly modified, and are crystallographically similar to the crystals from Gouverneur, N. Y., described and figured by Rose. (See Dana's Mineralogy, p. 136.) The color is a light clove-brown, and the crystals exhibit dichroism. Specimens cut and polished have much beauty as gems.

Red Zinc Oxyd.—Fine cabinet specimens of lamellar red zinc oxyd can be obtained at the zinc mine, Stirling Hill, Sussex Co., N. Y. The lamellar masses are disseminated in the highly crystalline limestone which has frequently a delicate pink hue and translucent,—cleaving readily into large rhombohedrons; the contrast between the red zinc and the gangue adds greatly to the beauty and mineralogical value of these specimens. These distinct nodules of oxyd are found at the junction of the vein of red zinc ore and the limestone, but the oxyd is free from any admixture with franklinite crystals; good crystalline specimens of franklinite are now very rare at the mine.

Molybdate of Lead.—The mineral examined and reported by me as chromate of lead* from the lead mines near Phœnixville, Pa., has since been found to be molybdate of lead, containing *chromic acid.* The crystallographic characters of the molybdate are clearly seen in specimens recently obtained, but in color they much resemble some specimens of chromate.

The mineral I announced as *lievrite*, from the "O'Neil mine," Orange Co., has since been described by Prof. Shepard as dimagnetite.†

3. *Eruption from the summit of Mauna Loa, Hawaii.*—The following highly interesting account of the eruption of the volcanic mountain Mauna Loa, is from the *Polynesian Extra* of March 8th:

The new eruption of Mauna Loa, of which our correspondent, Mr. Sheldon, notified us a few days ago, is likely to prove one of the most extensive that has taken place on these islands within the memory of man. From the last accounts given below, it will be seen that a most sublime spectacle is now to be witnessed on that island, and the end may be the destruction of the beautiful town of Hilo, by the molten river now on its course toward that point.

We give below the letters of our correspondents, which reach down to the 20th ult.

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* This Jour., vol. xiii, p. 116. 1852. † Ibid. p. 117.

"Hilo, February 21, 1852.

Dear Sir: The old lion is again out of his den, his eyes flash fire and his roar is awful. On the 17th instant, at twenty minutes past 3 A. M., a small beacon light appeared on the summit of Mauna Loa. This light increased until it looked like a rising moon. In half an hour brilliant columns of lava shot up against the heavens, and a general burst of blood red fusion poured out of the same orifice apparently, which disgorged such awful floods in 1843. We were awakened at about four o'clock, and saw a glare of light streaming through our windows. Our first thought was that some building near us was on fire, but on rising we soon perceived that the whole summit of the mountain was irradiated, and that a vast furnace was there glaring with vehement heat. The molten flood rolled down the side of the mountain so rapidly that in two hours we judged its progress to have been fifteen miles, the whole lava glaring with great brilliancy. This flow continued through the day, but with decreasing energy. It becomes sluggish at night, and the next day, or after twenty-four hours, no traces of it were visible from the station; no smoke by day and no fire by night. We had thought of paying a visit to the scene of action; but when the action ceased our pedestrian desires ceased also. Thus we slept.

But our slumbers were soon broken. At six o'clock, A. M., on the 20th, we perceived fire issuing from the side of the mountain towards Hilo, and about half way down the mountain. At first the stream shot directly down towards Hilo; but meeting some obstacle near the foot of the mount, its direction was changed to the north, and it is still flowing towards Mauna Kea.

A vast area between the mountains is already filled with fire, and the scene by night is one of terrible sublimity. The red-hot lava still rolls out of the side of the mountain in awful floods. It seems as if the bowels of Pluto were being disgorged. While I write, our whole atmosphere is filled with lurid smoke, through which the sun looks down upon us with a yellow and baleful light.

The horizon is hung in murky drapery; detonations, like distant thunder, are heard from the mountain, and capilliform vitrifactions are filling our streets. The flood may come down upon us or it may not. On Monday I am off to meet it. It is near the woods.

Monday, 23d.—The eruption is still internally active. The fiery fluid is in the upper region of the woods and the smoke is great. Dr. W. and myself are packed and ready to start for the mountain.

Yours truly, T. Coan."

Another correspondent writes as follows:—

"Hilo, February 24, 1852.

Another eruption is now taking place on Mauna Loa. It presents a scene of sublimity unsurpassed. The side of the mountain has opened about midway down the dome, and the lava pours out with unrestrained effort and comes rolling, tumbling and flashing on toward Hilo. It is accompanied with frequent explosions. At night the imagination cannot conceive a spectacle more awfully grand. The immense flow of lava reflects upon the clouds its cherry red hue, and as they gather in density about the mountain, are caught up by the upward current of atmosphere, and hurried with rapidity into every imaginable shape, presenting in the heavens a wild picturesque scene. Though the distance from the mountain to the sea seems too far for the lava to flow, it is not impossible, and if it continues to flow for many days as freely as it now does, it is quite probable it will reach the sea somewhere near Hilo."

"HILO, February 26, 1852.

DEAR SIR:—I add a line to the above to inform you that up to this date the action of the late eruption is undiminished. Truly our island is on fire. A line from Mr. Coan informs me that he passed within five or six miles of a stream of lava, yesterday, which was burning its path through the woods, in the direction of Puna. The action on the mountains was more intense last night than it has been since the morning of the 17th. I need not add that we are all deeply interested in knowing when, and where, and how, this fiery flood is to reach the sea. The locality of its source almost precludes the hope that its progress can be as harmless as on a former occasion.

Yours truly, F. COAN."

By advices to Hilo to the 2d inst., we further learn that the stream of lava had burned through the woods to within fifteen miles of Hilo, and that it was still progressing. The current was not so rapid as at first, but it is gradually filling up all the inequalities of the ground, and it was supposed at that date, that it would ultimately reach the sea, and discharge itself into the bay of Hilo.

The light at night was very brilliant, and at Hilo it was almost as light as day. Persons who left this city last week on a visit to Hilo, will arrive at a seasonable moment to witness one of the most sublime phenomena of nature, and one of so rare occurrence that few are fortunate enough to witness it.—*Alta California.*

[According to later accounts the eruption ceased when the stream had reached within seven miles of Hilo.]

4. *On the Structure of the Iguanodon, and on the Fauna and Flora of the Wealden Formation*, (Proc. Royal Institution of Great Britain, March, 1852.)—The geological phenomena of the southeast of England, comprising the lithological characters and organic remains of the Diluvial, Tertiary, Cretaceous, Wealden, and Oolitic deposits, were described in two lectures delivered to the members of the Royal Institution by Dr. Mantell in 1836 and 1849. In those discourses the Fauna and Flora of the *Wealden* were cursorily noticed, and the Iguanodon and other gigantic terrestrial reptiles, whose fossil remains have invested the strata of Tilgate Forest with a high degree of interest, were briefly alluded to. The present lecture was restricted to a consideration of the Fauna and Flora of the countries whençe the deposits constituting the Wealden districts were derived; and the osteological characters of the most remarkable fossil Saurians peculiar to this geological epoch, were especially illustrated.

After a concise exposition of the characters of the various formations which have succeeded, and now overlie the Wealden, or in other words, are of more recent origin—namely, the *Drift* or diluvium, containing bones of large mammalia, as the mammoth, mastodon, rhinoceros, horse, deer, &c.;—the *Eocene*, or ancient tertiary strata of the London basin, abounding in marine exuviæ of special and for the most part extinct types;—and the *Cretaceous* or chalk-formation, comprising the white chalk of the North and South Downs, and the chalk-marl, galt, and greensand, of Surrey, Kent, and Sussex, the whole characterized by innumerable marine shells, zoophytes, fishes, reptiles, &c., of extinct species and genera;—Dr. Mantell proceeded to illustrate the structure of the Iguanodon as exemplified by the isolated parts of the skeleton hitherto discovered, and of which numerous examples were exhibited on the tables of the Institution.

The perfect germ, and the unused tooth, of the Iguanodon, are characterized by the prismatic form of the crown, which is traversed on the thick enamelled face by three or four longitudinal ridges, and has the lateral margins denticulated, and the summit finely crenated; in this state the teeth resemble those of the living *Iguana* of the West Indies,—a resemblance which suggested the generic name of *Iguanodon.* But the fossil teeth are of enormous size in comparison with their recent prototypes; for the teeth of the Iguana are as small as those of the mouse, while those of the Iguanadon are often one inch wide, and three inches in length. Specimens exhibiting the above characters are, however, rare; the summit of the crown is usually more or less worn away by use, and the fang removed by absorption from the pressure induced by the upward growth of the successional teeth. In the first example discovered by Dr. Mantell (in 1820), the crown was ground down so as to present on its inner face a smooth oblique surface with a cutting edge on the summit, and the marginal crenations were worn away; in this state the fossil so strikingly resembled an upper tooth of a Rhinoceros, that Baron Cuvier pronounced it to belong to a species of that genus. Numerous teeth in different stages of growth and detrition were at length obtained, and the reptilian character of the animal to which they belong was satisfactorily determined. Three years since the first specimen of the lower jaw was discovered by Captain Lambart Brickenden, in the same quarry in Tilgate Forest, from which the earliest known tooth was obtained; and subsequently a portion of the upper jaw with teeth, has been procured from the Hastings' strata.

Referring to his various memoirs on the Iguanodon in the Philosophical Transactions, and to his recent work on the Organic Remains in the British Museum,* for details, the lecturer stated, that while the compound structure of the lower jaw, and the mode of dentition, established the reptilian character of the original animal, the maxillary organs presented a nearer approach to those of certain mammalia, than is observable in any other reptiles. The teeth in the upper and lower jaw were arranged in a sub-alternate order as in ruminants; the face of the crown, or that having the thickest coat of enamel, is placed mesially or on the inner side of the lower teeth, and on the external surface of the upper. The anterior part of the lower jaw is edentulous, and its symphysial extremity forms a scoop-like process, which resembles the corresponding part of the inferior jaw of the Edentate mammalia, as

* "Petrifactions and their Teachings, or a Hand-book to the Gallery of Organic Remains of the British Museum," one vol., 1851, published by H. G. Bohn.

for example the *Mylodons:* and the great number and size of the vascular foramina of the jaw, indicate a greater development of the lips, and integuments, than occurs in any existing animals of the class Reptilia; the sharp ridge bordering the deep groove of the symphysis, in which there are likewise several foramina for the exit of nerves and blood-vessels, evidently gave attachment to the muscles and integuments of the lip: while two deep pits for the insertion of the protractor muscles of the tongue, manifest the mobility and power of that organ. There are therefore strong reasons for supposing that the lips of the Iguanodon were flexible, and in conjunction with the long fleshy prehensile tongue, were the chief instruments for seizing and cropping the leaves, branches, and fruit, which from the construction of the teeth we may infer constituted the food of the original. The mechanism of the maxillary organs, as elucidated by recent discoveries, is thus in perfect harmony with the remarkable characters which rendered the first known teeth so enigmatical: and in the Wealden herbivorous reptile we have a solution of the problem, how the integrity of the type of organization peculiar to the class of cold-blooded vertebrata was maintained, and yet adapted, by simple modifications, to fulfill the conditions required by the economy of a gigantic terrestrial reptile, destined to obtain support from vegetable substances: in like manner as the extinct colossal herbivorous Edentata, which flourished in South America, countless ages after the country of the Iguanodon and its inhabitants had been swept from the face of the earth.

The structure of the cervical, dorsal, and caudal vertebræ, of the ribs, the pectoral and pelvic arches, the sacrum formed of six anchylosed vertebræ, the bones of the extremities, and certain dermal appendages, were successfully described, and illustrated by drawings and specimens. From the facts adduced, Dr. Mantell infers that this stupendous reptile equalled in bulk the largest herbivorous mammalia, and was as massive in its proportions; for living exclusively on vegetables, the abdominal region must have been greatly developed. Its limbs were of proportionate size and strength, to support and move so enormous a carcass; its length, as proved by recent disvoveries, was of crocodilian proportions, for there is no doubt that the tail was very long; and the largest Iguanodon may have attained a length of from fifty to sixty feet.

The *Hylæosaurus*, *Megalosaurus*, and several other genera of reptiles were severally noticed, and reference made to the specimens in the British Museum. The *Pelorosaurus* was next described somewhat in detail, and the characters of the stupendous humerus, or arm-bone, ($4\frac{1}{2}$ feet long,) scapula, clavicle, vertebræ, sacrum, and pelvis, were pointed out, with the view of illustrating a most interesting discovery made but a few days previously by S. H. Beckles, Esq., of St. Leonard's.

With much labor and skill, Mr. Beckles had succeeded in extracting from a block of Wealden sandstone lying on the Sussex coast, and which was only visible at low water, the perfect *radius* and *ulna* (bones of the fore-arm,) and *humerus*, (arm-bone,) of a gigantic reptile, which Dr. Mantell pronounced to be a *new species of Pelorosaurus*, and proposed to name *Pelorosaurus Becklesii*. The generic *identity* and *specific* difference between this humerus, and that of the *Pel. Conybeari*, which was placed beside it, were pointed out, and the remarkable modification of structure presented by the *ulna* was explained. The arm-bone of the *P. Conybeari* is 54 inches long, the corresponding bone of a Gavial or gangetic crocodile 18 feet long, in Dr. Grant's Museum, is but 11½ inches; the humerus discovered by Mr. Beckles is 22½ inches in length, and the bones of the fore-arm are 16 inches long. A portion of the scaly cuirass which covered the limbs and is composed of hexagonal plates, were exhibited.

The lecturer then took a rapid view of the other reptiles that were contemporary with the Iguanodon, enumerating the *Pterodactyles* or flying lizards, and several genera of Crocodilians and Chelonians. Examples of marine and fresh-water turtles are not uncommon in the Wealden deposits; and the strata near Swanage have furnished many beautiful specimens to the researches of Mr. Bowerbank.

Of *Fishes* there are nearly forty known species in the Wealden, which are chiefly referable to the *Ganoid* and *Placoid* orders. The fishes most abundant in the rivers of the Iguanodon country were two or three species of *Lepidotus*,—ganoids closely allied to the *Bony* or *Gar-Pike* of America; their teeth and scales are everywhere to be met with in the Tilgate strata.

The *Invertebrate Fauna* comprised many genera of *Insects*, a few *Crustaceans*, and numerous fresh-water *Mollusca*.

Insects.—The *Insects* (for a knowledge of which we are mainly indebted to the scientific acumen of the Rev. P. Brodie) amount to several hundred specimens, comprising between thirty and forty families or genera, and they are referable for the most part to the orders *Coleoptera*, *Orthoptera*, *Neuroptèra*, *Hemiptera*, and *Diptera*. Among them are several kinds of beetles, dragon-flies, crickets, May-flies, and other familiar forms which are closely allied to species that inhabit temperate climates.

Mollusca.—The most numerous shells belong to the genera *Cyclas* and *Paludina*. Of the latter, which is a genus of fresh-water snails, there are a few species that abound in the Wealden clays and Purbeck beds, and form extensive strata of shelly limestone, the compact masses of which are susceptible of a good polish and are known by the names of Sussex, Petworth, and Purbeck marble; the latter was in great request in the medieval ages, and is the material of which numerous tombs and monuments, and cluster columns in our ancient cathedrals are constructed. Two common inhabitants of our pools and streams, the Planorbis and Limneus, also occur. Several species of *Unio*, some of which rival in magnitude the pearl-mussels of the Ohio and Mississippi, likewise abound in the Wealden deposits. Fresh-water Entomostraceans, *Cyprides*, of several species, swarm in many of the clays and iron-stone beds of Sussex and the Isle of Wight.

The Flora of the country of the Iguanodon appears to have been as rich and diversified as the Fauna. Forests of *Coniferæ*, referable or closely allied to *Abies*, *Pinus*, *Araucaria*, *Cupressus*, *and Juniperus*, clothed its hills and plains; with these were associated arborescent and herbaceous Ferns, comprising upwards of thirty species; together with many *Cycadeaceæ*, and trees allied to *Dracæna*, *Yucca*, *&c.* Equisitaceous and Lycopodiaceous plants also abounded; and even the common inhabitants of our streams, the *Charæ*, flourished in the rivulets of that marvellous region.

As examples of the vegetation of the Wealden period, Dr. Mantell described the petrified forest of Coniferæ and Cycadeæ in the Isle of Portland: the accumulation of fossil firs and pines exposed on the southern shore of the Isle of Wight; and the coalfield of Hanover, which entirely consists of the carbonized foliage, trunks, and branches, of coniferous trees, drifted from the country of the Iguanodon.

The facts thus rapidly noticed proved that during the deposition of the Wealden, Oolitic, and Cretaceous strata, there existed an extensive Island or Continent, diversified by hills and valleys, and traversed by streams and rivers teeming with fishes, crustaceans, and mollusca, closely allied to types, which at present inhabit the fresh-water of temperate regions; and that with these were associated fluviatile turtles, and crocodilian reptiles, whose living analogues, are restricted to tropical climes. Colossal herbivorous and carnivorous saurians, differing essentially in structure from all known existing forms, were the principal inhabitants of the dry land; and these, together, with flying lizards, and possibly a few birds, and very small mammalia, constituted the vertebrate fauna of the country or countries, which supplied the materials of the Wealden strata, and of the fluvio-marine deposits which are intercalated with the purely oceanic beds of the Oolite and Chalk.

Thus it appears, according to the present state of our knowledge, that the classes Mammalia and Aves, which constitute the essential features of the terrestrial zoology of most countries, were represented through a period of incalculable duration solely by two genera of very diminutive mammals, and a few birds; while the air, the land, and the waters, swarmed with peculiar reptilian forms, fitted for aërial, terrestrial, and aquatic existence.

Admitting to the fullest extent the effect of causes that may be supposed to have occasioned the absence of mammalian remains in the secondary deposits, the immense preponderance of the reptile tribes is still unquestionable. Some authors have attempted to account for this anomaly by assuming that antecedently to the Eocene period, our planet was not adapted for the existence of mammalia, in consequence of its atmosphere being too impure to support higher types of animal organization than the cold-blooded vertebrata. But the certainty that some forms of marsupial and placental mammalia inhabited the countries of the Megalosaurus and Pterodactyle,—that birds in all probability existed with the Iguanodon,—and the fact that insects and mollusca, and trees, and plants, which now inhabit regions abounding in birds, and mammalia, flourished during the "Age of Reptiles,"—demonstrate that the physical conditions of the earth, and the constitution of the atmosphere, and of the waters, differed in no essential respect from those which now prevail, and that the laws which govern the organic and inorganic kingdoms of nature have undergone no change.

That the class Reptilia was developed during the periods embraced in this discourse to an extent far beyond what has since taken place, appears to be indisputable, nor can any satisfactory solution of the problem be offered from the data hitherto obtained. Future discoveries may however show that coeval with the country of the Iguanodon there were regions tenanted by birds and mammalia; and that the almost exclusively reptilian fauna of the lands whose zoological and botanical characters have formed the subject of this Lecture, was but an exaggerated condition of that state of the animal kingdom which is exhibited by the present fauna of the Galapagos Islands.*

In conclusion, Dr. Mantell alluded to the recent discovery of reptilian remains (the *Telerpeton Elginense*, and the presumed Chelonian foot-tracks) in the Old Red Sandstone of Morayshire,† in proof of the necessity of bearing in mind the salutary caution of Sir Charles Lyell, "that as our acquaintance with the living creation of past ages must depend in a great degree on what we term chance, we ought never to assume that the first appearance of any type of animals or plants took place at the precise point where our retrospective knowledge happens to stop."

5. *Note on the Fluor-spar locality of Gallatin Co., Ill.;* by G. J. Brush.—Shawneetown, Gallatin Co., Ill., has long enjoyed a reputation among American mineralogists as a locality for fluor-spar. Having had occasion, a few months since, to visit the southern portion of Illinois, I explored this locality. It was found however that the fluor-spar did not occûr, as reputed, at Shawneetown, but ten to fifteen miles farther down the Ohio, and a half a mile to a mile north of the river.

The fluor occurs in the carboniferous limestone, it forms numerous veins, many of which are from ten to twenty feet in thickness. It is highly crystalline and often very fetid; beautiful crystallized specimens are found in pockets in the veins, which are sometimes entirely colorless, frequently of a blue, a violet, or a pink tint, and more rarely of an emerald-green.

The localities have been quite extensively worked for lead, which, under the form of galena, is associated with the fluor. The amount of galena is quite considerable, although no regular vein has as yet been found; it is somewhat argentiferous, yielding, on an average of several specimens examined, about four ounces of silver to the ton.

The mining of these veins has developed, besides some fine crystallizations of fluor, as a compact variety in which the associated galena also has the compact structure. An immense amount of a remarkably fine quality of fluor-spar could be obtained from these veins should there be a demand for it in the arts.

Near Rosiclare there are large veins of calcite which have also been worked for lead, in these mines are found finely crystallized specimens of zinc-blende and calcite.

Five miles back from Elizabethtown, in the same county, is an extensive deposit of bog and pipe iron-ore. Two furnaces have been erected near the mine.

Nitre is found about a mile north of the river between Elizabethtown and Rosiclare.

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* See "Wonders of Geology," Sixth Ed., p. 893.
† Lyell's "Manual of Geology," Fourth Ed., p. x.

III. Botany and Zoology.

1. *The Camphor-Tree of Sumatra, (Dryobalanops Camphora.)*—An account of this tree, and of the mode of procuring the peculiar and high-priced *camphor* which it yields, is given by Dr. Junghuhn, who has travelled largely in Sumatra, and Prof. De Vriese, of Leyden, in the *Nederlandsch Kruidkundig Archief*, for 1851. An abstract of the memoir, translated into English by Miss De Vriese, is published in Hooker's Journal of Botany for Feb. and March, 1852. The Dryobalanops is a gigantic tree, rising for fifty or even a hundred feet above those which compose the chief mass of the forests where they grow, just as the steeples of churches appear above the roofs of the houses in a town. The trunks of the full-grown trees are from 7 to 10 feet in diameter at the very base, and from 5 to 8 feet higher up: they rise to the height of 100 or 130 feet, and their ample crown is from 50 to 70 feet in diameter. The tree has a limited range, being confined to the seaward slope of the mountains of south-western Sumatra, most abundant on the lower slopes and the outlying hills of the alluvial plain, and extending in latitude from 1° 10′ to 2° 20′ N. and perhaps farther to the North. *Camphor-oil* occurs in all the trees, and is most abundant in the younger branches and leaves. The solid Camphor is found only in the trunk of the older trees, especially in fissures of the wood, and in smaller quantity than is generally supposed. Colebrooke, and authors who have copied from him, assert that camphor is found in the heart of the tree in such quantity as to fill a cavity of the thickness of a man's arm; and that a single tree yields about eleven pounds. The price of this camphor, which at Padang sells for about $340 per hundred weight, suffices to show that the account is much exaggerated. The camphor occurs only in small fissures, from which the natives, having felled the trees and split up the wood, scrape it off with small splinters, or with their nails. From the oldest and richest trees they rarely collect more than two ounces. After a long stay in the woods, frequently of three months, during which they may fell a hundred trees, a party of thirty persons rarely bring away more than 15 or 20 pounds of solid camphor, worth from 200 to 250 dollars. The variety and price of this costly substance are enhanced by a custom which has immemorially prevailed among the Battas, of delaying the burial of every person who, during his life had a claim to the title of Rajah (of which each village has one,) until some rice, sown on the day of his death, has sprung up, grown, and borne fruit. The corpse, till then kept above-ground among the living, is now, with these ears of rice, committed to the earth, like the grain six months before; and thus the hope is emblematically expressed, that, as a new life arises from the seed, so another life shall begin for man after his death. During this time the corpse is kept in the house, inclosed in a coffin made of the hollowed trunk of a *Durion*, and the whole space between the coffin and the body is filled with pounded camphor; for the purchase of which the family of the deceased Rajah often impoverish themselves. The camphor-oil is collected by incisions at the base of the trunk, from which the clear, balsamic juice is very slowly discharged.

2. *The Chinese Rice-Paper Plant.*—It was long thought that the beautiful and well-known " rice-paper of China was made from the pith of an *Æschynomene:* but this has been shown to be incorrect. Two years ago Sir Wm. Hooker published, in his *Journal of Botany*, some selections from a series of Chinese drawings, representing its manufacture from a strange looking vegetable, which, it now appears, must have been a hoax upon Europeans. For at length Sir Wm. Hooker has obtained, from the island of Formosa, where alone it is known to grow, some imperfect specimens (stems and foliage) of the true plant; from which is made a figure, published in the January number of his Journal; and an account is given in the February number. Enough is now known to render it most probable that the plant is Araliaceous; and it is provisionally named *Aralia? papyrifera*, Hook. The stems are arborescent or frutescent, and are filled with a very large and beautifully white pith, from which the paper is made.

3. *Fungi Caroliniani Exsiccati.*--Sets of specimens illustrating the Mycology of North and South Carolina, are in preparation, we understand, by H. W. Ravenal, Esq., of Black Oak, South Carolina, one of the most zealous and active botanists of our Southern States, and who, incited by the example of Mr. Curtis, has engaged in the study of our Fungi with characteristic energy. He is aided by Mr. Curtis and by the Rev. Mr. Berkeley of England. The first fasciculus, comprising 100 species, nearly half of which are said to be peculiarly American, is announced to be published in the course of the present summer. The publisher is Mr. John Russel, of Charleston, S. Carolina, to whom early application should be made for copies.

4. *Antonio Bertoloni; Miscellanea Botanica;* parts 1–10. Bologna, 1842–51, 4to—with 44 colored plates.—The most important part of this work is an account of the tree that produces *Ebony*, from specimens received from Mozambique. The tree proves to be a *Leguminosea*, on which Prof. Bertoloni has founded a new genus, *Fornasinia ebenifera*, named after the Bolognese merchant, who collected and furnished the specimens. But in *Hooker's Journal of Botany*, the plant is referred to the genus *Millettia*. For us, however, the chief interest of the *Miscellanea Botanica* comes from the descriptions and figures here given of numerous species of plants, founded on a well-known collection made about 20 years ago by Dr. Gates, (here called "Dr. Gaves,") in Alabama. A set of these plants was presented by the Prince of Canino to Professor Bertoloni. Unfortunately Prof. Bertoloni was not aware that the new plants of this collection have been long since published by Nuttall, Torrey, and others; nor is the Italian botanist always happy in referring the plants to their proper genera. Before they find their way into systematic works, it may be well to refer the names here proposed to those generally received in the United States. Thus, Lactuca Alabamensis, *Bert. l. c.* 4, *p.* 10, is L. graminifolia, *Michx.* His Nabalus quercifolius, is N. Fraseri, *DC.*

Hieracium caulophyllum is H. venosum β subcaulescens.
Liatris radians is L. elegans, *Willd.*
Liatris sessiliflora is L. spicata, L. var. β *Torr. & Gr.*
Liatris lanceolata is L. gracilis, *Pursh.*
Liatris umbellata is Vernonia angustifolia, *Michx.*

Eupatorium glastifolium is Liatris odoratissima, *Willd.*
Eupatorium stigmatosum is E. album, *Linn.*
Eupatorium cassinefolium is E. cuneifolium, *Willd.*
Eupatorium racemosum is E. coronopifolium, *Willd.*
Erigeron integrifolium (excl. syn.) is E. vernum, *Torr. & Gr.*
Tussilago oblongifolia is Chaptalia tomentosa, *Vent.*
Aster scabrosus is Sericocarpus tortifolius, *Nees.*
Aster multiflorus is A. dumosus, *Linn.*
Aster microphyllus is A. adnatus, *Nutt.*
Aster rigidus is Diplopappus linariifolius, *Hook.*
Solidago obovata (not figured) is S. pulverulenta, *Nutt.*
Solidago genistoides (not figured) is apparently S. virgata, *Michx.*
Actinomeris alata (not figured) is probably Verbenia Siegesbeckia.
Rudbeckia nudiflora is Helianthus Radula.
Rudbeckia lanceolata (not figured) is probably R. hirta.
Helianthus gracilis is H. heterophyllus, *Nutt.*
Coreopsis callosa (not figured) is C. angustifolia, *Ait.*
Coreopsis heterophylla (not figured) is probably C. aurea, *Ait.*
Coreopsis cuspidata (leaf figured) is certainly C. aurea.
Coreopsis jasminifolia is another form of C. aurea.
Viguiera glandulosa (not figured) must be Baldwinia uniflora!
Gatesia Alabamensis, Nov. Gen. Compos. ("Eadem vero facile ostendit, quam infirma sunt systemata, opus manuum hominum. Dum enim fert habitum plantarum Compositarum, recedit ab iis antheris liberis, forma singulari corollæ, et stylo simplici," etc.) is Petalostemon corymbosum, *Michx.!*
Mariscus aureus is M. echinatus, *Ell.* (Cyperus Baldwinii, *Torr.*)
Cyperus pes-avium is apparently C. dentatus, *Torr.*
Cyperus filicinus, is apparently C. Gatesii, *Torr.*
Cyperus Fontanesii, is C. Nuttalii, *Torr.*
Petalostemon bicolor is P. gracile, *Nutt.*
Tephrosia mollissima is T. spicata, *Nutt.*
Poralea alnifolia and P. alopecurina are Rhyncosia tomentosa, *Torr.*
Clitoria Alabamensis is Centrosema Virginiana.
Lespedeza cytisoides is Pitcheria galactoides, *Nutt.!* with the flowers colored purple; whereas they are said to be yellow in the living plant.
Hedyotis fasciculata is H. purpurea, *Torr. & Gr.*
Diodia auriculosa is a variety of D. Virginica.
Sabbatia simplex is Rhexia stricta, *Pursh.*
Cuscuta remotiflora and C. fruticum, (not figured,) must be left for Dr. Engelmann to determine.
Melanthium biglandulosum, (not figured) is probably Zygadenus glaberrimus, *Michx.*
Euphorbia discolor is E. polygonifolia, *Michx.* non *Linn.* (E. corollata var.?)

A. G.

5. *Outlines of the Natural History of Europe.—The Vegetation of Europe, its conditions and causes;* by Arthur Henfrey, F.L.S. London, 1852, pp. 387, 24mo. Van Voorst.—This is the first of a series of popular works on the Natural History of Europe, undertaken by Mr. Van Voorst; and it is a very interesting one. Mr. Henfrey discusses

first, the General Influences on the distribution of Vegetation, namely the elements of climate in Europe, the soil, &c.; next the Special Influences on the distribution of plants; or the circumstances to which the peculiar vegetation of particular parts of the world may be supposed to be owing, in connexion with the hypothesis of creation at specific centres, (which he adopts) and the varied causes both of the diffusion and of the limitation of species. Then follows a general account of the Vegetation of Europe, treated under ten natural provinces, viz.: The Scandinavian Peninsula; Iceland and the Faroes; The British Islands; The North-European Plain; The East-European Plain; The Central European Highlands; The Alps; The Spanish Peninsula; The Italian Peninsula; The Greek Peninsula. Mr. Henfrey has availed himself of all that has recently been written on this class of subjects, has carefully digested and systematized it, and presented it in a clear and succinct manner.
A. G.

6. *Conspectus of the Crustacea of the Exploring Expedition under Capt. C. Wilkes, U. S. N.;* by JAMES D. DANA.—PAGURIDEA, continued, MEGALOPIDEA and MACROURA, (Proc. Acad. Nat. Sci., Philad., 1852. pp. 6–28.)—The genera of Paguridea described in this paper have already been mentioned in this Journal.* The following are the observations on the Megalopidea, together with the descriptions of the new genera, omitting those of the species.

MEGALOPIDEA.—The question of the maturity or immaturity of the Megalopæ and that of their true place in the natural system, still remain in doubt. Without touching on these points, at this time, I propose to describe some new genera and species pertaining to the group.

The species, however diverse, agree in the structure of the abdomen and its caudal appendages; in the position of the four antennæ *between* the eyes; in the articulations of the outer antennæ; in the inner antennæ folded longitudinally or obliquely either side of the beak; in the general form of the outer maxillipeds; in the large size and lateral position of the eyes without orbits; in the general structure of the legs; and in their habits. The beak is either horizontal or flexed downward, and has usually a sharp prominent tooth, either side of it, exterior to the inner antennæ.

The genus Megalopa, *Leach*, as now accepted, embraces two distinct sets of species—the *M. Montagui* and *armata* for which it was instituted by Leach, and the *M. mutica* of Desmarest. The former (the true Megalopæ) have the beak nearly horizontal, with rarely a tooth either side, and there is a reflexed spine on the ventral surface of the first joint of the 8 posterior legs. The latter has the beak bent downward vertically, and either side of it there is a prominent spine or tooth; the ventral surface of the base of the legs is unarmed. The *M. mutica* is very closely related to *Monolepis spinitarsus* of Say, the only difference being that the extremity of the posterior legs in this species of Monolepis bear 3 or 4 setæ rather longer than the tarsus, while the descriptions of the *mutica* make mention of no such setæ. The posterior legs in Monolepis fold up and overlie the carapax: but

* Vol. xiii, p. 121.

these legs are otherwise like the preceding, though somewhat smaller, and it is probable that this habit in the *M. mutica* has been overlooked, as these animals almost always swim with the posterior legs extended like the others, when taken and kept in a jar for examination, and they also have them extended when walking. These legs do not resemble at all the posterior pair in Porcellana or Galathea. I had examined several species before I discovered this habit with regard to the posterior legs. The animal also throws the fourth pair of legs forward along or over the borders of the carapax, so that the extremity overlies the bases of the eyes and the tarsi hang down in front; and at the same time the two preceding pair are folded up and lie against the sides of the carapax outside of the 4th pair, or the third pair may be thrown forward like the 4th. A Sooloo species, and another common off Cape of Good Hope, were observed swimming with the legs thus disposed.

Say's genus Monolepis* also embraces two groups, alike in the deflexed front, and the longish setæ at the extremity of the posterior tarsi. In one division, including the *M. inermis*, the tarsi are flattened styliform, and unarmed, with either lateral edge sparsely furnished with minute hairs; the fossa of the sternum along which the abdomen lies when inflexed, has a prominent trenchant border; the depression on the carapax for the posterior legs is rather abrupt and somewhat neatly defined; the body is very convex and obese, with the sides high and vertical, and much wider behind than before, being gradually narrowed forward.

The other division has the tarsi unguiform, compressed, and spinous below, the antepenult spine always longest; the fossa of the sternum with flaring borders; the depression of the carapax for the posterior legs shallow concave; the body more flattened above, with the sides more oblique. This division corresponds to *Monolepis spinitarsus.*

Besides the preceding, there is another group of Megalopidea, examined by the author, resembling Megalopa of Leach, except that the tarsus of the posterior legs is narrow lamellar instead of unguiculate, and edged with longish setæ somewhat shorter than the tarsus.

There is still another group in which the front is horizontal and tricuspidate, the inner antennæ when retracted being exposed in the interval between the beak or inner cusp and either outer, lying in view as in Plagusia.

With these explanations we give the characters of the genera.

1. Monolepis, *Say.*—Carapax fronte tricuspidatus sed valde deflexus ideoque frons superne visus medio non acutus sed truncatus. Pedes 5ti minores, supe carapacem sæpe restantes, depressione ad eos recipiendos abruptâ; tarsis inermibus, depressis, styliformibus, paris postici non depressis, apice 3—4 setis longiusculis (tarso paulo longioribus) instructo. Sterni fossa abdominalis marginibus bene prominens et subacuta.—*Monolepis inermis*, Say, typus est.

2. Marestia, *Dana.*—Carapax fronte uti in *Monolepi.* Pedes 8 postici ad basin infra non armati; 5ti minores, super carapacem sæpe

* Journ. Acad. Nat. Sci., Philad., i, 155. The author is indebted for the privilege of examining a specimen of Say's *M. inermis*, to Prof. Lewis R. Gibbes of Charleston, S. C. Another related species was obtained by the author in the East Indies.

restantes, depressione ad eos recipiendos parce concavâ : tarsis styliformibus, unguiculatis, spinis infra armatis, paris postici apice setis longiusculis instructis.—Typus est *Monolepis spinitarsus*, Say. Hic pertineret quoque *Meg. mutica*, Desm., si ejus pedes postici setis longiusculis confecti ; aliter genus novum instituendum. Verbum "Marestia" Desmarest commemorat clarissimum.

3. Megalopa. *Leach.*—Carapax fronte simpliciter rostratus, rostro vix deflexo, acuto. Pedes 8 postici ad basin infra uni-spinigeri ; 5ti minores tarso styliformi.—Typus *Meg. Montagui*, Leach.*

4. Cyllene, *Dana.*—Carapacis frons uti in *Megalopa.* Pedes 8 postici ad basin infra uni-spinigeri ; 5ti minores, tarso anguste lamellato, setis longiusculis partim ciliato.

5. Tribola, *Dana.*—Carapax fronte horizontalis, tricuspidatus, rostro (vel cuspide medianâ) tenui, cuspidibus externis vix longiore. Antennæ internæ inter rostrum et cuspides externas apertè inflexæ. Pedes postici minores, tarso unguiculato setisque longis non instructo.

List of new species of Megalopidea described in this paper :—Marestia elegans, M. atlantica, M. pervalida ; Monolepis orientalis; Cyllene hyalina, C. furciger; Tribola lata, T. pubescens.

Macroura.—In the account of the Macroura, this tribe is arranged anew, several new genera are added, and 59 new species described. In citing the general remarks, the writer and author here makes a single modification, which consists in removing the Penæus group from the Caridea, and making it a distinct subtribe.

We follow De Haan in placing the genus Galathea with the Anomoura ; and near it we arrange Æglea, which widely differs from most other related species in having penicillate instead of foliose branchiæ.

The Macroura, excluding these groups, includes three distinct sections or subtribes, pertaining to two series.

The *first series* includes the "Fossores" of authors, or the Thalassinidea, which have close relations on one side with the Paguri, and on the other with the Squillidæ. They constitute a line of gradation between these extremes, independent mostly of the other Macroura, and osculating only with the Astaci, although removed from them in general habit and structure. There is a diversity among the legs as to form and position, which is not found in any other Macroura, and calls to mind the Paguri. Moreover, there is in general a looseness of structure, a length of abdomen, and sluggish habit of body, unlike the trim compact forms of the typical Macroura. The anterior feet are thrown directly forward, and are thus fitted for the burrowing habits of the species.

The *second series* embraces the remaining Macroura. There are three grand divisions or subtribes included in the series—a superior, a typical, and an inferior.

The first is somewhat Brachyural in its characteristics, and is made up of the Astacidea. Their relation to the Brachyura and their cephalic

* Malac Pod. Brit., pl. 16. Leach describes three other species (not noticed by Edwards,) in Tuckey's Exped. to the Zaire, (London, 1818,) p. 404. The *M. Orustacei* may be a true Megalopa ; the others have a deflexed beak.

superiority, is seen in the fact that the sides of the carapax fold under and unite to the epistome, a peculiarity well shown in Scyllarus and also, though less perfectly, in Astacus. Another mark of this superiority is observed in the absence or small size of the basal scale of the outer antennæ—this scale existing in no Brachyura, and having a large size in the typical Macroura. The Astaci are the transition species between the Astacidea and the next division of Macroura, and in the genus *Paranephrops* of White, the antennary scale is quite large; the Astaci differ from all the Macroura of the following divisions in the transverse suture which crosses the carapax near its middle.

The remaining Macroura differ from the Astacidea in both of the characters above-mentioned; the carapax is free from the epistome, and the antennary scale is large. They are naturally separated into two sections marked off by the extent of their divergence from the higher Crustacea, and their different degrees of cephalic inferiority. The distribution alluded to is indicated by the position of the strong prehensile legs. In the Brachyura the anterior pair is uniformly the strong pair; and this uniformity through so extensive a group shows that the variations from it must be of importance in classification. This peculiarity of the Brachyura is a consequence of the concentration of force in the anterior portion of the cephalothorax or the anterior nervous ganglia; and the diffusion of this force posteriorly, which in different degrees marks the Macroura, is especially exhibited in the legs.

We observe then that through a large part of the Macroura the strong prehensile legs are either the first or second pairs. These species are all of a common grade; for the species having the first pair the larger are connected by so many transitions with those that have the second pair the larger, that no line of demarcation can be drawn which should make a grand division among them. These are the CARIDEA.

Another group remains, in which the stoutest prehensile legs are those of the *third* pair, and the line between these species and the preceding in this respect is strongly drawn. This peculiarity indicates a transfer of force, which pertained to the first pair in the Brachyura, and to the first or second in the typical Macroura, to a pair more posterior: giving the anterior part of the body a still lower character. These, the PENÆIDEA constitute our third division or subtribe. With the Penæidea should be included certain still lower species, approaching the Mysis group, in which none of the legs are stout chelate, (Sergestes, &c.) whose whole structure indicates their inferior character, and the low state of the forces within.

The three grand divisions, ASTACIDEA, CARIDEA and PENÆIDEA, constituting the second series, thus mark three grades of rank among the Macroura. The Thalassinidea are the *aberrant* species.

These subtribes may be divided into families.

Subtribe 1. *Thalassinidea.*—This section, as Milne Edwards observes, includes two strongly marked divisions; *one*, with only the ordinary thoracic branchiæ, and a *second* with the addition of *abdominal* branchial appendages, as in the Squillidæ. The former we name the *Thalassinidea Eubranchiata*, the latter, the *Thalassinidea Anomobranchiata.* The first group embraces three families, differing strikingly in outer maxillipeds and abdomen, as explained beyond. The second contains only two genera, *Callianidea*, Edw., and *Isæa*, Guerin: the last name was changed by Edwards to *Callianisea*; but as this word is so near Callianassa and Callianidea, a contraction to *Callisea* would be preferable.

Subtribe 2. *Astacidea.*—In this subtribe we adopt De Haan's sections, except that we exclude the Megalopidea, and we do not associate the Thalassinidea with the Astacidea. The sections or families are *Scyllaridæ*, *Palinuridæ*, *Eryonidæ*, and *Astacidæ*.

Leach in 1819 subdivided the old genus Astacus, naming the marine species (Homarus, *Edw.*) *Astacus*, and the fresh water (Astacus, *Edw.*) *Potamobius*. Edwards's division, of like character, now generally accepted, was not published till 1837. Leach hence has the priority. But according to Leach, the name Astacus is appropriated, not to the typical part of the group, that including the *Astacus fluviatilis* of old authors, or *Cancer Astacus* of Linnæus, and which embraces at the present time numerous species, but to that including the *Cancer Gammarus* of Linnæus, still but a small group. There is hence much objection to the names of Leach, and morever much confusion would now ensue from their adoption. There seems, therefore, to be sufficient reason for rejecting them, if it be of no weight that they have remained for 30 years unrecognized by British authors. They are adopted in the Catalogue of British Crustacea of the British Museum, published in 1850, but not in the general Catalogue of 1847.

Subtribe 3. *Caridea.*—In arranging the Caridea into groups, much stress is usually laid upon external form and length of beak. The unimportance of these characters is inferrible from the fact that they involve no essential variations of structure. Moreover, in a single natural group, we may find both the long and short beak. In the Crangon group, for instance, in which the beak is usually very short and the body depressed, we have a species with the beak and habit of an Hyppolyte.

There are other characters of more fundamental value; and these have been brought forward by De Haan. The mandibles afford the distinctions alluded to. In one section they are very slender and are bent nearly at a right angle, without enlargement at the crown. In another they are very stout, and somewhat bent above with a broad dilated crown. In a third, they are stout, but not bent, and have a dentate summit. In a fourth they have, in addition to a projecting lateral crown, a large summit process, which is often oblong and very prominent. These forms are characteristic of different sections of the Caridea.

The fact that the mandibles bear a palpus or not is of much less importance; for the portion of the mandible which is most essential to its functions is the crown.* Among the Palæmoninæ, there are genera having a mandipular palpus, and others without one; while the two kinds in other respects are remarkably close in their relations. We have found moreover, that in this group, the length of the palpus varies with the disjunction of the 2d and 3d flagella of the inner antennæ. If these flagella are separate to their bases nearly, (as in Palæmon,)

* The highest Crustacea have no mandibular palpi.

the palpus is long and 3-jointed; if united for some distance up, the palpus becomes short and finally only 2-jointed (Palæmonella;) if united nearly or quite to their summits, there is no palpus.*

In the arrangement of the genera into families, the fact *whether the 1st or 2d pair of legs is the stouter*, is here of great weight, much greater than has been recognized. By regarding this character, we are led to place Hippolyte and Rhyncocinetes with Alpheus, instead of with Palæmon; also Hymenocera and Pontonia with Palæmon, instead of with Alpheus.

In the preceding paragraphs we have but hinted at some of the more prominent principles involved in the classification of the Macroura here presented, a fuller exposition of which will be given in another place. Below is a synopsis of the families and sub-families thus arrived at, with a description of the new genera.

Synopsis Familiarum Crustaceorum Macrourorum.

Subtribus I. THALASSINIDEA, vel MACROURA PAGURO-SQUILLIDICA.

Carapax suturâ transversâ notatus, posticeque sæpe suturis duabus longitudinalibus. Abdomen sæpius multo elongatum. Antennæ externæ squamâ basali sive nullâ sive parvulâ instructæ. Pedes 2 antici prorsum projecti; 6 postici habitu raro consimiles. *Species fossores.*

Legio I. THALASSINIDEA EUBRANCHIATA.

Branchiis instructa thoracicis tantum.

Fam. 1. Gebidæ.—Maxillipedes externi pediformes. Appendices caudales et aliæ abdominales latæ.—Genera: Gebia, *Leach*, Axius, *Leach*, Calocaris, *Bell*, Laomedia, *De Haan*, Glaucothoe, *Edw.*†

Fam. 2. Callianassidæ.—Maxillipedes externi operculiformes. Appendices caudales latæ.—Genera: Callianassa, *Leach*, Trypæa. *D.*

Fam. 3. Thalassinidæ.—Maxillipedes externi pediformes. Appendices caudales lineares.—Genus: Thalassina, *Latr.*

Legio II. THALASSINIDEA ANOMOBRANCHIATA.

Genera:—Callianidea, *Edw.*, Callisea, (*Guerin*,) *D.*

Subtribus II. ASTACIDEA vel MACROURA SUPERIORA.

Carapax suturâ transversâ sæpius notatus, lateribus anterioribus epistomate connatis. Antennæ externæ squamâ basali sive nullâ sive

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* In our genus *Palæmonella*, the palpus of the mandible is 2-jointed, and in *Anchistia*, which is closely like Palæmon in habit in some of its species, there is no palpus, as in the Pontoniæ; and thus the transition to the Pontoniæ from Palæmon is exceedingly gradual. Harpilius and Œdipus (Pontonia of authors) fill up the interval between Anchistia and the true Pontoniæ. They are all similar in having the 2d pair of legs largest, and in other prominent characteristics.

† The genera of living species only are mentioned.

parvâ instructæ. Abdomen sat breve vel mediocre. Branchiæ sæpius penicillatæ. Pedes 2 antici oblique projecti; 6 postici directione consimiles.

1. *Antennæ externæ squamâ basali non instructæ. Pedes antici non chelati.*

Fam. 1. Scyllaridæ.—Carapax valde depressus, marginibus lateralibus sat tenuibus, carapace lateraliter subito inflexo. Antennæ externæ laminatæ, breves. Sternum trigonum.—Genera: Scyllarus, *Fabr.*, Arctus, *D.*, Thenus, *Leach*, Parribacus, *D.* Ibacus, *Leach.*

Fam. 2. Palinuridæ.—Carapax subcylindricus, lateraliter late rotundatus. Antennæ externæ basi subcylindricæ, longæ. Sternum trigonum.—Genera: Palinurus, *Fabr.*, Panulirus, *Gray.*

2. *Antennæ externæ squamâ basali instructæ. Pedes antici didactyli.*

Fam. 3. Eryonidæ.—Carapax non oblongus, depressus, lateribus subito inflexis, abdomine multo augustiore.—Genus: Eryon, *Desm.*

Fam. 4. Astacidæ.—Carapax oblongus, subcylindricus, abdomine parce angustiore. Sternum angustum.—Genera: Homarus, *Edw.*, Astacoides, *Guerin*, (subgen. incl. Astacoides et Cheraps, *Erich.*) Astacus (subgen. incl. Astacus et Cambarus, *Erich.*) Nephrops, *Leach*, Paranephrops, *White.*

Subtribus III. CARIDEA vel MACROURA TYPICA.

Carapax suturâ transversâ non notatus, cephalothoracem plerumque tegens, lateribus anterioribus liberis, epistomate non connatis. Antennæ externæ squamâ basali grandi instructæ. Corpus sive subcylindricum sive paulo compressum. Branchiæ sæpius foliosæ.

Fam. 1. Crangonidæ.—Mandibulæ graciles, valde incurvatæ, non palpigeræ, coronâ angustâ. Pedum pares 1mi 2di inter se valde inæqui.

Subfam. 1. Crangoninæ.—Pedes 1mi 2dis crassiores. Maxillipedes externi pediformes. Digitus mobilis in palmam claudens, immobilis spiniformis. Pedes 2di non annulati.—Genera: Crangon, *Fabr.*, Sabinea, *Owen*, Argis, *Kröyer*, Paracrangon, *D.*

Subfam. 2. Lysmatinæ.—Pedes 1mi 2dis crassiores. Maxillipedes externi pediformes. Manus bene didactylæ. Pedes 2di annulati. Genera: Nika, *Risso*, Lysmata, *Risso*, Cyclorhynchus, *DeH.*

Subfam. 3. Gnathophyllinæ.—Pedes 2di 1mis crassiores. Maxillipedes externi late operculiformes.—Genus: Gnathophyllum.

Fam. 2. Atyidæ.—Mandibulæ crassæ, non palpigeræ, coronâ latâ, parce bipartitâ, processu terminali brevi et dilatato. Pedum pares 1mi 2dique inter se æqui, carpo nunquam annulato.

Subfam. 1. Atyinæ.—Pedes thoracici palpo non instructi.—Genera: Atya, *Leach*, Atyoida, *Randall*, Caridina, *Edw.*

Subfam. 2. Ephyrinæ.—Pedes thoracici palpo instructi.—Genus: Ephyra, *Roux*, *DeH.*

Fam. 3. PALÆMONIDÆ.—Mandibulæ crassæ, sive palpigeræ sive non palpigeræ, profunde bipartitæ, processu apicali oblongo, angusto.

Subfam. 1. ALPHEINÆ.—Pedes 1mi crassiores, chelati; 2di filiformes, carpo sæpius annulati et chelati. Mandibulæ palpigeræ.—GENERA: Alpheus, *Fabr.*, Betæus, *D.*, Alope, *White*, Athanas, *Leach*, Hippolyte,* *Leach*, Rhyncocinetes, *Edw.*,—[Cujus sedis genus Antonomea, *Risso ?*].

Subfam. 2. PANDALINÆ.—Pedes 1mi gracillimi; non chelati; 2di filiformes, carpo annulato.—GENUS: Pandalus, *Leach.*

Subfam. 3. PALÆMONINÆ.—Pedes 2di 1mis crassiores, 4 antici chelati, carpis nullis annulatis. Pedes nulli palpigeri. Squama antennarum externarum non acuminata et extus non spinigera.—GENERA *mandibulis non palpigeris:* Pontonia, *Latr.*, Œdipus, *D.*, Harpilius, *D.*, Anchistia, *D.; mandibulis palpigeris,* Palæmonella, *D.*, Palæmon,† *Fabr.*, Hymenocera, *Latr.*, Cryphiops, *D.* [Cujus sedis genus Typton, *Costa, ?*]

Subfam. 4. OPLOPHORINÆ.—Pedes 2di crassiores, chelati, 1mi sive didactyli sive vergiformes. Squama antennarum externarum acuminata, extus spinis armata.—GENERA: Oplophorus, *Edw.*, Regulus, *D.*

2. *Maxillipedes 2di tenuiter pediformes.*

Fam. 4. PASIPHÆIDÆ.—Pedes 1mi 2dique chelati. Mandibulæ uti in Atyidis.—GENUS: Pasiphæa.

Subtribus IV. PENÆIDEA, vel MACROURA INFERIORA.

Pedes 3tii majores, 2dis similes; interdum toti debiles et vergiformes. Carapax uti in Carideis.

Fam. 1. PENÆIDÆ.—Pedes 3tii bene didactyli, validiores. Palpus mandibularis latus.—GENERA: Sicyonia, *Edw.*, Penæus, *Latr.* (*Aristæo*, Duvernoy, incluso,) Stenopus, *Latr.*, Spongicola, *DeH.*

Fam. 2. SERGESTIDÆ.—Pedes 3tii 2dique 1mique debiles, obsolete chelati vel non chelati. Palpus mandibularis gracilis.—GENERA: Sergestes, *Edw.*, Acetes, *Edw.*, et forsan Euphema, *Edw.*

Fam. 3. EUCOPIDÆ.—Pedes 3tii 2dique vergiformes, non chelati; 1mi maxillipedesque externi æque monodactyli et subprehensiles, digito in articulum penultimum claudente. Palpus mandibularis gracilis.—GENUS: Eucopia, *Dana.*

New Genera described.

TRYPÆA.—Pedibus *Callianassæ* affinis. Flagella antennarum internarum articulo precedente breviora, antennis supediformibus.

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* Periclimenes, *Costa*, (Ann. dell'Acad. degli Aspir. Nat. di Napoli, ii, 1844) hardly differs from Hippolyte, according to Erichson, Arch. f. Nat. 1846, p. 310.

† *Leander*, Desmarest, (Ann. Ent. Soc., France, 1849, p. 87,) appears to be identical with Palæmon.

Arctus, (Scyllari subgenus 5tum, *De Haan.*)—Rostrum perbreve, truncatum. Antennæ externæ inter se remotæ. Palpus maxillipedis flagello carens. Branchiæ 19. Sp. A. *ursus*, D. (Scyllarus arctus, *Auct.*)

Parribacus.—(Scyllari subgenus 2dum, *De Haan.*)—Rostrum subtriangulatum. Antennæ externæ inter se fere contiguæ. Oculi fere in medio inter antennas internas et angulos cephalothoracis externos. Branchiæ 21. Species, *P. antarcticus* et *P. Parræ* (Ibacus antarcticus et I. Parræ, *Auct.*)

Paracrangon.—Rostrum elongatum. Oculi liberi. Pedes 2di obsoleti, 4ti 5tique acuminati, gressorii.

Betæus.—Rostrum nullum. Oculis et ceteris *Alpheo* plerumque affinis. Manus paris 2di major fere inversa, digito mobili inferiore vel exteriore.—Species maris frigidioris. (*Alphei* manus non inversa et species maris calidioris.)

Pontonia., *Latr. D.*—Corpus depressum. Rostrum breve. Oculi parvuli. Maxillipedes suboperculiformes, articulo 2do lato, 3tio 4toque simul sumtis longiore, his subcylindricis.

Œdipus.—(Pontonia, *Auct.*)—Corpus plus minusve depressum. Rostrum longitudine mediocre. Oculi permagni. Maxillipedes externi latiusculi, articulis totis latitudine fere æquis. Tarsi infra elongatè gibbosi.

Harpilius, (Pontonia, *Auct.**)—Corpus non depressum. Rostrum longitudine mediocre. Oculi magni. Maxillipedes suboperculiformes, articulo 2do lato, 3tio 4toque simul sumtis breviore, his subcylindricis. Tarsi uncinati, infra non gibbosi.

Anchistia.—Rostrum tenue, sæpius ensiforme et elongatum. Corpus vix depressum, sæpe compressum. Oculi mediocres; antennæ duobus flagellis instructæ, unâ parce bifidâ. Maxillipedes externi omnino tenues, pediformes.

Palæmonella.—Corpus non depressum. Rostrum sat longum, dentatum. Oculi mediocres. Mandibularum palpus bi-articulatus perbrevis. Antennæ internæ flagellis duobus confectæ, uno apicem bifido. Maxillipedes externi tenues. (Palpus mandibularis specierum *Palæmonis* tri-articulatus.)

Regulus, *Dana.*—Rostrum longum, dentatum. Antennæ internæ flagellis duobus confectæ. Pedes toti palpigeri, 2 antici non chelati, 2di crassè chelati. Mandibularum palpus 3-articulatus. [Abdominis segmentum 3tium dorso postico instar spinæ productum longæ.]

Eucopia, *Dana.*—Carapax non rostratus, fronte integro. Pedis thoracis elongato-palpigeri, palpis natatoriis. Maxillipedes 2di 3tii et pedes 1mi monodactyli et prehensiles, ungue ad articulum precedens claudente.

The following are the names of the new species:

I. Thalassinidea.—Gebia pugettensis; Callianassa gigas; Trypæa australiensis; Thalassina gracilis.

* Pontoniæ veræ Œdipis et Harpiliis habitu multo discrepant; Pontoniarum oculis parvulis, abdomine valde inflexo, et modo vitæ sæpius Pinnotheroideis; horum oculis pergrandibus, abdomine minus inflexo, animalibus modo vitæ liberis, inter ramos corallorum sæpe natantibus. Pontonia macrophthalma, *Edw.*, Œdipo pertinet.

II. Astacidea.—Arctus vitiensis; Astacus leniusculus, Astacoides nobilis, Paranephrops tenuicornis.

III. Caridea.—Crangon munitus; Paracrangon echinatus; Nika hawaiensis; Alpheus strenuus, A. pacificus, A. euchirus, A. obesomanus, A. crinitus, A. mitis, A. acuto-femoratus, A. parvi-rostris, A. tridentulatus, A. neptunus, A. pugnax, A. diadema, A. malleator; Betæus truncatus; B. æquimanus, B. scabri-digitus; Hippolyte acuminatus, H. exilirostratus, H. obliquimanus, H. brevirostris, H. lamellicornis; Pandalus pubescentulus; Pontonia tridacnæ; Ædipus superbus, Æ. gramineus; Harpilius lutescens; Anchistia gracilis, A. longimana, A. ensifrons, A. aurantiaca; Palæmonella tenuipes, P. orientalis; Palæmon debilis, P. exilimanus, P. concinnus, P. lanceifrons, P. acutirostris, P. equidens; Cryphiops spinuloso-manus; Regulus lucidus, R. crinitus.

IV. Penæidea.—Penæus carinatus, P. avirostris, P. velutinus, P. tenuis, P. gracilis; Stenopus ensiferus; Eucopia australis.

7. *A Monograph of the Sub-class Cirripedia, with Figures of all the Species;* by Charles Darwin, F.R.S., F.G.S. The Lepadidæ or Pedunculated Cirripeds. 400 pp. 8vo, with 10 plates. London, 1851.—The Cirripeds, one of the least understood of all the departments of zoology, have fallen into good hands, and this volume of Mr. Darwin, although but the beginning, lays well the foundation of the science, and carries far forward its superstructure. Mr. Darwin recognizes the fact that the Cirripeds are Crustacean in structure. He divides them into three orders—*one*, including the common Cirripeds, and having six pairs of thoracic cirri; *a second*, containing the burrowing genus *Alcippe*, Hancock, and another allied; and *a third*, a peculiar genus (*Proteolepas*, Darwin,) having something of the form together with the sucking mouth of a Lernæan. The first order embraces three families, the *Lepadidæ* or pedunculated Cirripeds, the second *Verrucidæ*, including the genus *Verruca* or *Clisia*, and third, the *Balanidæ;* these last consisting of two distinct sub-families, *Balaninæ* and *Chthamalinæ.* The present work treats only of the Lepadidæ, and contains descriptions and figures of numerous species.

The author traces out the development of the species with much detail, and gives the results of his careful examination into their structure. Two prominent points of interest which he brings forward, are the occurrence of eye-spots, and the relation of the peduncle to the front or anterior part of the head of the young animal. Dr. Leidy's discovery of eyes in a Balanus, led to Mr. Darwin's examination for these organs in the Lepadidæ. The nervous system of the *Lepas fascicularis* consists anteriorly of two large ganglia, (called supracœsophageal by Mr. Darwin) and a chain of thoracic ganglia united by two chords between each. From each of the anterior ganglia, there is a nerve passing to the peduncle, and more interiorly another nerve, which extends to a spot on the median line of a nearly black color, which is the pigment of two united eyes having two distinct lenses. In each of the ophthalmic nerves there is a ganglion a short distance posterior to the eye.

The homology of the peduncle appears to be well made out. The young animal attaches itself by its anterior antennæ when the last metamorphosis takes place, and although the base of the peduncle may be the analogue of these antennæ, the main part corresponds to the front or cephalic portion of the body, which is elongated.

The Cirripeds are to a great extent hermaphrodites. Mr. Darwin has arrived at many interesting results on this subject, and some that are exceedingly curious. An exception to the general rule of their hermaphroditic character is found in the genus *Ibla*, in which there are true *males*, and the Cirriped proper is simply female. These males lie within the sack of the female Cirriped, and have an elongated body with a slender pedicel below. Although very unlike the female, the organs of the mouth have a similar arrangement, being constructed on the Cirriped type. The cirri are obsolescent; two pair may however be distinguished. That these were true males was ascertained by dissection; and although their parasitic character was questioned, Mr. Darwin traced so many resemblances in the organs that existed to those of the females, that in view of the facts, he concludes, "that the evidence is amply sufficient to prove that the little parasitic Cirriped here described, is the male of Ibla Cummingii." Mr. Darwin has observed further that in the genera Ibla and Scalpellum there are both females and hermaphrodites. And in some hermaphrodites, males have been observed by Darwin, so similar in general character to those of Ibla, that he concludes them to be true males of the species with which they are connected, although the animals are hermaphrodites and not simply females. They are hence called *complemental* males, being supernumeraries. This fact is so anomalous, that Mr. Darwin naturally has been slow in coming to the conclusion that they are not parasites distinct in genus and species. Bearing on this point, it is stated that *Ibla quadrivalvis* is distinguished from *I. Cummingii* by the length of the caudal appendages and the great size of the parts of the mouth; and the so-called males of these species have corresponding differences. So in other characters. Moreover the antennæ have the peculiar hoof-like discs at the extremity characteristic of Ibla and Scalpellum. Taking these and other facts into consideration in connection with the observation that there are true female Iblas that are not hermaphrodites, and with them, these parasites occur with male sexual glands affording spermatozoa and without any trace of ova or ovaries; Mr. Darwin draws the conclusion above mentioned. He closes his remarks on these males with the following observations.

"In looking for analogies to the facts here described, I have already referred to the minute male Lerneidæ which cling to their females,—to the worm-like males of certain Cephalopoda, parasitic on the females,—and to certain Entozoons, in which the sexes cohere, or even are organically blended by one extremity of their bodies. The females in certain insects depart in structure, nearly or quite as widely from the Order to which they belong, as do these male parasitic Cirripeds; some of these females, like the males of the first three species of Scalpellum, do not feed, and some, I believe, have their mouths in a rudimentary condition; but in this latter respect, we have, amongst the Rotifera, a closely analogous case in the male of the Asplanchna of Gosse, which was discovered by Mr. Brightwell* to be entirely destitute of mouth and stomach, exactly as I find to be the case with the parasitic male of *S. vulgare*, and doubtless with its two close allies. For any analogy to the existence of males, complimental to hermaphrodites, we must look to the vegetable kingdom.

Finally, the simple fact of the diversity in the sexual relations, displayed within the limits of the genera Ibla and Scalpellum, appears to me eminently curious; we have (1st) a female, with a male, (or rarely two) permanently attached to her, protected by her, and nourished by any minute animals which may enter her sack; (2d) a female, with successive pairs of short-lived males, destitute of mouth and stomach, inhabiting two pouches formed on the under side of her valves; (3d) an hermaphrodite with from one to two, up to five or six similar short-lived-males without mouth or stomach, attached to one particular spot on each side of the orifice of the capitulum; and (4th) hermaphrodites, with occasionally one, two, or three males, capable of seizing and devouring their prey in the ordinary Cirripedial method, attached to two different parts of the capitulum, in both cases being protected by the closing of the scuta. As I am summing up the singularity of the phenomena here presented, I will allude to the marvellous assemblage of beings, seen by me within the sack of an *Ibla quadrivalvis*,—namely, an old and young male, both minute, worm-like, destitute of a capitulum, with a great mouth, and rudimentary thorax and limbs attached to each other, and to the hermaphrodite, which latter is utterly different in appearance and structure; secondly, the four or five, free, boat-shaped, larvæ, with their curious prehensile antennæ, two great compound eyes, no mouth, and six natatory legs; and lastly, several hundreds of the larvæ, in their first stage of development, globular, with horn-shaped projections on their carapaces, minute single eyes, filiform antennæ, prohosciform mouths, and only three pairs of natatory legs; what diverse beings, with scarcely anything in common, and yet all belong to the same species!"

Mr. Darwin has also published a monograph on the Fossil Lepadidæ of Great Britain—88 pp. 4to, with 5 plates. London, 1851. Printed for the Palæontographical Society.

8. *Dr. A. Binney's Terrestrial Air-breathing Molluscs.*†—* * * In the onward movement of American zoology, conchology has not only occupied a prominent place, but its cultivators have kept it modernized by wisely following the French rather than the English, and one of the results of this has been, for example, that the genus Paludina has been called Helix in English conchological works twenty years after the error had been relinquished forever in France and America—an error so great, that we cannot conceive how it could have maintained its position a single day after its erection as a distinct genus.

Dr. Binney had an excellent general knowledge of conchology and zoology, and in undertaking a complete history of the land Mollusca of this country, he did it with a full appreciation of the difficulties of the

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* 'Annals of Natural History' (vol. ii, 2d series, 1848,) p. 153, Pl. vi. Mr. Dalrymple has published a very interesting paper on the same subject, in the 'Philosophical Transactions,' (p. 342,) 1849; and there is another Memoir by Mr. Gosse in the 'Annals of Natural History,' vol. vi, (1850,) p. 18.

† See this Journal, [2], xii, 450.

subject, as well as the mode of investigation, and the general features necessary to bring his work up to the requisitions of science.

The plan included the history of the genera and species; their geographical distribution and synonymy; the figure and description of the mollusc, and an accurate iconography of the shell of each species, (each shell being usually represented by three figures from as many different points of view,) and the special anatomy.

Dr. Binney was a cautious worker and arrived at his conclusions slowly. He employed the best artists, and after the drawings were made, he scrutinized them with great minuteness when comparing them with the original. Among his earlier limners was Mr. Nutting of Boston, distinguished by the minute finish of his work. Subsequently he employed Miss Helen E. Lawson of Philadelphia, and her father as engraver, both of whom had worked upon shells under the direction of the author of another illustrated work on American conchology, already favorably noticed in this Journal. In this preliminary practice the artists were instructed to pay great attention to the direction and curves of the lines of growth, and to draw the more delicate species as translucent objects, by avoiding a deep shade in the aperture of univalves, which would be the result if the light could not enter this part through the shell. The result has shown that a univalve shell may be accurately represented although the shade of the aperture is no darker than that of the exterior, and in the work cited, parts like the curved columella of Physa and Limnea, are represented with an accuracy never exceeded.

The skill acquired in this preliminary practice was transferred to the work of Dr. Binney, and although, from the regularly spiral form of the Helix shell, and the perspective of the lines of growth, it is a difficult object to represent zoologically and artistically, he has had such plates executed as must command the admiration of the naturalist and lover of art.

In addition to the judicious general remarks, the history of a large and well known species, Helix albolabris, is given at length, and the entire work presents such a mass of important matter, and such a complete survey of the field, that (apart from the discovery of new species and detached facts,) it must be considered as exhausting the subject, and we can imagine no contingency which can cause it to be superseded.

S. S. H.

9. *Note on Graptolites;* by Dr. H. B. Geinitz, Professor at Dresden (Sax.)—After having submitted all the species of *Graptolites*, published from Linnæus to the end of the year 1851, to a careful investigation, I hasten to give you the last result of my inquiries. The family of the *Graptolithina* contains the following generea:

(1.) *Diplograpsus*, McCoy.* (Syn. *Diprion*, Barrande, *Petalolithus*, Süss.) Graptolithina, with two series of cells separated by a solid axis, (17 species.)

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* It is much to be regretted that the old Crustacean generic name *Grapsus* is introduced into another branch of zoology. It would be fully as correct, and as euphonious to write the above names Diplograptus, Cladograptus, &c.; the identity in the names would then be avoided, and the form used in Graptolite at the same time would be retained.—J. D. D.

(2.) *Nereograpsus*, Geinitz. (Syn. *Nereites*, *Myrianites*, *Nemertites*, *Auct.*)—Graptolithina, with two series of cells, without an axis, or with a very soft axis, in the centre of the common canal. (over 7 species.) Representing *Nereites Cambrensis*, Murchison.

N. B. In the specimen of Saalfield in Thuringia I have clearly seen the apertures of the cells.

(3.) *Cladograpsus*, Geinitz.—Graptolithina, with two arms, or forked Graptolithina. (7 species.) Representing *Gr. Murchisoni*, Beck, and *Gr. ramosus*, Hall.

(4.) *Monograpsus*, Geinitz, (Syn. *Monoprion* et *Rastrites*, Barr.) Graptolithina, with one series of cells and a solid axis. (28 species.)

(5.) *Retiolites*, Barrande, (Syn. *Gladiolites*, Barr., *Graptophyllia*, Hall.) Graptolithina, with two series of cells, covered with a fine reticulated membrane, forming a middle axis on one side of the commnon canal. (1 or 2 sp.)

In general, the Graptolithina were characterized by the modes of development and habit of the living Virgulariæ; they were mostly free in the sea, rarely and very likely only in their young state, fixed; others inserted themselves in the mud near the coast. The Graptolithus gracilis, *Hall*, Grapt. Hallianus, *Prout*, and Lophoctenium comosum, *Richter*, I place in the family of Sertularides. The "partie en croissance de Mr. Barrande," or the small part of the most species of Graptolites, is in my view the lower part or the basis of the stem of these animals, and in this I agree with James Hall.

The surface of many Graptolites is metamorphosed very often into *talc*, not into silicious earth, and in the slates of Graptolites he found traces of *iodine*.

Dresden, April 12, 1852.

[Dr. Geinitz has just published on Graptolites, the following elaborate and elegantly illustrated work. "Die Versteinerungen der Grauwackenformation in Sachsen. Heft I. Die Graptolithen. 60 pp. 4to, with 6 lithog. W. Engelman, 1852. This work contains a review of the species, synonymy and classification of Graptolites.]

IV. Astronomy.

1. *Sixteenth Asteroidal Planet—Psyche*, (Astr. Jour., No. 39.)—A new planet was discovered March 17, 1852, by Prof. De Gasparis at Naples. Its light was equal to that of a star of the 10–11th magnitude; and its position March 17, 1852, $9^h\ 52^m\ 32^s{\cdot}5$, Naples m. t., was R. A. $9^h\ 57^m\ 56^s{\cdot}7$, and N. Decl. 12° 51′ 20″.

The following elements of its orbit are computed by Mr. G. Rümker of Hamburg, from the Naples observations of March 19 and 29, and the London observation of April 4, which they represent precisely: but they differ widely from elements computed by Mr. E. Vogel.

1852, April, 1·0, m. t. Berlin.

Mean longitude, . . .	280° 25′ 21″·5	
Long. of perihelion, . .	253 56 20 ·8	M. Eqx.
" " asc. node, . .	150 14 11 ·7	Jan. 0·0, 1852.
Inclination, ...	2 43 8 ·1	
Angle of excentricity, . .	7 42 56 ·3	
Log. of semi axis-major, .	0·4965374	
" " mean daily motion, .	2·8052005	

2. *Seventeenth Asteroidal Planet—Thetis*, (Astr. Jour., No. 40.)—A new planet was discovered April 17, 1852, by Mr. Luther, at the Observatory at Bilk, near Düsseldorf. Its light was very faint, and its position at April 17, $10^h\ 37^m\ 39^s$ m. t. Bilk, was R. A. 180° 38′ 24″, and north declination 8° 49′ 2″.

The following elements of the orbit have been computed by Dr. Brünnow of Berlin, from observations of April 17, 21 and 25.

1852, April 17·0, m. t. Berlin.

Mean longitude, ...	303° 57′ 38″·6
Longitude of perihelion, . . .	259 48 29 ·3
" " asc. node, . . .	124 27 33 ·5
Inclination, ...	5 37 40 ·9
Angle of excentricity, . . .	7 47 29 ·1
Log. semi axis-major, . . .	0·402348
Mean daily motion, . . .	884″·0650

3. *First Comet of* 1852, (Astr. Jour., No. 41.)—Dr. Petersen at Altona, discovered on the 17th of May, 1852, a small telescopic comet in the constellation *Cepheus*. The next night it was discovered independently by Mr. G. P. Bond at the Cambridge Observatory, Mass.

Mr. Bond has published the following elements computed from the observations of May 18, 21 and 25.

Perihelion passage, April 19·5446, Greenwich m. t.

Longitude of perihelion, ...	280° 17′ 42″	M. Eqx. 1852·0.
" " node, ...	317 17 54	
Inclination, ...	48 32 0	
Log. of perih. distance, ...	9·95645	
Motion, ...	Retrograde.	

4. *Observations on an Auroral Beam, April* 22, 1852.—During the evening of Thursday, April 22, 1852, there was seen at this place (New Haven, Conn.,) a display of the aurora borealis, not very extensive, but yet of much interest, because it presented one phase of the phenomenon well suited for satisfactory observations of parallax.

At about half past seven o'clock there was in the north a shooting of streamers up to an altitude of 20° or 30°, through an amplitude of about 100°. The display soon subsided into a general bright light. On going to the door about twenty minutes after nine, I saw in the northwest a segment of an auroral arc, belt, or beam, entirely isolated, moderately brilliant, having well-defined margins. There was at the time a faint light in the north, but there was no other auroral appearance with which this beam could be confounded. As an opportunity so favorable as this for definite observation on an auroral phenomenon rarely occurs, I endeavored to note its exact position, with the time, and now publish the results in the hope that they may meet the eye of other observers.

At $9^h\ 25^m$ mean time New Haven, the auroral beam stands up from the westerly horizon, about one degree wide, cutting with its southerly edge the star *Castor*, and extending up to and terminating at the star 38 *Lyncis*. There is nothing of the kind visible at a greater altitude, or in the east. Towards the easterly horizon, however, the view is obstructed by clouds and buildings.

The whole beam slowly moved southward, but during the brief period of observation the change of position in the basal portion was scarcely perceptible.

At $9^h\ 31^m$ the southerly edge cuts *mu* and *epsilon Geminorum*, and also *Pollux*. All above the star last named has faded: the sky is becoming hazy in this quarter, and the light of the beam rapidly fading.

During this period the beam has been wholly isolated. There are still some auroral indications on the northern horizon, without any special activity. My time was certain within thirty seconds, and the beam moved so slowly that an error of even a minute would be of little importance. E. C. HERRICK.

5. *Auroral Bow of June* 11, 1852.—On the evening of Friday, June 11, 1852, a narrow, serpentine, auroral belt stretching from E. to W., was seen at New Haven, between 9½ and 10 P. M. Observations made at East Windsor Hill, Ct., by Mr. Sereno Watson, compared with those taken here by myself, appear to make it certain that the height of this bow above the earth was not less than one hundred and fifty miles.

E. C. H.

V. MISCELLANEOUS INTELLIGENCE.

1. *Remarks on the Climate of San Francisco;* by Dr. H. GIBBONS, (from the California Christian Advocate of March 20, 1852.)—In a former article I gave the result of my observations on temperature.* The present chapter refers to the *winds*.

The course of the wind is noted in my journal by three daily entries, viz.: forenoon, afternoon, and evening. Should the wind change during either of these periods, as it very often does, especially in the forenoon, the change is marked, and taken into account in the summing up. With these explanations, the reader will have no difficulty in comprehending the following table, which shows the winds of each month of the year, and the total of the year.

1852.	N.	N. E.	E.	S. E.	S.	S. W.	W.	N. W.
January,	35	2	1	14	7	7	21	6
February,	18	5	2	6	9	13	15	16
March,	7	2	1	8	4	14	34	23
April,	3	5	1	4	7	13	45	12
May,	1	1	1	2	4	11	65	8
June,	1	1	1	1	5	14	62	5
July,	0	0	1	2	1	14	74	1
August,	0	1	1	1	6	11	72	1
September,	1	0	0	2	2	11	72	2
October,	8	3	3	6	6	2	54	11
November,	10	4	2	8	15	12	30	9
December,	15	9	3	12	24	7	13	10
	99	33	17	66	90	129	557	104

The direction of the coast is nearly N.W. and S.E., or about one point north of N.W., and one point south of S.E. Hence the winds from N.W. to S. inclusive, blow from the ocean, and those from N. to

* See Dr. Gibbons's observations on temperature, vol. xiii, p. 434.

S.E. from the land. The former greatly preponderate, exhibiting an aggregate of 880 observations, to 215 of the latter. That is to say, the winds blew from the ocean semicircle more than three-fourths of the year.

It is still more striking that the winds came from due west, or rather from the octant corresponding to that point, more than half the year; the summing up of that column being 557, against 538 from all other points, embracing seven-eighths of the compass.

Observe the remarkable contrast between the columns of west and east winds, the latter presenting only seventeen observations in the year! It is a well ascertained fact that westerly winds predominate, in the temperate latitudes of the northern hemisphere, on both continents. But I cannot discover that in any other spot on the globe the winds blow from one octant 186 days, and from the opposite octant only six days in the year.

Dividing the year into four seasons, January, February and December being classed as the winter months, we have the following result.

	N.	N. E.	E.	S. E.	S.	S. W.	W.	N. W.
Spring, . .	11	8	3	14	15	38	144	43
Summer, . .	1	2	3	4	12	39	208	7
Autumn, . .	19	7	5	16	33	25	156	22
Winter, . .	68	16	6	32	40	27	49	32

Thus it appears that the proportion of land winds to sea winds, in the several months, was as follows:—

January,	land winds	52	observations;	sea winds	41	observations.
February,	"	31	"	"	53	"
March,	"	18	"	"	75	"
April,	"	13	"	"	77	"
May,	"	5	"	"	88	"
June,	"	4	"	"	86	"
July,	"	3	"	"	90	"
August,	"	3	"	"	90	"
September,	"	3	"	"	87	"
October,	"	20	"	"	73	"
November,	"	24	"	"	66	"
December,	"	39	"	"	54	"

Grouping the months into seasons, and reducing the observations to days, three observations representing one entire day, we find in the—

Spring,	land winds	12	days;	sea winds	80	days.
Summer,	"	3	"	"	89	"
Autumn,	"	16	"	"	75	"
Winter,	"	41	"	"	49	"
Total,	"	72	"	"	293	"

In every month of the year the sea winds exceed the land winds, except January, when the reverse occurred. In January, 1852, the land winds were 61 and the sea winds 32. In February, however, the former were but 27 and the latter 60. In December, 1850, the land winds exceeded the sea winds by one observation, the figures standing 47 to 46.

By casting the eye over the tables, one is struck with the progressive increase of the sea winds after the month of January, and the almost entire absence of the opposite winds from May to September inclusive —the land winds in these five months occupying only six days.

The winds from N. and E. are always dry, and in winter cool. They are nearly always attended with a sky of cloudless blue. Those from N.W. to S.W. are cold and chilling at all seasons, and in summer loaded with ocean mists. But they do not often produce rain. The coast winds from S. and S.E. are most conducive to rain, and they are always warm. The course of the winds in relation to rain will be considered under the head of rains.

The force of the winds at different periods of the day, and from different points of the compass, is a subject of some interest. It is represented by figures, 0 indicating calm or nearly calm, 1 a light breeze, 2 a moderate breeze, 3 a strong breeze or wind, 4 a high wind, and 5 a very high wind. The observations occupy three columns, for the forenoon, afternoon and evening. The mean of each of these columns for every month is given in the following table, and the fourth column contains the mean of the three observations collectively, for each month.

	Forenoon.	Afternoon.	Evening.	Mean.
January,	1·21	1·45	·66	1·11
February,	1·45	1·93	1·07	1·48
March,	1·68	2·24	1·40	1·77
April,	1·55	2·32	1·33	1·73
May,	1·77	2·61	1·61	2·00
June,	1·85	2·80	1·92	2·19
July,	1·66	2·97	2·19	2·27
August,	1·45	2·66	1·77	1·96
September,	1·48	2·38	1·28	1·71
October,	·87	2·05	·87	1·26
November,	·85	1·22	·70	·92
December,	1·37	1·32	1·07	1·25
1851,	1·43	2·16	1·32	1·64

The reader will perceive that the average force of the wind in the afternoon was greater than in the forenoon, in every month of the year except December. By referring to my Philadelphia tables, I find there is no uniformity in this respect, the morning winds being stronger in some months and the afternoon winds in others.

The evening winds were uniformly lighter than the afternoon, and lighter than those of the forenoon except in the three summer months, when they were decidedly stronger than in the forenoon. At Philadelphia the evening winds sum up lower in strength than those of the forenoon or afternoon, in every month without exception.

The table shows a remarkable progressive increase in the force of the atmospheric currents from January to July, the latter being the most windy month of the year; and then a decrease till November, the calmest month. At Philadelphia there is no such regularity. Autumn is the calmest season at both places, but summer comes next in the Atlantic States, then winter, and lastly Spring, which is the windiest season on this side of the continent.

From May to September, inclusive, there is more wind at San Francisco than at Philadelphia, but in the remaining five months, from October to April, there is less.

Not only in regard to time do the winds from the western semi-circle greatly preponderate, but also in force. The land winds are often very light and transient, not affecting an ordinary vane. Besides, many of the observations placed in this column in my journal, are due to the influence of the bay, from which a gentle current—really a sea-breeze—frequently flows upon the city for a brief period in the forenoon, before the general current from the ocean sets in from the opposite quarter. These bay currents are strictly local, and on the opposite side of the bay they take the opposite direction, and swell the proportion of sea winds in that location.

The following table is a summary of three daily observations, continued through the year 1851, showing the direction of the atmospheric currents with reference to their comparative force.

	N. & N. W.	E. & N. E.	S. & S. E.	W. & S. W.
Nearly calm, . .	49	24	49	30
Light breeze, ...	86	39	88	146
Breeze, ...	69	5	36	335
Wind, ...	20	0	13	191
High wind, ...	2	0	2	29
Very high wind, . .	0	0	3	1

Thus it appears the wind was very high only three days in the year. Much as is said of the violence of the wind at this place, I have never yet witnessed a wind in California equal to that which frequently attends a thunder-gust or an easterly storm of the highest grade in the Atlantic States.

From the east quarter of the compass, the current did not rise beyond a moderate breeze in the entire year, and only for five observations did it reach that degree of force. As we recede from that limit either northward or southward, the winds increase both in frequency and force. But it is not until we pass the north point on one hand and the S. E. point on the other that they are high. Of the 20 observations above noted as "winds" from N. and N.W., seventeen were from N. W., and only three from N. The two high winds under the same head were from N.W. So, in regard to the 13 winds, 3 high winds, and two very high winds in the column headed S. and S.E; a small proportion were from due S.E., the mass of them coming from S.S.E. and S. The high winds of winter, when such occur, are from this quarter, and bring rain. The high winds of summer are always westerly, and without rain.

In the course of the year there were 169 windy days. On 123 of this number, the wind did not rise till after the sun had crossed the meridian, and it continued after sunset on 57 only. There were but twenty days in the year windy at sunrise.

The sea breeze of summer, which forms the most striking trait of the climate of San Francisco, demands something more than a passing notice, and will be reserved for another chapter, together with the subject of clouds, rains, electrical phenomena, &c.

2. *Remarks on the Winter of* 1851–2 *in Canada, &c.;* by Captain J. H. Lefroy, R.A., F.R.S., (from the Upper Canada Medical Journal, May, 1852.)—The following are extracts from the paper by Captain Lefroy:

Comparison of mean winter temperatures for twenty-one years at Toronto, Mr. Dade's observations with the corrections down to 1840, *being included.*

Table II.

	Nov.		Dec.		Jan.		Feb.		March.		April.		Mean of six months.
	8 A.M.	Mn.	8 A.M.	Mn.	8 A.M	Mn.	8 A.M.	Mn.	8 A.M	Mn.	8 A.M.	Mn.	
1830–1	....	...	....	...	17·4	19·4	12·4	15·5	33 2	35·3	41·8	42·9	.....
1831–2	33·4	35·0	12·6	14·6	19·0	21·0	16·7	19·8	28·0	30·1	38 0	39·1	26·60
1832–3	34·0	35·6	28·7	30·7	25·5	27·5	14·6	17·7	23·9	26·9	43·7	44·8	30·37
1833–4	30·9	32 5	28·8	30·8	16·4	18·4	27·3	30·4	30·6	32·7	43·0	44·1	31·48
1834–5	33·5	35·1	23·6	25·6	20·5	22·5	14·4	17 5	27·2	29·3	39·0	40·1	28·32
1835–6	34·0	35·6	21·4	23·4	22·0	24·0	10·9	14·0	20·2	22·3	37·2	38·3	26·26
1836–7	30·7	32·3	23·7	25·7	15·7	17·7	19·5	22·6	22·3	24·4	37·0	38·1	26·80
1837–8	35·7	37·3	26·3	28·3	25·4	27·4	12·8	15·9	32·2	34·3	35·0	36·1	29·88
1838–9	....	...	....	...	....	...	....	...	....	...	....	...	.....
1839–40	33·0	34·6	27·0	29·0	15·0	17·0	26·5	29·6	32·0	34·1	42·3	43·4	31·28
1840–1	34·0	35·9	22·3	24·3	21·8	25·1	18·2	22·6	24·6	27·8	38·3	39·2	29·15
1841–2	34·1	35·3	27·4	29·7	24·7	27·5	24·3	27·5	35·9	36·2	41·2	43·0	33·20
1842–3	31·4	33·1	23·1	25·3	26·6	28·5	11·3	15·0	19·4	21·7	39·2	41·0	27·43
1843–4	31·7	33·1	29·5	30·6	18·0	19·9	24·1	27·3	29·3	31·7	45·6	47·6	31·70
1844–5	32·8	34·8	27·2	28·8	25·3	26.3	24·0	26·8	34·3	35·9	41·4	42·1	32·45
1845–6	35·1	36·7	19·0	21·5	23·9	26·1	16·7	20·8	32·6	33·7	43·4	43·9	30·45
1846–7	39·4	40·8	24·5	27·7	21·9	22·9	19·7	22·5	24·6	26·7	39·1	39·8	30·07
1847–8	37·4	38·7	28·4	30·6	26·2	27·8	24·0	27·0	26·8	29·1	40·7	41·3	32·42
1848–9	....	34·3	....	29·6	....	18·5	....	20·0	....	33·9	....	39·4	29·28
1849–50	...	42·3	....	26·9	27·2	29·1	23·1	26·4	28·3	29·6	36·9	38·2	32·08
1850–1	36·5	38·7	20·6	22 5	22·2	25·6	26 5	28·3	30 4	33·1	40·4	41·5	31·62
1851–2	31·0	32·7	20·1	21·6	16·7	18·4	21·1	23·8	25·7	27·8	37·3	38·3	27·10
Mean	....	35·7	....	26·3	....	23·4	....	22·4	....	30·3	....	41·0	29·89

It will be seen that the mean for the *six months* compared is actually the lowest since the winter of 1836–7; and although slightly exceeded in severity by that winter and two earlier ones in the series, the difference in its favor is so trifling, both in that case, and as compared with the winter of 1831–2 that it might possibly disappear, if, instead of deducing mean temperatures, from one observation daily, which in individual months leaves a liability to error to the extent of about one degree, we possessed it from observation. This remark does not apply to the winter of 1835–6, which is said, however, to have been the most severe in North America since 1779–80, and was decidedly more severe than that of 1851–2.

So far therefore, the winter taken in its popular extent, maintains its character, but this results chiefly from our having excluded October, and included April. October 1851 was unusually warm and genial, having had a mean temperature of 47°·8, which is 3°·3 higher than the mean for the same series of years, while April, 1852, has been one of the coldest in it.

It is also remarkable that the lowest mean temperature of the series does not occur in any one month of the past winter, and is only approached by two, November and January: there was no individual month in it nearly so extreme of its kind as December, 1831, January, 1833, February, 1835, and February and March, 1843. The first of these is so very remarkable that but for the privilege Mr. Dade has kindly given me of consulting his original journal, I should have suspected an error. It appears that in this year the cold set in on the 28th of November, and with such severity that the mean temperature at 8 A. M. for three weeks, from the 30th November to the 18th December inclusive was only 10°, which is lower than the *mean* for the same hour for any one winter month at Montreal.

We may next refer to the meteorological winter, or months of December, January and February: the mean of which is given in the following table, together with the lowest temperature at 8 A. M. in each season—the lowest at any hour, and the number of observations which indicated at that hour temperatures below zero, and from zero to 20° in the three months.

TABLE III.

Winter.	Mean temp.	Lowest		No. of Obs. at 8 A.M.		Winter.	Mean temp.	Lowest		No. of Obs. at 8 A.M.	
		at 8 A.M.	at any hour.	B'low zero.	Zero to 20°			at 8 A.M.	at any hour.	B'low zero.	Zero to 20°
1830–1		–16·0	"	2	38						
1831–2	17·8	–20·0	"	6	61	1842–3	22·9	– 6·1	–11·0	2	23
1832–3	25·3	– 6·0	"	2	37	1843–4	25·9	– 7·5	– 8·5	5	16
1833–4	26·5	– 2·0	"	1	35	1844–5	27·3	– 3·6	– 5·5	2	16
1834–5	21·9	–15·0	"	6	40	1845–6	22·6	– 9·5	–16·2	5	31
1835–6	20·5	–20·0	"	10	43	1846–7	24·3	1·1	– 2·2	0	33
1836–7	22·0	– 7·0	"	5	39	1847–8	28·5	–11·8 (M)	–12·0	1	19
1837–8	23·5	– 2·0	"	1	"	1848–9	22·7	–15·2	–15·2	6	27
1838–9	....	....	"	....	"	1849–50 ...	27·5	2·7	– 5·4	0	18
1839–40....	25·2	– 8·0	–19·2	7	"	1850–1	25·5	–12·8	–12·8	2	25
1840–1	24·0	– 2·0	– 8·3	1	34	1851–2	21·3	–10·6	–14·8	3	34
1841–2	28·2	2·3	– 0·2	0	11						
(M) at 7 A.M.							24·25				

We see that, taken in its meteorological sense, the past winter was less severe than those of 1831–2, and 1835–6, but ranks decidedly among the coldest of the series. In respect to the lowest temperature recorded, it has been often exceeded. The winter of 1831–2 appears to have been the most exceptional of the whole, and it may be mentioned in this connection, on authority of Mr. Paine's observations at Boston, that the winter of 1827–8 was the mildest of the last twenty-seven, it is stated that the Hudson River did not close at all in that winter.

Toronto Bay was frozen over on the 13th December, 1851, and within a day or two of that early date was crossed in sleighs from the neighborhood of the Queen's Wharf. As to the date, it has been frequently frozen as early; in 1835 it was frozen on Dec. 1, in 1845 on the 3d, and in 1840 on the 6th December, but in most, if not all of these cases broke up again. This was not the case in 1851, when it was so solid that as early as December 18, the steamboats found it necessary to land their passengers at the edge of it, half a mile or more beyond that point, and at one time were reduced to landing them with great difficulty and some danger, upon the south side of the Peninsula, by boats; indeed the ice extended in a solid state considerably beyond the new Garrison, and with a broken margin nearly to the east point of the Humber bay, thus presenting a solid surface almost as far as could be seen from the city; all which are circumstances of very rare occurrence. Although the closing and opening of the bay are affected by accidental circumstances and an uncertain criterion of the character of the winter, the following memoranda on the subject may be interesting; the dates previous to 1840 are extracted from Mr. Dade's valuable notes, and for the subsequent years derived chiefly from memoranda kept for his own information by Serjeant J. Walker, Royal Artillery.

Bay first frozen.	Bay opened.	Bay first frozen.	Bay opened.
1832,	1833, April 4,	1842, December.	1843, April 23,
1833,	1834, March 14,	1843, " 13,	1844, " [illegible]
1834,	1835, March 30,	1844, " 18,	1845, " [illegible]
1835, December 1,	1836, April 25,	1845, " 3,	1846, " 8,
1836, "	1837, " 16,	1846, " 15,	1847, " 19.
1837, " 14,	1838, " 2,	1847, " 26,	1848, March 31,
1838, "	1839, "	1848, " 25,	1849, March 29,
1839, "	1840, March 28,	1849, " 26,	1850, April 3,
1840, " 6,	1841, April 12,	1850, " 13,	1851, March 24
1841, " 18,	1842, March 17,	1851, " 13,	1852, April 17.

There is one circumstance, in addition to the state of the thermometer, which very much affects the impressions derived from the senses as to the severity of a winter, namely, the occurrence of high wind with a low temperature; such was the case on many of the coldest days of the past season, particularly in December and January, when a long continuance of searching westerly gales enhanced to a distressing extent the sufferings of those badly provided with fuel, food or clothing. The following are a few examples:—

TABLE IV.

1851–2.	TEMPERATURE.		Lowest.	VELOCITY OF WIND.		IN MILES.
	Mean.	Below the average.		Mean per hour.	Above the average.	Highest hour.
				m	m	m
December 25,	10·00	15·2	−14·8	3·94	2·74	12·8
" 16,	4·78	21·4	− 3·2	10·58	4·38	16·1
" 17,	4·93	21·2	1·8	12·27	6·07	17·0
January 20,	0·85	21·8	− 3·8	13·47	6·73	17·8
" 19,	1·37	21·2	−10·6	10·17	3·44	18·8
" 15,	3·75	13·9	− 6·2	7·42	0·68	18·0
" 17,	6·77	15·8	2·0	7·59	0·85	14·2
" 22,	8·08	14·5	− 0·6	10·26	4·52	14·1
" 13,	10·75	11·0	7·0	9·08	2·34	14·2

On every one of these very cold days we have a high wind. With regard to direction, the mean direction, and mean velocity for each of the above months, from five years registration by Robinson's anemometer, and the mean of the same months in the past winter, are given below:

	MEAN OF 5 YEARS. Direction.	Velocity.	1851–2. Direction.	Velocity.
November, . .	W. 31 N.	4·87,	W. 37 N.	4·70
December, . .	W. 33 N.	6·20,	W. 8 N.	7·37
January, . . .	W. 31 N.	6·74,	W. 30 N.	7·67
February, . . .	W. 39 N.	6·65,	W. 16 N.	6·42
March, ...	W. 53 N.	6·45,	W. 83 N.	5·81
April, ...	W. 71 N.	6·96,	N. 23 E.	6·68

There was an unusual prevalence of westerly wind to December and February, of northerly in March, and of easterly in April, the other months offer nothing unusual, nor is the quantity of wind excessive in any other month than December and January.

It does not appear from Table III, that any very distinct alternation of mild and severe winters is to be recognized in the period covered by the comparison; on the whole, however, we find that of the last nine winters, six were warmer than the average, and, of the previous nine, six were colder than the average;—this latter period, again, as there is reason to think, was preceded by a series of mild seasons, so that there are some grounds for supposing that we may now expect a succession of the opposite character; but, it is evident, that a very cold winter frequently occurs in a warm series, and a mild one in a cold series. Of the former character may have been that of 1809–10, which by this rule should fall in a warm group, although it will long be remembered by the old inhabitants of Canada, for the memorable *black night*, the 18th January, 1810, in which the temperature changed in a few hours from a high thermometer, with rapid thaw, warm and genial sunshine, to the most intense frost, producing distress and devastation unparalleled in their recollection. There are probably in existence some precise notes taken on this remarkable occasion, but I have not been able to hear of them.

3. *Region of Lake Superior.*—Dr. J. J. Bigsby recently delivered a lecture before the Royal Institution of London on the Geography and Geology of Lake Superior. Dr. B. was well qualified for that duty, from personal acquaintance with the regions around the great lakes, on which he made valuable observations that were communicated many years ago to the Geological Society of London, and were published in their Transactions. His summary is interesting and instructive. We have room only for the following citations:

"The chief staple of Lake Superior is native copper. For ages before the appearance of Europeans in America, this metal was supplied from hence to the Indian nations far and near. The tumuli of the Mississippi, &c., contain the beautiful copper of this lake. Traces of ancient mining in Kewenaw, Ontonago and Isle Royal are abundant, in the form of deep pits, (a ladder in one,) rubbish, stone mauls, hammers, wedges, and chisels of hardened copper. In a native excavation near the river Ontonagon, with trees five hundred years old growing over it, lately lay a mass of pure copper eighty-one tons in weight, partly fused, and resting on skids of black oak."

The miners, forty in number, are assisted by steam power. Silver is always present, and sometimes in masses of considerable size. There are now in the Cliff mine masses of pure copper within view, estimated to weigh seven hundred tons. On the lands of the Minnesota company there is one block that weighs two hundred and fifty tons.

In 1851, sixteen hundred tons of copper were shipped, valued at £130,000.

4. *A New Fuel.*—Some curious experiments have been made at the Polytechnic Institution to test the results of a recent invention of Dr. Bachhoffner, for which patents have been obtained by the inventor and

Mr. N. Defries. The invention consists in the substitution of thin pieces of metal in the place of coals in fire-grates—which being acted on by a small jet of gas, immediately become red-hot, and emit a prodigious degree of heat. The flame which is produced by the proper, but very simple management of the gas co-operating with the metallic laminæ, gives the appearance of a brisk and cheerful coal-fire, and can scarcely be distinguished from it. The heat can be regulated by turning the cock of the gas tube. There is no deposit of soot, no smoke, nor any of the annoyances which attend coal-fires, and the gas can, it is said be extinguished *instanter*, or the fire kept as low as may be convenient.—*Athen.*

5. *Abstract of Meteorological Observations made at Attleboro', Mass.*, in lat. 41° 59′ 22″, long. 71° 22′ 45″, *for the year* 1851; by Henry Rice.

Months.	Means of the Barometer.*						Means of attached thermometers.				
	Sunrise.	9 A.M.	1 P.M.	4 P.M.	Range.	Monthly mean.	Sunrise.	9 A.M.	1 P.M.	4 P.M.	Monthly mean.
January, . .	29·733	29·751	29·751	29·754	1·62	29·747	42·90	49·29	57·50	58·61	52·075
February,	29·910	29·921	29·905	29·855	1·27	29·904	41·18	48·82	52·25	56·07	49·580
March, . . .	29·760	29·769	29·760	29·772	·96	29·790	49·13	57·97	60·96	63·08	57·784
April, ...	29·696	29·731	29·706	29·625	1·05	29·695	51·10	56·90	59·00	62·19	57·275
May, ...	29·795	29·806	29·794	29·791	·79	29·796	56·31	60·80	64·40	67·71	62·305
June, ...	29·734	29·747	29·731	29·726	·65	29·744	61·96	63·50	67·90	71·30	66·165
July, ...	29·663	29·687	29·635	29·668	·60	29·663	69·20	69·40	74·30	75·90	72·200
August, . .	29·791	29·807	29·796	29·790	·53	29·796	62·70	65·90	70·40	74·00	68·250
Septemb'r,	29·875	29·897	29·877	29·858	·78	29·815	63·03	63·10	67·57	70·57	66·065
October, . .	29·736	29·754	29·738	29·728	1·04	29·739	57·90	63·90	66·90	68·60	64·325
November,	29·706	29·727	29·654	29·647	1·50	29·683	46·00	50·47	52·63	55·53	51·160
December,	29·736	29·753	29·725	29·723	1·08	29·734	43·60	48·80	49·90	51·70	48·500
Ann. mean.	29·761	29·779	29·756	29·745	·99	29·760	53·75	58·23	61·98	64·60	59·064

Months.	Means of External Thermometer.									
	Sunrise.	9 A.M.	1 P.M.	4 P.M.	Mean.	Range.	Min.	Max.	Coldest day.	Warm't day.
January, ...	21·96	28·00	36·23	32·20	29·60	63	–8	55	31	26
February, . . .	25·16	31·18	38·21	36·57	32·78	61	–5	56	8	15
March, ...	29·86	39·46	45·28	44·53	40·17	66	12	78	14	31
April, ...	36·67	48·37	53·77	52·30	47·80	43	23	66	17	24
May, ...	45·70	59·56	67·56	65·47	59·58	55	31	86	5	28
June, ...	52·77	68·00	74·20	75·40	67·59	61	37	98	7	30
July, ...	61·27	75·33	81·10	78·66	73·92	49	46	95	29	17
August, ...	55·70	70·80	79·37	78·10	70·93	48	44	92	37	8
September, . .	51·26	62·76	71·46	69·83	64·08	60	31	91	25	11
October, ...	44·90	56·30	63·90	60·70	56·45	49	30	79	27	12
November, . .	30·40	36·13	43·03	40·00	37·39	42	16	58	11	2
December, . . .	19·03	23·65	31·90	27·42	25·52	57	–4	53	26	31
Ann. mean,	39·557	49 962	57·167	55·099	50·484	1·06				

The warmest day in the year was the 30th of June, the mean heat of which was 87·5°; the coldest day was the 31st of January, the mean of which was 2·5°.

* Altitude of barometer above tide water at Providence 175 feet;—diameter of tube ·12 inches. The readings of the barometer have not been corrected for temperature, sea-level or capillary action. The entire range of the barometer during the year was 1·71 inches.

Months.	Clearness, from 0 to 10. Sunrise.	9 A.M.	1 P.M.	4 P.M.	Winds.—No. of times the wind was observed to be in the N.	N.E.	E.	S.E.	S.	S.W.	W.	N.W.
January, ...	4·6	5·4	5·1	5·4	14	3	2	8	19	23	28	27
February, ...	4·3	4·7	4·4	4·7	14	6	3	6	29	10	17	27
March, ...	4·7	5·3	4·1	4·4	13	14	3	4	26	17	12	35
April, ...	5·5	5·3	4·6	4·8	21	27	6	7	18	5	11	25
May, ...	5·3	4·7	4·3	4·6	15	10	6	8	34	17	13	21
June, ...	5·9	7·0	6·5	6·4	14	7	4	6	29	15	25	20
July, ...	5·7	5·5	4·3	5·0	13	12	3	2	31	30	17	16
August, ...	6·0	6·4	5·8	5·5	13	6	3	3	35	24	13	27
September, ..	5·7	6·1	5·7	6·1	32	10	7	6	29	9	15	12
October, ...	4·7	5·5	4·8	5·4	13	7	6	13	28	14	14	29
November, ..	5·1	4·6	4·3	4·0	21	5	1	5	7	17	15	49
December, ...	5·8	6·2	5·3	5·8	9	3	1	8	12	17	12	62
	5·3	5·6	4·9	5·2	192	110	45	76	297	198	192	350

As a Meteorological Register has never before been kept in this town, I am unable to compare these results with those for any previous years. The location where the above observations were made, is at North Attleboro', on the Boston and Providence turnpike, twelve miles north of the latter place.

The robin, (Turdus migratorius,) blackbird, (Quiscalus ferrugineus), and bluebird, (Sialia Wilsonii,) appeared Feb. 24th; wild goose, (Anser canadensis,) March 14th. The frogs "gave their first concert for the season," March 25th.

The elm, (Ulmus americanus,) in blossom, April 1st; cowslip, (Caltha palustris,) 6th; anemone, (Anemone nemorosa,) 10th; skunk cabbage, (Symplocarpus fœtidus,) 20th; wild columbine, (Aquilegia canadensis,) May 1st; currant, (Ribes rubrum,) 5th; common pear, (Pyrus communis,) 10th; lilac, (Syringa vulgaris,) 15th; flowering almond, (amygdalus nana,) 12th; apple, (Pyrus malus,) 15th; buckthorn, (Rhamnus cathartica,) 17th; horse-chesnut, (Æsculus hippocastanum,) 20th; flowering dogwood, (Cornus florida,) 24th; large blue flag, (Iris versicolor,) 29th; yellow pond lily, (Nuphar advena,) 31st; trumpet creeper, (Bignonia radicans,) June 3d; spider-wort, (Tradescantia virginica,) 5th; common locust, (Robinia pseud-acacia,) 10th.

There was a display of the *aurora* on the evenings of the following days, viz., Jan. 19, 21, 23; Feb. 18; March 23, 29; May 1; Sept. 6, 8, 16; Dec. 19, 23, 29.

6. *Nees von Esenbeck*, (from the Phytologist, a London botanical Journal, No. cxxx, March, 1852, pp. 465–467.)—We are glad to find that we are not singular in sympathizing with the unfortunate Nees von Esenbeck, a man whose only fault it is to hold opinions contrary to those of the party which has acquired the ascendancy in Germany. Our able contemporary, Hooker's Journal of Botany, in announcing to its readers that M. Nees von Esenbeck had been requested to continue as President of the L. C. Academy of Naturalists, and that he had assented, continues: "This mark of respect towards one of the most classical and distinguished botanists of the age, who during a long series of years has contributed vastly to the celebrity of the Academy, will be hailed not only by its own members, but by every lover of natural science." Such generous expressions are highly creditable, both

to the journal in which they appear, and the writer from whose pen they issue, and cannot but comfort the illustrious philosopher to whom they refer.

Most of our readers are aware that M. Nees von Esenbeck, is the victim of the political reaction on the continent, but few know the unfeeling manner in which he has been persecuted. M. Nees von Esenbeck has always been the friend of true freedom—for who can be a thinking man without being so?—and has so much enjoyed the confidence of his countrymen that a few years ago, he was elected member of Parliament. His eloquence, his sound reasoning, and the warmth with which he spoke, soon gave him influence in the Assembly, so much so that he became the leader of the popular party. He always remained faithful to his colors; and when so many deserted the cause which they had advocated, when oaths were violated as soon as uttered, and treaties broken before the ink was dry, M. Nees von Esenbeck was true to his principles; and neither bribery nor threats produced any effect upon him. Venerable for his age, distinguished as a philosopher, and eloquent as an orator, it was evident that the influence of such a man was to be feared. Moreover, he was no hero behind the barricades; he had been legally elected, and conducted his discussions with prudence and propriety, and strictly within the bounds of parliamentary license. But as silence was thought indispensable, M. Nees von Esenbeck was suddenly suspended in his functions as Professor in the University of Breslau, and reduced to circumstances of the most distressing nature. An excuse for this arbitrary act, however, was thought necessary; and as despotism is never in want of arguments, however sophistical, to give a coloring to its proceedings, a domestic misfortune rather than a fault of M. Nees von Esenbeck's former life was taken for that purpose; and at an advanced age of nearly eighty, the venerable old man was punished for an act that happened twenty years before, and which, according to the laws of the country, must have been very slight indeed, to remain so long without being investigated. That public opinion has not been misguided in this matter is evident. M. Nees von Esenbeck had not only been re-elected President of one of the most ancient academies in the world, but men are everywhere stepping forward who endeavor to place him above the want to which the sudden loss of his situation has exposed him. Naturalists of eminence are, we understand, selling portions of their collections, in order to give the proceeds to the illustrious *savant*. We ourselves have been requested by several of our correspondents to open a subscription for his benefit, and we are only too glad to become the humble medium by which that great and good man may be benefitted. Having obtained permission from M. Nees von Esenbeck himself, we are ready to receive any sums, however trifling, to acknowledge them in our Journal, and afterwards in periodicals of a wider circulation.

It would be trifling with the cause we are pleading, were we to attempt to write a panegyric upon a man so unfortunate. A person who is eighty years of age, and in want, not only of the mere comforts of life, but the bare means of subsistence, and who has devoted his whole life and all he possessed to the advancement of science, is indeed worthy of consideration. Entomology, ornithology, botany, and many other branches of learning are indebted to him for some of the most important additions. He has always been ready to assist others whenever he was called upon; and there are many naturalists in Great Britain who have enriched their volumes with his labors. As a teacher he has done an immense deal. His lecture-rooms were always the most crowded, and subjects which, in the hands of others, appeared dry, insipid, and dull, his eloquence knew how to make interesting and charming. There are few who have ever seen him on the platform who can forget the impression which his lectures produced; the sparkling eye, the animation, and clearness of explanation never failed to produce most favorable effects. His labors as an author are numerous, and show great erudition and research. They belong to that class of writing which freed natural history from the pedantic sway of the Linnæan school, and fairly applied the light of philosophy to the investigation of organized beings. Indeed, M. Nees von Esenbeck is one of the remaining few who conclude the circle of illustrious men who raised natural science to the rank it now holds, and in which the names of Jussieu, DeCandolle, Göthe, and Link, not to mention any living ones, stand preëminent.

We have also been requested to prepare an address, and now have the pleasure of submitting the following one to the consideration of our readers. Whoever would wish to sign it is invited to send his name to our office, (9 Devonshire street, Bishopgate, London.) Previous to the delivery of the document we will cause the names, arranged alphabetically, to be printed in some of the journals of the widest circulation both at home and abroad.

TO M. NEES VON ESENBECK, PRESIDENT OF THE L. C. ACADEMY OF NATURALISTS.

Mr. President: The undersigned have learned, with feelings of the deepest regret and sorrow, that you have been suspended in your functions as Professor of the University of Breslau; that a man whom they have always regarded as one of the most classical, has suddenly been arrested in the pursuit of those investigations which have been productive of such invaluable results to science. It falls to the lot of but few to make, at an advanced age, those treasures available which a life of constant application and incessant study have enabled them to accumulate. You, Mr. President, are by the grace of Providence, still in possession of those faculties which allow you to add to the brilliant achievements and important labors of which your whole career has been an uninterrupted series. How painful then, becomes the reflection, that what God has granted, man has cruelly prohibited, and, by depriving you of those means essential to existence is about to bury for ever your vast amount of knowledge, and consign you, as it were, alive, to a premature grave. Keenly as we feel your misfortune, still more keenly do we feel our inability to alleviate it. Our voice of sympathy is the consolation we can offer; and we declare that, uninfluenced by the slanders with which malignity has overwhelmed you, we still remember your name with gratitude and respect; and, deaf to the arguments with which envy and hatred have attacked you, we still look upon you as the great philosopher who has raised for himself in the field of science a monument, which neither the violence of parties nor the lapse of time are capable of overturning.

[We have received also an advertisement of the Herbarium of Nees von Esenbeck, which is on sale, from which we cite the following.—*Eds.*]

The Herbarium includes about 340 volumes, besides 57 volumes in duplicate. It is arranged in the main in accordance with Lindley's Natural System of Botany, 2d edition. The value of the whole is estimated at 12,000 rix thalers, or about 30 rix thalers per volume. The whole number of species included is between 34,000 and 40,000, and each volume contains between 100 and 120 species. The species are from all parts of the world, Asia, the Indies, New Holland, Tropical America, &c.

List of the volumes and their contents.* The price is given in rix thalers, each worth about 72 cts.

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2. Magnoliaceae, Winteraceae, Anonaceae, Schizandraceae, Dilleniaceae, Myristicaceae,	1	
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34. Lauraceae,	7	560
35. Illigeraceae, Cassytaceae, Penaeaceae, Nepenthaceae, Aristolochiaceae,	1	60
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38. Polygonaceae, Petiveriaceae, Scleranthaceae, Nyctaginaceae, Menispermaceae, Brexiaceae,	1	
39. Pyrolaceae, Monotropaceae, Ericaceae, Vacciniaceae, Epacridaceae,	1	
40. Primulaceae, Myrsinaceae,	1	
41. Convolvulaceae,	1	
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43. Lobeliaceae, Campanulaceae, Stylidiaceae, Goodeniaceae, Scaevolaceae,	1	
44. Cinchonaceae,	2	
45. Caprifoliaceae,	1	240
46. Galiaceae,	1	
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(2000 Species.)		
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50. Labiatae,	6	180
51. Veronicaceae,	2	60
52. Lentibulariaceae, Scrophulariaceae,	1	
53. Orobanchaceae, Gesneriaceae, Sesamaceae, Selaginaceae,	1	
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71. Filicales, in all,	8	300
500 Species.		
72. Cellulares,	84	2400

Besides 57 packages and 30 volumes in Duplicate.

APPENDIX.

I.

73. The Wallichian collection of East Indian plants,	9	540
74. New Holland plants by Preiss,	7	420

II.

75. Sieber, Plantae insulae Trinitatis,	2	60
76. Sieber, Plantae insulae Mauritii,	2	60
77. Plantae Mexicanae,	2	120
78. Plantae Brasilienses, still undetermined,	1	60
79. Plantae Americanae, " "	1	30
80. Plantae Wightianae,	5	1400
(According to the Catalogue 2403 Species.)		
84. Plantae Javanicae, still undetermined,	3	180
85. Ibid.	1	60
86. Plantae Javanicae mixtae,	1	60
87. The same in large form,	1	30
88. Florula Zeylanica,	1	10
89. Plantae Abyssinicae,	1	20
90. Plantae Novae Hollandiae dubiae,	1	80
91. Plantae exoticae mixtae, indeterminatae,	1	60
92. Plantae aliquot Florae mixtae,	1	20.
93. Florula Vilnensis,	1	2
94. Plantae Italicae,	1	5
95. Florula Sickershusensis,	1	1

7. *Prices of Microscopes made to order, by* I. & W. Grunow, Opticians, 54 Pacific street, Brooklyn, L. I.—No. 1. Large compound microscopes, mounted on a stout brass tripod box and uprights; body with quick and slow motion; 2 corrected Huyghenian eye-pieces and ¼th inch object-glass; the moveable stage is 4 inches square, the concave mirror is 3 inches diameter, $105.

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[Messrs. Grunow's instruments are in mechanical structure unsurpassed.—*Eds.*]

8. *American Association for the Advancement of Science.*—The next meeting of this Association will be held at Cleveland, Ohio, commencing with the third Wednesday in August (Aug. 18). Professor Peirce of Harvard is President for the session and ensuing year.

9. *Gold of California.*—The total shipment of gold from San Francisco for April, 1852, was $3,419,847, for March, $2,549,704.

VI. Bibliography.

1. *Steam-Boiler Explosions :* Memorial of Samuel Guthrie, a Practical Engineer, submitting the results of an investigation made by him into the causes of the explosion of steam-boilers. 32d Congress, U. S., 1st Session, Senate, No. 32, Miscellaneous.—This is an excellent document, from an experienced man, who makes no pretensions to being more than he is, a skillful practical engineer. Mr. Guthrie has devoted many months to a careful investigation of all the causes of disaster in steam-boilers on the navigable waters of the United States. He has examined personally nearly all the steamboats on the Ohio and Mississippi, and has had the opportunity of seeing several boats just after they had exploded. We need not dwell on the preëminent importance of the adoption without delay of certain and efficient means of avoiding a class of accidents which no warning from past experience nor check of existing laws have prevented from increasing with the rapid extension of our immense inland commerce. In our opinion the conclusions and suggestions of Mr. Guthrie if adopted, with suitable legal guards and penalties, would reach the difficulty and totally prevent these frightful accidents so destructive to human life. After a careful review of the whole subject, Mr. Guthrie presents the following "Recapitulation."

Recapitulation of the principal causes tending to produce explosions of steam-boilers.—1st. Using iron of an improper thickness, or that of an inferior quality, in the construction of boilers ; also, the too frequent use of cast-iron in steam and water pipes, and parts of boilers.

2d. Using boilers defective in form or workmanship, ineffectually staybolted or fastened ; and also using boilers weakened by age or use.

3d. Employment of incompetent, reckless, or intemperate engineers.

4th. Using in the construction of steamboats, boilers, engines, paddle wheels, and machinery, without proper regard to the relative proportions which should exist between the different parts of the whole.

5th. Using inefficient or unsuitable pumping apparatus, and not providing for free and open passages for the water to the boiler, and afterwards for the exit of steam to the engines.

6th. In not providing a suitable or a sufficient number of safety-valves for the free and full discharge of steam when suddenly accumulating.

7th. Want of a proper and suitable system or mode of inspection of steam-boilers, engines, and machinery; want of suitable and uniform instruments for testing, by hydrostatic pressure, the actual powers of resistance of every boiler brought into use; and also an entire want of laws requiring an inspection of boiler-iron, or material for the construction of boilers.

8th. Want of competent and faithful inspectors, clothed with sufficient authority to regulate the conduct of engineers, and the management and general arrangement of engines and machinery, with power to establish a limit to excessive pressure, within the capabilities of the boilers to withstand it.

9th. Want of a board of supervising engineers, whose duty it is to exercise a general supervision over all boats or vessels navigated in whole or in part by steam, within the jurisdiction of the United States; and also to exercise a like supervision over boards of inspection, conduct of engineers, and others in charge of steam-engines.

Enumeration of the Causes tending to produce explosions, through the conduct of those in charge.—1st. Allowing water to get low in the boilers, through negligence, carelessness, or design.

2d. Overloading the safety valve, and permitting a dangerous accumulation of steam for the purpose of racing or wanton display.

3d. Through negligence in not blowing off steam when lying at a landing, or when the engines are not in motion.

He then proceeds to enumerate the remedies proposed, the most important of which are the organization of a Board of Superintending Engineers, who shall be the judges of competency in engineers, inspectors, and machinery,—and the adoption of certain improved apparatus to ensure abundant water, and conspicuous signals of approaching danger. Mr. Guthrie has contrived a new form of safety valve, to be regulated to such pressure as shall be found by experiment entirely safe in each case, and beyond the control of the officers of the boat. Also, a system of signals conspicuous to all passengers, which by an automatic and certain mentor will announce, "good water," "water getting low," or "water dangerous," as circumstances may require—and in the same manner, "steam safe," or "steam dangerous," ringing a bell at the same time. It is earnestly to be hoped that Mr. Guthrie's system of checks and contrivances to insure safety, should be immediately put to the most searching experimental proof by a commission of scientific and experienced men.

All the preliminary labor of investigation in this case has already been ably performed, and most valuable results reached by a commission of a similar character to that proposed, who about twenty years ago reported to the Franklin Institute at the request of the U. S. government—Prof. A. D. Bache, reporter. What now remains is to devise a system of safety, and the laws and provisions needed to secure its adoption, and constitute a central board of Engineers, with power to carry the law into efficient operation.

2. *Records of the School of Mines and of Science applied to the Arts.* Vol. i. Part 1; *being Inaugural and Introductory Lectures to the Courses for the Session*, 1851–52. Royal 8vo. pp. 148. London, 1852.—It is well known that the Museum of Practical Geology and Geological Survey was established by the British government on a suggestion from Sir Henry de la Beche, the head of the Geological Department of the Ordnance Survey. This was in 1835. In 1845 the present liberal establishment was decided on, and without reference to expense, the museum building was erected with abundant accommodations for its collections, lecture and research rooms, and an ample Chemical Laboratory. The volume before us contains the inaugural discourse by the President, Sir H. De la Beche, in which a view of the inception, progress and prospects of this institution is given, with many facts and reasonings, having for their object to show the national and permanent importance of the institution. It is needless to say that this inaugural is marked by the high character which appertains to all the productions of the Nestor of British geology.

The other discourses are on the Study of abstract science, essential to the progress of Industry; by Lyon Playfair, C.B., F.R.S. On the relations of Natural History to Geology and the Arts; by Edward Forbes, F.R.S. On the importance of cultivating habits of Observation; by Robert Hunt, Keeper of Mining Records. On the Science of Geology and its applications; by Andrew Ramsay, F.R.S. On the value of an extended knowledge of Mineralogy and the processes of Mining; by Warrington W. Smyth, M.A., F.G.S. On the importance of Special Scientific Knowledge to the Practical Metallurgist; by John Percy, M.D., F.R.S. These discourses are eminently worthy of an attentive perusal.

3. *Annual of Scientific Discovery, A Year Book of Facts in Science and Art, for* 1852. Edited by David A. Wells, A.M. 12mo. pp. 408. Boston, 1852. Gould & Lincoln.—This is the third yearly volume of the "Annual," we have had the pleasure of noticing. Covering the wide range of Mechanics, Useful Arts, Natural Philosophy, Chemistry, Astronomy, Meteorology, Zoology, Botany, Mineralogy, Geology, Geography, and Antiquities, it is remarkable how much the editor has been able to compress within the limits prescribed to each subject. We have read with much satisfaction, and we may add instruction, the introductory notes by the editor on the progress of Science in 1851. No one can review this progress as mirrored in this résumé without being very deeply impressed with the great amount of labor and talent at present employed in gleaning the fields of old knowledge, or in pushing new pioneer paths into the wilderness of facts and principles lying in the way of investigation. Comparing this activity in 1851, and in the United States with any former year of our history, no doubt can be entertained that substantial progress has been made in all departments of science. Among the signs of this advancement, we may adduce the fact that this annual has found so great encouragement as to be continued for three years until we may now regard it as an established order.

4. *A Handbook of Organic Chemistry, being a new and greatly enlarged edition of the "Outlines of Organic Chemistry," for the use of students;* by William Gregory, M.D., F.R.S., E., Professor of Chemistry in the University of Edinburgh. 3d edition, corrected and much enlarged. pp. 532. 12mo. London, 1852. Taylor, Walton & Maberly.—Chemists are very much indebted to Dr. Gregory for this new and very greatly improved edition of his excellent "Outlines," now well worthy of its present title. The author has taken great pains in bringing the work fully up to the present highly advanced state of the science, i. e., to the close of 1851.

The recent results of Würtz, Hoffman, Laurent, Gerhardt, and Cahours are introduced; and a valuable table of homologues is added, comprising the homologous compounds belonging to the radicals, ethyl, methyl, &c., as well as to acetyle, formyle, &c., derived from them; which table, although it extends to 17 vertical columns, and 22 horizontal ones, is yet but a corner of what might be drawn up, were we to have a column for every homologous series connected with the above groups of radicals. The author announces also a new edition of his Outlines of Inorganic Chemistry.

5. *Appleton's Mechanics' Magazine, and Engineer's Journal,* in 4to monthly numbers of 24 pp. Edited by Julius W. Adams, Civ. Eng. (No. 25 Nassau street, N. Y.) $3 per annum.—A Journal of high merit, and indispensable to all who would be acquainted with the recent applications of science to mechanics and engineering, and with the new discoveries in these and other allied practical departments of knowledge. Some idea of its range of subjects will be gathered from the following list of the papers of the number for June, viz.—Direct Acting Main Engine Plates; Longitude of Places, determined by Telegraph; Steam; Electro-magnetism on Railways; Engraving from Natural objects; Electro-metallurgy; Mechanics for the million; Lewiston and Queenstown Suspension Bridge; McCallum's Timber Bridge; Centrifugal power; Railway Axles, &c. &c. The plates are on steel or copper, and finely executed.

6. *The Naval Dry Docks of the United States;* by Chas. B. Stuart, Engineer-in-chief of the United States Navy. 4to. 24 fine engravings on steel. New Yok, 1852. C. B. Norton.—This book is a novelty in the history of American engineering, and we might add, in book publishing. The style of mechanical execution of the plates, the text, and all the accessories is such as we have been accustomed to regard as almost peculiarly English; and those who delight in the luxury of good workmanship and material will here find their taste gratified. Engineers must regard with great satisfaction works like this, designed to perpetuate and record their labors in the most honorable manner. The achievements of American skill and science are worthy of the vindication which this work supplies to the distinguished gentlemen of this profession in the United States, who have devoted their talents to our great works of public utility or defense.

This work is divided into two parts. The first describes the Granite Dry Dock, the second *the Floating Dry Docks.* To give any of the details or even the results of these great public works is foreign to our present purpose, and we will only add the hope that the success of this fine publication may be such as to induce our distinguished author to undertake the treatment of other departments of our public works in the same elaborate and thorough manner.

7. *Graham's Elements of Chemistry* (2d edition,) has been issued from the press of Blanchard & Lea, edited by Dr. Bridges. It is only the first part, of course, as far as the close of the metallic bases of the earths; the second and final part has not yet appeared in England. This work has a deservedly high reputation as a classic among the treatises on chemistry in our language, and Dr. Bridges' editorship is a guarantee for an accurate re-production of the English edition. He has also added valuable notes in correction or extension of the text.

8. *The Assay of Gold and Silver Wares: An account of the laws relating to the Standards and Marks, and of existing pay offices;* by Arthur Ryland. 12mo. pp. 212. London, 1852. Smith, Elder & Co. —This is entirely a technical book as its title shows, and is local to Great Britain. Those interested in these inquiries will find here much interesting and apparently accurate information.

9. *Lectures on the Results of the Great Exhibition delivered before the Society of Arts.* London: David Rouge. 12mo, (sixpence each.) —We have already* presented the lectures of Prof. Whewell and of Dr. Playfair to our readers. There have been twelve of this series in the following order:—

1. Rev. Dr. Whewell, Master of Trinity: The general bearing of the Exhibition on the Progress of Art and Science. 2. Sir H. De la Beche: Mining, Quarrying and Metallurgical Processes and Products. 3. Professor Owen: Animal Raw Products used in the Arts and Manufactures. 4. Jacob Bell, Esq., M.P.: Chemical and Pharmaceutical Processes and Products. 5. Dr. Lyon Playfair: On the Chemical Principles involved in the Manufactures shown at the Exhibition, as a proof of the necessity of an Industrial Education. 6. Professor Lindley: Substances used as Food. 7. Professor Solly: On the Vegetable Substances used in the Arts and Manufactures, in relation to Commerce generally. 8. Professor Willis: Machines and Tools for working in Metal, Wood, and other Materials. 9. James Glaisher, Esq.: Philosophical Instruments and Processes. 10. Henry Hensman, Esq.: Civil Engineering and Machinery generally. 11. Professor J. Forbes Royle: The Manufactures of India. 12. Captain Washington, R.N.: Shipping, particularly Life-Boats.

These of course are of unequal interest. Some of them are well worthy of the subjects discussed, others are less happy.

10. *Course of the History of Modern Philosophy;* by M. Victor Cousin; translated by O. W. Wight. 2 vols., 8vo. New York, 1852. D. Appleton & Co.—We can only announce the appearance of this translation of the eminent French metaphysician, just issued in handsome style by the Appleton's. The lectures, which are now for the first time in an English dress, were delivered by M. Cousin in the years 1828–9, and were received with great applause and admiration.

11. W. H. Buren, M.D., and E. E. Isaacs: *Illustrated Manual of Operative Surgery and Surgical Anatomy.* Part I. 84 pp., 8vo, with 26 steel engravings, by M. J. Léveillé. New York, 1852. H. Baillière; price with plates colored, $3.00, plain, $1.75.—The subject of

* Vol. xiii, p. 352.

operative surgery is illustrated in this admirable work by a large number of plates of exquisite finish, representing the instruments used, and also the various processes or modes of operation with different parts of the human body in all their details. The work is designed to serve as a companion to the ordinary text-books of surgery.

12. *Lectures on Histology, delivered at the Royal College of Surgeons of England, in the Session of* 1850, 1851.—Elementary Tissues of Plants and Animals; by JOHN QUEKETT, Assistant Conservator of the Mus. Roy. Coll. Surgeons of England. 206 pp. 8vo; illustrated by 159 wood-cuts. London and New York, 1852. H. Baillière.—Mr. Quekett, whose work on microscopes is well known, has embodied in his Lectures on Histology, a large amount of microscopic research, original and selected; and the abundant illustrations carefully made render the work a highly useful one. It treats of the microscopic structure of animal and vegetable tissues, of ducts, cells, juices, oils, and other parts in the intimate constitution of organic beings. Sections of wood, nuts, leaves, fruit, cartilages of different kinds, &c., are represented in detail. The work is a valuable companion to the microscope, directing the observer to many things of profound interest in the commonest objects around him, the study of which may afford constant instruction and rational amusement.

ISAAC LEA: On the Fossil Foot-marks in the Red Sandstone of Pottsville, Pa. (From the Trans. Amer. Phil. Soc., vol. x.) 14 pp 4to, with 3 lithog. plates.

ISAAC LEA: On a Fossil Saurian of the new Red Sandstone Formation of Pennsylvania, with some account of that formation. Also, on some new Fossil Molluscs in the Carboniferous Slates of the Anthracite seams of the Wilkesbarre Coal Formation. 20 and 4 pp. 4to, with 4 lithog. plates. *Philadelphia*, 1852. (From Jour. Acad. Nat. Sci., Part 3, vol. ii, 2nd ser. Read May 11, 1852.)

ISAAC LEA: A Synopsis of the Family of Naiades. 3d edit., greatly enlarged and improved. xx and 88 pp. *Philadelphia*, 1852.

ISAAC LEA: Observations on the Genus Unio, together with Descriptions of New Species in the Families Unionidæ, Colimacea and Melaniana. (Read before the Amer. Phil. Soc., and originally published in its Transactions,) Vol. v. 62 pp. 4to, with numerous plates. *Philadelphia*, 1852. Printed for the author.

The valuable memoirs here enumerated were received too late for any mention beyond that of giving their titles.

W. S. W. RUSCHENBERGER, M.D.: A notice of the Origin, Progress and Present Condition of the Academy of Natural Sciences of Philadelphia. 78 pp. 8vo. *Philadelphia*, 1852.

MAGNETICAL AND METEOROLOGICAL OBSERVATIONS at the Cape of Good Hope. Printed by order of her Majesty's government, under the superintendence of Lieut.-Col. Edward Sabine.—Vol. I. Magnetical observations 1841 to 1846, with abstracts of the observations from 1841 to 1850, inclusive. lxxii and 420 pp. 4to. *Lond.*, 1851.

MAGNETICAL AND METEOROLOGICAL OBSERVATIONS at Hobarton, in Van Diemens Land. Printed by order of her Majesty's government, under the superintendence of Lieut.-Col. Edw. Sabine. Vol. II. Commencing with 1843, with abstracts of the observations from 1843 to 1850 inclusive. l and 532 pp. 4to. *London*, 1852.

Das Quadersandsteingebirge oder Kreidegebirge in Deutschland, von HANNS BRUNO GEINITZ; 294 pp. 8vo, with 12 lithog. plates. *Freiberg*, 1849–1850.

Das Quadergebirge, oder die Kreideformation in Sachsen, Gekrönte Preisschrift von HANNS BRUNO GEINITZ, Dr. Phil. in Dresden. 44 pp. 4to, with 1 colored table. *Leipzig*, 1850.

Die Versteinerungen des Zechsteingebirges und Rothliegenden, oder des permischen Systems in Sachsen, von H. B. GEINITZ, und AUGUST VON GUTBIER. 4to, Heft i, 26 pp. with 8 lithog. plates of fossils, and Heft ii, 30 pp. with sections and 11 plates of fossils. *Dresden* and *Leipzig*, 1848–1849.

Considerazioni sulla Geologia della Toscana dei Professori CAV. PAOLO SAVI, *e* G. MENEGHINI. 244 pp. 8vo, with a large plate of sections.

Proceedings of the Boston Society of Natural History, 1852.—p. 161. Descriptions of new species of Cyclas and Pisidium, (continued); *Prime.*—p. 165. Note on the embryo of the Dogfish; *J. Wyman.*—p. 166. On certain impressions upon a slab from the mineral region of Lake Superior; *Desor.*—p. 168. Observations on the Pedicellariæ found in Echini, &c.—p. 169. Observations on the Hillsboro' Coal.—p. 175. Note on the Rhinoceros; *Dr. Kneeland.*—Observations on the Coal measures of Ohio; *Dr. L. Lesquereux.*

Proceedings of the Academy of Natural Sciences of Philadelphia, vol. vi, No. for March and April, 1852.—p. 51. Aurora of Feb. 19; *Dr. J. C. Fisher.*—p. 52. Remarks on an Eocene cervical vertebra, probably Cetacean, and the institution of a new genus *Chærodes* for the Hippopotamus Liberiensis of Morton; *J. Leidy.*—p. 53. Species of Hippopotamus from Northern Africa distinct from that of Southern Africa, as observed by Desmoulins and Duvernoy, and the name H capensis, proposed by Desmoulins to be retained; *J. Leidy.*—Castoroides ohioensis from near Shawneetown; *Dr. LeConte.*—p. 54. Note on the periodicity of the Family Unionidæ, and on a new species of Unio from China, U. Cummingii; *J. Lea.*—p. 55. Molybdate of lead from Pennsylvania; *C. M, Wetherill.*—Observations on fossil Pachyderms from Illinois referred to on page 3 of the Proceedings; *J. L. LeConte.*—p. 59. Fossil tortoises of Nebraska terrestrial and not aquatic, with the names of the species as they should stand; *J. Leidy.*—Red Snow (Protococcus nivalis) from the Arctic regions; *J. Leidy.*—p. 60. New Birds from Texas of the genera Vireo, *Vieill*, and Zonotrichia, *Swains.* (Vireo atricapilla and Z. Cassinii); *S. W. Woodhouse.*—p. 61. Note on Carpodacus frontalis, *Say*, and descriptions of a new species of the same genus from Santa Fe; *G. A. McCall.*—p. 62. Description of new species of Reptilia from W. Africa, (Phractogenus (*Hal.*) galeatus, Hemidactylus angulatus, Acontias elegans); *E. Hallowell.*—p. 65. Remarks on some Coleopterous Insects collected by S. W. Woodhouse in Missouri Territory and New Mexico; *J. L. LeConte.*—p. 68. Characteristics of some new Reptiles in the Museum of the Smithsonian Institution, (Siredon lichenoides (B.), Cremidophorus tigris, Crotaphytus Wislizenii, Uta (B. and G.) Stansburiana, Sceloporus graciosus, Elgaria scincicauda (=Tropidolepis scincicaudus, Skilton, Am. J. Sci. [2], vii, 202), Plestiodon Skiltonianum, Phrynosoma platyrhinos (G.), P. modestum (G.), Churchillia (B. and G.) bellona, Coluber mormon, Heterodon pasicum): *Spencer F. Baird* and *Charles Girard.*—This number contains plates 12 and 13 of vol. v, of Proceedings, with colored figures of Hirundo scapularis, *Cassin*, Atticora hamigera, *Cas.*, Cypselus leucopygialis, *Cas.*, Acanthylis cinereocauda, *Cas.*

Annales de Chimie et de Physique, MARCH, 1852, tome xxxiv.—Nouvelles recherches sur l'acide hypériodique et les hypériodates; *M. Langlois.*—Recherches sur la populine (Extrait d'une Lettre de *M. Piria* à M. Dumas).—Mémoire sur le développement de l'électricité dans les combinaisons chimiques, et sur la théorie des piles formées avec un seul métal et deux liquides différents; *M. Ch. Matteucci.*—Recherches sur les eaux employées dans les irrigations; *MM. Eug. Chevandier* et *Salvétat.* —Nouveau mode de séparation de l'acide phosphorique d'avec les acides métalliques; *M. Alvaro Reynoso.*—Sur l'équivalent du phosphore; *M. Schrötter.*—Recherches sur quelques huiles employées dans la parfumerie; *M. A. W. Hofmann.*—Sur l'ether œnanthique et l'acide œnanthique; *M. W. Delffs.*—Sur les produits de la distillation sèche des matières animales; *M. Th. Anderson.*—Mémoire sur la dilatation de quelques corps solides par la chaleur; *M. Hermann Kopp.*—Note sur la polarisation de la chaleur atmosphérique; *M. Elie Wartmann.*—Sur les propriétés magnétiques des gaz; *M. Plucker.*—Comparaison du magnétisme de l'oxygène et du magnétisme du fer; *M. Plucker.*—Sur la polarité magnétique et la force coercitive des gaz; *M. Plucker.*—Second Mémoire sur les propriétés magnétiques des gaz; *M. Plucker.*—Sur le calcul de la surface de l'onde de Fresnel; *M. Beer.*—APRIL. Recherches sur les quantités de chaleur dégagés dans les actions chimiques et moléculaires; *MM. P. A. Favre* et *J. T. Silbermann* (Fin de la première partie.)—Mémoire sur la théorie des machines électromagnétiques; *M. H. Jacobi.*—Note préliminaire sur la mesure du courant galvanique par la décomposition du sulfate de cuivre; *M. H. Jacobi.*—Sur quelques sels et sur quelques produits de décomposition de l'acide coménique; *M. H. How.*—Sur l'acide uroxanique, un produit de décomposition de l'acide urique; *M. G. Stædeler.*—Sur l'existence de la créatinine dans l'urine de veau; *M. N. Socoloff.*—Sur la constitution et sur les produits de décomposition de la codéine; *M. Anderson.*—Fragments d'un Mémoire de M. J. R. Mayer, de Heilbronn, ayant pour titre: Remarques sur les forces de la nature inanimée.—Mémoire sur les effets calorifiques des courants magnéto-électriques et sur l'équivalent mécanique de la chaleur; *M. Joule.*


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THE

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[SECOND SERIES.]

Art. XVIII.—*Second Report on Observations of the Aurora Borealis*, 1850–1851; by J. H. Lefroy, Capt. R. A., being a Circular Letter to officers of Honorable Hudsons' Bay Company, dated Magnetical Observatory, Toronto, April 13, 1852.

I am obliged to adopt the same method as before of communicating with the gentlemen from whom I have requested observations on the Aurora, namely, by a circular, to save the needless repetition in private letters of the information which it is incumbent upon me to give, of the result of those of the first winter.

Registers of aurora have reached me from the following quarters:

a Peel's River,	October 1850, to April 1851,	Mr. A. Peers.
a Youcon,	January to May 1851,	Mr. Hardisty.
a Fort Good Hope,	November 1850,	Mr. McBeath.
a Fort Confidence,	October 1850, to April 1851,	Dr. Rae.
a Fort Simpson,	October 1849, to May 1850,	Dr. Rae.
"	September 1850,	Mr. Bernard Ross.
a Pelly and Lewis,	December 1850, to April 1851,	Messrs. R. Campbell and Stewart.
a Fort Chipewyan,	November 1850, to April 1851,	Mr. J. Anderson.
b Moose Factory,	June 1850, to March 1851,	Mr. Clouston.
b Martin's Falls,	September 1850, to March 1851,	Mr. Wilson.
b Nipegon,	1842, to April 1850,	Mr. J. Anderson.
b Matawagomingen,	July 1850, to March 1851,	Mr. Colin Campbell.
b Michipicoton,	November 1849, to July 1851,	Mr. Swanston.

To each and all of these gentlemen, as well as to those who may have kept journals which have not yet reached me, I beg to tender my warmest thanks. Nothing can exceed the care and attention displayed by many of the registers, and their interest has fully equalled my expectations. Without meaning to draw invidious comparisons, I cannot deny myself the pleasure of especially naming here those of Mr. Swanston, Mr. Clouston, and Mr. Anderson; the first of these is a model of completeness and conciseness, Mr. Swanston having generally recorded the state of the sky and the weather every hour from dark to 10 P. M., and in terms which are always definite and expressive.

The registers have been continued at the Military Guardrooms of the Royal Artillery in Canada, and at a great number of stations of observation in the United States. I have now in my hands, through the kindness of Professor Henry, Secretary to the Smithsonian Institution, returns from upwards of an hundred observers, for 1849, 1850, and part of 1851, at stations scattered through all the States, from the Atlantic to the Mississippi. Not having received observations from any of the stations on the Saskatchawan, or Lake Winnipeg, there is a pretty wide blank, extending from Lake Athabasca to Lake Superior, in the chain by which it was hoped to trace and identify, displays from the polar circle downward to Canada, but I trust in future years some at least of the intermediate posts will oblige me with a journal: and if each observer will bear in mind that others, hundreds, and some of them thousands of miles off, are noting down the features of the very displays he may be looking at, as it appears to them, and that from a comparison of all these accounts, it is hoped to arrive at definite views concerning this most singular phenomenon, he cannot fail to see the value which every clear, distinct, and definite record of facts and particulars will possess, and to acquire a greater interest in the subject than the constant repetition of familiar descriptions might otherwise afford.

It has been often stated vaguely that aurora appears every clear night. This is certainly not true of any one station, as far as the earlier hours are concerned, we are still short of proof that it is true in the widest meaning; indeed, the statement, if true, would carry little weight with it, without the addition of dates, facts, and particulars. These, however, our registers promise, for the first time, to supply. Observations begin to be general in October, 1850. In that month we have evidence of it every night except four, 20, 21, 22, 23, one of them clouded everywhere, one of them full moon, the rest partially clouded. In November, 1850, every night but two, 22 and 23, the former, however, of these was generally clear and no moon. In December, 1850, every night but five, 5, 10, 18, 19, 20, but all the displays of a feeble character. In January, 1851, every night but two, 5, 12, many of the displays very feeble, several of them seen only by Mr. Anderson at Athabasca, and on the whole, a much smaller proportion than usual, extending to low latitudes. In February we have it every night,* some of the displays of great beauty, although I imagine they will have been far exceeded by those of February, 1852. The display of February 18th, 1851, was one of

* Every night but two, February 2 and 16.

those remarkable instances of the simultaneous *absence of cloud,* and intense development of aurora over a very large part of the whole northern hemisphere, which, from their frequent occurrence appear to have more than an accidental connection. It was seen at every station, with exception only of the Pelly Banks, from the polar circle to the United States, where no less than thirty-eight stations have forwarded accounts of it to the Smithsonian Institution; it extended also to Europe, having been recorded at Sandwick Manse, Orkney. The display of February 28th, was almost as universal. It is remarkable that in many cases the phenomenon was first seen, in absolute time, at the most eastern stations, notwithstanding the earlier commencement of darkness at the extreme north, where the difference of latitude in some cases more than compensates the difference of longitude; it would appear from this that the aurora does not commonly appear at a station upon any meridian until that meridian generally is in darkness; a result which if established, by the whole body of evidence, will be both new and interesting. For example, in the following list I have entered the hour of sunset in meantime of Göttingen at each station, and the hour at which the aurora is first recorded in the same; it is not to be supposed that each observer seized the exact time of first visibility, but in two of the examples at least the general result is sufficiently clear; namely, that it was seen at the lower and eastern stations sooner than at the northern but more westerly stations, although there is no reason to be given why it should not have appeared at the latter, as soon as at the former, daylight having ended there:—

TABLE I.

	January 27, 1851, ⊙ Decl. – 18½°, Eq. – 13ᵐ.				Feb. 18, 1851. ⊙ Decl. – 11½. Eq. – 14ᵐ.		Feb. 28, 1851. ⊙ Decl. – 8. Eq. – 13ᵐ.	
	N. Lat.	W. Long. from Gr'wich.	Sunset. Gott'g'n.	Aurora first seen.	Sunset. Gottingen.	Aurora first seen.	Sunset. Gottingen.	Aurora first seen.
Toronto, ...	43° 39′	–5·17	10·56	19·00	11·26	14·00	11·39	16·00
Halifax, ...	44 39	–4·14	10·01	....	10·18	11·49	10·15	....
Quebec, ...	46 49	–4·45	10·14	14·25	10·35	12·24	11·04	15·35
Newfoundland, .	47 33	–3·31	8·58	....	9·32	20·11	9·48	12·40
Michipicoton, ...	47 56	–5·40	11·06	....	11·50	16·40	11·57	13·55
Moose Factory, .	51 10	5·24	10·39	14·54	11·17	12·44	11·37	12·49
Martin's Falls, ..	51 52	5.47	10·58	14·30	11·36	13·01	12·00	13·01
Athabasca, ...	58 43	7·25	12·03	14·30	13·16	15·55	13·24	15·25
Lewis and Pelly,	61 30	8·40	13·08	21·30	14·16	....	13·41	15·58
Fort Simpson, ..	61 51	8·06	12·21	....	13·15	....	....	....
Youcon, ...	66 00	9·48	13·21	20·00	14·56	18·58	15·27	18·03
Fort Confidence,	66 54	7·55	11·21	17·00	12·55	16·25	....	....
Peel's River, ...	67 27	8·53	12·19	16·38	13·50	17·38	14·31	at dark

I do not offer these instances as conclusive, but they are somewhat remarkable, and I may state that having marked the Göttingen hour of the first appearance against every observation, the great majority give direct support to the inference I have drawn, and there are few or no instances contradicting it. The question will soon be decided if the time of commencement of each display is recorded, and a note also made of the latest hour at which it may have been noticed that there was no aurora. For example, the observer takes a look out at 7, P. M., no aurora, again at 8, aurora, which is duly entered. In this connection the fact that there was no aurora at 7, is almost as important as the fact that the phenomenon was visible at 8, and should be duly entered. On 29th September, 1851, at 6·30, P. M., there was no trace of aurora at Toronto; at 6·36, a brilliant heavy serpentine band occupied the northern sky. In this instance, and in various others, the time of appearance is fixed to five or six minutes, and if at any northern station it happens to have been fixed with any thing like the same exactness, the question will be answered.

In March, 1851, we have evidence of aurora every night save three, 13, 17 (full moon,) 19; these, however, were pretty generally clear nights. Registers for April, 1851, have reached me from a few stations only, but as far as they go, give evidence of aurora every night save four, 4, 14, 15 (full moon but clouded everywhere,) and 21. The 16th of December is the only instance in the winter, of aurora seen in Canada, which escaped notice at every northern station; the number seen at northern stations which do not descend to Canada is of course considerable, as will appear from Table III.

TABLE II—*Shewing the number of nights the Aurora is recorded at each station, in 1850 and 1851, and the total number of nights in each month in which there is evidence at present, to show that the phenomenon was developed somewhere or other on the American continent. The returns will, no doubt, be extended, and some observations at present omitted as doubtful, be confirmed, and included in the totals at certain stations.*

1850.	Jan.	Feb.	March.	April.	May.	June.	July.	August	Sept.	Oct.	Nov.	Dec.	Total.
a Peel's River, ...	...	...	...	...	...	...	...	...	...	6	11	9	
a Fort Good Hope, ...	...	...	...	...	...	...	...	...	...	...	20		
a Fort Confidence, ...	...	...	...	...	...	...	...	...	...	12	9	15	
a Fort Simpson, ...	3	5	5	0	*	*	*	*	8*e*				
a Lewis and Pelly,.......	...	...	...	...	...	...	...	...	...	...	...	4	
a Lake Athabasca, ...	...	...	...	...	...	...	...	...	...	...	12	19	
b Martin's Falls, ...	...	...	...	...	...	...	...	2*f*	10	10	10	11	
b Moose Factory, ...	...	...	...	...	...	7*a*	18	19	12	15	11	13	
b Matawagomingen, ...	...	...	...	...	...	...	3	7	4	4	2	0	
b Lake Nipegon,..........	...	5	6	7†									
b Michipicoton, ...	3	4	3	7	1	6	5	2	1*g*	3	2	2	39
c Newfoundland,.........	1	6	6	1	3	3	8	6	6	9	0	3	52
c Quebec, ...	0	2	3	3	1	3*b*	6*c*	6*c*	7*c*	5*c*	5	3	44
c Montreal, ...	1	3	5	5	3								
c Halifax, ...	1	4	6	4	3	6	13	10	9	11	8	4	79
c Fredericton, ...	...	...	...	...	...	...	4	4	5	5	9		
c Kingston, ...	0	4	1	3	0	0	6	3	5	5	1	0	28
c Toronto, ...	3	3	3	6	5	3	5	4	5	9	3	1	50
c London, C. W.	1	3	3	5	3	0	3	2	5	5	0	0	30
c Somerville, N. Y.	0	7	9	8	6	8	9	14	12	7	3	4	87
Total, ...	11	23	23	19	13	21	27	25	21	25	27	26	261

a From the 16th to 30th June. *b* Observed by Sergeant Maiden, at Grose Isle, near Quebec—none observed at Quebec. *c* Including observations at Grose Isle. *d* Begins on the 30th. *e* From 1st to 18th. *f* Begins on the 30th. *g* Begins on the 21st.
* Twilight too strong. † Register ends.

TABLE II.—(*Continued.*)

1851.	Jan.	Feb.	March.	April.	May.	June.	July.	Aug'st.	Sept.	Oct.	Nov.	Dec.	Year.
Peel's River, ...	10	16	12	1	*								
Fort Confidence, ...	11	15	12	4*b*									
Youcon, ...	7*a*	6	6	5	*								
Lewis and Pelly, ...	8	12	10	2*c*									
Athabasca, ...	20	19	20	19									
Martin's Falls, ...	10	12	14										
Moose Factory, ...	14	15	17										
Matawagomingen, ...	0	3	2										
Michipicoton, ...	2	6	7	9	5	2	5						
Newfoundland, ...	4	6	6	5	7	1	1	3	5	6	2	5	51
Quebec, ...	3	3	3	3	1	1	3	0	5	5	0	1	28
Montreal, ...													
Halifax, ...	4	5	8	9									
Fredericton, ...													
Kingston, ...	0	1	5	0	1	0	2	2	6	2			
Toronto, ...	2	3	7	2	3	4	5	7	9	7	5	9	63
London, C. W., ...	1	2	3	0	0	2	1	2	4	1	0	2	18
Somerville, N. Y., ...	0	3	5	6	6	2	6	3	9	7	1	5	53
Total, ...	26	26	28	26	25	9	15	11	19	13	6	3	207

In these enumerations doubtful entries are not included unless supported by an observation elsewhere in the same region. I have added the number of observations made by a most indefatigable observer (Dr. Franklin B. Hough), at Somerville, near Ogdensburgh, on the St. Lawrence, both as properly belonging to the Canadian chain of stations, and to shew that even in low latitudes a single observer, by great attention, may make surprising advance on the number of instances of aurora, which attract the attention of those who are less zealous or less favorably situated. The stations may be arranged in three groups. The first comprising all those marked (*a*) p. 1, which are from 500 to 1000 geographical miles distant from the magnetic pole; the second, those marked (*b*), which are from 1200 to 1500 miles distant; and the third, those marked (*c*), including the great majority of stations in the United States, which are from 1600 to 2000 miles distant, from the same point. Lake Athabasca, contrary perhaps to first impressions, is the nearest permanent station to this assumed centre of influence. Fort Confidence, which is not a permanent station, is of course nearer—but Fort Simpson and the other posts on McKenzie's River, notwithstanding their northerly position, are somewhat more distant.

(*a*) Commencing on the 19th. (*b*) Down to the 11th. (*c*) Down to the 10th.

TABLE III.—*Observations arranged according to position of Station with reference to the Magnetic Pole. The figures under the heading Proportion, shew the per-centage of observation of Aurora, to nights on which observation appear to have been possible, as regards the state of the sky.*

Date.	(*a*) In first circle, from 500 to 1000 miles distant.						(*b*) In second circle, from 1200 to 1500 miles distant.					
	No. of Stations.	No. of observations of Aurora.	Doubtful app'rance.	Tot'ly clouded nights.	Observat'n probably possible.	Proportion per cent.	No. of Stations.	No. of observations of Aurora	Doubtful app'arance.	Tot'ly clouded nights.	Observati'n probably possible.	Proportion per cent.
1850.												
January, ...	1	3	....	12	16	16	1	2	1	19	11	17
February, ...	1	6	....	10	12	33	2	5	....	20	3	62
March, ...	1	5	....	10	16	24	2	7	....	15	8	47
April, ...	1	0	....	13	17	....	2	10	....	14	6	62
May, ...	1	0		2	17*a*	....	1	1	1	14	16	
June, ...	1	6	1	4	3	....	2*b*	10	3	13	7	59
July, ...	....	....	....	...	....		3	19*c*	1	9	3	94
August, ...	....	....	....	...	....		3	22*d*	1	7	3	92
September, ...	1	8*f*	....	9	....	100	3	17*d*	1	7	6	74
October, ...	2	16	....	11	4	79	4	19	....	6	5	79
November, ...	4	25	....	3	3	93	4	16	1	9	5	79
December, ...	4	25	....	3	3	88	4	16	1	10	5	76
1851.			....									
January, ...	5	28	....	2	1	96	4	15	...	11	5	79
February, ...	5	25	....	1	2	93	4	17	....	9	2	89
March, ...	5	25	....	1	4	83	4	21	....	4	6	78
April, ...	4*e*	23	....	2	5	82	1	9	....	16	5	64
May, ...	....	....	....	...	....	....	1	5	....	13	13	28
June, ...	....	....	....	...	....	....	1	2	....	10	18	10
July, ...	....	....	....	...	....	....	1	5	....	13	13	28

(*a*) Down to the 19th May. There is no night, properly speaking, at Fort Simpson in May, that is to say, twilight lasts from sunset to sunrise. (*b*) Register at Moose Factory begins on 17th June. (*c*) Including Mr. Anderson's observations *en route*. (*d*) No observations made at Michipicoton from 21st August to 20th September, but probably no conspicuous aurora occurred. (*e*) 4 stations up to the 10th, from 14th to the end, only 2. (*f*) Register from 2d to 18th September.

In the third circle (*c*) or stations from 1600 to 2000 miles from the Magnetic Pole.

TABLE III.—(*Continued.*)

	1848.			1849.			1850.			1851.				
	N. C. Officers, Roy. Artillery.	Added by other Observers.	Total Aurora.	N. C. Officers, Roy. Artillery.	Added by other Observers.	Total Aurora.	N. C. Officers, Roy. Artillery.	Added by other Observers.	Total Aurora.	N. C. Officers, Roy. Artillery.	Added by other Observers.	Total Aurora.	Average in 4 years.	Relative number.
January, ..	8	3	11	8	...	8	5	4	9	8	3	11	9·7	70
February, .	13	1	14	17	...	17	13	6	20	7	6	13	16·	127
March, ...	13	1	14	11	5	16	12	10	22	15	5	20	18·	159
April, ...	17	....	17	20	2	22	12	5	17	13	3	16	18·	185
May, ...	11	....	11	10	7	17	10	3	13	9	5	14	13·7	161
June, ...	6	....	6	9	3	12	11	6	18	5	3	8	11·	141
July, ...	9	1	10	12	6	18	17	4	21	7	6	13	15·5	191
August, ...	6	3	9	8	6	14	15	4	18	8	3	11	13·2	143
September,	7	....	7	12	7	19	16	3	19	12	6	18	15·7	148
October, ..	14	1	15	12	2	14	17	1	18	12	1	13	15·	124
November,	10	....	10	12	2	14	15	3	18	6	...	6	12·	89
December,	12	1	53	6	4	10	10	2	12	12	1	13	12·	85
	126	11		137	44		154	51		114	42			

The figures in the last column are found by dividing the average of auroras in each month, by the number of hours *less one*, from sunset to sunrise at Toronto (taken as a middle latitude,) on the 15th of that month; they shew in a striking manner the diminished frequency of the phenomenon about the winter solstice, and its great development at the vernal equinox. The returns for the last three months of 1851 are not all collected.

The stations of observation in the first and second groups are not yet numerous enough to decide the question, whether the aurora ever appears in the exterior when it is absent in the interior circles, but in forming an opinion on the number which extend from the interior to the exterior of them, we must not forget that, notwithstanding, the large number of observers, both regular and occasional, in the third group, and their wide distribution, a considerable proportion of the entries in Table III, rest at present upon an observation at only one station,* and *unless particulars are given*, which is unfortunately not always the case, may be reasonably regarded as doubtful. Where particulars are given there can be, of course, no doubt.

The observations made under direction of the Smithsonian Institution begin to be general in March, 1849, and the stations are so numerous that we ought, perhaps, to consider observations to have been possible every night. Table III, has been made as complete as possible, by including some observations kindly communicated by Mr. E. C. Herrick, together with any that were found in the Regent's reports for 1848–1849 of which particulars were given, or which occurred at more than one station on the same evening. Also observations by Mr. Dougald Stewart at Ristigouche, L. C. The few observations at sea at present collected, for most of which we are indebted to Capt. Oliver Eldridge, have not yet been included.

It results from the comparison of the six winter months, October to March inclusive, 1850–1; that aurora was seen before midnight within the first circle on 88·5 per cent. of practicable nights, in the second circle on 80 per cent., and in the third on only 48·5 per cent., indicating a rapid falling off of the causes producing it at distances exceeding 1600 miles from the magnetic pole.

It is scarcely necessary to say that these simple numerical comparisons are but the first fruits of the observations; such as they are, however, they suggest to the mind a spectacle which if true in nature, must be of wonderful magnificence. The polar light kindling on each meridian, as that of day declines, sometimes with the splendor of prismatic coloring over half a hemisphere; sometimes contracting its circles and paling its fires, for a period of days or weeks; and sometimes spreading downwards over the globe, with an intensity of which our highest conceptions are probably inadequate, since, if the region of the display is as elevated as is usually supposed, about a third of its light must be absorbed by the atmosphere. To pursue the subject into all its details would lead me much beyond the limits of such a com-

* Of the total number of 261 observations in 1850, 54 are at one station only; of the total number of 207 in 1851, 71 are at present at one station only—the majority of these in the third group. The proportion to which any doubt can attach is not large.

munication as this; but I am truly anxious to convince any gentleman who may have doubts on the subject, that to keep, in ever so plain a way, a journal of such appearances as may occur at his station, will be a most acceptable contribution to an enquiry which will owe much of its interest and value to the scale on which it is pursued; and especially to induce those to whom I have not the advantage of being personally known, and those resident at the remaining posts in the northern, middle, and extreme western regions to swell the list.

With respect to the influence of these displays upon the movements of the magnetical elements registered by photography at Toronto, I may say that I find the symbols which represent, in the abstract, 'total absence of disturbance,' 'moderate disturbance,' 'considerable disturbance,' and so on, against almost every variety of observation, and am not yet prepared to give any settled opinion on the subject. * * * *

I shall look with much interest for the observations made in the past winter, which in Canada has been remarkable for the number of splendid displays of aurora—and the repeated occurrence of some of the rarest phenomena connected with it, such as the formation of arches of *dark* vapor, of which Mr. C. Campbell has given one instance.

Art. XIX.—*On the Arts and Manufactures of India;* from a Lecture by Prof. Royle.*

* * * * As the arrangement of the arts in the jurors' lists and catalogues of the Great Exhibition, though productive of great convenience, is not so well suited for general observations, in consequence of some which are closely allied to each other in their scientific principles being separated from each other, I propose treating of the arts and manufactures of India under the heads of—1. Chemical Arts; 2. Textile Arts; 3. Manual and Mechanical Arts; 4. Fine Arts.

I. Chemical Arts.—The arts which are strictly chemical may be supposed to have originated only in a country where the science of chemistry had made some advance, but the Hindoos are not usually supposed to have paid any attention to this subject. The Egyptians are thought to have practised, and the Arabs are acknowledged to have been the first who wrote on the subject; but their earliest chemist, Geber, acknowledges that he had only abridged the information to be found in the books of ancient phi-

* From the Lectures on the results of the Exhibition, delivered before the Society of Arts, Manufactures and Commerce, at the suggestion of H. R. H. Prince Albert, President of the Society.

losophers. That the Hindoos were among these, I have attempted to prove in a separate work,* where I have shown the probability of the Arabs having obtained much of their information from Sanscrit works, still in existence.

Chemistry, it has been inferred, must have originated in alchemy; but it appears to me that it must have originated wherever the arts began to be practised: for in seeing the wonderful changes which take place during the action of heat, and some of the most common re-agents, people may easily have been led to believe even in the transmutation of metals.

We know from a variety of sources, that the Hindoos have long been acquainted with many chemical substances, as well as that they have practised many chemical arts. The ordinary metals, including tin, they have long known, and have prepared the oxyds of iron, lead, tin, and zinc. The ashes of plants in a country of wood fires, led them to the discovery of potash. Soda is found effloresced on the soil, as well as crystallized on the margins of some of their lakes. The Arabic name, *sagimen*, indeed, seems to be derived from the Hindoo *saji-noon*, that is, *sajji*, or soda-salt. Nitre must have been produced then, as now, in their soil, and borax imported from Tibet, while sal-ammoniac must have been produced ever since they made bricks, as they now do. Alum they obtain by throwing potash on alum slate, which has been some time exposed to the air. Among the salts of the metals, we find the sulphates of copper, of zinc, and of iron, the acetates of copper and of iron, and the carbonates of lead and of iron. They seem, also, to have been long acquainted with the three mineral acids, for making which they have peculiar formulæ, while their lemons and limes gave them citric, and the gram-plant (*Cicer arietinum*) the oxalic acid.

It is evident, therefore, that the Hindoos possessed many chemical substances, and that they prepared others; hence we might infer that they may have practised some of the chemical arts, as, indeed, we know they must have done from other sources. But this would equally prove that they must have possessed various chemical substances, whencesoever obtained.

Pharmaceutical Products.—In the present state of the chemical arts, advanced as they have been by the cultivation of the science in Europe, it was not to be expected that such products as are obtained by the natives of India, by their original and primitive processes, could be sent to the Exhibition with any hope of attracting attention. Few, therefore, have been sent from the bazaars of India, except as curiosities. But there are others, prepared under European superintendence for the use of the public service, which are excellent in quality; and I know

* "Essay on the Antiquity of Hindoo Medicine."

not why India might not under such superintendence prepare some that might become articles of commerce: such, for instance, as benzoic and citric acids, the salts of morphia, narcotin as an efficient substitute for quinine in a number of cases; with some extracts and tinctures of substances which lose their effect by transmission and the influence of physical agents.

The sulphate of magnesia is interesting as prepared from magnesite or the natural carbonate of magnesia of the Peninsula.

Metallurgy.—Though it is difficult to understand how a primitive people could have overcome the difficulties of smelting iron and of forging steel, yet as we know from a variety of sources that the Hindoos have long known both, they must have overcome the difficulties which have stopped others. But it is hardly less wonderful to see a native with no other tools than his hatchet and his hands proceed to smelt iron, which he will convert into steel capable of competing with the best prepared in Europe. For this the prevalence of the black oxyd of iron, in the state of iron sand, and the common use of charcoal as a fuel, give him some facilities, while he prepares a furnace with clay, and makes bellows with the leaves of the forest. [Of this last, a specimen was shown from the hills of Mirzapore.]

Iron and steel, though not known in the earliest periods of the history of some of the civilized nations of antiquity, have yet been known from very early periods. Iron is mentioned as being applied to a variety of purposes in the earliest chapters of the Bible. But as it is too soft to be used for all the purposes stated, it has been justly inferred that they must have known of modes of hardening it, and reference is made to that kind which is called "northern iron." But as the term of "northern" is also applied to the roads of commerce and of conquest from the East, because these entered Judæa by the north, that is, by way of Damascus and Syria, so Mr. Aikin looks to the countries east of Babylonia as those where this hard iron and steel was produced; and this is confirmed by the passage in Ezekiel, where Dan and Javan are described as bringing "bright iron, cassia, and calamus," which are all Indian products, to Tyre.

The Hebrew name of steel, *paldah*, is evidently the same word as the Arabic *foulad*, which is also in use in Persia, where Indian steel is known by the name of *foulad-i-hind*. Even now the best Persian swords are made with steel imported from India, and Mr. Wilkinson has ascribed the markings on the famed Damascus blades to their having been made with Indian steel, which has long formed an article of trade from Bombay to the Persian Gulf.

Mr. Heath, at one time the managing director of the India Iron and Steel Company, and whose steel obtained a prize at the Exhibition, even says, "We can hardly doubt, that the tools with which the Egyptians covered their obelisks and temples of porphyry and syenite with hieroglyphics, were made of Indian steel." There is no doubt, that the ancient Indian temples and fortresses were carved with steel instruments, as they are at the present day. That they made steel which was highly valued in the time of Alexander the Great, is evident from Porus making him a present of about thirty pounds of steel; and still earlier, in the Rig Veda, we read of chariots armed with iron weapons, of coats-of-mail, arms and tools of different kinds, and of bright-edged hatchets.

Various descriptions of the manufacture of iron and steel have been given by observers in different parts of India; all of which bear a considerable resemblance to each other. Some of these Mr. Aiken carefully noticed when he lectured on this subject in this very place; but Mr. Heath has, I think, given the best explanation of the Indian processes.

Mr. Heath describes the ore used as the magnetic oxyd of iron, consisting of seventy-two per cent. of iron with twenty-eight of oxygen, combined with quartz, in the proportion of fifty-two of oxyd to forty-eight of quartz. It is prepared by stamping, and then separating the quartz by washing or winnowing. The furnace is built of clay alone, from three to five feet high, and pear-shaped; the bellows is formed of two goat-skins, with a bamboo nozzle, ending in a clay pipe. The fuel is charcoal, upon which the ore is laid, without flux; the bellows are applied for four hours, when the ore will be found to be reduced: it is taken out, and while yet red-hot, it is cut through with a hatchet, and sold to the blacksmiths, who forge it into bars and convert it into steel. In an old account which I possess, written on the spot, apparently in Mysore, it is said, that one pound and a half of iron is heated lower than red heat, and then beaten for about three minutes with a stone hammer on a stone anvil, experience having taught them, they say, that instruments of iron ruin the process. Mr. Heath says that the iron is forged by repeated hammering, until it forms an apparently unpromising bar of iron, from which an English manufacturer of steel would turn with contempt, but which the Hindoo converts into cast steel of the very best quality. To effect this he cuts it into small pieces, of which he puts a pound, more or less, into a crucible, with dried wood of the *Cassia auriculata*, and a few green leaves of *Asclepias gigantea*; or, where that is not to be had, of the *Convolvulus laurifolia*. The object of this is to furnish carbon to the iron.

As soon as the clay used to stop the mouths of the crucibles is dry, they are built up in the form of an arch in a small furnace, charcoal is heaped over them, and the blast kept up without intermission for about two hours and a half, when it is stopped, and the process considered complete. The furnace contains from twenty to twenty-four crucibles. The crucibles are next removed from the furnace and allowed to cool; they are then broken and the steel taken out. The crucibles are formed of a red loam, which is very refractory, mixed with a large quantity of charred husk of rice.

Mr. Heath, after remarking the astonishing fact that the Hindoos had discovered the way of making steel at such early periods, refers to Mr. Mushet's discovery of converting iron into cast steel by fusing it in a close vessel, in contact with any substance yielding carbonaceous matter, and then to that of Mr. Mackintosh, of converting iron into steel, by exposing it to the action of carburetted hydrogen gas in a close vessel at a very high temperature, by which means the process of conversion is completed in a few hours; while by the old method it was the work of from fourteen to twenty days. Mr. H. observes:—

"Now, it appears to me that the Indian process combines the principles of both the above described methods: on elevating the temperature of the crucible containing pure iron and dry wood and green leaves, an abundant evolution of carburetted hydrogen gas would take place from the vegetable matter, and as its escape would be prevented by the lúting at the mouth of the crucible, it would be retained in contact with the iron, which at a high temperature appears from Mr. Mackintosh's process to have a much greater affinity for gaseous than for concrete carbon: this would greatly shorten the operation, and probably at a much lower temperature than even the iron in contact with charcoal powder. In no other way can I account for the fact that iron is converted into cast steel by the natives of India in two hours and a half, with an application of heat that in this country would be considered quite inadequate to produce such an effect; while at Sheffield it requires at least four hours to melt blistered steel in wind furnaces of the best construction, although the crucibles in which the steel is melted are at a white heat when the metal is put into them, and in the Indian process the crucibles are put into the furnace quite cold."

By such simple methods the Hindoo prepared steel, which has long formed an article of commerce from the west of India to the Persian Gulf, and there is every probability of its being used in larger quantities if it were easily procurable in sufficient quantities, as manufacturers here have expressed a desire to employ it. In the arms which we have exhibited, as well as in the edges and points of the tools, we see its admirable fitness for the fabrication of all cutting instruments.

Among the arms we have a display of such as would appear to belong to different ages of the world, but which are actually in use in India at the present day; such as chain and scale armor, both for man and horse, helmets and shields, spears, battle-axes, bows and arrows, with daggers in every variety. Some of these display in a remarkable manner their skill as cutlers; as, for instance, the sword formed of two blades, and another in which pearls are let into the centre of its blade; and still more in the daggers contained one within another, all of hard steel, with the line of junction so beautifully welded as to be hardly perceptible even with a magnifier,—so also in the dagger, which on striking separates into five blades, as these are most nicely brought into juxtaposition. The twisting of gun-barrels and the damasks of their blades of steel have been imitated in all countries. These beautiful specimens have been sent chiefly by the native princes of the northwest of India from Putteala to Scinde, as well as from the central government of Hyderabad.

The other metal which it seems necessary to mention is tin, because connected with so many metallurgical compounds, and because by many it has been supposed that this country was the only source from which that metal was obtained in ancient times. But it exists in large quantities in the Malayan Peninsula, as well as in Banca, Borneo, and many other islands. Tin, we know, was employed by the Egyptians, because it forms an ingredient in some of their metallic compounds; but its use has long been familiar to the Hindoos for forming various metallurgical compounds, as well as for tinning copper. As it occurs as an oxyd, and near the surface of the soil in large quantities, and requires only charcoal for reducing it, we may suppose it would easily have been discovered by a people who forged iron and made steel. As the nations of antiquity employed tin for hardening copper, and used the alloy for forming swords and spear-heads, so the natives of India form various compounds with copper and tin, which are remarkable for their hardness, and for the fine sounds which they emit on being struck. Dr. Wight lately found that an alloy of ten grains of copper to two and a half grains of tin was the best mixture which a native made in his presence. British spear-heads are found to consist of one of tin to ten of copper, and a knife, of one of tin to seven and a half of copper. Mr. Aikin, in his experiments, found that eight grains of copper to one of tin formed the hardest alloy.

Alloys.—The natives of India are acquainted with a variety of alloys for making utensils and even ornaments, as with copper and zinc, tin and lead, besides being great workers in copper and brass for the various utensils employed for domestic purposes, and of which so large a variety was sent from different parts of India.

Bidery.—A metallurgical compound of considerable interest is that which has been named Bidery, from Bider, a city situated about sixty miles to the north-west of Hyderabad, and of which we have had a variety of articles at the Exhibition. Most of these have been greatly admired for the elegance of their form, as well as for the gracefulness of the patterns with which their surface is engraved. Though the groundwork of this composition appears of a blackish color, its natural color is that of pewter or of zinc. Dr. Heyne informs us that it is composed of copper sixteen ounces, lead four ounces, tin two ounces. These are melted together, and to every three ounces of the alloy sixteen ounces of spelter, that is of zinc, is added, when the alloy is melted for use. But to give the whole the black color which is esteemed, probably from bringing out the pattern, it is dipped into a solution of sal-ammoniac, saltpetre, common salt, and blue vitriol.

Dr. B. Hamilton saw of zinc 12,360 grains, copper 460 grains, and lead 414 grains, melted together, and a mixture of resin and bees-wax introduced into the crucible to prevent calcination. It was then poured into a mould made of baked clay, and the article handed over to be turned in a lathe. Artists then inlay flowers or other ornaments of silver or of gold. They first rub it over with sulphate of copper and water, which gives the surface a blackish color, and enables the artist more easily to distinguish the figure which he draws,—this he does with a sharp-pointed instrument of steel, and cuts it with small chisels of various shapes, and then with a hammer and punch fills the cavities with small plates of silver, which adhere firmly to the Bidery. It is then polished and stained as described above. The various articles made from it are vases, wash-hand basins and ewers, hookah-bottoms, spittoons, cups and dishes, small boxes and weights. These are inlaid commonly with silver, but sometimes with gold. The patterns are usually as much to be admired as the forms of the vessels. Though usually called Bidery, sometimes Vidry, it is also manufactured at others places. Specimens have been sent both from Bider and Aurungabad, in the Nizam's territories, from his Highness the Nizam and his minister, Siraj-ool-Moolk, which are peculiarly beautiful. Some also from north-west India, and from Bengal; the latter, however, was inferior to the others in workmanship. Bidery does not rust, yields little to the hammer, and breaks only when violently beaten. According to Dr. Hamilton it is not near so fusible as zinc or tin, but melts more easily than copper.

Glass.—Glass is one of those discoveries which could hardly escape being made by any people who employed furnaces to reduce metallic oxyds; for the necessary ingredients must often have been present, and the heat was sufficient. Beckmann has observed, that the discovery of colored glass must have followed very soon that of making glass itself. It is probable, however, that colored glass was made previous to colorless glass. For it is difficult to find materials pure enough to make good glass, and it would be some time before the original makers would find out the causes of discoloration.

The natives of India seem to have been long acquainted with making different ornaments of glass: for instance, armlets and anklets, while rings of glass form a part of their warping reels. Small glass bottles are also made; but all that I have seen are of a more or less greenish color. The green is called *kanch*, and the purer glass, *sisi*. It is probable that the extensive diffusion of oxyd of iron in the Indian soil, which may have led to the discovery of iron, has prevented the making both of good glass and of good pottery. That this is not incompatible with a knowledge of the method of making imitation gems, seems proved by the same having been the case in the time of Pliny; who states that great value was set upon glass quite free from color, which was called crystal. He also mentions artificial hyacinths, sapphires, and all kinds of black glass; and we know that the glass-houses of Alexandria were celebrated among the ancients.

One of the simplest processes for making glass is that practised in the district of Behar. The saline efflorescence of the soil, which is an impure carbonate of soda, is collected and thrown into a cistern lined with clay. This is then filled with water, which is afterwards allowed to evaporate. When dry, the bottom of the cistern is found covered with a thick saline crust, the earth which was intermixed having subsided before the salt began to crystallize. This soda makes glass without any addition, as it still contains a sufficient portion of siliceous matter. They make blackish and greenish glass: a bright grass-green is made by additions of oxyd of copper; and a blue glass by the addition of *rung*. In Mysore the process is more elaborate. Powdered white quartz, one part, being mixed with prepared soda, six parts, is filled into a crucible capable of containing five and a half Winchester gallons. About fifty of these crucibles are placed in a furnace, and the fire kept up for five days, when a frit is produced, with which they make a black, green, red, blue, and yellow glass, by means of additions of oxyd of copper, of an ore called *kemudu*, and of a blue substance called *runga*. What these are I have not been able to discover. Though the making of glass has made but little advance in India, the natives work up broken English glass even into barometer and thermometer tubes, &c. Glass globes, silvered in the inside, were sent from Delhi, but unfortunately got broken in the transmission. The mode of effecting this silvering is not mentioned, but an amalgam of quicksilver is probably employed, as, on the application of moderate heat, the silvering becomes dissipated. An art similar to this has of late years been discovered in this country.

Enamelling.—Enamelling, or the art of fixing colors by melting in fire, is of very ancient date: it was practised by the Egyptians, and carried to a high degree of perfection in Persia. The art is known in every part of India, and some exquisite specimens were sent to the Exhibition, both from Central and Northwestern India. It is chiefly employed in ornamenting arms and jewellery, not only in gold, but also in silver.

Enamels being vitrifiable substances, to which peculiar colors are given, we may compare the Indian with the European methods of making enamel. In general, ten parts of lead and three parts of tin are oxydized by continued heat and exposure to air. To the mixed oxyds add ten parts of powdered quartz, and ten parts of common salt, and melt in crucibles. Thus is obtained a white enamel, and the basis of colored enamel, metallic oxyds being added. The oxyd of lead or of antimony produces a yellow enamel: reds are obtained by a mixture of the oxyds of gold and iron. The oxyds of copper, cobalt, and iron, give greens, violets, and blues; and a variety of intermediate colors by mixtures. The workmen of Behar are stated to make two enamels, which are applied to the surface of some of the rings. One is yellow: five parts of lead are melted in a shallow crucible, and to these is added one part of tin; and the alloy is calcined for four or five hours. It is then heated to redness in the crucible of the glass-furnace. One part of white quartz is next added, and the mass stirred about for three hours. It is then taken out with a ladle, poured out on a smooth stone or iron, and cooled in water. They then take one part of their palest green glass, and add a fourth part of the other materials, to make the yellow enamel.

The green enamel is made in the same manner; and to the melted glass is added, not only the prepared lead and tin, but a small portion of the black oxyd of copper.

In Mysore they make a bright yellow enamel, by first calcining five parts of lead and one of tin, then adding one part of zinc, calcined in a separate crucible. When these begin to adhere they are powdered in a mortar. When the maker of glass rings is at work, he melts some of this powder, and while the ring is hot, with an iron rod applies some of it (the powder) to the surface of the glass.

Pottery, Encaustic Tiles, Cement.—The art of fashioning clay into vessels of a variety of shapes, and hardening it by the action of heat, is one of the most ancient of the arts. Fragments of pottery are everywhere found among the ancient cities of India, as in those of other parts of the world; pottery, as Brongniart has remarked, affording the best record of the early ages of man, as bones do of the earth.

So little is known of Indian pottery, that it is usually described as being hemispherical in shape. Some of it is no doubt so, for the convenience of being carried on the head; but it is a fact, that in the recent exhibition of Indian pottery, numbers of the best judges have greatly admired its elegant, even classical gracefulness of form. It is also stated to be black, and red, or yellowish. The clays which are generally employed in the more populous parts of the country, Dr. O'Shaughnessy has observed, "contain so much oxyd of iron and carbonate of lime that the vessels melt into a slag at a temperature little above that of redness." "Deposits of a black stiff clay, containing much vegetable matter, occur in some districts; vessels made with it sustain a higher temperature." Clays capable of bearing great degrees of heat have, however, been discovered in different parts of India. As one great object is to have porous vessels for cooling water, the ordinary clays answer sufficiently well for this purpose; and some of the forms, as that of the tortoise-shaped, expose a large surface to the air. The Hindoos, moreover, never use a vessel a second time, so no great expense will be incurred by them; thus encouragement is wanting to improve the nature of their pottery. But very successful experiments have been made to make improved pottery in India, as by Mr. Julius Jeffreys, the ingenious inventor of the respirator, who succeeded in making stone-ware soda-water bottles, crucibles, fire-bricks, tiles, &c., which seem to have been glazed by the silica uniting with the alkaline ashes of the furnace. Dr. O'Shaughnessy greatly improved the pottery in use in the dispensary of Calcutta, and which he glazed with the borate of lime. The glazed pottery of Pegu, of which two very large jars were sent, has long been known for its glaze not being affected by acids. Dr. Hunter has sent some excellent specimens of pottery from the School of Arts at Madras, and for which a prize has been awarded.

The ancient potter's wheel is the instrument with which the Hindoo works; and while it revolves, with the aid of his naked hands he fashions vessels of elegant forms, many of which have been admired as being of classical shapes, and some would appear almost as if they were of Etruscan origin: but there is no reason to believe that the Hindoos have ever had anything but their own unerring taste to guide them. This beauty of form is equally conspicuous in the pottery of Sewan near Patna, as in that of Azimgurh or of Ahmedabad, of Mirzapore, or of Moradabad.

Some of it is remarkable, also, for its extreme thinness and lightness, showing the great skill of the artist, and making it difficult to understand how it kept its shape when in a plastic state, as I cannot learn that the turning lathe is used to give a finish to any of the articles. The painted pottery of Kotah, and the gilt pottery of Amroha, have also been admired. The handles and the various ornaments of the Ahmedabad pottery are no doubt attached, as in Europe, by means of slip. From the specimens of basket-work pottery sent, there is no doubt that, with better materials and a little instruction, the natives could excel in this as in the forms of their pottery.

If we had no other information, we might yet infer from the crucibles employed by the goldsmith, by the workers in brass, and by the makers of cast steel, that some very infusible clays are to be found in India; but recent investigations have proved that crucibles and fire-bricks, superior in infusibility to those made of Stourbridge clay, have been made in India; and from the white goblets of Arcot, and the light-colored pottery of Madras, as well as from the white bricks sent from the Ceded Districts, we see that there are many useful clays without the usual admixture of iron.

As connected with pottery might be mentioned the variously colored *Encaustic* tiles, which have been used for the domes of some of the tombs near Delhi and Agra, as well as in Southern India; but I cannot learn that the art is at present practised. It was probably introduced by the Mahomedans from Persia. Specimens from some of these tombs were shown by Mr. Boileau.

I might have proceeded to notice their knowledge of *Cements*, but I may in preference notice a kindred art, which seems capable of adoption elsewhere when suitable; that is, the skill with which they give a facing of marble to a wall of brick. This they usually do by employing mortar made of shell-lime; but I found some made from pure limestone equally good. A thin layer of this fine white cement being spread, is brought to the lustre of marble by a process similar to burnishing.

Bleaching.—Bleaching is practised in all parts of India, and some places, which are also seats of the cotton manufacture, are famous for bleaching, such as Dacca and Baroche. This has been ascribed to the excellency of the water in the neighborhood of these places. A very good account has been given by Mr. Taylor,* late of Dacca, of the process of bleaching at that place. This is particularly interesting, as including what are called modern discoveries.

Fine muslins are merely steeped in water; other cloths are first washed: but all, of whatever texture they may be, are next immersed for some hours in an alkaline ley composed of soap and of sajie muttee, that is, impure carbonate of soda. They are then spread over the grass, and occasionally sprinkled with water, and when half dried are removed to the boiling-house in order to be steamed. This is effected by twisting the cloths into the

* "An Account of the Cotton Manufacture in Dacca," &c. Published by Mortimer.

form of loose bundles and placing them upon a broad clay platform, which is on a level with, and surrounds, the neck of a boiler sunk into the ground. They are then arranged in circular layers, one above the other, around a bamboo tube, which is kept upright by means of transverse supporters projecting from it, the whole forming a conical pile that rises to a height of five or six feet above the boiler.

The fire is kindled in the excavation below, and as the ebullition of the water proceeds, the steam diffuses itself through the mass of the cloths above, swelling by its high temperature the threads of the latter. The operation of steaming is commenced in the evening, and continued all night till the following morning. The cloths are then removed from the boiler, steeped in alkaline ley, and spread on the grass as on the preceding day, and again steamed at night. These alternate processes of *bucking* and *crofting*, as they are technically called, during the day, and of steaming at night, are repeated for ten or twelve days, until the cloths are perfectly bleached. After the last steaming, they are steeped in clear filtered water acidulated with lime-juice, in the proportion, generally, of one large lime to each piece of cloth. Lime-juice has long been used in bleaching in all parts of India, and Tavernier describes Baroche as famous as a bleaching station, on account of its extensive meadows and the large quantity of lemons reared there.

Mixed fabrics of cotton and Muga silk are steeped in water mixed with lime-juice and coarse sugar, which later article is said to have the effect of brightening the natural color of the silk.

Dyeing, Calico-printing, and Printing in Gold.—The art of dyeing is no doubt of very ancient date, and one with which the Hindoos have long been well acquainted. Their country produced all the raw materials for making a great variety of colors; some of these are of so conspicuous a nature, such as the large flowers of plants, that the desire must early have occurred to transfer these colors to the person in savage nations, or to the clothes of so early civilized a people as the Hindoos. This could easily have been done with the fugitive colors, but as they know how to make a color like that of indigo, which undergoes a considerable degree of chemical change during its formation as well as while applied to the dyeing of its blue color, it is evident, even if we had no other information on the subject, that they must have paid attention to some chemical subjects. But we know that they have long possessed, and knew how to manufacture, the several salts which have long been employed as mordants.

That the art of dyeing was early practised we have proof in the fact mentioned by Pliny, that flags of various colors were displayed by the Indians. It has been supposed that the Hindoos may have learned this art from the Egyptians, but the probability is as great that the latter learned the art from the former, from whom also they probably obtained the alum which was celebrated by the name of Egyptian alum. Alum is still manufactured in Cutch; the natives of India have long known the use of sulphate of iron and acetate of iron. The latter they prepare by macerating iron in sour palm-wine, or in water in which rice had been boiled. The alkalies and acids with which they are acquainted may have assisted them in changing the shades of colors. It would take too much time to enter into the details of these dyeing processes, many of which are, however, now well known, and seem to have been the original of many of those followed in Europe until very recent times. The Exhibition has shown that they can dye every color, and of a great variety of shades, and that, in a complicated pattern, they know the value and power of each in contrasting the effect of others, so as to produce an harmonious whole.

The art of *Calico-printing* is another of those which was common to the Egyptians and Indians, and is still largely practised by the latter, and with a skill which produced much to be admired even in the midst of the productions of the world, and after so many attempts have been made to improve an art certainly imported from the East. Pliny was acquainted with the wonderful art by which cloths, though immersed in a heated dyeing liquor of one uniform color, came out tinged with different colors, and which afterwards could not be discharged by washing. The Indians were found practising the art when first visited by the Europeans. The mordants they apply both by pencils and by engraved blocks, though it has been said that the former method was the only one employed. Blocks were sent from Cossipore, and are used in Mysore and in Central India; some specimens of silk handkerchief were exhibited by Mr. Warrington, to show the different stages of dyeing as practised in India. In one, the parts where the round spots were to be, were tied up with thread so as not to be affected by the dye-liquor.

The cloth-printers at Dacca are employed to stamp the figures on cloth which is to be embroidered. The stamps are formed of small blocks of khutul (*artocarpus*) wood, with the figures carved in relief. The coloring matter is a red earth imported from Bombay, probably the so-called "Indian earth" from the Persian Gulf.

Though the art is now practised to such perfection in this country, the Indian patterns still retain their own particular beauties, and command a crowd of admirers. This no doubt is due in a great measure to the knowledge which they have of the effects of colors, and the proportion which they preserve between the ground and the pattern, by which a good effect is procured both at a distance and on a near inspection.

Printing in gold and in silver is a branch of the art which has been carried to great perfection in India, judging by the several specimens sent from very different parts of India, as well upon thick calico as upon fine muslin. The size which is used I have not found mentioned, but in the Burmese territory the juice of a plant is used, which, no doubt, contains caoutchouc in a state of solution.

Leather is another chemical art with which the Hindoos have long been acquainted, though it is doubtful whether they ever made leather of very superior quality; but the art is practised in native states where it is not likely to have been introduced by European influence, as, for instance, in Cashmere and Cutch, whence we have had skins dyed of different colors. But leather of very excellent quality has been sent from the government farm at Hoonsoor in Mysore, likewise from Calcutta by the Messrs. Teil. The native shields are, however, not to be surpassed.

Soap seems to have been introduced by the Mahomedans, though the Hindoos have long used alkaline leys, obtained from the ashes of plants, for many of the purposes of soap; and they have a substitute for soap in several berries. Soap is made at Dacca, of shell lime, 10 mds.; sajie muttee, 16 mds.; common salt, 15 mds.; sesamum oil, 12 mds.; goats' suet, 15 seers. It is made of good quality at Saharunpore; and some marine soap, of excellent quality, though in small quantity, was sent from Calicut.

Candles may be appropriately mentioned here, though the mode of making them is probably not Indian, but taught by Europeans. The natives use oil lamps, of various shapes, often of metal fixed on an iron spike, which they stick into the ground. But excellent candles are now made in India; as, for instance, the wax candles from Patna, and the stearic candles of the Messrs. Sainte from Calcutta.

Lacquer Ware.—The word *lacquer* is evidently derived from the Indian name *lac* or *look*, which is the resin secreted together with lac-dye by the lac insect, a species of *coccus*. The name occurs in Avicenna, who mentions it, as described by some, as the gum of a tree like the myrtle, and by others as a substance like to, and having some of the properties of amber. It is mentioned in many Indian works, and is apparently alluded to by Ctesias. This substance is used for a variety of purposes in India, and it is the common material for uniting things together, as gum and glue are in Europe. (Toys of various kinds, lac chains gilt, and lac grindstones, were shown.)

The term *lacquer* is applied to laying on or covering with a preparation of lac; but two different processes are usually confounded under this term. The one prevailing in Burma and the southern parts of the Indian Peninsula was well known to Dampier, in 1638, as he says, "The lac of Tonquin is a sort of gummy juice which drains out of the bodies or limbs of trees," and that "the articles lackered are cabinets, desks, &c." Some chemical change, no doubt, takes place on exposure of these juices to the air.

This kind of lacquered ware was much appreciated in the last century, and was imported chiefly from China; much, however, was always prepared in Burma, though that of Japan was always considered superior to any other, and of which many fine specimens may still be seen in large folding screens, &c. Both these and the lacquer of Burma are prepared only from the juice of a family of plants, (the *Terebinthaceæ*,) the same as that to which the marking nut and sumach belong.

The chief expense of the manufacture arises from the care with which successive layers of varnish must be laid on. Various specimens of boxes have been sent from Moulmein and from Singapore, some showing different stages of the process.

Another kind of lacquer-work is rather of the nature of papier-mâché, covered with one or more layers of lac varnish. This is the case with the lacquered boxes from Cashmere and Lahore, so remarkable for the beauty and elegance of their patterns.

Sealing-Wax is also made from lac, and several varieties have been sent from different parts of India. Garcias ab Orto described it as made from lac in the year 1563. Tavernier mentions the same fact. The Spaniards have obtained credit for the invention; but they, no doubt, learned it from the Arabs. A Frenchman who travelled much in Persia and different parts of the East Indies is also thought to have been the discoverer; and by Beckmann it is considered to be a German invention. This is hardly a chemical art, but it is probably better placed here than elsewhere.

Paper.—The art of making paper is considered to be a Chinese invention, but it has long been known in India, where paper is made both of cotton and of the substitutes for hemp and flax. In the Himalayas it is made of the inner bark of *Daphne cannabina*, and in sheets of immense size. A large collection was exhibited from different parts of India, but, though well adapted for writing on in India, it is not suited for Europe, in consequence of the difference in the ink used.

(*To be continued.*)

ART. XX.—*Abstract of a Paper on the Humite of Monte Somma;* by ARCANGELO SCACCHI,* of Naples, with observations, by JAMES D. DANA.

M. SCACCHI in his elaborate paper points out the fact that there are three types of crystals of Humite. These several forms he illustrates by excellent figures both of simple and compound crystals, and with full crystallographic descriptions mathematically deduced.

The crystals of the different types agree in general similarity of form, even to the relative positions of the series of planes, as shown in the following figures I, II, III, yet they differ in these series, and in the inclinations of homologous faces. This difference corresponds to a difference in the lengths of the vertical axis, the ratio of the two lateral axes being nearly identical. The form is trimetric and the ratios of the axes as deduced by M. Scacchi, (n^2 in I and II, and n^4 in III, being taken as a face of the fundamental form) are as follows:—

	a :	*b* :	*c*		*a* :	*b* :	*c*
I.	1 :	0·245315 :	0·227101	[which equals	4·0764 :	1 :	0·92575]
II.	1 :	0·343769 :	0·318435	[" "	2·9090 :	1 :	0·92631]
III.	1 :	0·190730 :	0·176465	[" "	5·2430 :	1 :	0·92520]

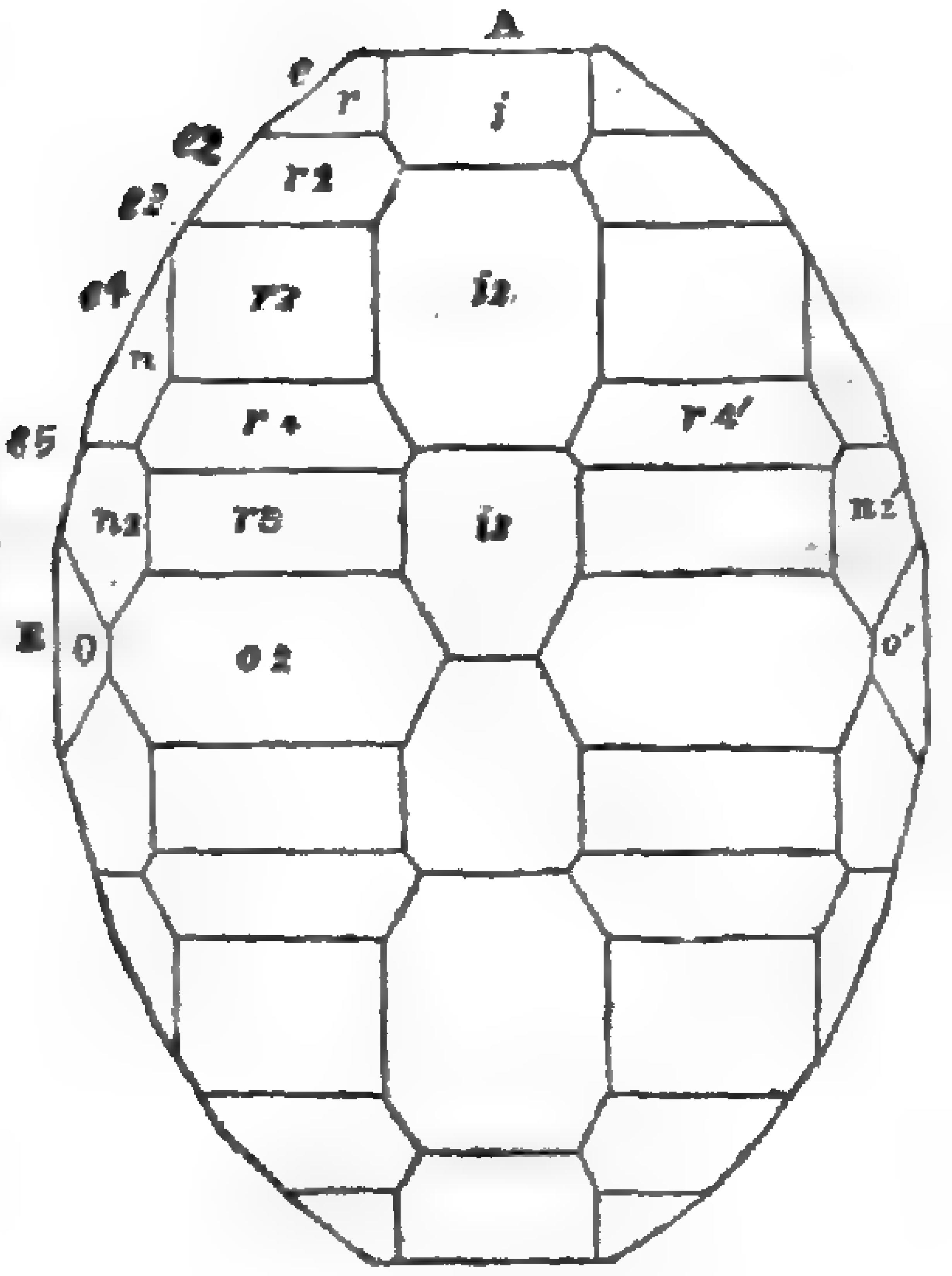
In the latter expression of the ratios, which we have here added, the similarity in the several ratios, *b* : *c*, is apparent; the mean of the three is, 1 : 0·92575. The ratio between the vertical axis for the three types, as M. Scacchi states, is 7 : 5 : 9, that is, $\frac{1}{0·245315} : \frac{1}{0·343769} : \frac{1}{0·190730} = 4·0764 : 2·9090 : 5·2430 = 7 : 5 : 9.$

This ratio according to M. Scacchi, represents the true relation of the types, and the three forms are therefore spoken of as probable examples of a kind of dimorphism, or pleomorphism: for where the same chemical compound crystallizes in forms so widely different in normal dimensions, they are properly regarded as distinct forms, though all three may belong to the same crystallographic system.

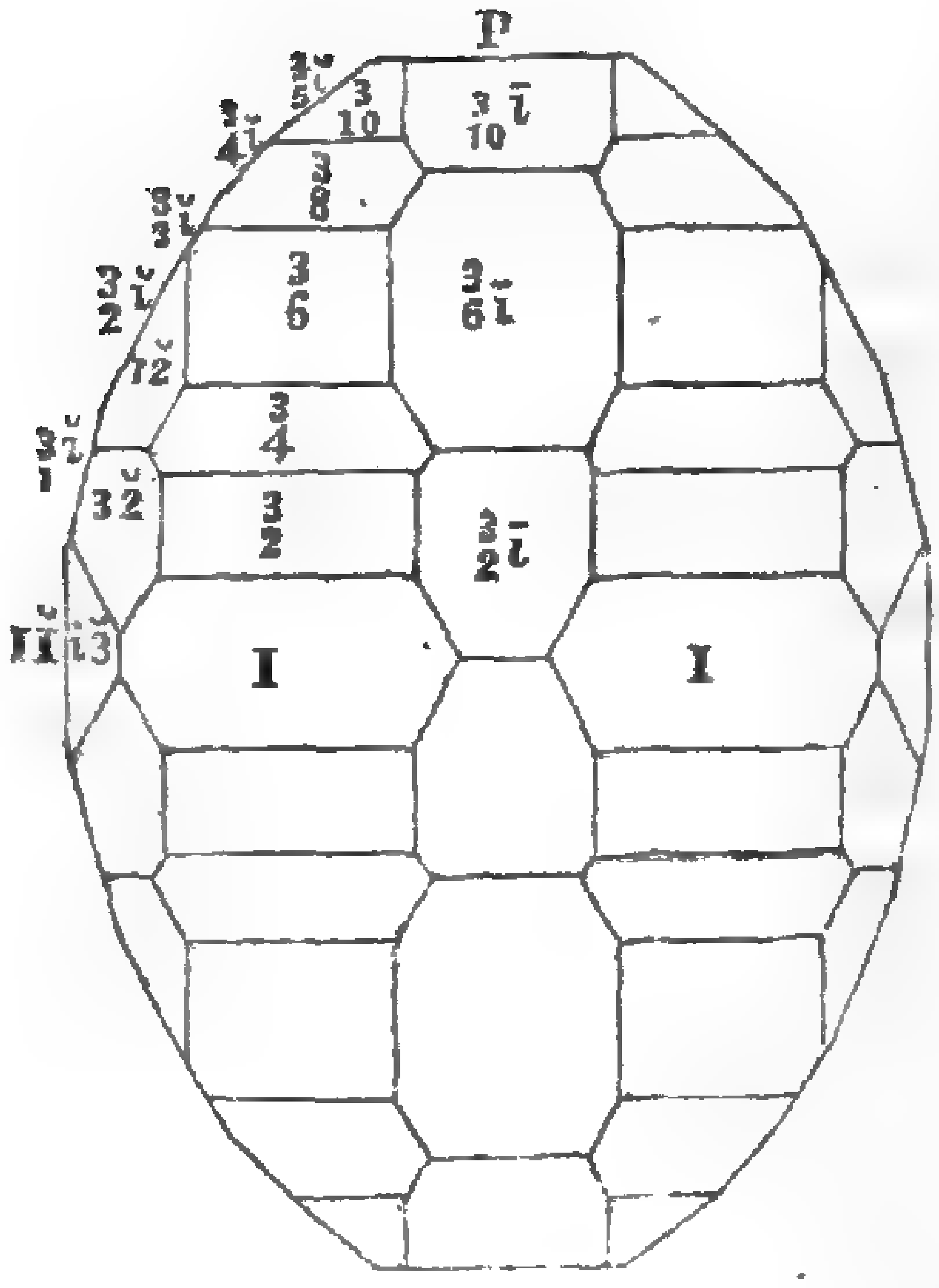
The mathematical relations of the planes as developed by M. Scacchi are of unusual interest. There is a regular succession in the exponents of the planes like parts of a geometrical series, which are different for the different types. On this account we are led to cite the symbols for the planes at length. These symbols are given by the author, both in accordance with the view of three types, and based on the axes above mentioned; and also on the ground that all belong to one type instead of three.

* Poggendorff's Annalen, 1851, Ergänzung, iii, 161.

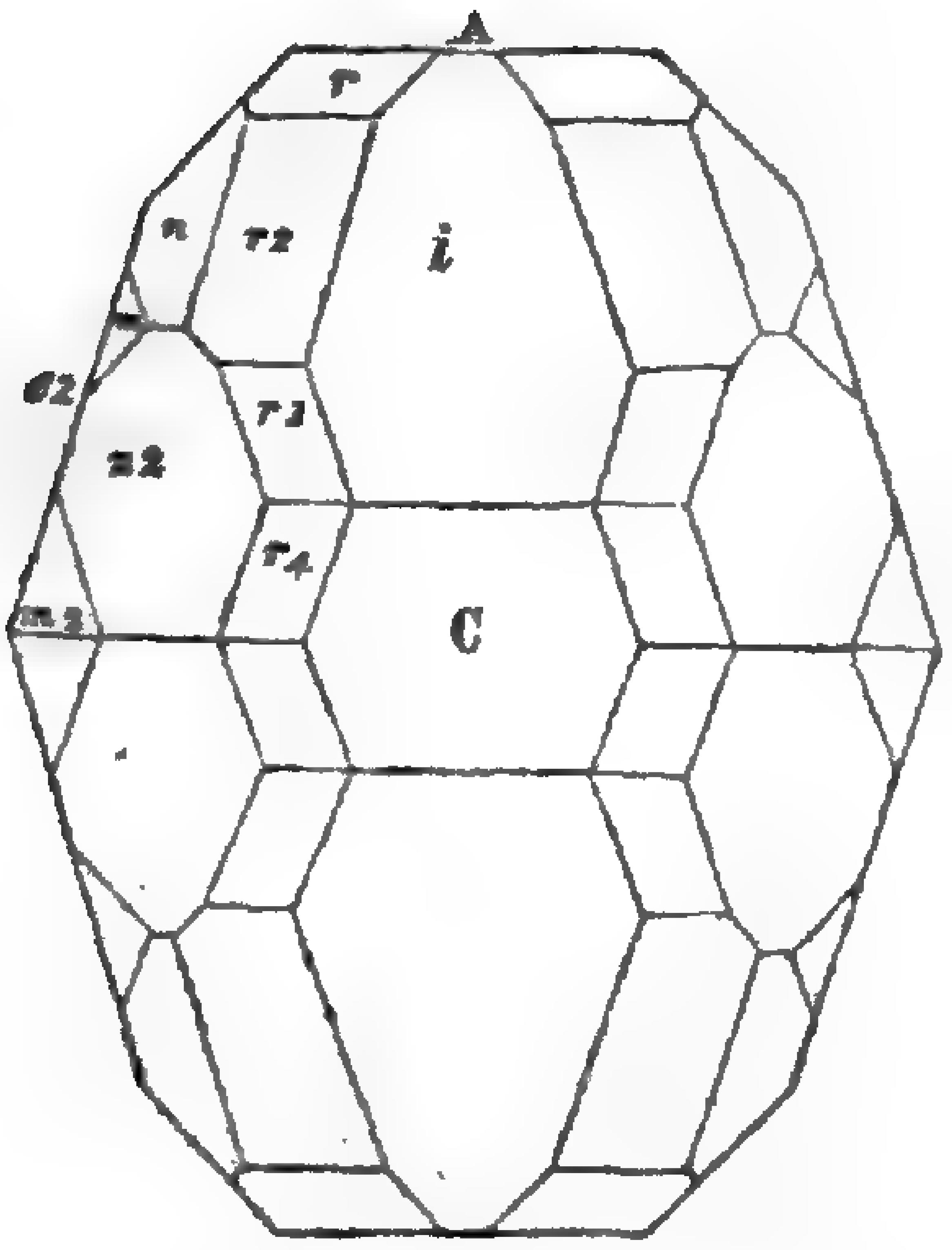
I.



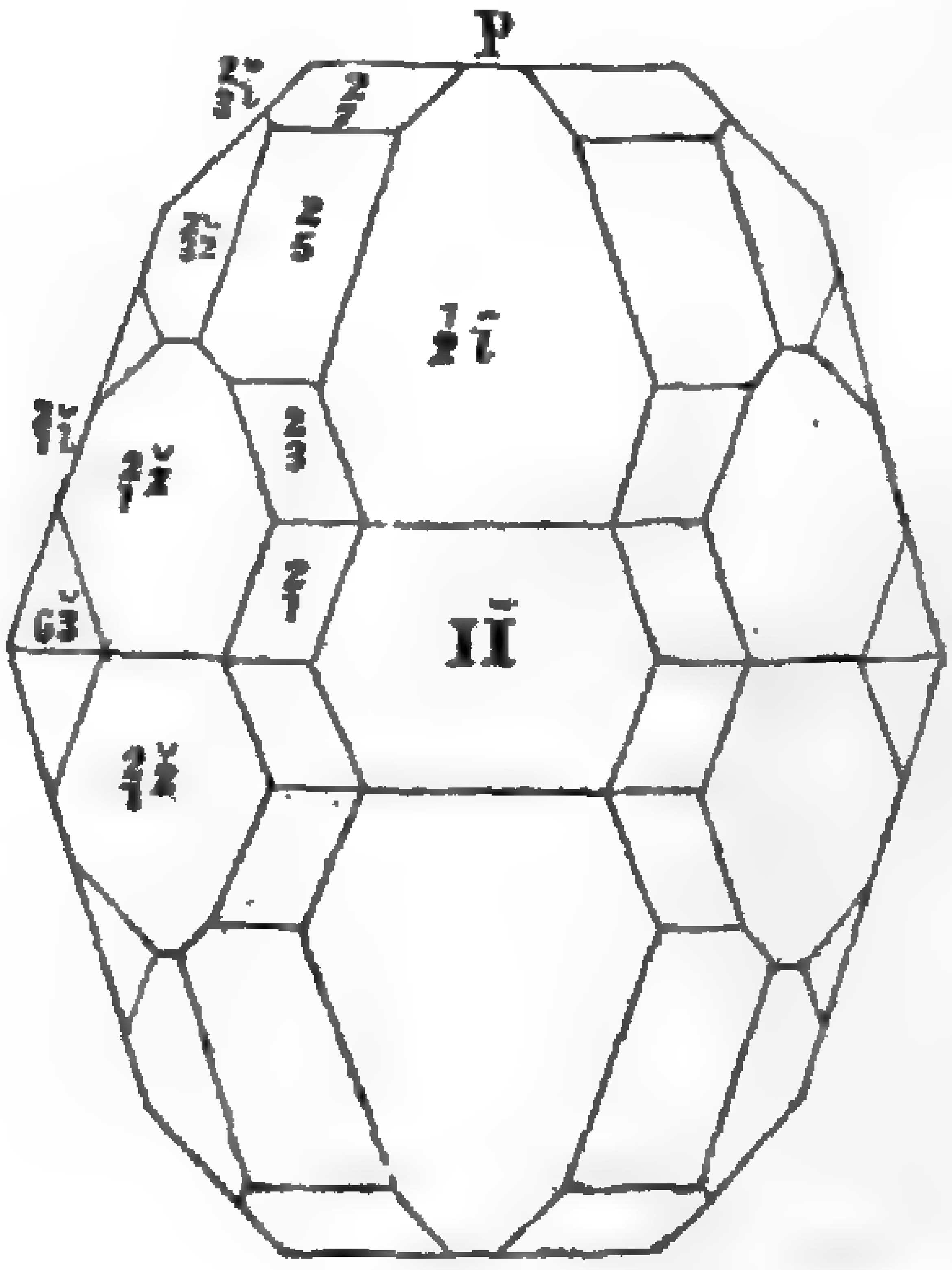
A.



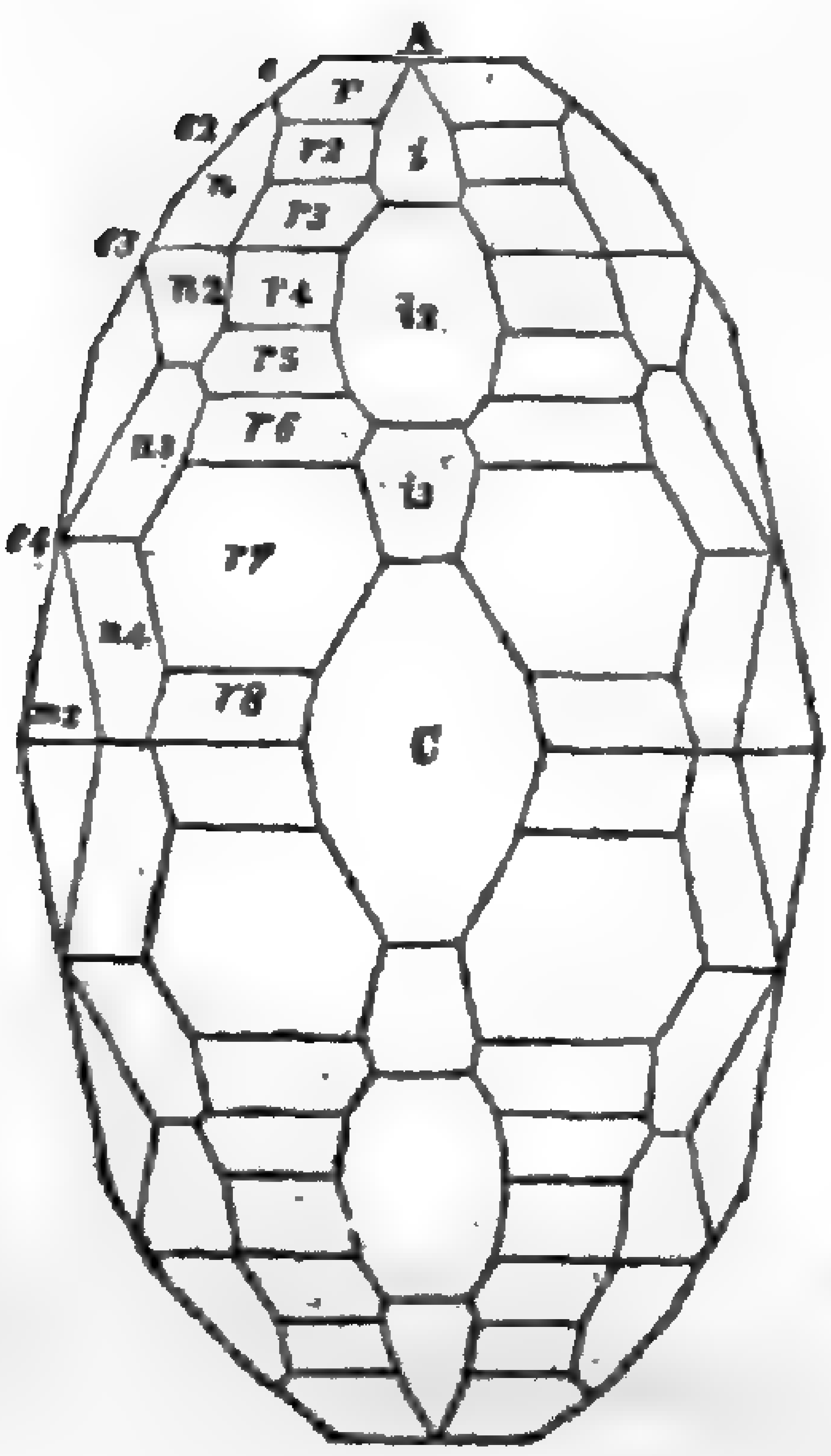
II.



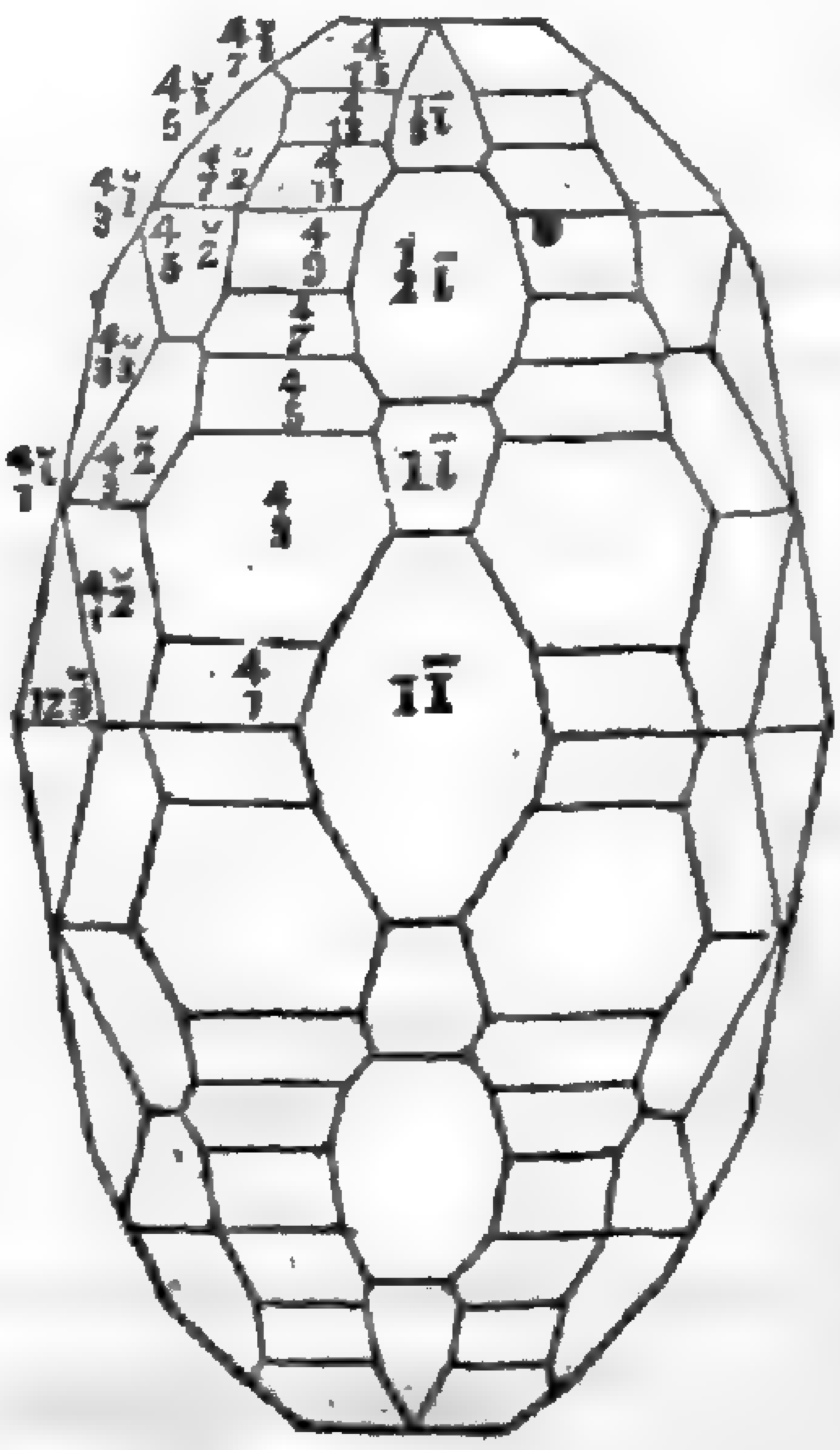
B.



III.



C.



The axes deduced for the common type are

$$a : b : c = 1 : 1{\cdot}7172 : 1{\cdot}5897.$$

The following are the symbols for type I (fig. I), based upon these axes:

e	$= 1 : \frac{5}{7} : \infty$	n	$= 1 : \frac{3}{7} : \frac{3}{7}$	r	$= 1 : \frac{10}{7} : \frac{5}{7}$	i	$= 1 : \infty : \frac{5}{7}$
e^2	$1 : \frac{4}{7} : \infty$	n^2	$1 : \frac{1}{7} : \frac{1}{7}$	r^2	$1 : \frac{8}{7} : \frac{4}{7}$	i^2	$1 : \infty : \frac{3}{7}$
e^3	$1 : \frac{3}{7} : \infty$			r^3	$1 : \frac{6}{7} : \frac{3}{7}$	i^3	$1 : \infty : \frac{1}{7}$
e^4	$1 : \frac{2}{7} : \infty$			r^4	$1 : \frac{4}{7} : \frac{2}{7}$		
e^5	$1 : \frac{1}{7} : \infty$			r^5	$1 : \frac{2}{7} : \frac{1}{7}$		

The symbols for the three figures, based on the hypothesis of three types and the axes given above, are as follows. The numbers in the ratios are the coefficients of the axes $a : b : c$ for each form.

	I.	II.	III.
e	$1 : 5 : \infty$	$1 : 3 : \infty$	$1 : 7 : \infty$
e^2	$1 : 4 : \infty$	$1 : 1 : \infty$	$1 : 5 : \infty$
e^3	$1 : 3 : \infty$		$1 : 3 : \infty$
e^4	$1 : 2 : \infty$		$1 : 1 : \infty$
e^5	$1 : 1 : \infty$		
n	$1 : 3 : 3$	$1 : 3 : 3$	$1 : 7 : 7$
n^2	$1 : 1 : 1$	$1 : 1 : 1$	$1 : 5 : 5$
n^3			$1 : 3 : 3$
n^4			$1 : 1 : 1$
r	$1 : 10 : 5$	$1 : 7 : \frac{7}{2}$	$1 : 15 : \frac{15}{2}$
r^2	$1 : 8 : 4$	$1 : 5 : \frac{5}{2}$	$1 : 13 : \frac{13}{2}$
r^3	$1 : 6 : 3$	$1 : 3 : \frac{3}{2}$	$1 : 11 : \frac{11}{2}$
r^4	$1 : 4 : 2$	$1 : 1 : \frac{1}{2}$	$1 : 9 : \frac{9}{2}$
r^5	$1 : 2 : 1$		$1 : 7 : \frac{7}{2}$
r^6			$1 : 5 : \frac{5}{2}$
r^7			$1 : 3 : \frac{3}{2}$
r^8			$1 : 1 : \frac{1}{2}$
m		$1 : \frac{5}{3} : \frac{5}{2}$	$1 : 3 : \frac{9}{2}$
m^2		$1 : \frac{1}{3} : \frac{1}{2}$	$1 : \frac{1}{3} : \frac{1}{2}$
i	$1 : \infty : 5$	$1 : \infty : 2$	$1 : \infty : 6$
i^2	$1 : \infty : 3$		$1 : \infty : 4$
i^3	$1 : \infty : 1$		$1 : \infty : 2$

The relation of the general and special symbols for fig. I, will be at once seen on comparison: they differ only in that the former have for the value of b and c, the quantities in the latter divided by 7. In the same manner, the divisor for figure II will be 5, and for figure III, 9. By keeping this in view, the general symbols are easily deduced and need not be here repeated: (e. g., for r in fig. III, the special symbol is $1 : 15 : \frac{15}{2}$, and hence the general symbol will be $1 : \frac{15}{9} : \frac{15}{18}$; for m^2 the special symbol is $1 : \frac{1}{3} : \frac{1}{2}$, and therefore the general symbol is $1 : \frac{1}{27} : \frac{1}{18}$).

The following are some of the angles obtained by M. Scacchi, calculating from the dimensions of the common type.

Type I, (fig. I.)—A on i 138° 38′, on i^2 124° 16′, on i^3 102° 48′.
A on r 135° 52′, on r^2 129° 30′, on r^3 121° 44′, on r^4 112° 24′, on r^5 101° 39′.
A on n 116° 34′, on n^2 99° 28′.
A on e 140° 49′, on e^2 134° 28′, on e^3 126° 21′, on e^4 116° 08′, on e^5 103° 47′.
B on o 144° 14′, on o^2 114° 50′.

Type II, (fig. II.)—A on i 122° 27′.
A on r 135° 17′, on r^2 125° 48′, on r^3 113° 24′, on r^4 98° 13′.
A on n 125°, on n^2 103° 8′.
A on m 114° 55′, on m^2 95° 19′.
A on e 135° 51′, on e^2 108° 58′.

Type III, (fig. III.)—A on i 136° 40′, on i^2 125° 14½′, on i^3 109° 27′.
A on r 140° 15′, on r^2 136° 11′, on r^3 131° 24′, on r^4 125° 48′, on r^5 119° 17′, on r^6 111° 50′, on r^7 103° 31′, on r^8 94° 35′.
A on n 132° 13′, on n^2 122° 57′, on n^3 111° 15′, on n^4 97° 23′.
A on m 114° 55′, on m^2 92° 57′.
A on e 143° 10′, on e^2 133° 39′, on e^3 119° 47′, on e^4 100° 48′.

Passing by, for the present, other details in the admirable paper of M. Scacchi, we proceed to a few remarks on another mode of viewing these crystals and to some deductions therefrom.

The difficulty in referring the three dissimilar types to a common fundamental form or to forms approximately identical, arises from the fact that the three crystals have no planes in common that can be referred to such a form. The planes of the series r, referred to a common type for all the crystals, are all different in symbol on one crystal, from what they are on either of the others; and so with the other series. For example, in the series e, for figure I, the planes are $1 : \frac{5}{7}$, $1 : \frac{4}{7}$, $1 : \frac{3}{7}$, $1 : \frac{2}{7}$, $1 : \frac{1}{7}$; for figure II, $1 : \frac{3}{5}$, $1 : \frac{1}{5}$; for figure III, $1 : \frac{7}{9}$, $1 : \frac{5}{9}$, $1 : \frac{3}{9}$, $1 : \frac{1}{9}$. The planes here are not identical in any one instance, neither have they a simple relation. And again we observe that planes which have nearly the same inclination towards A, are still different planes.

But the approximation of the three forms under a common type is still possible, and in such a way that we believe it to be the only true method of viewing the relations of the crystals. We observe that the inclinations of A on i^2 in figures I and III, and on i in figure II, differ but little from one another. In figure I this angle is 124° 16′; in figure II, 122° 27′; in figure III, 125° 14½′. The whole range of difference is only 2° 46′.* Taking these planes as homologous, the difference in the dimensions of the three types is small, not exceeding what in other species is known to be produced by small variations in composition dependent on isomorphous substitutions. Moreover, the symbols of the planes, on this plan, have greater simplicity, while affording, of course, the same angles as in Scacchi's method.

We may consider the fundamental octahedron as belonging to the *r* series (instead of the *n* series); and then taking i^2 in figures I and III and *i* in figure II, as the form $\frac{1}{2} : \overline{\infty} : 1$ the axes for the three forms will be as follows:—

	a		*b*		*c*
Fig. I, ...	1·3588	:	1	:	0·4629
" II, ...	1·4536	:	1	:	0·4629
" III, ...	1·3115	:	1	:	0·4629

It will be observed that

a in figure I is *one third* of 4·0764 (*a* of type I.)
a " II is *one half* of 2·9090 (*a* of type II.)
a " III is *one fourth* of 5·2430 (*a* of type III.)

Also *c* in each, is *one half* of *c* in the types I, II, III, which is owing to our taking as the zone of the fundamental form, the *r* series instead of the *n* series,—the axes *c* in these series having the relation of 2 : 1.

From the above, the vertical axes in these forms is observed to vary nearly as 136 : 145 : 131, not a large variation. This ratio is equivalent to

$$14 : 15 : 13\tfrac{1}{2},$$

which corresponds to the ratio 7 : 5 : 9 between Scacchi's vertical axes, as will be deduced by taking into view the ratio which subsists between *a* in each of the three types of M. Scacchi, and the *a* in our fundamental forms as above given.†

We have repeated the three figures of Humite, (see figs. A, B, C,) with a new lettering, the crystallographic symbols being

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* In Scacchi's method of viewing the crystals, these planes referred to the common type, have the following symbols:—i^2 in fig. I $= 1 : \infty : \frac{3}{7}$; *i* in fig. II $= 1 : \infty : \frac{2}{5}$; i^2 in fig. III, $= 1 : \infty : \frac{4}{9}$. In the author's method, each has the symbol $\frac{1}{2} : \infty : 1$ (equivalent to $1 : \infty : 2$).

† This is shown as follows:—

Since 4·0764 : 2·9090 : : 7 : 5, and 4·0764 = 3 × 1·3588 and 2·9090 = 2 × 1·4536 nearly,

Therefore, 3 × 1·3588 : 2 × 1·4536 : : 7 : 5

∴ 1·3588 : 1·4536 : : 2 × 7 : 3 × 5 : : 14 : 15.

By the same process the other ratios are obtained.

used in the lettering, as explained in the last volume of this Journal.*

From the crystals, the symbols of the planes may be at once read off, and those of each series compared. There is a remarkable simplicity in the series;—and moreover, the parallelism between these related forms is well brought out; we appear therefore to be sustained in this mode of viewing these complex crystals.

We observe that—

The $m:1:\bar{\infty}$ series in fig. A, (*e* of Scacchi), has for m the values	$\frac{3}{1}, \frac{3}{2}, \frac{3}{3}, \frac{3}{4}, \frac{3}{5}$
The " " in fig. B, " "	$\frac{2}{1}, \frac{2}{3}, \frac{2}{5}$,†
The " " in fig. C, " "	$\frac{4}{1}, \frac{4}{3}, \frac{4}{5}, \frac{4}{7}$
The $m:1:1$ " (*r* above) in fig. A, has for m the values	$\frac{3}{2}, \frac{3}{4}, \frac{3}{6}, \frac{3}{8}, \frac{3}{10}$
The " " in fig. B, " "	$\frac{2}{1}, \frac{2}{3}, \frac{2}{5}$
The " " in fig. C, " "	$\frac{4}{1}, \frac{4}{3}, \frac{4}{5}, \frac{4}{7}, \frac{4}{9}, \frac{4}{11}, \frac{4}{13}$
The $m:\bar{\infty}:1$ series (*i* above) in fig. A, have for m the values	$\frac{3}{2}, \frac{3}{6}, \frac{3}{10}$
The " " in fig. B, " " "	$\frac{1}{2}$
The " " in fig. C, " " "	$1, \frac{1}{2}, \frac{1}{3}$.

The values of m for the series $m:1:2$, (*n* above) and for $m:1:3$, (*m* above) will be read off from the figure.

In this method therefore, we have no sacrifice of accuracy in the angles, nor of simplicity in the exhibited relations of the planes; on the contrary, the crystals are more readily compared, and their actual differences more easily noted, than by Scacchi's method.

We gather at once, that the three crystals although approximately alike in their vertical axes, differ in the mathematical series expressing the positions of the secondary planes.

These series are—

For fig. B, $\frac{3}{1}, \frac{3}{2}, \frac{3}{3}, \frac{3}{4}, \frac{3}{5}$, or $\frac{3}{2}, \frac{3}{4}, \frac{3}{6}, \frac{3}{8}$, the latter not essentially differing from the former, as the two are alike in the alternate terms.

For fig. B, $\frac{2}{1}, \frac{2}{3}, \frac{2}{5}, \frac{2}{7}$.

For fig. C, $\frac{4}{1}, \frac{4}{3}, \frac{4}{5}, \frac{4}{7}, \frac{4}{9}, \frac{4}{11}, \frac{4}{13}$.

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* The writer has thought it preferable to use the letter I (or *i*), for ∞ (infinity) instead of O (or o), (as proposed in volume xiii, page 399), since the letter O is so readily confounded with 0 (zero). By way of explanation we give in this place Naumann's crystallographic symbols corresponding to some of those of figure A.

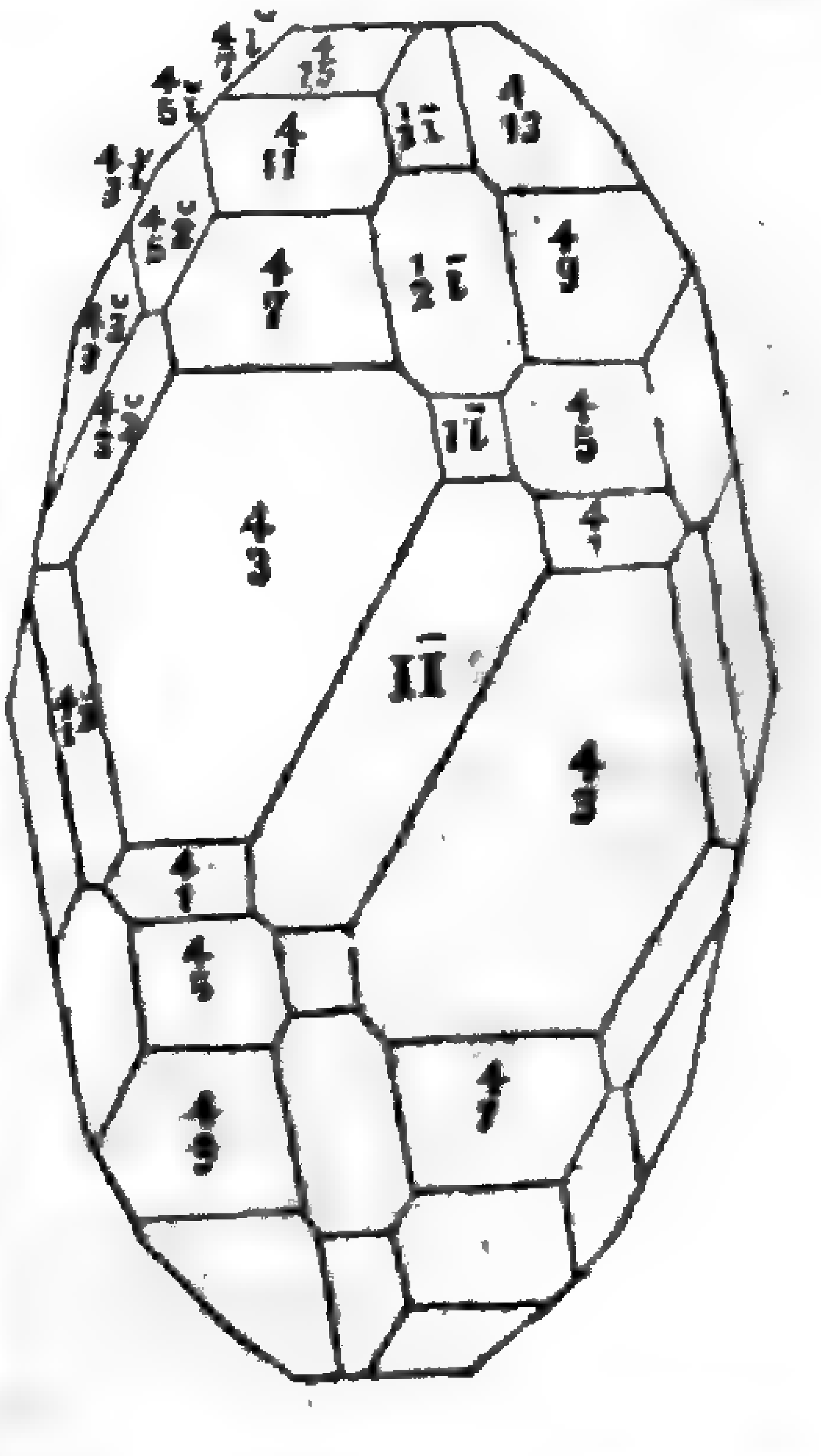
Fig. A,	$\frac{3}{6}$	$\frac{3}{4}$	$\frac{3}{2}$	I	$\frac{3}{10}\bar{i}$	$\frac{3}{6}\bar{i}$	$\frac{3}{2}\bar{i}$	$1\breve{2}$	$3\breve{2}$	$\frac{3}{2}\bar{i}$	$\frac{3}{1}\breve{i}$	$i3$	$I\breve{I}$
Naum.,	$\frac{3}{6}P$	$\frac{3}{4}P$	$\frac{3}{2}P$	∞P	$\frac{3}{10}\bar{P}\infty$	$\frac{3}{6}P\bar{\infty}$	$\frac{3}{2}\bar{P}\infty$	$\breve{P}2$	$3\breve{P}2$	$\frac{3}{2}\bar{P}\infty$	$\frac{3}{1}\breve{P}\infty$	$\infty\breve{P}3$	$\infty\breve{P}\infty$

In writing the symbols, such as $1\breve{2}$, $3\breve{2}$, the writer proposes to put in a hyphen, thus, $1\text{-}\breve{2}$, $3\text{-}\breve{2}$; on the crystal this is rarely necessary.

In the above $\frac{3}{1}$ is written for 3, in order to make more obvious the relations of the numbers in the series.

† The plane of composition for twins of fig. II or B and not an observed plane.

These are each parts of distinct infinite series, and they indicate the character of the modification in the attracting power of the molecules by which the secondary planes are produced. They in fact, appear to contain the elements or data for deducing a general law at the basis of such modifications in the attraction, both for these and all crystals. The relations of the curves indicated by these different series may be deduced, and thereby we may have an expression for the particular modifications in the attraction of the molecule, through which the several types originated. In a former paper, on attraction in crystals,* the writer has shown that, supposing the attraction in the normal state to be such as will produce in the monometric system a cube, or in the trimetric, a rectangular prism, it must be true, whenever secondary planes are produced, that the ratio between the force of attraction and the length of the axes is different, and further, that the attraction is relatively diminished, inasmuch as the angles and edges are not filled out. In the curves, indicated by the above series, the differences as regards these modifications of the attraction, between the three forms above, are exhibited, and we may almost say, measured off. To follow out this subject the condition of the force in the normal molecule of given dimensions, as partly illustrated by magnetism, should necessarily be first worked out, and then the variations which are indicated by the series of planes. We simply throw out these suggestions at this time, hoping that mathematical knowledge of the requisite power may soon be brought to bear upon the laws for the occurrence of secondary planes.



M. Scacchi also points out a singular example of hemihedrism observed in crystals of the 2nd and 3d type, as well as some compound crystals of the same types. The annexed figure, which is of the 3d type, illustrates this point. The alternate planes which are wanting on one side, are present alone, out of the series, on the other. There is hence a spiral arrangement as in plagihedral quartz, and the spiral turn may be to the right or left.

The twin crystals are compounded parallel to the plane e^3 ($\frac{4}{3}\breve{i}$) in the third type, and in the second parallel to an e ($\frac{2}{3}\breve{i}$) which has not yet been observed in this type, having Scacchi's symbol 1 : 5 : ∞. Of the former, stellate

* See this Journal, [2], iv, 373.

compound forms of 6 crystals, plagihedral in character, have been observed, and a figure is given in the paper.

The Humite occurs mostly either in foliated or granular limestone, or in a peculiar kind of granitic rock along with white olivine, mica and magnetite. In the former of these rocks the crystals are of the 2d or 3d type, and in the latter of the 1st or 3d. The color for each type varies between brown, reddish brown, yellow and white. G.=3·2; of a white crystal of the 1st type 3·234; a brown of the 3d, 3·199; a yellowish of the 3d, 3·186; a yellow of the 2d, 3·177. H.=6–6·5. The mineral is easily soluble with muriatic acid when pulverized. The identity of Humite with Chondrodite in chemical constitution was shown by Prof. C. Marignac, who also investigated with much labor the crystallography of the species, and distinguished three types among the crystals. He failed however of detecting their true relations, owing to his making e^3 of figs. I and II homologous planes, and r^4 of fig. I identical with r^6 of fig. III.

Art. XXI.—*Further Remarks on Ventilation and the Warming of Rooms;* by S. Webber, M.D., Charlestown, N. H.

In a former number of this Journal, in some strictures on an article by Prof. Hosking,† a tolerably full elementary statement was given of some of the leading principles of ventilation in connection with the warming of rooms by means of artificial heat. It is now proposed to carry on the subject by a few additional remarks necessary for setting forth fairly the merits of different modes of warming in connection with preserving purity of the air, with economy of fuel, and also of preserving purity of the air in assemblages of people, where warmth is not required, or when it becomes too great.

Supposing a room to be so tight by means of well and accurately fitted doors and windows, that no noticeable quantity of external air can enter by crevices, probably the most pleasant way of warming it in cold weather will be nearly that mentioned by Professor Hosking as a plan of recent origin, though from the writers recollections it was shown to have been used in this country nearly fifty years ago. This is, to have an open fire-place, adapted for either wood or coal, as either kind of fuel may be most convenient, with a hollow hearth, sides and back, into which hollows air shall be admitted by a pipe leading from the open air outside of the building, and which, when warmed by contact with the heated sides of the fire-place, in contact or nearly so with the fire, shall pass out into the room by openings in front of

† Volume xiii, page 374.

the jambs, which openings may be more or less, or wholly closed at pleasure, by some contrivance like a sliding lid or valve. In this case the air for the support of the fire will be furnished from the lower part of the room, and consists of the coldest part of the air in the room, and that most contaminated with carbonic acid gas. This by the constant ascent of the warm air from the supply openings to the upper part of the room, will be constantly and equably pressed towards the only mode of escape for it, the opening of the fire-place into the chimney above, and it will at the same time be drawn thither by the suction occasioned by the rarefaction and ascent of the air in the chimney from the action of the fire. The air of the room will thus be perpetually renewed, and the renewal will be made with warm pure airs. Unless the room be over crowded, over lighted, or over heated, no other ventilator will be wanted for preserving such a degree of purity of the air, as is necessary for comfort and health.

Some little attention however is requisite to the material of the fire-place. If it be made of iron, as has been sometimes the case, when the fire is strong, the iron, if in immediate contact with it, becomes greatly heated, perhaps red-hot, and in this condition will readily decompose some of the air coming in contact with it, depriving it of its oxygen, and sending into the room not pure warm air, but air unduly charged with nitrogen. Some other substance, which when heated, will not thus act upon the air, seems preferable. Iron will do well enough for the bottom or hearth, if a bed of ashes be permitted customarily to cover it, sufficient to prevent its becoming unduly heated. The sides and back may be built in the common way of brick, the only objection being, that this material is a slow conductor of heat, and considerable time must elapse after the kindling of the fire, before any perceptible effect can be noticed on the air contained in the hollows. Brick moreover, in houses of the better class, will hardly be considered handsome enough. A fire-place constructed of slabs of soapstone will be better in both of these points, though it is by no means so good a conductor of heat as iron, while it is a better one than brick. It may however be observed that by way of compensation, though the air in the hollows will not be warmed so quickly by these two substances, yet that it will continue to be warmed longer after the fire has gone out; as they seem to have a much greater capacity for caloric than iron, and under equal circumstances will continue to impart it long after iron has become cold.

The porcelain of which stoves are frequently constructed in France and Germany, might probably be applied with advantage to the construction of fire-places of this kind, if it could be readily obtained, where soapstone was not easily to be had. For the greater economy of fuel the upper part of the back of the fire-place should be brought forward, so as to leave the throat of the chimney as narrow as possible consistently with a fair and free escape of the smoke; and it might be provided with a slide under the mantle bar, for the purpose of rendering the opening wider or narrower, as the state of the fire and the chimney may require.

Another point to be carefully attended to is the character of the air brought in by the supply pipe to be warmed and passed into the room. This should be brought from the outside of the house, in some place where it may be presumed to have at least a fair average degree of purity, where the currents of the atmosphere have a free circulation, and, if possible, where sunshine penetrates during some portion of the day. To bring it from under the house merely, or from a cellar, from the neighborhood of a drain, or from a damp close, where wind and sunshine seldom or never penetrate, is only to change one poison for another.

But this mode of warming and ventilating rooms when artificial warmth is required, however excellent in some respects, is yet deficient in one great point, economy. However carefully a chimney and fire-place may be constructed, with an open fire whether of wood burning on the hearth or of coal burning in a grate, there must unavoidably be a great waste of caloric, as a large portion of it passes directly from the fire into the chimney, and out into the atmosphere, heating the chimney as it passes up, and thus increasing the strength of the draft by which it is raised. Hence a much greater consumption of fuel is necessary for giving the requisite warmth to a room, and moreover, as the bulk of the caloric that is sent into the room is thrown into it by radiation from one side or end, it is difficult to warm the room so equably, that a near approach to the fire shall not be very uncomfortable from heat, when the remote parts of it are not so from cold, whenever the temperature of the atmosphere abroad is very low.

Where not one or two rooms merely, but a considerable portion of a house, passages and all, are to be warmed,—as modern ideas of comfort in many cases require,—the expense of fuel in our long and severe winters becomes a matter of considerable importance to those not abounding in wealth; as also does the care necessary for attending to so many fires. Hence has arisen the plan of having one large general fire in the basement or cellar, this fire placed in a furnace arranged for heating a constantly renewed supply of fresh air, which is then distributed by pipes to the different rooms and passages which it is wished to warm. If this plan be carried into effect in an otherwise unexceptionable manner, it is probable, that though the first outlay be considerable, yet that as regards the regular consumption of fuel for obtaining a given degree of warmth in the house, and also as to the amount of labor necessary, there may be much sound economy in the plan. But that the arrangements generally made are unexceptionable, or even not in a considerable degree otherwise, is very doubtful to say the least. As generally constructed, the part of the furnace containing the fire and through which the caloric passes to be communicated to the air admitted between the inner and outer walls, is made of iron, and as the fire within is large and often fierce, it must, when much warmth is required, be often very intensely heated, so as not only to decompose the air, as before stated, but even the watery vapor contained in it, and thus throw into the rooms not only air with an undue portion of nitrogen, but unduly dry, and still more unfit for breathing from being contaminated with hydrogen. Furthermore, when there is, as is almost always the case, any fine organic dust floating in the atmosphere, such of this as comes in contact with the iron, if that should be at a red heat, will in part at least be burned, and the product of its combustion go still farther to pollute the air. The volume of gaseous matter that may be produced by the burning of a very minute quantity of organic dust, is vastly more considerable than those not familiar with the subject will readily believe. In short, all the cautions given under the head of hollow air-heating fire-places must be observed with greatly increased strictness in the management of furnaces for warming houses. The amount of precaution required increases with the size and intensity of the fire that is used. For regulating the purity of the air in rooms thus warmed, while still the full supply of warmth is desired, there should be, near the level of the floor, a good sized ventilating aperture, communicating with the flue of a chimney, or with an up-draught pipe.

Open stoves, as they are called, are but modifications of fire-places more or less detached from the chimney. They provide well for one part of the necessary ventilation, the means of discharging the impure air through the draft into the chimney, but they are usually entirely deficient in the other essential part, the means of warming and throwing into the room a supply of fresh air to take the place of that which thus passes out. For this the room has to depend upon the indraught of cold air through the crevices of doors and windows, and if these be well closed, such stoves smoke intolerably, and the air of the room soon becomes otherwise very impure. This may be obviated by making such stoves double, and admitting the air into the hollow under the hearth by a pipe leading from the external air beneath the floor. This air, well warmed by passing through the hollows of the back and sides, may be permitted to pass through a register in the upper plate of the top. The same remarks as to the materials and degree of heat, which were given under the head of fire-places, are appropriate to these open stoves. They are decidedly more economical than fire-places in the base of the chimney, when they are completely detached from the walls of an apartment, since all the caloric communicated by the inclosed air to the outer plates of the stove is radiated by them into the room, forming no inconsiderable addition to its warmth.

Still this kind of stove requires a large, free, and pretty direct passage for carrying off the smoke of the fire; and this also permits the escape of a large portion of the caloric produced by it, so that they are decidedly less economical than close stoves, where only a small opening is left for the indraught of the air from the room to the fire, to maintain its active combustion: through which small opening the current is so strong, that a much less sized smoke pipe is required, and this may be much more tortuous in its approach to the chimney flue, thus carrying from the stove less of the caloric, and permitting a considerable part of what it does receive, to escape by radiation from its sides. If a comparatively large stove of this kind be used, with a good length of funnel, making, if possible, several turns up and down before finally entering the chimney or passing into the air, as great an economy of fuel will be obtained as is probably desirable; for some amount of caloric must pass into the chimney, both that this may perform its office well, and for its preservation. As commonly used the two great defects of this kind of stove are, that the aperture for the supply of air to the fire is hardly large enough to carry off the foul air from a room, if occupied by several persons, and if two or three lights are burning in it; and that no provision is made for the renovation of the air by introducing warm fresh air. The first of these is easily remedied by a ventilating aperture on a low level communicating with the chimney flue, to be used more or less as occasion may require; the second may be corrected by making the stove double in the same way as was mentioned for open stoves. Stoves of this kind, made of soapstone or porcelain, are preferable to those made of iron; but if the latter be large and but moderately heated, no essential evil will arise from the material. When the polish with which it is customary to coat iron stoves, readily gets brown or ash colored, it is evidence that the stove is far too highly heated. Double close stoves made of soapstone have lately come into partial use, and their performance is in all respects very unexceptionable.

Air-tight stoves are excellent as to economy of fuel, but this is their only merit. They impart warmth in the highest possible degree, but in themselves do nothing for a change of air, neither carrying off any noticeable quantity of foul air, nor supplying any fresh warm air. These defects are the same with those of close stoves but in the highest degree, and they may be remedied in the same way; the ventilating opening into the chimney should however be larger than in a common close stove. The very perfection however with which they impart their caloric to the room, is a serious defect, for if a chimney is used only with one or more of these stoves, there is not sufficient warmth imparted to it in very cold weather, to prevent the pyroligneous acid generated in the combustion of the fuel, and passing in vapor by the edges of the *damper*, from being condensed against the inside of the chimney, where it penetrates the mortar with which the bricks are laid, and acting upon the lime destroys the tenacity of the cement and passes through it into the rooms. An instance of this kind fell under the writer's observation. The chimney in this case had two flues, one from the ground floor, and one from the chamber above. Both were provided with air-tight stoves, which were managed with rigor according to the directions of the inventor. In the course of the first winter the pyroligneous acid began to show itself in the chamber, oozing through the plastering, on the sides of the chimney where it was laid upon the bricks, and running in streams down to the floor. The same thing took place even more copiously in the loft above the chamber, and the fluid that ran down there, spread in puddles over the ceiling of the chamber which intercepted it, and before spring made its way through the plaster of this ceiling in large patches, dripping copiously in various places, defacing and spoiling the carpets and furniture below, and rendering it necessary to set a number of vessels on the floor to catch the dropping fluid, and prevent it from effecting the same destruction in the parlor below, which indeed, with all precautions that were taken, did not entirely escape. The chamber was rendered uninhabitable, and all that part of the house was troubled with "a most ancient and fish-like smell." The use of the stoves as *air-tights* had to be entirely given up; and it was found necessary to rebuild the chimney and new plaster the ceiling of the rooms. At the suggestion of the writer the chimney was built double, a space of two inches being left between the inner and outer walls, occasional bricks passing through this as binders, and the hollows being closed over at the top. The warm and impure air passed into these hollows through the ventilating opening of the rooms and issued into the internal flue by lateral openings near the top. Advice at the same time was given, to let the heat pass freely into the chimney occasionally so as to keep the bricks of the internal wall sufficiently warm to prevent the condensation of the pyroligneous vapor. These precautions for two or three years were found effectual. After that time a furnace was used.

The use of steam-pipes as a means of warming dwelling-houses has been attempted, but has found so little favor, that it is hardly worth while to say any thing about them. They are costly and troublesome, and have in themselves no means of changing the air. In establishments where steam is generated in large quantities for other purposes, it may be profitable to employ waste or spare steam for the purpose of warming such portions of the building as it can readily be conveyed to without much expense, the necessary purification of the air being otherwise provided for.

Such are the principal modes that have been employed for impartin gwarmth to dwelling-houses, with their advantages and disadvantages, both as to warming, and as to preserving the purity of the air while diffusing heat, with the means necessary for so doing while the increase or maintenance of warmth is desirable. But this warmth so artificially procured, may become excessive. From too large a fire, the presence of too many persons in a room where the fire is, and the burning of numerous lights, the air may become too warm and impure, and additional ventilation and with cooler air may be required. In this case a ventilating aperture in the upper part of the chimney is wanted, to permit the escape of the warm air from the upper part of the room and with it such of the gaseous exhalations, engendered in such cases, as are of a light specific gravity. Rooms therefore used for the reception of company where any considerable number of persons are likely to be occasionally assembled, should always be provided with a high ventilator. It may not be always convenient to put out the fire, or materially to lesson the number of lights, though the ingress of warm air from the supply pipes may be stopped, and that already in may be suffered to escape through the upper ventilator. That it may do this however, other air must be admitted. Opening doors and windows, one or more as the need may be, will readily do this; but unpleasant and excessive draughts are thus created, oftentimes more immediately prejudicial to health to those fully exposed to them, than a slower cooling and purification of the air by means of the upper ventilation only. A proper ventilating opening or openings, for the admission of fresh cool air will be required. These should not be on the floor, as the cool air would thus be thrown principally about the feet and ancles, where least needed and most prejudicial, and whence it would ascend slowly to the level of the mouth and nostrils, much warmed in its ascent, and much loaded with emanations from the body. It should be admitted at a high level near the ceiling, at some distance from the upper warm-air ventilator, and if possible on the opposite side of the room, so as to diffuse itself to some distance in that higher portion, driving the warm air before it to its appropriate place of escape, and descending as it moves forward, mixing with, condensing, and quickly bearing down with it to the lower part of the room, the impurities it might meet with, conveying grateful refreshment to the lungs, and checking the ascent of impurities from below the mouth and nostrils. The very coolness applied to the head is one of the best means of preventing the bad effects of the inhalation of air impure from an undue mixture of carbonic acid, as this part of the system is the first almost to manifest the effects of blood not duly purified in the lungs.

The common mode of admitting air into too warm a room by letting down the upper sash of a window, where it can be done, in preference to raising the lower, is founded upon this principle, and is perfectly correct. The mode however is somewhat defective, as the air is admitted in too large a body and with too strong a current, except for excessive cases, and by producing too sudden a check to perspiration and to the secretions of the mucous membranes of the air-passages, is apt to produce inflammatory affections of the head and throat. Were it to pass through a sheet of wire gauze or perforated plate of thin metal, its force and intensity would be much lessened, as it would be divided into numerous minute currents, and instead of descending like a cataract, would fall quietly like spray or mist, mixing intimately with the warm air and gently cooling it, and refreshing and cooling without chilling, the heads, necks and air-passages of the persons in the room. Were a space of a foot in depth in the upper part of one or two windows with a moveable upper sash thus provided, (and this might easily be done, and so as even to be ornamental,) no better ventilators for supplying cool fresh air to an over-heated room need be wished for.

This ventilator with the internal one into the upper part of the chimney will be found very serviceable at times when a fire is not needed, and also when from the number of persons and lights a room becomes too warm, while the weather is still so cool that the external air cannot be admitted freely by open windows. Indeed it seems as if, in a room provided with these different ventilators and the means of warming recommended, there would be no great difficulty to be encountered in keeping the desirable degree of warmth and purity of the air in any but hot and sultry weather, when of course the temperature of the external air must in some degree limit the amount of coolness to be obtained by ventilation.

It was mentioned in the former part of these remarks in connection with the subject of keeping a vessel of water upon a stove in order to supply the air with what was considered a proper degree of moisture, that the air heated by a stove was not the more dry for heating, but only had its capacity for dissolving vapor increased, by which means it absorbed the moisture from all things in the room containing it, rendering *them* indeed more dry, but becoming more moist itself. This undoubtedly has a bad effect upon furniture not thoroughly seasoned and dried in the making, causing it to shrink, crack, and warp; and even furniture made in a moist or cool season of the year, though of apparently well seasoned wood, will under the influence of a steadily warmed room, where the heat is kept up to summer temperature, say 76° of Fahrenheit, shew often manifest signs of undue dryness. The effects upon the human system, especially in a person unaccustomed to it, are an unusual dryness of the air-passages of the mouth and throat, creating a disposition to thirst, and requiring a larger supply of fluid in the way of drink, than is customary in the cold season of the year, while if, as is commonly the case in this season even in the house, the dress is materially thicker than in summer, a corresponding increase of the perspiration from the surface of the body is also produced, and this elimination of fluid from the skin, though it renders it more moist, diminishes rapidly the quantity in the system, and coöperates with the increase of evaporation from the lining of the air-passages, in creating the demand for a larger supply of drink. In this however there is no especial harm, as it is only what happens naturally in the warm season of the year, and if the desire be moderately and reasonably gratified with appropriate liquid, the adjustment of the system will take care of itself. This amount of heat, 76°, is however rather excessive for persons in health warmly clothed, and who are frequently passing out into the cold external air, as the pores of the skin are too much opened by it, and they run the risk of taking cold by a sudden check of the perspiration in the parts of the surface most exposed to the chill of the atmosphere.

Now the effect of throwing into air already warm and unduly moist, a large additional supply of warm vapor, as is the case when water is suffered to evaporate from the top of a stove, is to produce a relaxing effect upon all the surfaces of the body exposed to its influence, both the mucous membranes and the skin, and thereby to render one more liable to feel the ill effects of a check from coming in contact with the cold external air. If any thing in the way of an extra supply of moisture were advisable or admissible, it would be simply to place a vase or two of water in different parts of the room, and let the air drink from it gradually and at its own temperature, a sufficient supply of moisture to satisfy its capacity. It would thus be naturally saturated, and no more; and the furniture at least would escape injury, and possibly, perhaps probably, the human form would receive no detriment, if the warmth of the room was limited to about 62°–65°, which will be quite sufficient for comfort for healthy persons fairly clad for the cool or cold season. In the case of invalids some departure from these limits both of warmth and moisture, may be advisable according to circumstances, but these should be regulated by the advice of the medical attendant, to suit the requisitions of each case.

ART. XXII.—*Notes on the Use of the Zenith Telescope in Determining Latitudes in the Coast Survey, by Talcott's Method, and on the Reduction of the Observations;* by A. D. BACHE, Superintendent U. S. Coast Survey.*

THE method of determining latitudes, by measuring differences of meridian zenith distance of two stars, of nearly the same distance from, and on opposite sides of, the zenith, employed by Capt. Andrew Talcott, late of the U. S. Corps of Engineers, appears to me one of the most valuable improvements in practical astronomy of recent years. It has been described, with care, by Professor Courtenay, in the Journal of the Franklin Institute; by Major Emory, in his report of observations in connection with the northeastern boundary of the United States; and by Capt. Lee, of the U. S. Topographical Engineers, by whom it was repeatedly used in the operations of the Coast Survey.

The chief modifications in the instrument, since its introduction in the Survey, have been—in securing stability, by a brass arc, instead of a sliding rod, (proposed by Major Emory and by me;) in increasing the facility of reaching the zenith, by raising the central columns, and somewhat diminishing the diameter of the azimuth circle; in substituting a single for a double micrometer; in providing a parallactic eye-piece; in illuminating by a lamp, not resting on the instrument; in bringing the divisions of the level and micrometer into just relations; in an adjustment for the verticality of the axis, (adapted by Mr. Simms, of London;) and in providing stops to set the instrument in azimuth.

Quite a new form was proposed for the instrument, by the late R. H. Fauntleroy, one of the Assistants of the Coast Survey, in which the telescope was to be used for determining time; which it is capable of doing with sufficient precision for observations of latitude. The instruments of this kind used upon the Coast Survey, have been, generally, made by William Simms, of London; one has, however, been recently constructed by Mr. Würdemann, of Washington,† and another is in progress of making, under Mr. Saxton's direction.

As used by us, the observations are made when each star is very nearly in the meridian, and as nearly as possible when passing the center of the field of the telescope. When there is a recorder to assist the observer, he calls out the setting of the instrument for each pair of stars, and when the star should enter the field; thenceforward calls each ten seconds, the observer follow-

* From the Proceedings of the American Association for the Advancement of Science, vol. v, (5th Meeting, at Cincinnati,) p. 151.

† In this instrument the circular or "windmill" clamp has been applied for keeping the instrument in position, and with great advantage.

ing the star with the horizontal wire, and moving the instrument in azimuth, if it appears necessary, as the time of culmination approaches, to bring the star in the middle of the field. When within ten seconds, the recorder calls each second, and the instant of the previously computed culmination, when, the wire being upon the star, the first part of the observation is complete. The level and micrometer are read and recorded. The same process is repeated after the instrument has been turned 180° to observe the opposite star of the pair; on the other side of the zenith. A single observation on the meridian has, in our experience, been found preferable to several circum-meridian observations.

NUMBER I.

Form for recording Observations for Latitudes with Z. Telescope, Mt. Independence, (Black Strap,) Maine, Sept. 25, 1849.

STAR.	N. or S.	MICROMETER.		LEVEL.		Time of observation by Chronom.	Time of culmination by Chronom.	MERIDIAN DISTANCE.	Coef. red.	REDUCTION TO MERIDIAN.	REMARKS.
		Turns.	Divis.	N.	S.	H. M. S.	H. M. S.				
{ 6851	S	14	97·0	37·0	47·0	19 50 13	19 50 13				Sidl. chron. 179 at $20^h. 14^m. 28·91^s$.
{ 6928	N	7	27·5	49·0	35·0	20 01 49	20 01 48				Slow $00^h. 00^m. 28^s. 06$. Hourly rate gaining, $00·09^s$.
{ 6893	N	8	3·0	47·0	38·0	20 10 23	20 10 22				Commencement of obser.: Barometer 29·22; interior thermometer 63·3;
{ 6986	S	6	91·3	38·0	47·0	20 12 21	20 12 20				exterior thermometer 62·7.
{ 7008	S	14	10·0	46·5	38·5	20 14 21	20 14 21				* Taken off the meridian.
{ 7076	N	1	74·5	39·0	46·2	20 23 26	20 23 25	H. M. S.			Lat. = 43° 45′ 30″ cos = 9·85870; N. P. D. 47° 15′ 32″ sin = 9·86594
{ 8076	S	11	60·0	50·0	35·5	23 03 15	23 03 05	*0 00 10	0·05	−1″·49	Z. D. = 1° 01′ 02″ ar. co. sin. 1·75063
{ 8115	N	2	98·5	37·5	48·0	23 10 27	23 10 27				X = 29·9 = 1·47527

The form of record is not essentially different from that used by Captain Talcott, and by subsequent observers. By recording the readings of the level as N. and S. ends, instead of object and eye-ends, some trouble is saved. The table, with its headings, is as above.

Of the arrangement of the instrument in its place, and the simple adjustments it requires, when not employed to obtain time, it is not necessary to speak. We mount it, usually, on a block of stone, or wood, sunk about two feet in the ground, and find little advantage in one material over the other.

The instrument being in place, the first point is, to determine the value of the micrometer in angular measure. Several methods have been used for this purpose: the most common is, by turning the micrometer at right angles to the position in which it is generally used, and noting the number of divisions passed over by Polaris, or some other circumpolar star, in a given time, when near its culmination. Another method, introduced by Assistant C. O. Boutelle, is, to observe Polaris near elongation, when rapidly rising or falling, with but a slight motion in azimuth. This is a pretty method, and avoids the displacement of the micrometer. When a theodolite is at hand, we generally obtain the micrometer values by the apparent diameter of a distant object, as measured in angular and in micrometer divisions, by the two instruments.

A ring of lead is placed around the sliding tube at the eye-end of the telescope, to prevent a change of focus. It is usual to test the different parts of the screw in obtaining these values, turning the micrometer both forward and backward. A record of a series of observations of the last named kind is given, below, with their discussion:

NUMBER II.

Values of Micrometer Divisions, No. 1, by Distant Mark.

Date.	Distance from	With Micrometer.	With Theodolite.	Mic. value of one division.	$a \backsim x$	$(a \backsim x)^2$
		divis.	$''$	$''$		
May 16,	0 to S	1213·0=	463·1	·3818	·0004	·00000016
	0 " W	1324·0	503·2	·3800	14	0196
	0 " A	2845·0	109·6	·3152	38	1444
	Sums					

$e = 0''\cdot0051 =$ probable error of a single observation.
$E = 0\ \cdot0012 =$ " " mean of all.
Mean value of one division of micrometer $= 0''\cdot3805 \pm 0''\cdot0012$

From these observations, a table is made, which, by simple inspection, shows the angular value of any number of turns of the screw, and parts of a turn. By suitably selecting the pairs of stars, any effect of inaccuracy in this determination may be avoided, by making the sum of the zenith distances, of all the pairs N. and S. of the zenith, zero. It is, generally, convenient to approach nearly to the fulfillment of this condition.

The value of the divisions of the level is next found in terms of the micrometer value; passing the bubble from one end to the other of the level, so as to detect and measure any irregularities. The telescope is pointed at a distant mark, or a collimating telescope is used; the displacement of the line of collimation, as the bubble of the level is made to travel from one end of the tube to the other, being measured by the micrometer. The advantage of the collimator, from the stillness of the air through which the observation is made, is shown in the following comparative results, by the two methods:

NUMBER III.

Value of Level Divisions, No. 1, by Distant Mark.

SERIES.	Level.		Micrometer.		Differ.	Differ.	Value of one division of level in micr. divisions.
	O	E	Turns.	Divis.	Level.	Micr.	
	64·5	14·7	0	0	4·25	19	4·47
	60·3	19·0	0	19	4·40	20	4·54
	56·0	23·5	0	39	5·50	21	3·82
	50·5	29·0	0	60			

$e = 0·5862$ in micr. divisions.
$E = 0·03275$ " "
Mean value of one division level $= 1''·5193$

No. 2 by collimator.

$e = 0·0770$
$E = 0·0181$

The value of the level divisions is then converted into arc, and a table prepared, which, by inspection, shows the correction to twice the latitude for an excess of sum of readings of north ends over sum of south ends, or *vice versa;* applying this correction in north latitude, with the sign N.−S. I constructed a table, from which the correction for level could be taken by inspection; the sum of the north end readings being arranged at the top, and the sum of the south end at the side—the correction being found on a diagonal line. It has not, however, found favor with the observers: but they usually prefer a table of single entry, in which the argument is the difference of the series of north and south end readings, and opposite the correction in arc.

There are two corrections, which it may be as well to notice in this place; viz., for reduction to the meridian and refraction.

If the line of collimation of the telescope is off the meridian, the reduction to the meridian employed in altitude and azimuth instruments, and in sextant observations, applies. If the axis, or vertical wire, is in the meridian, and the star is observed before or after culmination, then the correction is such as is used with the zenith sector and with the meridian circle, viz.: $x = -\frac{H^2}{4}$.

Sin 2Δ, in which x is the correction, H the hour angle, and Δ the polar distance of the star.

These corrections were formerly tabulated, but now are generally avoided by the mode of observing, and the cases in which they occur are computed separately. In general, the tendency is to avoid methods which introduce tedious calculations, unless attended with decided advantage.

One of the great advantages of Talcott's method is, that the correction for refraction is very small; being for the difference, merely, of the two refractions on each side of the zenith. The correction for temperature and pressure of the air is, usually, insignificant; amounting, at the distance of 25° from the zenith, and for a difference of 20 minutes of zenith distance, two inches of the barometer, and 50° of the thermometer, (Fahr.), to only 0.″02. The whole correction for refraction is obtained by the following easy method, first used, I believe, by Prof. Gibbes, of Charleston: The refraction being nearly proportional to the tangent of the zenith distance, the differences for the two stars of the pair will be nearly the differential of the tangent of the zenith distance of the star south of the zenith, and will be inversely proportional to the square of the cosine.

Call Zs the true zenith distance of the star south of the zenith, and Zn the same for the star north of the zenith.

Then in each case the true zenith distance = the observed distance + the refraction, which is proportional to the tangent of the zenith distance;—or calling Zs_0 and Zn_0 the observed zenith distances of the star S and N of the zenith,

$$Zs = Zs_0 + m \tan Zs, \quad \text{and} \quad Zn = Zn_0 + m \tan Zn$$

$$Zs - Zn = Zs_0 - Zn_0 + m(\tan Zs - \tan Zn).$$

Since $\tan Zs - \tan Zn = \tan(Zs - Zn)(1 + \tan Zs \tan Zn)$ a table may easily be rigorously computed, or approximately,

$$d \tan Zs = \frac{dZs}{\cos^2 Zs}$$

And the log correction is Log $\dfrac{m \sin 1'' \text{ diff. zen. dist.}}{\cos^2 Zs}$, from which a table is easily constructed.

The following table for correction for refraction to the nearest hundredth of a second, for different zenith distances and differences of zenith distance, has been computed by this method, by sub-assistant G. W. Dean, of the U. S. Coast Survey:

[B.]

Corrections for Refraction, to be used in correcting observations with Z. Telescope.

Micrometer arc.	ZENITH DISTANCES.										
	0° 30′	4° 10′	9° 40′	13° 00′	15° 40′	17° 50′	19° 40′	21° 20′	22° 50′	24° 10′	25° 25′
0′ 0″	·00	·00	·00	·00	·00	·00	·00	·00	·00	·00	·00
30	·01	·01	·01	·01	·01	·01	·01	·01	·01	·01	·01
1	·02	·02	·02	·02	·02	·02	·02	·02	·02	·02	·02
30	·02	·02	·03	·03	·03	·03	·03	·03	·03	·03	·03
2	·03	·03	·03	·04	·04	·04	·04	·04	·04	·04	·04
30	·04	·04	·04	·04	·05	·05	·05	·05	·05	·05	·05
3	·05	·05	·05	·05	·05	·06	·06	·06	·06	·06	·06
30	·06	·06	·06	·06	·06	·06	·07	·07	·07	·07	·07
4	·07	·07	·07	·07	·07	·07	·08	·08	·08	·08	·08
30	·08	·08	·08	·08	·08	·08	·09	·09	·09	·09	·09
5	·08	·08	·09	·09	·09	·09	·10	·10	·10	·10	·10
30	·09	·09	·10	·10	·10	·10	·10	·11	·11	·11	·11
6	·10	·10	·10	·11	·11	·11	·11	·12	·12	·12	·12
30	·11	·11	·11	·12	·12	·12	·12	·13	·13	·13	·13
7	·12	·12	·12	·12	·13	·13	·13	·14	·14	·14	·15
30	·13	·13	·13	·13	·14	·14	·14	·15	·15	·15	·16
8	·14	·14	·14	·14	·15	·15	·15	·16	·16	·16	·17
30	·14	·14	·15	·15	·16	·16	·16	·17	·17	·17	·18
9	·15	·15	·16	·16	·16	·17	·17	·18	·18	·18	·19
30	·16	·16	·17	·17	·17	·18	·18	·19	·19	·19	·20
10	·17	·17	·17	·18	·18	·19	·19	·20	·20	·20	·21
30	·18	·18	·18	·19	·19	·20	·20	·21	·21	·21	·22
11	·19	·19	·19	·20	·20	·20	·21	·21	·22	·22	·23
30	·19	·20	·20	·21	·21	·21	·22	·22	·23	·23	·24
12	·20	·20	·21	·21	·22	·22	·23	·23	·24	·24	·25
30	·21	·21	·22	·22	·23	·23	·24	·24	·25	·25	·26
13	·22	·22	·23	·23	·24	·24	·25	·25	·26	·26	·27
30	·23	·23	·24	·24	·25	·25	·26	·26	·27	·27	·28
14	·24	·24	·24	·25	·26	·26	·27	·27	·28	·29	·29
30	·25	·25	·25	·26	·27	·27	·28	·28	·29	·30	·30
15	·25	·26	·26	·27	·27	·28	·29	·29	·30	·31	·31
30	·26	·26	·27	·28	·28	·29	·30	·30	·31	·32	·32
16	·27	·27	·28	·29	·29	·30	·31	·31	·32	·33	·33
30	·28	·28	·29	·30	·30	·31	·32	·32	·33	·34	·34
17	·29	·29	·30	·30	·31	·32	·33	·33	·34	·35	·35
30	·30	·30	·31	·31	·32	·33	·33	·34	·35	·36	·36
18	·31	·31	·31	·32	·33	·34	·34	·35	·36	·37	·37
30	·31	·32	·32	·33	·34	·35	·35	·36	·37	·38	·38
19	·32	·32	·33	·34	·35	·36	·36	·37	·38	·39	·40
30	·33	·33	·34	·35	·36	·36	·37	·38	·39	·40	·41
20	·34	·34	·35	·36	·37	·37	·38	·39	·40	·41	·42
30	·35	·35	·36	·37	·38	·38	·39	·40	·41	·42	·43
21	·36	·36	·37	·38	·38	·39	·40	·41	·42	·43	·44
30	·36	·37	·38	·38	·39	·40	·41	·42	·43	·44	·45
22	·37	·38	·38	·39	·40	·41	·42	·43	·44	·45	·46
30	·38	·38	·39	·40	·41	·42	·43	·44	·45	·46	·47
23	·39	·39	·40	·41	·42	·43	·44	·45	·46	·47	·48
30	·40	·40	·41	·42	·43	·44	·45	·46	·47	·48	·49
24	·41	·41	·42	·43	·44	·45	·46	·47	·48	·49	·50

The same table may be formed as conveniently by differences from the usual refraction tables.

In selecting the pair of stars for use with this instrument, we have found the following rules convenient or necessary to be observed. The British Association Catalogue has afforded ready means for their selection, and the computation of their places.

1. The latitude of the place is assumed to the nearest two or three minutes of arc.

2. The zenith distances should be as small as practicable (the instruments now used admit of ready access to the zenith in observations), and should not be extended beyond twenty-five degrees.

3. The differences of zenith distance should be small, and in no case exceed a convenient range of the micrometer, say, ten minutes of arc, corresponding (in the instruments which we use) to about thirteen turns of the micrometer.

4. The interval of time between the culmination of the stars of a pair should not be less than one minute; so as to give time deliberately to read the micrometer, and to turn the instrument in azimuth, to be prepared for observation; and should not exceed about twenty minutes, to avoid changes in the instruments.

5. The interval between the pairs should afford time for reading the micrometer and level, and for setting the instruments for the next pair. This will vary with different observers; but three minutes is about the time adopted by most of our observers. When the intervals between pairs are unavoidably long, they are filled up by observing transits for time.

6. The VI½ magnitude is the least that admits of easy observation, with the telescopes which we use. They are by Simms of London, have a focal length of forty inches, and object-glasses about three inches in diameter; and we commonly observe with a magnifying power of fifty or sixty.

7. In selecting pairs, all stars marked "doubtful" are rejected; in general, those having but one authority are not taken.

8. In order to be certain to embrace all desirable combinations, the catalogue is to be consulted from the earliest AR which the daylight, at the time of beginning the series of observations, permits, to the latest hour at which it is desirable to observe. Within this period of AR, the stars are divided into belts by their declinations; the breadth of each being equal to that of the field of the instrument, and being paired accordingly, the corresponding declinations north and south of the zenith, as in the following table for Mount Independence, near Portland, Maine; assumed latitude, 43° 45′, and field of the telescope 15′:

TABLE No. I.

For Selection of Pairs for Observation with Zenith Telescope.

No. of Star in B. A. C.	N. or S.	Mag.	Auth.	A. R.			N. P. D.
				h.	m.	s.	46° 00′ and 46° 30′
5997	S	VI	1	17	36	05	46° 27′ 14″
6095	"	"	1	17	53	25	46° 34′ 04″
6162	"	"	1	18	02	57	46° 33′ 16″
6720	"	"	1	19	29	59	46° 22′ 56″
7241	"	V½	3	20	44	45	46° 30′ 14″
7681	N	VI	1	21	56	53	46° 04′ 18″

(15′ each side of zenith.)

No. of Star in B. A. C.	N. or S.	Mag.	Auth.	A. R.	N. P. D.
				h. m. s.	45° 45′ and 46° 45′
6013	N	VI	1	17 38 39	45° 50′ 53″
6728	S	V½	1	19 31 46	46° 37′ 40″
6731	N	VI	1	19 31 59	45° 38′ 02″
7317	N	"	1	20 57 02	45° 47′ 55″
7333	S	IV	3	20 59 28	46° 40′ 06″
7402	S	VI	2	21 12 52	46° 40′ 59″
7705	N	"	3	21 59 56	45° 42′ 51″

The table is continued, as above, until 20° to 25° from the zenith is reached. It contains the information necessary to apply the foregoing rules for selection. The pains which may be bestowed on this table are not lost. Some of the observers prefer, in filling it up, to take zones of five degrees at a time, on each side of the zenith, and to go through the catalogue thus, several times within the limits of the AR determined upon.

The pairs, then, are selected, and placed according to the right ascensions, as in the following table:

TABLE No. II.

For Selection of Pairs for Observation with the Zenith Telescope. From 17*h. to* 19*h.*

Stars.	N. or S.	Mag.	Auth.	A. R.	N. P. D.
{ 6238	S	VI	3	18*h* 15*m* 10*s*	61° 11′ 52″
{ 6289	N	V	3	18 21 43	31 17 07
{ 6179	N	III½	3	17 50 56	33 06 09
{ 6147	S	V½	3	18 01 20	59 27 23
{ 6178	S	V	3	18 06 10	58 37 40
{ 6184	N	VI	1	18 07 21	33 45 58
{ 6368	N	VI	2	18 35 35	34 53 24
{ 6427	S	VI	3	18 44 17	57 37 07
{ 6091	N	II	5	17 53 08	38 29 29
{ 6235	S	IV½	3	18 14 37	53 59 59

From 19*h. to* 21*h.*

Stars.	N. or S.	Mag.	Auth.	A. R.	N. P. D.
				h. m. s.	° ′ ″
{ 7008	S	VI	1	20 14 49	51 04 03
{ 7076	N	VII	3	20 23 53	41 34 42
{ 6983	N	IV½	3	20 10 50	42 44 38
{ 6996	S	V½	2	20 12 48	49 43 59
{ 7277	S	IV	3	20 51 35	49 24 29
{ 7301	N	V½	3	20 54 43	43 03 45
{ 7100	S	VI	1	20 27 39	47 19 05
{ 7171	N	I	5	20 36 19	45 15 12
{ 7317	N	VI	1	20 57 03	45 47 55
{ 7333	S	V	3	20 59 29	46 40 06
{ 6851	S	V	3	20 50 41	55 18 47
{ 6928	N	V½	1	20 02 16	37 16 42
{ 6932	N	V	3	20 03 09	28 26 20
{ 6944	S	VI	3	20 05 43	63 57 55
{ 7001	S	VI	1	20 13 30	51 27 48
{ 7062	N	V½	3	20 22 27	41 06 45
{ 7132	S	V½	4	20 31 27	58 59 51
{ 7189	N	VI½	2	20 38 33	33 09 09
{ 6571	S	VI	2	19 06 01	58 57 45
{ 6583	N	V	3	19 08 50	33 23 41

NUMBER III.

Pairs Selected for Observation.

No. of Pair.	Star.	N. or S.	Mag.	Auth.	AR.	N. P. D.	$\Delta+\Delta'$	Z−Z′	ZD.
					h. m. s.	° ′ ″			
1	6109	N	VI	3	17 55 39	44 29 23	92°		1° 46′
	Time μ′ Sagittarii at				18 04 46				
	6203	S	VI	1	18 10 59	47 53 21	22′ 44″	−6 16	1° 38
	Time α Lyræ				18 31 51				
	Time 6599........				19 11 09				
	Time δ Aquilæ....				19 17 55				
2	6681	N	VI½	3	19 23 04	32 16 29	27 53	−1 07	13 59
	6740	S	IV	3	19 33 27	60 11 24			13 56
3	6771	S	V	3	19 38 53	53 00 19	30 19	+1 19	6 45
	6865	N	VI	1	19 52 38	39 30 00			6 45
4	6937	S	V	3	20 03 51	53 35 56	35 08	+6 08	7 20
	6959	N	V	1	20 08 22	38 59 12			7 16
5	7001	S	VI	1	20 13 29	51 27 51	34 39	+5 39	5 12
	7062	N	V½	2	20 22 27	41 06 48			5 09
	Time 61′, Cygni				21 00 11				
6	7398	S	IV½	4	21 11 31	51 13 58	21 23	−7 37	4 59
	7411	N	VI	1	21 14 18	41 07 25			5 08
	Time β Aquarii				21 23 39				

From the table No. II, the pairs which best fulfill the conditions heretofore stated, are selected, and the difference between twice the co-latitude of the place and the sum of polar distances, is entered with its proper sign, $\left(180°-2L-(\Delta_n+\Delta_s)\right)$ this quantity being equal to the difference of the zenith distances of the two stars composing the pair, (since $180°-2L=\Delta_n+\Delta_s+Z_n-Z_s$. L being the latitude Δ_n and Δ_s the polar distances of the star N. and S. of the zenith respectively, and Z_n and Z_s the zenith distances of the same star.)

The object of obtaining the zenith distances approximately, is, so to select the pairs that the sum of all their differences, with their proper signs, shall be nearly zero; which, as before stated, corrects for any error in the determinations of the micrometer values which are used in the observations.

$\Sigma Z - \Sigma Z_1 = 2' \; 41''$ *for* 17 *pairs.*

No. of Pair.	Star.	N. or S.	Mag.	Auth.	AR.	N. P. D.	△+△'	Z − Z'	ZD.
					h. m. s.	° ' "		' "	
1	6109	N	VI	3	17 55 39	44 29 23	92°		1° 46'
	Time, μ' Sagittarii at				18 04 46				
	6203	S	VI	1	18 10 59	47 53 21	22'·44"	−6 16	1 38
	Time, α Lyræ ...				18 31 51				
	Time, 6599				19 11 09				
	Time, δ Aquilæ ..				19 17 55				
2	6681	N	VI½	3	19 23 04	32 16 29			13 59
	6740	S	IV	3	19 33 27	60 11 24	27 53	−1 07	13 56
3	6771	S	V	3	19 38 53	53 00 19			6 45
	6865	N	VI	1	19 52 38	39 30 00	30 19	+1 19	6 45
4	6937	S	V	3	20 03 51	53 35 56			7 20
	6959	N	V	1	20 08 22	38 59 12	35 08	+6 08	7 16
5	7001	S	VI	1	20 13 29	51 27 51			5 12
	7062	N	V½	2	20 22 27	41 06 48	34 39	+5 39	5 09
	Time, 61', Cygni, ..				21 00 11				
6	7398	S	IV½	4	21 11 31	51 13 58			4 59
	7411	N	VI	1	21 14 18	41 07 25	21 23	−7 37	5 08
	Time, β Aquarii,...				21 23 39				
7	7598	N	V	3	21 41 15	41 23 03			4 52
	7614	S	VI	1	21 44 52	51 09 56	32 59	+3 59	4 54
8	7803	S	VI	1	22 15 38	47 00 37			0 45
	7894	N	VI½	3	22 31 48	45 35 50	36 27	+7 27	0 40
9	153	N	IV	3	00 28 38	36 55 50			9 20
	158	S	VI	3	00 29 20	55 25 43	21 34	−7 26	9 10
10	226	N	VI	1	00 41 13	43 03 18			3 12
	283	S	VI	3	00 54 29	49 27 54	31 12	+2 12	3 12
11	318	S	V	3	00 59 25	46 51 35			0 36
	352	N	VI	3	01 03 54	45 27 50	19 25	−9 35	0 47
12	487	N	III½	3	1 28 48	42 08 06			4 07
	502	S	V	3	1 31 44	50 11 13	19 19	−9 41	3 56
13	649	S	V½	3	1 59 27	52 51 20			6 36
	673	N	V½	3	2 03 38	39 38 07	29 27	+0 27	6 37
14	706	N	V	3	2 09 37	43 18 55			2 57
	727	S	V	3	2 13 31	49 17 18	36 13	+7 13	3 02
15	819	N	VI	1	2 32 26	37 07 08			9 08
	877	S	V½	3	2 42 16	55 33 47	40 55	+11 55	9 18
16	915	S	V½	2	2 49 45	55 25 27			9 10
	947	N	III½	3	2 53 57	37 05 11	30 38	+1 38	9 10
17	953	S	IV	3	2 55 34	51 44 44			5 29
	1043	N	II½	4	3 13 37	40 40 42	25 26	−3 34	5 35
							Sum	+ 47' 57"	
							"	− 45' 16"	
							ΣZ−ΣZ' =	+ 2' 41"	

The places of the stars are next accurately worked up by the method laid down in the preface to the B. A. C.

The forms used for computing the observations with the zenith telescope are shown, in the annexed tables. There are briefer methods; but this one has the advantage that all the quantities are spread out in the table, so that a second computer (the office computer) who differs from the first (the field computer) may trace, readily, the source of discrepancy.

DATE.	No. * B. A. C.	N. or S.	Micrometer. Turns.	Micrometer. Divis.	Diff. Z. D. By Mic.	Diff. Z. D. Arc.	180°—Sum of Polar Distances.	Twice Approx. Latitude.	Levels. N.	Levels. S.	State of level.	Merid. Dist.	Red. to Merid.	CORRECTIONS. Level.	CORRECTIONS. Merid.	CORRECTIONS. Refrac.	Twice lat.	Latit'de
1849.	6983	N	5	30·2			42 44 20·04		58·0	34·6								
Sep. 20	6996	S	4	15·0			49 43 41·46	87°	37·0	55·6							87° 30′	43° 45′
					−115·2	−0′ 51″·86	92 28 01·50	30 66·64	95·0	90·2	+ 4·8			+2·15		−0·02	68 77	34″·39
							87 31 58·50											
	6983	N	4	91·5			42 44 19 87		45·1	46·2								
" 21	6996	S	3	85·3			49 43 41·30		41·2	50·2								
					−106·2	−0′ 47 ·81	92 28 01·17	30 71·02	86·3	96·4	−10·1			−4·54		−0·02	66 46	33″·23
							87 31 58·83											
	6983	N	8	3·0			42 44 19·30		47·0	3·80								
" 25	6996	S	6	91·3			49 43 40·79		38·0	47·0								
					−111·7	−0′ 50 ·29	92 28 00·09	30 69·62	85·0	85·0	− 0·0			−0·00		−0·02	69 60	34″·80
							87 31 59·91											
	6983	N	5	88 8			42 44 19·04		41·0	56·0								
" 27	6996	S	4	79·0			49 43 40·56		57·0	40·0								
					−109·8	−0′ 49 ·43	92 27 59·60	30 70·97	98·0	96·0	+ 2·0			+0·90		−0·02	71 85	35″·92
							87 32 00·40										Mean =	34″·58

In discussing the results of the observations, the first step is to ascertain the probable error of observation. For this purpose, the latitude which results from each observation, on each pair of stars, is compared with the mean latitude, from all the observations on that pair. If the observations were numerous, of course the probable accidental error would be thus obtained with more precision than in the actual case.

The following table gives a convenient form for applying this method. The results were obtained by one of the sub-assistants in the U. S. Coast Survey, at Mount Independence, with the Zenith Telescope of the Coast Survey, No. 3.

For Probable Error of a Single Observation.

No. of Pairs.	Results for Latitude.	x	$(a-x)$	$(a-x)^2$
I	37·92			
	35·71		1·79	3·2041
II	33·01		·91	·8281
(4)	32·90		1·02	1·9400
	34·05		·13	·0169
		33·92		
	36·15		·05	·0025
III	27·84		1·64	2·6896
(4)	34·59		1·61	2·5921
	36·23		1·03	·0009
		36·20		
	42·41		·67	·4489
IV	41·44		·36	·0900
	41·50		·24	·0576
(4)	41·60		·14	·0196
		41·74		
	31·97		·28	·0784
V	32·80		·55	·3025
(5)	32·55		·30	·0900
	31·44		·81	·6561
	32·48		·23	·0529
		32·25		
	29·81		1·39	1·9321
	28·22		·20	·0400
VI	28·11		·31	·0961
(5)	26·72		1·70	2·8900
	29·24		·82	·6724
		28·42		
	34·39		·19	·0361
	33·23		1·35	1·8225
VII	34·80		·22	·0484
	35·92		1·34	1·7956
(4)		34·58		
				21·5038

SUMMARY.	
I, II, III, IV, sum of sqs.	10·9907
V, VI, VII,	10·5131
VIII, IX, X,	6·0435
XI, XII, XIII, XIV,	8·5117
XV, XVI, XVII, XVIII,	6·7534
XIX, XX, XXI, XXII,	7·8312
XXIII, XXIV, XXV, XXVI,	7·3678
XXVI, XXVII, XXVIII,	5·5054
XXIX, XXX, XXXI,	6·9242
XXXII, XXXIII,	2·3263
$\Sigma(a-x)^2 =$	72·7673

Number of observations, $x = 150$

" " pairs, $v = 32$ $m^2 = \Sigma\left(\frac{a-x}{x-v}\right)^2 = \frac{72 \cdot 7673}{118} = 0 \cdot 6167$

$x - v = \overline{118}$

Then $0 \cdot 6167 = \Sigma(a-x)^2$ on a single pair having but a single observation upon it.

The probable error of one observation $= \sqrt{\cdot 4549 \times 0 \cdot 6157} =$ 0″·53

" " " " the result of a pair having three observations upon it, ... 0·31

For four observations upon a pair, ... 0·27

" five " " " . . . . 0·24

" six " " " . . . . 0·22

" seven " " " . . . . 0·20

From this, results the mean probable error of any number of observations upon a pair of stars, by dividing the value just found by the square root of the number of observations.

We are now prepared to estimate the error of the places of the stars used; for the discrepancies which they show are composed of errors of observation and of errors of the catalogue,* if the computations have been rightly made. The form in which this discussion is made is given in the annexed table, with the results.

Number of Pairs.	Number of Star in B. A. Catalogue.		Mean of each pair. x	Mean latitude. a	$a \backsim x$	$(a \backsim x)^2$
I	6368	6427	37·92	34″·50	3·42	11·6964
II	6497	6522	33·92		·58	·3364
III	6571	6583	36·20		1·70	2·8900
IV	6673	6712	41·74		7·24	52·4176
V	6745	6754	32·25		2·25	5·0625
VI	6851	6928	28·42		6·08	36·9664
VII	6983	6996	34·58		1·23	·0064
VIII	7008	7076	33·27		·08	1·5129
IX	7100	7171	34·55		·05	·0025
XXXIII	953	1043	35·12		·62	·3846
		33	1138·66	$\Sigma(a-x)^2$		169·6906
Mean lat. $=43^\circ\ 45'\ 34''\cdot50$					ΣM^2	4·4418
					Diff.....	165·2488

For $x-1$ pairs.

$$e^2 \text{ Catalogue} = \frac{\Sigma(a-x)^2 - \Sigma M^2}{x-1} = \frac{165\cdot2488}{32} \quad \begin{array}{l}\text{Log.} = 2\cdot21814 \\ \quad " \quad = 1\cdot50515\end{array}$$

$$0\cdot71299$$

$$\cdot4549 \quad " \quad = 9\cdot65792$$

$$e^2 \text{ Cat.} = 0\cdot37091$$

$$e \text{ Cat.} = 1''\cdot53 = 0\cdot18545$$

Probable error of position of one pair of stars, given in B. A. Catalogue, . . . $=1''\cdot53$

The omission of the observations on the four pair of stars having the greatest probable error, would reduce the average Catalogue error of each pair to $0''\cdot95$, and alter the mean latitude but $0''\cdot05$. The omission of five pairs, having the next greatest probable errors, would but slightly change the probable error of the Catalogue, (to $0''\cdot93$), while it would affect the mean latitude $+0''\cdot32$. The effect of a few very discordant results on the probable error is not peculiar to these results, or confined to this class of observations.

A general comparison of the results obtained in the Coast Survey,—as I propose, on some other occasion, to show,—confirms

* This supposes the error of micrometer value to be too small to enter into the discussion.

the conclusion here deduced, that the weak point of this method is in the Catalogue places of the small stars used. The steps which have been taken to obtain determinations of these, in connection with the Survey, I hope, also, to bring before the Association. In the meanwhile, we multiply the number of pairs of stars, and make a number of observations on each pair; which would keep our results in due relation to those of the Catalogue, if much more perfect than at present.

Art. XXIII.—*Contributions to Analytical Chemistry;* by Wolcott Gibbs, M.D.

In an interesting memoir* on the analogy between the chemical relations of peroxyd of lead and the so-called ozone, Schönbein has pointed out the remarkable fact that peroxyd of lead precipitates manganese completely from its solutions in chlorhydric and sulphuric acids, a compound of peroxyd of lead and peroxyd of manganese being formed. A portion of the lead is at the same time reduced to protoxyd and unites with the acid with which the manganese was combined: the oxydizing action which takes place may be represented by the general equation

$$Pb\,O_2 + Mn\,O\,.\,XH = Mn\,O_2 + Pb\,X + HO.$$

Schönbein appears not to have remarked the importance of this observation in an analytical point of view. In investigating the subject carefully I have been led to the conclusion that the peroxyd of lead constitutes one of the most valuable reagents in analytical chemistry, since by means of it the oxyd of manganese may be easily and completely separated from a number of other bases without the employment of ammoniacal salts. The use of ammonia, as is well known, frequently renders analyses conducted by the ordinary methods laborious and inaccurate, either from the number of operations involved, from the absorption of carbonic acid from the air, or from the unavoidable loss in driving off the ammoniacal salts by heat. The facts which I have determined and which serve as the basis of the analytical applications of the peroxyd of lead are as follows.

1. Peroxyd of lead completely precipitates manganese from its neutral solutions in chlorhydric, sulphuric, and nitric acids, slowly in the cold, but very rapidly by digestion or by boiling.

2. The presence of an excess of chlorhydric or sulphuric acid does not prevent the complete precipitation of the manganese; in these cases, however, chlorine or oxygen is set free, and the quantity of lead dissolved is greater than that which corresponds to the quantity of manganese precipitated. Such an excess of acid should be avoided as far as possible.

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* Pogg. Ann., lxxviii, 162.

3. The presence of an excess of nitric acid prevents the precipitation of the manganese, since, as Crum long since showed, hypermanganic acid is formed and remains in solution.

4. Tartaric acid and those organic substances which are burned at the expense of the peroxyd of lead, do not interfere with the precipitation of the manganese. The organic matter is first destroyed by the oxygen of the peroxyd of lead, and afterward the manganese is precipitated by the excess of the peroxyd added. When the quantity of organic matter present is large it is always better to separate the manganese by means of sulphydrate of ammonium in the usual manner.

5. When, however, oxalic acid is present, we may avoid the use either of an inconvenient quantity of peroxyd of lead, or of sulphydrate of ammonium, by means of chlorine or bromine. Either of these agents readily converts oxalates into carbonates by a well known reaction, $RO, C_2O_3 + Br = RrB + 2CO_2$.

6. The presence of an excess of free acetic or succinic acid does not prevent the complete precipitation of manganese by peroxyd of lead.

7. The same observation applies to the presence of sulphate, nitrate, and chlorid of ammonium, and therefore, probably, to all ammoniacal salts.

8. Salts of protoxyd of iron are oxydized and partially precipitated by peroxyd of lead.

9. The same remark applies to the salts of cobalt. The precipitation is not complete even after long digestion upon the sandbath.

10. The salts of nickel and zinc are not precipitated by peroxyd of lead, and the nickel undergoes no higher oxydation.

11. Peroxyd of lead when perfectly free from protoxyd does not precipitate baryta, strontia, lime, magnesia, or alumina from their solutions. The same remark applies as might be supposed, à fortiori, to the alkaline bases. The application of these facts to the quantitative separation of manganese from the above mentioned bases, with the exception of iron and cobalt, is obvious. The different cases deserve however to be considered separately.

Manganese from potash and soda.—Peroxyd of lead is to be added to the neutral solution of the three bases in chlorhydric, nitric or sulphuric acid; the whole is then to be digested upon the sandbath for an hour at a temperature of 85° C., care being taken to agitate the solution frequently and thoroughly with a glass rod. For every gramme of matter analyzed it is well to employ about five grammes of peroxyd of lead. After digestion the solution is to be filtered and the mass upon the filter thoroughly washed with hot water. The filtrate contains the alkaline bases and lead, but is absolutely free from manganese. The lead is to be separated by means of a current of sulphuretted hydrogen, and in the filtrate from the sulphide of lead the alkalies are to be determined in the usual manner; as there are no ammoniacal salts present the estimation of the alkalies offers no difficulty when they are in the form of chlorids. When but a single alkali is present its quantity may be determined by simple evaporation to dryness and ignition. The mass upon the filter after washing consists only of the peroxyds of lead and manganese. The filter is to be dried, ignited gently in a porcelain crucible, and then heated with fuming nitric acid which speedily produces a colorless solution. This is to be diluted sufficiently with water and the lead separated by sulphuretted hydrogen. The filtrate from the sulphide of lead contains only manganese which may then be determined as usual by carbonate of soda. In the above process it is almost always best to reduce the bases to be separated to the form of chlorids. The separation of the lead is much less easy when sulphates are present, while on the other hand the presence of nitric acid renders it difficult subsequently to determine the alkalies. When however but one alkali is present with manganese, we may employ a solution of the nitrates, since in this case the alkali after the separation of the lead may be estimated by fluosilicic acid and alcohol, as recommended by Rosé. When the solution of the bases is acid it may be neutralized with carbonate of lead, but this should be avoided if possible, since it is not desirable to introduce more lead into the solution than is absolutely necessary.

When, as is generally the case in mineral analyses, iron is associated with manganese and the alkalies, it is most advantageous to peroxydize the iron by means of chlorine or bromine, and then to separate it from the other bases by means of carbonate of baryta. After the separation of the iron, the manganese may be separated from the alkalies by the methods above given, the presence of a salt of baryta not interfering in the process.

Separation of manganese from baryta, strontia, lime, magnesia and alumina.—The separation of manganese from these bases may be effected by the same process as that given above for its separation from the alkalies. When the alkalies are also present in the solution, all the bases should be if possible in the form of chlorids. When this is not the case, however, it is most convenient to employ the bases in the form of nitrates, avoiding the least excess of free nitric acid. After the digestion upon the sandbath and before filtering, it is well to add a few drops of nitric acid, when magnesia or alumina are present; the acid however should only be added after the solution has become nearly cold and when no alkalies are present. When iron is also present but no alkalies, we may peroxydize and precipitate it by ammonia, and then separate the manganese from the filtrate by means of peroxyd of lead. In this case of course the precipitated peroxyd of iron also contains manganese which must be separated in the usual manner. When however the alkalies are present, we may separate the iron and alumina by means of carbonate of baryta, and then determine the manganese as above, thus avoiding the presence of ammoniacal salts in the solution.

Separation of manganese from zinc and nickel.—The processes to be followed in this case are the same as in the last. The addition of a few drops of nitric acid to the solution after digestion and cooling is advantageous, as the precipitation of a trace of zinc or nickel by any minute quantity of *protoxyd* of lead which may be present is prevented. The peroxyd of lead is a reagent of especial value for the separation of manganese from zinc, but is less serviceable where manganese is to be separated from nickel, since this metal is usually associated with cobalt. When cobalt and nickel are both to be separated from manganese, Ebelman's method appears preferable to any other. From what has already been stated (8 and 9) it will be evident that the peroxyd of lead cannot be employed to separate manganese from iron and cobalt. On the other hand, however, it is highly probable that this reagent will effect the perfect separation of manganese from glucina, zirconia, and the metals of the cerium group. But upon this point the writer cannot speak from actual experiment.

For the analysis of a mineral which contains silica, alumina, oxyd of iron, manganese, lime, magnesia, and the alkalies, I propose the following process which appears, a priori, likely to prove advantageous. The silica is first to be separated in the usual manner by chlorhydric or fluohydric acid. The solution of the bases, after peroxydizing the iron, is to be treated with carbonate of baryta to separate alumina and iron. To the filtrate from these bases peroxyd of lead is to be added to separate the manganese. The filtrate, after separating the lead by means of sulphuretted hydrogen, will then contain baryta, lime, magnesia, and the alkalies, which are to be separated in the usual manner. By this method we may avoid in a great measure, if not entirely, the presence of ammoniacal salts, and obtain more accurate determinations of the lime and manganese than by the ordinary process.

As the investigations which form the subject of the present paper have been chiefly of a qualitative character, it was a matter of especial importance to the writer to possess a sufficiently delicate test for manganese. Crum's test offered of all others the greatest advantages; but as in the original paper in which this test is described it is simply stated that the reaction is a very delicate one, and as the circumstances which modify or prevent its process are not alluded to, it became necessary to make this point the subject of special study. The results obtained in this investigation are as follows:

1. By means of Crum's test it is easy to detect the presence of the $\frac{1}{100000}$ of manganese in a solution otherwise colorless. With proper care a much smaller quantity of the metal may be detected, but the above will form a good *practical* limit to the sensibility of the reaction.

2. The manganese in this reaction may be present as chlorid, nitrate, sulphate or phosphate, without effecting the result.

3. The presence of sulphate or nitrate of ammonium even in very large excess does not sensibly affect the delicacy of the reaction.

4. The presence of chlorid of ammonium in small quantity does not affect the reaction. When, however, the chlorid is present in great excess, it is necessary to add a very large proportion of peroxyd of lead in order to obtain the characteristic rose or violet tint, as the lead is reduced to a chlorid so long as there is sal-ammoniac in the solution. In this case, therefore, it is better to precipitate the suspected liquid by sulphydrate of ammonium, and then to test the precipitate by nitric acid and peroxyd of lead.

5. When organic substances are present, the solution should either be evaporated to dryness and ignited, or else precipitated by sulphydrate of ammonium, and the precipitate tested. The first method would probably answer best in testing mineral waters.

6. The bases to be tested for manganese may be present as nitrates, sulphates, or chlorids. In the latter case the characteristic violet or rose color makes its appearance, even though chlorine is copiously evolved from the solution, on boiling with the nitric acid and peroxyd of lead.

7. The presence of iron even in large excess does not very sensibly affect the delicacy of the reaction.

8. The presence of an excess of a salt of nickel completely prevents the reaction for manganese, the violet color of the hypermanganic acid being lost in the green of the nickel compound.

9. The presence of a small excess of a salt of cobalt does not materially affect the reaction for manganese. It is, however, impossible by the direct application of Crum's test to detect the presence of a small quantity of manganese in a large quantity of a cobalt compound.

10. The difficulty which arises in the application of Crum's test when cobalt or nickel is present, may be completely avoided by the following process, which is based upon the observation of Maumené that the colors of solutions of cobalt and nickel are complementary to each other. The solution of cobalt which is suspected to contain manganese, is first to be freed as completely as possible from arsenic, copper, and iron. To a portion of this solution contained in a test tube, a solution of a pure salt of nickel is to be gradually added until the color of the mixed fluid vanishes or becomes almost insensible. Nitric acid and peroxyd

of lead are then to be added, and the whole boiled for a few seconds, when the characteristic tint will appear if but a trace of manganese be present. The same process is to be applied in testing solutions of nickel for small quantities of manganese, a pure solution of cobalt being added till the original green color of the solution is destroyed. It rarely happens in the application of this method that a perfectly colorless solution can be obtained; usually the mixed solution has a faint brown tinge like that of commercial sulphuric acid. This tint, however, has no sensible influence on the result.

11. In all cases in which Crum's test is employed the color of the liquid must be observed immediately after boiling and subsidence of the excess of peroxyd of lead, as the tint fades when the solution is exposed to air and light.

The constitution of the black substance which is precipitated from solutions of manganese by peroxyd of lead has not yet been satisfactorily determined, in consequence of the difficulty of obtaining it perfectly free from an excess of peroxyd of lead, and I propose to resume the subject in another paper. It appears, as stated by Schönbein, to be a chemical combination of the peroxyds of lead and manganese; its chemical relations are as follows:—Chlorhydric acid readily dissolves it, even in the cold; the solution has a dirty brown color, and evolves chlorine copiously on heating, becoming colorless. Red and fuming nitric acid gradually dissolves it with the aid of heat; ordinary nitric acid, nearly free from nitrous acid, dissolves but a very small portion even after long digestion. Sulphuric acid has no action in the cold, but on heating evolves oxygen, while sulphate of lead is found. Oxalic and tartaric acids are readily oxydized by digestion with the black compound, with evolution of carbonic acid, and formation of carbonates of lead and manganese.

In another memoir I shall return to this subject and give the results of quantitative analyses, conducted according to the methods pointed out in the present communication. It may be proper to state in conclusion, that the peroxyd of lead employed in the above mentioned investigations was obtained by the action of chlorine upon hydrate of protoxyd of lead suspended in water. The resulting mixture of chlorid and peroxyd was thoroughly washed with boiling water to separate the chlorid, and then repeatedly digested with nitric acid to remove every trace of protoxyd of lead, washed and dried. As thus prepared the peroxyd is very dark brown, or nearly black; the commercial peroxyd, which is prepared by the action of nitric acid upon minium, cannot be used either in qualitative or quantitative analysis, as it contains iron and manganese as well as the other impurities of the minium employed.

New York, July 18th, 1852.

Art. XXIV.—*On Certain Analogies in the Solar System*; by
Professor Daniel Kirkwood, of Delaware College.

I. *The Rotations of the Planets.*—When we compare the distances of the planets with their times of orbitual revolution, we cannot fail to observe that a greater period always corresponds to a greater mean distance—suggesting at once the important fact, that the former varies according to some function of the latter. This is the great truth which underlies the celebrated third law of Kepler. The case is very different, however, when we come to compare the periods of rotation. Here no order or connection is at first apparent. Jupiter, the first planet exterior to the asteroids, is the *largest* in the system, and has the *shortest* period of rotation. Mars, the next *interior* to this group, is, with the exception of Mercury, the smallest of the eight principal planets, and is the *longest* in completing its diurnal revolution. Saturn, whose diameter is rather *less* than that of Jupiter, has a *longer* time of rotation; while Venus, whose volume is somewhat less than that of the Earth, revolves on its axis in a *shorter* period. Again: Venus, the planet next *interior* to the earth's orbit, and Mars, the first *exterior*, have nearly the same density; while the rotation period of the one is forty minutes *less*, and of the other forty minutes *greater* than that of our planet. Thus whether we compare the masses, volumes, or distances of the planets, we find the same apparent independence in regard to their rotations. This fact has been noticed by various writers. "We know as yet," says Humboldt, "of no inherent necessity, no mechanical, natural law, similar to the one which teaches us that the squares of the periodic times are proportional to the cubes of the major axes, by which the above named six elements* of the planetary bodies and the form of their orbit are made dependent either on one another, or on their mean distance from the Sun."† "There is no apparent reason," remarks another distinguished writer, "why this globe should turn on its axis just three hundred and sixty-six times while it describes its orbit round the Sun. The revolution of the other planets, so far as we know them, do not appear to follow any rule by which they are connected with the distance from the sun. Mercury, Venus, and Mars have days nearly the length of ours. Jupiter and Saturn revolve in about ten hours each. For any thing we can discover, the earth might have revolved in this or any other smaller period; or we might have had, without mechanical inconvenience, much longer days than we have."‡

* Viz.: "Their absolute size, density, period of rotation, eccentricity, and the inclinations of their orbits and the axes." † Cosmos, vol. i, p. 77.
‡ Whewell's Astronomy and General Physics, p. 27.

Again, "we cannot see anything which could have prevented either the size or the density of the earth from being different, to a very great extent, from what they are."*

The first attempt, so far as I know, to develop a connection between those apparently independent elements, was made by the writer a few years since. Finding, generally, that law and harmony characterize the operations of nature around us, I have ever thought it extremely improbable, since my attention was first turned to the subject, that the Creator had, in this instance, departed from his ordinary mode of action. The result of these efforts has been now nearly three years before the public, and has attracted some degree of attention. The most recent notice with which it has been honored is that of Professor Cherriman, whose article in the last number of the *American Journal of Science and Arts* has suggested the propriety of a brief re-discussion of all the known facts which have an immediate and obvious bearing upon this interesting subject.

The quantities to be used in our examination, it will be observed, are extremely various. Thus Jupiter's mass is about 3,000 times greater than Mercury's; the interval between Saturn and Uranus when in conjunction is 33 times greater than that between Venus and the Earth in similar circumstances; and the number of Saturn's days in his year is 280 times greater than the number of Mercury's. If, therefore, all the known elements of the solar system, so far as applicable, consisting of magnitudes so widely different, harmonize together in a complicated formula, is it not, to say the least, extremely probable that this formula is the expression of a law of nature?

In the able "examination" of my analogy by Sears C. Walker, Esq.,† a numerical error in Jupiter's time of rotation was admitted. In constructing the following table I have, besides correcting this mistake, used masses somewhat different from Walker's. It is well known that there is some uncertainty in regard to the quantity of matter in several of the planets: an *exact* agreement with all the *received* values is therefore not to be expected. All that can be demanded is an approximation so close as to come within the limits of error of the masses. The distances, sidereal revolutions, and axial rotations which I have employed are those used by Professor Loomis.‡ I have adopted Encke's masses of the Earth, Jupiter, and Saturn; the last, however, may hereafter require some slight modification. For Uranus, I have employed the latest determination, that of Struve, from

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* Whewell's Astronomy and General Physics, p. 32.

† See this Journal, [2], x, 22.

‡ Ibid. [2], xi, 219. In Loomis's table the mass of the Earth alone was erroneously used instead of the sum of the masses of the Earth and Moon.

his observations in 1848. The resulting diameter of Saturn's sphere of attraction is

$$D=8{\cdot}618608,$$

and the corresponding value of the constant of rotation is

$$\frac{n}{D^{\frac{3}{2}}}=C=972{\cdot}929,$$

where $n=$ the number of axial rotations performed during one revolution round the sun. The values of D for the other planets whose periods of rotation are known, are then determined from the formula

$$log.\,D=\frac{2}{3}(log.\,n-log.\,C).$$

If we assume that the adopted values of m for Jupiter, Saturn and Uranus are entirely correct, the received masses of Mercury, Venus, and Mars will not perfectly harmonize with my analogy. My tabular masses of the two latter differ from the received masses by about one-seventeenth of their values. That of Mercury differs from Leverrier's mass by about one-fiftieth. Are these interpolated masses admissible?

It is distinctly stated by Humboldt that these elements for the three planets mentioned probably need correction.* "The masses of Mercury and Venus," says Captain Smyth,† "are still subject to discussion, since the question is surrounded by every difficulty, as neither of them has a satellite." In regard to Mars, Mr. Hind remarks, that "in the absence of a satellite to afford us a more exact value, we can only be said to have *approximated* to the mass of the planet."‡ It is unnecessary to quote other authorities. That the received mass of each of these planets may be in error to the amount of one-seventeenth of its value, will hardly be called in question.

To interpolate the elements of the asteroid-planet, we have the equations :—

$$\frac{\mu}{\varrho'^2}=\frac{M}{R^2} \quad \ldots\ldots\ldots\ldots \quad (1)$$

$$\frac{\mu}{\varrho_{,}^2}=\frac{m}{r^2} \quad \ldots\ldots\ldots\ldots \quad (2)$$

$$\Delta=\varrho'+\varrho_{,} \quad \ldots\ldots\ldots\ldots \quad (3)$$

$$\delta=d+r+\varrho_{,} \quad \ldots\ldots\ldots\ldots \quad (4)$$

whence

$$\varrho_{,}=\frac{r\Delta\sqrt{M}}{r\sqrt{M}+R\sqrt{m}},$$

* Cosmos, vol. iv, pp. 445, 472, 503.
† Cycle of Celestial Objects, vol. i, p. 106.
‡ Hind's Solar System, p. 78.

$$\mu = m\left(\frac{\varrho_{,}}{r}\right)^2,$$

$$\delta = d + r\left(\frac{\varDelta\sqrt{\mathrm{M}}}{r\sqrt{\mathrm{M}} + \mathrm{R}\sqrt{m}} + 1\right),$$

where

m = the mass of Mars,
μ = " the asteroid planet,
M = " Jupiter,
r = the outer radius of Mars's sphere of attraction,
R = the inner " Jupiter's " "
$\varDelta$ = the diameter of the asteroid planet's sphere of attraction,
ϱ' = the outer radius " " " "
$\varrho_{,}$ = the inner " " " " "
d = the mean distance of Mars from the sun,
δ = " " the asteroid planet from the sun.

If the asteroids, however, are considered as independent planets, the analogy is still applicable to Mars and Jupiter: Flora, the nearest of those bodies, being immediately exterior to the outer limit of Mars's sphere of attraction; and the mean distance of Hygeia, the most remote, nearly corresponding with the interior limit of that of Jupiter.

TABLE I.

Planetary Elements conforming with Kirkwood's Analogy.

Planet.	Mean Distance.	Distance to next exterior orbit.	Mass.	Period.	Rotation.	Diam. of Sph. of attraction.	Outer Radius.	Inner Radius.
	d	b	m	P	p	D	r'	$r_{,}$
				d.	*h. m. s.*			
Mercury,	·03870981	·3362335	$\frac{1}{2935873}$	87·96925	24 5 28·3	·200979	·088919	·112060
Venus,	·7233316	·2766684	$\frac{1}{379515}$	224·7007869	23 21 21·9	·383390	·136076	·247314
Earth,	1·0000000	·5236923	$\frac{1}{355499}$	365·256361	23 56 4·09	·521349	·380756	·140592
Mars,	1·5236923	1·544983	$\frac{1}{2522609}$	686·979645	24 37 20·4	·779537	·636601	·142936
Ast. Planet	3·068675	2·134101	$\frac{1}{1238931}$	1969·		·968693	·060311	·908382
Jupiter,	5·202776	4·3360101	$\frac{1}{104787}$	4332·5848	9 55 26·5	4·876551	2·802761	2·073790
Saturn,	9·538786	9·643604	$\frac{1}{35016}$	10759·21	10 29 16·8	8·618608	7·085359	1·533249
Uranus,	19·18239	10·85711	$\frac{1}{26860}$	30686·8208	37 19 ?	7·437871	4·879626	2·558245
Neptune,	30·03950		$\frac{1}{17900}$ *	60126·7000				

On the Application of this Analogy to Mercury.—The statement of Professor Cherriman that my analogy is inapplicable to Mercury is but partially correct: the *mass* and *distance* of this planet conform with the law in question. The inner radius of Mercury's sphere of attraction, however, extends to a considerable distance within the orbit. This would seem to indicate, (1) the existence either of a planet or a ring of minute asteroids interior to Mercury's orbit; or, (2) that the original nebulous ring was from some cause precipitated upon the sun. For several

* Hind's value, found by a combination of all the observations of the satellite. (See Hind's Solar System, p. 136.)

years I have had a growing belief that Mercury is not the nearest planet to the center of our system. This conjecture was first suggested by the fact that the ratio of the sun's diameter to Mercury's distance is much greater than that of the diameter of any planet to the distance of its nearest satellite. My confidence in the existence of such a body was strengthened by the discovery of the analogy in the periods of rotation of the planets. The distance from the center of the sun to the limit at which the centrifugal and centripetal forces would be in equilibrium is ·168; that to the inner limit of Mercury's sphere of attraction, ·275. Hence the probability that in this interval there may be an undiscovered planet. The existence of this hypothetical body seems also to be indicated by a certain order found to prevail in the arrangement of the planetary masses. This will be referred to hereafter. Upon the whole, I cannot but regard the probabilities as sufficiently strong to justify some search for the planet. Admitting its existence, an interesting question arises in regard to its perturbative influence on Encke's comet. Perhaps the diminution in the period of the latter might in this way be at least partially accounted for.

Application to the Asteroids.—If it be asked, what is the bearing of this analogy on the *Olbersian* hypothesis of the origin of the asteroids?—I answer, it does not essentially require that those bodies should ever have been united in *one* perfect planet. It merely indicates what *would have been* the mass, mean distance, and time of rotation of the resulting planet, had all the matter in the primitive ring collected about a single nucleus. If, however, we admit the hypothesis of an explosion, may we not likewise suppose a subsequent disruption of some of the larger fragments? In this case it might be impossible to trace all the resulting asteroids to the first point of separation.

But it seems more probable that those small planets were formed by the separation of the primitive mass while in the nebular state, or at least previous to its solidification. This separation may have been produced by the perturbative influence of the other planets—chiefly that of Jupiter—either on the original ring, as suggested by Professor Peirce,* or on the asteroid-planet while in its primordial condition. In regard to the perturbations of this asteroid-ring, the following considerations may be worthy of notice:

1. Owing to the proximity of the asteroid-orbit to the enormous mass of Jupiter, the disturbance would be very much greater than in any other part of the planetary system.

2. The breadth of the ring, or the primitive diameter of the planet, was probably such that the influence of Jupiter on opposite sides would be very unequal.

* Gould's Astronomical Journal, No. 27.

3. The period, (1969 days according to Table I.) which my analogy assigns to the asteroid-planet, is almost exactly commensurable with that of Jupiter; eleven of the former being about equal to five of the latter.

4. If we assume that the period of Encke's comet has diminished uniformly at the present rate, the time of revolution, at no very remote epoch, was 1238 days; that is, seven of its periods were precisely equal to two of Jupiter's.

5. Among the swarms of minute asteroids which may be supposed to revolve in this zone, there have probably been many whose periods were commensurable with that of Jupiter. Those completing a revolution in 1444 days—precisely one-third of Jupiter's period—would be in conjunction with that planet, in the same point of the orbit once in every 4332 days. The consequence in such case would be a permanent derangement.

6. It is possible that in consequence of mutual attractions, intersections of orbits, &c., new combinations and aggregations of matter not unfrequently occur in this part of the planetary system. Important discoveries, I have no doubt, are yet to be made in regard to those mysterious objects.

When my analogy was discovered no asteroid had been detected beyond the orbit of Pallas. Since that time, however, two of those small bodies, Hygeia and Psyche, have been found at distances considerably greater: the orbit of the former being exterior to that of the primitive (hypothetical) planet, and that of the latter nearly coinciding with it. The mean distances, periods, and inclinations of the small planets, together with the date of the discovery of each, are as follows:

TABLE II.

Name.	Mean dist.	Period.	Inclination.	Date of discovery.	Discoverer.
Flora, ...	2·2018	1193*d*	5° 53′	1847, October 18,	Hind.
Clio, ...	2·3349	1303	8 23	1850, Sept. 13,	Hind.
Vesta, ...	2·3612	1325	7 8	1807, March 29,	Olbers.
Iris, ...	2·3855	1346	5 28	1847, August 13,	Hind.
Metis, ...	2·3862	1346	5 36	1848, April 25,	Graham.
Hebe, ...	2·4249	1379	14 47	1847, July 1,	Hencke.
Parthenope, ...	2·4483	1399	4 37	1850, May 11,	De Gasparis.
Thetis, ...	2·4612	1410	5 36	1852, April 17,	Luther.
Astræa, ...	2·5774	1511	5 19	1845, December 8,	Hencke.
Egeria, ...	2·5825	1516	16 33	1850, November 2,	De Gasparis.
Irene, ...	2·5849	1518	9 6	1851, May 19,	Hind.
Eunomia, ...	2·6476	1574	11 49	1851, July 19,	De Gasparis
Juno, ...	2·6687	1592	13 3	1804, September 1,	Harding.
Ceres, ...	2·7673	1681	10 37	1801, January 1,	Piazzi.
Pallas, ...	2·7729	1687	34 37	1802, March 28,	Olbers.
Psyche, ...	3·0661	1961	3 30	1852, March 17,	De Gasparis.
Hygeia, ...	3·1514	2043	3 47	1849, April 12,	De Gasparis.

Application to Uranus.—The rotation-period of Uranus has never been determined by observation. With the masses adopted in Table I. it is found, according to my analogy, to be about

37 hours. It has been objected, however, that a more rapid rotation would seem to be indicated by Mädler's determination of the ellipticity. In addition to my remarks on this subject in a former number of this Journal,* I will merely state that Mädler's measurement has not been confirmed. "Other astronomers, with more powerful telescopes, have not succeeded in gaining any certain evidence of an appreciable difference in the diameters."† Mr. O. Struve states "that the grand refractor at Pulkova affords no indications of ellipticity." If any thing, therefore, can be inferred from the figure of Uranus, it is a *slow* rotation.

The objection that the rotation-period of this planet ought to be nearly equal to that of Jupiter or Saturn, because of the similarity of the three bodies in other respects, has certainly but little of reason or analogy to sustain it. It has been customary to regard the principal planets as arranged in two distinct groups, separated by the region of the asteroids. It has been stated that in magnitude, density, polar compression, &c., there is a striking uniformity between the members of each group, and hence it has been argued that in order to complete the similarity, we must suppose their rotatory velocities to be nearly equal. Now what are the facts in regard to this classification? Let us briefly examine.

The volume of the Earth or Venus is about seven times that of Mars, or nearly twenty times that of Mercury; while in the exterior group, the volume of Uranus or Neptune is less than one-tenth that of either of the other two major planets. Jupiter and Saturn are very much compressed at the poles, while the best telescopes in Europe afford no evidence of the ellipticity of Uranus or Neptune. Again: Venus and the Earth have greater masses compared with Uranus or Neptune, than these latter in comparison with Jupiter and Saturn. To any one who will compare the planetary elements other discrepancies cannot fail to present themselves.

II. *On the Arrangement of the Planetary Masses.*—We have seen that the classification of the planets into two groups is very far from exact. The following will be found more in harmony with nature: several considerations, moreover, seem to favor the presumption that it is not a mere unmeaning order, but a significant fact, whose explanation is to be referred to the theory of the system's formation. Its publication in this connection may not therefore be improper.

If we commence with Neptune, the most remote planet known, we shall find that the primary planets are arranged in PAIRS, the

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* [2], xi, pp. 394–398. Sir W. Herschel's opinion in regard to the figure of Saturn has been found erroneous.

† Hind's Solar System, p. 121. See also Main's Rudimentary Astronomy, p. 130.

members of which are nearly equal in diameter. This is exhibited in the second column of

TABLE III.

Planets.	Mean diameter.	Density.
I. { Neptune,	4·739	·187
Uranus,	4·428	·153
II. { Saturn,	9·205	·133
Jupiter,	11·255	·243
III. { Ast. Planet,	·584 ?	1·472 ?
Mars,	·519	1·032
IV. { Earth,	1·000	1·000
Venus,	·991	·973
V. { Mercury,	·391	1·930
——	——	——

Remarks on the foregoing Table.—1. Encke's mass of the Earth is 1/359[illegible]51; that of the Earth, and Moon together, $\frac{1}{355499}$. It is scarcely necessary to observe that the former is to be used in determining the density, and the latter in estimating the diameter of the sphere of attraction. By applying the other masses in Table I, and the diameters in Table III, we obtain the densities in column third of the latter.

2. In each pair, ***the densities of the members are to each other as the volumes; or, what is the same thing, as the square roots of the masses;*** whence also it follows that the masses are to each other as the sixth powers of the diameters.

Thus if D, d = the respective diameters of the members of any pair;

Δ, δ = the densities;

M, m = the masses;

then $D^3 : d^3 :: \Delta : \delta$,

$\sqrt{M} : \sqrt{m} :: \Delta : \delta$,

and $M : m :: D^6 : d^6$.

3. The most recent authorities in regard to the diameters of the planets are *Hind's Solar System* and *Humboldt's Cosmos*, vol. iv, both published in 1852. The mean diameters of Mercury, the Earth, Mars, Jupiter, and Uranus are taken from the latter work, pp. 428, 511. Those of Venus, Saturn, and Neptune, which are known with less certainty than the diameters of the remaining members of the respective pairs to which they belong, are obtained by the preceding formula; ***the resulting value in each instance falling between those of Humboldt and Hind.****

* Cosmos, vol. iv, pp. 428, 511, 517. Hind's Solar System, pp. 24, 103, 138. A remarkable error in regard to the diameters of Uranus and Neptune occurs in the latter work, pp. 120, 138. The apparent diameter of the former, reduced to the Earth's mean distance, is put for that of the latter, and *vice versa;* and hence it is erroneously concluded that the true diameter of Neptune is rather less than that of Uranus.

4. These analogies seem to indicate, (1) the existence of a planet within the orbit of Mercury; (2) a similarity in the original constitution of the members of each pair; and (3) an intimate mutual dependence or connection in their primitive condition.

5. If *one* trans-Neptunian planet should be hereafter discovered, the existence of a *second* would be rendered highly probable.

In the preceding article no special attention has been given to the objections of Professor Cherriman. Those, therefore, which have not been already discussed shall now be briefly considered.

Mr. C. first observes "that this law is not universal, being inapplicable in the case of the outermost planet (Neptune, so far as we know), and also of the Sun regarded as the innermost planet; in the former case, k being made to vanish by D becoming infinitely great; in the latter, by n vanishing." If the planets were formed from rings of vapor, was the primitive breadth of the outermost ring "infinitely great?" or does Neptune's sphere of attraction extend beyond the fixed stars and the Milky Way? Will Professor Cherriman also inform us why the "analogy between the periods of rotation of the PRIMARY PLANETS," should be rejected because of its inapplicability to the SUN?

Mr. C. has calculated the values of the rotation, constant for Venus, the Earth, and Saturn. These values he thinks "do not agree with sufficient exactness to establish the analogy;" he is, therefore, "compelled to reject" it, and "must agree with Professor Loomis," who "has most ably and strikingly pointed out" similar discrepancies. Unfortunately, however, while Professor Loomis's value of the rotation constant for Venus is *too small*, Professor Cherriman's is *too large*. The latter result was obtained by using Lagrange's mass of Mercury, $\frac{1}{2025810}$. That eminent astronomer observing, *previous to the discovery of Uranus*, that Jupiter is denser than Saturn but less dense than the Earth, concluded that the density varied inversely as the distance from the Sun. From this long since exploded hypothesis is derived the result which "compels" Mr. C. to withhold his assent from my analogy.*

Professor C.'s final difficulty, which, I have no doubt is entirely original, may be expressed as follows:—If one of the planets—the Earth for instance—should change its dimensions, and consequently its rotary velocity, the existing harmony between the periods of rotation *would be destroyed*. I beg leave to inquire of the ingenious objector whether the adoption of this mode of reasoning might not be fatal to other laws, as well as that of the planetary rotations? I assure him, however, that whenever we

* Professor C.'s value of k for the Earth is grossly erroneous.

shall find the Earth's time of rotation diminishing, I will cheerfully grant that my analogy can no longer be regarded as the expression of a "physical fact." But inasmuch as our planet's period of diurnal revolution *has not varied* the three hundredth part of a second during the last two thousand years, it may be as well to leave the discussion of this point to posterity.

Delaware College, July 5, 1852.

Art. XXV.—*On the Eruption of Mauna Loa, Hawaii, February,* 1852; by Rev. Titus Coan.*

Old Kilauea has been quite tame since I last wrote you. Changes have, however, taken place. The key stone of the great dome over Halemaumau (the lake) has parted, the top of the dome has fallen in, an orifice of about one hundred feet diameter has been opened, and an abyss of raging fire may be seen below at the depth of one hundred feet. Small lakes of fire have also broken out here and there in the crater, but the action has been partial and comparatively feeble. No light shines upon us from Kilauea, and we have no new terrors to record of Mother Pele at this point.

But we have other wonders among the fiery sisterhood.

At half-past 3 on the morning of the 17th ult., a small beacon-light was discovered on the summit of Mauna Loa. At first it appeared like a solitary star resting on the apex of the mountain. In a few moments its light increased and shone like a rising moon. Seamen keeping watch on deck in our port exclaimed, "What is that? The moon is rising in the *West!*" In fifteen minutes the problem was solved. A flood of fire burst out of the mountain, and soon began to flow in a brilliant current down its northern slope. It was from the same point, and it flowed in the same line, as the great eruption which I visited in March, 1843. In a short time, immense columns of burning lava shot up heavenward to the height of 300 or 400 feet, flooding the summit of the mountain with light, and gilding the firmament with its radiance. Streams of light came pouring down the mountain, flashing through our windows, and lighting up our apartments so that we could see to read large print. When we first awoke, so dazzling was the glare on our windows, that we supposed some building near us must be on fire; but as the light shone directly upon our couch and into our faces we soon perceived its cause. In two hours the molten stream had rolled, as we judged, about fifteen miles down the side of the mountain.

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* From a letter to Rev. Chester S. Lyman, dated Hilo, March 5, 1852.

This eruption was one of terrible activity and surpassing splendor. But it was short. In about twenty-four hours all traces of it seemed to be extinguished.

At day break on the 20th we were again startled by a rapid eruption bursting out laterally on the side of the mountain facing Hilo, and about midway from the base to the summit of the mountain. This lateral crater was equally active with the one on the summit, and in a short time we perceived the molten river flowing from its orifice direct towards Hilo. The action became more and more fierce from hour to hour. Floods of lava poured out of the mountain's side, and the glowing river soon reached the woods at the base of the mountain—a distance of twenty miles.

Clouds of smoke ascended and hung like a vast canopy over the mountain, or rolled off upon the wings of the wind. These clouds assumed various hues—murky, blue, white, purple, or scarlet—as they were more or less illuminated from the fiery abyss below. Sometimes they resembled an *inverted* burning mountain with its apex pointing to the awful orifice over which it hung. Sometimes the glowing pillar would shoot up vertically for several degrees, and then, describing a graceful curve, sweep off horizontally, like the tail of a comet, farther than the eye could reach. The sable atmosphere of Hilo assumed a lurid appearance, aud the sun's rays fell upon us with a yellow, sickly light. Clouds of smoke careered over the ocean, carrying with them ashes, cinders, charred leaves, etc., which fell in showers upon the decks of ships approaching our coast. The light was seen more than a hundred miles at sea, and at times the purple tinge was so widely diffused as to appear like the whole firmament on fire. Ashes and capillary vitrifactions, called "Pele's hair," fell thick in our streets and upon the roofs of our houses. And this state of things still continues, for even now, while I write, the atmosphere is in the same sallow and dingy condition. Every object looks pale and sickly, showers of vitreous filaments are falling around us, and our children are gathering them.

As soon as this second eruption broke out, I determined to visit it. Dr. W. agreeing to accompany me, we procured four natives to carry our baggage, one of them, Kekai (Salt Sea), acting as guide. On Monday, the 23d of February, we all set off, and slept in the outskirts of the great forest which separates Hilo from the mountains. Our track was not the one I took in 1843, viz., the bed of a river. We attempted to penetrate the thicket at another point, our general course bearing southwest. In ancient days an Indian trail had been beaten through in this direction, but it was now entangled with jungle so that all traces of it were nearly obliterated. However, we plunged into the forest, with a long knife, hatchet and clubs, cut and beat our way at the rate of one and a fifth mile an hour. At night we slept in the bush, and listened to the distant roar of the volcano. On Wednesday, the 25th, we gained a little eminence in the woods, from which we could see the lava stream which was now opposite us on our left, distant six miles. This fiery flood was now half way through the forest, and more than three-fourths of the way from the crater to the shore, sweeping all before it. Apprehending that it might reach the sea in a day or two, and that the ladies at the station might be alarmed, Dr. W. determined to return. Taking one of the natives, and leaving three with me, he retraced his steps, while I pushed on through jungle and bog and dell, beating every yard of my way out of this horrible thicket. On the 26th, we emerged from the forest, but plunged at once into a dense fog more dark than the thicket itself. Pushing up the mountain we encamped for the night on a rough, bushy ridge. A little before sunset the fog rolled off, and Mauna Kea and Mauna Loa both stood out in grand relief; the former robed in a fleecy mantle almost to its base, and the latter belching out floods of fire from its burning bowels. All night long we could see the glowing fires, and listen to the awful roar of this fearful crater.

We had now been out four nights, and were within twenty miles of the crater, with the long, brilliant river of fusion on our left, shining in a line of light down the side of the mountain till it entered the woods.

We left our mountain aerie early on the 27th, determined, if possible, to reach the seat of action on that day. Taking the pillar of fire and of cloud as our mark, and still having the great river of lava on our left, we pushed onward over a rough and almost impassable surface—the attraction increasing as the square of the distance decreased. Our intense interest mocked all obstacles. At noon we came upon the confines of a tract of naked scoria, so intolerably sharp and jagged that our baggagemen could not pass it. Here I ordered a halt; stationed the two carriers; gave an extra pair of strong shoes to my guide; gave him my wrapper and blanket; put a few crackers and boiled eggs into my pockets; took my compass and staff, and said to Mr. Salt Sea, (Kekai), "Now go ahead, and let us warm ourselves to-night by that fire yonder." Thus equipped we pressed up the mountain, over fields of lava of indescribable roughness; now mounting a ridge of sharp and vitreous scoria, when the fiery pillar stood full in view; and then plunging into some awful ravine or pit, from which we slowly emerged by crawling upon "all fours." But I soon found that my guide needed a leader. He was too slow. I therefore pressed ahead, leaving him to get on as best he could. At half-past 3 P. M. I reached the awful crater, and stood alone in the light of its fires. It was a moment of unutterable interest. I seemed to be standing in the presence and before the burning throne of the eternal God; and, while all other voices were hushed, His alone spoke. I was 10,000 feet above the sea; in a vast solitude untrodden by the foot of man or beast; amidst a silence unbroken by any living voice, and surrounded by scenes of terrific desolation. Here I stood, almost blinded with the insufferable brightness; almost deafened with the startling clangor; almost petrified with the awful scene. The heat was so intense, that the crater could not be approached within forty or fifty yards on the windward side, and, probably, not within two miles on the leeward.

The eruption, as before stated, commenced on the very summit of the mountain, but it would seem that the lateral pressure of the emboweled lava was so great as to force itself out at a weak point in the side of the mountain; at the same time cracking and rending the mountain all the way down from the summit to the place of ejection. The mountain seemed to be siphunculated; the fountain of fusion being elevated some 2,000 or 3,000 feet above the lateral crater, and being pressed down an inclined subterranean tube, escaped through this valve with a force which threw its burning masses to the height of 400 or 500 feet. The eruption at first issued from a depression in the mountain, but a rim of scoria 200 feet in elevation had already been formed around the orifice in the form of a hollow truncated cone. This cone was about half a mile in circumference at its base, and the orifice at the top may be 300 feet in diameter. I approached as near as I could bear the heat, and stood amidst the ashes, cinders, scoria, slag and pumice, which were scattered wide and wildly around.

From the horrid throat of this cone vast and continuous jets of red-hot, and sometimes *white hot*, lava were being ejected with a noise which was almost deafening, and a force which threatened to rend the rocky ribs of the mountain, and to shiver its adamantine pillars. At times the sounds seemed subterranean—deep and infernal. First a rumbling, a muttering, a hissing, or deep premonitory surging. Then followed an awful explosion, like the roar of broadsides in a naval battle, or the quick discharge of park after park of artillery on the field of carnage. Sometimes the sound resembled that of ten thousand furnaces in full blast. Again, it was like the rattling of a regiment of musketry. Sometimes it was like the roar of the ocean along a rock-bound shore, and sometimes like the booming of distant thunder. The detonations were heard along the shores of Hilo.

The eruptions were not intermittent but continuous. Volumes of the fusion were constantly ascending and descending like a jet d'eau. The force which expelled those igneous columns from the orifice, shivered them into millions of fragments of unequal sizes, some of which would be rising, some falling, some shooting off laterally, others describing graceful curves; some moving in tangents, and some falling back in vertical lines into the mouth of the crater. Every particle shone with the brilliancy of Sirius, and all kinds of geometrical figures were being formed and broken up. No tongue, no pen, no pencil, can portray the beauty, the grandeur, the terrible sublimity of the scene. To be appreciated it must be *felt*.

It was more than half an hour after my arrival at the crater before my guide came up. Night was approaching, and I had no defense against the piercing cold but in the wrapper and blanket committed to his care. I had began to fear that he had given up the pursuit, and, like my guide in 1843, left me to my own resources. I strained my eyes to examine every ridge and elevated spot on the track by which I approached the crater. At length his form rose to my view, slowly wending his way among the black and craggy masses of lava; and if ever my heart leaped for joy, or loved a man, or blessed the Lord, it was then. Throwing up his hands and opening his mouth like a crater, the old hero of the hills exclaimed, "*Kapaianaha!* KAPAIANAHA!!" *Wonderful!* WONDERFUL!! "*Kapaianaha loa na hana ake Akua!!*" *Most marvelous are the works of God!!*

Night coming on we now retired about a mile from the crater, and took up our position where we had a most perfect command of the whole scene. Here we halted, not indeed to sleep, for that were impossible, but to keep vigils—to listen to the awful roar and to watch the wonderful operations of this great furnace of Jehovah.

During the night the scene surpassed all power of description. Vast columns of lava, at a white heat, shot up continuously in the ever varying forms of pillars, pyramids, cones, towers, turrets, spires, minarets, etc. While the descending showers poured in one incessant cataract of fire upon the rim of the crater down its burning throat, and over the surrounding area—each falling avalanch containing matter enough to sink the proudest ship. A large fissure opening through the lower rim of the crater gave vent to the molten flood which constantly poured out of the orifice, and rolled down the mountain in a deep, broad river, at the rate, probably, of ten miles an hour. This fiery stream we could trace all the way down the mountain, until it was hidden from the eye by its windings in the forest—a distance of some thirty miles. The stream shone with great brilliancy in the night, and a long horizontal drapery of light hung over its whole course. But the great furnace on the mountain was the all-absorbing object. Hour after hour it sent out its thunders as the voice of Almighty God, and through the long night it loaded the atmosphere with its sulphurous breath, scattering far and wide its showers of fiery cinders, and throwing a terrible radiance over the dark and desolate mountain.

At day break on the 28th we retraced our steps down the rugged mountain, rejoined the baggagemen, broke up the camp, and, by a forced march, regained the confines of the woods before dark. This was on Saturday, and here we rested on the Sabbath. On Monday, by hard travelling for twelve hours, we reached Hilo, found all well, and felt rewarded an hundred fold for our toil of eight days.

March 6.—The fire has not yet reached the shore, and it may not. It is winding in the woods, filling our atmosphere with smoke, and sending down showers of ashes, charred leaves, etc.

The great furnace in the mountain is still in terrible blast. No decrease of activity, but rather an *increase.*

Old Kilauea is as dosy as ever. She has taken no interest in our exciting scenes, and seems to feel no sympathy with her fiery sister of the hills.

Art. XXVI.—*On the Rocks of Canada;* by Messrs. W. E. Logan and J. W. Salter.*

1. *On the Age of the Copper-bearing Rocks of Lake Superior and Huron, and various facts relating to the Physical structure of Canada.* By W. E. Logan, F.R.S. & G.S., Director of the Geological Survey of Canada.

In the present paper it is my purpose to place before the Association, in as a condensed a form as possible, one or two of the main features of the physical structure of Canada, ascertained in the progress of the Geological Survey now carried on in the country, under my direction, by the authority of the Provincial Government.

With the exception of the drift, the country is composed of rocks, none of which are newer than the carboniferous epoch. The general geographical distribution of these rocks, as far as ascertained and as connected with the physical structure of the bordering states of the American Union on the one hand, and the sister British provinces on the other, is represented on the map which is displayed to view.

One of the points to which it is my wish to draw attention is the age of the copper-bearing rocks of Lake Superior and Huron, as determined by the evidences collected on the Canadian survey; and another, the differences that exist in the structural condition of the western and eastern parts of the province.

The rocks on the north shore of Lake Superior consist of reddish granite and syenite, which in ascending order pass into micaceous and hornblendic gneiss and allied forms. These are succeeded by chloritic and partially talcose slates, which become interstratified with obscure conglomerates with a slaty base, and

* From the Proceedings of the British Association for 1851.

upon them rest unconformably bluish slates, with intermingled bands of chert and limestone towards the bottom, and a thick and extensive overflow of greenstone trap at the top. Reposing on these are white sandstones, which pass by an alternation of colors into red sandstones and conglomerates, often with jasper pebbles, and these are repeated after the occurrence of an uncertain amount of reddish limestone of an argillaceous quality. The sandstones and conglomerates become interstratified with amygdaloidal trap layers, and an enormous amount of volcanic overflow divided into beds crowns the summit. The sandstones are often argillaceous, and display ripple-mark and crack casts on their surfaces, while the concentric curves of flow sometimes characterize those of the trap. Innumerable dykes cut up the sedimentary and volcanic beds, and both the dykes and the overflows are almost universally marked by a transverse columnar structure. The thickness of the whole from the base of the blue slates cannot be less than 12,000 feet, and the whole formation is intersected by copper lodes of different characters in different places, which run in directions both with and transverse to the strike.

On the north shore of Lake Huron the granite is succeeded by a formation consisting of white, often vitreous sandstone or quartz-rock of great thickness, sometimes passing into a beautiful jasper conglomerate, and alternating with great beds of slate and bands of conglomerate with a slaty base, both being interstratified with thick masses of greenstone. A persistent band of limestone of about 150 feet in thickness and interstratified with thin cherty layers, occupies a place in the series, probably somewhere about the middle. The surfaces of the sandstone often exhibit ripple-marks, and the total thickness of all the members of the formation may be about 10,000 feet. Different intrusive rocks intersect those of stratification, and as related to one another, they display a succession of events in the history of the formation. There is of course a set of dykes—greenstone no doubt—cutting the sedimentary rocks and giving origin to the greenstone overflows. It is difficult, however, to identify these; but another set of greenstone dykes are seen cutting both the sedimentary and igneous strata; intrusive granite, sometimes occupying considerable areas, thrusts these antecedents aside, sending forth dykes of its own order, intersecting all and reaching to considerable distances from the nuclei; and then another set of greenstone dykes cuts through the intrusive granite, its dykes, and all that previous causes had placed. Evidences of disturbances and dislocations accompany all these successive intrusions, those connected with the granite being the most violent. But there is in addition another set of disturbances of still posterior date, and it is to these that is due the presence of those metalliferous veins which give the country its value as a mineral region.

In respect to the age of the Huron cupriferous formation, the evidence afforded by the facts collected by my friend and associate, Mr. Murray (published in our Report of Progress for 1847-48), on the Grand Manitoulin, La Cloche, Snake, Thessalon, Sulphur, and other islands, points ranging along a line of 90 miles out in front of the coast, is clear, satisfactory, and indisputably conclusive. On these islands, the Potsdam sandstone, the Trenton limestone, the Utica slates, and the Loraine shales, successive formations in the lowest fossiliferous group of North America, were each, in one place or another, found in exposures denuded of all vegetation, resting in unconformable repose, in a nearly horizontal position, upon the tilted beds and undulating surface of the quartz rock and its accompanying strata, filling up valleys, overtopping mountains, and concealing every vestige of dykes and copper veins; and it would appear that some of these mountains have required the accumulation of the whole thickness of the lowest three and part of the fourth fossiliferous deposit, equal to about 700 feet, to bury their summits.

The chief difference in the copper-bearing rocks of Lakes Huron and Superior seems to be the great amount of amygdaloidal trap present among the latter, and of white quartz rock or sandstone among the former. But on the Canadian side of Lake Superior there are considerable areas without amygdaloid, while white sandstones are present in others, as on the south side of Thunder Bay, though not in the same vast amount, or the same state of vitrification as those of Huron. But notwithstanding these differences, there are such strong points of resemblance in the interstratification of igneous rocks, and the general mineralized condition of the whole, as to render their proximate equivalence highly probable; and the conclusive evidence given of the age of the Huron would thus appear to settle that of the Lake Superior rocks in the position given to them by Dr. Houghton, the late State Geologist of Michigan, as beneath the lowest known American fossiliferous deposits; and in this sequence those of Lake Huron, if not those of Superior, would appear to be contemporaneous with the Cambrian series of the British Isles.

The eastern limit of this formation on Lake Huron is in the vicinity of Colling's Inlet, opposite the eastern extremity of the great Manitoulin Island, whence it gradually recedes inland, taking a northeastern course; and farther down the St. Lawrence and its lakes, the Lower Silurian appear to rest upon gneissoid rocks without the intervention of the Cambrian.

If a line be drawn on the map in continuation of the Hudson River and Lake Champlain valleys to the vicinity of Portneuf, about thirty miles above Quebec, and thence in a northeastward direction, it will divide the country into two areas, which, though nearly resembling one another in the general formations of which they are composed, yet present important differences in their structural condition. Each area belongs to a great trough of fossiliferous strata resting in Canada, with the exception of the supporting Cambrian formation of Lakes Huron and Superior, on gneissoid rocks, and containing coal measures in the centre, and the conditions in which the two areas differ, are the general quiescence and conformable sequence of the formations from the base of the Lower Silurian upwards in the western, and the violent contortions and unconformable relations of those in the eastern. The coal measures of the eastern area are those of Rhode Island, and in a metamorphic state of Massachusetts, and those of Nova Scotia and New Brunswick. None of the productive part of the New Brunswick coal-measures reaches Canada, but there comes out from beneath it, on the Canada side of the Bay Chaleur, 3,000 feet of carboniferous red sandstones and conglomerates. These are succeeded by 7,000 feet of Devonian sandstones, which rest upon 2,000 feet of Upper Silurian rocks consisting of limestones and slates. The base of the Upper Silurian group has been traced a distance of about 700 miles from Gaspé on the Gulf of St. Lawrence, first to Memphramagog Lake in Canada, thence to Halifax on the southern limit of Vermont, and further into Massachusetts, keeping in its outcrop at a variable distance from the coal. In the interval, between the Upper Silurian and the carboniferous formations, there can be little doubt the Devonian sandstones will display a conspicuous figure in the eastern area, as they are known to be still 2,500 feet thick in the eastern portion of the western area, in which they do not die away until reaching the banks of the Mississippi. In the eastern area the Lower Silurian strata sweep round the Upper, occupying a zone of between 40 and 50 miles broad, and the lowest rock common to both, connecting the troughs on the anticlinal, in the valley of Lake Champlain, is the Trenton limestone.

On the northwestern side of the western area the formations are generally in a flat and quiescent condition from Lake Superior to Pennsylvania, and they succeed one another, without any observed want of conformity, from the base of the Lower Silurian to the summit of the carboniferous. But it has been shown by Professor Rogers, that proceeding from northwest to southeast there occurs in the State of Pennsylvania a set of successive parallel undulations which increase in intensity in the direction mentioned, and on the southeast side of the Appalachian coal-field are sufficiently violent to produce overturn dips in all the formations together, the coal inclusive. These plications with their overturn dips thus form the southeastern rim of the western area, and are distinctly traceable by the Appalachian chain through Vermont into Canada, and through Canada to the Gulf of St. Lawrence; in this part constituting the northwestern rim of the eastern area. But while in the western division there is no want of conformity from the Lower Silurian rocks to the carboniferous, and the plications there appear to be of a date subsequent to the carboniferous deposit, in the eastern, there are evidences of a want of conformity between the Upper and Lower Silurian formations, and though the folds in the former do not seem quite so violent, they are in parallel directions with those in the latter. There is another and a greater want of conformity between the Devonian rocks and the carboniferous. A large portion of the carboniferous deposit of New Brunswick shows but very moderate dips, and on the shores of Bay Chaleur it lies in a quiescent condition on the tilted edges of the lower formations, sometimes resting on one and sometimes on another. Its north-western outcrop however, or rather, I should say, the longitudinal axis of the whole coal-field from New Brunswick to Newfoundland, has a parallelism with the folds of the inferior rocks, and there are several parallel undulations in nearly the same direction on the south side of the carboniferous deposit.

The conclusion to be drawn from these facts appears to be, that some cause producing folds in the stratification in one general direction has been in operation from at least the cessation of the Lower Silurian epoch to the termination of the carboniferous; and it only requires the inspection of a map of Atlantic America to observe how the features of its physical geography, displayed in the configuration of its coast, in its valleys of undulation and those of transverse fracture, are almost entirely dependent on the results of this cause.

The fossiliferous rocks of both these divisions, with the exception of that part supported by the Cambrian formations of Lakes Superior and Huron, rest, along the valleys of the St. Lawrence and the Ottawa, upon a series consisting of micaceous and hornblendic gneiss interstratified towards the south with great bands of crystalline limestone, sometimes highly charged with magnesia and associated with vast masses of magnetic iron ore, but without calcareous beds on the north. These rocks constitute a part of the low granitic ridge, which to the westward has been traced by Sir J. Richardson as extending with a northwesterly curve to the Arctic Ocean.

The Canadian rocks on the north side of this granitic ridge, as displayed toward the head of Lake Temiscamang, consist, in ascending order, of chloritic slates and conglomerates with a slaty matrix; the volume of these is probably not less and may be much more than 1,000 feet. On them rests a set of massive pale greenish-white or sea-green sandstones, the total amount of which, as determined by the height of hills which they compose in nearly horizontal layers, is between 400 and 500 feet. These are succeeded by about 300 feet of buff and whitish fossiliferous limestones, the lowest bed of which is composed of a collection of great boulders and blocks of sandstone, some of them nine feet in diameter, that were lying immediately on the strata from which they were derived when they became covered up, and in which great cracks and worn fissures are filled with the calcareous deposit that envelops the whole. The sandstones being without discovered fossils, it is not easy to determine their age; but the limestones by their organic contents are distinctly shown to belong to the Upper Silurian epoch. The Lower Silurian deposits, unless the non-fossiliferous sandstones be a member of the group, appear to be wholly wanting in the locality, and as all the forms brought from other localities on the north side of the granite ridge by Bigsby, Richardson and others, are, I believe, referable to Upper Silurian types, it appears not improbable that the absence of the Lower Silurian rocks may spread over an extensive area, and the south side of the ridge indicate an ancient limit to a Lower Silurian sea.

The nearest locality of the well-defined forms which inhabited this sea is at the island of Allumette, about 200 miles southward from the Upper Silurian rocks of Lake Temiscamang; there is, however, a patch of the same lower formation which is only about 100 miles southward from them, but in it the fossils are obscure. Instead of giving any remarks of my own on the fossils of the two sides of the granitic ridge, I shall append to my paper a note, which my friend Mr. Salter, of the Geological Survey of the United Kingdom, has been so kind as to make on them after a careful inspection, only stating that the specimens which have been examined are but a small part of an important collection, chiefly from the eastern of the two divisions that have been alluded to, brought from Canada for comparison, and that twice as many specimens as have been brought remain in the province from other parts, while great additions, it is hoped, will annually be made to them.

2. *Note on the Fossils above mentioned, from the Ottawa River.* By J. W. Salter, F.G.S., A.L.S.

Lower Silurian.—The fossils from the southeast end of Allumette Islands, on the Ottawa River, are the only Lower Silurian fossils yet examined of Mr. Logan's large collections, and they bear out well the opinion he has expressed, that in some parts of Canada but one calcareous group can be distinguished between the Potsdam sandstone below, and the Hudson River group above, agreeing in the main with the celebrated "Trenton limestone" of New York, but possessing also many of the fossils characteristic of the lower limestones which in that country have received separate names.

For instance, one of the most abundant fossils is a species of *Scalites* (*Euomphalus uniangulatus*), described as a fossil of the calciferous sand-rock by Hall. The corals, again, *Stromatocerium rugosum*, *Columnaria alveolata*, which are very abundant, are those of the Bird's-eye and Black River limestones. The former of these corals, too, is usually found investing (after the manner of a sponge) a large and fine species of *Maclurea*, a genus of gasteropods which in New York does not mount above the "Chazy" or lowest limestone, and is there abundant. Hall, indeed, expressly mentions that the *Stromatocerium* occurs in beds above those which contain the *Maclurea*. In this case, however, the parasitic zoophyte has generally selected this fine and new shell, to which I propose giving the name of its discoverer. It is well distinguished from *M. magna*, by the much more rapid increase in diameter of its whorls and its minute umbilicus. It is possessed, moreover, of a most peculiar operculum, which will at once establish the right of *Maclurea* to rank as a distinct genus, being furnished within with a broad and strong bony process for the muscular attachment, and being itself very strong and massive. Prof. Forbes has undertaken to compare this peculiar operculum with that of some rare living gasteropods of far inferior size, so that more need not be said of it at present.

The *Stromatocerium* affects also a small and new species of *Scalites* allied to the one above mentioned, and frequently covers all but the mouth, so as to mask the form of the shell completely.

But it is with the Trenton limestone that the greater number of species agrees; and while a large portion of them, especially the gasteropods, appear to be undescribed in Hall's work, still the analogies are very evident. A list of ten or more *Murchisoniæ* or *Pleurotomariæ* affords one, *M. ventricosa*, characteristic of the Bird's-eye limestone; two common in the Trenton limestone, *M. bicincta* and *M. gracilis* (very abundant species), and *M. bellicincta*, Hall, a large *Turritella*-like form; the rest seem to be new; and some of them are remarkable for the tendency of the whorls to separate and become what may be called vagrant, as happens in some accidental varieties of the common snail. The shells are tolerably thick and strong.

Some smooth shells, exactly like the *Euomphali* of the carboniferous limestone, and several roughly sculptured *Turbines* or shells of apparently allied genera, occur; and one exceedingly elegant, with close thread-like lines of growth, is very common. *Holopea* of Hall, an ill-defined genus, offers one or two species of the typical form, and one closely allied to *H. bilix* of the Western States. There are three species of *Scalites*, a genus with the mouth notched like *Pleurotomaria*, but destitute of a spiral band; one is the small species so commonly encrusted over; a second, of which we have but a single specimen, is muricated with spines, like a *Delphinula ;* the third is the very common *S.* (*Euomphalus*) *uniangulatus* above mentioned, which also, but rarely, shows a tendency to become spinose. There are also two or three species of the genus *Raphistoma*, which appears to be only a discoid form of *Scalites.* We have a *Turritella?* spirally ribbed, and undistinguishable in general form from living species. But the most abundant and characteristic shell is the *Maclurea*, fragments of which, with scattered opercula, occur on almost every surface.

Among bivalve shells, which chiefly belong to the *Arcacidæ*, a very interesting new genus has rewarded examination. It was found that two species resembling *Nucula* in every general character, differed from it importantly by having no internal ligament, but a very manifest exterior one; one of these species measures three inches across, and from the general analogy of several accompanying species it is believed that this form will be found common in the Silurian rocks, and will include many species now referred to *Nucula.* It might be called *Ctenodonta.* Of the same family also, a *Lyrodesma* (a genus with radiating teeth beneath the beak and synonymous with *Actinodonta*, Phillips) is closely allied to a Trenton limestone species. There is a new genus, probably belonging to the *Arcacidæ*, but only possessing two or three anterior teeth; but the collection does not include any *Aviculæ*, or indeed any other of the usual Silurian genera of this order, and of the seven or eight lamellibranchiate shells none appear quite identical with those from New York; but, as might be expected, the common *Brachiopoda* of this locality are those most abundant also in the Trenton limestone. *Orthis tricenaria*, Conrad, swarms here, as does also *Leptæna filitexta*, Hall, a shell very like the common *L. alternata* of the Trenton limestone, but reversed as to the convexity of the respective valves. But the latter shell, so abundant in New York, does not occur here at all. *Atrypa hemiplicata*, Hall, and *A. increbrescens* are tolerably frequent; and there are two or three other species of *Orthis*, and some small plaited and smooth *Terebratulæ*, which require further examination.

The *Bellerophons*, two of which are probably identical with New York species, are those of the lowest or chazy limestone, namely, *B.* (*Bucania*) *sulcatina*, Emmons, and *B. rotundata*, Hall. The group to which these two belong is that of which the English *B. dilatatus* is a familiar type, the whorls scarcely enveloping each other, and the mouth wide and trumpet-shaped. There is, however, a true *Bellerophon* so like *B. obtectus*, Phill., from the Ludlow rocks of Pembrokeshire, that, but for its treble size, it might be taken for it.

Perhaps one of the most interesting of the mollusks is a large *Cleodora*, quite new to America, and not yet described as such from Britain. On attentively comparing the American, Irish and

North Welsh specimens of this fine shell, which measures two inches across, I can find only trivial variations. It does not require a new specific name, having been figured from an imperfect specimen, as *Atrypa transversa*, by Portlock. It is interesting to find this species (which of course, as a Pteropod, had ready means of migration) in the two countries. There are but few other species identical with those of Great Britain, but I think I recognise *Turbo trochleatus*, and perhaps *T. tritorquatus*, M'Coy, as common to the two regions.

Of the Cephalopoda, the remarkable two-edged *Orthoceras*, called *Gonioceras anceps* by Hall, is a Black River limestone species. *Cyrtoceras* is common, both smooth and ornamented; *C. annulatum* and *C. lamellosum*, the same with those of Trenton; *Orthoceras arcuo-liratum*, *bilineatum*, and *laqueatum*, Hall, are Trenton limestone species; and lastly, there are two species of *Ormoceras*, Stokes, the larger of which is in all probability *O. tenufilum*, Hall, a species both of the Black River and Trenton beds.

Schizocrinus nodosus, Hall, of the Trenton limestone, is the common crinoid; its stems are very characteristic.

Among the corals, one or two species of *Streptolasma*, apparently the same as those of New York, and the branched varieties of *Favosites lycoperdon*, accompany those before mentioned; and we may here notice the *Receptaculites*, already described by Hall, but not I think identical with *R. Neptuni* of Europe. The fine series brought home by Mr. Logan shows all the structural characters;—the circular expanded form and cup-like centre,—the surface composed of rhomboidal plates, which cohere by lateral processes, and which are the flattened ends of separate and equidistant columns. Unfortunately the entire structure is replaced by cycloidal silex, but perhaps it will, by careful polishing, enable us to see if it be really a coral, somewhat of the character of the *Tubiporidæ*.

To crown all these are slabs full of the large *Asaphus* (*Isotelus*) *gigas*, the characteristic trilobite of the Trenton rocks.

Upper Silurian Rocks.—Ascending the Ottawa to the head of Lake Temiscamang and so crossing the granitic axis of Canada, the first fossiliferous rock that presents itself is of a totally different character to that last described, as stated by Mr. Logan in his Report of Progress for 1845.

This limestone is weathered like the last; its siliceous fossils also stand out in bold relief; and one of the most common is the characteristic crinoid of the Trenton limestone, *Schizocrinus nodosus*, at least I believe I am correct in this reference. But along with this are abundance of *Favosites gothlandica*, *Stromatopora striatella*, *Cyathophyllum*, a *Heliolites* (*Porites*), with small tubes; *Syringopora* (*Harmodites*) with *Halysites catenulatus*

(*Catenipora escharoides*), and *Strombodes striatus*, Milne Edwards, fossils characteristic of the *Niagara* and *Onondaga* limestones, and in America never found in the lower rocks; with these occur *Atrypa reticularis* in plenty, a *Terebratula* with three raised plaits, and very rarely a *Leptæna* or *Strophomena*. One or two spiral shells recall the shapes of some of Hall's species of *Holopea*, but are too imperfect for identification; and there is a long spiral shell, like *Murchisonia gracilis*. *Encrinurus punctatus* is the only trilobite.

The most striking shell, perhaps, is a species of *Ormoceras*, the short broad siphuncles of which are well preserved, while the shell has decayed, and these so much resemble those figured by Dr. Bigsby and Mr. Stokes in the Geological Transactions, second series, vol. i, pl. 30, figs. 4, 5, 6, 7, that we think there can be no doubt of their identity. And it is very interesting, as bearing no the question of age, that these were found at Drummond Island, the only limestones of which are Upper Silurian.

Indeed the whole aspect of this collection, small as it is, is as strikingly Upper Silurian as that of the former one was Lower Silurian. The preponderance of the *Catenipora*, *Favosites* and *Stromatopora*, &c., is characteristic of the higher rocks, and they are associated with *Pentamerus oblongus* (the characteristic fossil of the Clinton group, which may be regarded as the base of the upper division), and this shell in America is far more limited in its vertical range than it is in Britain.

Art. XXVII.—*The Inverted Microscope—a new form of Microscope; with the Description of a New Eye-piece Micrometer, and a New Form of Goniometer for Measuring the Angles of Crystals under the Microscope;* by J. Lawrence Smith, M.D., Professor of Chemistry in the University of Louisiana.

The instrument forming the subject of this article, was invented by me in the summer of 1850, and first brought to the notice of the *Société de Biologie* of Paris in the month of September of the same year; and, with additional improvements in the micrometer movement, was laid before the American Scientific Association in 1851. Besides the mention made of this instrument in the minutes of the proceedings of those scientific bodies, no account of it has been published, giving a full detail of the objects sought after and effected by this new form of Microscope: and this I now hasten to do, in justice to myself, since seeing in the last edition of Quekett's work on the Microscope, a short description of this instrument under the title of Nachet's Chemical Microscope. How it is that my name has been entirely omitted in connection with it, is a mystery to me; it must have arisen through Mr. Nachet's neglect to mention who the inventor of it was while exhibiting it at the World's Fair in London last year, or through the forgetfulness of Mr. Quekett, after being informed on the subject. This omission is still more glaring, from the fact that the instrument as then exhibited, with one or two very unimportant modifications, is the same in all its mechanical details as was constructed for me, from my plans, by Mr. Nachet, of Paris, and used in the laboratory of Messrs. Wurtz and Verdiel.

I am sorry to be obliged to preface the description of the Microscope with this reclamation; but after considerable experience, I feel that the instrument is an important one for general as well as chemical purposes, and that it will in time be considered a decided advancement in the construction of microscopes; with these views in the matter, I am unwilling to yield what little credit might be due to the inventor of it.

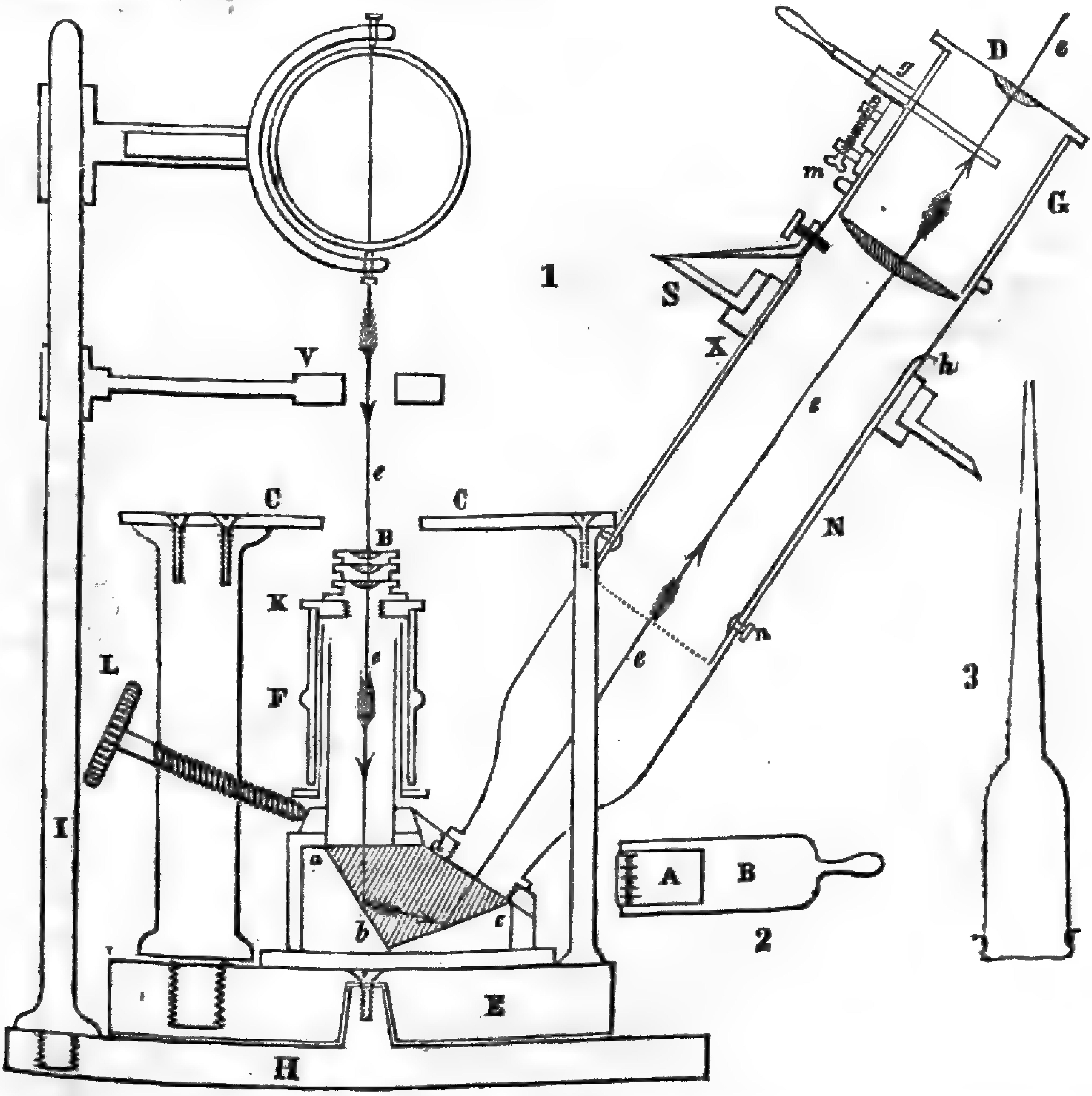
The great development made in microscopic research, during the last twenty or thirty years, is due in great part to improvements in the construction of achromatic object-glasses; still, the mechanical arrangements of the instrument have contributed their share to facilitate observation, and diminish the fatigue dependent upon this character of research. In fact, observers have not hesitated to make use of different descriptions of mounting in their varied field of research; and now, we have instruments for general purposes, but the construction of which is imperfectly adapted to certain special researches; as, for instance, the dissection of animal tissues. This last circumstance has given rise to the invention of various forms of dissecting microscopes, such as the Pancreatic Microscope of Oberhauser, and more recently the simple and better instrument for arriving at the same end constructed by Nachet, of Paris.

These remarks are made to show how the use of the microscope might be extended by paying proper attention to its mechanical arrangements, and it is from this cause I have been led to seek out a form of instrument, by means of which micro-chemical research might be facilitated and enlarged. The instrument about to be described is calculated to produce these results.

The great obstacle to chemical research beneath the microscope, are two-fold; first, the necessity of manipulating in the limited space between the object-glass and the stage; and, secondly, the exposure of the most essential parts of the instrument to the vapors emanating from the re-agents employed, and the condensation of vapor on the under surface of the object-glass thereby obscuring the view. A less important obstacle is the impossibility of heating a liquid or other substance while beneath the microscope.

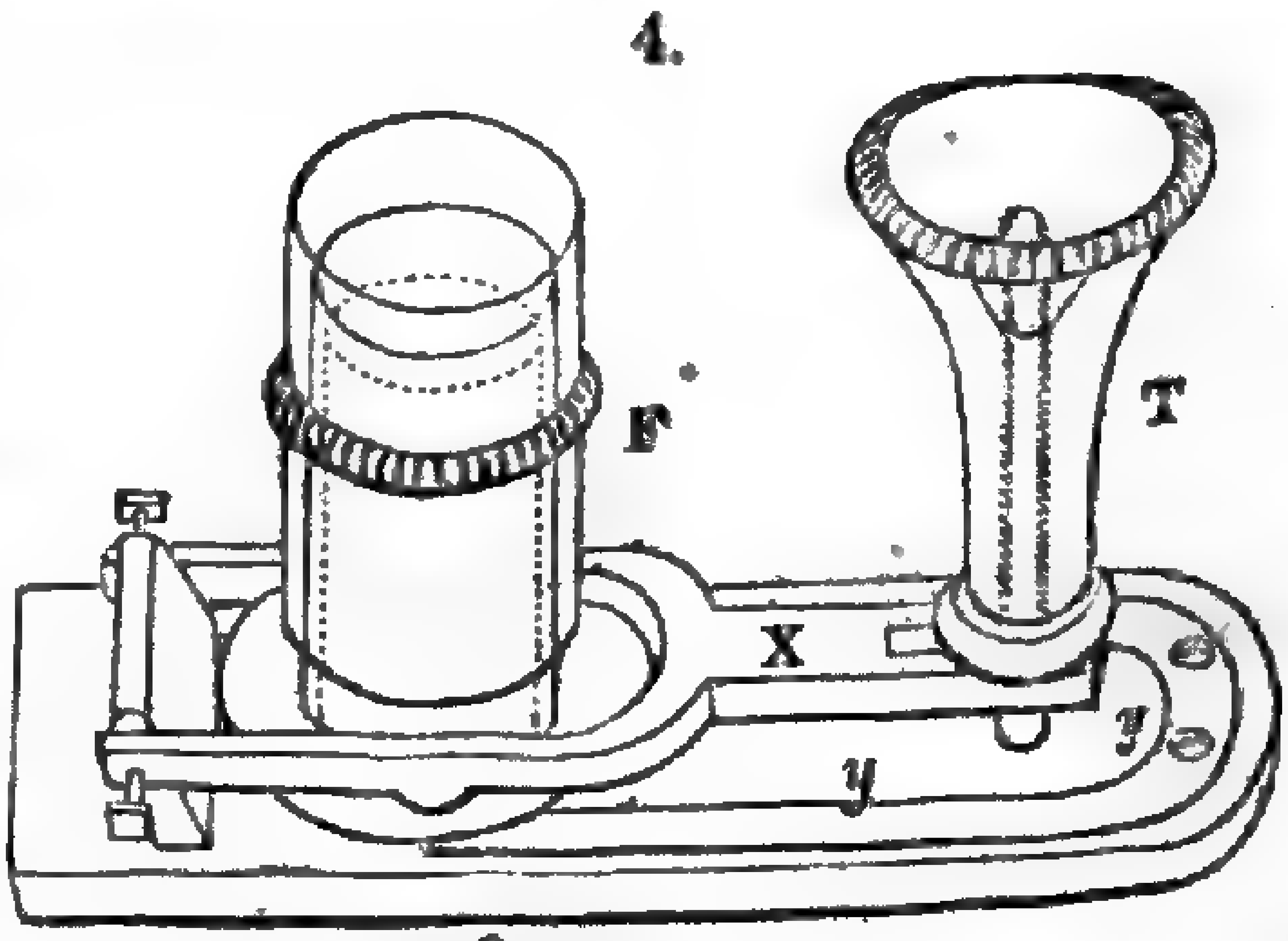
The only way by which these difficulties can be surmounted, is to place the object-glass beneath the stage, and the object above it, with an optical arrangement of such a nature as to permit observation. It was with this in view, that M. Chevalier made a chemical support to go with his general instrument, but those familiar with it know how awkward it is for manipulation, although exceedingly ingenious, and, doubtless, as perfect as could be for attaching to his instrument. Feeling then the want of something more effective, I was led to the construction of the Inverted Microscope, entirely with reference to its chemical uses; other purposes to which it might be applied being of secondary consideration; but I would here remark, that since its completion, its value even in this latter respect yields to no other form of instrument, and has induced me to change its original designation of Chemical Microscope to that of Inverted Microscope, as the former name might mislead as to the extent of its uses.

It was important for the arrangement in question, so to have the relative position of the stage and eye-piece, that the eye, while on a level with the latter, could readily see the former and guide the required manipulations.



Without entering into any detail of the steps taken in the construction of the instrument, I will at once proceed to a description of it, that will be readily understood by referring to the figure. The most important part is a four sided prism, with the angles *a*, *b*, *c*, *d*, respectively 55°, 107½°, 52½°, 145°, the angles being of such dimensions, that a ray of light passing into the prism in the directions shown by the arrows, and perpendicular to the surface *a d*, after undergoing total reflection from the inner surfaces *a b* and *b c* (on both of which the light strikes at an angle much less than forty-five degrees) will pass out perpendicular to the surface *c d*. If the line *c* be followed, it will be readily seen how a ray of light passing through the object-glass B, descends into the prism, and passes out of it upwards through the eye-glass D, the tube of which is inclined to the perpendicular 35°. The other parts of the instrument are understood by simply looking at the figure. E is a heavy support that revolves on another support H, which carries a column I, on which are placed the mirror, diaphragm, &c. The prism used has each side nearly an inch in length, and little less in width, which is about the most convenient size. The arrangement for adjusting the focal distances is somewhat peculiar, and is readily understood by reference to fig. 4. There are three tubes (the outer one of which is F) that slide on each other, the inner is fastened to the plate O, the second tube has a projecting collar, on the under surface of which rest the extremities of two springs *y*, and on the upper surface two points of the lever X, which is moved by means of the screw T. The plate O is fastened on to the top of prism by the binding screw L (fig. 1), that readily allows of the plate being detached at pleasure, which it is necessary to do at times in order to wipe the upper surface of the prism. The way in which the observer operates, is to screw one or other of the object-glasses to a small cap K (fig. 4) that simply rest on to the upper end of the outer tube F, which is readily moved up and down by the finger for the coarser adjustment, while the minute adjustment is obtained by moving the screw T.

4.



This description suffices to make it clearly understood how the instrument is used, and the conveniences arising therefrom. In examining an object with this microscope, the object is arranged in the ordinary way; when liquid it is placed in a watch glass or such glass cells as are convenient to use. In employing re-agents they can be added, and their effects watched immediately, for it is readily seen how the eye guides the manipulations on the stage, and looks into the instrument almost at one and the same time; a circumstance that facilitates and renders highly satisfactory all such operations, as nearly two years experience has convinced me.

With this arrangement we need not hesitate to employ hydrofluoric acid among our re-agents, as Prof. Bailey has already done, for the purpose of settling in a most ingenious manner, that the markings on certain microscopic siliceous animalculæ are elevations and not depressions, as they appear last under the action of this acid.

On the supporting ring V, are placed the diaphragms, palarascope, achromatic condenser, &c. I have also arranged a small ring of ivory, through the edge of which two wires pass that can be made the poles of a galvanic battery, and thereby subject anything to an electric action while on the microscope. The extremities of the wires may be united with a spiral of small platinum wire, which would become heated by the passage of the electricity, and in this state can be brought immediately over the object under examination.

There is another and very simple method which I have adopted for heating or evaporating liquids while on the stage of the microscope; it consists of a thin plate of brass about five inches long and an inch wide, with a hole in the centre. About an inch and a half each side of the hole, there are two screws projecting about the tenth of an inch. When required it is placed on the stage with the projecting screws downwards, that prevent the plate from touching the stage, and the part of the plate projecting beyond the stage is heated by a small lamp; the heat is readily propagated along the plate, and imparted to the glass that may be placed along it.

In using this instrument for chemical purposes, it is very necessary to be able to apply the re-agents conveniently, and for this purpose I place such of them as are used in two ounce phials, in the neck of which there is a small drop tube as represented in fig. 3, over the top of which is stretched a piece of sheet india-rubber, and by pressing and relaxing it, the liquid is drawn in, and by pressing the same the smallest possible quantity can be discharged on the object subject to examination. The tube also serves as a stopper to the phial, for the length of the capillary extremity is such that it reaches nearly to the bottom.

The acids and ammonia used are always diluted to about one half their ordinary strength, to prevent any unnecessary disengagement of vapors.

A moveable stage under many circumstances is very convenient, and I have adopted one of a very simple character, and quite equal to any of those where the motion is produced by screws or pinions. It is a circular plate of metal or glass, about three-fourths of an inch less in diameter than the fixed stage of the instrument, and an eight of an inch thick, with a hole in the centre of nearly an inch diameter. This is laid in the stage of the instrument, the glass sustaining the object placed on it, and when required the former is moved by the fingers, which can readily impart to it the most delicate motion, as they are in part supported by the edge of the fixed stage. For this suggestion I am indebted to Prof. Riddell, and both he and myself, after much experience, feel convinced of its usefulness.

In observing with high powers, as the object-glass is beneath the glass supporting the object, and as this glass is usually of a certain thickness, we have to change our method of observation —for all powers resorted to in chemical examination this difficulty never occurs, and in using high powers it is easily obviated. Where the object is already mounted and dry, the thin glass can be readily turned downwards; but where it is moist, as, for instance, in examining fresh *Desmidiæ* and *Diatomaciæ*, the following plan is resorted to, namely to use a cell made of a thin piece of brass or glass, perforated with a hole about a half an inch in diameter, it is best to give the hole a considerable bevel in one direction, as it facilitates the cleaning of it, over the small end of the hole a piece of thin glass is stuck with balsam or other cement. When used the object to be examined is placed within, and a cover of thin glass placed above. When brass is used to make the cell, it may be as thin as the twentieth of an inch, and I have two such in my possession, made for me by Prof. Riddell, and they are certainly the most convenient things of the kind I have ever used. And here I may remark that for all observation with high powers, the Inverted Microscope is decidedly superior to the ordinary forms of mounting, for in the latter case, when an object-glass of a $\frac{1}{12}$th or $\frac{1}{16}$th inch focus is used, the focus is too short to admit of the use of cells, whereas in the inverted form, as the object is looked at from beneath, the cell may be as thick as one pleases. Another thing that I have discovered connected with this class of observations, is that the *Diatomaceæ* and *Desmidiæ* can be observed to much greater advantage from beneath than from above, for reasons that will be obvious to persons accustomed to observe these classes of objects.

Another advantage possessed by this instrument calculated to extend its use for general purposes, is its great capacity for every variety of illumination, without sacrificing the ease and freedom from fatigue belonging to the use of this form of Microscope; for when placed on a table, rather higher than the one commonly used, and a foot or two from the edge, the observer can recline on his arms, and observe for hours without the slightest sensation of fatigue.*

* As Prof. Riddell, of the Medical Department of the University of Louisiana, has been using my microscope for general purposes for more than a year, I requested of him his opinion as to its advantages, which is expressed in the following letter:

Prof. J. Lawrence Smith:—*Dear Sir,*—In reply to your note respecting your Inverted Microscope, I have to say that having formerly been in the habit of using the mountings of Pritchard, Dollard, Raspail, Chevalier and Nachet, and having the

Many little additional conveniences will suggest themselves to almost all microscopists who may use this instrument, but the great principle belonging to it is what I desire to make public, and any other adjuncts that might be described are such as belong to all forms of microscope.

New form of Eye-piece Micrometer for Measuring Objects under the Microscope.—Facility of measuring objects under the microscope is a great desideratum; and for that reason I now make known what I have been using for this purpose for upward of two years, as it furnishes all that can be desired. The eye-piece micrometer ordinarily in use, consists of a glass with divisions drawn in it, contained in a special eye-piece adapted for its use; and whenever the measurement of an object is required, we replace the eye-piece used by the micrometer eye-piece, and move the object on the stage, so that its image falls on the marking of the micrometer. With all its advantages this form has many inconveniences, among which I will mention the necessity of using an eye-piece which is not always the best for examination, the constant interposition of the micrometer in the field of observation, and the necessity of moving the object so as to superpose its image on the micrometer.

The eye-piece micrometer of Mr. George Jackson, described in Quekett's work on the Microscope, is an improvement on the one just mentioned, but does not do away with all the objections.

By the present arrangement, the micrometer can be used with any eye-piece, it can be withdrawn at pleasure and placed over the image of the object without regard to its position in the field; for this purpose the tube of the microscope is in two parts, G and N (fig. 2), the former has a collar *h*, and projects a couple of inches into N, turns freely in it, and is retained by a small screw *n* passing through N and playing on a grove in G. On the upper part of G there is a small rectangular opening in a little mechanical arrangement as seen in *m*. The various eye-pieces are so mounted that when placed in the tube G, the planes of their foci

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past year constantly used my best lenses (Spencer's make) in the Inverted Microscope, I am fully satisfied of the practical superiority of the latter for general purposes. With it, observation can be made with more ease and comfort, the light admits of more convenient and efficient management, chemical re-agents can be applied to the object with the greatest facility, without endangering the instrument, and the slides can be moved or changed with the utmost facility, and with perfect safety to the object-glass and the slides themselves. The instrument is so firm as to manifest no vibration with the highest powers, and admits of the attachment of every collateral appliance. I shall never willingly return to the habitual use of any other known form of microscope, especially with high powers. The excellency of your form of microscope depends on having a good reflecting prism below the object-glass; the one used by me, made by Oberhauser of Paris, seems to be perfection itself, and seems neither to absorb or distort the luminous rays in the slightest degree.

Respectfully yours, J. L. Riddell.

correspond with the opening at *g*, and at the same time there is an opening in their mounting which is made to come opposite to that of *g*. The micrometer is seen in fig. 2, and consists of a brass mounting B with a small plate of glass A, having near the outer edge a fine graduate scale (the one used is ten millimetres divided in one hnndred parts) made in the direction of the breadth and not of the length of the micrometer, which little circumstance is of vast importance: for made as it is, it can sweep the field of the microscope; whereas were it graduated longitudinally, it would simply move in the radii of the field, and therefore could not be brought on the object in many of its positions.

The manner of using the micrometer can be understood in a few words. In examining with any eye-piece, if it be required to measure an object. The micrometer B is introduced into the opening *g*, and if not seen distinctly, by turning the screw *p* it is readily adjusted, and by pushing it backwards and forwards, or turning the tube D, the graduated scale can be readily brought over the image of the object, either longitudinally or otherwise; and knowing the value of each division, the dimensions of the object is readily made out. The manner of ascertaining the value of these divisions is learnt in almost every work on the microscope. This method of mine is now adopted by M. Nachet, of Paris, in the construction of his large microscope.

A new form of Goniometer for Measuring Angles of Crystals under the Microscope.—The measurement of the angles of crystals beneath the microscope is at best a very imperfect operation, for we can only measure plane angles, the angles between the faces not being measurable; yet, imperfect as it is, it is an important adjunct in certain researches, as may be seen by referring to the following, which is an extract from Lehmann's work on Physiological Chemistry, where he speaks of detecting a minute quantity of urea in albuminous fluids.

"If the residue of the fluid, from which the coagulated matters have been filtered, be extracted with cold alcohol, and the solution rapidly evaporated, so as to cause the chlorid of sodium (taken up by the cold alcohol) to separate as much as possible in crystals, or then bringing a drop of the matter-liquid in contact with nitric acid under the microscope, we shall observe the commencement of the formation of rhombic octahedra, and the hexagonal tablets, in which, if the investigation is to be unquestionable the acute angles ($=82°$) must be always measured. After the determination of the nitrate, we may also obtain the oxalate, and submit it to microscopic examination. *A good crystalline determination yields the same certainty as an elementary analysis, which, in these cases, would never or extremely seldom be possible.*"

Two of the best goniometers used for this purpose are those of Ross and Leesom, the latter being doubtless the best, and based on the use of the double refracting spar. After trial, however, I find it neither as accurate nor as economical in its construction as the following :—

Around the tube N, fig. 1, there is a collar X fastened to it; on the collar there is a graduated circle S, about three inches in diameter, turning freely on X. On the tube G a small index *t* is fastened. These are all the additional parts necessary, as the micrometer just described is used to aid in the measurement, which is accomplished as follows: The angle of the crystal to be measured is brought as near the centre of the field as the eye can readily judge of, (a little deviation will not sensibly affect the measurement); the micrometer is then introduced in the opening *g*, and turned about until the lines are parallel to one side of the angle, or until one of the long marks correspond with that side; this done, without disturbing the tube G, the graduated circle S is turned, until the index *t* points to zero. Now look again into the instrument, and turn G until the markings on the micrometer are parallel with the other side of the angle; read the number of degrees on the circle, and this will be the angle or its compliment. It frequently happens that the micrometer has to be moved in or out to make the lines on it accord with the second side, but as this motion is altogether a parallel one, the accuracy of the measurement is not at all effected. The simplicity of the mechanical arrangement is readily seen; the same advantage in using the micrometer with every eye-piece belongs to the goniometer.

Art. XXVIII.—*Abstract of a Meteorological Journal, kept at Beloit College, Beloit, Wis., for the year* 1851. Lat. 42° 30′ 23″ N., long. 12° 03′ 20″ W. from Washington: elevation above Lake Michigan, 172 feet—above the ocean, 750 feet; by S. P. Lathrop, M.D., Professor of Chemistry and Natural History.

MONTH.	BAROMETER.			THERMOMETER.			Clearness of sky.	Prevailing winds.	Inches rain & melted snow.
	Max.	Min.	Mean.	Max.	Min.	Mean.			
January,	29·89	28·68	28·70	56	−19	24·72	5·04	N.W. & S.	2·16
February,	29·83	28·95	29·37	55	0	33·57	5·20	S. & N.	3·43
March,	29·58	29·10	29·29	76	8	39·00	6·95	S. & N.	·55
April,	29·85	28·85	29·28	76	24	43·80	6·37	N. W. & N.	2·35
May,	29·61	28·85	29·32	84	23	57·30	5·50	S.E. & N.W.	15·46
June,	29·50	28·90	29·34	88	44	62·40	5·85	N.W. & S.W.	5·52
July,	29·43	29·09	29·26	95	46	71·84	6·48	S.W. & N.W.	5·52
August,	29·49	29·09	29·32	98	50	68·68	5·50	S. E. & S.	9·85
September,	29·68	29·01	29·40	94	32	66·90	6·82	S.W. & S.E.	3·40
October,	29·56	28·71	29·14	76	20	49·61	6·12	S. & N.	3·40
November,	29·82	28·74	29·26	48	16	34·83	4·85	N. & N. W.	1·63
December,	29·74	28·55	29·39	56	−12	22·10	4·56	N.W. & S.W.	2·63
Year,	29·665	28·543	29·339	98	−19	46·895	5·77	N. W. & N.	55.90

The mean temperature of the past year is 47°·895, being a little above that of the year 1850, which was 47°·200.

The mean temperature of the winter months of 1850–51 is 27°·43; of the spring months of this year 46°·70—being 3°·62 higher than the temperature of the same months in the year 1850. The temperature of the summer months is 67°·64, being 3·86 lower than the temperature of the same months in the year 1850. The temperature of the autumnal months is 50°·45, being ·88 of a degree above the temperature of the same months of the previous year.

The average density of the atmosphere as indicated by the barometer—29·339 inches—is a trifle greater than in the year 1850, it being for that year 29·27 inches when corrected by adding the decimal ·64, which, by comparison with one of Green's barometers—the kind now recommended by the Smithsonian Institute—is found to be the true amount of correction necessary for the barometer then in use.

The observations have been made, as last year, at the hours required by the Smithsonian Institute, viz.: sunrise, 9 A. M., 3 P. M., and 9 P. M.

The amount of rain and melted snow for the year is 55·90 inches, being 4·66 inches more than in the year 1850, though the amount for that year was more than is thought to be the annual average. This amount, as may be seen by the table, was not very equally distributed through the year—being for the month of May 15·46 inches, and for the month of August 9·85, while for the month of March it was only ·55 of an inch, and for the month of November 1·63 inches.

The rains in the month of May occuring mostly in the latter part of the month, amounting in the last day of the month to 4·5 inches, raised the Rock River to an unprecedented height, causing a flood which did much damage, carrying off animals, bridges and dams.

The amount of snow which fell in the winter of 1850–51 was greater than in the winter previous, being nearly 15 inches, but was so equally distributed through the winter as to afford but little sleighing.

The past year is considered usually productive, though some of the crops were greatly injured. The spring was very backward, more so even than the year before, notwithstanding the temperature was a little higher. The heavy rains of May greatly delayed the planting of corn, on which account it was, at first, feared that there would be but a partial crop, but the mild fall and the delay of hard frosts gave abundant time for it to ripen, and it thus became a good crop. The yield of grass was very heavy. The wheat crop was comparatively a failure; much of the spring wheat, especially the hedge-row, being greatly injured by the *blight.* Hundreds of acres were not harvested. The winter wheat, and some kinds of spring wheat, however, did well, furnishing an abundance beyond what is necessarily consumed. The crop of oats was very heavy. The yield of potatoes was very light, not being injured, however, so much by the *rot* as by the *blight*, a kind of indefinite term given to some cause which eludes the search of the agriculturist. Some portions of the State, it is understood, were almost destitute of this important vegetable.

Some farmers in this region have commenced the raising of flax, which gives a profitable yield, and is destined to be a crop of much importance both on account of the seed and the stalk. The late invention of a machine for pulling flax has obviated the great objection to the raising of this crop, while the building of mills for the dressing of flax has opened for it a ready market.

The fruit that has been introduced into the country did well the past year, and has kept up the fair promise for the future. In some instances the fruit trees have suffered from the blight. Some grapes were injured by the frost while in the blossom, but those later in flowering did finely.

Garden vines were greatly injured by the heavy rains. Some being entirely drowned out, while others rotted at the roots.

There was no second flowering of plants as noticed last year, except the case mentioned in the calendar on November 10th.

The *Cantharis cinerea* which has made its appearance here in increasing numbers for the few previous years was not observed to any amount. Neither was anything heard of the *chinch-bug*, so troublesome the last two years in the northern counties of Illinois.

There were during the year some heavy storms of electric fluid, particularly in the month of May, frequently striking buildings and other objects elevated much above the ground.

The prevailing winds have been, as last year, northwest and north, though we have quite frequent and strong winds from the southwest. There was a violent wind on the 30th of May, which did some damage by unroofing buildings, removing fences, &c., though its track, as it passed this place, was quite narrow, being but four or five rods in width. Its direction was from southwest to northeast. The law of rotation of the winds, alluded to in the last years abstract, is, in the general, corroborated by this year's observations; there were, however, marked exceptions.

CALENDAR.

January.—2d, Morning, meteor seen in the northeast; 16th, the thermometer fell from 35° at sunrise to 3° at 9 P. M.; tulips and jonquils above ground; humble bee seen flying about; 30th, coldest day in the year, thermometer averaging 11° below zero.

February.—23d, severe storm of thunder and lightning, with rain in the night.

March.—7th, Ranunculus fascicularis in flower; Pæonia humilis and star of Bethlehem up; 16th, bluebirds seen and robins heard to sing—some say that they remain here all winter near houses (?); wood Anemone, Pulsatilla patens in blossom; 24th, meadow lark seen; 27th, wild pigeons seen; Missouri currant in leaf; 29th, bee larkspur in leaf.

April.—2d, frogs singing; 4th, snow storm; 8th, farmers sowing wheat; 12th, spring beauty in flower; 16th, dwarf iris, Dutchman's breeches, blood root and pepperwort in flower; 18th, wild geese flying north, strawberry and jonquils in flower; 24th, asparagus fit to cut, lanced-leaved and hood-leaved violets, periwinkle, filbert and hyacinth in flower; 25th, cherry in leaf, currant in flower; 26th, Missouri currant, plum, cherry and pear in flower; 28th, gooseberry in flower.

May.—3d, Lousewort in flower; 6th, box elder in blossom; 7th, frogs singing the second time, having commenced *too soon* before; 8th, ground ivy, flowering almond in blossom; 8th, blue bell and puccoon in flower; 10th, peach, tulip and painted cup in flower, Baltimore oriole seen; 12th, American cowslip and apple in flower, burr and black oak in leaf—these trees did not blossom this year; 13th, horse-chestnut in leaf; 14th, Solomon's seal and bladder nut in flower; 15th, tartarian-fly-honey-suckle in blossom, locusts begin to put out their leaves; 16th, cranes bill, lilac and daisy in flower; 17th, blue-eyed-grass in flower; 19th, white moccasin flower in blossom; 20th, wild columbine, wild lupine and white oak in blossom; 23d, milk weed in flower; 24th, Virginian anemone and snow-ball in blossom; 25th, Potentilla canadensis in flower; 26th, rose acacia in flower, catalpa and hercules club in leaf; 27th, fringe tree and yellow moccasin flower in blossom; 28th, Polygala senega in flower; 30th, feyerwort.

June.—3, sweet scented syringa and spiderwort in flower; 24th, spotted lily in flower.

July.—15th, one of the two hottest days of the year, the thermometer averaging for the day 83¾°; 16th, catalpa in blossom; 20th, Bignonia rachicans in flower; 26th, the other hottest day, the thermometer averaging the same as on the 15th.

August.—27th, some say there was frost.

September.—10th, splendid aurora; 28th, heavy frost.

October.—23d, water froze and ice formed 1½ inch thick.

November.—4th, first snow; 10th, Flos adonis in full bloom.

December.—15, thermometer 19° below zero at 5¾ A. M.

ART. XXIX.—*Solidification of the Rocks of the Florida Reefs, and the Sources of Lime in the Growth of Corals;* by Professor HORSFORD, of Harvard.

I. It is required to ascertain by what processes, chemical or mechanical, or both chemical and mechanical, the surface and the submerged coral rocks have become hardened.

By the surface rock is intended that thin brown crust, composed of numerous layers, which is distinguished by great compactness, and a peculiar ring, when, in detached condition, it is struck by a hammer, and which occurs on the abrupt ocean side, and more abundantly on the long slopes on the land side of the Keys.

By the submerged rock, is intended the rock of oolitic appearance which has solidified under water, and which is of inferior hardness to the surface rock.

The surface rock, so called, has in many places no longer the outermost position, though it had at the time of its formation. It is indeed interstratified with friable light-colored limestone. The epithet indicates the circumstances of its formation, not its present position.

1. We are familiar with the fact that a mixture of quicklime, water and sand, spread out upon walls and ceilings exposed to an atmosphere containing more or less of carbonic acid, in a few days becomes hard. Analyses have shown that two chemical phenomena are concerned in the solidification, to wit.: the absorption of carbonic acid from the air, forming carbonate of lime (which salt, uniting in equivalent proportions with the hydrate, forms, according to Fuchs, a compound of great stability); and the union of the outer portions of the sand-grains with the lime, forming a silicate. Investigation has shown that sand fulfills mechanically a more important office, by increasing the extent of surface to which the compound of the hydrate and carbonate may attach itself. The latter office may also be performed, and equally well, by pulverized limestone.

2. It is well known that calcareous springs deposit carbonate of lime in crystalline forms. The salt had been held in solution by carbonic acid contained in the water. Upon reaching the surface under less pressure and the influence of a high temperature, its carbonic acid is given up, and with it a precipitate of carbonate of lime takes place. The process is exclusively chemical.

3. The value of hydraulic cements is now conceived to depend chiefly upon the presence of silica and lime, the oxyd of iron having little or nothing to do with the process of solidification. The alumina, in the form of a silicate, yields its silica to the lime, which, for its transportation, requires water. This explains the necessity of its being retained under water periods of variable

length, according to the proportions of the ingredients. The processes are both chemical and mechanical.

4. Gypsum from which the two atoms of water of crystallization have been expelled by heat, rapidly hardens upon being mixed with water. This is ascribed to the reunion of the sulphate of lime with the water.

Do either of the above processes suggest the method by which the rocks of the Florida reefs have been hardened?

The facts presented in the furnished specimens are as follows:

The rock formed under water exclusively is composed of grains of size less than that of a mustard seed, which, to the naked eye, appear quite globular and of uniform diameter. More carefully examined with a microscope, they are found to be far from regular in form or uniform in size, but present numerous depressions and prominences. Distributed throughout the intervening spaces is a fine deposit of carbonate of lime, which adheres with considerable tenacity to the surface upon which it rests.

The surface or crust-rock, though not strictly homogeneous, is composed of particles so minute as not to be distinguished from each other. It dissolves in hydrochloric acid, leaving a flocculent residue. The solution, when evaporated to dryness and ignited, readily redissolves in hydrochloric acid, with only an occasional residue. The solution gives no precipitate with chlorid of barium. Nitrate of silver gives, in a nitric acid solution, a white precipitate soluble in ammonia. The aqueous extract gives to alcohol flame the characteristic soda tint. The powdered rock, dried at 100° C., when heated in a dry tube, gives off water.

Thus the qualitative analysis of the incrusting rock showed it to consist of lime, soda, carbonic acid, hydrochloric acid, water, and organic matter. There were also variable traces of peroxyd of iron, magnesia and silica. The former two were wanting in most of the specimens examined, and the silica in some. Numerous specimens were examined for alumina, without in any instance finding a trace of this substance.*

In a quantitative analysis by Homer, and another by Mariner, the following results were obtained.

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* I examined, also, all the species of coral at my command, without finding a trace of alumina in any of them. The hydrochloric acid solution of the coral was precipitated with ammonia. The washed precipitate was digested for several hours with potassa (previously tested for and found to be free from alumina), and filtered. The filtrate was then neutralized with hydrochloric acid, and ammonia added. After standing for several hours, there appeared filaments which were soluble neither in potassa nor nitric acid, and which, examined with the microscope, proved to be paper; they had been derived from the filter. Beside these, there was no precipitate. The quantities employed were, in several instances, from a quarter to half a pound of material. There were examined, Millepora alcicornis; Meandrina labyrinthica, two specimens; Manicina palmata; Mycedia areolata; Astræa microcosmos, two specimens; rock subaërial, and rock submarine, numerous specimens.

The total loss by prolonged ignition included organic matter, water as hydrate of lime and carbonic acid, was as follows:

I. 2·7875 gr. lost 1·2687 gr. II. 0·5910 gr. lost 0·2600 gr.

The water was determined in a chlorid of calcium tube, with the aid of a low red-heat and an aspirator. (A heat of 175° C. in an oil bath, expelled but a very small proportion of the water.)

I. 0·7519 gr. lost 0·0259 gr. II. 1·2890 gr. lost 0·0280 gr.

The organic matter was determined by washing on a dried filter the hydrochloric acid residue.

I. 1·7181 gr. gave 0·0028 gr. II. 0·4461 gr. gave 0·0021 gr.

The carbonic acid was determined in an evolution flask glass. The results with different specimens varied greatly, and are far from being satisfactory.

I. 0·8605 gr. lost 0·3347 gr. III. 0·1720 gr. lost 0·0585 gr.
II. 0·1745 gr. lost 0·0600 gr. IV. 1·6116 gr. lost 0·6277 gr.

The lime was precipitated as oxalate and weighed as carbonate.

I. 1·3248 gr. gave 1·2581 gr. II. 0·2550 gr. gave 0·2330 gr.

The silica was determined in the usual way.

I. 1·3245 gr. gave 0·0002 gr. II. 0·3760 gr. gave 0·0005 gr.

The chlorine of the chlorid of sodium was determined as chlorid of silver.

I. 0·8933 gr. gave 0·0303 gr. II. 0·6850 gr. gave 0·0101 gr.

Expressed in per cents. we have :—

Volatile Matter from	-	43·99 p. c.	to	45·51 p. c.
Water "	-	2·17	"	3·44
Organic Matter "	-	0·16	"	0·47
Carbonic Acid "	-	{ 34·01 34·38	"	{ 38·89 38·94
Lime "	-	51·17	"	53·12
Chlorid of Sodium "	-	0·04	"	0·04
Silica "	-	0·01	"	0·01

It is conceivable that the variability in the carbonic acid and water, is due to the more or less advanced stages of change which the rock has undergone. In the ultimate form of limestone all the water existing as hydrate in the earlier stages, will have become carbonate.

These ingredients permit no action like that occurring in hydraulic cements, in which silica plays an important part; or like that presented in the hardening of gypsum, in which sulphuric acid is necessary. To one of the two remaining processes, if to either, must it be ascribed; and as hydrate of lime is present, it cannot be exclusively assigned to a place with calcareous spring deposits. Now, how could hydrate of lime be provided from carbonate of lime?

The completeness of the suite of collections provided for me by Prof. Agassiz, has enabled me to answer this question in such a manner as leaves, I think, little room for doubt. On the main land against the Keys, there are depressions which are filled with water only at long and irregular intervals. This water, like that within and about the Keys, abounds with animal life. As the water evaporates, these animals die, and fall upon and mingle with the coral mud at the bottom. As the beds become more and more completely dry, the layer of mud and animal matter hardens till it forms a mass resembling the surface or crust rock.

Of this soft, growing rock, specimens were collected. Agitated with water, it yielded a turbid, fœtid solution. Tested with acetate of lead, it betrayed the presence of hydrosulphuric acid. After standing some hours, a delicate white film was deposited upon the containing vessel, at the surface of the water, which proved to be carbonate of lime. Test-paper showed the liquid to be alkaline. The addition of soda solution set ammonia free, and the addition of chlorid of barium and hydrochloric acid showed the presence of sulphuric acid.

Conceiving this soft rock to be in the condition in which the solidified crust was at first, the process of hardening seemed of easy explanation.

The animal matter mixed with the carbonate of lime, containing sulphur and nitrogen, besides carbon, hydrogen and oxygen, in the progress of decay, which warmth and a small quantity of water facilitated, gave, as an early product of decomposition, hydrosulphuric acid; this, by oxydation at the expense of the oxygen of the atmosphere, became water and sulphuric acid. The sulphuric acid coming in contact with carbonate of lime, a salt soluble in 10,600 parts of water, resolved it into sulphate of lime, a salt soluble in 388 parts of water. The carbonic acid set free, uniting with an undecomposed atom of carbonate of lime, rendered it soluble. The nitrogen going over into the form of ammonia, at a later period, decomposed the sulphate of lime, forming sulphate of ammonia and soluble hydrate of lime. This hydrate of lime, with an atom of carbonate of lime, united to form the compound in ordinary mortar investigated by Fuchs. The carbonate of lime in solution from the added carbonic acid, as the water is withdrawn by evaporation, takes on the crystalline form, giving increased strength and solidity to the rock.

That this explanation may serve, in however small measure, for the crust rock on the land slopes of Key West and all localities of a similar character, it is necessary that there be animal exuviæ in coral mud, or finely divided carbonate of lime. Both these occur. The water about the Keys abounds in animal life.

With the influx of the tide, the slopes become overspread with the water and what it contains in suspension. The retreating water, at ebb tide, leaves a thin layer of the animal matter, mixed always when the water is agitated with the fine calcareous powder. Before the return of flood tide, exposure to the atmosphere and warmth have secured the succession of chemical changes enumerated above, and a thin layer of rock is formed. A repetition of this process makes up the numerous excessively thin layers of which this rock is composed.

On the ocean side the deposit is formed from spray, during winds which drive the froth of the sea, containing, with coral mud, the exuviæ from the barrier of living corals upon the low bluffs of the Keys.*

To these chemical changes must be added the simple admixture of the animal and vegetable matter, which, like mucilage or glue, fills up the interstices, increases the extent of surface, and with it the cohesive attraction; and still further to the decomposition of the organic matter furnishing carbonic acid, which gives solubility to the pulverulent carbonate of lime.

The exceeding fineness of the coral mud is due in part to the stone plants which flourish in the waters within the reef, and which admit of ready reduction to a powder of extreme fineness. Of these, two species of Millepora, I, II, and one of Opuntia, III, were analyzed by Mr. Scoville in my laboratory.

	I.		II.		III.	
Organic matter,	4·45	4·45	1·26	2·58	4·18	5·72
Carbonic acid,	40·09	39·64	41·08	2·70	37·68	35·81
Sulphuric acid,	0·0056	0·0056	——	——	——	——
Lime,	47·71	47·98	46·35	46·80	51·81	51·36
Magnesia,	——	——	6·23	5·90	——	——
Water,	3·67	3·30	4·52	——	5·59	5·92
	95·92	95·37	99·44	8	99·26	98·81

* Professor Dana in a note to his last paper on Coral Reefs and Islands in the July number of this Journal, p. 83, after enumerating briefly the details of the above process of consolidation, remarks:—

"In the first place, his (Prof. H.'s) paper only alludes to the rock formed above low-tide level, which I have called the coral sand-rock. Again, the amount of organic matter in corals, as found by analysis, does not exceed five per cent.; and the sulphur present in this organic matter, is not over *one-tenth of one* per cent. It hence appears that the amount of sulphur is altogether inadequate for such changes.

"But as the sands of the beach (which have a peculiarly white and clear appearance) are washed by the breakers, and the animal matter they contain is either undecomposed within the several grains, or is borne off by the waters, even the animal matter present cannot contribute to the consolidation. The waters of the tides along a sand beach on the open ocean have certainly not been proved to carry in dissolved animal matter for dissemination among the sands."

Two or three points in this note demand attention from me.

The first sentence of the first paragraph should be read in connection with the conclusions I and II, expressed at the end of my paper.

In reply to the remainder of the paragraph, the criticism would be just, if I had any where ascribed the solidification, or any part of it, to any action of the organic matter in corals.

Since the publication of my article in the Proceedings of the Association, there have been made quantitative analysis of the more important ingredients of the soft rock, corresponding, as I conceive, with the rock of sub-aerial solidification in the

The discrepancies in the analyses of the different specimens of the same species are due to the circumstance that different parts of the stone plant contain organic matter in unlike proportions; and it is very difficult to procure two specimens which, when

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first stages of its formation. When first supplied to me, it was of the consistency of well tempered pottery clay. It is now so hard as to yield only to a severe blow with a hammer, and is, beside, brittle and coated with fibrous crystals of common salt.

The following analysis made by Everett and Warren, upon samples differing but little from each other in appearance, have been conducted with great care. They vary, it will be seen, considerably from each other:—

Dried at a temperature of 100° C.	By prolonged ignition.
I. 1·1450 gr. lost 0·0890 gr.	0·8270 gr. lost 0·4870 gr.
II. 1·5325 gr. lost 0·1175 gr.	1·9020 gr. lost 0·8000 gr.

The hydrochloric acid solution left a residue of organic matter.

I. 1·1450 gr. gave 0·2930 gr. II. 1·6424 gr. gave 0·2805 gr.

The mass, digested in diluted hydrochloric acid, yielded from existing sulphate upon the addition of chlorid of barium to the filtrate, sulphate of baryta.

I. 2·3380 gr. gave 0·1040 gr. II. 1·5325 gr. gave 0·1304 gr.

The organic matter by itself, oxydated in nitro-hydrochloric acid, with addition of pulverized chlorate of potassa, yielded to chlorid of barium a precipitate of sulphate of baryta.

I. 1·5325 gr. gave 0·1505 gr.

The whole mass oxydated in a mixture of fused nitrate of potassa and carbonate of soda, yielded to chlorid of barium and hydrochloric acid, a precipitate of sulphate of baryta.

I. 2·3090 gr. gave 0·2850 gr. II. 1·4322 gr. gave 0·1550 gr.

The hydrochloric acid solution filtered from the organic matter gave a precipitate of oxalate of lime, which was determined as carbonate.

I. 0·8770 gr. gave 0·4100 gr.

Expressed in per cents. the above determinations give of

Water, expelled at 100° C.

I. 7·77 p. c. II. 7·66 p. c. Average, 7·72 p. c.

Total volatile matter,

I. 41·17 p. c. II. 42·06 p. c. Average, 41·58 p. c.

The following per cents. are estimated upon the substance as dried at 100° C.

Sulphur existing as sulphate and soluble in diluted hydrochloric acid.

I. 0·65 p. c. II. 0·90 p. c. III. 1·26 p. c. Average, 0·94 p. c.

Sulphur in organic matter.

I. - - - - - - - - - 1·45 p. c.

Total sulphur of the above determinations, 2·39 p. c.

Total sulphur by oxydation of the mass, including the organic and inorganic parts.

I. 1·61 p. c. II. 1·84 p. c. Average, 1·72 p. c.

Average by the two methods, - - - - - 2·05 p. c.

Lime, I. - - - - - 30·09 p. c.

Placing side by side the results of the above determinations with the quantities which Prof. Dana justly conceives to be inadequate to the changes ascribed, we have

	Per cent.	Per cent.
Organic matter, - - - - - -	5·	20·16
Sulphur, - - - - - - -	0·1	2·05

The conditions of this soft rock, and of the surface or crust rock at the time of its formation, I conceive to have been quite identical. The soft rock is the residue left

pulverized, will present homogeneous powders of the same consititution.

II. *Source of Lime in the Growth of Corals.*

Marcet,* as early as 1823, observed carbonate of lime in the sea-water near Portsmouth. Jackson† found it in two specimens of sea-water furnished by the United States Exploring Expedition; one from 600 feet, and the other from 2,700 feet below the surface. J. Davy‡ found the sea-water of Carlisle Bay, Barbadoes, to contain about $\frac{1}{10000}$th part of carbonate of lime. There was found scarcely a trace near the volcanic island of Fayal. White‖ is of the opinion that it fails only near the surface; but the elaborate analysis by Bibra§, of no less than ten specimens taken generally from a depth of twelve feet, but in one instance from a

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by spontaneous evaporation of a considerable body of sea-water thrown, with its mingled coral mud and animal matter, into an inland basin, at the rare juncture of favorable high wind and tide. A single layer of the surface rock is the residue left by evaporation of the water mingled with coral mud and animal matter, thrown up in spray from the dashing of the waves, or carried up by flood-tide, and left by evaporation in the interval between the two tides. This will account for its stratification, for its occurrence on eminences as well as in depressions and along abrupt slopes, for its interstratified arrangement with the coarse coral sand; indeed, for all the phases and peculiarities of it which are presented in the extensive suite of collections submitted to me.

In addition to the changes enumerated in the above paper as resulting from the decay of the animal matter, another may be mentioned. The ammonia evolved in the process of decomposition, would provide hydrate of lime from the sulphate present in the sea-water. This ingredient, taking the average of Bibra's analysis, is to the chlorid of sodium as 1 to 16, and may be conceived to have furnished no inconsiderable amount of hydrate of lime for the process of consolidation.

Prof. Dana attributes the formation of this crust-rock which has been the more prominent object of my investigation, to the action of simple rain-water, dissolving the carbonate of lime and again depositing it upon evaporation.¶ This would account for its occurrence in depressions of the rock, but would not account for its occurrence on eminences or on abrupt slopes; nor would it account for the presence of water as hydrate of lime.

The first sentence of the second paragraph of the above criticism has been replied to. I have ascribed no solidifying action to the animal matter in corals.

In regard to the second:—It will not be questioned that there is a great amount of organic matter in various stages of decomposition about coral reefs. Bibra found organic matter in all the ten specimens of sea-water analyzed by him. I have, in the paper above, repeated the statement made to me by the parties who collected the specimens, that the waters within the Keys abound in animal life. That procured for analysis from within the Keys was found exceedingly offensive from the decomposition of animal matter. It yielded the odor and reactions of hydrosulphuric acid, and gave a total amount of organic matter of 2·98 per cent.

Now, it is difficult to see how sea-water should fail to carry the animal matter it holds in solution, and more or less of that it holds in suspension into the coral sands, which are saturated at every high water and again drained at low tide.

* Annals of Philosophy, April, 1823, p. 261.
† Am. Jour. Science, [2], vol. v, p. 47.
‡ Phil. Magazine, [3], xxxv, p. 232.
§ Ann. de Chemie et de Pharmacie, lxxvii, 90.
¶ Am. Jour. Sci. [2], xiv, 77 and 81.
‖ Ib., p. 308.

depth of four hundred and twenty feet, in various latitudes on both sides of the equator, shows quite conclusively that it is not a constant ingredient of sea-water. His analyses do not mention a trace of carbonate of lime. The quantity found by Davy is very nearly that which is soluble in water, and is obviously due to the calcareous marl which abounds near the Barbadoes.

The water from within the Keys was carefully analysed in my laboratory: it contained lime and sulphuric acid among its ingredients, but not a trace of carbonic acid.

The total want of carbonic acid in a water in which coral life is so luxuriant, suggests naturally that the stone plant, as well as the coral animal, possesses the power of abstracting lime from the sulphate; the change being due to double decomposition with carbonate of ammonia excreted from the plant and animal, yielding carbonate of lime, quite insoluble, and sulphate of ammonia of the highest solubility. The building up of the calcareous skeleton becomes, upon this hypothesis, of exceeding simplicity. The surrounding element yields at once to the exhaling carbonate of ammonia the framework of stone.

With this view, there is no difficulty in finding a supply of carbonate of lime for the vast masses of coral. The sulphate of lime, decomposed to furnish the carbonate, is perpetually renewed through rivers from the continents and islands.

The following inferences are legitimately deducible from this view:—

1st. Corals would soon die in bodies of salt water wholly cut off from the ocean.

2d. They might flourish to some extent in waters accessible to the sea only at high tide.

In Dana's Report on Coral Reefs and Islands,* he states that "where there is an open channel, or the tides gain access over a barrier reef, corals continue to grow, etc. At Henuake the sea is shut out except at high water, and there were consequently but few species of corals, etc. At Ahii there was a small entrance to the lagoon; and though comparatively shallow, corals were growing over a large portion.†

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* Am. Jour. Science, [2] xii, 34 to 41, and Geol. Report Expl. Exp., p. 63.

† In my article, as published in the Proceedings of the Association, I have further quoted from Prof. Dana's papers in support of other inferences deduced from the foregoing view. I have since learned from the author that I had misconceived the sense in which the quotations were to be understood, and have become satisfied, especially after examination of the map of the Feejee Islands accompanying Prof. Dana's last article, that the inference that fresh water streams, by their supply of sulphate of lime, exerted any considerable influence upon coral formations, is not sustained. The sulphate of lime of sea-water, however, being one-sixteenth of the chlorid of sodium, is abundant for the supply of the carbonate of lime, without the aid to be derived from such a source.

These facts seem to me to give some support to the view expressed above.

It was of interest to ascertain, in the case of corals, whether the formation of new coral without was attended with absorption or partial solution in the interior, and a corresponding reduction of its specific gravity. Specimens of coral, from the centre, periphery, and midway between, of a mass of Meandrina a foot in diameter, were reduced to powder, washed with hot water until the chlorid of sodium was all removed, and their specific gravity ascertained by Storer. The average of three specimens from the centre, three from the middle, and two from the periphery, gave the following specific gravities:—

Centre.	Middle.	Periphery.
2,695	2,749	2,785

These results so far support the affirmative of the suggestion above, as to make a repetition of the determinations desirable.

The chief conclusions to which the above research has conducted are:—

I. That the submerged or oolitic rock has been solidified by the infiltration of finely powdered (not dissolved) carbonate of lime, increasing the points of contact; and the introduction of a small quantity of animal mucilaginous matter, serving the same purpose as the carbonate of lime, that of increasing the cohesive attraction.

II. That the surface rock has been solidified by having, in addition to the above agencies, the aid of a series of chemical decompositions and recompositions resulting in the formation of a cement.

And I may add that it lends support to the suggestion,

III. That the carbonate of lime of corals is derived from the sulphate in sea-water, by double decomposition with the carbonate of ammonia exhaled from the living animal.

[*Note.*—Mr. Dana will add some farther explanations and criticisms on the subject of Prof. Horsford's paper in another number of this Journal.—Eds.]

Art. XXX.—*Note on the Eruption of Mauna Loa;* by James D. Dana.*

The account of Mauna Loa, by Rev. Titus Coan,† together with the additional information from letters appended to this paper, suggests a few thoughts confirmatory of views mentioned in another place by the writer.

I. The eruption described, although so vast in its extent, commenced with no earthquake—no internal thunderings—no premonitions whatever that were perceptible at the base of the mountain. In almost all descriptions of volcanoes, these phenomena are set down as essential to the result, especially if the eruption be of much extent. Some force is supposed, in one way or another, to get beneath the column of lava, and by sudden action to eject the lavas with violence, amid terrific exhibitions of volcanic power. But in the majestic dome of Mauna Loa, where the lavas are carried to a height of 14,000 feet, the outbreak is quiet and noiseless; the mountain opens, the lavas flow. The vivid description of Mr. Coan, marked as it is with the actual terrors of the scene, strikingly sustains these statements. For how unlike Vesuvius in her great outbreaks is the Hawaian volcano, when the crater, in its intensest eruption, could be approached "within forty or fifty yards on the windward side," or "within two miles on the leeward," and the traveller need retire but to the distance of "a mile" from the very scene of eruption for his "night vigils."

II. The mobility of the Hawaian lavas is most remarkably exemplified in this eruption. The fiery rock at the crater formed literally an open boiling fountain, instead of appearing in eruptive discharges through a narrow-necked funnel. A *jet* of clear liquid lava shot up in ceaseless flow to a height of 300 feet or more, and, with its surrounding jets and falling spray, produced, as Mr. Fuller says, the effect of a Gothic structure of molten metal, with its shafts and pinnacles and buttresses, in quick incessant change—now rising into a tall spire 700 feet in height, now spreading into more massy forms, and ever dazzling the sight with its brilliancy. The scene of this display, according to Mr. Coan, was 5,000 feet below the summit outbreak,‡ and it would actually appear, as he implies, that the hydrostatic pressure of the central column of lavas in the mountain was the power that kept the jet in action. Such a fountain of molten rock is majestic beyond conception; and the more wonderful, the more majestic, viewed as the effect of simple pressure, with none of the convulsive heavings

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* See farther the author's Expl. Exp., Geol. Report, Chapters III and VII; also, this Journal, [2], ix, 347, and x, 235. † This volume, p. 219.

‡ Seven thousand feet, or half way to the base, according to Mr. Fuller.

common in other volcanoes. The terrible roar of the crater was the sound of the ponderous mass agitated to its depths, by the tossing and falling jets and the escape of the imprisoned vapors; it was not enhanced even by the occasional shocks of an earthquake.

III. Kilauea, a crater on the flanks of Mauna Loa, but 4,000 feet above the sea, having its larger diameter 18,000 feet, or 3½ miles, exhibited at this time no signs of sympathy with the summit action.* If ever a region had its *safety valve*, we should say that this immense crater would be such to Hawaii. But the lavas rise in the centre of the mountain 10,000 feet above this vast pit, (or nearly 11,000 feet above its bottom), without producing the slightest fluctuation in its boiling lakes.

IV. From the eruptions of Kilauea in 1823, 1832 and 1840, the writer, in tracing out its history, stated that the course of changes leading to a new outbreak required eight or nine years, this being the interval between the known eruptions. The process was shown to consist in a gradual filling up of the great pit for 400 or 500 feet of its depth, attended with an increased activity when at this height, and followed by a discharge from some fissure or fissures opened through the slopes toward the sea.

But since 1840, thirteen years have passed and still no eruption has been observed. The process has, however, been essentially as indicated by the author, although under a new modification of its action. The crater did go on filling up at its usual rate, so that in 1846, it had already risen to a height of 400 feet above the level it had after the eruption of 1840.† The crater, moreover, was then in violent activity, and the black ledge was nearly obliterated; the bottom continued still to rise, and an eruption was speedily expected. But instead of an eruption, we learn that in 1848 and 1849,‡ all was nearly quiet, excepting a single convulsive heaving in the latter year. The lower pit was filled with solid lavas, and the great lake became finally the site of a solid dome or cone.

It is however altogether probable, from the retreat of the liquid lavas and the disappearance of the fires, that a discharge actually took place at the time expected, but beneath the sea. Such a discharge occurring in the usual quiet way, might be unperceived by the inhabitants of the island. The outflow of lavas, however, must have been but a partial one; and, consequently, the bottom of Kilauea, instead of subsiding, as the lavas retreated, 400 feet (as commonly happens), retained its place.

Five years have now passed, and the fires, as Mr. Coan states, are again breaking out. This is a further confirmation of our view.

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* This volume, p. 220.

† See the author's papers referred to. Also a detailed account, by Rev. C. Lyman, in this Journal, [2], xii, 75.

‡ This Journal, [2], ix, 362, and x, 80.

The process of elevation in the liquid internal lavas has evidently been going on, as after previous eruptions, although out of sight, deep beneath the solid rock that forms the bottom of Kilauea; and they have again reached a height that enables them to be distinguished. The mode of progress and of eruption may therefore correspond throughout with the views presented by the author in his Exploring Expedition Geological Report, and this Journal, vol. ix, 347. Yet it is also possible that the fires of Kilauea are dying out and that thus the change of condition is to be explained.

Although the discharges at the summit of Mauna Loa produce no oscillations in the lavas of Kilauea, it may still be possible that the increased activity at the summit, and the diminished action of the flank crater, during the past few years, may be connected with the same changes below. These changes may consist in some variations in the distribution of the heat, or, more probably, in a variation of size or direction in the openings or channels that serve to supply the water which feeds the fires.

V. If Kilauea were to become extinct in its present condition, no evidence would exist of its former depth, or of the black ledge or shelf which has been so remarkable a feature in this crater. The present depth does not exceed 600 feet—400 feet less than after the eruption of 1840.* Moreover, as the precipitous rocky walls are wholly free from scoria and all other signs of recent fires (looking much like bluffs of ordinary stratified rock), there is no evidence as to the great eruptions that have taken place, and only signs of a sort of Solfatara action with outflows of lava over the bottom of the confined area. These facts bear on the conclusions that might be deduced from the existing features of extinct volcanoes.

VI. Mr. Coan speaks of the lavas as flowing from an orifice in a broad stream down the mountain. It is probable that fissures opening to the fires below were continued at intervals along the course of the eruption, and that these afforded accessions to the fiery flood. Such was the case in 1840, and the three tufa hills at Nanawale, on the sea-coast, mark the positions where these opened fissures reached the sea. Any internal force sufficient to break through the sides of a mountain like Mauna Loa, must necessarily produce a linear fissure or a series of fissures, and not a single tunnel-like opening.

VII. We have yet received no definite facts as to the angle of slope down which the lavas descended. Yet we do know that in this and in a former eruption the stream continued over the declivities for thirty miles, and these declivities have an *average* angle of six or seven degrees, though made up of subordinate slopes varying probably between one and twenty degreees, as Mr.

* The central portions of the crater are much more raised than the lateral, and over them the depth cannot exceed 500 feet.

Coan mentions when describing the descent of the lavas in the summit eruptions of 1843.* The slopes of Mauna Loa, although the mountain is over 14,000 feet high, are therefore not too steep to receive accessions from top to bottom, from eruptions of vast extent over its sides. With such facts, in connection with others brought forward by the writer, we are assuredly sustained in not admitting the universal application of the so-called *elevation* theory. But in rejecting this theory, we do not go to the opposite extreme, and adopt in its full extent the *overflow* theory. The truth, as usual, lies between the two extremes, as the writer has elsewhere urged. Both causes have acted in the history of all volcanoes; both act from the very commencement of the germ-cone. There is elevation from the central action, from the opening and filling of fissures about the centre, and also from the outflow of lavas. The first of these operations may be most effective in the earlier periods of the rising mountain; but each continues to act till the fires die out; and in the later periods, especially, there is often a *flattening* process, arising from the spread of lavas ejected from fissures about the base of the mountain, which extend the shores, and diminish the angle of slope.

VIII. The interval of time between the last three eruptions of the central crater of Mauna Loa is nine to ten and a half years. The *first* of these three took place in June, 1832; the *second* in January, 1843; the *third* in February, 1852. The recorded eruptions of Kilauea have occurred as follows, leaving out that of 1789: the first in 1823, the second in 1832, the third in 1840, probably a fourth through a submarine or subterranean vent in 1847 or 1848, and the fires are now increasing again in activity. In 1832 there were thus eruptions from both of these extensive craters of Mauna Loa.

We annex additional notes on the eruption from different sources. The account of the *whirlwinds* produced by the crater are of much meteorological interest.

1. *From a Letter of H. Kinney, dated Waiohinu, Hawaii, April* 19, 1852, (published in "The Pacific," San Francisco, of June 18.)

The light of the volcano, at night, was very great—illuminating the surrounding country for many miles distant, and giving to the overhanging clouds the appearance of an immense body of fire. After witnessing this for several nights, my desire to visit it became so strong, that I resolved to make the long and tedious journey, to take a near view of this grand display of the Almighty's power. Accompanied by Mr. Fuller, I set out on the 1st day of March. After travelling through woods and over wide districts of naked lava, we arrived at the vicinity of the eruption on the forenoon of the third day. Its deep, unearthly

* This Journal, [2], x, 244.

roar, which we began to hear early on the day before, "waxed louder and louder," as we drew nearer and nearer the action, until it resembled the roar of the ocean's billows when driven by the force of a hurricane against a rock-bound coast, or like the deafening roar of Niagara.

We first reached the deep channel, through which a wide stream of liquid lava had flowed down the mountain, desolating an area of vast extent; it had ceased to flow in this direction, but was flowing still at a little distance, where we gazed with delight. The main stream was still beyond, which we could not approach, on account of the great heat; but at night we had a fine view of the fiery river, at no great distance from our encampment. Though the lava gushed out in several places like water-springs, yet the main fountain was one of indescribable grandeur. In the midst of a forming cone, with a base of 200 or 300 feet there shot up a jet of clear liquid lava to the height of from 400 to 800 feet, combining in its ascent and descent all the beauties of the finest water fountains—jet after jet ascended in constant and regular succession, day after day; descending, it mostly fell back into the crater, but sometimes it fell spattering on its sides, and flowed down, uniting with the main stream. The outer portions cooled to a blackened mass while in the air; the upper and lighter portions were carried by the propelling force to the regions of the clouds, and fell in showers over the surrounding country.

The intense heat of the fountain and stream of lava, caused an influx of cool air from every quarter; this created *terrific whirlwinds*, which constantly stalking about, like so many sentinels, bade defiance to the daring visitor. These were the most dangerous of any thing about the volcano. Sometimes we were compelled to prostrate ourselves for safety. Once we ventured within about a quarter of a mile of the great jet; soon one of the most terrific whirlwinds formed at the crater, and advanced straight towards us, threatening us with instant ruin; but fortunately for us, it spent its force and turned to the right, leaving us to make a rapid retreat.

We saw a similar one whirling around the jet, and concealing it with a dense cloud of ashes, as if engaged in a furious combat. The two contending elements presented a most wonderful spectacle. When the strife ceased, the fountain appeared in constant action, as though nothing had occurred. Clouds approaching the volcano were driven back, and set moving in wild confusion.

The glare of the liquid fountain was very great, even when the sun was shining; but at night it was vastly more so, casting the light of nearly a full moon in the shade, and turning night into day.

2. *From a Letter by Mr. Fuller, dated Waiohinu, March* 28.

There played a *fountain of liquid fire* of such dimensions and such awful sublimity, shaking the earth with such a constant and deafening roar, that no picture of the classic realms of Pluto, drawn by Grecian or Roman hand, can give you any adequate conception of its grandeur. A few figures may assist your imagination in its attempts to paint the scene. I made the following calculations, after careful observations during nearly twenty-four hours, from different points within a mile of the crater, and, after deliberate discussion with Mr. Kinney and companion, with different objects around us. Some of these calculations have been confirmed by a somewhat accurate measurement by Mr. Lyman, of Hilo.

The diameter of the crater, which has been entirely formed by this eruption is about 1,000 feet, its height from 100 to 150 feet. One part of the crater was raised 50 feet during our presence on the spot. The height of the column of red-hot liquid lava, constantly sustained above the crater, varies from 200 to 700 feet, seldom falling below 300. Its diameter is from 100 to 300 feet, and rarely perhaps reaching 400 feet. The motions of this immense jet of fire were beautiful in the extreme, far surpassing all the possible beauties of any water fountain which can be conceived; constantly varying in form, in dimensions, in color and intensity; sometimes shooting up and tapering off like a symetrical Gothic spire, 700 feet high; then rising in one grand mass, 300 feet in diameter, and varied on the top and sides by points and jets, like the ornaments of Gothic architecture. The New Yorker, who, as he gazes on the beautiful spire of Trinity Church, can imagine its dimensions increased three-fold, and its substance converted into red-hot lava, in constant agitation, may obtain a tolerable idea of one aspect of this terrific fire fountain. But he should stand at the foot of Niagara Falls, or on the rocky shore of the Atlantic when the sea is lashed by a tempest, in order to get the most terrific element in this sublime composition of the Great Artist. For you may easily conjecture that the dynamical force necessary to raise 200,000 to 500,000 tons of lava at once into the air would not be silent in its operation.

The eruption of which I have written broke out on the morning of the 18th of February, at about 3 o'clock, and continued twenty days. The crater is situated on the base of Mauna Loa, about 35 miles from Hilo, and 25 from the old crater of Kilauea. Its height, above the sea, is about 7,000 feet. It has formed a stream, winding down the mountain side, with several branches 30 or 40 miles long, from one-fourth to two miles broad, having a depth, in some places, of 200 or 300 feet.

SCIENTIFIC INTELLIGENCE.

I. Chemistry and Physics.

1. *Determination of Arsenic in Organic Substances.*—Schneider has proposed a method of determining the presence of arsenic, based upon the fact that arsenous acid, in the presence of sulphuric acid and metallic chlorids, is converted into chlorid of arsenic and volatilizes with the vapor of chlorhydric acid under 100 C. Experiment has shown that the presence of organic matter, even in great excess, does not prevent the formation of chlorid of arsenic; and that by distillation all the arsenic can be isolated from the organic substance. The arsenic must be in the form of oxyd or chlorid, and no other oxydizing substance should be present. The substance to be investigated is cut into small pieces, and introduced into a tubulated retort; fragments of fused chlo-

rid of sodium are to be added, and a sufficient quantity of water to cover the mixture. The retort is to be connected with an empty receiver, and this by a tube bent twice at right angles, with a flask containing distilled water and cooled externally. Sulphuric acid is to be introduced into the retort, in small portions at a time, through a Welter's safety tube, and the retort very slowly heated. The distillation goes on quietly, and there is but moderate foaming when the proper quantity of water is used: the boiling is to be continued as long as a portion of the distillate, tested with sulphuretted hydrogen, gives a yellow precipitate. It is best to employ in this process an excess of salt, to prevent the formation of sulphurous acid; fused salt gives the most constant and lasting evolution of gas. When the distillation is over, the distillate is to be oxydized very carefully by means of nitric acid, or chlorate of potash, to determine the arsenic quantitatively, as arsenate of ammonia and magnesia. The residue in the retort contains no traces of arsenic. [The method here given appears to deserve attention, but it must be borne in mind that antimony would probably be volatilized in the same manner as arsenic under the circumstances. The process would admit of ready verification by a repetition of the whole distillation, in a fresh apparatus, with the chemical materials used in the previous investigation, but without the substance to be tested for the presence of arsenic.] —*Pogg. Ann.*, lxxxv, 43.

2. *Identity of Donarium with Thorium.*—The results of Damour's investigation of the supposed new metal donarium, have already been noticed in this Journal. Prof. Berlin, of Lund, in Sweden, has also studied the subject, and, like Damour, infers from his analysis that orangite is identical with thorite, and, consequently, donarium with thorium. Bergemann has, however, continued his researches, and while expressing himself with due caution, is not prepared to admit the conclusions of the French and Swedish chemists, so that some doubt may still be entertained upon the subject.—*Pogg. Ann.*, lxxxv, 555.

3. *Conversion of Sulphates into Chlorids.*—Rose has found that the alkaline sulphates are converted into chlorids by repeated ignition with chlorid of ammonium. This method cannot, however, be employed when the sulphates of lithia or magnesia are present, as these salts are not decomposed by sal-ammoniac.—*Berliner Monatsberichte, February*, 1852.

4. *Anhydrous Organic Acids.*—Gerhardt has succeeded in isolating acetic and benzoic acids, $C_4H_3O_3$ and $C_{14}H_5O_3$, and in pointing out a method by which many other bodies of a similar nature may doubtless be obtained. When an equivalent of dry benzoate of soda is carefully heated in a sand bath, with an equivalent of oxychlorid of benzoyl a reaction takes place which is expressed by the equation

$$C_{14}H_5O_5, NaO + C_{14}H_5O_2Cl = NaCl + 2C_{14}H_5O_3.$$

The mass in the retort, washed with water and carbonate of soda, leaves a white substance crystallizing in beautiful oblique prisms fusing at 33 C., entirely neutral and volatile without decomposition. This substance is the anhydrous benzoic acid, $C_{14}H_5O_3$, which boiling water gradually transforms into ordinary benzoic acid, $C_{14}H_5O_3 + HO$; caustic alkalies effect this transformation almost instantly. Heated with alkaline cinnamates, cuminates or salicylates, the oxychlorid of benzoyl produces what may be termed double acids, that is to say, compounds of two anhydrous acids. These are oily liquids, inodorous and insoluble in water, but rapidly converted by boiling water into mixtures of the hydrated acids. Anhydrous acetic acid is obtained by heating the oxychlorid of benzoyl with an excess of fused acetate of potash. It is a perfectly colorless mobile liquid, highly refracting and possessing a very strong odor analogous to that of glacial acetic acid but more powerful. It boils at 137° C.: it is heavier than water with which it does not mix; by long agitation, however, with water, or by gentle heating, it is dissolved and converted into ordinary acetic acid. By the action of the oxychlorid of phosphorus upon the acetates, Gerhardt has succeeded in obtaining the oxychlorid of acetyl, $C_4H_3O_2Cl$, as a colorless liquid boiling at 56° C., and readily decomposed by water into acetic and chlorhydric acids.—*Comptes Rendus*, xxxiv, 755.

[*Note.*—It will be seen that the method employed by Gerhardt is identical in principle with that used by Williamson in preparing his new alcohols. The same questions arise in this case as in the case of the alcohols cited. Gerhardt doubles the formulas of the anhydrous acids which he has discovered, and unites them (in the ordinary equivalents) $C_{28}H_{10}O_6$ and $C_8H_6O_6$, or using his own equivalents, $C_{14}H_{10}O_3$ and $C_4H_6O_3$. The whole question of the constitution of the new compounds depends upon this: can a given molecule unite *chemically* with another molecule of the same species so as to form a third molecule of a different species? There are at present, we believe, no means of answering this question, and the views of Williamson and Gerhardt are pure assumptions not based upon any known facts, as is also the idea that the equivalents of all organic bodies must be represented by four volumes of vapor. Gerhardt's fine discovery only lends new strength to the views of Berzelius with reference to the organic acids, by pointing out the great analogy which exists between the anhydrous organic acids and the anhydrous inorganic acids as SO_3 and NO_5.—W. G.]

5. *Equivalents of Sulphur and Barium.*—Struve has determined the equivalent of sulphur by reducing sulphate of silver by hydrogen. A mean of six determinations gives 16·001 or 200·00, which confirms the correctness of the received number. The same chemist has also determined the equivalent of barium by decomposing the chlorid of barium by sulphuric acid, and weighing the resulting sulphate. As a mean of two experiments he obtained the number 68·13 or 851·62.—*Ann. der Chemie und Pharmacie*, lxxx, 203. W. G.

6. *On the Corrosion of Lead by Galvanic action;* by R. Buckler, (from a letter to the editors, dated Baltimore, July 16th, 1852.)—I am perfectly aware that the corrosion of lead by galvanic action, induced by uniting lead with other metals under water is a well known fact first proved by the experiments of Dr. Paris of England; and being well known, I am surprised that so little attention has been given to it, when we consider the suffering brought on by impregnating the system with lead.

A case recently occurred here, which demonstrates clearly the impropriety of connecting lead with another metal under water. A gentleman residing near the city having occasion to get the pump supplying his house with water repaired, it was found on examination that the portion of the lead pipe connected to the pump by a brass coupling, was to the extent of an inch almost entirely destroyed and only held together by a few shreds of lead. As it seemed impossible that this could have been caused by the action of the water alone, more especially as the rest of the pipe was entirely uninjured, I was requested by Dr. T. H. Buckler to examine the water, both as to its action on lead and chemical constituents. I procured some of the water, and the following is an extract from a note which was sent with the water. "This water is forced from the well by a brass or copper-force pump through a lead pipe; it has been in use since 1847. This year the pump became out of order, when a leak was discovered in the lead pipe at its connection with the brass coupling which joins it to the pump, the lead being nearly all destroyed. An inch from the connection the lead was apparently as perfect as when first used nor can we discover that any other part of it has been affected either by the water or the other metal."

About four ounces of the water were placed in two beaker glasses. In No. 1 a bright strip of lead was immersed; in No. 2 a strip of lead and brass connected. In order to obtain comparative results I likewise experimented on water from "Jones Falls," that now used by this city. They were covered over with paper so as not to exclude the air entirely, and allowed to remain undisturbed for a week, at the end of which time both waters had become slightly turbid and the lead in each was covered in some parts with a thin white film.

After acidulating the solutions with hydrochloric acid, a current of sulphuretted hydrogen was passed through each separately.

"Pump water."—No. 1. Lead, alone, very slight precipitate of the sulphid. No. 2. Lead and brass, copious precipitate.

Jones Falls.—No. 1. Lead, alone, no precipitate. No. 2. Lead and brass, copious precipitate.

I evaporated twelve ounces of each down to two, and a qualitative analysis gave the following constituents.

"Pump water."	Jones Falls.
Hydrochloric acid.	Carbonic acid, free and in combination.
Sulphuric acid.	Sulphuric acid.
Magnesia.	Hydrochloric acid.
Lime.	Lime.
Soda.	Magnesia.
Iron, (perox.)	Soda.
Reaction neutral.	Iron, (perox.)
	Reaction, slightly acid.

Judging from the quantity of the sulphuric acid precipitated from the well water by nitrate of baryta, I should infer that there existed a sufficient amount of sulphates to have protected the lead under ordinary circumstances. I have never been able to detect a trace of lead in 'Jones Falls' water, nor am I aware of any bad effects ever resulting to the city from the use of lead pipe; nevertheless it has been just proved by experiment that it will act on lead when united with brass, and placed under the necessary conditions.

The only method which I think will counteract this galvanic action, is to coat the surfaces with some substance which will entirely prevent the water from coming in contact with the pipe at the junction.

7. *Crystallization of Glass.*—Some interesting experiments on this subject have been made by M. Leydolt, in the course of his investigations upon the crystallization of the silicates. He had examined agate by subjecting it to the dissolving action of fluohydric acid, and obtained a surface with *projecting crystals* of quartz, that were left untouched by the acid. On subjecting glass in the same manner, he was surpised to see that it was far from homogeneous in its texture. All the kinds of glass examined contain more or less perfectly distinct crystals, regular and transparent, encased in an amorphous base. The crystals were brought out by exposing it to the vapors of fluohydric acid (obtained from fluor spar and sulphuric acid) and vapor of water, and arresting it when the crystals appear; the amorphous part is a little the most soluble in the acid.

M. Leydolt observes also that some natural crystals pure and transparent and apparently homogeneous, present similar deficiency in homogeneity, with the glass; and he has the subject under further examination.

8. *Analyses of Snow and Rain water;* by M. Eugene Marchand.—The snow and rain analyzed fell at Fécamp (France) in the months of March and April, 1850. A kilogramme of water contained

	Snow.	Rain.
Sulphuric acid, free or combined,	*doubtful*	*sensible proportions.*
Chlorid of potassium,	*doubtful*	*trace*
Chlorid of sodium,	0·017037 gr.	0·01143 gr.
Chlorid of magnesium,	*trace*	*trace*
Alkaline iodids and bromids,	*trace*	*trace*
Bicarbonate of ammonia,	0·001290	0·00174
Nitrate of ammonia,	0·001447	0·00189
Anhydrous sulphate of soda,	0·015627	0·01007
Sulphate of magnesia,	*trace*	*trace*
Sulphate of lime,	0·000877	0·00087
Animalized organic matter containing some iron and calcium,	0·023846	0·02486
Pure water,	999·939876	999·94914
	1000·000000	1000·00000

The organic matter of the snow deprived of fuliginous matters afforded oxyd of calcium 0·008116 grammes, peroxyd of iron 0·000450, organic matter 0·015280 = 0·023846.

9. *Titanium and Zirconia in Mineral Waters,* (L'Institut, No. 964.)—Dr. Mazade of Valance states that he has detected in the mineral waters of Neyrac (Ardèche), both titanium and zirconia. He had previously announced his having found in the same waters, molybdenum, tin, tungsten, tantalum, cerium, yttrium, glucinum, nickel and cobalt.

II. Mineralogy and Geology.

1. Mineralogical Notices, No. IV.

(*a.*) *On General Characters of Minerals and Crystals.*

On Crystallization and Amorphism; by Prof. Dr. M. L. Frankenheim, (J. f. pr. Chem., liv, 430.)—Frankenheim reviews the subject of crystalline structure and amorphism at considerable length, and arrives at the conclusion that although the structure of the intimate particles of so-called amorphous substances is not actually proved to be *crystalline* by observation, it is still true that all the properties of substances so-called are perfectly consistent with such a structure.

Delafosse on a relation between the crystalline form and atomic constitution of certain minerals, (Ann. des Mines, [4], xix, 3,) *reviewed with objections;* by C. Marignac, (Bib. Univ. de Genève, May, 1851, xvii, 33.)

On Lettering figures of Crystals; by James D. Dana, (This Jour., xiii, 399, xiv, 180.)

On Pseudomorphous minerals; by Prof. Sillem, (Leonh. u. Bronn's Jahrb., 1851, 385.)—The pseudomorphous forms described in this paper are

Pseudomorphs.	Forms imitated.
Native copper,	Red copper ore.
Silver glance,	Red silver ore.
Malachite,	Red copper ore.
Azurite,	" " "
Copper pyrites,	Fahlerz.
Copper glance,	Copper pyrites.
Horn silver,	Silver.
Brown iron ore,	Red iron ore.
Wad,	Pyrolusite.
Gypsum,	Calc spar.
Bitter spar,	" "
Kaolin,	Leucite, Sodalite.
Mica,	Wernerite.
Talc,	Kyanite.
Soapstone,	Tourmaline, Actinolite, Scapolite, Kyanite, Staurotide.
Galena,	Pyromorphite.
White lead ore,	Galena.
Red and brown iron ore,	Pyrites, Specular iron, Sphærosiderite.
Brown iron ore,	Marcasite, Calcite, Beryl.

Pseudomorphs.	Forms imitated.
Scheelite,	Wolfram.
Malachite,	Copper pyrites, Fahlerz, Calcite.
Electric calamine,	Blende, Psilomelane, Fluor spar.
Calamine,	" "
Calcite,	Feldspar, Pyrope, Garnet.
Quartz,	Fluor spar, Calcite, Wolfram, Augite, Carbonate of lead, Corundum, Stilbite.
Chlorite,	Calcite, Magnetic iron, Brown iron ore.
Galena,	Calcite.
Specular iron,	Calcite.
Marcasite,	Stephanite.
Spherosiderite,	Calcite.
Pyrites,	Marcasite.
Pinite,	Hornblende.
Antimony blende,	Antimonite.
Magnetic iron,	Actinolite.
Green earth,	Prehnite.
Talc,	Actinolite.

On Artificial Apatite and Topaz; by A. Daubrée, (Compt. Rend., xxxii, 625.)

(*b.*) *New Species.*

On Paisbergite, and Stratopeite, two new minerals; by Igelström, (J. f. pr. Chem., liv, 190, from Oefv. of. Vet. Akad. Förh., 1851, No. 5, p. 143).—*Paisbergite* is from Pajsberg's iron mine in Philipstadt, and is a variety of rhodonite. It is described as transparent. Composition:

	$\dddot{\text{Si}}$	$\dot{\text{Mn}}$	$\dot{\text{Fe}}$	$\dot{\text{Ca}}$	$\dot{\text{Mg}}$
	46·46	41·88	3·31	8·13	0·91=100·69
Ox.	24·14	9·40	0·73	2·31	0·35

Hence the formula $(\dot{\text{Mn}}, \dot{\text{Fe}}, \dot{\text{Ca}})^{8}\,\dddot{\text{Si}}^{2}$.

Stratopeite occurs in the same iron mine. It is pitch-black, and opaque in masses, and brown or brownish red in thin splinters. Amorphous; fracture flat conchoidal; streak brown; easily scratched with a knife blade; G.=2·64. B. B. fuses to a black translucent globule. With borax on platinum or with soda, a strong manganese reaction. With muriatic acid dissolves, giving out much chlorine and leaving a silica skeleton. Composition:

	$\dddot{\text{Si}}$	$\overline{\ddot{\text{Mn}}}$	$\overline{\ddot{\text{Fe}}}$	$\dot{\text{Mg}}$	$\dot{\text{H}}$
	35·43	32·41	10·27	8·04	13·75
Ox.	18·41	9·83	3·08	3·16	12·22

This affords the formula $\dot{\text{Mg}}^{3}\,\dddot{\text{Si}}^{2}+4(\overline{\ddot{\text{Mn}}}, \overline{\ddot{\text{Fe}}})\,\dddot{\text{Si}}+12\dot{\text{H}}$.

Stratopeite approaches most nearly *neotokite*, whose formula is

$$\dot{\text{Mg}}\,\dddot{\text{Si}}+4(\overline{\ddot{\text{Mn}}}+\overline{\ddot{\text{Fe}}})\,\dddot{\text{Si}}+8\dot{\text{H}},$$

and specific gravity 2·70. A mineral from Wittinge in Finland, called *wittingite* is also related to it, its formula being $2(\overline{\ddot{\text{Fe}}}+9\overline{\ddot{\text{Mn}}})\,\dddot{\text{Si}}+3\dot{\text{H}}$, and specific gravity 2·71—2·76.

Chrismatine, a new mineral resin; GERMAR, (Deutsche Geol. Zeits., i, 40, and Leonh. u. Bronn's N. Jahrb., 1851, 353.)—This resin occurs in a red argillaceous sandstone of the coal formation at Wettin near Halle. Color oil-green to yellowish; translucent to semi-translucent; shining. Unchanged at 16 to 20° R., but softens at 10 to 12° R. Burns with flame, without smell.

Stanniferous pyrites or *Ballesterosite.*—This mineral, from Galicia, described by Schulz and Paillette, (Bull. Geol. de France, vii, 21,) is a pyrites in cubes containing traces of zinc and tin. It was named after Lopez Ballesteros. G.=4·75—4·90.

Chalcodite; C. U. SHEPARD, (from Shepard's Min. 3d edit., p. 153.)—H.=1·0—1·5. In globules, stellar groups and thin scales, or granular. Blackish green, to yellowish brown, with a bronze lustre. Form, rhombohedral? The columnar individuals possess one very distinct cleavage, upon which the lustre is pearly and semi-metallic. Streak corresponds to the color, though paler. Translucent. Sectile. Laminæ very flexible. Yields water abundantly in a closed tube; and the darker varieties change to brown. B. B. on charcoal, fuses to a black glass, which is magnetic. It disappears with rapid effervescence in borax, affording a glass deeply stained with iron. Not acted upon sensibly by cold acids; but dissolves easily, in hot hydrochloric acid, with separation of silica. It appears to be a hydrated silicate of protoxyd of iron and magnesia; containing, in the light brown varieties, an intermixture of perox. iron. Found with red iron ore, at the Sterling iron mine, in Antwerp, Jefferson county, N.Y.; and is named from χαλκώδης, *like brass*, from its bronze-like lustre.

[The mineral externally resembles cacoxene, to which species it was formerly referred. An analysis of it is much needed.]

Xanthosiderite, a new mineral from Thüringer Wald; E. E. SCHMID, (Pogg. Ann., lxxxiv, 495.)—The xanthosiderite is found with manganese ore at Ilmenau. It occurs in fine needles united into concentric columnar stellate individuals. H.=2·5; color golden yellowish-brown to brownish-red, the former silky, the latter greasy in lustre. On gently heating gives out water and becomes darker in color, and with a continued heat, the color becomes reddish brown. B. B. acts as hydrated oxyd of iron. With concentrated muriatic acid a brown solution, containing flocks of gelatinized silica. Composition:—

	$\dddot{\mathrm{Si}}$	$\overline{\dddot{\mathrm{Fe}}}$	$\dot{\mathrm{Mn}}$	$\overline{\dddot{\mathrm{Al}}}$	$\dot{\mathrm{H}}$	
1. Yellow	2·51	74·96	1·82	1·32	15·67	96·28
2. Brown	5·02	75·00	1·33	1·51	14·10	96·96

The loss is due to undetermined carbonate of lime, magnesia, alkalies, antimony, lead, or bismuth, present as impurities. The formula deduced is $\overline{\dddot{\mathrm{Fe}}}\dot{\mathrm{H}}^2$.

On Carrollite, a new cobalt mineral; by Wm. L. Faber.—This Journal, xiii, 418.

Two new minerals from Orange Co., N. Y., Dimagnetite and Jenkinsite; by Prof. C. U. Shepard.—This Jour., xiii, 392.

Description of two new minerals, and a new Earth; by D. D. Owen, M.D.—Jour. Acad. Nat. Sci. Philad., vol. ii, part 2, p. 179, 1852, and this Jour. xiii, 420.

On Remingtonite, a new cobalt mineral; by J. C. Booth.—This Journal, xiv, 48.

New Species by Prof. Meneghini, *of Pisa, with analyses by Prof.* Bechi.—This Journal, xiv, 60. Includes the new species, meneghinite, picranalcime, picrothomsonite, portite, sloanite, schneiderite, savite.

(*c.*) *Described Species.*

Red Sapphire in New Jersey.—This Journal, xiii, 116.

Anhydrite and Sulphate of Potash (Glaserite.)—The crystals of anhydrite, according to Hausmann (Pogg. Ann. lxxxiii, 572) afford a prism having the angle 105° 6′, which is near the angle of anglesite. A prism also in sulphate of potash has the angle 106° 46′. The following comparisons of several sulphates are presented in this paper.

	Atomic volume.	Axial ratio.	Prism ∞	Prism 1-$\bar{\infty}$	Prism 1-$\breve{\infty}$
$\dot{K}\dddot{S}$	412·23	0·7431 : 1 : 0·5717	120° 29′	106° 46′	75° 8′
$\dot{Na}\dddot{S}$	330·18	0·7494 : 1 : 0·5918	118 46	106 18	76 34
$\dot{Ba}\dddot{S}$	329·37	0·7659 : 1 : 0·6234	116 22	105 6	78 18
$\dot{Pb}\dddot{S}$	300·75	0·7686 : 1 : 0·6084	117 20	104 55	76 49
$\dot{Sr}\dddot{S}$	293·47	0·7817 : 1 : 0·6181	117 10	103 58	76 2
$\dot{Ca}\dddot{S}$	289·99	0·7636 : 1 : 0·6531	113 42	105 16	81 6

The author compares also the sulphates and carbonates, in the following table.

	Atomic volume.	Diff. of at. volume.	Prism ∞	Prism 1-$\bar{\infty}$	Prism 1-$\breve{\infty}$
$\dot{Ba}\dddot{S}$	329·37	0·139	116° 7′	106° 54′	78° 18′
$\dot{Ba}\ddot{C}$	286·65		118 30	105 6	77 30
$\dot{Sr}\dddot{S}$	293·47	0·139	117 10	103 58	76 2
$\dot{Sr}\ddot{C}$	255·33		118 19	108 12	80 12
$\dot{Pb}\dddot{S}$	300·75	0·149	117 20	104 55	76 49
$\dot{Pb}\ddot{C}$	258·9		117 13	108 16	80 20
$\dot{Ca}\dddot{S}$	289·99	0·316	113 42	105 16	81 6
$\dot{Ca}\ddot{C}$	210·94		116 16	108 27	81 33

Heavy Spar.—Limpid crystals are mentioned by Mr. F. B. Hough, as occurring at the iron mines in Rossie, St. Lawrence Co., N. Y.—5th Rep. in Cab. Nat. Hist. N. Y., 1852, p. 43.

Heavy Spar of Nutfield, near Bletchingly in Surrey.—Crystals occur, according to Prof. E. J. Chapman, in the fuller's earth pits in the greensand formation. They are tabular in form, with the basal plane (0P) predominating. Description in Naumann's system (as modified in the last volume of this Journal) $0, \infty\text{-}\breve{\infty}, \infty, 1\text{-}\bar{\infty}, 1\text{-}\breve{\infty}, 1$.—*Phil. Mag.* [4], iii, 141.

Carbonate of Strontian, in Oneida Co., N. Y.—This Jour., xiii, 264.

Chiolite.—An analysis of the chodneffite by M. Durnev, made under the direction of Jevreinov, affords, as published by Kokscharov (Pogg. Ann. lxxxiii, 588)—

Al	Na	Fl	Ca	$\bar{Fe}$ and $\bar{Mn}$
13·41	32·31	53·48	0·25	0·55=100

which gives the formula $3NaFl + Al^2Fl^3$, or that of cryolite. The specific gravity of the Russian cryolite, according to Durnev, is 2·95, according to Kokscharov 2·962. Transparent colorless crystals of chiolite gave Kokscharov the specific gravity 2·67; or the mass in powder 2·90. A crystal one millimeter in diameter had the form of a square octahedron; angle of the pyramidal edges 107° 32′ (mean of 18 trials); of the basal, 113° 25′—113° 30′, giving the axial ratio 1·077 : 1 : 1. In one crystal, were two additional planes. There is no cleavage in chiolite, though so stated by Auerbach and Hermann; the angle they obtained, 114°, is an angle between two faces of a crystal. In one crystal there were three planes in the same zone, which gave (calling them x, y, z), $x : y = 113° 20'$; $y : z = 135° 45'$; $x : z = 69° 10'$.

On the classification of the Silicates and their allied compounds; by Prof. E. J. Chapman, (Phil. Mag. [4], iii, 270.)—Our limited space prevents our citing this paper, which hardly admits of condensation. The classification is based upon a crystallographic as well as chemical view of substances. We only question whether the former is not allowed too much weight: whether there are not striking differences, for example, in the chemical relations of quartz and beryl, which would lead one who viewed the elements and their compounds in their widest relations, to hesitate with regard to placing them in a common group. The subject is acknowledged to be one of great difficulty.

Identity of Williamsite and Serpentine.—Hermann has analyzed the williamsite of Shepard, and points out its identity with serpentine. He obtained (J. f. pr. Chem. liii, 31)—

	$\dddot{Si}$	$\bar{Al}$	$\dot{Fe}$	$\dot{Ni}$	$\dot{Mg}$	$\dot{H}$	
	44·50	0·75	1·39	0·90	39·71	12·75=100	G.=2·60
Oxygen	23·09	——	0·30	0·19	15·80	11·29	

The oxygen ratio afforded, for the water, protoxyds and silica is 2·07 : 3 : 4·24, or nearly 2 : 3 : 4. [See for another analysis of williamsite by Mr. Brush, Dana's Mineralogy, 3d edit., p. 692, where the conclusion is stated that the mineral is an impure serpentine. Mr. Brush obtained 3·35 p. c. of alumina.]

Soapstone from Südermannland.—Analysis by Bahr, (J. f. pr. Chem. liii, 313)—

	$\ddot{\text{S}}\text{i}$	$\ddot{\text{A}}\text{l}$	$\dot{\text{M}}\text{g}$	$\dot{\text{F}}\text{e}$	$\dot{\text{M}}\text{n}$	$\dot{\text{H}}$
	61·73	0·84	30·65	2·93	1·40	2·18=99·75
Oxygen	32·05	0·39	11·66	0·65	0·29	—

Oxygen ratio 1 : 3 and formula $\dot{\text{M}}\text{g}\,\ddot{\text{S}}\text{i}$. Gray, massive, and without a trace of crystallization. Resembles meerschaum, but somewhat harder. Occurs in disseminated grains or massive in iron ore. Whitens when heated, and very slowly fuses with soda to a globule greenish while hot, and brown when cold. Some manganese reaction.

Note on Clinochlore, a mineral of the chlorite family; by W. P. Blake.—This Journal, xiii, 116; analysis of the same, by W. J. Craw, ibid., 222.

Loganite of T. S. Hunt.—The hardness of this mineral, as stated by Mr. Hunt in his paper, (Phil. Mag. [4], ii, 65,) is 3, and the specific gravity 2·60 to 2·64.

[A small, imperfect crystal placed in the writer's hands by Mr. Hunt, presents two prismatic planes of nearly or quite similar lustre, though almost dull, and not smooth, the mutual inclination of which was found to be approximately 126°. Another specimen afforded two cleavages apparently alike, with the angle between them of 123° to 124°. These angles are not far from the angle of hornblende.—J. D. D.]

On the Optical characters of Micas; by H. Senarmont, (Ann. de Ch. et de Phys. [3], xxxiv, 171. See this Journal, xiii, p. 409.)—M. Senarmont shows that in twin crystals of mica, the component crystals have a common cleavage, instead of forming an oblique angle with one another, as with twins of oblique crystals, and hence concludes that the form in all instances is a right and not an oblique prism, and that consequently there is in fact no *oblique* mica. Polarization has enabled him to detect such twins when not otherwise distinguishable. The following are the results of his measurements; omitting only, in most instances, those observations which were made on micas of *unknown* locality.

(1.) *Micas whose optical axes are situated in the diametral plane of the longer diagonal.*

		Appar. Incl.
1.	Odontchelon, Daouria; gangue dolomite and diopside; brown; cryst.	1– 2°
2.	Loc. —— ? Hexagonal; transparent; brown, a little greenish,	1– 2°
3.	Loc. —— ? Hexag.; transparent; clear brown,	1– 2°
4.	Loc. —— ? Hexag.; transparent; copper-colored,	3– 4°
5.	Ceylon. Hexag.; transparent; clear green, nearly colorless,	3– 4°
6.	Philadelphia. Transparent; clear olive-green,	57–58°
7.	Siberia, in white quartz. Silvery, imperfectly trp.,	57–58°
8.	Zillerthal, in albite. Silvery, imperf. transparent,	58–59°
9.	Arendal, in a feldspathic rock. Transparent; pale,	58–59°
10.	Loc. —— ? Transparent; gray, rhombs,	58–59°
11.	Loc. —— ? Hexag.; { outer parts grayish brown,	58–59°
	{ central parts colorless,	67°
12.	Loc. —— ? Transparent; clear brown,	58–59°
13.	Couzerans? Silvery, greenish-grey, with concave surface of cleavage,	60°
14.	St. Gothard, in quartzose gneiss; hexag.; silvery; clear gray,	60°
16.	Miask. Transparent; clear olive-green,	62–63°
18.	Ekatherinenburg. Transparent; clear pale rose,	63–64°
21.	Schetank. Imperfectly transparent; rose-colored,	67°
23.	Brittany. Transparent, rhombic octahedrons; blonde,	68°

	Appar. Incl.
24. Kimito, Finland. Rhombic octahedrons; transparent; clear blonde,	67–68°
25. Finland. Crystals, silvery; grayish green,	67–68°
27. Aberdeen. Transparent; blonde,	68°
28. Ekatherinenberg. Rhombic prisms in feldspar; cryst.; trp.; nearly blonde,	69–70°
29. Loc. —— ? Colorless; but affords { a central region,	70°
an outer region,	60°
32. American, probably; Lepidolite or rose mica,	74–76°
33. Alençon. Hexag.; transparent; grayish blonde,	76–77°

(2.) *Micas with the optical axes in the diametral plane of the shorter diagonal.*

34. Lake Baikal. Hexag.; deep brown; transparent,	1°
35, 36, 37, 38—micas of unknown locality,	1– 4°
39. Loc. —— ? Hexag.; deep bottle green,	15°
40. Saxony. Hexag.; silvery, clear gray; transp., macled,	44°
42. Zinnwald, with tin ore. Hexag.; silvery, greenish blonde by trp.,	46–47°
43. Loc. —— ? Hexag.; transparent; colorless,	50°
44. Lepidolite; rhombic,	55°
46. Piedmont. Rhombic; silvery reflection; grayish green by trp.,	63°
48. St. Féréol, near Brives. Transparent; olive-green,	65°
49. Milan. Hexag.; greenish-white; silvery; unctuous, not elastic,	65°
51. Fossum, Norway. Hexag.; clear olive-green,	66°
52. Scotland. Brown; in large thick crystals,	68°*
54. Tarascon (Ariége). Rhombic; transparent; colorless,	69°
55. Ural, in graphic granite; octahedrons in quartz; silv. lustre; col. blonde,	72°
56. Utö. Rhombs; lustre silvery; yellowish blonde by trp.,	72–73°

On examining different micas pressed between two plates of glass, and subjecting them to changes of temperature, there was no perceptible change in the optical axes.

On Mica and Cordierite, especially upon Masonite, Chloritoid, Pearl mica, Kämmererite, Rhodochrome, Baltimorite and Chrome-chlorite; by R. Hermann, (J. f. pr. Chem. liii, 1.)—This paper contains general observations on the mica family of minerals, presenting a view of their composition and adding some new analyses. According to the hypothesis of the author, *phlogopite*, with Meitzendorff's formula, and *muscovite*, constitute, either separately or by a combination of the compounds in different proportions, the ordinary micas. Thus the mica of Sala, analyzed by Svanberg, is said to consist of 12 of the former to 1 of the latter ($12a+1b$), ordinary magnesian mica of $6a+b$; lepidomelane of $a+2b$. Other groups explained in a similar manner, each with its own relation of a and b, are the Lepidolite group, the Pyrophyllite group, the Margarite group. The Pyrophyllite group includes Gilbertite, Talcite, Damourite, Pyrophyllite, Agalmatolite; and the Margarite group includes Seybertite, Xanthophyllite, Brandisite (Disterrite) Chloritoid, Masonite, Diphanite, Margarite, Emerylite, Corundellite, Euphyllite. The following are analyses by Hermann of species of this group.

	$\ddot{Si}$	$\bar{\ddot{Al}}$	$\bar{\ddot{Fe}}$	$\dot{Fe}$	$\dot{Mg}$	$\dot{\bar{H}}$			
Chloritoid,*	24·54	30·72	17·28	17·30	3·75	6·38—G.=3·52			
Oxygen	12·71	14·33	5·18	3·84	1·47	5·60			
Masonite,	32·68	26·38	18·95	16·17	1·32	4·50	G.=3·46		
Oxygen	16·96	12·28	5·67	3·57	0·51	4·00			
Margarite,	32·46	49·18	1·34	$\dot{Ca}$ 7·42	3·21	4·93,	$\dot{K}$ 0·05,	$\dot{Na}$ 1·71=100·30,	G.=2·99
Oxygen	16·81	22·96	0·40	2·12	1·27	4·35	0·01	0·43	

* From Katherinenberg.

[M. Hermann cites the analyses of emerylite, corundellite and euphyllite, but had not seen the corrected results, as published in the writer's Mineralogy, 3d edit., pp. 362, 689, and this Journal, [2], x, 116, where other analyses are given, and corundellite is shown to be emerylite. There are also new analyses of emerylite by J. Lawrence Smith in this Journal, xi, 60. The analysis of margarite by Hermann renders it altogether probable that *emerylite and margarite are identical.*—J. D. D.]

The chlorite group includes Baltimorite, Chrome-chlorite, Kämmererite, Rhodochrome, Chlorite, Steatite, Thuringite and Cronstedite. The following are new analyses of species of this group:—

	$\dddot{\text{Si}}$	$\bar{\text{Al}}$	$\bar{\text{Cr}}$	$\dot{\text{Fe}}$	$\dot{\text{Mg}}$	$\dot{\text{H}}$	
Baltimorite,	33·26	7·23	4·34	2·89	38·56	12·44	$\ddot{\text{C}}$ 1·30=100·02
Oxygen	17·23	3·36	1·28	0·62	15·32	11·02	
Chrome-chlorite, Texas, Pa.	31·82	15·10	0·90	$\bar{\text{Fe}}$ 4·06	35·24	12·75,	$\dot{\text{Ni}}$ 0·25=100·12
Oxygen	16·50	7·05	0·26	1·21	13·70	11·29	0·05
Kämmererite, L. Itkul,	30·58	15·94	4·99	$\dot{\text{Fe}}$ 3·32	33·45	12·05	=100·33. G=2·62
Oxygen	15·88	7·42	1·49	0·73	11·48	10·66	
Rhodochrome, L. Itkul,	34·64	10·50	5·50	$\bar{\text{Fe}}$ 2·00	35·47	12·03	=100·14. G=2·65
Oxygen	17·95	4·90	1·63	0·60	14·08	10·61	

The chrome-chlorite of Texas, Pa., has a violet-blue to reddish color; H.=2·5; G.=2·63; lustre pearly. Texture micaceous or foliated like talc, and also somewhat plumose. In a glass tube yields water, with reaction of fluorine and chrome. Wholly dissolved in concentrated sulphuric acid, with a separation of the silica, producing a green solution.

Iron-Natrolite; Dr. C. Bergemann, (Pogg. Ann. lxxxiv, 491.)—Along with the brevicite of Brevig occurs a dull green mineral, partly semi-crystalline in large plates and partly in perfect prismatic crystals, having the form of natrolite, with a perfect diagonal cleavage. Streak or powder light green; in thin splinters opaque; H.=5; G.=2·353. B. B. on charcoal infusible, but becomes brownish-black; with the fluxes fuses and gives an iron-reaction; with borax, a yellowish glass; with salt of phosphorus a green glass, which is colorless on cooling. In a tube affords water and does not decrepitate. Easily dissolved in acids (e. g. muriatic and oxalic) and gelatinizes, even after heating. Composition:—

$\dddot{\text{Si}}$	$\bar{\text{Al}}$	$\bar{\text{Fe}}$	$\dot{\text{Fe}}$	$\dot{\text{Na}}$ & little $\dot{\text{K}}$	$\dot{\text{Mn}}$	$\dot{\text{H}}$
46·537	18·944	7·486	2·402	14·042	0·550	9·367=99·328

A Sodalite-like mineral; ibid.—Bore has examined a sodalite of a lavender-blue color from the island Lamo near Brevig. There is also at Brevig another related mineral, occurring in green feldspar with greenish elæolite. Color of the mineral dull greenish; streak and powder white; H.=5; G.=2·302; translucent; lustre vitreous. Occurs in large crystalline masses, having a cleavage which seems to be rhombohedral. Heated in a tube yields no vapor. B. B. on charcoal becomes white, and after long blowing the edges become fused without intumescence. With soda fuses very slowly to a white enamel; with borax or salt of phosphorus, forms a glass with much difficulty, which is colorless. In acids easily decomposed, forming a jelly; after heating also dissolves readily. Composition:—

$\bar{Si}$	$\dddot{\bar{Al}}$	$\dot{Na}$	Cl	$\bar{\ddot{P}}$	$\dot{Ca}$ & $\dddot{\bar{Fe}}$	
46·028	23·972	21·483	7·431	0·857	*trace*	=99·771

Oxygen ratio in the silica, alumina and soda is 6 : 3 : 1, whence the formula is $\dot{Na}\,\bar{Si} + \dddot{\bar{Al}}\,\bar{Si} + Cl\,Na$.

Nepheline, variety Sommite or Davyne.—A. Scacchi gives the following as the observed inclination of the basal plane on planes of the series of hexagonal pyramids, $\frac{1}{5}$, $\frac{1}{4}$, $\frac{1}{3}$, $\frac{1}{2}$, 1, 2, 3,—on $\frac{1}{5}$ 158° 52′, on $\frac{1}{4}$ 154° 15$\frac{1}{2}$′, on $\frac{1}{3}$ 147° 18′, on $\frac{1}{2}$ 136°, on 1 117° 22′, on 2 104° 35′, on 3 99° 45′. Cleavage lateral, distinct. The crystal occurred in a geode in limestone on Mt. Somma with crystals of sodalite. (Pogg. Ann. 1852, Ergänz. iii, Stuck 3, 478.)

Mizzonite and Meionite, varieties of Scapolite.—M. Scacchi also gives figures illustrating the mizzonite and meionite of Mt. Somma. In mizzonite the adjacent planes in the same pyramid have the angle 135° 56′, (see figures of scapolite,) in meionite 136° 11′; adjacent planes in opposite pyramids in mizzonite 64° 08′, in meionite 63° 40′. The terminal plane of the prism is often found in crystals of mizzonite and seldom in meionite. The mizzonite, before the blowpipe does not intumesce as much as the meionite, and is not so easily soluble in acids. The mizzonite often occurs in pearly acicular crystals.—(Ibid. p. 478.)

On Scapolite; by R. Hermann, (J. f. pr. Chem. liv, 410).—The following new analyses are given in this paper.

	$\bar{Si}$	$\dddot{\bar{Al}}$	$\dddot{\bar{Fe}}$	$\dot{Fe}$	$\dot{Mn}$	$\dot{Ca}$	$\dot{Na}$	$\dot{K}$	$\ddot{C}$	
1. Strogan'wite	40·58	28·57	0·89	—	*trace*	20·20	3·50	—	6·40	=100·14
Ox.	21·08	19·34	0·26	—	—	5·74	0·89	—	4·65	
2. Scapolite,	45·99	28·80	—	2·25	0·25	13·83	2·11	0·70	4·06	$\dot{H}$ 0·30=98·29
Ox.	23·87	13·45	—	0·50	0·05	3·96	0·53	0·11	2·93	
3. Ekebergite,	49·49	26·06	2·65	$\dot{Mg}$.0·36	0·25	12·89	4·50	0·80	3·00	$\dot{Li}$ *tr.*=100·00
Ox.	25·69	12·14	0·78	0·14	0·05	3·69	1·15	0·14	2·16	
4. Scapolite,	52·94	27·64	—	$\dot{Fe}$ 0·30	0·25	9·10	6·89	0·54	1·50	$\dot{H}$ 0·66=99·72
Ox.	27·50	12·93	—	0·06	0·05	2·60	1·76	0·08	1·08	
5. Red Scap.	50·16	28·44	$\dot{Mg}$ 0·76	0·12	0·14	13·12	1·42	0·91	2·94	$\dot{H}$ 0·8, $\dot{Li}$ *tr'ce*
Ox.	26·00	13·28	0·30	0·02	0·03	3·67	0·36	0·15	2·12	[=98·81
6. White Scap.	54·64	23·32	" 0·20	1·00	0·14	9·05	8·44	1·24	2·50,	$\dot{Li}$ *tr.*=100·53

No. 2, from Diana, N. Y.; No. 3, from Hesselkulla, massive, oil gray; No. 4, from Gulsjo, white; No. 5 and 6, from Bolton, Mass.

Sp. gr. of 1, 2·79; of 2, 2·74; of 3, 2·80; of 4, 2·69; of 5, 2·70; of 6, 2·66. The Stroganowite is identical with Hartwell's Pargas Scapolite.

M. Hermann considers the carbonic acid as replacing silica, while it is regarded by others, with more probability, an impurity.

M. Hermann makes 4 groups of species or varieties in the scapolite family, the distinctions in which depend not on the oxygen proportions, but upon the hypothetical "heteromerous molecules" assumed as existing in the mineral. The groups are—

(1.) *Gehlenite group.*—Gehlenite $= \dot{R}^3\,\bar{Si} + \dddot{\bar{Al}}\,\bar{Si}$.

(2.) *Humboldtilite group.*—The "heteromerous molecules" are, *a*, having the oxygen ratio 1 : $\frac{1}{2}$: 1$\frac{2}{3}$; and *b*, with the ratio 1 : 2 : 3. Humboldtilite =(*a*); Sarcolite =(*a*+*b*); Atheriastite =(*a*+*b*)+8$\dot{H}$.

(3.) *Dipyre group.*—The "heteromerous molecules" are, *a*, having the oxygen ratio 1 : 2 : 4, *b*, with the ratio 1 : 2 : 6. Stroganowite = (*a*); Dipyre = *b*; another variety of dipyre =(6*a*+*b*); a third (3*a*+*b*).

(4.) *Wernerite group.*—The "heteromerous molecules" are *a*, having the oxygen ratio 1 : 2 : 3, and *b*, with the ratio 1 : 3 : 6. Anhydrous Meionite $=(a)$; Edingtonite $(a)+12\dot{\mathrm{H}}$; Wernerite, 1st var. $=(a+b)$; 2nd var. $(a+2b)$; 3d var. $(a+6b)$; 4th, $(a+12b)$. Wernerite $=(b)$.

[This mode of viewing the composition cannot claim for itself simplicity. The various compounds of the scapolite group are isomorphous, from their atomic volume, and this splitting up of the formulas into hypothetical parts affords little satisfaction to theory. The various attempts to write out formulas by different theorists are so diverse in their results, that we may question whether, in the case of the silicates for example, truth and the highest generalizations are not the best displayed by simply giving the oxygen ratios. We cannot suppose such compound molecules actually to have existence in the above $(a+b)$ minerals. They are at the best, imaginary quantities for the convenience of classification.]

Mineralogical Notes by Prof. E. J. Chapman, (Phil. Mag. [4], iii, 141.

Crednerite.—Rammelsberg's formula for crednerite is $(\dot{\mathrm{B}}\mathrm{a}, \dot{\mathrm{C}}\mathrm{u})^3 \bar{\bar{\mathrm{M}}}\mathrm{n}^2$. Prof. Chapman remarks on the monoclinic cleavage of crednerite and the probable approximation of the angle to that of augite; and then supposing that $\overline{\mathrm{Si}}$ may replace $\bar{\bar{\mathrm{M}}}\mathrm{n}$, (the examples of which mentioned are those of manganesian garnet, spinels, vesuvian, hausmannite), he considers the above formula as of the augite type.

Helvine.—On the same supposition as to the isomorphism of $\overline{\mathrm{Si}}$ and $\bar{\bar{\mathrm{M}}}\mathrm{n}$, and also considering S and O as isomorphous, helvine is observed to fall into the formula of garnet $r+R$, or one part of protoxyd bases to one of silica or peroxyd bases, stated by Mr. Chapman to be "equal atoms of base and acid." The formula of helvine,

$$(\bar{\bar{\mathrm{B}}}\mathrm{e}, \bar{\bar{\mathrm{F}}}\mathrm{e})\,\overline{\mathrm{Si}} + 2\dot{\mathrm{M}}\mathrm{n}\,\overline{\mathrm{Si}} + \mathrm{Mn\,S},$$

becomes on the above hypothesis, 3 atoms of $(\dot{\mathrm{M}}\mathrm{n}, \mathrm{Mn\,S})$ and 3 atoms of $\bar{\bar{\mathrm{R}}}, \overline{\mathrm{Si}}$, equivalent to the oxygen ratio of 1 : 3. [The oxygen ratio in garnet, for the protoxyds, peroxyds and silica is 1 : 1 : 2; which gives the ratio of 1 : 1 for the oxygen of the bases and the silica,—if we suppose that the peroxyds and protoxyds replace one another, as is shown to be true in very many cases by Gerhardt. This view appears to be better sustained as a general principle, than that of the mutual substitution of $\overline{\mathrm{Si}}$ and $\bar{\bar{\mathrm{R}}}$, although instances of this last exist. In either case, the relation of helvine to garnet is made out, as stated by Mr. Chapman; for the above formula becomes thus, $\bar{\bar{\mathrm{R}}}\,\overline{\mathrm{Si}}+(\dot{\mathrm{M}}\mathrm{n}, \mathrm{Mn\,S})^3\,\overline{\mathrm{Si}}$, which is essentially the usual formula of garnet, having the ratio 1 : 1 : 2. The identity does not require us to suppose the isomorphous relation of the peroxyds and silica.—J. D. D.]

Phenacite and Beryl.—The isomorphism as well as general resemblance in external characters of phenacite and quartz, is remarked upon by Prof. Chapman, and he observes that the common phenacite rhombohedron$=\frac{1}{2}$R compared to the quartz form as unity. Beryl is also referred to the quartz group, and it is remarked that if glucina be looked upon as a sesquioxyd, there can be no difficulty in placing both phenacite and beryl in that group "On the other hand, if the formula of glucina be Be O, the isomorphism of $3\dot{\mathrm{B}}\mathrm{e}$ and $\overline{\mathrm{Si}}$, and the sesquioxyd isomorphs of the latter must be allowed. Of the other glucina compounds, chrysoberyl may be a trimetric and euclase a monoclinic quartz. With the former are associated staurolite, andalusite, topaz, &c." [If we calculate the angle of the form $\frac{1}{2}$R for quartz, we find it 126° 52′, which is 7 or 8 degrees larger than that of the common rhombohedron of phenacite (115° 25′—116° 40′.) This appears to be at variance with the above conclusions.—J. D. D.]

Prof. Chapman applies the same principle—the isomorphism of silica and the peroxyds,—to other groups, as sphene and epidote; chlorite spar and chloritoid; wichtyne, epidote, &c.

Analysis of Caporcianite and Humboldtite; MENEGHINI and BECHI. This Jour., xiii, 62 and 65.

Heulandite.—This mineral, according to Mr. G. W. Fahnestock, occurs in small prismatic crystals covering the sides of fissures in a hornblende rock several miles southwest of Philadelphia. The surface is rusty from oxyd of iron, which has probably proceeded from the decomposition of the rock.

On a Garnet-like mineral from Brevig, Norway; Dr. C. BERGEMANN, (Pogg. Ann. lxxxiv, 485.)—This mineral occurs in black opaque crystals associated with elæolite, zircon and fluor spar at Brevig. Streak yellowish-green; H.=5·0; G.=3·880, or 3·898 after strong heating. Form like that of garnet; crystals sometimes half an inch through. B.B. in thin splinters unchanged; with soda, a silica skeleton, and the glass yellowish; with borax, a deep yellowish green glass, which does not change color on cooling; with salt of phosphorus, a yellowish-green pearl and gives the reaction of titanium. With muriatic acid, easily and wholly decomposed, without gelatinizing; after heating, still dissolved but with difficulty. Composition:—

	$\dddot{Si}$	$\dot{Fe}$	$\dot{Ca}$	$\dot{Mn}$	$\ddot{Ti}$ & Z	$\dot{Mg}$ & $\dot{K}$
	33·355	34·598	25·804	1·807	3·071	*trace* = 99·319
Oxygen	17·30	7·66	7·32	0·44		

The mineral differs from all garnets in its infusibility and its perfect solubility in acids. It may hereafter be proved to be a partly altered mineral; but it is more probable, the author states, that it is a new variety.

Garnet from Gustafsberg with Stilbite.—Analysis by BAHR, (J. f. pr. Chem. liii, 312.)

	$\dddot{Si}$	$\ddot{\overline{Al}}$	$\ddot{\overline{Fe}}$	$\dot{Fe}$	$\dot{Ca}$	$\dot{Mn}$	$\dot{Mg}$
	37·80	11·18	15·66	4·97	30·28	0·13	*trace*
Oxygen	19·63	5·22	4·70	1·00	8·61	0·02	

It gives the usual formula $\dot{R}^3 \dddot{Si} + \ddot{\overline{R}} \dddot{Si}$. Specific gravity 3·6.

On the Composition of Epidote.—RAMMELSBERG, in Pogg. Ann. lxxxiv, 453, opposes the views of M. Hermann with regard to the composition of epidote, and sustains the conclusion that the oxygen ratio for the protoxyds, peroxyds and silica, is essentially 1 : 2 : 3.

Chrome Tourmalines.—The Siberian tourmalines sometimes contain a small amount of oxyd of chromium. They are in acicular groups and have a fine green color; H.=7·0, G.=3·181. Fusible.—Prof. CHAPMAN, *Phil. Mag.* [4].

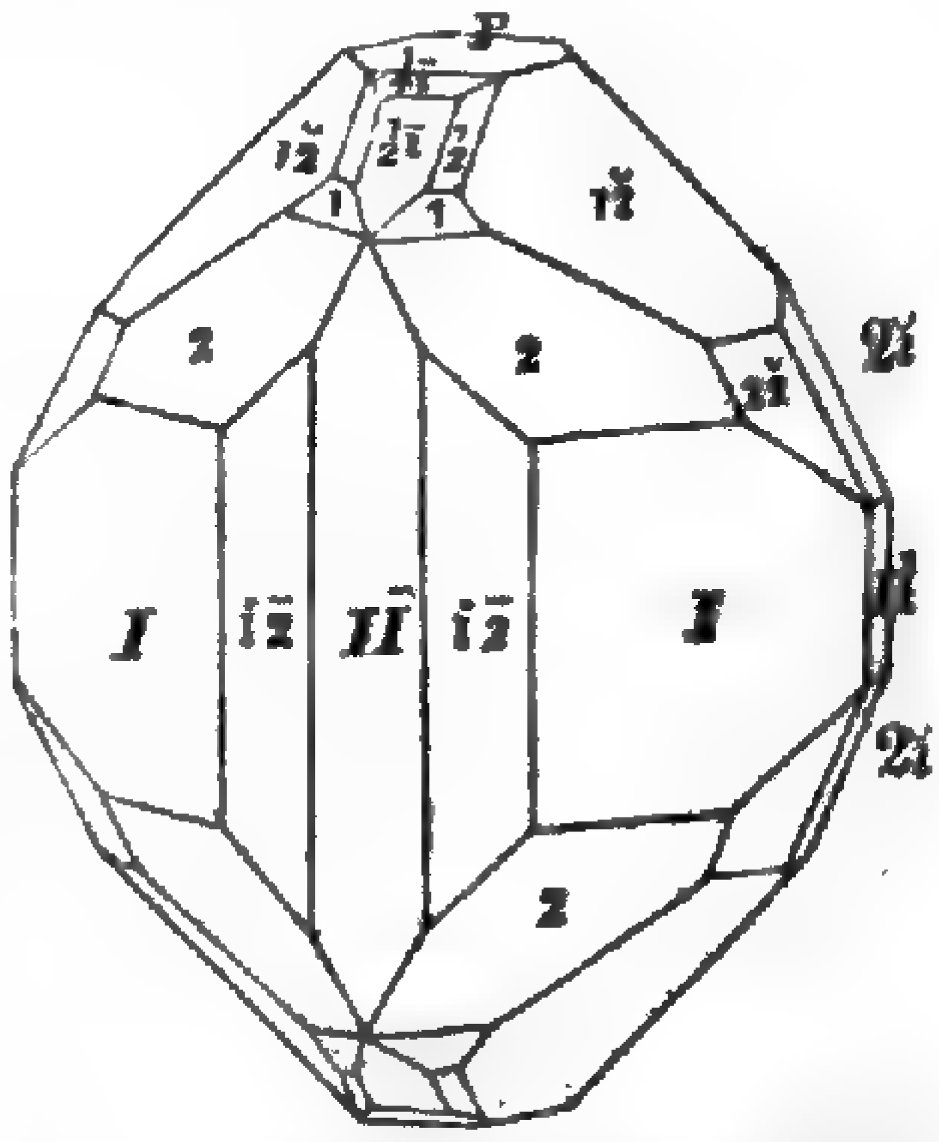
Tourmaline.—A reply to Rammelsberg on the composition of tourmaline by Hermann, is published in the Jour. f. prakt. Chem. liii, p. 280.

Emerald of New Grenada.—M. B. LEWY has examined the locality of emeralds of Muzo. The rock is a black limestone, and the mineral is accompanied with crystals of calc spar and parisite or carbonate of lanthanum. In the same deposits, M. Lewy collected an ammonite peculiar to the Neocomian series.

On the Gigantic Beryls of New Hampshire; by O. P. HUBBARD. This Jour. xiii, 264.

On the angles of Eumanite; by J. E. TESCHEMACHER.—This Jour. xiii, 117.

On Crystals of Brookite from the Ural; by N. VON KOKSCHAROV, (Verh. der Min. Ges. zu St. Pet., 1848–49).—This paper was mentioned by us in vol. xi, p. 228. We now add a figure from it, and give the angles anew. I : I=99° 50′ and 80° 10′, $i\bar{2} : i\bar{2}$=134° 21½′, $2\breve{i} : 2\breve{i}$ (over $I\breve{i}$)=124° 12′; $\frac{1}{2}\bar{i} : \frac{1}{2}\bar{i}$ (over P)=121° 24½′; $\frac{1}{4}\bar{i} : \frac{1}{4}\bar{i}$ (over P)=148° 39½′; angles of octahedron 1, 101° 35′, 115° 43′, 111° 25½′; octahedron 2, 87° 12′, 104° 54′, 142° 21′; octahedron ½, 126° 12′, 135° 14′, 72° 30½′; $1\text{-}\bar{2}$, 135° 37′, 101° 3′, 95° 22½′; $2\text{-}\breve{2}$, 124° 36′, 77° 1½′, 131° 3′.



Zircon.—Hyacinth occurs on the North fork of the American river, California, in almost microscopic crystals: form a square prism, with the diagonal prism, and often with the faces of an octahedron and a zirconoid, sometimes with also a basal plane. Colorless or with a smoky tinge.

Chromic Iron occurs at the same locality, in rounded grains, sometimes showing octahedral faces. Also *ilmenite* in iron-black grains.—*F. A. Genth*, Proc. Acad. Nat. Sci. Philad. vi, 113.

Pyrochlore and Garnet of the Urals.—KOKSCHAROV has described and figured octahedral crystals of pyrochlore (Vesh. Min. Ges. St. Pet., 1848,) in which the angles are truncated, and two additional planes 2-2 and 3-3 replace the edges between the truncating plane (∞-1, dodecahedron) and the octahedral faces. A garnet is also given in his paper which has the obtuse angles of the dodecahedron replaced by 6 planes, 3(2O) inclined on the faces, and $3(\frac{4}{3}O\frac{4}{3})$ on the edges intermediate.

Xenotime in Georgia and North Carolina.—This Jour. xiii, 143.

Malacone of the Ilmen Mountains.—The Ilmen malacone has been examined by M. HERMANN (J. f. pr. Chem. liii, 32.) The crystals are much like those of zircon and present the faces of an octahedron 1 : 1 : 1, and of a square prism, $\infty : 1 : \infty$; pyramidal angle of the octahedron about 124°. Lustre rather weak, somewhat greasy, inclining to adamantine. Lustre of surface of fracture weak and greasy. Color nut-brown. H.=1·5. G.=3·91. Composition;—

	$\bar{Si}$	$\ddot{Zr}$	$\dot{Fe}$	$\dot{Mn}$	$\bar{H}$
	31·87	59·82	3·11	1·20	4·00
Oxygen	16·50	15·72	0·68	0·26	3·55

This gives the formula, $3\ddot{Zr}\,\bar{Si}+2\bar{H}$.

White Antimony in the Province of Constantine, Algeria, (Ann. des Mines, [4], xx, 81.)—An analysis by M. E. Cumenge afforded—

Sb 62 O 17 $\dot{H}$ 15 $\ddot{\overline{F}}e$ 1 Argillaceous gangue 3 = 98

The formula deduced is $3SbO^5+2SbO^3+15HO$.

There are two mines of oxyd of antimony in the Province of Constantine, one north of Ain-Bebbouch, at Sensa, and the other at Oued Hamimim, northeast of Sensa. The two yielded 1541 metric quintals of ore in 1850.

Analysis of White Antimony of Pereta, Tuscany; Meneghini and Bechi.—This Journal, xiv, 61.

Native Iron.—M. Bahr has described specimens of carbonized wood associated with bog ore from Smaoland, which afforded grains of malleable iron having a specific gravity 6·248—6·4972, and 6·6255 after hammering, and he considers it as probably a result of deposition through some electric process, and not artificial in origin. He suggests for coal containing iron in this manner, if hereafter found, the name *Sideroferite.*

On Chrome Iron and Magnetic Chrome Sand from Pennsylvania; by T. H. Garrett.—This Journal, xiv, 45.

Analyses of Braunite, Chromic Iron and Silicated Chrome, from Tuscany; Meneghini and Bechi.—This Journal, xiv, 61.

Vanadium in the iron from the Perm Smelting Works, Russia.—Schubin showed in 1839 that vanadium existed in the iron smelted at Perm. In a cupreous sandstone, in which with the help of a lens, vanadate of copper was recognized, he found on analysis 0·53 p. c. of vanadic acid. An analysis of the pig-iron afforded—

C	Va	$\bar{S}i$	Cu	Fe	Al	Mg	Ca
3·03	1·99	2·51	12·64	75·97	0·89	0·78	0·95=98·76

The *black copper* obtained at the same time with the cupreous pig-iron afforded—

Carbon 0·94 Va 1·21 Cu 90·52 Fe 6·17

—J. Fritzsche, *Bull. de St. Petersb., Chem. Gaz.*, No. 218.

On Octahedral Specular Iron; by T. S. Hunt.—This Jour. xiii, 370.

Titanic Iron from Miask; E. E. Schmid, ibid. (Pogg. Ann. lxxxiv, 498.)—A large crystal of titanic iron from Miask is a broad table 150mm. broad and 95mm. thick, presenting the planes 0R, R,—½R. Cleavage basal but not perfect; H.=6; G.=4·85–4·89; streak black; very weak magnetic. Composition:—

$\ddot{\overline{T}}i$ 28·05 $\ddot{\overline{F}}e$ 70·7 $\ddot{\overline{M}}n$ 0·7 = 99·9

agreeing closely with the analysis by Mosander.

Olivine of the Meteoric iron of Atacama; E. E. Schmid, (Pogg. Ann. lxxxiv, 501.)—Composition:—

$\dddot{\bar{S}}i$	$\dot{M}g$	$\dot{F}e$	$\ddot{\overline{M}}n\ \dot{M}n$
36·92	43·16	17·21	1·81 = 99·10

affording the general formula $(\dot{M}g, \dot{F}e, \dot{M}n)^3 \dddot{S}i$, or $5\dot{M}g^3 \dddot{S}i + (\dot{F}e, \dot{M}n)^3 \dddot{S}i$.

Analysis of a Nickeliferous magnetic Pyrites from Pennsylvania; by Prof. M. H. Boye.—This Jour. xiii, 219.

Manganese Ores.—The following analyses are by Bahr, (J. f. pr. Chem. liii, 308, from Oefvers. af Akad. Förh. 1850, No. 9, p. 240.)

	$\ddot{\text{Si}}$	$\overline{\text{Al}}$	$\overline{\text{Fe}}$	$\overline{\dot{\text{Mn}}}$	$\dot{\text{Ca}}$	$\dot{\text{Mg}}$	$\dot{\text{H}}$	
1. From Klapperud,	36·20	1·11	0·70	47·91	0·61	4·43	9·43=100·39,	*Bahr.*
Ox.	18·79	0·53	0·21	14·54	0·17	1·71	8·38	
2. " "	36·11	0·90	11·31	42·00	0·70	0·57	9·43=101·03,	*Svanberg.*
Ox.	18·75	6·42	3·39	12·75	0·20	0·22	8·38	
3. " "	34·72	1·09	10·45	42·64	0·56	0·36	9·76=99·98,	*Bahr.*
Ox.	18·04	0·51	3·13	12·79	0·16	0·14	8·67	
4. " "	23·69	0·61	9·14	56·21	0·50	0·39	9·51=100·05,	*B.*
Ox.	12·30	0·29	2·74	17·04	——	——	6·45	
5. " "	35·81	1·03	7·53	$\dot{\text{Mn}}$46·18	0·72	1·42	9·57=100·26,	*B.*
Ox.	17·55	0·48	2·26	10·38	0·20	0·55	8·51	
6. " "	43·30	6·80	4·57	$\dot{\text{Mn}}$ 9·88	15·96	11·90	6·13,	$\dot{\text{Co}}$ 0·39=98·93
Ox.	22·48	3·18	1·37	2·22	4·54	4·61	5·45,	0·08=98·93
7. From Skidberg,	0·92	0·75	2·70	$\dot{\text{Mn}}$ $\overline{\text{Mn}}$ 66·16	0·59	0·28,	ign. 12·07,	$\dot{\text{Ba}}$ 15·34, $\dot{\text{Co}}$ 0·02, $\dot{\text{K}}$ 0·28=99·11

Analyses 1 to 3 give the oxygen ratio for the water, peroxyds and silica 1 : 2 : 2, and the formula $2\overline{\text{Mn}}\,\ddot{\text{Si}}+3\dot{\text{H}}$. The species resembles externally Klaproth's black silicate of manganese. Color dull lead-gray.

Analysis 4 affords the ratio $1 : 2\frac{1}{2} : 1\frac{1}{2}$, and the formula $\overline{\text{R}}^6\,\ddot{\text{Si}}^3+6\dot{\text{H}}$, or, it may perhaps be written $(2\overline{\text{Mn}}\,\ddot{\text{Si}}+3\dot{\text{H}})+(\overline{\text{R}}^3\,\ddot{\text{Si}}+3\dot{\text{H}})$. The mineral occurs mixed with the preceding. Color pure black; fracture earthy; but little hardness. G.=3·207.

Analysis 5 may have the formula $(6\dot{\text{Mn}}^2\,\ddot{\text{Si}}+\dot{\text{H}})+\overline{\text{Fe}}\,\dot{\text{H}}^3$.

Analysis 6 affords the ratio for water, protoxyds, peroxyds and silica 1·19 : 2·51 : 1 : 4·94. The loss is probably part alkali and part protoxyd of iron, which possibly may make the ratio 1 : 3 : 1 : 5, and give the formula $(3\dot{\text{R}}^3\,\ddot{\text{Si}}+\dot{\text{H}})+\overline{\text{R}}\,\ddot{\text{Si}}^2$. Color light yellow; massive; cleavage not distinct; fracture fine splintery; hardness small; lustre between vitreous and greasy; G.=3·320 at 15° C. It blackens in a glass tube, and fuses with intumescence on a coal to a black glassy globule. In fragments dissolves with difficulty in acids, but easily when pulverized; gives the manganese color. Not dissolved in heated muriatic acid and only imperfectly in concentrated sulphuric acid.

Analysis 7 belongs to a *psilomelane*. G.=4·254 at 15° C.; scratched with difficulty by felpspar; powder black; soluble in muriatic acid.

Placodine.—Dr. Schnabel states (Pogg. Ann. lxxxiv, 585,) that the *Placodine* of Breithaupt (Pogg. 1841, p. 631) is probably a furnace product, which has resulted from a reduction of nickel ore. Prof. G. Rose (ibid. lxxxiv, p. 589) also observes that in his system of Mineralogy, published in 1847, he remarked that placodine was probably identical with the *nickelspeise* of Wöhler, and a furnace product. Although the angles of the two do not seem to agree, still there is a general similarity in the crystals, and he found some angles the same. A new analysis of the nickelspeise has been made by H. Schlossberger, who obtained—

As	S	Ni	Cu	Co	Fe
44·72	1·82	49·45	1·16	0·81	0·45

a result agreeing well with that of Wöhler (Pogg. Ann. xxv, 302). Prof. Rose closes with the remark that a revision of the analysis of placodine is needed.

Sulphuret of Nickel in Pennsylvania.—This Journal, xiii, 117.

Erubescite and Copper Pyrites of the Espedal Copper Works, Norway; Mr. DAVID FORBES, (Jameson's Edinb. Jour., l, 278.)—The erubescite has the sp. gr. 4·432, at 60° F. Composition:—

S	Cu	Fe	Mn	$\ddot{S}i$
24·49	59·71	11·12	0·1	3·83 = 99·15

This corresponds to the formula $7\text{Cu}\,S+Fe^3\,S^4$ = sulphur 25·23, copper 63·17, iron 11·60=100. Mr. Forbes reviews various analyses of this mineral, and concludes that the species is a compound of a protosulphuret and disulphuret of copper, with more or less of the copper replaced by iron. He thus deduces the formulæ:

$2Cu^2\,S+Cu\,S$, (corresponding to S 23·28, Cu (with Fe) 76·62=100)—for the Killarney mineral, analyzed by Phillips.

$Cu^2\,S+Cu\,S$ (corresponding to S 25 31, Cu (with Fe) 74·69), for the above ore, and that analyzed by Bodemann, Plattner and Hisinger.

$Cu^2\,S+2Cu\,S$, (corresponding to S 27·60, Cu 72·40), for the crystallized ore analyzed by Plattner.

Digenite is included under the last, it being a variety containing no iron.

The copper pyrites has the hardness 3·5, and G. (at 60° F.)=4·185. Composition obtained:—

S	Cu	Fe	Mn	$\ddot{S}i$
33·88	32·65	32·77	*trace*	0·32 = 99·62

Analyses and descriptions of Fahlerz, Copper glance, Chalcopyrite, Erubescite, Zigueline, of Tuscany; MENEGHINI and BECHI.—This Journal, xiv, 60.

Chalcotrichite at the Perkiomen Lead mine.—This Journal, xiii, 117.

On the Galmei of Weisloch in Baden; by GUSTAV HERTH, Dr. Philos. Inaug.-dissert., 46 pp. 8vo. *Heidelberg*, 1851.

Analysis of Marmatite and oxyd of Zinc from Tuscany; MENEGHINI and BECHI.—This Journal, xiv, 60.

Note on the Lead ores of Chester Co., Pennsylvania.—This Journal, xiii, 116.

Analyses and deseriptions of Galena and Feather ore of Tuscany; MENEGHINI and BECHI.—This Journal, xiv, 60.

Platinum and Iridosmine in California; Dr. F. A. GENTH, (Proc. Acad. Nat. Sci. Philad., vi, 113).—A few steel-colored rounded grains of platinum were observed among specimens of gold from the American fork, California, 30 miles from Sacramento city. *Iridosmine* from the same locality occurs in lead-colored scales. A collection of white grains from California, afforded, after separating the platinum, six-sided scales of a color between lead and tin-white, which on heating on platinum foil, gave a strong odor of Osmium, and were probably therefore the *Sisserskite* ($Ir\,Os^4$); when thus heated, the scales became iridescent and assumed yellow orange and blue colors like steel. Dr. Genth, on trying the Ural iridosmine, found that the lead-colored scales afforded the same colors; and he suggests that this may be a good test for distinguishing the *Sisserskite* from the *Newjanskite.* He adds that there are probably in nature only two distinct compounds of iridium and osmium, viz: $Ir\,Os^4$ and $Ir\,Os$; and the compound $Ir\,Os^3$ is probably a mixture of the two.

Sulphur mine in Upper Egypt.—An extensive bed of sulphur has been opened in Egypt between the village of Keneh and the Red Sea, at the strait called Bahar el Sefingue. It is soon to be worked.—Ann. des Mines [4], xviii, 541.

Sulphuret of Arsenic and Sulphur in Koordistan.—This Jour. xiv, 103.

Mineralogy of the Granular Limestone in the Gneiss of the Vosges; M. Delesse, (Ann. des Mines, [4], xx, 145.)—(1.) *Mica.*—The most prevalent mineral contained in the limestone is mica. The mica has G.=2·746; color greenish; lustre somewhat greasy; unaltered by atmospheric action. Two axes of double refraction very near one another. B. B. exfoliates and gives out a bright light, and fuses with difficulty to a white enamel. Analysis, p. 153:—

	$\dddot{\mathrm{Si}}$	$\dddot{\mathrm{Al}}$	$\dot{\mathrm{Fe}}$	$\dot{\mathrm{Mn}}$	$\dot{\mathrm{Ca}}$	$\dot{\mathrm{Mg}}$	$\dot{\mathrm{Na}}$	$\dot{\mathrm{K}}$	Fl	ign.
	37·54	19·80	1·61	0·10	0·70	30·32	1·00	7·17	0·22	1·51=99·97
Ox.	19·51	9·25	0·37	0·02	0·20	11·73	0·26	1·22	—	—

This gives the oxygen ratio for the protoxyds, peroxyds and silica 13·79 : 9·25 : 19·51=3 : 2 : 4, affording the formula $3\dot{R}^3\dddot{\mathrm{Si}}+\dddot{R}^2\dddot{\mathrm{Si}}$. The optical character appears to show that the mica is a phlogopite, although differing from that species a little in composition. The formula given for phlogopite is $3\dot{R}^3\dddot{\mathrm{Si}}+2\dddot{R}\dddot{\mathrm{Si}}$.

(2.) *Pyrosclerite?*—Occurs especially at St. Philippe. Color grayish, to bluish, nearly emerald green; lustre greasy or waxy; soft; G.=2·622. Attacked completely by muriatic acid, but without giving a jelly. B. B. fuses with difficulty to a whitish glass; a pure blue color with nitrate of cobalt. Composition, p. 157:—

	$\dddot{\mathrm{Si}}$	$\dddot{\mathrm{Al}}$	$\dddot{\mathrm{Cr}}$	$\dot{\mathrm{Fe}}$	$\dot{\mathrm{Mn}}$	$\dot{\mathrm{Ca}}$	$\dot{\mathrm{Mg}}$ (by diff.)	$\dot{\mathrm{H}}$
	38·39	26·54	*trace*	0·59	*trace*	0·67	22·16	11·65=100·00
Ox.	19·95	12·40	—	0·13	—	0·19	8·55	10·36

The mineral resembles serpentine, but contains much more alumina, and is more fusible. The formula afforded is $3\dot{\mathrm{Mg}}\dddot{\mathrm{Si}}+4\dddot{\mathrm{Al}}\dddot{\mathrm{Si}}+9\dot{\mathrm{H}}$, or possibly $\dot{\mathrm{Mg}}^3\dddot{\mathrm{Si}}+\dddot{\mathrm{Al}}\dddot{\mathrm{Si}}+3\dot{\mathrm{H}}$.

Pyroxene.—A pyroxene (sahlite) from Chippal, afforded, p. 145—

$\dddot{\mathrm{Si}}$	$\dddot{\mathrm{Al}}$	$\dot{\mathrm{Fe}}$	$\dot{\mathrm{Mn}}$	$\dot{\mathrm{Ca}}$	$\dot{\mathrm{Mg}}$ (by diff.)	ign.
54·01	1·10	4·25	*trace*	16·10	20·94	3·60=100·00

Specific gravity 3·048. Structure that of a sahlite. It is probable, Delesse suggests, that the original composition of the mineral may have been modified by a pseudomorphic process.

M. Delesse observes that the pyrallolite, of Storgard, Finland, has the angles nearly of pyroxene and differs but little in composition from the sahlite of Chippal.

The gneiss enclosing the limestone contains both feldspar (orthoclase) and oligoclase, with pyroxene and hornblende. The following analyses are given.

	$\dddot{\mathrm{Si}}$	$\dddot{\mathrm{Al}}$	$\dot{\mathrm{Fe}}$	$\dot{\mathrm{Ca}}$	$\dot{\mathrm{Mg}}$	$\dot{\mathrm{Na}}$	$\dot{\mathrm{K}}$
1. Orthoclase,	64·04	19·92	—	0·39	0·33	2·18	11·48=98·34
2. Pyroxene,	53·42	1·38	8·53	21·72	14·95*	—	—=100·00
3. Hornblende, gn'h-bk,	44·82	13·18	11·17	9·69	19·48*	—	ign. 1·66=100·00

* By difference.

M. Delesse remarks on the mineral similarity of the granular limestones of the Vosges and those of the United States and other regions; pyroxene, tremolite and other varieties of hornblende, spinel, sphene, graphite, phlogopite, pyrosclerite, are common to both.

Analyses of Limestones of Herzogthums Nassau; by Dr. R. FRESENIUS, (J. f. pr. Chem. liv, 85 and 374.)

Hydraulic Limestome, explored near Thonon (*Chablais.*)—MARIGNAC obtained as the result of two analyses—

$\dot{Ca}\ddot{C}$	$\dot{Mg}\ddot{C}$	Clay.	Water.
50·25	40·95	8·17	0·92 = 100·29
50·36	41·99	7·05	0·37 = 99·77

The carbonates of lime and magnesia are in the proportions of a true dolomite. The color of the rock is a deep gray, texture very fine and compact, fracture conchoidal.

On the Diorites of the Vosges; by M. DELESSE, (Ann. des Mines, [4], xix, 149.)—In the course of this excellent paper, M. Delesse gives the following analyses:

	$\ddot{Si}$	$\dddot{Al}$	$\dddot{Fe}$	$\dot{Mg}$	$\dot{Ca}$	$\dot{Na}$	$\dot{K}$	ign.
1. Oligoclase, Clefcy,	66·11	19·33	0·50	0·47	1·82	8·17	2·89	0·80=100·09
2. " Visembach,	63·88	22·27	0·51	*trace*	3·45	6·66	1·21	0·70= 98·68

The name *Kersantite* is applied to the rock at Visembach. It is a crystalline rock associated with gneiss, consisting mostly of oligoclase and mica, with sometimes hornblende, while *Kersanton* consists mainly of feldspar. Plate 2, represents very beautifully the appearance of these and other rocks.

Meteoric Stone of Stannern.—This meteorite fell in numerous pieces on the 22nd of May, 1808. Rammelsberg obtained in an analysis (Pogg. Ann. lxxxiii, 591). Part soluble in hydrochloric acid 34·98 p. c. Part insoluble 65·02 p. c. Composition:—

	$\ddot{Si}$	$\dddot{Al}$	$\dddot{Fe}$	$\dot{Mn}$	$\dot{Ca}$	$\dot{Mg}$	$\dot{Na}$	$\dot{K}$	Cr Fe
Soluble part,	46·19	31·26	2·93	—	16·98	1·12	1·14	0·50	— =100·12
Insoluble "	49·44	2·64	$\dot{Fe}$ 28·31	1·25	8·20	9·97	0·35	0·10	0·83=101·09;

[mean of 2 determinations.

The soluble part has nearly the oxygen ratio of *Anorthite*, and the insoluble part, that of *augite*. The composition is quite near that of the Juvenas meteorite.

Appendix.

Molybdate of Iron, a new Mineral from California; D. D. OWEN, (Proc. Acad. Nat. Sci. Philad., vi, 108).—This mineral is from near Nevada city, California. It has a deep yellow color, and a fibrous or acicular structure, or is in tufted crystals. An approximate analysis afforded

$\dddot{Mo}$?	$\dddot{Fe}$	$\dot{Mg}$	Alkali	$\dot{H}$
40	35	2	8	15

The oxyd of molybdenum is, in all probability, molybdic acid. B. B. fuses easily, and if supported on its quartz matrix, a bluish ring is formed around the assay. With salt of phosphorus, a green bead is obtained.

[A very small fragment of this mineral was received here from Prof. Blake, and its quantitative analysis by Mr. Wm. J. Craw afforded molybdic acid and oxyd of iron ; but the amount was too small for any definite determinations, or even to ascertain whether the iron was in chemical combination.—J. D. D.]

Strontiano-calcite, a new species ; Dr. F. A. Genth (Proc. Acad. N. Sci. Phil., vi, 114, June, 1852).—Crystallization and cleavages like calc spar : secondary form an acute rhombohedron of 65° 50′. Crystals minute ; occurs in globular masses, the globules terminating in this acute rhombohedron. H=3·5. G. undetermined. Colorless and transparent or white and translucent, the former vitreous, the latter pearly in lustre. B. B. yields a brilliant light, a slightly crimson flame, and becomes caustic. The solution in acids gives a white precipitate with sulphate of lime, but not with sulphate of strontia, and it therefore contains strontia. After precipitating the strontia in a portion of the solution, the addition of oxalate of ammonia produced a precipitate of oxalate of lime. The quantity was too small for a quantitative analysis, but Dr. Genth infers that the lime and strontia are in about equal proportions.

The specimen was from Girgenti, Sicily, where it is of rare occurrence associated with celestine and sulphur.

2. *Large Deposit of Graphite.*—At St. John, N. B., near the new suspension bridge over the St. John's river, a very extensive deposit of graphite has been opened and explored to a considerable extent. The vein, or bed as it might more properly be called, is nearly vertical, and inclosed between beds of highly metamorphic schists. It is entered near the water on the face of a precipitate cliff about seventy feet high, the walls of the lode being in the main parallel to the graphite deposit. This bed has been explored by a gallery or adit level over a hundred feet, and by cross cuts at right angles to this some twenty or more feet. All these are in the graphite mass, and of course the floor and roof of the levels are of the same mineral. The quartzose walls have occasionally approached, and in some cases masses of quartz, or schist, have been included in the graphite. The course of this deposit is about northeast and southwest, or nearly in the direction of the strike of the strata of schist. The graphite is not of a very superior quality as a mass, though portions of it are quite pure. As yet no solid and perfectly homogeneous masses have been taken out. It has a foliated structure more or less highly marked. Iron pyrites is too abundantly diffused in it to admit of its use for crucibles. The chief economical use made of it has been in facing the sand moulds for iron castings, for which purpose it is ground to a fine powder. Some of the finer parts are also used to manufacture pencils. Many hundred tons of graphite from this deposit have already been taken out since the mine was opened two years ago, and the supply may be esteemed inexhaustible. The vein or bed reäppears on the opposite side of the St. John's river, and on the side now opened it has been traced over a mile. The position of the deposit in conformable metamorphic schists, suggests the conjecture that this deposit of graphite may represent a former coal bed.

3. *Flora of the Tertiary Formation,* (from the Augsburg Gazette of 27th May, 1852 ; communicated for this Journal by W. G. Lettsom.)—The flora of the tertiary formation has been hitherto, comparatively

speaking, far less known than that of the coal formation which is of a far older date; and even in Silesia, notwithstanding its numerous and important deposits of brown coal, the entire amount of leaves, blossoms and fruits belonging to this formation, exclusive of stems of trees, did not exceed forty-three species up to the close of last year.

Since then, however, a discovery has been made which in a few months has already brought more treasures to light, than Monte Bolca in Italy and the celebrated deposit of Oeningen in Germany have done in a century. This new deposit was discovered by the Superior Councillor of Mines, Von Oeynhausen, near the end of January, of this year, in the immediate neighborhood of Breslau, at Schossnitz, near Kanth, on the railroad; it is a bed of fossil plants in tertiary clay and is unique in richness, variety, and admirable preservation. From the end of January up to the beginning of March there were already discovered no less than 130 species in about six cwt. of clay; and every fresh quantity examined gives additional results. Dr. Göppert has read a very interesting paper upon the results of the examination thus far made before the natural history section of the Breslau Society. The clay is of a whitish color; the plants seldom preserve their original texture, but usually occur as impressions of a pale brown color, in which however they are displayed with such precision that even the delicate anthers of the catkins of the willow tribe are readily distinguishable. These anthers, as well as those of the male catkins of the plane tribe, occasionally exhibit the pollen. With respect to the families and genera, it may be said that they agree, speaking in a general way, with those of the other local floras of the brown coal formation. The species are, however, for the most part different; only one species has been hitherto observed, Libocedrites salicornioides, that is met with in Silesia, in amber, and in the brown coal formation of other parts of Germany. Of the 130 species that have been found at Schossnitz up to the beginning of March, there are no less than 118 which are new. As a peculiarity in this tertiary flora may be cited the considerable number of oaks, of which already 25 varieties have been observed, whereas at present only 13 are known to occur in Europe, and for the most part the species discovered belong to those with incised leaves. There are, moreover, no less than 17 varieties of elm, some unquestionable planes, and varieties of maple perfectly distinct from any hitherto observed. The genera Daphnogene, Ceonanthus, Dombayopsis and Taxodium have been also met with. It need hardly be observed that our acquaintance with the riches of this recently discovered deposit is as yet necessarily very imperfect. Palms, which are met with in other tertiary deposits in the immediate neighborhood, have not thus far been found; indeed, no monocotyledons have been observed with the exception of a few leaves of grass. The origin of the deposit has been explained on the supposition that there existed here formerly an inland lake, into which the leaves and blossoms of the trees that perished on its banks were carried by the wind, and became subsequently imbedded in the clayey mud. This recently discovered deposit bears out the idea that although the majority of the genera of the plants occurring in the tertiary formation are similar to those now met with in Europe, although the species are different and agree rather with African forms than ours, yet that this formation, speaking generally, contains a flora distinct from that of the actual flora of the districts mentioned, and analogous rather to that of countries situated several degrees more to the south, the flora of the deposit at Schossnitz answering, it will be seen, to that of the vegetation in the southern portion of the United States, or to that of the north of Mexico. Professor Göppert purposes to lay the results of the examination of the Schossnitz deposit before the scientific public, as far as it has at present been made, in a separate work.

4. *On the Causes which may have produced changes in the Earth's Superficial Temperature;* by W. Hopkins, Esq., (Quart. Jour. Geol. Soc., viii, 56.)—The following are some of the important deductions brought out in this extended paper, the whole of which is worthy of attentive perusal and study.

The present effect of the internal heat of the globe on the mean temperature of the surface, as deduced by Poisson, is about $\frac{1}{20}$th of a degree: and the rate of increase of temperature on descending below the surface is 1° F. for every 60 feet. If the effect of the internal heat were 1°, or twenty times the present amount, the descending rate of increase would be twenty times as great as now, or about 20° F. for every 60 feet; if 10°, the temperature at 60 feet would exceed 200° F., a physical condition inconsistent with the existence of animal life on the surface. Prof. Hopkins hence concludes that internal heat cannot have modified the external temperature within the more recent geological epochs.

The sun (and therefore our system) moves, according to O. Struve, at such a rate as to describe an arc of $\frac{1}{3}$d of a second in a year to an eye situated at the mean distance of the stars of the first magnitude; which motion would require a period of nearly 700,000 years to pass over a space equal to that of the mean distance of the stars referred to from the earth. Now, the heat of space depends on the heat of the stars or suns radiating heat into it, and this motion is changing the part of space in which the earth is. But the influence on space of stars so distant must be exceedingly small and wholly inappreciable. There is no source of *cold* among them, and the remoter distance from the stars that might be acquired would fail to modify at all the effects of our sun, and can account for none of the cold of the so-called glacial period.

Changes in the arrangement of the land and in the direction of the oceanic currents, are now generally admitted, since the able discussion of the subject by Sir Charles Lyell, to be efficient causes of variations in the earth's temperature. Prof. Hopkins discusses the effects on the isothermal lines, and on the production of glaciers, under different changes of this kind. He shows that to produce glaciers in England by an elevation of the northern part of Europe, or by an elevation of the bed of the Atlantic so as to unite the two continents, an elevation of many thousand feet would be required. The limit of perpetual snow in high latitudes is usually much above the isothermal of 32°, and somewhat below it in the tropical. In the tropics, the temperature is nearly uniform through the year, and so the limit of the snow. In colder regions this limit is the *limit in summer*, which is much above the line of the mean for 32°. The descent of glaciers is from 1,500 to 5,900 below the snow line. It hence follows that to produce glaciers on

Snowdon, in England, by raising the land, the elevation of the region must be 7,000 or 8,000 feet above the present level, or to a height of 11,000 feet, as this would be required to carry it 1,000 feet above the snow level, and the glaciers might in such a case be expected to descend 2,000 feet below the snow line.

Considering such an elevation, (or the uniting of the continents, which would require much the same conditions as to the height of the region,) very improbable and without any proof, Prof. Hopkins next considers the effect of a *subsidence* of northern Europe, and concludes that by this means, together with a diversion of the Gulf-Stream, the requisite glaciers for the production of glacial effects in England would be had. A depression of 500 feet, according to his calculations, would produce a cold temperature at Snowdon, having the probable mean of 39° or 40° F., making the line of 32° F. at a height of 2,200 feet, or 800 feet below the summit of the Snowdon peak; and glaciers would then descend from the snow line to the level of the sea. If then a cold current strike on the land, this would diminish the temperature further; and should it make a difference of but 3° or 4°, it would bring the snow limit down 1,000 or 1,200 feet lower, which would account for glaciers reaching the sea, even on the lower mountains of Ireland. The same conditions would make the snow-line on the Alps 5,000 or 6,000 feet above the sea. The present climate of Fuegia illustrates well the theory.

III. Astronomy.

New Planet, (Astr. Jour., No. 45.)—Another planet was discovered on the night of June 24, 1852, by Mr. J. R. Hind, of London. It appeared like a star of the ninth magnitude, with a steady yellowish light. Its apparent place June 24, $13^{h.}\ 13^{m.}\ 53^{s.}$ Gr. m. t. was R. A. $18^{h.}\ 12^{m.}\ 58^{s.}{\cdot}78$, N. P. D. 98° 16′ 0″·9.

IV. Miscellaneous Intelligence.

1. *Remarks on the Climate of San Francisco.—The Sea-Breeze;* by Dr. H. Gibbons, (from the California Christian Advocate of April 1, 1852.)—The tables contained in my last number,* exhibit the great excess of sea winds over land winds in every month of the year 1851, excepting January, when the excess was in favor of land winds. In this respect, the month of January in the present year, corresponds with the last. December, 1850, shows a very slight preponderance of land winds. From these data I infer the general rule, that the westerly or sea winds predominate in every month, except January and December, and that the latter month varies in this respect, being sometimes on one side and sometimes on the other.

I have already stated that the westerly winds increase both in frequency and in force from February to July, and then begin to fall off very gradually. The precise relation of sea to land winds, in each month, as to frequency, is shown by computing their per-centage of the whole number of observations. The result for the year 1851, is as follows:

* This volume, page 132.

January,	sea winds,	44 per cent.	July,	sea winds,	97 per cent.
February,	"	63 "	August,	"	97 "
March,	"	81 "	September,	"	96 "
April,	"	87 "	October,	"	78 "
May,	"	95 "	November,	"	73 "
June,	"	96 "	December,	"	38 "

To which may be added—

December, 1850,	sea winds,	. . . .	49 per cent.
January, 1852,	"	. . . . . .	34 "
February, 1852,	"	. . . .	69 "

Whatever may be the direction of the wind in the forenoon, in the spring, summer, and autumn months, it almost invariably works round towards the west in the afternoon. So constant is this phenomenon, that in the seven months from April to October inclusive, there were but three days on which it missed: namely, on the 8th of April, the 18th of May, and the 27th of August. And these three days were all rainy, with the wind from south or south-southwest.

The sea winds are moderate in the spring until the month of May, when they begin to give trouble. In June they increase in force, reaching their greatest violence about the beginning of July. In August they begin to decline in force, though not in constancy. In September they continue steady, though moderate, and in October they lose their annoying qualities, and become gentle and agreeable.

The sea winds of summer are commonly supposed to come from the northwest. But this is a great error, arising no doubt from the fact that our citizens have mostly been accustomed to cold winds in the Atlantic States from that quarter. In the early spring they sometimes proceed from north of west. As the season advances they depart entirely from this course, and are almost invariably from south of west. From May to September, a period of five months, the direction of the afternoon sea breeze was north of west on twelve days only; and even on these occasions it was mostly within one point of west. The prevailing direction was west-southwest.

I have reason to believe that the wind off the coast, at sea, during the period referred to, is more northwardly than on land, and that it is deflected from that course about the Bay of San Francisco. Such at least is the account given by the captains of vessels navigating the coast.

There was a decided sea-breeze on 23 days in March, 17 days in April, 22 days in May, 24 days in June, every day in July and August, 28 days in September, 30 days in October, and 8 in November.

The number of afternoons that might be described as *windy*, was, in February 8, March 16, April 15, May 18, June 24, July 29, August 23, September 19, October 8, November 2. On the 162 days thus noted, the mornings were seldom windy, the wind rising above a moderate breeze in the forenoon on 34 days only. In May there were 5 days windy at sunrise, and one in June; but not one in the months of April, July, August, September and October.

The sea-breeze generally rises to its height soon after noon-day, mostly between one and two o'clock, but sometimes not till three or four. It commonly falls about sunset, or soon after. Sometimes it continues till midnight. In the early part of the season it is apt to set in earlier and continue later. There were 8 windy evenings in May, 11 in June, 11 in July, 5 in August and none in September.

The idea of mist and vapor is commonly associated with these winds; but the sky is clear, or partially so, more than half the time. There were 6 cloudy mornings in May, 11 in June, 16 in July, 21 in August, and 22 in September. About 9 or 10 o'clock, the clouds mostly broke away rapidly, a light breeze springing up at the same time. Several hours of very pleasant weather occurred towards noon, almost every day. The sun shone forth with genial warmth, the mercury rising generally from about 50 at sunrise, to 60 or 65 at noon. But when the sun had reached the zenith, the wind rapidly increased, coming down in gusts from the hills, which separate the city from the ocean, and often bringing with it clouds of mist. But the dampness is never sufficient to prevent the elevation of clouds of dust and sand, which sport through the streets in the most lively manner. The mercury falls suddenly, and long before sunset it fixes itself within a few degrees above 50, where it sticks pertinaciously till next morning; often not moving a hair's breadth for twelve hours. Sometimes I have examined the instrument on the idea that some defect had fixed the column immovable. The chilling temperature adds to the effect of cloud and dust. Persons who have business out of doors are seen buttoning up their coats or overcoats, and rubbing industriously at the various apertures about the face as they hurry through the streets, in the worst possible humor. Such weather, at the summer solstice, with an almost vertical sun, is pronounced "perfectly ridiculous!"

The mist often increases towards evening, and when the wind falls, remains all night in the shape of a heavy fog. Sometimes, when the sun has been shining brightly, the mist comes in from the ocean in one great wave, and suddenly submerges the landscape. In a few minutes it may vanish, and give place to the cheerful sunshine. In short there is no conceivable admixture of wind, dust, cloud, fog and sunshine, that is not constantly on hand during the summer at San Francisco. Not unfrequently you are tantalized with a rainbow at sunset. Once I saw a solar rainbow before night in the east, and soon afterwards another bow in the west, made by the moon.

I have already noticed the almost constant prevalence of the west and southwest currents. As the sea-breeze becomes established, the entire absence of winds from north and northwest is remarkable. In the month of May, and in the beginning of June there were a few light breezes from that quarter. But from the 13th of June until near the middle of October, a period of four months, there is not a solitary observation noted in my record, even of the lightest or most transient wind, from north or northwest; I think it probable that the same cannot be said of any other spot on the globe, in the north temperate zone.

The uniformity of the summer weather is occasionally broken by the intervention of a few warm and pleasant days, when the wind is not high enough to convert summer into winter. Under these circumstances the thermometer mounts to 70 or 75. In the later spring and early autumn months it is warmer. But as soon as the "summer" has fairly set in, flannels and firewood are in almost constant demand, at least until August.

No one but an actual observer can appreciate the utter impotency of an almost vertical sun, during a brisk sea-breeze. The rays of the sun have scarcely more warmth than moon beams. Instead of raising the thermometer 30 or 40 degrees, they seldom produce more than ten degrees of elevation, in the sweep of the wind.

Such is the "summer" at San Francisco. Every body complains of the chilly winds, the mist and the dust. If you have nothing to do but sit in the house you are perfectly comfortable. Even for out-door employment or exercise, the mornings are almost invariably pleasant. The evenings are generally too cool to sit without fire, and the nights are never too warm to dispense with blankets. For the purpose of rest and sleep, the night in California is perfectly luxurious all the year through.

It might be inferred that a climate such as I have described, is unfavorable to health, especially with persons liable to diseases of the chest. But the fact is just the reverse. The tone and vigor given to the animal frame by the uninterruptedly bracing temperature, appear to raise it above the control of inherent tendencies to pulmonic disorders. I believe the humid and saline condition of the atmosphere coöperates in the benefit. But I shall consider this subject more fully under a distinct head.

In all other parts of California, except the region about the Bay of San Francisco, the summer is very different. Along the coast are mists and sea breezes, but the winds are moderate, and not so chilling. Inland, they do not extend beyond the barrier of hills which skirt the coast. A distance of fifty miles in any direction from San Francisco, brings you into a different climate. In a southeast course towards San José, you escape the winds and fogs of summer by traveling 20 or 30 miles. Even in Contra Costa directly accross the Bay, they are less severe, though the trees show, by their semi-prostrate attitudes, the direction of the prevailing atmospheric currents.

The general principles on which depend the diurnal currents of air, which set in from sea to land, are well known. The land being more heated than the ocean by the sun's rays, the superincumbent heated air rises in a steady column. Its place must be supplied from some quarter, and the colder and denser air of the ocean accordingly flows in, constituting a sea-breeze. Independently of this, we have the universal westerly current, coinciding in its course and tending to add strength and constancy to the sea-breeze, while the topographical features of the Bay of San Francisco, and the region of country bordering on it enhance the effect. These several causes combined, will explain the extraordinary constancy and force of the westerly winds at this point.

The importance of these winds in connection with the climate of San Francisco, has led me to dilate much more than I intended on taking up the subject. There are other incidents of the climate yet to be considered.

2. *Heat of the Solar Disk.*—M. Secchi, of Rome, has made a series of photometric experiments on the disk of the sun, by means of a thermo-electric pile. He has found that the heat of the borders of the disk is nearly half that of the centre, which confirms, as regards radiation of heat, what was already known for light and chemical action. But

he observed further, that the heat was not the same at all points equidistant from the centre; and that the place of maximum temperature was 3′ above the centre; the isothermal curves were a species of parabola. The sun's surface hence differs in temperature not only because of the absorption due to its atmosphere, but also from certain inherent differences in the surface itself. But M. Secchi also remarks that at the time of the observations, the 20th, 21st and 23d of March, the solar equator was raised about 2′·6 above the centre, and hence the inferior part of the disk presented the south pole of the sun, while the north pole was concealed; and, moreover, the ascertained point of its greatest heat *lies in the solar equator.* The conclusion therefore follows that the *equatorial regions of the sun are hotter than the polar.* M. Secchi's observations did not extend to the spots of the sun; yet in a few trials they were found to produce a sensible diminution of temperature. He says that the prevalence of the spots about the equatorial region corresponds well with the view that this part is the hottest in the sun.—*L'Institut, No.* 957.

3. *On Rain Waters.*—M. Chatin makes the following statements as results of his observations:—

(1.) The chlorids, which abound in the rains of maritime countries, are at Paris more abundant than in the waters of the Seine whenever the wind blows from the sea.

(2.) Sulphates exist in a notable quantity in the rain of Paris and in that of Central France; rain waters, though generally containing less of chlorids than the waters of rivers, usually surpass the latter in the proportion of sulphates.

(3.) Salts of lime and soda are contained in rain waters in an appreciable quantity.

(4.) Rain waters are especially distinguished by containing even half a decigramme to a litre of azotised organic matter, which may be represented in its composition by a mixture of ulmate of ammonia and ulmic acid; this ingredient is found also in the lower strata of the atmosphere (though less at Turin and on the borders of the sea than at Paris and in Maurienne), whence it is deposited by the dews and mists, and may be separated by washing.

(5.) Argillaceous earths retain better than lighter soils this principle dissolved in rain waters. The atmosphere, and the rains which wash it, perform an important part in agriculture, in restoring to the soil a portion of soluble mineral and organic matters highly useful to vegetation.

4. *Pendulum Experiment.*—In this Journal, vol. xii, p. 399, a paper upon the Pendulum in the Philosophical Transactions for 1742, is attributed to Marquis de Poli, a statement taken from the London, Edinburgh and Dublin Phil. Mag. for 1851.—M. Secchi, of Rome, observes (L'Institut, No. 951, March, 1852), that the author, as stated in the Transactions referred to (years 1742–43, No. 468), was *Marquis de Poleni.* The title is in Latin, as follows: *Johannis Marchionis Poleni*, R.S.S. de novis quibusdam cogitationibus ad explorandum num pendula vi aliqua centrifuga perturbentur, commentariolum illustrissimæ Societati regali Londinensi oblatum. The author was an Italian, born at Venice in 1683. The paragraph referred to, as containing the

knowledge of the phenomena relating to the pendulum, is the following: —Tum animadvertam (considerata hypothesi Terræ motæ) in una penduli oscillatione non describi ab ejus centro perfecte unum eundemque arcum in plano eodem: nihilo tamen secius cum nascentes inde differentiæ rem meam non turbent, negligi a me tuto possunt; sufficitque hæc semel indicavisse, etc.

In M. Secchi's experiments with the pendulum he obtained the mean hourly deviation 9° 53′ 16″. The calculated deviation for the latitude of Rome is, for an hour of sidereal time, 10° 1′ 2″·7.

5. *Microscopic Photographs*, (Athenæum, May 22, 1852.)—As the photographic delineation of microscopic objects appears to be occupying the attention of many at the present moment, I beg to inclose one or two examples in that way, in the hope of obtaining some further information on the subject through the medium of your journal, should you consider them sufficiently noteworthy. The collodion process on glass offers peculiar facilities for working with the microscope; but as the accumulation of the plates is highly inconvenient, it appeared desirable that some method should be devised for the preservation of the picture without the glass. This may be effected by transferring it to a piece of waxed paper, which forms a most excellent substitute. The process is very easy. The picture having been obtained, the film of collodion is floated off the glass under water, and removed to a bath of isinglass so weak as to be fluid when cold; in this bath the waxed paper having been previously soaked for a few minutes, the arrangement and extension of the pellicle is effected by gently moving it with the fingers, and then carefully raising up both it and the paper together, holding them so as to let the water run from between them. It is necessary to hold both, for the film slips about very easily. Blotting paper will then absorb some of the superfluous water, and the remainder may be forced out by rubbing slightly, but always in one direction. By drying the whole under pressure the picture will be found firmly adherent to the paper. I am far from offering the specimens sent as perfect examples of what may be effected by the aid of the microscope,—but shall be glad to know whether the transfer of the film of collodion from the glass plate to the waxed paper may be considered an improvement, as it would certainly seem to offer some advantages. I may observe with respect to the production of images of transparent objects, that there may be some doubt whether in all cases the photographic picture is true:—for the light being decomposed in its passage through them, will, of course, affect the faithfulness of the image. I am, &c.,

Royal Institution, Edinburgh. E. W. Dallas.

Mr. Archer has been in the habit of separating the film of collodion from the glass and transferring it to paper; but it appears to us that there are some valuable suggestions in our correspondent's note.

6. *On a Lunar Rainbow;* by C. M. Tracy, (from a letter dated Lynn, Mass., Aug. 1, 1852.)—Friday, July 30, at 8h. 10m. P. M., a fine lunar rainbow was observed here, formed by the newly risen moon at the close of a slight shower. The arch was without interruption and beautifully distinct; being placed against a heavy cloud which occupied the western sky. Slight prismatic tints were discoverable at one time

on the northern limb, otherwise the color was only the delicate white which seems characteristic of this phenomenon. The span of the arch, measuring on the horizon, was about 105°, and its approximate height, 42°. Whole duration about ten minutes. To give a clearer idea of the position of things, I may remark that the time of sunset was 7h. 21m., and that of moonrise six minutes later.

7. *Meteorological Observations taken by the Royal Astronomer at the Observatory of Athens*, (Greece), *on the Hill of the Nymphs, west of the Acropolis, and at an elevation of* 120 *French metres above the surface of the sea*, (translated from the official Greek report, by Rev. John H. Hill, of Athens.)—Mean temperature during the month of

January,	1851,	+6°·	Reaumur.	July,	1851,	+21°·1	Reaumur.
February,	"	7°·6	"	August,	"	20°·8	"
March,	"	8°·8	"	September,	"	18°·4	"
April,	"	12°·9	"	October,	"	14°·3	"
May,	"	17°·6	"	November,	"	9°·5	"
June,	"	19°·9	"	December,	"	7°·1	"

Mean temperature throughout the year, +13°·7 Reaumur. During winter Reaumur's thermometer rarely falls below −3°·, and during the period of the greatest heat of summer it rises to +29°· in the shade, and to +45°· in the sun.

The mean state of the barometer (at a temperature of 0°· of the mercury) is 753·02 (thousandth parts of a metre). The highest and lowest extremes observed are respectively 765·00 and 744·02.

Mean degree of humidity, 66·67 per cent.

The prevailing winds are southerly, northeasterly and north; the latter during the months of June, July and August are strong, and hot, and known as the Etesian winds. The rains generally fall in heavy showers (torrents), but are of short duration. Rain seldom falls in summer, or snow in winter. Thunder and lightning; loud, vivid, but unfrequent. The sky is generally without clouds, and in winter very bright.

8. *Aurora Borealis.*—The aurora was observed in Belgium by Prof. Montigny, of Namur, on the evening of the 28th of December last. It was first seen at 7½h., and by 9½h. it had almost wholly disappeared. A low dark zone in the north was surmounted by a zone of light, from which occasionally rays or columns shot up, especially in the northwest. Towards 7¾h. the light of the zone lessened, the diminution of light seeming to propagate itself rapidly from northwest to northeast through the whole length of the zone.—*L'Institut, No.* 965, p. 208.

9. *Freedom of the Arabs from Leprosy.*—M. Guyon, in a note to the Academy of Sciences, Paris, attributes the absence of leprosy among the Arabs to their living under the direct action of light and air in tents, while the Kabyles, who often suffer from this disease, live in fixed dwellings often more or less beneath the level of the earth's surface.—*L'Institut, No.* 965.

10. *Prizes of the Academy of Sciences of Paris.*—At the session of the 22d of March, the prize in Astronomy for 1852 was divided between Mr. Hind and M. de Gasparis, the former for his discovery of the new planet Irene, and the latter for that of Eunomia. The Cuvierian prize

(a triennial prize and never before awarded) was given to Prof. Agassiz for his Researches on Fossil Fishes.

Among the prizes offered, is one for 1854 in the department of Mathematics, as follows:—To determine the equations of the general movements of the earth's atmosphere, having in view the rotation of the earth, the calorific action of the sun, and the attraction of the sun and moon. The authors are desired to exhibit the concordance of their theory with the best observations on the atmospheric movements. Even if the whole question is not resolved, but some important steps are made towards its solution, the prize will be awarded by the Academy. The prize is a gold medal of 3,000 francs.

There is also an extraordinary prize for 1853, on the application of steam to navigation. The prize was proposed first in 1836, and has been continued to 1838, 1841, 1844, 1848, and finally to 1853. It is offered "for the best work or memoir on the most advantageous employment of steam for steamships, and upon the best system of mechanism, 'installation,' stowage, and armament for such vessels." The prize is 6,000 francs. Time, Dec. 1, 1853.

11. M. Oberhauser, the distinguished microscopic artist, has been decorated with the Cross of Merit, by the king of Bavaria.

12. Dr. Mantell, of London, has received from the British government a pension of one hundred pounds sterling in testimony of his distinguished services to science.

13. Mitscherlich, of Berlin, was lately elected foreign associate of the Academy of Sciences, in place of Oersted, of Copenhagen, deceased.

OBITUARY.

14. The Academy of Sciences, in Stockholm, has lost the oldest of its members in the person of M. Wilhelm Hisinger, the mineralogist, who has died at the age of 86. Norway has also been deprived of one of her most learned historians, Dr. Nilo Wulfsberg, aged 67.

15. Dr. James B. Rogers, Professor of Chemistry in the Medical Department of the University of Pennsylvania, died in Philadelphia, in June last.

V. Bibliography.

1. *On the Osteology of the head of Hippopotamus and a description of the Osteological Characters of a new genus of Hippopotamidæ;* by Dr. J. Leidy. 15 pp. 4to, with a plate. (From the Journal of the Acad. Nat. Sci., vol. ii, 2d ser., Part 3, 1852.)—Dr. Leidy in this paper describes specimens of the skulls of the Hippopotamus amphibius, *Linn.* (H. senegalensis, *Desmoulins*) and H. capensis, *Desmoulins*, in the collections of the Academy. He next takes up, with much detail, the H. minor of Morton, which he had referred to a new genus *Chærodes*, in the Proceedings of the Academy (vi, 52), but now names *Chæropsis Liberiensis*, the name Chærodes being in use for a genus of Insects. The specimens of this species in the collections of the Academy now include an entire skeleton, besides an imperfect skin, both from a nearly adult animal, from St. Paul's River, Africa; and also two other separate skulls. The length of the skeleton is 5 feet 8 inches.

2. *Exploration and Survey of the Valley of the Great Salt Lake of Utah;* by Howard Stansbury, Capt. Corps Topog. Engineers, U.S.A. 486 pp. 8vo, with numerous plates. 1852. Senate Exec. Doc. No. 3, 1851.—This volume includes a description and survey of the Geography, Natural History and Minerals of the Utah region, an Analysis of its Waters, with an authentic account of the Mormon Settlement; also, a Reconnoissance of a New Route through the Rocky Mountains, with two maps. Appendix A. contains a Table of distances along the Route travelled by the Expedition in 1849.—Appendix B. Latitudes and Longitudes in the Great Salt Lake Valley.—Appendix C. Zoology, including the descriptions of the Quadrupeds and Birds, by Prof. Spencer F. Baird; the Reptiles, by Prof. Baird and Chas. Girard; the Insects, by Prof. Haldeman.—Appendix D. Botany, by Prof. John Torrey.—Appendix E. Geology and Palæontology, by James Hall.—Appendix F. Chemical Analyses, &c., by Dr. L. D. Gale.—Appendix G. Meteorological Tables. The natural history portion, as well as the rest of the work, is illustrated by excellent plates, and the whole volume is of high value to science.

3. *DeCandolle's Prodromus Syst. Nat. Regni Vegetabilis.* Pars XIII, Sect. Prior. Paris, 10 Mai, 1852, pp. 741.—This long-expected volume, which finishes the *Monopetalæ*, has at length reached us. It is entirely occupied with the Solanaceæ, by Prof. Duval, and the Plantaginaceæ, by Decaisne. The former family is made to include two tribes, which perhaps should rather be called suborders, the *Nolaneæ*, and the *Solaneæ*, of which the first is divided into two subtribes, the second, into nine. There are 63 admitted genera. Of the species described, about 1,700 in number, 165 belong to Cestrum, 58 to Nicotiana, 60 to Physalis, and 900 to Solanum! A proper revision will doubtless considerably reduce this number, but still it would appear to outnumber Senecio. The species of *Plantago*, 207 in number, appear to be thrown into excellent sections. Several of the North American species will probably fall into P. gnaphalioides, *Nutt.* The *Diapensieæ*, comprising two genera, each of a single species, are referred by Alphonse De Candolle to the order *Polemoniaceæ*. The 14th volume, which, we presume, will go to press without delay, is to comprise the *Polygoneæ*, *Thymelaceæ*, *Proteaceæ*, &c., principally elaborated by Prof. Meisner, of Basle. We are glad to hear that Prof. Alphonse DeCandolle will himself prepare the *Euphorbiaceæ* and the *Urticaceæ*. A. GR.

4. *A detailed description of the British Palæozoic Fossils in the Geological Museum of the University of Cambridge;* by Fred. McCoy, Professor of Geol. and Min., Queen's College, Belfast. 1st Fasciculus Radiata and Articulata. 4to. Reeve & Benham, Cambridge; J. W. Parker & Son, London.—We would again call attention to this important volume on Palæontology,* published mostly at the expense of Prof. Sedgwick, it being Part II. of his British Palæozoic Rocks. Prof. McCoy's excellent work treats of the fossils of the same rocks that abound through the middle and western states of this country, and should be in the hands of all interested in this department of science.

* See our former notice, vol. xii, p. 448.

5. *Annales de L'Observatoire Physique Central de Russie*, published by order of his majesty the Emperor Nicolas I, by A. T. Kupffer. No. 1, for 1848, 606 pp. 4to; No. 2, for 1848, 182 and 260 pp., with plates; No. 3, for 1848, 104 pp., with plates. St. Petersburg, 1851.

At Fellin, lat. 58° 22′ N., long. 43° 18′ E. from Ferro, the mean temperature of the months for 1848 was as follows in Reaumur's scale:—

Jan.	Feb.	March.	April.	May.	June.	July.	August.	Sept.	Oct.	Nov.	Dec.
−5°·48	−4·73	−1·44	+4·20	+8·69	+11·81	+12·69	+10·68	+6·57	+2·09	−1·85	−4·78

The mean temperature of the year was +3°·20. The winds were from the north 35 days, northeast 7, east 50, southeast 40, south 46, southwest 101, west 72, northwest 14. The southwest wind blew for 11 days in October, 10 in each January, July and August, 8 to 9 in June, September, November, December, 7 in February, March, April; 5 in May. The northwest, blew 1 day in each month except May and June, which blew 2 days; the southeast, 2 to 4 days each month through the warmer half year, and 3 to 5 each through the colder half year.

6. *Compte-Rendu Annuel addressé à M. Le Comte Wrontchenko, Ministre des Finances, par le Directeur de l'Observatoire Physique Central*, A. T. Kupffer. Année, 1850. 24 pp. 4to. St. Petersburg, 1851.

7. *Journal de Conchyliologie comprenant l'etude des Animaux, des Coquilles Vivantes et des Coquilles Fossiles.* Publié sous la Direction de M. Petit de la Saussaye. Paris.—This important Journal is a quarterly, and was begun in 1850. The volume for that year contains 450 pages with 15 plates, colored or uncolored, and includes descriptions of new species, anatomical details, &c., by men of eminence in the science. Price 18*fr*. Address M. Petit de la Saussaye, Rue Neuve-des-Mathurins 19.

8. *Considerazioni sulla Geologia della Toscana dei Professori Cav. Paolo Savi e G. Meneghini.* 246 pp. 8vo., with 1 plate of sections. Firenze (Florence), 1851. The distinguished authors of the Geology of Tuscany, Professors Savi and Meneghini, aim in their work to present together the geological notices of the structure of Tuscany hitherto published, especially the results of Murchison in his classical work, and also to fill out what is unfinished in the investigations of this geologist. The rocks described are, beginning with the uppermost, as follows:—

1. Macigno (sandstone) and Calcareous Alberese.
2. Nummulitic limestone and upper Galestrini schist.
3. Argillaceous schist, called lower Galestrini schist and compact limestone.
4. Dark gray limestone, with flint or hornstone.
5. Variegated schist and impure limestone.
6. Ammonitiferous limestone.
7. Saliferous limestone.
8. Dark gray limestone without hornstone.
9. Quartzose Anagenite and schist of Verrucano.

These rocks are described in order, and their geological age discussed. The following are the epochs assigned to them:—

1. Eocene Tertiary; 2. Lower Eocene; 3. Upper Cretaceous; 4. Cretaceous; 5 and 6. Jurassic; 7. Liassic or Triassic; 8 and 9, in part at least Carboniferous.

The descriptions of the fossils, among which are many new species, occupy about 140 pages of the work.

9. *Über die Larven und die Metamorphose der Echinodermen;* by Joh. Muller, Vierte Abhandlung. 50 pp. 4to, with 9 copper-plates. Berlin, 1852. From the Transactions of the Königl. Akad. der Wissenschaften zu Berlin.

10. *Nineteenth Annual Report of the Royal Cornwall Polytechnic Society.* 8vo. Falmouth, 1851.—This report for 1851 contains a paper on the Actiniæ of Falmouth and its neighborhood, by W. P. Cocks, Esq., embracing descriptions of numerous species, as well as two crowded plates of figures. There is also a list of the species collected about Falmouth in other branches of Zoology, by the same author, in addition to information on patents and meteorological registers.

11. *Fifth Annual Report of the Regents of the University of New York* on the Condition of the State Cabinet of Natural History and the Historical and Antiquarian Collection annexed thereto. 118 pp. 8vo, with numerous wood-cuts and 32 lithographic plates.—The wood-cuts and plates are principally in illustration of Indian relics or manufactures, and the latter are mostly colored. There are also two zoological plates, one of the *Cervus alces*, or moose, and another of the *Mustela canadensis.* The moose was taken in Herkimer Co., N. Y.; it measured 10 feet 2 inches from point of nose to root of tail; height of shoulder, 6 feet 3 inches; length of tail, 8 inches.

12. *Sixty-fifth Annual Report of the Regents of the University of the State of New York.* 400 pp. 8vo. 1852.—This report, besides its review of the schools and colleges of the State, contains an appendix of 150 pages, embracing numerous meteorological tables and registers of atmospheric phenomena, among which are tables of meteorological observations made at Norway House on Nelson's River, at Mishipicoten, at Lake Superior, at Tabreez and Tehran in Persia, at Constantinople, Broosa, Erzeroom, Trebizond, communicated by Jas. H. Coffin; also, contributions by Prof. C. Dewey, F. B. Hough, J. L. Hendrick and others, relating in part to Auroras, Halos, Parhelia, etc.

13. *Transactions of the American Philosophical Society of Philadelphia*, vol. x, new series, Part II.

Sears C. Walker: Investigations which led to the detection of the coincidence between the computed place of the planet Leverrier and the observed place of a star recorded by Lalande in May, 1795.—p. 341.

C. D. Meigs: On the Reproduction of the Opossum (Didelphys virginiana).—p. 153.

Capt. R. F. Stockton, U. S. N.: On some of the results of a series of experiments relative to different parts of Gunnery.—p. 167.

R. A. Tilghman: On the decomposing power of water at high temperatures.—p. 173.

C. M. Wetherill: On the neutral Sulphate of Oxyd of Ethyle, and the products of its decomposition by water.—p. 177.

C. A. Jahn: De calculo Eclipsium Besseliano.—p. 183.

Lieut. J. M. Gilliss: On the Longitude of Washington computed from the moon-culminations observed during the years 1839–1842, inclusive.—p. 211.

Miers Fisher Longstreth: On the Accuracy of the Tabular Longitude of the Moon to be obtained by the construction of new Lunar Tables.—p. 225.

J. Leidy: On the organization of the genus Gregarina of Dufour.—p. 233.

J. Leidy: Some observations on Nematoidea Imperfecta and description of three Parasitic Infusoria.—p. 241, with plates, (pl. 10, 11.)

Dr. Bettelheim: Meteorological Observations at Loo-Choo.—p. 245.

I. Lea: Descriptions of new species of Unionidæ.—p. 253, with plates 12 to 29.

I. Lea: Descriptions of a new genus (Basistoma) of the family Melaniana, together with some new species of American Melaniæ.—p. 295, with plate 30.

I. Lea: Description of a new species of Helix from California, and a new characteristic form of certain American Colimaceæ.—p. 302, and plate 30.

I. Lea: On the Fossil Footmarks in the Red Sandstone of Pottsville, Schuylkill county, Pa.—p. 307, and plates 31, 32, 33.

14. *Annals of the Lyceum of Natural History of New York*, vol. v, No. 6, February, 1852, and Nos. 7 and 8, June, 1852.

John L. Le Conte: New species of Californian Coleoptera.—pp. 185–206.

S. F. Baird: Description of a new species of Sylvicola (S. Kirtlandii), with a plate (pl. 6).—p. 217.

Temple Prime: Descriptions of two new species of Fresh-water shells (Cyclas securis and Pisidium compressum), with figures on plate 6.—p. 218.

J. G. Bell: Description of a new species of the genus Fuligula (F. viola).—p. 219.

G. N. Lawrence: Ornithological notes.—p. 220.

J. H. Redfield: Descriptions of new species of Marginella (M. vexillum, amabilis, antiqua), with notes on sundry species of Marginella and Cypræa.—p. 224.

C. B. Adams: Catalogue of shells collected at Panama, with notes on Synonymy, Station, and Habitat.—p. 229–296, and to be continued.

Proceedings of the American Association for the Advancement of Science, fifth Meeting, held at Cincinnati, Ohio, May, 1851. 262 pp. 8vo. *Washington*, 1851. Published by the citizens of Cincinnati. Copies are in the hands of Prof. S. F. Baird, of the Smithsonian Institution.

J. R. Hind: The Solar System. 12mo, pp. 198. From the English edition. *New York*, 1852. G. P. Putnam.

A. von Humboldt: Cosmos. Vol. 4, 12mo, 234 pp., translated by E. C. Otté and H. B. Paul. *New York*, 1832. Harpers.

J. Torrey: Plantæ Fremontianæ; or Descriptions of Plants collected in California by Col. J. C. Fremont. 4to, with 12 plates. (In the press.)

Dr. F. E. Melsheimer: Catalogue of the Coleoptera of the United States. 8vo. (In the press.)

Report on Light Houses. 760 pp. 8vo, with numerous plates. 1852. Ex. Doc. 28, 32d Congress, 1st session.

Justin R. Loomis, Prof. Chem. and Geol. in Waterville Coll.: Elements of Geology, adapted to the use of Schools and Colleges. 198 pp. 12mo, with numerous illustrations. *Boston*, 1852. Gould & Lincoln.

Annual Report of the Trustees of the State Library of New York. 288 pp. 8vo.

M. Faraday: Experimental researches in Electricity, 28th series, On lines of magnetic force, their definite character, and their distribution within a magnet and through space; 29th series, On the employment of the induced magneto-electric current as a test and measure of magnetic forces, and on the amount and general disposition of the forces of a magnet when associated with other magnets. Trans. Roy. Soc. 1852.

J. H. BALFOUR: Elements of Structural Botany. 1 vol. demy, 8vo., with 1060 illustrations, forming Part I. of a New Botanic Class Book. 1852. *London and Edinb.*

SESTERTIUS HOLT: Zoological Anecdotes. Post, 8vo. *London*, 1852. Bentley 10*s.* 6*d.*

T. HORSFIELD: Plantæ Javanicæ rariores, etc. Descrip. et charact. plurimarum elaboravit J. J. Bennett; observ. struct. et affin. præsertim respicientes passim adjecit Robertus Brown. 4th and concluding part. Imp. 4to, with a map of Java. *London*, 1852. 21*s.*; col. 30*s.*

J. SEDGWICK: The Law of Storms. The true Principle of the Law of Storms practically arranged for both Hemispheres. 182 pp. 8vo. *London*, 1852. 3*s.* 6*d.*

W. STURGEON: Scientific Researches, Experimental and Theoretical, in Electricity, Magnetism and Electro-Chemistry; with copper-plates. 4to, 562 pp., 18 plates. *London*, 1852. 3*s.* 6*d.*

JOHN ARTHUR PHILLIPS: A Manual of Metallurgy, or Practical Treatise on the Chemistry of the Metals. 8vo, pp. 590. 1852, *London*. Griffin.

Dr. J. D. HOOKER: Flora of New Zealand. With colored plates. *London*, 1852. Reeve & Co. Part I. just issued.

BERTHOLD SEEMANN: Flora of Esquimaux-land, including the Sound to Point Barrow and the adjacent Islands. 40 pp. 4to, with plates. *London*, 1852. Reeve & Co. 10*s.* Forms Part I. of the Botany of H. M. S. Herald.

F. WALKER: Insecta Brittanica; Diptera. Vol. 1, 8vo, with plates. *London*. Reeve & Co. 25*s.*, plain.

HENRY SOWERBY: Popular Mineralogy. In royal 16mo, with 20 plates. *London*. Reeve & Co. 10*s.* 6*d.*, colored.

THOMAS MOORE: Popular History of British Ferns, comprising all the species. Royal 16mo, with 20 plates. *London*. Reeve & Co. 10*s.* 6*d.*, colored.

ROBERT HUNT: Elementary Physics. Foolscap 8vo. *London*. Reeve & Co. 10*s.* 6*d.*

CHARLES KNIGHT'S Imperial Cyclopedia of Sciences and Arts. Illustrated with numerous engravings on steel and wood. *London*. Part I. announced to appear in August, 1852. To be completed in 36 parts, and 9 volumes. 316 pp. each part. 15*s.* per vol.

MEYER'S British Birds and their Eggs. *London*. No. III. ready. 2*s.*

WOOD'S British Entomology. A complete illustrated catalogue of the Lepidopterous Insects of Great Britain. New edition, revised and improved, by J. O. Westwood. This work will contain nearly 2,000 colored figures. No. III. ready. 3*s.* 6*d.*

MACGILLIVRAY'S British Birds. 4th and 5th volumes, completing the work, now ready. *London*. W. S. Orr & Co. Price of 5 vols. demy 8vo, 2*l.* 10*s.*, cloth.

ROBERT FORFAR: Analytical Physics, or Trenology; a new theory of Physical Science. Post, 8vo. *London*. H. Baillière. 3*s.* 6*d.*

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Proceedings of the American Academy of Arts and Sciences, Vol. ii.—p. 236. Observations on Coryne; *Prof. Agassiz.*—p. 238. Note on a subcutaneous cavity behind the humerus in the Siluridæ; structure of the scales in the Bonito; origin of sound made by Cat-fish when suddenly drawn out of water; *Agassiz.*—p. 239. On the spheroidal state of bodies; *Horsford.*—p. 241. Note on the fraction which expresses the law of vegetable growth; *Prof. Peirce.*—p. 242. On Apatite of Hurdstown; *C. T. Jackson.*—p. 243, 246. Crystals of gold from California; *F. Alger.*—p. 250. Empirical connection of the theory of Saturn alluded to, and suggestion as to the secular action of a Planet within the orbit of Mercury; *Prof. Peirce.*—On the theories of Electricity; *Prof. Lovering.*—p. 254. On the age of certain Western Rocks; *J. Hall.*—p. 256. Charcoal takes fire at a low temperature: *C. T. Jackson.* —p. 256, 258. Vis viva instead of vis inertiæ; *Prof. Peirce.*—p. 256. Occultation of Aldebaran; *W. Mitchell.*—p. 259. Transit of Mercury; *J. D. Graham.*—p. 261. Analysis of Apatite of Hurdstown; *C. T. Jackson.*—p. 263. Reptile remains found as low as the Carboniferous; *Desor.* The same referred to fishes; *Agassiz.* Fossil Sigillaria of Nova Scotia; *F. Alger.*—p. 267. On an inscription on a rock in the island of Manānas; *Dr. Jenks.*—p. 270. The slate rocks of Nahant are metamorphic shales of the Mansfield coal formation; *Agassiz*, with remarks by *Bouvé, Jackson.*—p. 282. On a case in the theory of Probabilities; *Prof Peirce.*—p. 284. Experiment illustrating Whirlwinds; *Guyot.*—p. 289. On Whirlwinds; *Prof. Peirce*, also *Dr. W. F. Channing* and *Prof. Eustis*—pp. 295. On the permeability of metals to mercury; *Prof. Horsford.*—p. 298. Plan of the tornado in Middlesex county, Mass.; *Prof. Eustis.*—p. 302. On a Corona about the Moon; *Prof. Lovering.* On the Eppelsheim fossils; *Dr. J. C. Warren.*—p. 311. Explosion of "burning fluid;" *Prof. Horsford.* On new genera of Plants; *Prof. Gray.*—p. 326. On the use of direct light in Microscopic Researches; *O. W. Holmes.*

Proceedings of the Acad. Nat. Sci. Philadelphia, Vol. vi, No. 3.—MAY.—p. 71. The generic name Bootherium suggested for extinct species of Ox, one of them the Bos bombifrons of Harlan; *J. Leidy.*—p. 71. Notice of the Honey Ant.—p. 73. Conspectus of the Crustacea of the Exploring Expedition, including new species of Crustacea Cancroidea and Corystoidea; (including Cancer, 2 species; Liomera (D.), 1; Actæa, 2; Xantho, 4; Euxanthus, 2; Xanthodes, 3; Panopæus, 1; Medæus (D.), 1; Etisus, 4; Zozymus, 2; Carpilodes (D.), 1; Actæodes (D.), 7; Chlorodius, 7; Pilodius (D.), 4; Cyclodius (D.), 2; Polydectus, 1; Galene, 1; Pseudozius (D.), 3; Pilumnus, 6; Actumnus (D.), 2; Eriphia, 2; Trapezia, 3; Tetralia (D.), 2; Quadrella, (D.), 1; Lupa, 1; Amphitrite, 3; Carupa (D.), 1; Thalamita, 3; Charybdis, 2; Lissocarcinus, 1; Platyonychus, 1; Trichocera, 1; Gomeza, 1); *J. D. Dana.*—p. 87. A revision of the N. American Astaci, with observations on their habits and geographical distribution (new sp. of Cambarus, 14); *C. Girard.*—p. 91. Synopsis of the Anthicites of the United States (Notoxus, 2 n. sp.; Formicomus, 1; Anthicus, 7; Tanarthrus, Le C., n. gen.); *J. L. Le Conte.*—JUNE.—p. 108. Notice of a new mineral (Molybdate of iron) from California; *D. D. Owen.*—p. 109. A new species of Eschara, from the eocene of Alabama; *I. Lea.*—p. 110. A new Sciurus (S. dorsalis) from New Mexico: *S. W. Woodhouse.*—p. 111. Chemical Investigation of the Mexican Honey Ant; *C. M. Wetherill.*—p. 113. On some minerals which accompany gold in California; *F. A. Genth.*—p. 114. On Strontiano-calcite, a new mineral; *F. A. Genth.* Description of a new North American Fox (Vulpes Utah); *Audubon* and *Bachman.*

Proceedings of the Boston Society of Natural History.—MAY, 1852.—p. 177. Coal near Marietta and Wheeling; *Dr. Lesquereux.* The Stigmaria not roots of Sigillaria; *C. T. Jackson.*—p. 181. Note on the drift of Long Island affording shells.—p. 183. On the difference of the climates of Germany and New England.—p. 185. On two new genera and two species of Nemertes, (Hecate (G.) elegans and Poseidon (G.) Colei;) *C. Girard.*—p. 188. Notice of a mass of anthracite coal from the calciferous sandstone of New York, attributed to a fucoidal origin.—p. 189. On the equivalency in geological age of the coal formation of the United States, and the anthraciferous strata of France in the departments of Mayenne and Sarthe.—JUNE.—p. 193. New genus and species of Tubularidæ (Globiceps tiarella); *W. O. Ayres.*—p. 199. On resinous nature of coal plants; *J. E. Teschemacher.*—p. 202. On a shark taken in the Bay of Fundy; *R. Foulis.*—p. 207. A new Holothuria (Pentamera, *A. pulcherrima*); *W. O. Ayres.*

APPENDIX.

On the Classification of the Crustacea Choristopoda or Tetradecapoda; by James D. Dana.

The term Choristopoda, applied to the Tetradecapods, alludes to the subdivision of the thorax into segments, each devoted to a separate pair of legs; this is a prominent peculiarity of the species, distinguishing them from all the Podophthalmia, and with rare exceptions from the Entomostraca.

This division of Crustacea is subdivided by Latreille and other subsequent authors into three groups, the *Amphipoda*, *Læmipoda* and *Isopoda.* Kröyer has suggested that the Læmipods are essentially Amphipods in structure, and his investigations have shown that in the only important distinction between them, that based upon the abdomen, the two groups are united by gradual transitions. In the organs of the mouth, they are the same,—also in having thoracic branchial appendages and in the position of the thoracic legs; and moreover the abdominal appendages conform to the same type, as is seen when the abdomen in the Caprellidæ is partly elongated, as in the genus Cercops of Kröyer.

Rejecting the division Læmipoda, the number of tribes is reduced to two. There is however a third tribe, which hitherto has not been recognized. It is intermediate in its characteristics between the Amphipods and Isopods.

The Amphipoda are uniformly characterized by having—

1. The three posterior pairs of thoracic legs thrown backward and more or less obliquely outward, and constituting one series, while the four anterior pairs are thrown forward and outward, in another series; this arrangement may be represented by the figures 4 : 3, (or 2+2 : 3, as the four pairs of the first series are often in two sets of two pairs each).
2. The branchial appendages thoracic.
3. The abdominal members in two sets, the three anterior pairs subnatatory, the three posterior styliform—an arrangement represented by the figures 3 : 3.

The true Isopoda, on the contrary, have—

1. The four posterior pairs of thoracic legs in the backward series, and three anterior pairs in the forward series—3 : 4.
2. The branchial organs abdominal.
3. The abdominal members in two sets, the 5 anterior pairs branchial (the first sometimes operculiform), and only the last styliform—5 : 1.

These are two distinct types of structure of fundamental character; and any species which do not partake of these peculiarities are intermediate forms and are naturally arranged in a separate group. These constitute the tribe here named

The ANISOPODA.

1. Like *Amphipoda*, the three posterior pairs of thoracic legs are in one series, and the four anterior in a different series or usually in sets of two pairs each ;—4(or 2+2) : 3.
2. Like *Isopoda*, the three posterior pairs of abdominal members are not styliform, only the last pair being of this character ; the branchial organs are abdominal and not thoracic, with a rare exception.

These are constant characteristics of the whole group. Although strongly *Amphipodan*, the species have in general more external resemblance to the *Isopods ;* yet the intermediate character of some genera is so obvious that they have been arranged in the former group by one author and in the latter by another.

The genera that pertain to this tribe, Anisopoda, are the following: *Arcturus* and the allied *Anthura*, *Tanais*, *Apseudes*, *Rhæa*, *Praniza*, *Anceus*, *Serolis*, *Bopyrus* and allied. Each of the larger subdivisions of the Isopoda, as laid down by Edwards, affords one or more genera, and they are genera which in his system are in some instances marked off as anomalous in character.

In *Arcturus* and *Anthura*, the *thoracic* members have the Amphipod character, the series being 4 (or 2+2) : 3, and not 3 : 4 as in the Isopods. The abdominal appendages are like those of Idotæa.

In *Tanais*, there is the same arrangement. The abdominal appendages are Isopodan in being characterized by the series 5 : 1, but the 5 anterior are elongated and subnatatory, the abdomen is more flexibly articulated, approximating to the Amphipods ; the 6th pair is a pair of stylets. *Apseudes* and *Rhœa* are closely like Tanais, and actually more resemble Amphipods than Isopods. The abdomen is more elongated, and differs from the Amphipodan abdomen mainly in having but one pair of stylets with 5 pairs of subnatatories instead of three of stylets and three of natatories.

Praniza and *Anceus* have the thoracic legs Amphipodan in their arrangement. The abdomen in Praniza is considerably elongated and flexible, approaching the Amphipodan ; but the arrangement of its appendages is Isopodan.

In *Serolis*, although the general aspect of the species is strikingly Isopodan, the arrangement of the thoracic legs is Amphipodan. Further than this, the abdomen is partly Amphipodan, for instead of the series 5 : 1, it has the series 3 : 3 ; yet while the 3 anterior pairs are natatory as in the Amphipoda, the next two, instead of being styliform, like the last, are branchial (one opercular to the other), and in this particular they are Isopodan.

In the *Bopyri*, the thoracic legs are so arranged in a single continuous series, that it is difficult to make out the series 4 : 3 or 3 : 4. Yet in some figures, the former (the Amphipodan) arrangement is indicated. The males are closely like Tanais in some instances, both in the length of the abdomen, its free articulations and its appendages.* In a female not adult of the *Bopyrus abdominalis*, figured by Kröyer,† all the tho-

* See Kröyer, in Voy. Scand., pl. 28, fig. 1 A., *Dajus Mysidis.* † Ibid. pl. 29, fig. 11.

racic legs of one side are obsolete excepting the 3 posterior, a fact pointing to the Amphipod arrangement 4 : 3. Rathke's figure of the "*Phryxus Hippolytes*"* represents a male with the 3 posterior legs either side thrown backward and the 4 anterior forward, confirming the same view.

In *Ione*, there are *thoracic* branchial appendages, which is a wide divergence from the Isopoda. In view of these facts, we conclude that the Bopyri are properly Anisopods. The resemblance in habit to the Cymothoidæ is no objection, for we find this habit also in the Cyami, species still more remote. In fact, the male Bopyri show that the species in all essential points of structure, are nearest to Jæra and Tanais. Moreover the Jæræ are mostly parasitic.

The genera *Crossurus*, and *Liriope* of Rathke† are near Tanais, though also related in form to male Bopyri. In Liriope the thoracic legs are grouped as in Tanais, and the abdominal appendages are subnatatory or nearly Amphipodan in structure, although, like Tanais, diverse from true Amphipods in having 5 pairs subnatatory, and only one pair of stylets. Liriope is referred to the Amphipoda by Rathke. Cryptothir is the name of another related genus, a species of which was found by the author in the cavity of a living barnacle (Creusia).

We therefore adopt as the grand divisions of the Choristopoda, the three tribes, ISOPODA, ANISOPODA and AMPHIPODA.

It is an important fact, the basis of a philosophical principle, that the most sluggish and most stupid of the Decapods are found in the transition group, Anomoura. So in the Tetradecapods, the transition group, *Anisopoda*, contains those species of the order that are lowest in activity and structural perfection; for the Bopyri, the females especially, when mature, are nearly memberless, motionless and senseless.

The *Isopoda* seem to have the same relation to the *Amphipoda* that the *Brachyura* have to the *Macroura*, and are the higher in rank.

Tribe I. *Isopoda.*—The Isopoda thus stripped of genera that are not properly of the tribe, are naturally divided into three subtribes, as follows:—

Subtribus I. IDOTÆIDEA.—Appendices abdominales duæ posticæ bene operculiformes, appendices alias optime tegentes.

Subtribus II. ONISCOIDEA.—Appendices abdominales duæ posticæ styliformes et non operculiformes, fere terminales, raro obsoletæ.

Subtribus III. CYMOTHOIDEA.—Appendices abdominales duæ posticæ lamellatæ, apud abdominis latera dispositæ.

Tribe 2. *Anisopoda.*—Among the Anisopoda, we find the three subtribes of the Isopoda represented. Allied to the *Idotæidea*, there are *Arcturus*, *Leachia*, *Anthura*; allied to the *Oniscoidea*, the genera *Tanais*, *Apseudes*, *Bopyrus* and others related; allied to the *Cymothoidea*, the genera *Serolis*, *Praniza*, &c. Praniza is an aberrant form, abnormal in the number of its legs. The three grand divisions are hence as follows:—

Subtribus I. SEROLIDEA, vel ANISOPODA CYMOTHOICA.—Appendices duæ posticæ abdominales lamellatæ, apud abdominis latera dispositæ.

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* Fauna Norwegens, pl. 2, f. 3. † Fauna Norwegens, pp. 35 and 60, pl. 1.

Subtribus II. Arcturidæ, vel Anisopoda Idotæica.—Appendices duæ posticæ abdominales lamellatæ et bene operculiformes, appendices branchiales tegentes.

Subtribus III. Tanaidea, vel Anisopoda Oniscica.—Appendices duæ posticæ abdominales plus minusve styliformes, subterminales, interdum obsoletæ.

Tribe 3. *Amphipoda.*—The Amphipoda contain two prominent divisions, distinguished by the organs of the mouth, the eyes and general habit, the Gammarus and Hyperia sections, as laid down by Edwards. The addition of the Læmipoda to the Amphipoda introduces a third division. The sections are hence :—

Subtribus I. Caprellidea.—Maxillipedes elongati, palpiformes. Caput oculique mediocres. Abdomen obsolescens.

Subtribus II. Gammaridea.—Maxillipedes elongati, palpiformes. Caput oculique mediocres. Abdomen appendicibus sex natatoriis sexque styliformibus instructum.

Subtribus III. Hyperidea.—Maxillipedes abbreviati, lamellati, operculiformes. Caput grande, oculorum corneis plerumque tectum. Appendices abdominales ac in *Gammarideis*, latius lamellatæ.

The Caprellidea have the habit of certain of the Anisopoda, and their short abdomen calls to mind the Isopoda. They therefore properly stand first among the Amphipoda. The Caprellids like the species of Arcturus and Tanais, cling and stand upon seaweeds, etc., by their six hinder legs, while the body and the other legs are extended, for the purpose of capturing their food and conveying it to the mouth.

In the following synopsis of the Families, Subfamilies and Genera, some new genera are included, discovered by the author in the course of the cruise of the Exploring Expedition under Capt. Wilkes.

TRIBUS I.

ISOPODA.

Subtribus I. IDOTÆIDEA.*

Fam. I. IDOTÆIDÆ.

Pedes fere consimiles, plus minusve ambulatorii.

G. 1. Idotæa, *Fabr.*—Antennæ externæ longiores, flagello multiarticulato confectæ.

G. 2. Edotea, *Guerin.*—Antennæ externæ internis parce longiores, flagello pauci-articulato confectæ, basi paulo longiore quam basis internarum.

G. 3. Erichsonia, *Dana.*—Antennæ externæ internis multo longiores, geniculatæ, 6-articulatæ, flagello carentes. Pedes subæqui consimiles.

G. 4. Cleantis, *Dana.*—Antennæ externæ multo longiores, 5–6-articulatæ, non geniculatæ, flagello carentes. Pedes 4ti 3tiis valde breviores, et 4ti 5ti 6ti 7mi longitudine sensim increscentes. Abdominis opercula laminam appendiculatam ad articulationem gerentia.

G. 5. Epelys, *Dana.*—Antennæ breves, longitudine subæquæ; externæ flagello carentes, non geniculatæ. Pedes subæqui.

Fam. 2. CHÆTILIDÆ.

Pedes 6ti longissimi, setiformes et multi-articulati.

G. 1. Chætilia, *Dana.*—Antennæ 1mæ longiores, superiores, 2dæ flagello multi-articulato confectæ. Pedes 7mi breves, non unguiculati. Abdominis opercula laminam appendiculatam ad articulationem gerentia.

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* The genera *Erichsonia*, *Cleantis*, *Epelys* and *Chætilia*, are described by the author in this Journal, [2,] viii, 424, 1849.

Subtribus II. ONISCOIDEA.

Fam. I. ARMADILLIDÆ.*

Corpus bene convexum, stricte articulatum. Abdomen multi-articulatum, segmento ultimo parvo. Appendices caudales† ultra abdomen non exsertæ, lamellatæ. Mandibulæ non palpigeræ. Antennæ internæ inconspicuæ.

Subfam. 1. TYLINÆ.‡—Appendices caudales infra abdominis segmentum posticum celatæ et operculiformes.

G. 1. Tylus, *Latreille.*

Subfam. 2. ARMADILLINÆ.§—Appendices caudales inter duo abdominis segmenta postica partim visæ.

G. 1. Armadillo,‖ *Latr.*, partim, *Brandt, Edw.*—Basis appendicum caudalium grandis, ramo interno parvulo, altero obsoleto.
G. 2. Spherillo, *Dana.*—Basis appendicum caudalium grandis, ramo interno parvulo, externo parvulo, in latere basis interiore versus apicem insito.
G. 3. Armadillidium,¶ *Brandt.*—Basis appendicum caudalium brevis, ramo externo lato, terminali, interno parvulo.
G. 4. Diploexochus, *Brandt.*—*Armadilloni* appendicibus caudalibus similis. Segmenta thoracis processu horizontali utrinque armata.

Fam. II. ONISCIDÆ.

Corpus sæpius minus convexum, vel stricte vel laxe articulatum. Abdomen multi-articulatum, segmento ultimo parvo. Appendices caudales valde exsertæ, styliformes. Mandibulæ non palpigeræ. Antennæ internæ inconspicuæ.

Subfam. 1. ONISCINÆ.**—Maxillipedes 3-articulati, articulis duobus ultimis brevibus et parvulis. Antennæ externæ ad articulationem 5tam bene geniculatæ. Basis appendicum caudalium perbrevis, duos stylos multum inæquos gerens, stylo interno sub abdomine partim celato.

G. 1. Oniscus, *Linn.*—Antennæ externæ subcylindricæ, ad basin fronte partim tectæ. Flagellum 1–3-articulatum,†† articulo precedente vix brevius vel longius.

Subgen. 1. Trichoniscus, *Brandt.*‡‡—Antennæ externæ 6-articulatæ.
Subgen. 2. Porcellio, *Latr*—Antennæ externæ 7-articulatæ.
Subgen. 3. Oniscus, *Latr.*—Antennæ externæ 8-articulatæ.

G. 4. Philoscia. *Onisco* affinis. Antennæ externæ usque ad basin apertæ, 7-articulatæ, subcylindricæ. Flagellum ac in *Porcellione.*
G. 5. Platyarthrus, *Brandt.*—Antennæ externæ quoad articulum 5tum latæ, latere externo dilatatæ.
G. 6. Deto, *Guerin.*—Flagellum antennarum externarum perbreve, 4-articulatum, articulo precedente multo brevius, articulo 5to cylindrico.

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* *Armadillidæ*, Koch, Deutschl. Crust., 34th Heft, 1840; also Cat. Brit. Crust. Brit. Mus, 1850, p. 73.

† Appendices normales abdominis 6tæ nobis denominatæ *appendices caudales;* segmentum abdominis ultimum *segmentum caudale* est.

‡ *Tylosiens*, Edw. § *Armadilliens*, Edw.

‖ *Pentheus*, Koch. ¶ *Armadillo*, Koch, et Latr. partim.

** *Porcellioniens*, Edw. *Porcellionidæ*, Cat. Brit. Crust. Brit. Mus., 1850. We deem it better to derive the family name from the *older* generic name, Oniscus.

†† Præter hos tres articulos, flagellum articulis minutis 1–3 inconspicuis ad extremitatem confectum, ultimo styliforme et apice setigero. ‡‡ *Itea*, Koch.

Subfam. 2. SCYPHACINÆ.—Maxillipedes 2-articulati, articulo 2do lamellato. Antennæ externæ ad articulationem 5tam non geniculatæ. Styli caudales ac in *Oniscinis*. Basis appendicum caudalium aut brevis aut oblongus, ramo interno interdum omnino aperto.

G. 1. SCYPHAX, *Dana*.—Flagellum antennarum 1–3-articulatum.
G. 2. STYLONISCUS, *Dana*.—Flagellum antennarum tenue, multi-articulatum.

Subfam. 3. LYGINÆ.—Maxillipedes 4-articulati, elongati. Antennæ externæ ad articulationem 5tam non bene geniculatæ. Styli caudales longi, basi longè exserto, ramis setiformibus, subæquis et æque apertis.

G. 1. LYGIA, *Fabr*.—Basis appendicum caudalium apice simplex, ramosque duos simul gerens.
G. 2. LYGIDIUM, *Brandt*.*—Basis appendicum caudalium apice furcatus, brachio utroque ramum setiformem gerente.

Fam. 3. ASELLIDÆ.

Corpus sæpius plus depressum et laxè articulatum. Abdomen 6-articulatum, segmento ultimo grandi, scutellato. Appendices caudales styliformes, interdum brevissimæ. Mandibulæ palpigeræ. Antennæ internæ conspicuæ.

Subfam. 1. LIMNORINÆ.—Abdomen 5–6-articulatum.

G. 1. LIMNORIA.—Segmenta abdominis duo postica grandia, simul sumta scutellata.

Subfam. 2. ASELLINÆ.—Abdomen 1–2-articulatum.

1. *Pedes thoracici subæqui.*

G. 1. JÆRA, *Leach*.—Appendices caudales perbreves; branchiales laminâ impari tectæ.
G. 2. JÆRIDINA, *Edw*.—Appendices caudales perbreves; branchiales apertæ.
G. 3. ASELLUS, *Geoffroy*.—Appendices caudales elongatæ. Pedes antici subchelati.
G. 4. JANIRA, *Leach*.†—*Asello* affinis. Pedes toti unguiculati, ungue bifido.
G. 5. HENOPOMUS, *Kröyer*.‡—Pedes 1mi subchelati, digito 2-articulato; reliqui ambulatorii, articulo 6to sub-rudimentario. Appendices branchiales laminâ unicâ permagnâ tectæ. Thoracis segmenta latere incisa et dentata.

2. *Pedes posteriores valde elongati.*

G. 6. MUNNA, *Kröyer*.§—Appendices caudales rudimentariæ. Pedes antici crassiores, subchelati; posteriores corpore multo longiores.

Subtribus III. CYMOTHOIDEA.

[The Cymothoidea correspond nearly to the *Isopodes nageurs* of Edwards.|| The subtribe thus embraces along with Edwards's "Cymothoadiens" (Serolis excluded) his "Spheromiens." The *Cymothoa*, *Æga* and *Spheroma* sections are closely related, and constitute a single natural group. The *first* (*Cymothoidæ*) has the antennæ attached to the under surface of the head somewhat remote from the front margin, and the caudal stylets are free; the *second* (*Ægidæ*) has the antennæ

* *Zia*, Koch.
† *Oniscoda*, Latreille.
‡ Nat. Tidsskr., [2], ii, 1847.
§ Ibid. ii, 1838, 1839, p. 612 and [2], ii, 1847.
|| The exceptions consist in our removal of his *Pranisiens*, and the genus *Serolis*, to the Anisopoda.

attached to the front of the head, with the caudal stylets free; the *third* (*Spheromidæ*) has the antennæ attached to the front of the head, with the inner lamina of the caudal stylets united to the abdomen. In the Cymothoidæ, the legs are all ancoral and the caudal stylets and branchiæ are not ciliated; in the Ægidæ and Spheromidæ, only the two or three anterior pairs of legs are ancoral, if any, and the caudal stylets and branchiæ are commonly ciliated. A single genus of the Cymothoidæ (*Ægathoa*) has the habit of Æga and ciliated caudal stylets, with the antennæ and ancoral legs of Cymothoa. This ciliation of the lamellar abdominal appendages appears to be a mark of degradation in the species, and is strikingly characteristic of the abdominal natatory feet of the Amphipoda. The family Ægidæ contains two groups, distinct in habit; one (*Æginæ*) often parasitic, having the 6 anterior legs ancoral, the other (*Cirolaninæ*) not parasitic, and with none of the legs ancoral.]

Fam. I. CYMOTHOIDÆ.*

Maxillipedes breves, 3–4-articulati, operculiformes, articulis terminalibus angustis brevibus. Appendices caudales liberæ, marginibus rarissimè ciliatæ. Antennæ sub capite infixæ. Abdomen 4–6-articulatum, segmentis anterioribus raro connatis. Pedes toti ancorales. Branchiæ sæpissime non ciliatæ. Epimeræ conspicuæ.

Subfam. 1. CYMOTHOINÆ.—Lamellæ caudales nudæ. Abdomen multiarticulatum, segmentis liberis.

G. 1. Cymothoa, *Fabr.*—Femora lata, posteriora latissima. Segmenta thoracis 2 3ve postica multo breviora nunquam latere acutè producta. Segmentum caudale sæpissimè valde transversum. Antennæ graciles; 1mæ ad basin paulo remotæ.

G. 2. Ceratothoa,† *Dana.*—*Cymothoæ* affinis. Antennæ 1mæ crassæ basi conjunctæ. Caput postice latum, fronte productum et sæpe angustum.

G. 3. Livoneca, *Leach.*—Femora latiuscula, 6ta vel 7ma 5tis vix latiora, non angustiora. Segmenta thoracis 3tium 4tum 5tum 6tumque fere æqua, 7mum paulo brevius. Abdomen thorace subito vix angustius. Caput parvulum. Frons non involutus et in processum inter-antennalem conspicue non productus. Segmentum caudale vix transversum. [Corpus sæpe oblique distortum.]

G. 4. Anilocra, *Leach.*—Femora angusta, posteriora angustiora. Segmentum thoracis 2dum 3tium 4tumve 5to 6to 7move multo brevius. Abdomen thorace subito angustius, segmentis processu laterali spiniformi infra non instructis, ultimo vix transverso.

Subgen. 1. Anilocra.—Rami appendicis caudalis multo inæqui.
Subgen. 2. Canolira, *Leach.*—Rami appendicis caudalis subæqui.

G. 5. Nerocila, *Leach.*—Femora et segmenta thoracis ac in *Anilocrâ.* Abdomen thorace subito angustius, segmentis processu laterali spiniformi infra instructis, ultimo vix transverso.

G. 6. Olencira, *Leach.*—Femora latitudine mediocria. Segmenta thoracis 3 postica anterioribus non longiora. Abdomen thorace subito multo angustius, segmentis cum processubus spiniformibus infra non instructis, ultimo non transverso.

Subfam. 2. OROZEUKTINÆ.—Segmentum abdominis posticum ac in *Cymothoâ*; segmenta alia coalita et non libera.

G. 2. Orozeuktes, *Edw.*

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* *Cymothoadiens Parasites,* Edw. Crust., iii, 228, 247.

† *Cymothoa Gaudichaudii* et *C. parallela* hìc pertinent.

Subfam. 3. ÆGATHOINÆ.—Lamellæ caudales ciliatæ. Abdomen multiarticulatum, segmentis liberis.

G. 1. ÆGATHOA, *Dana.*—Abdomen thoracis subito non angustius, segmentis subæquis. Caput subtriangulatum, latum, thorace parce angustius. Oculi grandes.

Fam. II. ÆGIDÆ.*

Maxillipedes elongati, 4–6-articulati, articulis totis lamellatis, terminalibus latis et brevibus. Appendices caudales liberæ, marginibus ciliatæ. Antennæ ad frontis marginem capitis affixæ, apertæ. Abdomen 4–6-articulatum. Pedes 6 antici interdum ancorales aut prehensiles, sæpius simpliciter unguiculati, 8 postici unguiculati et nunquam ancorales. Branchiæ ciliatæ. Epimeræ conspicuæ.

Subfam. 1. ÆGINÆ.—Pedes 6 antici ancorales, unguibus validis; reliqui unguibus parvulis confecti.

G. 1. ÆGA, *Leach.*—Pedes 6 antici æque ancorales. Antennæ 1mæ basi contiguæ, 2dæ per epistomatis processum sejunctæ. Frons capitis non saliens.

Subgen. 1. ÆGA.—Oculi remoti. Antennæ 1mæ basi complanatæ.
Subgen. 2. CONILERA, *Leach.*—Oculi remoti. Antennæ 1mæ basi subcylindricæ.
Subgen. 3. ROCINELA, *Leach.*—Oculi grandiores, inter se contiguæ. Antennæ 1mæ basi complanatæ.

G. 2. ACHERUSIA, *Lucas.*†—*Ægæ* affinis. Antennæ 2dæ per processum non sejunctæ. Frons capitis saliens.

G. 3. PTERELAS, *Guerin.*—*Ægæ* affinis. Pedes 2di 3tii sæpeque 1mi subdidactyli, processu e articulo penultimo instar digiti immobilis, processu sive acuminato sive acie instructo.

Subfam. 2. CIROLANINÆ.—Pedes nulli ancorales.

G. 1. CIROLANA, *Leach.*‡—Segmenta thoracis subæqua. Pedes unguibus parvulis confecti. Antennæ 2dæ per processum epistomatis tenuem sejunctæ. Abdomen 6-articulatum.

G. 2. CORALLANA, *Dana.*—Segmenta thoracis subæqua. Pedes unguibus parvulis confecti. Antennæ 2dæ epistomate transverso latissimè sejunctæ et partim tectæ, epistomate antennisque 1mis latè conniventibus.

G. 3. ALITROPUS, *Edw.*—Segmenta thoracis 3 postica anterioribus longiora, ac in *Nerocila.* Pedes unguibus crassiusculis confecti.

Fam. III. SPHEROMIDÆ.§

Maxillipedes elongati 5–6-articulati et palpiformes. Appendices caudales margini abdominis laterali conjunctæ. Antennæ ad frontis marginem capitis affixæ, apertæ. Abdomen 1–2-articulatum. Pedes non ancorales (raro 4 antici ancorales). Branchiæ ciliatæ. Epimeræ non distinguendæ.

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* *Cymothoadiens errans*, Edw. Crust., iii, 233.—*Ægidæ*, Cat. Brit. Crust. Brit. Mus., 1850, p. 78.

† Expl. de l'Algiers, pl. 8, f. 3.

‡ Genera *Eurydice* et *Nelocira*, Leach, inclusa cum Cirolanâ. Eurydice discrepat abdomine 5-articulato tantum.

§ *Spheromiens onguiculés*, Edw. Crust., iii, 199.—*Spheromidæ*, Cat. Brit. Crust. Brit. Mus., 1850, p. 75.

Subfam. 1. SPHEROMINÆ.—Lamella appendicis caudalis externa sub internâ se latens.

1. *Corpus in globum contractile.*

G. 1. Spheroma, *Latr.*—Lamellæ appendicis caudalis subæquæ.

2. *Corpus in globum non contractile.*

G. 2. Cymodocea, *Leach, Edw.**—Caput valde transversum, multo convexum. Lamellæ appendicis caudalis subæquæ.
G. 3. Cerceis, *Edw.*—Caput parce transversum, subtriangulatum, vix convexum. Antennæ 1mæ quoad basin capite tectæ, processu non sejunctæ.
G. 4. Cassidina, *Edw.*—Corpus latum; caput valde transversum. Lamellæ appendicis caudalis angustæ, valde inæquæ, externâ parvulâ. Antennæ 1mæ quoad basin processu frontis sejunctæ.
G. 5. Amphoroideum, *Edw.*—Antennæ quoad basin lamellate portentose productæ ultra capitis frontem.

Subfam. 2. NESÆINÆ.—Lamella appendicis caudalis externa saliens, sub internâ se non latens, usquam aperta. Pedes nulli ancorales.

G. 1. Nesæa, *Leach, Edw.*†—Lamella caudalis externa recta.
G. 2. Campecopea, *Leach.* Lamella caudalis externa arcuata.

Subfam. 3. ANCININÆ.—Pedes 4 antici ancorales.

G. 1. Ancinus, *Edw.*—Appendices caudales unâ lamellâ oblongâ saliente basique brevissimo instructæ.—An tribus Anisopodorum est genus Ancinus?

TRIBUS II.

ANISOPODA.

Subtribus I. SEROLIDEA, vel Anisopoda Cymothoica.

Fam. I. SEROLIDÆ.

Appendices abdominales sex anticæ liberæ, subnatatoriæ, quatuor sequentes branchiales, bene lamellatæ, ultimæ ac in *Cymothoadis*. Antennæ 1mæ sub capite insitæ.

G. 1. Serolis, *Leach.*

Fam. II. PRANIZIDÆ.‡

Appendices abdominales totæ ac in *Ægidis*. Antennæ 1mæ sub capite insitæ. Pedes thoracis numero decem, paribus duobus anticis rudimentariis. Thoracis segmenta numero quinque non superantia.

Subfam. 1. PRANIZINÆ.—Caput parvum. Mandibulæ vix salientes.

G. 1. Praniza, *Leach.*

Subfam. 2. ANCEINÆ.—Caput grande. Mandibulæ ultra caput longè exsertæ.

G. 1. Anceus, *Risso.*

Subtribus II. ARCTURIDEA, vel Anisopoda Idotæica.

Fam. I. ARCTURIDÆ.

Subfam. 1. ARCTURINÆ.—Opercula abdominis ad ventrem stricte appressa.

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* Genus *Dynamena*, Leach, is included. † Genus *Cilicæa*, Leach, is included.
‡ *Pranisiens*, Edw. Crust. iii, 92.

G. 1. Arcturus, *Latr.*—Segmenta thoracis subæqua. Antennæ 2dæ flagello longo confectæ.

G. 2. Leachia, *Johnston.*—Segmentum thoracis 4tum prælongum. Antennæ 2dæ longæ, ungue 1–3-articulato confectæ. Pedes 8 antici ciliati, non unguiculati.

Subfam. 2. ANTHURINÆ.—Opercula abdominis ad ventrem non bene appressa, sed libera et latera abdominis partim tegentia.

G. 1. Anthura, *Leach.*—Antennæ breves, 4–8-articulatæ. Pedes antici subchelati.

Subtribus III. TANAIDEA, vel Anisopoda Oniscica.

Fam. 1. TANAIDÆ.

Pedes 1mi 2dive subchelati, sequentes non ancorales. Abdomen paribus 5 appendicum subnatatoriis unoque postico stylorum instructum.

Subfam. 1. TANAINÆ.—Corpus lineare, segmento thoracis 1mo sæpe oblongo capiteque parvulo. Styli caudales longo.

G. 1. Tanais, *Edw.**—Antennæ 1mæ flagello non confectæ. Pedes antici breves, crassè chelati, reliqui unguiculati. Styli caudales sat longi, 3–7-articulati, simplices.

G. 2. Paratanais, *Dana.*—*Tanai* similis. Styli caudales biramei, ramis inæquis, articulis uno vel pluribus instructis. Pedes antici breves.

G. 3. Leptochelia, *Dana.*†—Antennæ 1mæ longæ, flagello confectæ. Pedes antici longi, digitis hiantibus; reliqui unguiculati. Styli caudales sat longi, articulati, ramo laterali instructi.

G. 4. Apseudes, *Leach.*—Antennæ 1mæ 2dæque flagello unico confectæ. Pedes antici breves, crassè chelati, 2di extremitate laminati, non unguiculati.

G. 5. Rhœa,‡ *Edw.*—Antennæ 1mæ 2dæque flagello confectæ, 1mis quoque flagello appendiculari. Pedes 1mi 2dique crassi, 1mis chelatis, 2dis unguiculatis.

Subfam. 2. LIRIOPINÆ.—Corpus antice latius, postice sensim angustans, segmento thoracis 1mo reliquis vix longiore, capite sat grandi. Appendices abdominales numero decem elongatæ.

G. 1. Liriope, *Rathke.*§—Pedes 4 antici subprehensiles, 5ti 6tique unguiculati, 7mi abbreviati, articuloque styliformi confecti. Antennæ 1mæ perbreves [setarum scopulâ ornatæ].

C. 2. Cryptothir, *Dana.*—*Liriopi* affinis. Pedes 7mi non abbreviati, unguiculati.

Subfam. 3. CROSSURINÆ.—Corpus antice latius, postice sensim angustatum, segmento thoracis 1mo vix longiore, capite sat grandi. Appendices abdominales inferiores numero sex, ciliatæ.

G. 1. Crossurus, *Rathke.*‖—Pedes antici chelati, robusti, reliquis unguiculatis. "Abdomen duabus tæniis semicircularibus e magno pilorum erectorum numero compositis fimbriasque duas exhibentibus cinctum."

Fam. II. BOPYRIDÆ.¶

Pedes toti plerumque aliquo modo subprehensiles vel ancorales. *Maris*, corpus angustum, abdomen 1–6-articulatum, appendicibus subnatatoriis stylisque duobus sæpe instructum, interdum totis appendicibus obsoletis; *feminæ*, corpus latum et obesum, oculis carens, et quoad pedes sæpe partim obsoletum.

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* Genus *Zeuxo*, Templeton, (Trans. Ent. Soc., ii, 203,) is included.

† Amer. J. Sci. [2], iii, 425, 1849. Here falls *Tanais Edwardsii*, Kr. (Tids. iv, 1842.)

‡ Genus *Triura*, Tellkampf (Archiv. f. Nat., 1844, p. 321) Rhœæ forsan affinis. Styli caudales longissimi et setiformes. Speciei descriptio et icon non bonæ.

§ Faun. Norw., 60, pl. 1, f. 8–12. ‖ Ibid. 35, pl. 1, f. 1–7.

¶ *Epicarides*, Latr.; *Isopodes sedentaires*, Edw. Crust., iii, 277.

Subfam. 1. BOPYRINÆ.—Thorax appendicibus branchialibus carens.

G. 1. Bopyrus, *Latr.*—Pedes thoracis *feminæ* manu imperfectâ confecti. Appendices abdominis branchiales laminatæ, laminâ unicâ compositæ et abdomine tectæ.
G. 2. Phryxus, *Rathke.**—Pedes thoracis *maris* ancorales, *feminæ* manu imperfectâ confecti. Appendices abdominis *feminæ* branchiales magnæ, laminis duabus inæquis nudis compositæ, una vel ambæ laminæ laterales; *maris* rudimentariæ.
G. 3. Cepon, *Duvernoy.*†—Pedes thoracis feminæ non unguiculati, per pulvillum terminalem ancorales. Appendices abdominis *feminæ* branchiales numero duodecim, elongatè lamellatæ et bene ciliatæ.
G. 4. Dajus, *Kröyer.*‡—*Maris* abdomen 6-articulatum, segmento ultimo prælongo; pedes thoracis bene unguiculati; appendices abdominis numero decem, oblongæ, ciliatæ, aliis duabus terminalibus minutis. *Feminæ* appendices abdominis laterales, duæ posticæ caudales breves, exsertæ.

Subfam. 2. IONINÆ.—Pedes thoracis ad basin appendices simplices branchiales gerentes.

G. 1. Ione, *Latr.*—Pedes thoracis manu imperfectâ confecti. Appendices abdominales laterales, *maris* tenuiter cylindricæ, *feminæ* ramosæ præter duas ultimas simplices.
G. 2. Argeia, *Dana.*—Pedes thoracis manu imperfectâ confecti. Appendices *feminæ* abdominales laterales, biramææ, ramis simplicissimis, nudis; *maris* nullis, abdomine non articulato, nudo.

TRIBUS III.

AMPHIPODA.

Subtribus I. CAPRELLIDEA.

Fam. I. CAPRELLIDÆ.

Corpus longum et fere filiforme. Antennæ 2dæ longitudine mediocres. [Species non parasiticæ.]

1. *Pedes thoracis numero* 14.

G. 1. Proto,§ *Leach.*—Mandibulæ palpigeræ. Branchiæ segmentis 2do 3tio 4toque affixæ. Pedes thoracis toti articulis normales.
G. 2. Protella, *Dana.*—Mandibulæ palpigeræ. Branchiæ segmentis 3tio 4toque affixæ. Pedes 3tii 4tique obsoleti articulo 1mo styliformi excepto.

2. *Pedes thoracis 3tii 4tique omnino obsoleti.*

G. 3. Caprella, *Lamk.*—Mandibulæ non palpigeræ. Branchiæ segmentis thoracis 3tio 4toque affixæ. Abdomen brevissimum, 1–2-articulatum.
G. 4. Ægina, *Kröyer.*‖—Mandibulæ palpigeræ, palpis 3-articulatis. Branchiæ ac in *Caprellâ.* Abdomen brevissimum, 1–2-articulatum.
G. 5. Cercops, *Kröyer.*¶—Mandibulæ palpigeræ. Branchiæ segmentis 2do 3tio 4toque affixæ. Abdomen 5-articulatum, appendicibus 4 elongatis 3-articulatis.

3. *Pedes 3tii 4ti 5tique obsoleti.*

G. 6. Podalirius, *Kröyer.***—Branchiæ segmentis 3tio 4toque affixæ.

Fam. 2. CYAMIDÆ.

Corpus latum, depressum. Antennæ 2dæ obsoletæ. [Species parasiticæ.]

G. 1. Cyamus.

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* Fauna Norwegens, p. 40.
† Annales des Sci. Nat. [2], xv, 110, pl. 4.
‡ Voy. Scand., etc., Crust. tab. 28, 29.
§ *Leptomera*, Latreille.
‖ Tids. iv, 1842.
¶ Ibid.
** Voy. Scand., pl. 25, and Tids. [2], i, 283.

Subtribus II. GAMMARIDEA.

[Among the Gammaridea, the author finds that the posterior caudal stylets offer important characters for distinguishing natural groups or genera, and upon this ground, some new genera have been recognized among the Corophidæ and Gammaridæ, and others *that have been rejected* are sustained. Thus *Iphimedia* is distinct from *Amphithoe*, *Mæra* and *Dercothoe* from *Gammarus*, etc.]

Fam. I. DULICHIDÆ.

Gressoriæ, habitu Capnelloideæ. Corpus lineare, epimeris obsoletis. Pedes posteriores longi, subprehensiles. Abdomen 5-articulatum.

G. 1. Dulichia, *Kröyer.**—Pedes 5ti 6ti 7mique, subæqui, 2di manu confecti. Antennæ quatuor longæ, superiores prælongi.

Fam. II. CHELURIDÆ.

Corpus fere cylindricum, epimeris mediocribus. Abdomen segmentis 4to 5toque coalitis et oblongis, stylis inter se valde dissimilibus.

G. 1. Chelura, *Philippi.*†

Fam. III. COROPHIDÆ.

Gressoriæ, pedibus partim lateraliter porrectis. Corpus plus minusve depressum, sæpe latum, epimeris perbrevibus, interdum obsoletis. Abdomen formâ appendicibusque normale. Antennæ sæpe pediformes.

Subfam. 1. CLYDONINÆ.—Styli caudales sex simplices, subulati.

G. 1. Clydonia, *Dana.*‡—Pedes filiformes, 5ti 6ti 7mique, longitudine increscentes, 1mi 2di non prehensiles. Antennæ duæ longæ, crassæ, rigidæ.

Subfam. 2. COROPHINÆ.—Antennæ plus minusve pediformes. Styli caudales 1mi 2dique biramei.

A. digitus nullus 2-articulatus.

1. *Styli caudales 3tii minuti, simplices, 2di 1mique ramo externo cultriformi.*

G. 1. Corophium, *Latr*—Antennæ inferiores longiores et crassiores, flagello carentes. Pedes 2di non prehensiles, 1mis crassiores, articulo 4to latiore quam 5tus.

G. 2. Siphonœcetes, *Kröyer.*§—Antennæ inferiores longiores, flagello carentes. Pedes 1mi 2dique subchelati. [Pedes 3tii 4tique articulo 4to laté obcordato. Tubum lapillis fragmentisque concharum formatum inhabitat.]

* Tids. [2], i, 512, 1845.

† Arch. f. Nat. 1839; and G. J. Allman, Ann. and Mag. N. H. xix, 361, June, 1847.

‡ Amer. J. Sci. [2], viii, 140; *Icilius*, D., on same page.

§ Voy. Scand., etc., 1838–1840, pl. 20, f. 1; Tidsskr. [2], i, 481, 1845. Kröyer in his description says:—

"Pedes thoracici primi et 2di paris validissimi, manu instructi subcheliformi. Pedes 3tii et 4ti paris articulo primo latissimo, laminari; articulo quarto obcordato, laminari, manum præbente, cujus unguis efficitur articulo quinto subconico articuloque sexto aciculari. Pedes 5ti 6tique paris minutissimi, sed robusti, recurvati, articulo primo clavato, ungue furcato. Pedes 7mi paris graciles, recurvati, articulo primo laminari, ungue minutissimo, furcato. Pedes abdominales 1mi, 2di et 3tii paris natatorii breves validissimi, parte basali latissima, rhomboidali; pedes 4ti, 5tique paris saltatorii, pes abdominalis sexti paris natatorius unica instructus lamina terminali."

2. *Styli caudales 3tii minuti, vix exserti, simplices, 2di 1mique ramis extus non præcipue spinosis nec cultriformibus, interdum nudis.*

G. 3. PLATOPHIUM, *Dana.*—Corpus superne visum subellipticum, abdomine bene inflexo. Antennæ flagello brevi sæpe instructæ, inferiores longiores, superiores appendiculatæ. Pedes 1mi 2dique subchelati, 2dis validioribus. Pedes 10 postici mediocres.

G. 4. CYRTOPHIUM, *Dana.*—*Platophio* similis. Antennæ superiores non appendiculatæ.

3. *Styli caudales 3tii parvuli, biramei, ramo externo non uncinato, 2di 1mique ramis extus non præcipue spinosis nec cultriformibus.*

G. 5. UNCIOLA, *Say.**—Pedes 1mi 2dique manu confecti, 1mis validioribus. Antennæ flagellis confectæ, subpediformes, validæ, superiores paulo longiores, appendiculatæ.

4. *Styli caudales 3tii paulo elongati, biramei, ramo externo uncinato.*

G. 6. PODOCERUS, *Leach.*†—Pedes 1mi 2dique subchelati, 2dis validioribus. Antennæ superiores breviores, non appendiculatæ. [An maris digitus 2dus interdum 2-articulatus Kröyero teste.]

G. 7. CERATOPHIUM, *Dana.*—Pedes 1mi 2dique subchelati, 2dis validioribus. Antennæ superiores breviores, appendiculatæ.

B. DIGITUS 2DUS 2-ARTICULATUS.

G. 8. CERAPUS, *Say.*—Antennæ pediformes, subæquæ, flagellis carentes. Pedes 1mi 2dique prehensiles, 1mis parvulis, 2dis manu bene confectis. Styli caudales 3tii biramei, ramis subæquis, longiusculis. [Tubum membranaceum inhabitat.]

G. 9. CERAPODINA, *Edw.* (*Cerapus,* Templeton). Antennæ totæ flagellis confectæ. Pedes 4ti 5ti 6tique obsoleti (?) [Tubum papyraceum inhabitat.]

G. 10. ERICHTHONIUS, *Edw.*‡—Antennæ flagellis confectæ. Pedes 10 postici mediocres. Epimeræ anteriores obsoletæ. [An styli caudales 3tii simplicissimi ?]

Subfam. 3. ICILINÆ.—Antennæ non pediformes nec subpediformes, flagellis sat longis basique sat brevi instructæ. Styli caudales ac in *Corophinis.*

G. 1. ICILIUS, *Dana.*—Pedes toti unguiculati et tenues, 4 antici longi, non prehensiles, ciliati, 10 postici fere similes. Antennæ superiores breviores non appendiculatæ.

G. 2. PTERYGOCERA, *Latr.*—Pedes posteriores sublamellati. Antennæ superiores breviores, appendiculatæ, inferiores basi dilatatæ.

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* Jour. Acad. Nat. Sci. Philad., i, 388.

Glauconome of Kröyer has the hands and antennæ and apparently the other characters of Unciola. Say describes the hands of the 2nd pair in Unciola as *adactyle;* but they still are probably like those of Glauconome. The following is Kröyer's description:—

"*Antennæ* subpediformes; superiores flagello ornatæ appendiculari perparvo. *Oculi* minuti, parum distincti. *Maudibulæ* apex in duos fissus ramos qui dentibus sunt armati conicis; tuberculus molaris dentibus confertissimis instructus. *Labium superius* breve, depressum latissimum, margine anteriori medio inciso; *labium inferius* quatuor compositum laminis setosis. *Laminæ maxillares* pedum maxillarium dentibus armatæ validis; unguis palpi apice setosus. *Pes primi paris* robustissimus, manu subcheliformi; pes *secundi* paris gracilior, manu carens subcheliformi, pedes 3tii, 4tique paris pergraciles; pedes 5ti, 6ti, 7mique paris graciles femoribus parum dilatatis. Pedes abdominales 1mi 2di et 3tii paris natatorii, breves sed robustissimi; 4ti, 5tique paris saltatorii, validi; 6ti paris fere rudimentares, natatorii. Epimera minima fere evanescentia."

† *Jassa* of Leach may without inconvenience be united to *Podocerus,* as there is no essential generic difference between them.

‡ The author obtained three species in the cruise of the Expedition having the hands and many other characters of Erichthonius, but with the epimerals of the anterior thoracic segments of considerable size; and moreover no gressorial habits were observed. They are therefore with some hesitation arranged in a genus named Pyctilus, among the Gammaridæ, subfamily Gammarinæ.

Fam. IV. ORCHESTIDÆ.*

Saltatoriæ, pedibus nullis lateraliter porrectis. Corpus compressum, epimeris magnis. Abdomen appendicibus normale. Antennæ non bene pediformes. Styli caudales 1mi 2dique biramei; 3tii simplices, brevissimi et ultra 2dos non prolongati. Mandibulæ non palpigeræ. Maxillæ 1mæ palpo sive parvulo et 1-articulato sive obsoleto instructæ.

G. 1. ORCHESTIA.—Maxillipedes non unguiculati. Antennæ 1mæ basi 2darum breviores. Epimeræ 5tæ 4tis parce breviores.

Subgen. 1. TALITRUS.—Pedes 1mi *maris feminæve* manu non instructi.
Subgen. 2. TALORCHESTIA, *D.*—Pedes 1mi *maris* ac in *Talitro, feminæ* manu parvulâ instructi.
Subgen. 3. ORCHESTIA.—Pedes 1mi *maris feminæque* manu plus minusve instructi.

G. 2. ALLORCHESTES, *Dana.*—Maxillipedes unguiculati. Antennæ 1mæ minores, basi 2darum longiores. Epimeræ 5tæ 4tis sæpius multo breviores.

Fam. V. GAMMARIDÆ.

Saltatoriæ vel natatoriæ, pedibus nullis lateraliter porrectis. Corpus sæpius compressum, raro subdepressum, epimeris sive magnis sive parvis. Styli caudales laxiores, duobus ultimis oblongis sæpiusque ultra 2dos prolongatis, raro simplicibus. Mandibulæ sæpissimè palpigeræ. Maxillæ 1mæ palpo 2–3-articulato (rarissimè 1-articulato) instructæ.

I. PEDES 10 POSTICI NON PREHENSILES.

Subfam. 1. STEGOCEPHALINÆ.—Antennæ breves, superiores basi crassæ. Mandibulæ acie denticulatâ instructæ, palpo brevi uniarticulato intus dentato. Epimeræ permagnæ.

G. 1. STEGOCEPHALUS, *Kröyer.*†—Epimeræ 4tæ maximæ, 5tis parvis. Antennæ superiores appendiculatæ. Pedes 1mi 2di manubus carentes. [Pedes 5ti 3tii 4tique directione similes.]

Subfam. 2. LYSIANASSINÆ.—Antennæ breves, superiores basi crassæ. Mandibulæ apice parce dentatæ, acie vix instructæ, palpo 2–3-articulato. Maxillipedes lamellis internis grandibus. Epimeræ permagnæ.

1. *Pedes 1mi 2dique non subchelati, 2dis parvulis interdum exceptis.*

G. 1. LYSIANASSA, *Edw.*—Antennæ superiores appendiculatæ.
G. 2. PHLIAS, *Guerin.*—Antennæ superiores non appendiculatæ.

2. *Pedes 1mi subchelati, 2dis non subchelatis.*

G. 3. OPIS, *Kr.*‡—Antennæ superiores appendiculatæ. Pedes 1mi crassè chelati, 2di debiles.

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* The author gives a different arrangement of the species of Orchestidæ from that published in this Journal, [2], viii, 135 and ix, 295, and rejects the genus Talitronus there instituted. He follows Fr. Müller (Archiv f. Nat., 1848, 53) in considering the Talitri and Orchestiæ as forming a single genus, his recent investigations confirming this view. The Gammaridæ also are rearranged.

† Kröyer's Nat. Tids. iv, 150, 1842. "Caput oculis ut videtur destitutum."

‡ Tids. iv, 149. "Pedes 1mi paris chelis armati portentosæ magnitudinis. Reliqua cum genere Anonyce ferme conveniunt."

G. 4. URISTES, *Dana*.*—Antennæ superiores non appendiculatæ. Pedes 1mi subchelati, 2di articulo styliformi confecti.

3. *Pedes 1mi 2dique plus minusve subchelati.*

G. 5. ANONYX, *Kr*.†—Epimeræ permagnæ. Antennæ superiores appendiculatæ, basi breves. Maxillipedes lamellis internis grandibus. Styli caudales postici biramei, ramis subulatis.

G. 6. UROTHOE, *Dana*.—Epimeræ permagnæ, 5tis parvis. Antennæ 1mæ breviores, appendiculatæ, basi sat elongato. Styli caudales postici longi, biramei, ramis foliaceis, ciliatis. Mandibulæ palpo 3-articulato.

Subfam. 3. LEUCOTHOINÆ.—Antennæ superiores basi plus minusve graciles. Maxillipedes elongati, angusti, articulo longo unguiformi confecti, *lamellis internis perbrevibus*. Mandibulæ sive palpigeræ sive non palpigeræ, processu molari carentes. [An semper ?] Epimeræ magnæ.

G. 1. STENOTHOE, *Dana*.—Epimeræ permagnæ, 4tæ maximæ, 5tæ parvulæ. Pedes 4 antici subchelati, 2dis validioribus. Antennæ superiores longiores, non appendiculatæ. Mandibulæ *non palpigeræ, processu molari carentes*. Styli caudales 1mi 2dique ramis bene subulati, 3tii simplicissimi, subulati, spinâ crassâ confecti.

G. 2. LEUCOTHOE, *Leach*.‡—Epimeræ magnæ, 5tæ parvulæ. Pedes 4 antici subchelati, 2dis validioribus. Antennæ superiores longiores, non appendiculatæ. Mandibulæ palpigeræ. Styli caudales toti biramei, ramis subulatis.

[Cujus sedis est *Microcheles*, Kröyer,§ Amphithoe affinis, cui mandibulæ processu molari carentes: quoque *Amphithoe Marionis*, Edw., cui mandibulæ non palpigeræ.]

Subfam. 4. GAMMARINÆ.—Antennæ 1mæ basi graciles. Maxillipedes sat lati, lamellis internis sat elongatis. Mandibulæ acie denticulatâ instructæ et alterâ accessoriâ quoque processu molari et palpo 3-articulato. Pedes 10 postici non subprehensiles.

A. FRONS PRODUCTUS ET INFRA ANTENNIGERUS NON EST, ANTENNIS 1MIS INFERIORIBUS NON ANTERIORIBUS.

1. *Styli caudales postici biramei, ramis subæquis.*

A. PEDES 2DI NON SUBCHELATI.

G. 1. ACANTHONOTUS, *Owen*.—Antennæ quatuor subæquæ, 1mæ non appendiculatæ. Epimeræ magnæ. Pedes 2di filiformes, manu omnino carentes, 1mi manu vix confecti.

G. 2. ALIBROTUS, *Edw*.—Antennæ 1mæ breves, appendiculatæ. Epimeræ magnæ. Pedes 1mi validi non subchelati.

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* Amer. J. Sci. [2], viii, 135. The genus *Stenia* is rejected.

† Tids. ii, 256, and iv, 164.

The genus *Ephippiphora* of White (Ann. and Mag. N. Hist. [2], i, 226, 1848) has been but briefly described, and we cannot pronounce upon its exact relation to either of the genera of Lysianassinæ. The habit is like that of Anonyx, the epimerals large, the superior antennæ appendiculate, the posterior caudal stylets elongate as in Anonyx and not short like the Orchestidæ. But the character of the termination of the 4 anterior legs is not stated, neither are they in view in the figure of the species on plate 5 of the Zool. of the Erebus and Terror. This figure represents the 5th and 6th pair of legs as rudimentary, or the basal joints twice as long as the following part, and the basal joint of the 6th smaller than that of the 5th or 7th.

‡ Kröyer states that the *bi-articulate* finger of Leucothoe is not a true generic characteristic, and adds two species to the genus, one of which has this character imperfectly and the other not at all. (Nat. Tids. iv, 141, 1842, and [2], i, p. 539, 1845). This character of the hand depends mainly on the prolongation of the inferior apex of the antepenult joint, which prolongation is variously developed in species of allied genera. They agree with Leucothoe in their peculiar slender maxillipeds; in the very small epimerals to the 1st segment, large 4th, and small 5th, 6th and 7th; in the caudal stylets; the very short 3d joint of the superior antennæ, and other characters.

§ Tids. N. R. ii, 5.

G. 3. LEPTOCHIRUS, *Zaddach.**—Antennæ 1mæ appendiculatæ. Pedes 1mi bene subchelatæ, 2di manu carentes.

B. PEDES 2DI 1MIQUE SUBCHELATI.

* Antennæ 1mæ non appendiculatæ.

G. 4. IPHIMEDIA, *Rathke,*† *D.*—Epimeræ magnæ, 4tæ maximæ, 5tis multo brevioribus et vix bilobatis. Styli caudales postici ramis duobus oblongis consimilibus apice setigeris et non uncinatis instructi. Antennæ 1mæ sæpius breviores.

G. 5. ŒDICERUS, *Kröyer.*‡—*Iphimediæ* affinis. Pedes 7mi longissimi, fere filiformes. Antennæ 1mæ breviores.

G. 6. AMPHITHOE, *Leach, D.*§—Epimeræ magnæ, 5tæ maximæ, vix bilobatæ lobo posteriore minimo. Styli caudales postici ramis duobus brevibus dissimilibus instructi, ramo externo apice recurvatim bi-uncinato, interno compresso apice non spinuloso sed pilis parce ciliato. Antennæ 1mæ sæpissime longiores.

** Antennæ 1mæ appendiculatæ.

G. 7. GAMMARUS, *Fabr., D.*‖—Epimeræ sive mediocres sive breves. Styli caudales postici 2dis non similes, ramis sæpe longis cum pilis raro spinulis ornatis, apice non uncinatis. Antennæ superiores sæpius longiores.

2. *Styli caudales postici sive ramo uno longo altero parvulo instructi, sive simplicissimi et apice non paulo reflexi.*

* Antennæ 1mæ non appendiculatæ.

G. 8. PHOTIS, *Kröyer.*¶—Epimeræ magnæ, 5tæ 4tis non breviores et postice profundius excisæ. Styli caudales ramo interno rudimentario.

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* The genus *Leptochirus*, (Syn. Crust. Borus. Prodromus, 1844) is described by Zaddach as having no appendicular branch to the superior antennæ. But Fr. Muller states (Archiv für Naturgeschichte, 1848, xiv, 62) that there is a small one-jointed appendage in the Leptochirus pilosus. The legs of the 2nd pair are described as having no proper hand, but terminating as in the genus Talitrus. May the form be female only?

† Beit. zur Fauna Norwegens, p. 85, Act. Leop. xx. *Dexamine* of Leach, may perhaps be included here.

The genus *Hyale* of H. Rathke (Fauna der Krym, Mem. Acad. Imp. St. Petersb., iii, 1837, p. 378, pl. 5) contains no characters in its description by this author which do not apply equally well to species of Iphimedia. The description is as follows:—"Corpus elongatum, compressum. Antennæ inferiores superioribus aliquantulum longiores; earum quælibet e tribus articulis atque flagello composita. Oculi disciformes. Pedes 14: duo eorum paria antica chelis monodactylis complanatis, 2di paris multo majoribus. Stylorum abdominalium paria tria. Abdominis appendicula terminalis simplex, erecta, verruciformis." The posterior stylets are 2-branched though short; and the species (H. pontica) is thus distinct from the Allorchestes.

‡ Tids. iv, 155, 1842. "Frons in rostrum producta, plus minus acutum obtusumve, semper vero nodo pellucenti, ovali, flavo-rubescente turgidum. Oculi nulli?" "Pedes 3tii 4tique paris validi, ungue instructi lato laminari, quod quoque usu venit 5to 6toque pari, quorum articulus 1mus dilatatus non est."

§ Includes *Pherusa* of Leach.

‖ *Amathia*, Rathke (Fauna der Krym, Mem. Acad. Imp. St. Petersb., iii, 1837, p. 291, and Beit. zur Faun. Norw. Act. Leop. xx) includes those Gammari that have the superior antennæ the shorter—not a proper basis for a genus. The eye is described as reniform.

The genus *Eusirus* of Kröyer is very near Gammarus, and it is doubtful whether it should be separated. Its habit however is somewhat different. The hands of the 2 anterior pairs of legs are large and equal, and the carpus is articulated with the upper margin of the hand near its middle. The eye is reniform. The superior antennæ have a short appendicular branch, consisting of a minute joint. "Mandibula parva, apice bifurco, dentato, flabello setarum marginis interioris, tuberculo molari transverso-elliptico dentibus minutissimis confectis formato; palpus triarticulatus duplam fere æquat mandibulæ longitudinem. Sex branchiarum paria in maribus (annuli thoracici 2di–7mi), 4 laminarum in feminis paria (annuli 2di–5ti)."—Tids. [2], i, 501.

¶ Tids. iv, 155, 1842, "Pes 5ti paris recurvatus, inversus, ungue rudimentari. Epimera permagna, 5 paria anteriora ad marginem inferiorem setis sat longis instructa, 5tum eadem est ac 4tum altitudine, postice profundius excisum. Lamina terminalis interior pedis saltatorii 3tii paris rudimentaris."

The *inversion* of the 5th pair of legs is not a generic character.

G. 9. Melita, *Leach, D.*—Epimeræ 5tæ 4tis multo breviores (sic an semper ?) Styli caudales uno ramo longo, sive subcylindrico sive foliaceo, altero brevi vel obsoleto. [Digitus in manus latus sæpe claudens.] Antennæ 1mæ sæpius longiores.

** Antennæ 1mæ appendiculatæ.

G. 10. Mæra, *Leach, D.*—Epimeræ et styli caudales postici ac in *Melitâ.*

3. *Styli caudales postici simplicissimi, ramo uno brevi et nudo, apice paulo reflexo et spinas duas perbreves paulo exsertas gerente.*

G. 11. Dercothoe, *Dana.*—Epimeræ mediocres, 5tæ bene bilobatæ, 4tis sæpius vix breviores. Pedes 1mi 2dique digito uni-articulato confecti.

G. 12. Pyctilus, *Dana,* (Erichthonius, *Edw.?*)—Epimeræ mediocres vel breves corpore lineari, subdepresso. Antennæ longæ, flagellis sat longis. Manus 1mæ articulis 4to 5toque sæpe instructæ, digito uni-articulato; 2dæ digito 2-articulato.

G. 13. (An hujus sedis?) Pardalisca, *Kröyer.**—Epimeræ breves. Pedes 1mi 2dique digito 2-articulato manuque 1-articulatâ instructi. Antennæ tenues, 1mæ appendiculatæ.

B. frons productus antennasque 1mas versus extremitatem gerens. [an species corophidis affiniores.]

G. 14. Atylus, *Leach.*—*Iphimediæ* paulo affinis. Antennæ subpediformes, breviores, non appendiculatæ. Digiti 1mi 2dique uni-articulati.

G. 15. Ischyrocerus, *Kröyer.*†—*Gammaro* paulo affinis. Antennæ pediformes, 1mæ appendiculatæ. Palpus mandibularis longus, articulo ultimo obovato. Pedes 2di *maris* manu validissimâ instructi. Digiti uni-articulati. Epimeræ mediocres.

II. pedes 10 postici partim prehensiles.

Subfam. 5. PONTOPORINÆ.—Pedes 3tii 4tique plus minusve prehensiles; 6 postici non prehensiles.

1. *Antennæ 2dæ inferiores et non posteriores.*

G. 1. Lepidactylis, *Say.*‡—Epimeræ magnæ. Antennæ superiores appendiculatæ, inferiores basi infra valde dilatatæ et partim dolabriformes. Pedes 4 antici filiformes; 3ti 4tique manu compressâ digitoque laminato instructâ; 5ti 6ti 7mique valde compressi, 7mis longioribus, articulis superne valde productis.

G. 2. Pontiporeia, *Kr.*§—Epimeræ magnæ. Antennæ superiores appendiculatæ. Pedes 1mi 2dique perbreves, robusti, 1mi manu latâ ungue brevi confecti, 2di manu carentes; 3tii 4tique validi, manu articulo 4to dilatato instructâ, ungue conico aculeato; 7mi ungue vel articulo 6to rudimentario.

G. 3. Ampelisca, *Kr.*‖—Epimeræ magnæ. Antennæ graciles. Pedes 1mi 2dique manu nullâ subcheliformi; 3tii 4tique manu articulo 3tio instructâ, digito articulis 3 sequentibus formato, articulo ultimo vel ungue longissimo et gracillimo; 5ti 6tique 5-articulati, ungue rudimentario recurvo, immobili (vel parum mobili). Styli caudales postici natatorii.

G. 4. Protomedeia, *Kr.*¶—Corpus subdepressum, epimeris sat brevibus. Antennæ superiores appendiculatæ, inferiores pediformes, basi prælongo. Manus 3tiæ 4tæque articulis 3tio 4toque instructæ et digiti longi articulis sequentibus coalitis. Pedes 2di parvi, manu subcheliformi non instructi.

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* Tids. iv, 153, 1842. "Caput crassiusculum." "Mandibula apice dilatata, quadridentata, palpo 3-articulato." "Pedes 3tii 4tique paris ungue sublaminari postice subtiliter serrulato." "Pedes spurii [abdominales] 2di et 3tii paris natatorii, reliqui saltatorii."

† Tids. iv. "Pedes spurii 4ti 5ti 6tique paris saltatorii; articulus basalis 6ti paris articulis terminalibus triplo vel quadruplo longior."

‡ Jour. Acad. Nat. Sci. Philad., i, 379. Here falls *Bellia* of C. Spence Bate (Ann. and Mag. N. Hist. 1851, [2], vii, 318.)

§ Tids. iv, 152. "Pedes 5ti et 6ti paris recurvi, articulo 1mo parum modo dilatato ungue armati pusillo."

‖ Tids. iv, 154. "Oculi simplices?" "Sextum pedum abdominalium par natatorium."

¶ Tids. iv, 154.

G. 5. AORA, *Kr.**—Corpus subdepressum, epimeris sat parvis. Antennæ superiores longæ, appendiculatæ, inferiores subpediformes. Pedes 1mi 2dique manu subcheliformi, 1mis maximis, articulo 3tio posticè in apicem longissimum producto, manu angustâ, ungue fere lamellari. Manus 3tiæ 4tæque articulo 4to ovali instructæ digitis articulis 5to 6toque. Styli caudales saltatorii, 6tis 7mis setis non aculeis apice instructis.

2. *Antennæ 2dæ multo posteriores, fronte in rostrum producto.*

G. 6. PHOXUS, *Kr.*†—Epimeræ permagnæ. Pedes 1mi 2dique manu subcheliformi validâ instructi. Manus 3tiæ 4tæque articulo 3tio 4toque junctis instructæ, digitis 5to 6toque. Pedes 6ti multo longiores. Caput longum, triangulare, antice productum et acuminatum. Antennæ anteriores perbreves (capite breviores), elongate appendiculatæ; posteriores paulo longiores. Mandibulæ palpo longissimo. Segmentum caudale laminis constans duâbus.

Subfam. 6. ISÆINÆ.‡—Pedes quatuor vel sex postici subprehensiles.

G. 1. ISÆA, *Edw.*—*Gammaro* similis. Pedes 10 postici similes, articulo 5to apice dilatato et truncato, ungue in articuli 5ti extremitatem latiusculam claudente. Pedes 2di manu grandi confecti. Antennæ superiores appendiculatæ.

G. 2. ANISOPUS, *Templeton.*—Pedes 4 postici ac in *Isæâ*, validiores, articulo 5to apice inferiore dentato, ungue magno. Pedes 1mi tenues et breves; 2di manu angustâ; 3tii manu grandiore; 4ti 5ti 1mis similes.

Subtribus III. HYPERIDEA.§

[In the first family of the Hyperidea, (the *Hyperidæ*) neither of the 5 posterior pairs of legs are subchelate, and the antennæ are not folded up beneath the head or thorax. In the second, (the *Phronimidæ*,) one or more of the 3 posterior pairs of legs are subchelate or much enlarged, apparently for grasping in coition, and the antennæ are as in the Hyperidæ. The third family (the *Typhidæ*) differs from both the preceding in the concealment and folding of the inferior antennæ beneath the head or thorax, and in many of the species, the abdomen closes up against the venter.]

Fam. I. HYPERIDÆ.||

Antennæ 2dæ exsertæ. Abdomen in ventrem se non flectens. Pedes 5ti 6ti 7mique formâ longitudineque mediocres, 5tis 6tisve non percrassis nec prehensilibus.

Subfam. 1. VIBILINÆ.¶—Corpus formâ paulo Gammaroideum. Caput oculique mediocres. Maxillipedes palpo parvulo instructi. Palpus mandibularis tenuis.

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* Tids. [2], i, 335, 1845. † Tids. iv, 150.

‡ An genus *Laphystius* (Kröyer, Tids. iv, 156, 1842) Isæinis vel Corophidis affine. Species in Sturiones Squalosve parasitica! Descriptio sequens:—

Corpus latum, depressum, epimeris mediocribus, 4tis infra acutè productis. Caput transversum, rostratum. Antennæ sat breves, subulatæ, validæ, 1mæ validissimæ, anteriores, 2dæ posteriores. Mandibulæ palpo instructæ. Pedes 1mi gracillimi, manu lineari; 2di breves, manu validâ, ungue sublaminari. Reliqui decem pedes validi, subcheliformes, longitudine subæqui. Styli caudales debiles. Palpus maxillarum 1marum uniarticulatus.

§ *Hyperines* of Edwards, Crust. iii, 70: *Hyperita*, Cat. Brit. Crust. Brit. Mus. 56.

|| Familiæ duæ nostræ Hyperidæ et Phronimidæ sunt Tribus "Hypérines ordinaires." Edw. (Crust. iii, 74; et *Phronimadæ* Cat. Brit. Crust. Brit. Mus., p. 56.

¶ *Hyperines Gammaroides*, of Edwards, Crust. iii, 72.

G. 1. VIBILIA, *Edw.*—Antennæ 4 breves, 1mæ obtusæ. Pedes 1mi 2dique subprehensiles.

Subfam. 2. HYPERINÆ.—Caput tumidum. Oculi pergrandes. Palpus mandibularis tenuis.

1. *Antennæ sive 1mæ sive 2dæ flagello longo confectæ.*

G. 1. LESTRIGONUS, *Edw.*—Antennæ 1mæ 2dæque flagello longo confectæ. Pedes 1mi 2dique paulo prehensiles.
G. 2. TYRO, *Edw.*—Antennæ 1mæ flagello longo confectæ; 2dæ perbreves, flagello nudo.

2. *Antennæ totæ breves. Caput oculique pergrandes.*

G. 3. HYPERIA, *Latr.*—Antennæ 1mæ 2dæque conspicuæ, 2dis gracilioribus. Pedes 2di sæpiusque 1mi subprehensiles, manibus multum imperfectis, articulo 4to ad apicem inferiorem paulo producto tantum.
G. 4. METOECUS, *Kröyer.*—*Hyperiæ* affinis. Pedes 1mi 2diqne perbreves, manibus melioribus bene didactylis confecti.
G. 5. TAURIA, *Dana.*—Antennæ ac in *Hyperiâ.* Pedes 2di non prehensiles, articulo 4to apice inferiore non expanso nec producto.
G. 6. DAIRA, *Edw.*—Antennæ 1mæ non conspicuæ, 2dæ exsertæ. Pedes 1mi 2dique plus minusve prehensiles: tarsi pedum reliquorum breves. Rami stylorum caudalium longi.
G. 7. CYSTISOMA, *Guèrin.**—Antennis pedibusque 1mis *Dairæ* affine. Tarsi prælongi. Styli caudales longi, ramis brevibus.

Subfam. 2. SYNOPINÆ.—Corpus gracilius. Palpus mandibularis sat brevis, latissimus. Oculi grandes.

G. 1. SYNOPIA, *Dana.*—Caput subtriangulatum, non oblongum. Pigmentum oculorum unicum. Pedes 1mi parvuli, prehensiles; 2di setis longiusculis confecti; 4ti subprehensiles; 5ti 6ti 7mique subæqui.

Fam. II. PHRONIMIDÆ.

Antennæ 2dæ exsertæ. Abdomen in ventrem se non flectens. Pedes 5ti 6tive sive crassi sive elongati, sæpius prehensiles, quoque 3tii 4tique sæpe prehensiles.

Subfam. 1. PHRONIMINÆ.—Abdomen versus basin sat gracile. Pedes 5ti magnâ manu didactylâ vel monodactylâ confecti; 3tii 4ti extremitate graciles, non prehensiles. Antennæ breves.

G. 1. PHRONIMA, *Latr.*—Manus pedis 5ti didactylæ. Segmentum thoracis 1mum oblongum.
G. 2. PRIMNO, *Guèrin.*—Manus pedis 5ti monodactylæ. Segmentum thoracis 1mnm non oblongum.

Subfam. 2. PHROSININÆ.—Abdomen versus basin sat crassum. Pedes 5ti prehensiles, monodactyli; quoque 3tii 4tique prehensiles. [Antennæ sat breves.]

1. *Manus pedis 5ti latæ, digito arcuato.*

G. 1. ANCHYLOMERA, *Edw.*†—Manus pedis 5ti latè et crassè subtriangulatæ. Pedes 6ti non prehensiles.
G. 2. PHROSINA, *Risso.*‡—Manus pedis 5ti latæ, oblongæ. Pedes 6ti prehensiles, 5tis fere similes, minores. Mandibulæ non palpigeræ.

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* Guèrin, Rev. Zool., i, (1842) p. 214. Species *C. neptunus* portentosæ magnitudinis ($3\frac{1}{2}''$.)
† *Hieraconyx*, Guèrin.
‡ *Dactylocera*, Latreille.

2. *Manus pedis 5ti elongatè lineares, digito recto, longissimo, tenui.*

G. 3. Themisto, *Guèrin.*—Pedes 3tii 4tique prehensiles, manibus latis.

Subfam. 3. PHORCINÆ.—Pedes 5ti 6tive valde elongati et crassi, sed manu non confecti. [Antennæ breves.]

G. 1. Phorcus, *Edw.*—Pedes 1mi 2di 3tii 4tique graciles, unguiculati, 5ti 6tique prælongi, 5ti aciculares, 6ti crassissimi.

Fam. III. TYPHIDÆ.*

Antennæ 2dæ sub capite thoraceve celatæ et sæpius replicatæ. Abdomen in ventrem sæpe se flectens. Pedes 6 postici interdum abbreviati, articulo 1mo operculiformi, interdum longitudine mediocres.

Subfam. 1. TYPHINÆ.—Abdomen in ventrem se flectens.

G. 1. Dithyrus, *Dana.*—Pedes 5ti 6tique articulo 1mo latè lamellati, articulis reliquis omnino obsoletis. Antennæ 2dæ breves, sub capite celatæ, non replicatæ, articulo 1mo longiore quam 2dus.
G. 2. Typhis, *Risso.*—Pedes 5ti 6tique articulo 1mo late lamellati, articulis reliquis paulo abbreviatis. Antennæ 2dæ biplicatæ, articulo 1mo longiore quam 2dus.
G. 3. Thyropus, *Dana.*†—Pedes 5ti 6tique articulo 1mo late lamellati, articulis reliquis paulo abbreviatis. Antennæ 2dæ 4–5-plicatæ, sub thoracis latere celatæ, articulo 1mo multo breviore quam 2dus.

Subfam. 2. PRONOINÆ.—Abdomen in ventrem se non flectens. Caput non oblongum, antennis frontalibus.

G. 1. Pronoe, *Guèrin.*—Pedes 2di non prehensiles. Pedum 6 posticorum articuli 1mi lati, reliquá parte paris 7mi fere obsoletâ.
G. 2. Lycæa, *Dana.*—Pedes 1mi 2dique subchelati. Articuli pedum 6 posticorum 1mi angusti, subæqui, reliquâ parte paris 7mi paulo abbreviatâ.

Subfam. 3. OXYCEPHALINÆ.—Abdomen in ventrem se non flectens. Caput oblongum, antennis 1mis superficiem capitis inferiorem insitis.

G. 1. Oxycephalus, *Edw.*—Caput breviter acuminatum. Styli caudales longitudine mediocres.
G. 2. Rhabdosoma, *White.*‡—Caput rostro longo styliformi armatum. Styli caudales valde elongati.

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* *Hypérines anormales* of Edwards, Crust. iii, 94. *Typhidæ*, Cat. Brit. Crust. Brit. Mus., 57.
† Species *Typhis ferox* (Edw.) is here included.
‡ Crust. Voy. Samarang, p. 63, pl. 13, f. 7.

Corrections.—Page 305, last line, for 92, read 192.—Page 306, 5 lines from bottom, for iii, read viii.

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W. J. CRAW,
First Assistant.

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Yale College, New Haven, August, 1852.

LIEBIG MEDAL.

A MEDAL of considerable artistic merit has just been issued by the celebrated medalist, FERDINAND KORN in Mayence. It has been struck in honor of the great chemist, JUSTUS LIEBIG, whose numerous friends will be happy to learn that the artist has secured the right of disposing by sale of a number of copies. The medal is of a diameter of 20 Rhenish lines. The obverse presents a striking likeness of the great chemist. The reverse presents an allegorical composition, consisting of a number of figures, among which the four principal ones are the personifications of Science in General, Chemistry, Botany, and Mineralogy, the others representing other sciences bearing upon Chemistry. The whole is a noble and spirited work of art, and an adequate tribute to the great merits of M. LIEBIG.

The medal is sold for the artist by Mr. C. G. KUNZE, Bookseller, Mayence.

September, 1852.

APPENDIX.

☞ As most of our subscribers wish the Journal continued to them without a special renewal each year, we would request all, who desire a discontinuance, to give us a definite word to that effect by the close of the current year, even in cases where the Journal may have been ordered expressly for the current year only.

The next No. of this Journal will be published on the first of Nov.

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XIV. NOVEMBER, 1852. No. 42.

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THE

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OF

SCIENCE AND ARTS.

CONDUCTED BY

PROFESSORS B. SILLIMAN, B. SILLIMAN, JR.

AND

JAMES D. DANA.

AIDED

IN THE DEPARTMENTS OF CHEMISTRY AND PHYSICS

BY

DR. WOLCOTT GIBBS.

SECOND SERIES.

No. 42.—NOVEMBER, 1852.

WITH FOUR PLATES.

NEW HAVEN:

PUBLISHED BY THE EDITORS.

[FOR AGENTS ADDRESSES, SEE NEXT PAGE.]

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THE

AMERICAN

JOURNAL OF SCIENCE AND ARTS.

[SECOND SERIES.]

Art. XXXI.—*Davis's Report on the Nautical Almanac.*

Our readers may not be aware that the American Nautical Almanac, established by Congress some three years since, and placed under the supervision of the Navy Department, is already so far advanced under the able superintendence of Lieut. C. H. Davis, that a few weeks will witness the appearance of the first volume, computed for the year 1855. The ability and position of the gentlemen charged with the execution of the work, affords the best reason for expecting a publication which shall materially add to the scientific reputation of our country.

The attention of our legislators has recently been recalled to the subject by a series of most singular resolutions offered in the United States Senate by a distinguished member of that body, whose philanthropy is evidently more enlarged than his astronomy. The resolutions of inquiry were as follows.

"*Resolved*, *&c.*, That the Secretary of the Navy be instructed to inform the Senate where and at what observatory the observations and calculations for the Nautical Almanac are made.

Why the same are not made at the National Observatory at Washington?

What expenses are necessary therefor, except the pay of the superintendent?

What progress has been made towards making a Nautical Almanac?

For how long a period the calculations of the first almanac are expected to extend?

Whether it is necessary to the perfection of the Nautical Almanac to make observations at more than one observatory: and if so, are they made at two observatories; and if so, at what two?

Whether any persons except the Superintendent have been paid for services in preparing the Nautical Almanac, and if so, how many and what compensation have they received?

When is it expected that a Nautical Almanac will be prepared for publication?

What improvement, if any, is it expected the American Nautical Almanac, when published, will have over the English?

After the first Nautical Almanac is published, will the succeeding numbers cost as much as or more than the first?

Will the same time be necessary for the second and subsequent numbers, respectively, as for the first?"

The Senate of the United States is fortunate in numbering among its members some gentlemen whose enlightened minds have been trained to scientific study in their own professions, and who are always on the alert to protect and defend the interests of the few truly scientific institutions which owe their support in any degree to the U. S. government. Mr. Pearce of Maryland, in particular, who has so often and so ably defended the Coast Survey of the United States, both when openly and when covertly assailed, was able and willing on this occasion also to vindicate the claims of true science and its practical applications in this country; and in so doing has added a new "ornament of grace" to his distinguished reputation as a Senator.

But these queries, singular as they may appear to scientific readers, have been very serviceable, as eliciting the careful and instructive report of Lieut. Davis, in reply.

The object of these few remarks is simply to introduce this report,—which we reprint entire from Senate Documents Ex. No. 88, of the present session.

ANSWER TO RESOLUTION OF INQUIRY.

1. *That the Secretary of the Navy be instructed to inform the Senate, where, and at what observatory, the observations and calculations for the "Nautical Almanac" are made.*

This inquiry comprises several distinct interrogatories, which, with your permission, I will answer separately.

The calculations of the Nautical Almanac are made at no observatory, and have no direct connection with, or dependence on the current duty of any particular observatory. The daily duties of observatories, and of offices like this, of the "Nautical Almanac and Astronomical Ephemeris," are perfectly distinct from each other. The business of the observatory proper, is to record events and appearances, and to make the calculations requisite to render these records immediately useful to the astronomer; it also endeavors to add to the sum of knowledge by the discovery of new facts, and the observation of new truths and phenomena, as exemplified by the frequent discovery of planets and comets, and the constant observation of those, the periods of which are still to be investigated—by the study of the nature of comets, of the rings of Saturn, of the comparative brightness of stars and planets, &c.

The business of the office of a "Nautical Almanac and Astronomical Ephemeris," is to *predict*, one or more years in advance, the events and phenomena, the actual occurrrence of which the observatory records, and which the navigator compares, observes and calculates while on the otherwise pathless sea, in order to pass in safety from country to country.

The calculations of the Nautical Almanac are made principally at Cambridge, the residence of the present superintendent, where the printing of the work can be conducted most expeditiously, most economically, and, what is still more important, most accurately; and where convenient reference can be had to the best scientific libraries of the country, an indispensable aid in laying the permanent foundation of a work of this magnitude and importance.

But as the superintendent of the almanac has succeeded in engaging the limited services of some distinguished mathematicians and astronomers in other parts of the Union, a portion of the computations have been made elsewhere; for example, by Professor Winlock, of Kentucky; by Mr. Sears C. Walker, of Washington; by Professor Kendall, of Philadelphia; by Professor Smith, of the Wesleyan University, at Middletown; and by Miss Mitchell, of Nantucket.

The observations used by the Nautical Almanac, that is the observations on which the fundamental laws of the astronomical prediction are based, have not been made at one observatory, but at all observatories; not at one place, but at all places of correct and well attested observation on the globe; not at one time, but in all times of authentic history.

2. *Why the same are not made at the National Observatory at Washington?*

Whenever, in the progress of theoretical investigation, or in consequence of entirely new discoveries, or for the purpose of anticipating the official publication of printed volumes, it has been occasionally desirable and expedient to have recourse to an observatory, the national observatory at Washington is the *only one* to which the superintendent of the almanac has applied for information.

The superintendent of the national observatory has been requested, for example, to make some meridian observations of stars of comparison, which were used in the reduction of those observations of the planet Mars which have been made during the last hundred years at the Greenwich observatory; to test by immediate observations the accuracy of the elements of the new planet Iris; to furnish from the records of the observatory certain information in anticipation of the next printed volume of the "Washington observations;" and to direct the attention of the observers towards the new planets discovered since the year 1827, concerning which astronomical history supplies, of course, no information, and concerning which all our knowledge is to be gleaned from future observation.

But it is the printed and published transactions of this and other observatories, in which the observations, &c., are given to the world in their reduced and complete and final form, that are employed in the large computations of the almanac, and not the separate observations made at the various instruments from day to day, in the prosecution of a great scientific enterprise.

3. *What expenses are necessary therefor, except the pay of the superintendent?*

The pay of computers, the cost of publication, including composition, press-work and correction, paper, books, &c., &c., the expense of stereotyping, the printing of auxiliary tables for computation, of blanks, of instructions, and mathematical formulas and methods.

4. *What progress has been made towards making a Nautical Almanac?*

The first volume is nearly completed, and its printing far advanced. All the main and heavy computations are done.

The progress of the printing, &c., is necessarily slow, because forms which are to be permanently adopted, are now for the first time decided upon, and because in a work of such a character, which is destined essentially to add or to detract from the scientific reputation of the nation, it is advisable to proceed with the utmost care and circumspection.

5. *For how long a period the calculations of the first almanac are expected to extend?*

For a period of one year; the first number of the almanac will be published in the year 1852, for the year 1855.

6. *Whether it is necessary to the perfection of the Nautical Almanac to make observations at more than one observatory; and if so, are they made at two observatories; and if so, at what two?*

The reply to this question is partly comprised in the reply to the first question; but it should, perhaps, be more explicitly said that no observatory, neither that at Washington nor that at Cambridge, as has been suggested, receives any portion whatever of the sum appropriated for the "Nautical Almanac" in any way whatever; and it may be proper to repeat, that no connection of any kind, either expressed or implied, exists between the Nautical Almanac and the observatory at Cambridge, or between their respective directors and assistants.

Discoveries in astronomy and accurate observation of new phenomena, are equally valuable wherever made. The optical discovery of the planet Neptune was not less interesting and available to American astronomers on account of its being made at Berlin, than it would have been if made at Washington; and the identification of this planet with Lalande's star of May 8 and 10, 1795, was not less important and useful to German astronomers because first announced from the national observatory at Washington, than if the merit of this determination had belonged to the observatory at Berlin.

The fundamental laws of planetary motion which form the basis of prediction in the pages of the Nautical Almanac, result from the study and comparison of all well authenticated observations in all periods of history. The theory of the moon's motion, on a knowledge of which depended the answer to the most important practical question ever investigated by astronomers, a problem, the solution of which was indispensable to the progress, security and growth of commerce, the problem of determining the longitude at sea, and for which the British House of Commons offered at one time a reward of twenty thousand pounds sterling, has been confirmed by the discussion of the observations made before the Christian era, by Hipparchus of Rhodes.

If all the established observatories in Europe and elsewhere, published to the world the results of their labors in the same convenient, complete and elegant form as the observatories at Washington and Greenwich, they would not be too numerous for the wants of those astronomers who devote their attention to the improvement of the theories of planetary motion. And it is from these *published* volumes, of whatever date, that the almanac derives its useful and serviceable facts and information.

The "Washington Observations" of 1846, have supplied the mean places of what are called the "fundamental stars;" and this volume, together with subsequent observations at the same instruments, not yet printed, have enabled computers to employ a more exact measure of the sun's diameter.

For this and similar reasons, it has been correctly said that the national observatory now contributes to the general sum of the requisite materials for making an almanac of our own.

7. Whether any persons except the superintendent have been paid for services in preparing the "Nautical Almanac," and if so, how many, and what compensation have they received?

A list of the computers and other persons employed in the office of the Nautical Almanac is hereunto annexed, and also a statement of the number of persons, except the superintendent, who have been paid for services in preparing the Nautical Almanac, and the compensation they have received up to the last payment.

8. *When is it expected that a Nautical Almanac will be prepared for publication?*

The reply to No. 8 is contained in that to No. 4. It is expected that the first volume will be ready for sale and distribution in about three or four months.

9. *What improvement, if any, is it expected the American Nautical Almanac, when published, will have over the English?*

The American Nautical Almanac has made improvements upon the English in the ephemeris of the moon, and that of most of the planets. It has rejected the lunar tables of Burckhardt and Damoiseau, now pronounced obsolete, and has constructed lunar tables for its own use, which embrace the corrections of Professor Airy deduced from the lunar observations made at the royal observatory of Greenwich, from 1750 to 1830, and the corrections arising from the discovery of Hansen. It is only necessary to turn to the last published volumes of the Washington or Greenwich observatory to become acquainted with the errors and irregularities that abound in the ephemeris of the moon, very often extending to one-third of a minute of arc. The determination of the longitute at sea, however, by the method known as "the lunar observation," the only method employed in the common practice of navigators, where chronometers are wanting, or are untrustworthy, or require verification or examination of their rates, depends essentially or intrinsically upon the accuracy of the moon's predicted place. Now, this error of one-third of a minute of arc involves an error of ten miles in the determination of a ship's longitude at sea.

The lunar tables prepared in the office of the Nautical Almanac, reduce the average errors in the moon's place as derived from the obsolete tables and given in the British Astronomical Ephemeris to one-third of their amount, and a distinguished gentleman of Philadelphia, Mr. Miers Fisher Longstreth, has since published an improvement of the lunar formula, which has probably reduced this remaining error by two-thirds; Mr. Longstreth's corrections have been embodied in the new tables of the almanac, and thus, owing to the genius and labors of Peirce, Longstreth, and other distinguished astronomers, the almanac has it now in its power to predict the moon's place in the heavens with a degree of precision far surpassing anything heretofore attained elsewhere. And the proof of this is at hand. Whilst the lunar tables were in the course of preparation, the Department, in a letter dated August 5, 1850, authorized the superintendent of the Nautical Almanac to publish his predictions and elements of the total eclipse of the following year, July 28, 1851, for the express purpose of testing the accuracy of the new tables, and of acquiring the means of further improvements; and on the 25th of August, 1850, the superintendent, by permission of the Department, communicated the predictions of his office to the American association for the advancement of science at that time in session at New Haven; he, at the same time, announced to the mathematical and physical section of that body, the preparation of the new lunar tables, and submitted to its criticism and approval the objects in view, and the mode in which they were to be accomplished. His communication is contained in the printed proceedings of the association at that meeting.

The event proved highly satisfactory, by showing conclusively the superiority of the lunar tables now in use in the office of the American almanac.

For the prediction at Cambridge the British almanac was in error eighty-five seconds, and the American almanac only twenty seconds.

At Washington, the British almanac was in error for the beginning of the eclipse seventy-eight seconds, and for the end sixty-two seconds. The American almanac was in error for the beginning only thirteen seconds, and for the end only one second and a half.

The observations were made by Mr. Sears C. Walker, at Cambridge, and by Professor Hubbard and Mr. Ferguson, (and communicated by Lieutenant Maury,) at Washington. Where the eclipse was total, and where, for this and other reasons, the test was more rigid and conclusive, the result was still more gratifying and decisive as to the superiority of our own lunar tables. The same tables of the moon are used in the French and Berlin almanacs as in the British; the errors, therefore, are the same. The errors exposed in this eclipse may give rise to an error of from fifteen to twenty miles in the determination of the longitude at sea by means of lunar distances, and to an uncertainty of twice that amount. The possibility of such an error, arising from this source, is removed in the American ephemeris. And it may be added that calculations of certain occultations have been made at the office of the Nautical Almanac, for the sake of ascertaining by further comparisons, to what extent the new tables answer the end in view. The examination by this method has proved equally satisfactory. But it is to be remarked here, that although the opportune occurrence of this rare and interesting event, a total eclipse of the sun, visible in some of its various phases throughout the continent of Europe, and in all parts of North America, and thus affording occasion for numerous and very valuable tests, was seized upon to compare the moon's observed place with the tabular place derived from the American tables, yet the calculation of eclipses is very far from being a chief part, but on the contrary, is an inferior and secondary part of the business of the almanac. It occupies a very small portion only of the time and labor of the computors, and a very humble place in the pages of that comprehensive work.

It may be mentioned among the benefits conferred by these lunar tables, that they bring into practical availability a large number of "moon culminations," as they are technically called, observed by the astronomers of the coast survey on the western coast of the United States, which have been hitherto lost. These observations are made on the land for the nice and accurate determination of geographical longitudes, and in that now difficult and extensive field of labor, are of the highest importance; owing, however, to the imperfections in the tables by means of which the place of the moon in her orbit is computed, no other observed "moon culminations" can be usefully applied than those which have been correspondingly observed elsewhere. That is, these "moon culminations," to be available, must be observed at the same date at two different places. In consequence of this necessity some six hundred or more of the observations made in California and Oregon, to be found in the books of the coast survey, have been laid aside "for want of moon's places more reliable than the British Nautical Almanac can give us." (Letter of A. D. Bache, superintendent United States Coast Survey, to the superintendent of the Nautical Almanac, November 20, 1851.)

These more reliable moon's places, such as are sufficiently accurate for immediate comparison with observation, being given by the new tables of the Nautical Almanac, the heretofore unavailable "moon culminations" are made at once to serve their original purpose, and the determination of numerous geographical positions in our recently acquired territory on the Pacific is rendered more expeditious and more complete.

It was said that the ephemeris of the planets has been improved. The ephemeris of the planet Mercury will be derived, for the first time, from the new and elegant theory of M. Le Verrier.

In preparing the ephemeris of Venus, with that of Mars, the correctness of Lindenau's elements of the orbits of these planets deduced from the Greenwich planetary observations from 1750 to 1830, by Mr. Hugh Breen, have been for the first time introduced. But some labor has been bestowed in combining the rough groupings of Mr. Breen in such a manner as to carry forward the corrections uninterruptedly; all his results have also been discussed anew according to the method of least squares, and the work is left in such a form that the observations of all observatories, particularly those of Washington and Greenwich, on account of the complete form in which they are given to the world, can be used from year to year for the continued improvement of the elements of the planets. The perfection of the places of these planets is the more important and valuable that they are used very constantly in lunar distances by the navigator, and their errors are highly magnified at the time they are best seen and most useful, by the greater relative change in their distances from the earth than in those of the other planets employed in this way.

In preparing the ephemeris of Jupiter and that of Saturn, as well as in those of the preceding planets, all the errors and alterations pointed out by Professor Airy in the introduction to the Greenwich Planetary Reductions, have been corrected and adopted, and the tables of Bouvard and Lindenau have been entirely remodelled and reconstructed for the convenience of computation. But it is well known to astronomers, that the theory of Jupiter and Saturn demands a thorough revision, and their combination presents a case of peculiar difficulty which has been ably treated by Professor Hansen. To prepare Hansen's theory for use in practical computation, is a work of time. It will be entered upon immediately, and will probably by completed in the course of two years.

In the case of Uranus, there are no tables which can be relied upon. Those of Bouvard possess only an historical interest for having led, by their manifest anomalies, to the famous theoretical discovery of the planet Neptune. But they must now be rejected as wholly worthless. On the 4th of April, 1848, however, Prof. Peirce communicated to the American Academy, the completion of his new theory of Uranus, giving a perfect representation of all its historical normal places; and this theory, combined with the researches of Le Verrier, will, for the first time, form the basis of the new ephemeris of Uranus.

With regard to the new planet Neptune, the world has already accepted with grateful acknowledgments the labors which American astronomers have bestowed upon it with illustrious success. The computation of the tables of the perturbations of Neptune by Prof. Peirce, and the computation of the elliptic elements of Neptune by Mr. Sears C. Walker, have resulted in the preparation of an ephemeris by the last named gentleman, which admits of no sensible correction. Observation has proved, up to this period, that the theoretical places of this planet, and that of Uranus, are more nearly perfect than those of any of the older planets.

The ephemeris of the fixed stars has also been improved by the introduction of the latest and most approved constants of precision, nutation, and aberration. In this improvement, it is just to say, the National Observatory took the lead, having occasion to construct certain star-tables for the reduction of its own observations. The preparation of tables of reductions of the fixed stars to supply the place of the standard tables of Bessel, the date of which has expired, is in progress, and has received great facilities from the previous labors of the observatory. The new constants, above mentioned, will be introduced into the formula for the reduction of the fixed stars.

The general list of occultations has been very much extended, in order to make it especially useful to geographers in general, the boundary and other surveyors of the government in the interior, to the coast survey of the United States on both oceans, and the explorers of unknown parts of the continent.

Other changes regarded as improvements might be recited. The astronomical part of the ephemeris has been adapted to the meridian of Washington; sidereal dates have been introduced; what is believed to be a more correct obliquity of the ecliptic has been adopted; and more convenient forms and a better typographical execution are kept in view. A work comprising such a multiplicity of details may admit of many similar amendments.

To the above it should be added, that an entirely new reduction has been made of the early Greenwich observations of Mars by Bradley, Bliss and Maskelyne, preparatory to a new theory and to new tables of this planet. This has conducted to a valuable discovery in stellar astronomy noticed by Humboldt in the third volume of his *Cosmos*, and to the detection of some errors of former astronomers.

A new method, with new tables, of clearing lunar distances will be given in the first number of the almanac, in which improvements are presented leading to the correction of errors of ten, fifteen, or twenty minutes in the longitude, common to the methods at present in use; which errors may, in rare cases, amount to a whole degree.

There are two other signal advantages to be derived from the publication of the Nautical Almanac, the mention of which should not be omitted; they concern the navigator, surveyor, astronomer, and geographer.

One of these is a more complete, full, and accurate table of latitudes and longitudes, particularly of American latitudes and longitudes, than is now anywhere to be found. The multiplied determinations of geographical positions form a part of the duties of the hydrographical office of the topographical bureau, and of the coast survey of the United States. They are published from time to time in the reports of these offices to Congress, and there they remain for future reference, but necssarily combined with so much other matter that, even if they were always accessible, they would not be convenient for practical use. It belongs to the Nautical Almanac to publish these positions in a suitable form; and, being an annual publication, it keeps pace with the corrections and additions of every successive year. In the particular case of the coast survey these positions are determined astronomically, geodetically, and by means of the electro-magnetic telegraph.

They comprise the light-houses, beacons, capes, headlands, shoals, points of entrance to harbors, &c., on the shores of the Atlantic, Pacific, and the Gulf of Mexico. They are indispensable to the safety of the navigator and to the security of the property under his care; and being found in the pages of that work to which he resorts for the elements of his astronomical calculations, they are always at his hand.

These positions also embrace in their number the most conspicuous towns and trigonometrical stations with their magnetic and astronomical bearings, along both sea coasts, and as far in the interior as the operations of the coast survey extend. When, therefore, the American surveyor or astronomer of a boundary commission opens the almanac for the requisite astronomical data of his observations, he may find also such terrestrial data as will answer for the proper basis of his field work, and, at the same time, as the standard of accuracy to his own independent computations. To meet his wants, some additional constants will be occasionally inserted, as height of station above the sea, mean barometric pressure, variation of the needle, &c. And as a separate list of the latitudes and longitudes of the principal observatories in this country and in every quarter of the globe is a customary part of the almanac, so the stationary astronomer will, in turn, find his purposes served. An assistant is employed in verifying the positions, in the world generally, given in the best European lists, and a suitable selection will be made from the determinations of the offices of hydrography, topography, and the coast survey, to enrich the American table with the best and most numerous list of American geographical positions extant.

Similar tables are published in the French almanac; but no such tables, with the exception of the observatories, are given in the British. This, therefore, is regarded as another improvement in the American almanac upon the latter.

The other signal advantage spoken of, relates to the subject of the tides. The conduct of a general system of tidal observations, their reduction and their scientific discussion by which is evolved the rules for the prediction of the tides, are all the property of the hydrographical and astronomical departments of the coast survey. But it is the province of the Nautical Almanac to present the results of these various labors in a manner suited to answer the practical demands of navigation and engineering. We have hitherto been indebted to the observations and discussions made in France and Great Britain for the principal part of our knowledge of these interesting and important phenomena. The tide tables of the American Statistical Almanac and Repository, as well as those of the numerous other popular Almanacs published in this country, which consist almost exclusively of the times of high and low water only, are derived directly from the tide table of the British Almanac, computed, of course, without any reference to our own coast and its peculiarities. It is another of the improvements proposed in the American Nautical Almanac, to remedy this disadvantage, the nature of which may not be understood without a word of explanation.

The subject of the tides is an astronomical problem. To trace out the astronomical laws of these phenomena, that is, their distinct dependence on the sun and moon and on the places of these luminaries absolutely, or relatively to each other, and also on the changes in the moon's distance from the earth, required the study and comparison of the actual phenomena of the tides noted without interruption, and for a long period, at some particular port. This was first effectually undertaken by La Place, who made use of a long series of observations at the port of Brest, by means of which he obtained rules for the prediction of the tides applicable to that port. These rules, though peculiar to one place, were for a long time made to answer for all places, the Brest series of tides being the only one that had been thoroughly investigated.

Subsequently, however, to the year 1830, Dr. Whewell, master of Trinity College, Cambridge, England, and Sir John Lubbock of the Royal Society of London, commenced a series of papers on the tides in the "Transactions of the Royal Society," one of the objects of which was to perform the same service for several ports in England, that La Place had rendered to Brest; to furnish, in short, those constant values in the general formulas of prediction which can only be derived from the full discussion of numerous and continuous local observations. To stimulate his labor and exercise his genius, Sir John Lubbock found ready for use a complete and connected series of tidal observations at the dry docks in London, (instituted for purposes of construction and improvement) running through nineteen years, the period of the Metonic cycle. He afterwards took up the tides at Liverpool, and accomplished there what he had previously done for London. Portsmouth, Plymouth, and other places were subsequently treated to some extent in a similar way. The result is the present tide table in the British Nautical Almanac, from which we are in the habit of taking the tide tables for the American coast, in our common annual publications, by simple differences. One book alone in the country pretends to prediction, and that of the times and heights merely of those remarkable tides which occasionally do so much injury; and in this instance, the first numbers of La Place deduced from the Brest observations, form the basis of calculation.

But it will be readily perceived that if the results obtained by La Place on the east side of the channel are not applicable to the British shores and harbors, still less are those derived from observations made on the east side of the Atlantic likely to represent the real phenomena on the American coasts. It will not perhaps be irrelevant to cite a single case under the general problem of the tides. In order to be able to give rules practically useful to the pilot, engineer and seaman, for applying to the ordinary tides, corrections depending on the moon's varying distance and declination, it is necessary to know to what meridian passage, or southing of the moon the tide is due; or, what the distance is from the land of the general tide wave that causes the local tide which the observer is actually registering; or, in fine, what is the age of the tide when it arrives at any particular part of our coast. This knowledge is the result of the careful study of a large number of observations made at various points. The age of the tide at London differs from that at Key West; and that of Key West again from that of New York, or Hampton roads.

Our exclusive dependence upon European authority for that knowledge of our coasts which no European authority can, from the nature of the case, supply, has been a disadvantage and a reproach. Both the disadvantage and the reproach the American Nautical Almanac will help to remove by making use, as it has been authorized to do, of the materials in the records of the coast survey, for furnishing a tide table founded on the actual observations of tides in our own northern and southern harbors, and their subsequent reduction and discussion in the office of that institution.

The coast survey has established several *permanent* stations, as at Boston, New York, Old Point Comfort and Key West, where a continuous series of observations is kept up for ascertaining the peculiar connections of the phenomena at each place, the constants of theoretical calculation, and the very important influence of local peculiarities, such as geographical situation, winds, and barometric pressure. At numerous intermediate places, *temporary* stations have been erected, from the registers of which are procured the best *corrected establishments.* It is true that all the results thus obtained will be found in the successive reports of the superintendent of the coast survey to Congress, or in his communications to learned bodies. But it is the recognized duty of the Nautical Almanac to lay them in a compendious form annually before the navigator, pilot and engineer, in the work to which they recur, more or less frequently, for other information needed in their professions. The British publications, as Johnston's Physical Atlas for instance, are notoriously in fault concerning these and kindred subjects. In truth, these publications must unavoidably rely on crude sources of information here, which, after being transmitted across the Atlantic return to us stamped with the seal of foreign authority, and therefore doubly pernicious. And such must continue to be the case so long as we are intellectually dependent; so long as we look abroad for those practical guide and hand-books, which we ourselves can alone create in a manner adapted to our own national circumstances, and which are indispensable to our navigators, surveyors, astronomers, and in some respects, to our engineers, for it must be remembered that the whole question of the improvement of our southern harbors rests chiefly, and to such an extent that it might almost be said wholly, on a perfect acquaintance with the tides in all their relations and effects.

One consequence of the announcement of the preparation of the American Nautical Almanac, may be noticed here. It has reduced the price of the British Almanac by one-half, that is from *5s.* to *2s. 6d.*

The counter effect of a restoration of the British monopoly in the American market will probably be a return to the former price.

10. *Is it expected that any errors of former astronomers or observers are to be corrected, or any new means suggested by which more precision is to be given to astronomical science?*

This inquiry is, for the most part, answered in the reply to the preceding question. All the improvements there recounted aim at the correction of the errors of the former astronomers, and at the attainment of greater precision in astronomical science.

But in speaking of the errors of former astronomers, it is not intended to apply that term invidiously. Astronomy, like all sciences, is formed by successive accumulations. This year there is an imperative necessity for the correction of an error which last year, owing to the comparative imperfection of instruments, or of modes of observation or reduction, was not even ascertained.

The idea of the influence or existence of a transuranian planet, like Neptune, never could have been entertained until the anomalies of Uranus were detected by Alexis Bouvard in 1821. After this it was requisite still to wait for the further development of the irregularities caused by this extraneous action, and of the inequalities in the theory of Uranus, before the problem of Neptune's existence could be successfully handled by the genius of Le Verrier and Adams.

The active and inventive minds of our countrymen have recently discovered and brought into successful operation a new method of recording astronomical observations, which enables the observer to perform in one night the work of several nights under the old system, and is much more accurate.

This, which is known by distinction in Europe as the *American method*, leads to the detection of former errors. But neither in this nor in similar cases, are the errors regarded otherwise than as unavoidable defects, unveiled and remedied in the continually advancing progress of the science; and to this progress it may be said, the Nautical Almanac will make a valuable contribution. With the authority of the Department, Mr. Sears C. Walker has executed for that office the great task of computing the numerical values of what are technically known as the "Le Verrier coefficients of the perturbative function."

The eminent design of this undertaking is to correct the errors of former astronomers, and to create the means by which more precision is to be given to astronomical science.

11. *After the first Nautical Almanac is published, will the succeeding numbers probably cost as much or more than the first?*

After the first volume of the Nautical Almanac is published, it is estimated that the sum of $19,400 will be the probable cost of the succeeding volumes; and this sum is not more than sufficient to allow the first class computors, who must be gentlemen of liberal education and of special attainments in the science of astronomy, the lowest salary paid for similar services in other offices of the government. The annual estimate for the British Almanac is between sixteen and seventeen thousand dollars; but, generally speaking, intellectual labor commands a higher compensation in this country than in Great Britain.

A portion of the appropriation will be returned into the treasury every year when the sale of the book commences. The cost of the first number includes the expense of the various works of preparation already detailed. These preparatory productions are permanently useful; they are the instruments to be employed in the computation of all future numbers. If the American Almanac should be continued uninterruptedly for as long a period as the British has existed, the cost of preparation, thus distributed, would amount to about two hundred and twenty-two dollars a number.

12. *Will the same time be necessary for the second and subsequent numbers, respectively as for the first?*

The succeeding numbers of the almanac will appear annually, three years in advance of the year for which they are computed, according to the custom in England, France and Germany. The time spent in the computation of each number will be one year.

Finally, in reply to this resolution in general, let it be said that the *Nautical Almanac and Astronomical Ephemeris* is not a work of insignificant value, or of trifling labor. It has been viewed by the Department, and is considered by American astronomers and mathematicians as a work of consummate utility and of real national importance, resembling in this respect the *Nautical Almanac and Astronomical Ephemeris* of Great Britain, the *Connaissance des Temps* of France, and the *Astronomical Annual* of Prussia.

In laying the foundation of a work of this character, it was due to the scientific reputation of the country, already established and widely extended by the coast survey and the national observatory, that the most careful regard should be had to the advanced and advancing state of modern astronomical science, and that the highest attainable accuracy should be secured by the application of the most improved methods. It is on these conditions and with this character only, that the Nautical Almanac would venture to ask, or would be entitled to receive, the support of Congress. On any other conditions and with any other character, it would bring discredit upon the nation.

The foregoing pages are intended to reply to the several interrogatories contained in the resolution of the Senate. But the present seems to be an appropriate occasion for offering a succinct explanation of the nature and objects of the work entitled "The Nautical Almanac and Astronomical Ephemeris."

This work, published annually, each number of which consists of between five and six hundred pages, embraces all the elements necessary for determining at any time the absolute and relative places of the sun, moon, and seven principal planets, of many of the largest and most useful of the fixed stars, together with several different series of phenomena for the determination of longitudes, as occultations of fixed stars and planets by the moon, distances of the moon from fixed stars and planets, combined transits of the moon and certain fixed stars, eclipses and configurations of Jupiter's satellites, &c.

To these are added the places of the minor planets and their elements, rules and tables for practical use in nautical astronomy and land observations, new rules and methods whenever invented, tables of tides and geographical positions, and a chapter explaining the plan of the work and the mode of applying its various parts in practice, in which is included some elementary scientific instruction.

These details are the results of numerous, laborious, and complicated calculations. Strict uniform accuracy is an indispensable requisite. In the case of the mariner, errors expose life and property to danger; and in that of the astronomer on the land, they cause a waste of time and labor, and not seldom the irretrievable loss of valuable opportunities. None of the precautions, therefore, that experience has pointed out for the attainment of correctness, and for security against mistake, are neglected.

The Nautical Almanac is stamped by this circumstance with a peculiar character. Unfailing precision and exactness are the absolute conditions of its usefulness and respectability. But every person of experience knows that neither such extensive computations, nor the printing of so many figures, can be conducted with entire freedom from error; and to remedy this defect, inherent in such productions, the errors detected are printed and the corrections applied in the subsequent volumes, probably before the former come into general use.

The calculations of the Nautical Almanac in reference to the sun, moon, principal planets, &c., are in the case of each one of them, based upon our knowledge of their motions and the laws by which they are controlled, derived from the general theories of celestial mechanics, and from observations which, while they test the truth of the general theory, lead to the discovery of new facts and data, to the detection of other laws, and to the inference of new generalizations.

The observations thus employed comprise all the calculations of good authority, which from age to age have accumulated in the rich treasury of astronomical science; ending with the latest publications of existing observatories, and going back to the beginning of authentic history. In order suitably to convey our knowledge of the laws governing the motions of the heavenly bodies, and regulating their more or less rapid change of place, and to put this knowledge in a form adapted to the wants and uses of the computer, numerical tables have been prepared of the sun and the planets separately, which constitute the abbreviated expressions of these laws.

The numerical tables greatly facilitate the labor of computations; they are the computer's tools of trade.

To construct these tables; to make, compile, and arrange these observations; to discuss them; to discover and investigate the theories and laws; and to invent that kind of logic, the higher mathematics, by which alone such investigations can be profitably pursued and their results succinctly defined, have been the occupations in every enlightened age of the most illustrious genius and the most exalted talents. And a correct and well conducted astronomical ephemeris, which comes up to the latest standard of modern improvement and discovery, is to be regarded as the full exponent of all this human thought and labor.

But from this very compendious exposition of the scientific character of the "Nautical Almanac and Astronomical Ephemeris," of the intellectual basis on which it rests, it may be well to turn to an inquiry into its practical utility, into the manner in which it has benefited mankind; for knowledge is always instrumental in promoting the best interests of humanity.

The primary motive for computing and publishing the Nautical Almanac, was to promulgate the lunar method for determining the longitude at sea, and to furnish the requisite elements and precepts for the computation of this problem. This was as early as the year 1767. Its appearance created a new era in navigation, to which it is now acknowledged to have rendered more essential service than any thing of the kind ever undertaken. But the old lunar method of Maskelyne was very defective, owing to the existing state of astronomical science and instruments. As the instruments of the seaman and the astronomer, however, were improved, and astronomy itself advanced, corresponding changes were made in the almanac, which, since its first foundation has always kept up with the progress of knowledge and art; if not *pari passu*, at least without lagging behind for any great length of time.

It was discovered, soon after its publication was begun, that the work was destined to obtain general circulation as an astronomical ephemeris for the use of observatories, and that it would be impracticable, even if desirable, which it was not, to separate pursuits of practical science so closely allied to each other, and so effectually promoted by the same means. In the progress of time, therefore, as the pages of the almanac were multiplied and their contents varied to meet the wants and conveniences of nautical astronomy, so the usefulness and suitableness of the work for the daily duties of observatories were increased, until it has become less indispensable to the fixed observer on the land than the floating observer on the sea. And this could not be otherwise. The improvement of navigation is intimately connected with and dependent on the improvement in practical astronomy. The security of the mariner, the advancement of the geographer, and the refinements of the astronomical observer are harmoniously united and benefited by similar provisions.

To these considerations the "Nautical Almanac and Astronomical Ephemeris" is indebted for its present character and condition.

On one hand, it is the text-book of the navigator. It informs him of his place on the ocean, where there are no other guides than the sun and stars. It is his intellectual rudder and compass; without it no ship-master leaves the shores of the United States. When he loses sight of the last light-house or head-land, he turns to that for his further direction.

On the other hand, it is the *vade mecum* of the astronomer, whether stationary or travelling. He learns from it in the fixed observatory how his instruments must be *set* that he may see any particular body, and what is the precise moment for observation: and in the movable observatory he turns to its pages to ascertain how, on any given day, he can best determine his latitude and longitude, the astronomical bearings of his stations, and the rate and error of his chronometer. Thus, as the tables of the Almanac owe their origin to the labors of the observatories, so they repay the obligation by affording the most ready and complete facilities by which those labors are, at the present time, safely and expeditiously conducted.

Such are the general character and objects of the Nautical Almanac; but the American Nautical Almanac, besides sustaining this character and fulfilling these objects, will, it is expected, remedy some defects, and accomplish some special ends, which no similar work prepared in Europe is qualified to take into account.

And what these ends are, may be gathered from a consideration of the isolated position of this vast continent of North America, in respect to the other great divisions of the globe, the enterprising character of the people, and the wide extent of territory that still remains to be explored, surveyed and settled.

This consideration makes it apparent that neither the authorities nor standards of Europe can satisfy our demands.

In the useful arts of life, the United States have no superior, and but one rival; in the successful application of the sciences to the useful arts the nation has already accomplished signal performances; and in the present case of a Nautical Almanac, which has been regarded as a beneficial example of such application by every nation undertaking it, the very work which consults the practical wants of the community, has proved in a high degree subservient to the advancement of science and the diffusion of sound knowledge.

Art. XXXII.—*Notes on the Cereus giganteus of South Eastern California, and some other Californian Cactaceae;* by Dr. Geo. Engelmann, of St. Louis, Missouri.

In Emory's *Notes of a military Reconnaissance*, published in 1848 by order of Congress, I have ventured, from the data furnished by Col. Emory, to describe one of the largest Cacti ever known. Since then several travellers have met with this giant of the Gila country, and have confirmed the extraordinary accounts of the first discoverer. But no further scientific details were obtained till Col. Emory, now again in those regions, as the chief of the scientific corps of the U. S. boundary commission, had occasion early this spring (1852) to send an expediton down the Gila river. Dr. C. C. Parry, who was connected with this party, paid particular attention to the Cacti of that region, and made it an especial object carefully to examine the *Cereus giganteus*. From his very full notes, kindly communicated by Col. Emory, I have completed the description of the plant, with the exception of the flower and fruit, the account of which rests as yet on the verbal information obtained by Dr. Parry.

Cereus giganteus, *Engelm. in Emory's Rep.*, p. 158.—Erectus, elatus, simplex, sæpius parce ramosus; ramis erectis caule cylindrico versus apicem sensim attenuato brevioribus; vertice parum depresso lanato; costis ad basin 12 versus apicem 18-20 rectis compressis obtusiusculis (versus basin obtusissimis) subrepandis; sinubus profundis angustis; areolis prominentibus orbiculatis albido-tomentosis; aculeis rectis, radialibus 11–17 brevioribus setaceis albis, centralibus 6 robustioribus longioribus (quorum imus robustissimus deflexus) tenuiter sulcatis albidis basi bulbosa nigris apice rubellis; floribus .... bacca ... seminibus oblique obovatis nigris lævibus lucidis.

Dr. Parry found this splendid species, which the Indians name "Suwarrow," in rocky crevices and on gravelly table lands, from Tueson, north to the Rio Gila; he learned that it also occurs in Central Sonora, near the heads of streams which empty into the Gulf of California. Col. Emory observed it in 1846, from the middle towards the lower Gila; and Dr. LeConte, who explored California in 1850, informs me that he found it "common along the Gila to within thirty miles of its mouth, where it suddenly disappears." It is no doubt the same plant of which Humboldt makes mention in his work on New Spain, (II, p. 225,) where he says that the Spanish missionaries found at the foot of the Californian mountains nothing but sand or rocks, on which grew a cylindrical Cactus (Organos del Tunal) of extraordinary height.

Stems 25 to 60 feet high and 1 to 2 feet in diameter, not absolutely cylindrical, but thickest about the lower third, where generally the few (mostly 2–3) alternate or sometimes opposite branches start, and from thence slightly tapering toward the summit. Stems and branches marked by superficial transverse furrows, indicating, as it seems, the annual periods of growth, forming rings of 4 to 8 inches in height. Branches unequal, and always of less height than the main stem, mostly 5–10 feet long, with 12–18 ribs.

The stem consists of an exterior fleshy substance, 3–6 inches in thickness; this encloses a circle of bundles of ligneous fibres, corresponding with the intervals between the ribs; these bundles are of a loose texture, but tough and elastic, and form continuous columns or sticks of one-half to three inches in diameter, frequently anastomosing, increasing in thickness towards the base, and swelling into irregular, knotted, horizontally spreading roots. This frame-work remains after the decomposition of the fleshy parts. The exterior fleshy tissue passes between the bundles and forms in the centre of the stems the pith, of 4–6 inches diameter.

The ribs are mostly vertical, at the base about 12 in number, broad, rounded, 4 inches or more wide, with broad and shallow intervals, (also 4 or 5 inches wide,) worn, and destitute of spines.

Upwards, the number of ribs increases by bifurcation, or additional ribs originate in the intervals. There the ribs are "sharply rounded," 1½ inch wide, with deep intervals, 2¼ inches wide, densely set with spines. Areolæ somewhat elevated, circular, one inch distant from another. Radiate spines ½–¾ inch long; central spines stouter and longer; the lowest deflexed, ½–2½ inches long, the two next lateral, the three upper ones pointing upwards and outwards, and shorter.

Dr. Parry was informed that the flowers were produced in May and June, from the summit of stem and branches; they are said to be white, with a red centre, and three inches in diameter. The fruit matures in August, and is set with small spines: it is obovate, one and a half inches in diameter, red, pulpy, of sweet taste. The seeds obtained by Col. Emory and by Dr. LeConte have already been noticed in Emory's Report; they are 0·7 lines long, obovate, obliquely truncate at base, black, smooth, shining. Embryo hooked, without an albumen; cotyledons foliaceous, unequal, incumbent.

My opinion that our plant is a true *Cereus* and not a *Pilocereus*, which was based on the structure of the seeds (the foliaceous, not globose cotyledons), appears to be further confirmed by the fact that this Cactus bears no hair-like spines, and no *cephalium*, or distinct woolly head, and that the fruits are (as is said) spinulose and not scaly. It is by far the largest *Cereus* known; and only some *Pilocerei* approach it in size.

The only *Cactaceæ* thus far known to grow in California were those vaguely noticed by Humboldt (the "Organos del Tunal" and some Opuntiæ); the *Echinocactus viridescens* and *Cereus Californicus* discovered by Nuttall in 1834; the Cacti found on the Gila by Col. Emory in the fall of 1846 and mentioned in his report; *Mamillaria Goodrichii*, lately described by Scheer, of Kew, and *Echinocactus Californicus* of Monville.

Dr. Parry has in the years 1849 and 1850, when he was also attached to Col. Emory's corps in the survey of the Mexican boundary, examined and described ten or eleven distinct species of Cactaceæ, all found along the southern boundary of California, from the sea-coast to the mouth of the Gila. He, as well as Dr. LeConte, states that much farther to the north no species of this family are found, except an Opuntia, cultivated and now naturalized about the missions.

I subjoin here a short memorandum of Dr. Parry's Californian Cactaceæ, reserving a fuller description for a more extended memoir.

1. Mamillaria tetrancistra, n. sp.: subglobosa; aculeis radialibus brevibus albis numerosis, centralibus 4 longioribus cruciatis uncinatis; floribus centralibus parvulis flavido-rubellis; stig-

matibus 3; bacca coccinea pyriformi; seminibus nigris hilo spongioso fusco auctis.

From San Diego to the junction of the Gila with the Colorado. —*M. Goodrichii*, Scheer, obtained on the island of Cerro on the coast of California, is distinguished by the lower central spine only being hooked, by much smaller tubercles, etc.

2. Echinocactus viridescens, *Nutt.* Depressed; berry subglobose green, coated with lunate membranaceous scales. On dry hills and ridges near San Diego.

3. E. viridescens, β? cylindraceus, is distinguished by its oval or cylindrical shape, larger size, longer spines. Found near San Felipe, on the eastern slope of the California mountains.

Note.—E. Californicus, *Monv.*, is the name of young plants raised from seed in Europe. I am informed that neither the identity nor the native country of these seedlings is satisfactorily known.

4. Cereus Emoryi, n. sp.: caule prostrato; ramis erectis cylindraceis 15-costatis; aculeis radialibus 40–50, centrali singulo robustiore porrecto; bacca globosa spinulosa.

In thick patches, on dry hills near the sea shore, about the boundary line. Erect branches 6–9 inches high.

5. C. Engelmanni, *Parry in litt.*: caulibus pluribus pedalibus; costis 13 tuberculatis; aculeis 4 centralibus inæqualibus radiales tenuiores superantibus; bacca ovali aculeata pulposa.

Mountains about San Felipe, on the eastern declivity of the Cordilleras.

Note.—C.? Californicus, *Nutt. in Torr. and Gray's Flora*, is most probably a cylindraceous Opuntia, with "small yellow flowers," which I cannot now identify.

6. Opuntia Engelmanni, *Salm.* San Diego, on dry hillsides, in patches, 4 to 6 feet high. Originally discovered about Chihuahua, this species appears to extend westward to the Pacific.

7. O. Tuna, *Mill.*, is cultivated for fences, and naturalized about the missions; called "Tuña." It is 10–15 feet high; the fruit large and edible.

8. O. prolifera, n. sp.: caule erecto ligneo; ramulis cylindricis tuberculatis divaricatis; aculeis fuscis vaginatis; bacca spinulosa.

San Diego, on arid hills and in dry creek beds. Plant 3–8 feet high, forming impenetrable thickets. Near *O. arborescens* of New Mexico; but the red flowers smaller, the berry spinous, etc.

9. O. serpentina, n. sp.: procumbens; articulis cylindricis elongatis tuberculatis; aculeis 7–9 vaginatis; bacca sicca hemisphaerica aculeatissima.

Dry hillsides, San Diego.

10. O. ramosissima, n. sp.: caule erecto ligneo divaricato-ramosissimo; articulis gracilibus cylindricis tuberculatis cæsiis; aculeis subsolitariis saccato-vaginatis; bacca sicca tuberculata setosa et aculeata.

Gravelly soil near the Colorado, and in the desert. Plant two feet high; the joints half an inch in diameter. Approaches the Opuntia cylindraceæ graciliores.

11. O. Parryi, n. sp.: caule prostrato; articulis adscendentibus tuberculatis; setis fuscis; aculeis brevibus albidis, singulo longiore deflexo; bacca subglobosa setoso-aculeata.

Eastern slope of the California mountains, near San Felipe. Joints four to eight inches long; the longest spines half an inch long. Flower one and a half inch in diameter, yellowish-green. Approaches the Opuntiæ clavatæ.

Mr. Charles Wright, well known to the botanical world by his collections made in the southwest, now also attached to the Mexican boundary commission, has, under the instruction of Col. Graham, made large and interesting collections of Cacti in western Texas and southern New Mexico, and sent them to me for examination.

It is impossible here to give as full an account of them as would be desirable; but most of them are now in cultivation and will be described hereafter. Most of the Cactaceæ discovered by Wislizenus, Fendler and Gregg are among them, together with a considerable number of new species. I will here only state that my doubts in regard to the fruit of *Cereus Greggii*, expressed in my account of the plant in Emory's Report, have been entirely dispelled by Mr. Wright. He says that the plant is large, much branched, has a very large fleshy root, generally implanted in hard stony soil, and the pulpy scarlet fruit is just as figured in Emory's Report, stiped at base and attenuated above. The seeds he sends are black and opaque, rugose and pitted, about one line in diameter. They have germinated well with me. This same plant has been sent from Chihuahua to Kew by Mr. Potts; and has been described by Prince Salm as *Cereus Pottsii*, which name however must give way to the prior name, *C. Greggii*. It is every way a very singular plant, and though found from western Texas and Chihuahua to El Paso, the copper mines, and the lower Gila, appears to be rare every where.

ART. XXXIII.—*Examination of some American Minerals;* by T. S. HUNT, of the Geological Commission of Canada.

Columbite.—THE specimen here described is from a locality at Haddam, Connecticut, in which the mineral was recognized by myself, while visiting the place, six years since. It occurs some two miles from the famous locality of chrysoberyl, where also columbite is met with in minute crystals, and is in a huge granitic vein traversing gneiss. The vein is made up of large cleavable forms of yellowish-white feldspar and brown muscovite, with quartz and beryl. The latter mineral is sometimes found in crystals four or five inches in diameter, and a foot or two in length; these are subtranslucent and brownish or greenish-yellow, while the smaller crystals are sometimes almost transparent, of a topaz-yellow or straw color, and if they were not fissured, would constitute gems. They are frequently modified by truncations of the terminal edges and solid angles, but the edges are rounded, and do not admit of accurate admeasurement. The columbite occurs disseminated through the vein, alike in the feldspar, mica and beryl; some of the crystals were said to have been several ounces in weight, and had been carried off by ameteur collectors as specular iron; a crystal since procured from the locality by Prof. Silliman, Jr., weighs 36 ounces. The smaller crystals were abundant and often beautifully perfect, some of them are imbedded in translucent yellow beryl, and have the form represented in figure 1, p. 401 of Dana's Mineralogy, 3d edition.

The hardness of the columbite was about 6, and the specific gravity of a crystal of two grammes weight was 5·85. Lustre, sub-metallic; color, iron-black with a steel-blue tarnish, often very brilliant; powder, dark chocolate-brown. The finely pulverized mineral was decomposed in the usual way by fusion with bisulphate of potash, and the insoluble residue was digested with hydrosulphate of ammonia, but no tungstic acid was taken up, and only a trace of tin. The metallic acid was then washed with hydrochloric acid and with water, to remove a trace of sulphuret of iron, dried and ignited. The acid filtrates yielded with sulphuretted hydrogen, no indications of copper or lead, and the iron and manganese were precipitated by the addition of ammonia and hydrosulphate of ammonia, and afterwards separated by a succinate. The alkaline filtrate from the sulphurets contained a little lime, which was precipitated as oxalate. The following results were obtained:

Metallic acid,	80·60
Protoxyd of iron,	15·57
" of manganese,	3·25
Lime,	·50
Oxyd of tin,	a trace
	99·92

The composition is identical with that of the Bavarian and Middletown columbites; like the latter, the Haddam specimens appear to contain principally niobic acid.

Samarskite.—This species was announced two years since by Prof. C. U. Shepard as existing in the auriferous gravel of Rutherford County, North Carolina. This conclusion was based upon the hardness of 5·5, and a specific gravity of 5·69, conjoined with the general physical characters of the specimens, which were those of samarskite; no chemical examination having been made by him. Last autumn, however, he placed in my hands a fragment of the mineral, which I have submitted to examination; the results show the correctness of Prof. Shepard's conclusion.

The specimen at my disposal was a worn and rounded fragment weighing about ·7 grammes, and having adherent a small portion of iron-stained quartz, near to which it was penetrated with a yellowish earthy matter, which made my determination of the specific gravity a little below the truth; it was 5·45, and the hardness was 6. Externally the color was dull iron-black; the fracture was perfectly conchoidal, and exhibited a velvet-black color, and a splendent vitreous lustre like obsidian; it was very brittle, and the fragments were perfectly opaque, even on the edges. The powder was a dark reddish or clove-brown color, and acquired a sub-metallic lustre under the pestle. Heated in a tube, the mineral decrepitates slightly, but gives off no water; the powder becomes of a pale chocolate color.

When the pulverized mineral is heated to boiling with concentrated sulphuric acid, it is readily and completely decomposed, and forms a grayish and gelatinous mass, which yields with cold water an opalescent solution. Upon the application of a gentle heat, a snow-white flocculent precipitate separates, and the transparent filtrate is not disturbed by ebullition. The moist precipitate when heated with several volumes of strong sulphuric acid becomes as before apparently soluble in water, but is entirely separated in a flocculent form by a heat below the boiling point. When fused with an excess of bisulphate of potash, the precipitate was completely dissolved, but on digesting the crystalline mass with cold water, it was entirely left behind in an insoluble form. Having been washed and ignited, the precipitate was fused with hydrate of potash in a silver crucible; the mass was soluble in water, and the cold solution gave a copious white flocculent precipitate with hydrochloric and sulphuric acids. The solution with hydrochloric acid and a fragment of zinc gave a fine blue color, rapidly becoming of a dirty hue, and finally changing to brown. On adding tincture of galls to the solution slightly acidulated with hydrochloric acid, the precipitate assumed a very bright orange-red color. The addition of tincture of galls to a solution which had been partly precipitated by hydrochloric acid, but was still feebly alkaline, gave a pure orange-colored precipitate, more dense than the last; the supernatant liquid blackened in the air; a strongly alkaline solution assumed a deep orange-brown color, but gave no precipitate. The precipitate in the slightly acid solution gave with ferrocyanid of potassium a bright reddish-fawn color, resembling persuccinate of iron. These reactions according to Rose are characteristic of *niobic acid* unmixed with tungstic acid. The metallic acid from the Haddam columbite gave precisely similar reactions.

The liquid filtered from the niobic acid, and holding in the form of sulphates, the soluble portions of the mineral, gave no precipitate with sulphuretted hydrogen; it was boiled with a few drops of nitric acid, and mixed with ammonia, which gave an orange-fawn colored precipitate, that became black on the addition of hydrosulphate of ammonia; the filtrate was not affected by phosphate of soda. The precipitate was dissolved in hydrochloric acid, boiled with some nitric acid, and again precipitated by ammonia; the filtrate was not disturbed by hydrosulphate of ammonia. The orange colored precipitate was now digested with a solution of carbonate of ammonia, which dissolved a portion and assumed a yellow color; on filtering and boiling the ammoniacal solution, a yellowish matter separated, which was dissolved by dilute hydrochloric acid, and thrown down by ammonia as a lemon-yellow flocculent precipitate, which became greenish-black on ignition, and gave before the blowpipe the reactions of *oxyd of uranium.* With microcosmic salt in the outer flame it yielded a yellowish-green glass, which became bright green in the inner flame, and on cooling remained emerald-green and transparent.

The portion not dissolved by the carbonate of ammonia was dried and ignited; it dissolved in hydrochloric acid with an evolution of chlorine. Oxalic acid being added to the solution, a pale rose-red granular precipitate fell; ammonia was now added in slight excess, and a farther portion of oxalic acid to restore the acid reaction. After some hours, the precipitate was collected, washed, and ignited; it was fawn colored, and readily soluble in nitric acid diluted with fifty parts of water. The concentrated nitric solution gave with sulphate of potash a small portion of a crystalline double salt, insoluble in a solution of the sulphate, and the oxalic solution gave a minute portion of a similar precipitate. The two being united, were dissolved in boiling water, and decomposed by potash; the precipitate was chesnut colored after ignition, and was partially soluble in dilute nitric acid, leaving a chesnut-brown residue. These characters indicate *oxyd of cerium* mixed probably with lanthanum and didymium. The substance precipitated with the cerium by oxalic acid, which was also thrown down by ammonia, was insoluble in potash, and but slightly soluble in solution of carbonate of ammonia, yielded no insoluble salt with sulphate of potash, and was soluble in dilute acids after ignition, was regarded as *yttria*, to which alone all these characteristics belong. The two filtrates from the double salt of cerium, containing yttria and a persalt of iron, were mixed and precipitated by potash; the ignited precipitate dissolved in hydrochloric acid with a slight odor of chlorine, indicating a remaining trace of ceric oxyd. Tartaric acid and ammonia in excess having been added to the solution, the iron was thrown down as sulphuret, and on boiling the filtrate a white bulky precipitate fell, which carbonized on ignition, and finally left a whitish residue, readily soluble in hydrochloric acid with a slight evolution of chlorine, and yielding a solution which was copiously precipitated by ammonia, and left on spontaneous evaporation a crystalline salt, which was not deliquescent.

The quantitative analysis was performed upon ·405 grammes of the mineral, which lost ·001 grm. by ignition. It was decomposed by sulphuric acid, and the bases separated by the processes just described; these are not exact, as yttria and oxyd of cerium are both somewhat soluble in an excess of solution of carbonate of ammonia, but the oxyd of uranium first separated by digestion in the ammoniacal solution, appeared by the reaction with microcosmic salt to be free from yttria; it was found in the qualitative examination, that by digesting the oxyds a second time with carbonate of ammonia, a portion of a base yielding an insoluble salt with sulphate of potash was taken up, and very little uranium. The residue from the calcination of the oxalate, which contained the yttria and the oxyd of cerium, with the exception of the trace of the latter in the oxalic solution, weighed ·060. If from this we subtract the weight of the ceric oxyds which was ·016, there remains ·044 grammes for the yttria. Subsequently, the solutions of iron and yttria being mingled, the weight of the mixed oxyds was ·108, while the amount of peroxyd of iron separated from this was ·063, leaving a difference of ·045 grammes for the yttria. The analysis of the ·405 grammes gave the following results:

Niobic acid, ...	·222	=	54·81
Peroxyd of uranium, ...	·069	=	17·03
Protoxyd of iron, ...	·057	=	14·07
Yttria, ...	·045	=	11·11
Oxyds of cerium, etc., . . .	·016	=	3·95
Loss on ignition, ...	·001	=	·24
	·410		101·21

This analysis agrees very closely with the results obtained by Perez under the direction of Rose, from the samarskite or uranotantalite of the Ilmen mountains; this according to Rose, is identical with the yttro-ilmenite of Hermann, which the latter conceives to contain a new metallic acid called ilmenic acid, associated with titanic acid, yttria, oxyd of iron, and a little uranium. The samarskite of North Carolina resembles Hermann's mineral in containing oxyd of cerium, which is not indicated in the analyses of Perez, but the presence of titanic acid could not be detected, and the metallic acid present has been already shown to have the characters assigned by Rose to niobic acid. Rose has proved that the ilmenic acid of Hermann is the niobic contaminated with a little tungstic acid.

Rutherfordite.—Under this name Prof. C. U. Shepard has described as a new species, a mineral which is found with samarskite, rutile, brookite, zircon and monazite, in the gold washings of Rutherford County, North Carolina. A small fragment of ·273 grammes weight, given me by Prof. Shepard, has enabled me to make a partial examination of the proposed species. It was a rounded pebble, iron-black exteriorly, and not at first sight distinguishable from the samarskite; it yields to the knife with difficulty, and has a hardness probably of 5·5; its specific gravity is 5·55 (5·58–5·69, Shepard.). The fracture is perfectly conchoidal, and the lustre vitreo-resinous, shining; the color of the fresh surface is blackish-brown; thin fragments however are translucent, and transmit a smoky orange-brown light. This mineral is very brittle, and its streak and powder are of a yellowish-brown approaching to fawn color, and completely earthy in appearance; by the streak and by its translucency, rutherfordite is readily distinguished from samarskite, which it otherwise closely resembles. Exposed to heat in a glass tube, it decrepitates slightly and gives off a little water; the mineral on cooling is dark yellowish-brown with a resinous adamantine lustre, in appearance resembling some varieties of blende.

A portion of the pulverized mineral weighing ·164 grammes, which had not been artificially dried, lost by strong ignition over a spirit-lamp ·003 grammes, and assumed a light cinnamon-brown color; no glow was observed during the process. It was decomposed by prolonged boiling with concentrated sulphuric acid, and was then completely soluble in a large volume of warm water. The clear solution became turbid on boiling, and threw down a white precipitate, which adhered in part to the surface of the glass vessel, but was completely dissolved by heated strong sulphuric acid even after ignition, and was thrown down again by ammonia as a voluminous precipitate which glowed brilliantly when ignited. The solution gave with tincture of galls a deep reddish-brown precipitate; it was regarded as titanic acid. The amount precipitated by prolonged ebullition was ·096 grammes =58·5 per cent. The filtrate gave with ammonia a small amount of reddish gelatinous precipitate, which contained a trace of oxyd of iron; it was examined without success for alumina, and gave with sulphate of potash no satisfactory evidence of the presence of oxyd of cerium; it was perhaps only titanic acid; the ammoniacal filtrate gave about 10 per cent. of lime. An accident having occurred at this stage of the process, I had no means of determining whether there were present any other ingredients than titanic acid and lime, but I hope for a farther supply of the mineral which may enable me to complete its analysis. Meanwhile by its specific gravity, which is greater than that of perovskite or polymignite, it is distinguished from any titanate hitherto described, and is entitled to the rank of a distinct species.

Prof. Shepard in his qualitative examination of the rutherfordite, having separated a portion of titanic acid by boiling the sulphuric solution, added ammonia to the liquid and obtained a precipitate, which when redissolved in hydrochloric acid and mixed with a solution of sulphate of potash gave a very copious granular precipitate, in which, from some characters, he suspected the presence of oxyd of cerium, It is not improbable that this reaction arose from the presence of a peculiar form of titanic acid, which has never to my knowledge been described.

The sulphuric solution of ignited titanic acid is not affected by sulphate of potash, and the titanic acid precipitated by ammonia from this solution, and redissolved in hydrochloric acid, gives no precipitate either with sulphuric acid or a solution of sulphate of potash. If however the sulphuric solution is heated to boiling, so as to precipitate a small portion of the titanic acid, that which remains dissolved is found to have acquired peculiar properties. If it is thrown down by ammonia, carefully washed and dissolved in dilute hydrochloric acid, the solution is scarcely disturbed by ebullition, but the addition of a few drops of dilute sulphuric acid, a crystal of sulphate of potash, or any soluble sulphate, in the cold, produces an immediate copious, white, flocculent precipitate, which includes almost all of the titanic acid present. It may be washed with water, in which it is insoluble, and now seems to contain but a trace of sulphuric acid; it is soluble to a considerable extent in heated dilute hydrochloric acid, from which a sulphate again precipitates it. It is also somewhat soluble in dilute sulphuric acid, especially when aided by heat, but even from this solution is separated by sulphate of potash, which likewise causes a copious precipitate in the original boiled sulphuric solution, perhaps by changing the free acid into bisulphate. The hydrochloric solution of the ordinary form of titanic acid, assumes the same characters when heated to ebullition.

A solution of ilmenite in hydrochloric acid, effected at a gentle heat, contains the ordinary form of titanic acid, but that dissolved from sphene under similar circumstances, has the characters of the new modification. When the acid precipitated from this solution by sulphuric acid, is ignited and dissolved in sulphuric acid, or when concentrated sulphuric acid is employed to decompose the sphene, the titanic acid is obtained in the ordinary form, and is converted into the new modification by diluting and boiling its solution.

This state of titanic acid corresponds perhaps to the soluble form of the *metatitanic acid* of Demoly, who has described under that name the insoluble form of titanic acid thrown down on boiling its sulphuric solution, and existing in salts as Ti_3O_6, corresponding to an anhydrous monobasic acid. The real nature of this modified titanic acid, and the action of sulphuric acid in thus precipitating it from its solutions, are questions which I propose to examine at the earliest opportunity.

Montreal, C. E., July 4th, 1852.

Art. XXXIV.—*Additional Notes of a Discussion of Tidal Observations made in connection with the Coast Survey at Cat Island, Louisiana;* by Prof. A. D. Bache, Superintendent U. S. Coast Survey.*

In my communication on the subject of the tides at Cat Island, coast of Louisiana, at the New Haven meeting of the American Association,† I showed that I had succeeded in decomposing the curves of rise and fall into a diurnal and semidiurnal curve, which were nearly curves of sines; the diurnal curve having its maximum approximately nine hours in advance of the first maximum of the semidiurnal curve, and the interference of these two waves producing the tidal wave as observed. The comparison of the curves deduced from the observations for three months, and the computed curves of sines, was shown to be satisfactory. This comparison, made as before by averages of periods of a week combined into one general mean, has now been extended to the whole year, as shown in the subjoined table. By increasing the maximum ordinate of the diurnal curve 0·02 of a foot, which will make the rise and fall agree more nearly with the average deduced from observation, we obtain, as shown in No. 2, a resulting curve not differing in any ordinate more than a quarter of an inch from observation, and in which the positive and negative errors nearly balance, and the mean error deduced by summing the square of the errors is little more than one-eighth of an inch.

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* Read at the meeting of the American Association at Albany, and revised by the author, for publication in the American Journal of Science.

† See this Jour., xii, 341.

TABLE No. I.

Showing the comparison of diurnal and semidiurnal curves deduced from observations, with curves of sines. DIAGRAM No. 1.

Hours from first mean level of water.	No. 1. FROM OBSERVATION. Diurnal curve.	Semidiurnal curve.	Mean tidal curve.	No. 1. FROM CALCULATION. Diurnal curve.	Semidiurnal curve.	Mean tidal curve.	Observations calculated No. 1.	No. 2. FROM CALCULATION. Maximum ordinate diurnal curve increased 0·02 feet.	Semidiurnal as before.	Resulting mean tidal curves.	Observations compared No. 2.
	ft.	ft.	ft.	ft.	ft.	ft.	ft.	ft.	ft.	ft.	ft.
0	0·00	0·00	0·00	0·00	0·00	0·00	0·00	0·00		0·00	0·00
1	·17	− ·03	·14	·15	− ·04	·11	·03	·15		·11	·02
2	·31	− ·06	·25	·28	− ·07	·21	·03	·29		·22	·02
3	·44	− ·08	·36	·40	− ·08	·32	·03	·42		·34	·02
4	·51	− ·06	·45	·50	− ·07	·43	·02	·51		·44	·00
5	·56	− ·03	·53	·55	− ·04	·51	·02	·57	Same as foregoing.	·53	·00
6	·57	− ·00	·57	·57	− ·00	·57	·00	·59		·59	− ·02
7	·56	+ ·03	·59	·55	+ ·04	·59	·00	·57		·61	− ·02
8	51	·06	·57	·50	·07	·57	·00	·51		·58	− ·01
9	·44	·08	·52	·40	·08	·48	·03	·42		·50	·02
10	·31	·06	·37	·28	·07	·35	·01	·29		·56	·00
11	·17	·03	·20	·15	·04	·19	.01	·15		·19	·00
12	·00	·00	·00	·00	·00	·00	·00	·00		·00	·00

Nothing would be gained in closeness of representation of the result by displacing relatively the two tidal waves. It is only remarkable that in averages including the whole of the tides, even when most irregular, the results are so satisfactory. I have accordingly used the hypothesis of the representation of each wave by a curve of sines, deducing the maximum ordinate of computation from each observed ordinate. These laborious computations were made by Alexander S. Wadsworth, Jr., sub-assistant of the Coast Survey, and by Mr. P. B. Hooe. They give tables of heights of the diurnal and semidiurnal curve for each day of observation, which form the basis of the discussion of the heights. The next step after decomposing the curves of observation into diurnal and semidiurnal curves, is to discuss each separately to ascertain if they follow the laws deduced from them in regard to heights and times.

1. *Diurnal wave. Heights and times.*

If the diurnal curve is a curve of sines, then the ordinates found for each hour enable us to determine the value of the maximum or six-hour ordinate. Setting out from the mean line, then, we have for each day six determinations of the rise and fall above or below that line. Tables were computed from these, in which the daily curves were decomposed into their diurnal and semidiurnal components. In making these tables, the very irregular tides have been in general omitted. These tables were arranged according to the moon's declination, beginning and ending with the days on which the declination was zero, determining the maximum ordinate of each day from zero of declination. As the irregular tides occur near the time of the moon's passing the equator, the averages of the heights about these times are deduced from a less number of observations than the others, and are therefore less reliable. The following table gives the average heights, with the number of days from which they have been deduced. No advantage resulted from displacing the epoch of the moon's declination relatively to the day of highest tide.

TABLE No. II. (Diagram 2.)

Showing the value of the maximum ordinates of the diurnal curve, on the several days from zero of declination of the moon to zero again, with the number of days from which the results are deduced.

Days from zero of declination.	1	2	3	4	5	6	7	8	9	10	11	12	13	14
No. of observations.														
Heights.	0·33	0·33	0·32	0·41	0·59	0·65	0·78	0·77	0·87	0·85	0·77	0·70	0·58	0·51
Nat. sin. 2× moon's declin'n	0·05	0·11	0·12	0·24	0·41	0·46	0·52	0·58	0·60	0·59	0·54	0·46	0·37	0·27

The dependence of the height of the diurnal wave upon the moon's declination appears by comparing the lowest line of the table, containing the sine of twice the moon's declination, with the line next above it: it is also shown by the curves of Diagram No. 2. This agrees with Mr. Whewell's approximate formula for the diurnal inequality, namely, $dh = C. \sin 2\delta'$; in which dh is the difference in height of two consecutive high or low waters, C a constant, and δ' the moon's declination.

The variation of this same height with the sun's declination may be made at once apparent by classifying the heights for different values of the sun's declination with the same declination of the moon. The following table contains the greatest heights of the diurnal curves during the several lunations of the year, with the values of the sun's declination and of the moon's declination, grouped as described in the several columns.

TABLE No. III. (Diagram No. 3.)

Showing the effect of change of sun's declination on height.

Natural sine 2 sun's declination.	Number of lunations in group.	Natural sine 2 moon's declination.	Maximum ordinate diurnal curve.
Greater than 70°	5	·572	1·02
70 to 60	6	·577	0·99
60 to 40	6	·565	0·93
40 to 20	5	·530	0·94
20 to 00	4	·550	0·74

The effect of the change of parallax of the moon may be shown satisfactorily by grouping the values of the heights at the greatest southern declination of the moon, and for the greatest northern declination, for the year; comparing them for slightly varying declinations of the moon, for mean declinations of the sun, and for large variations of the parallax. The result is as shown in the following table, and in Diagram No. 4.

TABLE No. IV.

Showing the effect of change of moon's parallax on height.

Number of results.	Mean sine 2 moon's declination both series.	M'n sine 2 sun's declination both series.	M'n parallax correct. for 1st series.	M'n parallax correct. for 2d series.	Mean height for lesser parallax.	Mean height for greater parallax.
13½	59·4	48·5	52·9	65·9	0·74	0·88

The parallax correction is taken as the cube of the parallax multiplied by the sine of twice the moon's declination.

These are the principal variable terms in the formula derived by Mr. Lubbock, from Bernouilli's theory of the tides, for the diurnal inequality, namely,*

$$dh = \mathrm{B}[\mathrm{A} \,.\, \sin 2\delta \,.\, \cos(\psi - \varphi) + \sin 2\,\delta' \,.\, \cos\psi];$$

in which dh is the difference in height of the morning and evening tide, B and A are constant coefficients, δ' is the moon's declination and δ the sun's; ψ is a small variable to be added to the mean lunitidal interval to give the interval corresponding to the moon's age, and φ is the hour angle of the moon at the time of transit. The second term, introducing the parallax of the moon, would be

$$m \,.\, \frac{\mathrm{P}'^3}{\mathrm{P}^3} \,.\, \sin 2\,\delta';\dagger$$

in which m is a constant coefficient, P is the mean parallax, and P′ the parallax at the time under consideration.

In the application of this formula to the observations, the maximum ordinates, found as before stated, were tabulated; and first the coefficients were deduced from the cases corresponding to the maximum of the sine of twice the moon's declination and to the minimum of the sun's, and *vice versa*, neglecting the small variations due to $\cos(\psi - \varphi)$ and $\cos\psi$. This gave the following values for the coefficients, and the two sets of equations derived conformed with each other.

TABLE No. V.

Showing the value of coefficients deduced from maximum sine twice moon's declination and minimum of sun's, and vice versa; neglecting variations due to $\cos(\psi - \varphi)$ *and* $\cos\psi$.

	B. cos ψ.	B . A . cos (ψ − φ).
First six months, ...	1·07	0·43
Second six months, ...	1·00	0·39
Whole year, ...	1·04	0·52

As each day's results are referred to the mean level of the day, and the mean of the low and high waters is taken as giving the height of the diurnal tide, the constant from the mean level of the whole should not appear in the values. In beginning these

* Transactions of the Royal Society of London, 1836, p. 223.
† Lubbock's Elementary Treatise on the Tides, London, 1839.

researches, I did not suppose that small differences would come out of them such as have been deduced. The reference to the level of each day compensated in a degree for the effect of an entire raising or depressing of the water by the wind's action.

The results promising success, the coefficients were deduced by the method of least squares for the first, and then for the second six months, and finally for the whole year. These laborious computations were made with much skill by Mr. W. W. Gordon, of the Coast Survey. The result for the second six months, in reference to the coefficient of the term of the sun's declination, is discrepant from the final result; but as the coefficients for the whole year were used, after endeavoring to trace the errors, if any, without immediate results, it was not pursued further.

TABLE No. VI.

Coefficients of $\cos(\psi-\varphi)$, *deduced from the method of least squares.*

	$B.\cos\psi$.	$B.A.\cos(\psi-\varphi)$.
First six months, ...	1·00	0·26
Second six months, ...	0·90	0·60
Whole year, ...	0·96	0·24

The sum of the positive and negative quantities balance, and rather better by the use of the coefficients from the first method, which differs chiefly in the coefficient of the sun's action.

The coefficient of the first term of dh is $B\times(A)$, and of the second term B; and it will be seen hereafter in discussing the semidiurnal tide, that (A) is 0·36, which, with $B=0·96$, gives $B\times(A)=0·34$.

A set of tables was next made, containing the values of the two terms of the formula for each day. To these was subsequently applied the small correction for the parallax from the term $\frac{P'^3}{P^3}$; and the terms, being summed, were compared with the observed maximum ordinate, and the difference in the final column of the table showed the residual to be accounted for.

For these tables I am indebted to Lieut. Trowbridge of the Corps of Engineers, assistant in the Coast Survey. The tabular quantities were also traced in curves, and then compared with the maximum ordinates. The positive and negative differences are usually small, not exceeding in the average about 0·12 of a foot, and are quite irregular.

The irregularities apparent in the phenomena themselves induced me, in first commencing this investigation, to hope merely to be able to trace the phenomena generally; but it now appears, from the character of the results obtained from the averages, that the theory may be followed much more closely by the results than I had at first supposed.

The accordance of observation and theory, after the corrections have been applied, is as good as the accidental errors of the separate results render necessary; as will be seen from the results for July given in the annexed table, and for July and part of August as given in Diagram No. 5: but as the averages seemed to indicate that the residuals would show the laws of the phenomena, I discussed them further.

TABLE No. VII.

Showing the value of maximum ordinates of the diurnal curve, computed from the moon's declination and parallax, and from the sun's declination, compared with ordinates from observation, for the month of July.

PART OF A TABLE FOR THE YEAR.

DAYS.	Maximum ordinate.	$0{\cdot}96 \cdot \frac{P'^3}{P^3} \cdot \sin 2\delta'$.	$0{\cdot}26 \cdot \sin 2\delta$.	
July 1	1·43	·66	·19	·60
2	·93	·59	·19	·17
3	·96	·35	·19	·43
4	·75	·33	·19	·26
5	·62	·22	·19	·17
6	·37	·08	·19	·10
7	·35	·14	·19	·12
8	·36	·14	·19	·03
9	·32	·25	·18	—·09
10	·52	·34	·18	·01
11	·65	·42	·18	·07
12	·75	·47	·18	·15
13	..	·54	·18	...
14	·78	·52	·18	·10
15	·73	·53	·18	·02
16	·62	·55	·18	—·10
17	·89	·53	·17	·19
18	·93	·48	·17	·29
19	·61	·40	·17	·06
20	·52	·15	·17	·20
21	·57	·00	·17	·40
22	·41	·02	·17	·22
23	·56	·33	·17	·07
24	·65	·45	·17	·05
25	·61	·55	·16	—·08
26	·77	·63	·16	·00
27	·90	·65	·16	·12
28	·86	·65	·16	·08
29	·90	·56	·16	·10
30	·90	·48	·16	·27
31	·69	·37	·15	·18

In looking for an explanation of the irregularities to the terms $(\psi - \varphi)$ and ψ, the residuals were classed according to the moon's age, and the averages taken for the separate hours. The result of these tables is given in that annexed, which shows the residual for each six months and for the year. I have introduced them for the half year, to show that the same law is deducible, notwithstanding the irregularities of the individual results, from the observations for each six months.

TABLE No. VIII. DIAGRAM No. 6.

Showing the residuals from the comparison of computed and observed ordinates of diurnal curves, classed according to the ages of the moon.

Hours of moon's transit.	RESIDUALS.		
	First six months.	Second six months.	Mean.
0½	·23	·21	·22
1½	·17	·12	·13
2½	·15	·15	·15
3½	·15	·12	·13
4½	·16	·00	·08
5½	·08	—·03	·02
6½	·06	—·03	·01
7½	·08	—·02	·03
8½	·13	·04	·08
9½	·12	·12	·12
10½	·09	·14	·11
11½	·19	·14	·16

These residuals, instead of following the law of $\cos(\psi-\varphi)$, follow that of $\cos(2\psi-2\varphi)$, or that of the semidiurnal curve.

Before examining this result, which is shown in Diagram 6, I pass to the residual which results from carrying on the former table to 23½ hours; which was in fact the form of the table before the development of the law of variation showed that the term for 12½ hours belonged to 0½, instead of 11½, with which it would agree if the law of $\cos(\psi-\varphi)$ were followed. The following table contains the residuals in question, shown also in Diagram No. 7.

TABLE No. IX.

Showing residuals after deducting those following law of change of $\cos(2\psi-2\varphi)$.

Age of moon.	Residuals.	Residuals.	Mean.
hours.	feet.	hours.	feet.
0½	—·07	23½	—·01
1½	—·02	22½	—·01
2½	·01	21½	·01
3½	·03	20½	·03
4½	·00	19½	·02
5½	·01	18½	·04
6½	·05	17½	·08
7½	·04	16½	·09
8½	·07	15½	·04
9½	·02	14½	·00
10½	—·03	13½	·03
11½	·03	12½	·06
		Mean....	·03

The existence in the first residuals of the law belonging to the semidiurnal curve indicates that the separation of the two curves (diurnal and semidiurnal) is not complete, as indeed the hypothesis of a constant difference in time between the recurrence of the two maxima requires. Before undertaking to modify this hypothesis, I proceed to inquire whether these numbers would receive modification from any other source. In examining the hypothesis that the component curves were curves of sines, a separation of the several hourly ordinates was necessary, and thus the four points at which the curves for twenty-four hours cross the line of mean level were brought into consideration each day. Two of these points varied necessarily considerably in position, while the two twenty-four hours apart were regular. Having found that the curves of sines represent very nearly the observation, the law thus obtained may be used in computing from all the hourly observations of the day the values of the maximum ordinates for each curve; forming the ordinates of the observed curve into groups containing respectively the same positive and negative values of the ordinates of the diurnal curve, and again of the semidiurnal, arranging the groups for the consecutive twenty-four hours. It was soon apparent that the ordinates for the semidiurnal curve would in this way prove more considerable, in the average, than in the former mode of computation, and that the results would be more regular; that the ordinates of the diurnal curve would, on the average, be slightly diminished, and in general prove more regular. These revised tables have been prepared chiefly by Mr. W. W. Gordon and Mr. P. B. Hooe. They show on the average of the year a diminution of the maximum ordinates of the diurnal curve of 0·04 feet, and an increase of the maximum ordinates of the semidiurnal curve of 0·07 feet.

Classifying the corrections according to the moon's age, though they are irregular, it is apparent that there were entangled in the values of the former computed maximum ordinates, heights which belonged to the semidiurnal curve. The table of correction for the two periods of six months, and for the year, is given below.

TABLE No. X.

Showing the difference of maximum ordinates of diurnal curves, as computed by the last method of groups, and by that first applied.

Time of moon's transit.	Correction of maximum ordinates diurnal curve.		
	First 6 months.	Second 6 months.	Mean of year.
hours.	feet.	feet.	feet.
0½	−·10	−·06	−·08
1½	+·03	+·03	+·03
2½	−·08	−·02	−·05
3½	−·08	−·09	−·08
4½	−·08	−·09	−·08
5½	−·03	−·05	−·04
6½	−·02	−·02	−·02
7½	−·05	+·02	−·01
8½	+·01	+·02	+·01
9½	−·05	−·03	−·04
10½	−·08	−·03	−·05
11½	−·03	−·04	−·03

A consideration of the general formula for the height indicates a second correction. The height of high water, as given by the formula is not the sum of the two greatest heights of the diurnal and semidiurnal tides. The hypothesis of the interference of the two waves makes the high water the sum of two ordinates (neither of which is the maximum), depending upon the laws of increase and decrease of the curves respectively, and of the relative position of the two ordinates. The correction due to this cause is readily found. The part of it which belongs to the diurnal curve will be the difference between D and $D \cdot \cos(t-E)$; where E, according to the hypothesis of the interference of the two waves, is 9 hours; and t is the value for the maximum ordinate of the compound curve, namely (Proc. Amer. Assoc. Cambridge Meeting, page 289),

$$\operatorname{cosec} t - \sec t = \frac{4C}{D\sqrt{\frac{1}{2}}}.$$

This value of t, containing C (the maximum ordinate of the semidiurnal curve), shows that the quantity will vary with the time of the moon's transit, according to the half-monthly inequality of the height. Following the course which I have taken throughout this communication to give the resulting tables merely, I subjoin the corrections thus derived from the tables for $\frac{4C}{D\sqrt{\frac{1}{2}}}$ from observation, the computed values of t, and of $D \cdot \cos(t-E)$. The agreement of the general form of this correction with the theory is a new confirmation of the values of the quantities C and D, deduced from observation, which it contains.

TABLE No. XI.

Showing correction to height of the diurnal wave for difference of maximum ordinate, and of high water ordinate in compound curve.

Time of moon's transit.	Correction to maximum ordinate diurnal curve.
hours.	feet.
0½	—·03
1½	—·05
2½	—·03
3½	—·04
4½	—·04
5½	—·07
6½	—·08
7½	—·07
8½	—·06
9½	—·05
10½	—·05
11½	—·04

The correction furnished by the last two tables, and the corrected residual from the table, are given in Table No. 12 next following.

TABLE No. XII.

Showing residuals after correcting for new computations of ordinates, and difference between high water and maximum ordinates.

Time of moon's transit.	Correction of residual.	Residual.	Corrected residual.
hours.	feet.	feet.	feet.
0½	—·11	·22	·11
1½	—·02	·13	·11
2½	—·08	·15	·07
3½	—·12	·13	·01
4½	—·12	·08	—·04
5½	—·11	·02	—·08
6½	—·10	·01	—·08
7½	—·08	·03	—·05
8½	—·05	·08	·03
9½	—·09	·12	·03
10½	—·10	·11	·01
11½	—·07	·16	·09
			+·21
			Mean... ·017

Comparing the residuals in this table with the uncorrected ones, we find their magnitude much decreased; the average is now less than 0·02 of a foot: but the form of the series is, as before, that belonging to the semidiurnal curve, and is as well marked as when the quantities were more considerable. Diagram No. 6 shows this fact; containing the curve of residuals from Tables 8 and 12, and of half-monthly inequality deduced from the observations. This persistence in the form of the residuals affords the best evidence that the irregularities of the observations, and changes in the mode of computation, do not introduce errors of sufficient magnitude to mask the laws of the phenomena. I propose therefore to modify the original hypothesis, so as if possible to obliterate this form in the residual.

Some collateral questions have been examined in the course of this discussion, the results of which are interesting. One of these is the comparison of the maximum ordinates of the diurnal curve, corresponding to the moon's declination north and south. The average value of the sine of twice the moon's declination, and the corresponding average maximum ordinate for northern and southern declinations, are shown in the next table; from which it appears that if the values of $\sin 2\delta'$ were equal, the heights would not differ appreciably.

TABLE No. XIII.

Showing the mean value of twice the moon's declination, and the corresponding maximum ordinates for northern and southern declinations.

Sine 2δ'.	Maximum ordinate.	Sine 2δ'.	Maximum ordinate.
·410	·621	·351 ·410	·538 ·531

Another question was, whether the residuals, of which Table No. 7 shows a part, contained any portion which varied with the moon's declination. To test this, the residuals for six months were grouped according to the declinations, with the following result.

TABLE No. XIV.

Containing the residuals after subtracting the terms containing the sine of twice the moon's declination, and the sine of twice the sun's declination, from the maximum ordinates, grouped according to the values of the sine of twice the moon's declination.

	Average value of twice sine moon's declination.				
Groups,	0 to 20	20 to 35	35 to 45	45 to 55	55 to 70
Average value,	·151	·147	·169	·115	·267
No. of observation,	(33)	(27)	(26)	(44)	(37)

The result indicates that there is no such term remaining in the residual.

Another question was, as to whether changing the epoch would improve the results. Several attempts of this kind were made at different stages of the work, but without any marked advantage. The average result for the year, as shown by comparing the dates of occurrence of the greatest and least maximum ordinate of the diurnal curve, and the greatest and least values of the term containing the moon's declination, is shown in the next table. The comparison is made in two different ways: first, by the date of the greatest value of the ordinate shown in the table of maximum ordinates; and secondly, by the date shown by the highest point of the curve, which was traced to represent the observations.

TABLE No. XV.

Showing results of comparison of dates of occurrence of the greatest and least maximum ordinate of the diurnal curve, and the greatest and least value of term containing the moon's declination.

DATE OF OCCURRENCE—AVERAGE IN DAYS.					
Maximum ordinate from table.	Maximum ordinate from curve.	Term embracing sun and moon's declination.	Minimum ordinate from table.	Minimum ordinate from curve.	Term containing sun and moon's declination.
15·4	16·1	16·0	16·5	16·6	16·0

The *times* of occurrence of the maximum of the diurnal curve are, as I have already stated, connected by the hypothesis with those of the semidiurnal curve. The times deducible from the observations were so irregular, that I supposed it impracticable to do more than this. Notwithstanding all these irregularities, it turns out that the laws of the phenomena for the times are deducible from the results. The average values follow those for the semidiurnal curve at the proper intervals. It will be practicable, therefore, to resume the examination of this part of the subject, which I accordingly purpose to do.

2. *Semidiurnal Curve.*

The results in relation to the semidiurnal curve have exceeded my anticipations. The half-monthly inequality, both in height and time, is very well shown by the maximum ordinates deduced; though the greatest value of the height is only 0·22 feet, and the irregularities in the separate observed high waters fall upon hours instead of minutes. In the following table, the maximum ordinates obtained by the method of groups are used, and the small correction for the difference between maximum and high water ordinates is omitted. The latter contains time of moon's transit corresponding to observed height; and the height computed from the formula given by Mr. Lubbock as resulting from Bernouilli's theory, and the difference between observation and theory.

TABLE No. XVI.

Showing half-monthly inequality in height.

Hours of moon's transit.	Observed height.	Computed height.	O — C. Diff. of observed and computed.
0½	·220	·223	— ·003
1½	·196	·206	— ·016
2½	·199	·174	·025
3½	·147	·131	·016
4½	·132	·087	·045
5½	·074	·056	·018
6½	·047	·056	— ·009
7½	·074	·087	— ·013
8½	·113	·131	— ·018
9½	·135	·174	— ·039
10½	·133	·206	— ·073
11½	·189	·223	— ·034

The greatest difference between observed and computed heights is 0·073, and the least difference 0·003; and the mean, without regard to sine, is 0·026. Diagram No. 8 shows the observed and computed curves of half-monthly inequality of heights. The average interval corresponds to $2^h\ 35^m$ of the moon's transit; which is therefore the zero point, or epoch of the half-monthly inequality in the interval.

The interval corresponding to the moon's

	h m		h m
transit at	3 30	is	11 45
" for	9 30	"	13 05
		Diff. is	1 20

which, converted into arc, is 20°.

$$\text{Log tan } 20^\circ = \log (A) = 9{\cdot}56107;$$

$$(A) = 0{\cdot}364; \qquad \frac{1}{A} = 2{\cdot}747;$$

which is nearly the same as that obtained by Mr. Lubbock for Liverpool. The difference between the greatest and least heights is

$$(0{\cdot}220-0{\cdot}047)=0{\cdot}173 \qquad \text{and } E=\frac{0{\cdot}173}{2(A)}=0{\cdot}238:$$

also the greatest height $0{\cdot}220=D+(E)\times(1+A)=D+{\cdot}325$; and $D=-0{\cdot}10$.

$$\text{Since } \frac{m'}{m'+M}=\frac{(0{\cdot}07480)^2}{(A)}=\frac{1}{65{\cdot}06}, \quad \frac{m'}{M}=\frac{1}{64{\cdot}06}.$$

For the half-monthly inequality of the intervals, we have

$$\text{tang}\, 2\psi=\frac{(A)\times\sin 2\varphi}{1+(A)\times\cos 2\varphi}=\frac{0{\cdot}364\times\sin 2\varphi}{1+0{\cdot}364\times\cos 2\varphi};$$

and in the heights,

$$h=-0{\cdot}10+(E)\times(A)\times\cos(2\psi-2\varphi)+(E)\cos 2\psi$$
$$=-0{\cdot}10+0{\cdot}087\times\cos(2\psi-2\varphi)+0{\cdot}238\times\cos 2\psi.$$

The following table contains the half-monthly inequality of times deduced from the observations, and computed from the formula for tang 2ψ, and the comparison of observed and computed quantities.

TABLE No. XVII.

Showing differences between the results obtained from the observations and from formula.

Mean from observation 12h. 35m.

φ	ψ	C. From formula.	O. From observation.	O − C. +	O − C. −
h. m.	h. m.	h. m.	h. m.	m.	m.
0 30	0 08	12 27	12 31	04	
1 30	23	12 12	12 31	19	
2 30	36	11 59	11 19		40
3 30	42	11 53	11 45		08
4 30	38	11 57	12 03	06	
5 30	17	12 18	12 24	06	
6 30	17	12 52	12 38		14
7 30	38	13 13	13 09		04
8 30	42	13 17	13 27	10	
9 30	36	13 11	13 05		06
10 30	23	12 58	13 05	07	
11 30	08	12 43	13 05	22	
				+74	−72

12h 35m not being the exact mean of the observed times, the + and − differences do not balance exactly.

Diagram No. 9 shows the observed and computed results. The greatest and least heights correspond with the average interval, as they should do by Bernouilli's theory.

The average interval corresponds to 0h 23m nearly, showing that transit E should be used instead of transit F.

ART. XXXV.—*Review of Researches on the Physical Geography of the Alps, in relation to the phenomena of Glaciers, to Geology, Meteorology, and the Geography of Plants;** by HERMANN SCHLAGINTWEIT and ADOLPH SCHLAGINTWEIT.†

THIS work is the result of investigations carried on in the Central Alps, and in which the authors were mutually engaged for several years. It is divisible into four chief parts:—1. Researches on Glaciers; 2. Geological Researches; 3. Meteorological Researches; and 4. Researches on Botany and the Geography of Plants.

The first part gives the researches on the important physical phenomena of the great ice-masses of the glaciers in seven chapters; treating particularly of the characters and properties of ice, of the highest portion of glaciers [firn-meer], of the topography of the glaciers, their structure, movement, oscillation, and waste. In the second, geological, part, we have five chapters, on the hypsometrical determinations of the Alps, on the formation of the valleys and the form of the mountain-chains in the Alps, on the geology of the Oetz valley and the Tauern, the formation and temperature of springs, the isogeothermal lines of the Alps, and on the alteration of the surface by erosion and weathering. The third part contains five chapters on meteorological phenomena; the ranges of temperature, atmospheric pressure and winds, moisture of the atmosphere, optical phenomena of the atmosphere, and the proportion of carbonic acid contained in it. In the fourth part, relating to botanical researches, the manifold connection of vegetation with climatal conditions is considered; and the effect of altitude in limiting vegetation, the periodic phenomena of vegetation, the influence of altitude on the thickness of the annual rings in coniferous plants, and the peculiar conditions of the vegetation of the Upper Alps, in the Upper Möll district, are comprised in four chapters.

Among the numerous points of interest offered to the geologist in the chapters above enumerated, the glaciers, their formation, motion, and effects, have a high place. The memoir‡ on the *Physical Characters of Ice*, by M. Hermann Schlagintweit, (pp. 1–25,) shows that:—1. in their crystalline structure, glacier- and water-ice, under the alternate influence of heat and cold, resolve themselves into quite identical forms:—2. the air-bubbles enclosed in the ice especially participate in the formation of the crystals, and exert an influence on the form of all *free* surfaces:—3. the

* Untersuchungen über die physikalische Geographie der Alpen, u. s. w. Leipsic. Imper. 8vo, pp. 600. With 71 wood-cuts and 18 lithographic plates and maps.
† From the Quarterly Jour. Geol Soc., vii, part ii, 14.
‡ Originally communicated to Poggendorff's Annal. Physik. u. Chem.

distinctly crystaline formation reaches, with the exception of the blue bands, a maximum depth of three metres; infiltration, however, in irregularly distributed canals and capillary chinks penetrates still deeper:—4. the air enclosed in the white ice amounts, on an average, to 6 per cent. of the whole volume of the mass:—5. the water of thawing ice absorbs air to saturation:—6. the air absorbed by the water is richer in oxygen than the atmosphere, whilst that freed from the melting ice (the portion not absorbed) is poorer in that respect:—7. the blue color of the depths in snow, glaciers, and ice does not arise from the reflection of the firmament above, but is the peculiar color of water in a fixed condition; in the mean it is identical with a mixture 74·9 per cent. of Kremser-white [white-lead], 24·3 per cent. cobalt, and 0·8 per cent. of burnt ochre; being, therefore, always lighter than the blue of the atmosphere in the zenith for mid-latitudes:—8. ice exhibits throughout the properties of a hard and even a dry body; and the interstitial movability [verschiebbarkeit] of the mass, recognized in a glacier from its structure and motion, appears to arise from the fine splintering of the ice, caused by the pressure of enormous masses and their friction against the underlying rock.

The conclusions arrived at by M. Hermann Schlagintweit in the second chapter (pp. 26–47) in regard to the *regions of granular snow* [Firn-regionen], and from his researches on snow, granular snow [Firn, or Névé], the passage of "firn" into ice, &c., are:—1. the extent of the field or sea of granular snow [firn-meer] is in general greater than that of the glacier belonging to it:—2. the altitude of the lowest places where "firn" is met with in the Alps sometimes does not exceed 2500 feet (French); but its existence is limited also by great elevation, since it becomes converted into the more icy masses [summit-ice, or Hoch-eis] at the height of more than 11,000 feet (French):—3. the snow always becomes the more crystalline, and at the same time the more difficult to thaw, the older it is:—4. the region of the dust-snow avalanches [staublawinen] commences above the limits of the forests, and continues downwards only in some cases to the "montane region:"—5. the marking of the "firn-meer" by snow-disks [Schnee-rädchen] is only superficial, but it shows that even slightly inclined firn-seas are composed of much smaller basins:—6. the "firn" or *névé* is generally laminated; an annual layer is from 0·75 to 1 metre in depth:—7. with few exceptions, there are no glaciers on limestone; the most essential conditions for the formation of glaciers are wide basins and an underlying rock impenetrable to water.

From the consideration of the general characters of ice and the different forms of the important snow and "firn" beds that constitute the earliest conditions for the formation of glaciers, we are next led to the subject of the *Topography of Glaciers proper.*

The glaciers of the Alps are mostly assembled in extensive groups in the neighborhood of the most considerable elevations. According to their extent and the regularity of their forms they have been divided into the first or second order of glaciers, or primary and secondary; there is, however, a natural series of intermediate degrees. Those glacier groups that lie on the declivities beside a larger one, constituting glaciers of the second order, as well as forming the sources of the larger glacier, have been also termed lateral glaciers. The glaciers of the first order, on account of their extent and of the greater scale on which they exhibit all the peculiar phenomena of glaciers, are more particularly adapted for special examination. MM. Schlagentweit have, therefore, for the most part confined themselves to a full topographical survey of such of the larger glaciers, as those of Pasterze, and the Oetz valley; giving only occasional details of the phenomena of the lateral glaciers, particularly those of the Oetz valley, as Vernagt, Hintereis, &c. In the third chapter (pp. 48–76) the authors proceed to explain the details of the two elaborate charts of the abovementioned larger glaciers, accompanying the volume, and the instruments used in making their observations, and to treat of the general extent of glaciers. The measurements of the Pasterze and of the Oetz-thal glaciers follow, with descriptions of their characters and external forms, illustrated with colored lithographic sketches and numerous wood-cuts, their sources, and moraines, and observations on single and compound glaciers, the origin of rock- and firn-moraines, &c. The results arrived at are:—1. the formation of glaciers is a very general phenomenon in great mountains, and is not only brought about by certain conditions of temperature and atmospheric moisture, but also by the peculiar formation of the valleys:—2. the least mean inclination of a glacier is 3°; for glaciers of the first order 5° to 7° is the inclination from their lower to their upper extremity, including their "firn-meer:"—3. in an alpine valley occupied by a glacier, the following conditions obtain: the glacier proper—hard ice; the widely-extended "firn-meer"—granular snow; both are slightly inclined, and are intimately connected together. The sides of the surrounding mountains are covered with summit-ice and summit-snow [Hocheis and Hörnerschnee, forms peculiar to very great elevations], which are really separated from the "firn-meer" by deep circular crevasses ["Bergschrunde" and "Rimayes"]:—4. every larger glacier has several sources, the separations of which are marked by superficial lines of stones (stone-moraines), or by extended deposits of masses of "firn"-ice.

In chapter iv, (pp. 77–101) M. H. Schlagintweit describes the *Intimate Structure of Glaciers*, noticing the arrangement of the lines and bands on the surface and in the interior, also the dirt-bands, and the crevasses and ravines in the ice; and in the fifth chapter (pp. 104–124) he enters upon the subject of the ***Motion of Glaciers***, describing his method of observation, and giving tabular views of the rate of motion of the Pasterze, Hintereis, and Vernagt glaciers, with notices of the alterations of velocity; influence of temperature and effect of the weather; relative velocities in a diagonal and straight line; lateral movement; annual movement; motion of secondary glaciers and of "firn"-masses; and with remarks on the causes of the motion of glaciers, on the "sliding" theory;* the theory of "infiltration" or "dilatation";† the plasticity of glaciers; and the interstitial movability [verschiebbarkeit] of large masses of ice. It results from these observations, that:—1. in all glaciers the centre moves faster than the edges:—2. in the most regularly formed glaciers the rate of motion near the end is less than in the higher parts; but irregularities of the valley-bottom, depressions, or greater width of troughs, have considerable influence on the alterations of the velocity:—3. the maximum rate of motion occurs in the first summer months; the velocity in autumn in all glaciers is next to that of the mid-year:—4. a motion of 20–40 centimetres in twenty-four hours takes place locally in all extensive glaciers; the absolute maximum hitherto obtained (by Prof. Forbes in the Glacier des Bois) amounts to 132 centim. a day:—5. the direction of the progressive movement usually agrees very nearly with the direction of the length of the glacier, yet also, from local conditions, lateral deviations either towards the side or the centre may take place:—6. the smaller (and all secondary) glaciers move more slowly than the larger ones, since the influence of the friction becomes more sensible, if the thickness of the ice be diminished:—7. the phenomena of glacier-motion appear to be connected with the movability of the integral parts [verschiebbarkeit] of the ice, and this arises from the fine splintering of the mass in consequence of its dryness, the enormous pressure, and the friction of the underlying rock-surface. The rate of progress becomes essentially altered by the degree of the inclination of the underlying surface and by the vertical height of the ice, to both of which conditions the retarding influence of the friction is more or less due:—8. heat or considerable atmospheric precipitations hasten the motion, since, by the infiltration of the thaw- or rain-water into the ice-cavities, the absolute weight of the glacier is increased:—9. the rate of progressive movement is subject to considerable retardation from the friction of the ice on the supporting surface; the base, however, of the glacier is not usually ice-bound.

Chapter vi,‡ (pp. 125–146) treats of the ***"Oscillation" of Glaciers***, that is, the alterations and fluctuations in the absolute bulk

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* Saussure. † Charpentier.

‡ This and the following chapter are also by M. Hermann Schlagintweit.

of the glaciers,—1. dependent on fluctuations of temperature,—2. arising from accumulations of snow and the formation of moraines,—3. owing to the irregularity of the valley-bottoms, causing irregular rates of progress in individual glaciers. The *Wasting of Glaciers* is noticed in the seventh chapter (pp. 147–159), and the conclusions arrived at from researches on the distribution and quantity of the water, the terminal cavities of glaciers, the influence of superficial thawing, the measure of the waste, and the repair of the waste, are:—1. the mass of ice becomes considerably diminished by thawing in the summer months; and the glacier-streams are fed in the winter by the continual supply from the gradual emptying of the canals and cavities in the ice:—2. the currents of air at the exits of the stream are the principal cause of the greater terminal cavities of the glaciers: their formation is favored by the presence of a second, contrary aperture:—3. small bodies strewed singly over the surface favor the wasting away, but heaped up together in greater masses they hinder it, causing thereby a considerable increase of bulk in their neighborhood:—4. the yearly amount of waste is in a great part repaired by the motion of the glacier, combined with its specific inclination; at the same time local accumulations, arising from unequal movement, appear to have considerable influence in this respect.

The geological division of the work commences with a chapter on *Hypsometric Observations* on the Alps* (pp. 163–197), written by MM. Schlagintweit conjointly. Their method of determination and the several stations for corresponding observations are first noticed, and the authors who have established previous determinations are enumerated. They then proceed to explain the elaborate Table of Altitudes that succeeds. This Table comprises 191 determinations in topographical arrangement, from which we extract some of the most important.

Number of the Table.		Altitude. Meters.		Paris feet.
I. Northern limestone Alps.				
1.	Munich,	518·77	......	1597·0
54.	Lavatschjoch,	2084·4	......	6416·8
II. Central Alps. Tauern.				
70.	"Firn-meer" of the Pasterze glacier on the Todtenlöcher,	3358·9	......	10340·2
83.	Johannishütte (where MM. Schlagintweit resided some months),	2462·6	......	7581·1
92.	Heiligenblut,	1300·8	......	4004·4
103.	Salmshöhe,	2671·1	......	8222·8
104.	Salmshütte,	2729·8	......	8403·6
105.	Firn-line on the Leitergletscher,	2813·1	......	8660·4
106.	Hohenwarte,	3187·7	......	9813·1
107.	Adlersruhe,	3388·8	......	10432·3

* Determined partly by means of a siphon barometer, and partly by a hypsometer (thermo-barometer).

No. of the Table.		Meters.	Altitude.	Paris feet.
108.	Grossglockner, First Peak,†	3926·8	......	12088·4
109.	————, Second Peak,	3949·5	......	12158·2
116.	Summit of the Racher,	3365·9	......	10361·6
117.	Summit of the Wasserradkopf,	3190·6	......	9822·2
III. Central Alps. The Oetz Valley Group.				
134.	Vent,	1881·3	......	5791·4
143.	Gurl,	1788·0	......	5504·2
149.	Similaun,	3617·2	......	11135·4
150.	Wildspitze,	3732·0	......	11489·1
151.	Vernagt glacier, the lowest part of the,	2100·0	......	6464·8
IV. Pass between the Eisack and Oetz Valleys.				
170.	Jaufenhaus,	1969·9	......	6064·2
177.	Timbls,	2527·9	......	7782·6
V. Southern Declivities.				
185.	Sources of the Drau,	1363·6	......	4197·8
190.	Mühlbach,	753·0	......	2318·2

The above is accompanied by an appendix on the Grossglockner Peaks. Some remarks upon, and a tabulated view of, the altitudes of twenty-eight of the most important of the Alpine summits conclude this chapter.

Chapter ix, pp. 198–221, by M. Adolph Schlagintweit, on the *Formation of Valleys and the Form of the Mountain-chains of the Alps*, succeeds. In following out our special researches, says the author, on the above-mentioned subjects, it has always been our endeavor to derive therefrom some clue to the causes of the external forms of the valleys and mountains. These researches, therefore, were of twofold importance, both in a geological point of view, and with respect to other branches of physics. The temperature, vegetation, and the whole climate of a mountain-district are intimately connected therewith, whether it consists of a moderately elevated plateau, intersected by a few narrow valleys, or whether, as in the case of the Alps, it forms a series of narrow, lofty, barren summits, between which expanded valleys pass in all directions.

Valleys have been sometimes regarded as almost exclusively the effect of vehement floods and torrents; but in later times causes more complicated and connected with the stratigraphical disposition of the district have been sought for. Bouguet and Buffon believed that in most valleys the salient angles of one side corresponded with the re-entrant angles of the opposite declivity of the valley, and that all valleys have their origin in the serpentine windings of submarine currents; whilst by Pallas, Saussure, and Werner, diluvial floods, and erosion by streams and by atmospheric precipitations, were regarded as partial causes

† Of the method of reckoning used by the authors in determining heights, an example (that of the Grossglockner) is given at page 166. The notices of the Grossglockner and the neighboring heights were originally communicated to Haidinger's Jahrbuch d. d. K. K. Geologischen Reichstanstalt, 1850, p. 125.

of the formation of valleys.* A local influence was also ascribed to a partial overturning and breaking up of the strata.† We must regard as erroneous the opinions, that the manifold forms of valleys can be comprised in one point of view, and that reduced, with few modifications to one cause. One easily understands how the great valleys excavated by rivers continually eroding strata more or less soft and destructible are distinguishable from the ramifying valleys of elevated districts, which are sometimes widened out into basins and sometimes struggle through narrow ravines. In the latter, mountain masses of ever varying profile rise on both sides many thousand feet high, whilst in the former case, above the slopes on either side, we meet with nearly horizontal plateaux, but slightly raised above the valleys.

In the Alps, on account of the vast mass of the mountains and the various inclinations and summits, it becomes very difficult to distinguish definite "groups" and their laws. Vegetation, also, and culture, and especially the products of weathering, obscure the original form of the district. To correct the errors arising from hence it is highly desirable to examine these valleys at intervals more or less extended, as we were enabled to do in the Tauern Alps and in the Oetz Valley.

The following researches have especial reference to the crystalline slates of the Upper Alps; we did not, however, omit to study the characteristic phenomena of the limestone Alps. And in this we have sought, by our determinations of height, by the comparison of inclinations, and by the execution of numerous profiles, to preserve assured data which may serve to give accurate and well-defined ideas of the characteristic forms. Such special researches are not without value for the general questions of geology. L. von Buch, in his well-known "Researches on Granite and Gneiss," has shown how intimately their external forms are connected with the most important processes that have taken place at their appearance on the earth's surface.‡

Basin-shaped Valleys in the Alps.—In considering the characteristic forms of the Alpine valleys, much importance is to be attached to their upper extremities. Here are found peculiar basin-like cavities, which are sometimes occupied by the great Firnmeers, so essential to the existence of glaciers. Such a cavity is known as a "Mulde" (basin) or "Circus," in French *Cirque* (*de névé*); in many parts of the German Alps it is termed a "Kahr." The great bodies of ice and *névé* of the glaciers, by the covering up of slight inequalities, are well qualified to exhibit more clearly the character of these circular cavities; and only interfere with

* Compare Voigt on the Formation of Valleys, 1791.
† D'Aubuisson, Traité de Géognosie, i, 1819.
‡ Abhand. d. Acad. Berlin für 1842.

the general features so far as to cause the crests surrounding the basins to appear as naked mountains of snow and ice, while by closer examination they are found to be regular rock-ridges. These differ considerably in relative elevation; particularly in the hindmost, highest parts, it is often so slight, that only some grotesque, jagged pinnacles form the boundary of the basin; their base is for the most part hidden by the "firn," but their outline is more or less recognizable by means of the bedding of the "firn" and the direction of its crevasses. We have also, at rather lower altitudes, altogether similar forms not covered by snow, which may be compared with them. They are pretty clearly distinguishable from the peculiar "Kessel-" [cauldron-like] valleys, in which the lines of inclination must converge towards a central point. In the Alpine basins [Mulden] there is evidently a decided inclination towards the middle in the direction of the transverse axis of the two sides; and we can trace more or less clearly a kind of central axis downward throughout the whole basin. These lines, however, together with the whole basin, have a very constant inclination towards its front entrance. In consequence of the bottom of the valley not being itself horizontal, it happens that on many maps the true form of these valleys can scarcely be recognized, since the far greater slope of the walls is not sufficiently distinguished from the more gentle inclination of the basin itself. The extent of these basins is very considerable; the largest, among which the firnmeers are especially to be remarked, attain to half a square mile [German] and more.

Behind and at the sides they are enclosed by crests that surround them in the form of the segment of a circle, subject of course to much irregularity. Forwards they pass into narrow, extended valleys; the transition being either gradual, or, as in most cases, rather sudden. This narrow valley or dell [Thalenge] opens into a second open basin, having very often a breadth of 2000 to 3000 feet [French]. This continual succession of wide basins and narrow dells is very conspicuous in all the *transverse* valleys of the Alps, and has already been noticed in the valleys of the Aar, Linth, Reuss, Gastein, &c., by Saussure, L. von Buch, Escher, Studer, and others. Similar basins and circus-valleys are found in all the Alpine ranges, and in the Pyrenees, the Jura, and other mountains, and they have been noticed by Hutton and Playfair in England; their examination, therefore, must have a very general interest.

Transverse Valleys.—Fully to exemplify these phenomena the author gives a copious detailed account of the following cross-valleys:—1. The Oetzthal, with its seven basins, illustrated by a woodcut profile. This is described (p. 201) as opening into the *longitudinal* valley of the Inn, five or six miles [German] above Inspruck, by a narrow gap in the mica-schist mountains of the right bank. The great volume of the water of the Oetz alone shows that there exists an extensive valley behind this narrow cleft. The valley is composed of a series of great basins; the mountains, retreating mostly on both sides and less frequently merely on one side, enclose wide level valley-bottoms. These basins are connected in two ways; either, from a sudden subsidence or depression of the floor of the valley, a high precipice divides them, or there occurs a longer interruption by means of a ravine. The last is here more common, whilst we find the sudden depressions more developed in the Tauern Alps. 2. The Möllthal and its three basins, with a profile; and 3. The Fuschthal, with its three basins. The interesting basins of the Gastein, noticed by Von Buch, are also described (p. 207).

Longitudinal Valleys.—These long-valleys are very numerous in the Alps, and possess a similar alternation of basins and ravines as that so constant in the transverse valleys. This character however suffers certain modifications, owing to the great longitudinal extension and the less height and inclination of the former. Special examples of their most important phenomena are given in detailed descriptions of the longitudinal valleys of the Drau and Rienz, which, properly speaking, form one great valley (the Pusterthal) dividing the long chain of the crystalline slates in the Tauern Alps from the southern limestone Alps.

In the Alps it is sometimes rather difficult to define the characteristics of a longitudinal valley. It would be a great mistake to expect that these valleys must always run parallel to the chief longitudinal axis of the Alps from west to east. Under no other circumstances can we so easily perceive that the Alps are composed of a series of "groups" [Gruppen, *massifs*], and not of parallel lines. The long valleys enclose these "groups" and hence take very various directions. We find them, therefore, stretching sometimes from north to south, as the two arms of the Etsch Valley, and many others.

They are for the most part reducible to two divisions. The one set are characterized by a stronger inclination and by the alternation of great flat basins with dells, often very long and narrow, and, as in the cross-valleys, having a greater fall than that of the basins. The upper extremity of the valleys varies considerably. They may, indeed, as in the transverse valleys, take their rise on high crests; generally, however, this is not the case. These longitudinal valleys must on the whole be considered as deep depressions around the lofty mountain groups. Their upper extremities, therefore, lie for the most part deeper than those of the transverse valleys. The water-shed between two long valleys is sometimes formed by a broad tract, which is enclosed by high mountains and slopes gently on two opposite sides, as is so clearly the case in the Pusterthal or on the Brenner. Sometimes, however, the two sides have very different inclinations; this happens especially with those branches that pass to the south, since the fall is here always more considerable. A fine example of this occurs in the valley of the Inn, the unusually broad plateau of which, at the Maloja Pass, descends towards the south with steep precipices.

Longitudinal valleys of the second division commence as soon as they descend to a certain height and pass as broad depressions between parallel mountain-chains, which very often belong to different geological formations. The fall then becomes trifling; the valley-bottoms are filled with beds of gravel; they are always broad, and often of great longitudinal extent, and are almost entirely free from any alteration of its character, there being a discontinuance of the basins and terrace-like sinkings. The direction of the valley also is less subject to variation. When, however, the direction is changed, ravines, or narrow passes, "Klausen," often occur which are overlooked by ancient fortifications, and have attained historic celebrity; in these cases the longitudinal valleys form the most important roads through the Alps. Such narrow passes are frequently found when the valleys leave the Alpine districts and descend towards the northern or southern plains, as in the case of the Porta Westphalica. In comparing the longitudinal and the transverse valleys, we find that the mean inclination of the former is less, both on the whole and at particular parts. The basins of the former are larger and more level, their valley-bottoms broader, and their upper ends attain by no means such an absolute altitude as those of the latter. In both, however, the mean inclination increases in the highest portion and is greatest in the ravines (intervening dells).

Secondary transverse Valleys.—Besides the long and the cross-valleys, before mentioned, there is an extensive series of smaller valleys. Their proportion to the former appears also to be important, and to be very various in different districts. In a district where plateaux predominate, and which is intersected only by a few valleys, these lateral valleys are but few and of a trifling extent. In the Alps, however, they are very numerous and have manifold peculiarities. A description of these, and of the *Valleys of the Limestone Alps*, succeeds.

Forms of the Mountain-chains (p. 215).—The division of the Alps into the "groups" [*massifs*], previously referred to, appears to be far more regular, both in an orographical and a geognostical point of view, than the condition of long parallel chains, which Ebel sought to trace throughout the Alps. Studer in particular has closely investigated many of these different "groups" and their combinations. He finds, particularly in the larger "groups" of the crystalline slates of the Central Alps, that two chief inclinations are distinguishable; at their borders a series of greater mountains occur, which indicate the line of highest mean elevation. Both of these declivities are usually intersected by large transverse valleys, parallel to one another and at right angles to the line of the greatest altitude. On both of the other extremities also of the "groups" are still smaller transverse valleys. Only in a few of the "groups" does an entirely regular arrangement of the valleys occur; since frequently, sometimes the one, and sometimes the other system of cross-valleys preponderates. It is worthy of remark, that when the longitudinal axes of such "groups" extend from west to east, their slope to the south is for the most part unusually steep, while to the north it is but gradual. This is a repetition of the law that we found to obtain generally in the Alps; and as the northern plain clearly lies higher than the southern plain (of the Po), so also the longitudinal valleys in the south surround such "groups" at lower altitudes, than those which surround them in the north. Other features of the mountain-chains, resulting from the transverse valleys, are also described, with observations on the mean height of the passes, crests, and summits.

Mountains and Summits (p. 217).—The mountains of the Alps are not great isolated cones; they rather form portions of definite ridges, above the mean height of which some of the cones eminently rise. It is only in their neighborhood that we can form a correct idea of this condition. Viewed from out of the deep valleys, many of the mountains appear as vast independent pyramids; while, if we stand over against them on higher ground, this error is easily corrected, and we perceive that they are only portions of a long crest. Only at the extremities of a ridge are the mountains seen to stand out independently.

In the limestone ranges the forms of the mountains are somewhat different, since here the lower portions very often have steep precipices to an extent that seldom occurs in the crystalline slates. At the rear of these precipices are level spaces, above which the summits rise with only gradual ascent.

On the contours of the highest peaks, weathering and erosion by hydrometric operations certainly exercise considerable influence. Hence those horns and peaks rising from the narrow crests, and which particularly characterize the Central Alps. We must, however, distinguish the indentations of the ridges thus effected from the great independent peaks that often rise more than 1000 feet (French) above the surrounding parts. The latter are, in all probability, connected with the original formation of the mountain, and not resulting from the disintegrating of the atmosphere; for, if weathering and the rain have had the power to remove extensive beds of hard rock from around an isolated peak, the latter itself ought also to have entirely disappeared long since, as it offers for these operations a proportionally far greater surface than a ridge. Although the limestone mountains are in general less peaked, in comparison, yet, on account of their destructibility, and by the removal of the softer materials, gypsum and clay, they sometimes assume very curious forms. Their pinnacles (needles, teeth), owing to the continual disintegration, fall in great masses, and cause the devastation so much dreaded in their vicinity.*

In treating of the *Causes of the present forms of the Valleys and Mountain-chains*, it is stated, that both erosion by means of rivers and the disintegrating effects of the atmosphere and its precipitations, can be considered as having only subordinate influence on the formation of the Alpine districts. How (it is asked) is it possible for erosion to have effected such equal declivities, not only of the valleys, but also of the mountain ranges, and such a frequent regularity in the distribution of elevations? How could it be possible for an Alpine valley to be excavated by such means from the summit of Mont Blanc down to the depth of 3000 feet (French)?

With regard to the sudden expansion of the basins, characterizing the transverse valleys of the Alps, it is stated (p. 200), that this could not have been the result of violent outbursts of water; it not being possible for water to have collected in great masses where no dam was present to restrain it; and, if a dam had once existed, it could only have been cut through by a deep gap, and not removed entirely, without a trace being left through its whole extent. And at page 207, in considering how far great local collections of water may have been concerned in the formation of these valleys, the author observes, that were their figure due to this form of aqueous agency, they must be regarded as cauldron-shaped cavities, that gradually became filled with débris, and now offer levelled surfaces. But this view is decidedly opposed not only by the fact of the very frequent protrusion of the underlying rock, but by the usual occurrence of the rock-surface at the slight depth of 10–12 feet (French) beneath the superficial gravel. That the basin- or trough-like forms especially, that is, the retreating of the sides of the valley on both sides, cannot have been effected by the presence of a lake, is sufficiently clear. We should otherwise confound the effect with the cause. The question, whether collections of water have generally occupied these cavities, is easily answered in most cases. We usually find here smaller gravel-beds, that by their equal distribution are decidedly shown to have been deposited in standing waters. The inequalities of the valley-bottoms may, indeed, in many cases be sufficient cause for this; but sometimes (for example, near Lengenfeld) the form of the ravine immediately following, and the depth of the erosion of the river-channel, show that here a stopping of the

* A notable example occurs in the case of the Diablerets near Bex.

water-course had taken place. At all events, this kind of aqueous operation was only subordinate, and more deeply lying causes for the forms of these cavities must be sought for in the configuration of the whole district, and in the original mode of the formation of the valleys. This is the more evident when we consider that many such basins are separated by precipitous depressions only, similar to terrace-like declivities, where there has been a perfect absence of any dams for the collection or restraint of water.

In the longitudinal valleys, on reaching which the Alpine streams have already lost much of their force, considerable beds of gravel occur (p. 212), which have been cut through by the rivers. Here again river-erosion always appears of slight importance in relation to the extent of these valleys. At the terminal gap-like openings of these valleys the eroding power of the streams is abundantly perceptible; but we can scarcely dare to attribute the cutting through of these rocks to such a cause. The signs of erosion reach at the highest to some 100 feet (French), whilst the rock-walls are many thousand feet high. It is remarked (p. 219), that the distinguished observers, L. von Buch, F. Hoffmann, O. d'Halloy, E. de Beaumont, Thurmann, B. Studer, and others, have indeed proved in different regions of the earth, that the formation of valleys is not effected by casual erosion, but is most intimately connected with the causes that gave rise to the general configuration of a district. In relation to this are especially to be regarded the manifold windings of valleys, the great change in their direction and extent; whereas in mere erosion, water would have taken the shortest and straightest passage. It frequently happens also that a valley cuts through a lofty mountain crest; whilst, on the other hand, running water would have taken an easier, and frequently already opened, course to one side. Hoffmann has proved this particularly by the well-known Porta Westphalica in the Weserthal; Omalius d'Halloy cites very similar phenomena in the course of the Rhone.

The author considers, therefore, that although running water and atmospheric influences effect important changes in the earth's surface,* yet these operations have not been sufficient to give rise to the extensive series of Alpine valleys.

The real causes of the origin of these valleys appear to lie in a series of successive elevations, associated with certain sinkings. The great basins found at the extremities of the valleys and in their wider developments, and repeated on a smaller scale on the declivities of the mountains, seem especially to point to a retreat or withdrawal [zurückweichen] of the masses. We ought here to observe, that the study of the valley-formation of the Alps can

* A series of observations on erosion and weathering is given in chapter xii, of this work.

only be well followed out, in proportion as the general upcast of the strata approaches the perpendicular. For the strata often preserve over large tracts the same strike and dip, and are frequently cut through by a series of valleys without suffering any change. One might expect that in the great basin-like depressions the inclination of the strata would be in some degree altered. Still we must consider that the uprise or tilting of the strata is unusually steep in the Alps; a partial withdrawal, therefore, may happen without any very striking disturbance of the inclination and the succession of strata, and is far more possible than under the conditions of horizontal stratification. Occasionally only are we led to notice very striking disturbance of the stratification, particularly in the limestone Alps, and there indeed, where the greatest irregularity of the valley-bottoms has been effected by the deep depressions that even yet are occupied by the Alpine lakes. These are confined chiefly to the north and south districts, and are altogether wanting in the central parts, where crystalline slates abound and where the elevation is most regular.

Chapter x. (pp. 222–234) contains M. Adolph Schlagintweit's observations on the *Geological formation of the Oetz Valley and the Tauern Range.* In speaking of the Alps generally, the author observes that crystalline slates, mica-schist, gneiss, and granite, are widely distributed, and with great regularity, throughout the Alps, stretching from the Maritime Alps, in important mountain-"groups," to Mont Blanc, and continuing on to the eastern extremity of the Alps, where they suddenly disappear beneath the tertiary formations. The constituent rocks are very various. Gneiss and mica-schist predominate, with manifold modifications; granite occurs but sparely, and mostly in isolated masses on the southern declivities of the Alps, in company with red porphyry and melaphyre. After some observations on the connection of geological formations with orographical conditions, and enumeration of treatises on the structure of the Alps in general, and of the Oetz Valley in particular, our author proceeds to give in detail the geological constitution of the Oetz-thal "group;" premising, that the great regularity of elevation over so considerable an area, and the pretty equal distribution of the formations, are here very remarkable. In this extensive district no true granite is found. Gneiss, hornblende rock, and mica-slate are the most prevalent rocks; amongst these the last preponderates in extent, and indeed of itself composes the highest parts. Besides these, at the boundaries of the mountain-"group" there are some narrow ridges of grauwacke-like rocks of red sandstone and clay-slates; and at the northern limit towards the valley of the Inn there are tracts of limestone. The latter reach to inconsiderable heights only, and evidently belong to the great limestone ranges in the north, separared by the Inn valley. These, together with the small beds of calc-tuff, often compose low terraces, behind which the crystalline rocks rise with steep ascents. Within the district under notice occur some isolated masses of limestone of considerable interest. Masses of gneiss, hornblende rock, and mica-schist, of different widths, form some not always very distinct radiating groups, similar to such as are so frequently seen in the crystalline slates of the Western Alps. Detailed accounts of these rocks succeed; after which we have the geology of the Tauern Alps in the Upper Möll district, preceded by a list of the geological authors who have treated of this Alpine "group" (p. 228).

The Tauern are a lofty chain of crystalline rocks, forming a part of the Rhætian Alps. Especially in the north of this range the Alps exhibit a great regularity, for here there succeeds a district of tolerably developed transition rocks, whereon the vast range of the northern limestone Alps in Salzburg and Bavaria are elevated.

The composition of this extensive "group" is somewhat various. Gneiss and mica-schists predominate; between these rocks occur great masses of chlorite slates, of hornblende rock, of calcareous schists, and of calcareous mica-schists. Granite also and isolated patches of serpentine are found at many points. The geological characters of this district follow in considerable detail.

M. Adolph Schlagintweit, in chapter xi.* (pp. 235–273), dwells upon the *Formation of Springs and their different Temperatures*, and on the *Geothermal conditions* of different Alpine districts. He finds that:—1. In using the springs for the determination of the local temperatures of the earth, it is indispensable that, in arriving at comparable results, we direct our attention to the geological formations and local conditions, on which the nature of the origin of springs is necessarily dependent;—2. The origin of springs is not only connected with the mode of stratification, but also, and that most intimately, with the general character of the rock formation;—3. The fissures and porosity of limestone give rise to important differences in the conditions attendant on this rock and on crystalline schists. In limestone the springs are rare, copious, and, coming through this rock from the higher districts, often issue with a much lower temperature than usually found in springs flowing out at such a level;—4. The altitude at which the last springs can occur depends on the general elevation of the mountain-mass; their distance from the mean altitude of the summits and crests is greater in limestone ranges than in those of crystalline schists of equal height. In Alpine ranges of similar geological formations this distance becomes far greater when they rise far above 9000 feet (French), where, owing to the formation

* Originally communicated to Poggendorf's Annal. der Physik u. Chemie.

of steep precipices and summits, and of massive snow-beds and glaciers, the depression of the limit of springs is, comparatively, very considerable;—5. The diminution of the temperature in proportion to the altitude does not take place in an equal arithmetical or geometrical progression. In the valleys it progresses more slowly than at the declivities and summits; and *cæteris paribus* advances more rapidly at higher elevations;—6. Almost the same temperature is found at the limits of the growth of trees in the different Alpine ranges, although the altitude of this limit may itself somewhat vary. We may take 3·5° C. as the mean temperature. Immediately above the limit of arboreal growth we remark the most sudden diminution of the ground-temperature, and the most marked differences between the various springs;—7. The springs in valleys are, at equal heights, warmer than those on the declivities and summits, and this is strikingly perceptible in the higher regions. In like manner, owing to the greater radiation from isolated rock-masses, a remarkable depression of the ground-temperature takes place in the limestone Alps on the free declivities towards the north;—8. The minimum temperature of the highest springs in the Alps appears to be 0·8° C.;—9. The height of the mountain-ranges has considerable influence on the ground-temperature. We find at equal altitudes above the sea-level the warmer springs where the mean elevation is greater; the isogeothermal lines are thereby subjected to curvatures analogous to those of the lines of elevation in the district. These curvatures are shown in a diagram representing a section of the Alps. The numerical results of the numerous observations (given in a tabulated form at pp. 269–273), made with reference to the temperature of the Alpine springs and the isogeothermal conditions of these mountains, are expressed in the accompanying table (see next page).

The Changes effected on the earth's surface by Erosion and Weathering are considered by M. Adolph Schlagintweit, in the twelfth chapter (pp. 274–316). The hydrographical conditions of the Alps are first insisted upon. The mass and annual distribution of the Alpine waters is noticed, also the determinations of the quantity of water flowing from glaciers, illustrated by a table. The temperatures of the Alpine lakes, springs, brooks, and rivers, the rapidity of flowing water, with a table, and the powers of suspension and solution exercised by the waters of the Alps, also accompanied by tables, are copiously treated of. With regard to the quantity of matter suspended in water, there is considerable variation in different seasons of the year, and the quantity is always considerably increased by heavy rains and falls of snow. It is important to notice the great quantity of matter suspended by glacier-streams. This is occasioned by the water, produced by the thawing of the surface, having no definite channel at the bottom of the glacier, and forming a great number of little streams that deposit a quantity of finely triturated rock-substance between the ice and the underlying surface. By the friction of this sand and the ice on the floor beneath, fresh detrited material is always being produced for the brooks.

Centigrade.	Limestone Alps.	Tauern.	Jaufen and Timbls.	Southern Declivities of the Alps.	Centigrade.
10°	Does not occur......	In this "group" the point of our lowest observation was only 2800 feet. We therefore found no springs of more than 7°.	The lowest point of our obs'rvation here was 4000 feet.	2200 Eisack-valley, Franzensfeste. 2380 Somewhat to the south.	10°
9	1540 Munich ...... 1660 (Unger).	....	....	3000 Ollang	9
8	2150 Krün Isar-thal . 2540 (Unger). 2580 (Unger).	....	....	3350 Ollang, as far as the Springs of the Drau.	8
7	2710	2900 Möll-valley .... 3400 Fusch-valley.	....	3650	7
6	3050 Benedictenwand 3150 Hinterau-thal.	4990 Briccius .... 4990 Kasereck.	....	3950 Between Ollang and the Drau-springs.	6
5	4100 Benedictenwand 4100 (Unger).	5800 Gössnitz-mine..	4400 Gasteig,....	4290 Sources of the Drau.	5
4	4690 Isar .... 4970 (Unger).......	6180 Gössnitz ...... 6800? Trog.	5850 Jaufen	4600 Sources of the Drau.	4
3·5	5700 Isar-valley	6500 Petersbrunn ...	6160 Jaufen Pass.	....	3·5
3	6400 Isar-valley	7580 Johannis-springs 8000 Salmshütte.	6470 Timbls.....	....	3
2	....	8180 Hochthor......	7170 Timbls.....	....	2
1	7450 Dachstein	7780 Goldzeche	....	....	1

According to Dollfuss the water of the Aar near its exit from the glacier contains 142 grammes of suspended matter in a cubic metre.

Besides detrital matter held in suspension, water in every instance contains certain constituents that have been dissolved by it. These are very various, both quantitatively and qualitatively, in the different rivers, and are connected with the general geognostical conditions of the different districts. The glaciers in high regions are of course far poorer in soluble matters than the Rhine and Aar. The substance most abundantly held in solution is carbonate of lime. A quantitative examination of the waters of two Alpine streams, made by M. Adolph Schlagintweit, is here given.

	1. The Möll at Heiligenblut. 378000 grammes of the water evaporated.	2. The Oetz at Vent. 29000 grammes of the water evaporated.
Carbonate of lime,	0·3182	0·13044
Carbonate of magnesia,	0·1334	0·00144
Silica,	0·2719	0·25170
Chlorid of potassium, Chlorid of sodium,	0·0330	0·01256
Oxyd of iron,	0·0363	0·37728
Manganese,	0·1221	traces.
Argilla,	traces.	traces.
Sulphates,	traces.	——
Sand in suspension,	0·0733	0·24888
	0·9882	1·02230

Although both of these rivers rise in the crystalline slate range, and resemble each other in the mass of the substances held in solution, yet the above analyses show important differences in the individual constituents. This is particularly the case with the carbonate of lime and carbonate of magnesia; the larger proportion of these in analysis No. 1, is due to the general distribution of carbonate of lime in all the rocks of the Upper Möll district, the composition and stratigraphical conditions of which are referred to in chapter x; whilst in the Oetz Valley only a few, quite isolated limestone masses occur. On the other hand, the greater proportion of oxyd of iron is present in analysis No. 2; and this is always an important product of weathering. The greater proportion of calcareous matter in the Möll district is of much interest with respect to the series of observations on Alpine vegetation, given by the author in a subsequent chapter of this work.

The history of the hydrographical phenomena of the Alps is succeeded by observations on Erosion, having reference to the present effects of rivers as eroding agents, and their relation to the formation of valleys in general; the sudden emptying of large reservoirs of water; notices of the course of the great flood (from the bursting of the Vernagt Lake) in the year 1848, with a table, showing the remarkable differences between the time required for the passage through the valley of the great bulk of the flood-water from place to place, and the usual rate of the river-water passing the same places; the influence of valley-basins on the course of great bodies of water (as seen in the table above referred to); the transport of blocks and shingles; and the collecting of the water of the Alpine lakes.

The subject of Weathering, or the mechanical disintegration and chemical decomposition of rocks by means of the atmosphere and its precipitations, succeeds, and demands notices of the physical properties of the earth and its composition, of the nature and properties of humus, and of the influence of vegetation on the formation of the earth; of the influence of glaciers on the destruction of rocky materials, the formation of sand, the transport of shingle, land- and mountain-slips, and the movement of great masses of débris.

The results arrived at from the study of these and other numerous allied and subordinate subjects, connected with aqueous and atmospheric erosive agencies, appear to be:—1. The influence of the masses of "firn" and glaciers in the Alpine streams is not confined to the increase, but extends also to the various distribution of the water:—2. At a certain depth all the larger lakes have nearly constant temperatures, connected with the maximum density of the water: the vertical distance of this stratum from the surface varies according to the mass of the water, the form of the lake-basin, and the season of the year:—3. The velocity of the mountain streams in comparison with the rivers of the plains, is not in the same mass greater than their inclination, while their mass is considerably less:—4. A maximum velocity in the regular course of many rivers in transverse valleys is frequently between 7 and 11 Paris feet per second. Their velocity, however, is at other places so considerable, that they have always force sufficient to move small shingle:—5. The quantity of matter held in suspension in glacier-brooks and all Alpine streams is usually very great, and exceedingly increases their eroding power:—6. By erosive action the bed of a river may be very deeply excavated in the hard rock: such channels reach their utmost development in the more inclined ravines; they remain, however, confined to the valley-bottom, and have no important influence on the formation of the ravine itself:—7. The sudden evacuation of vast reservoirs of water participates very considerably in the phenomena of erosion and transport of rocks. Owing to the velocity and power of these floods, it results that the volume of rushing water is far surpassed by the mass of rocky material washed down and deposited about at different places:—8. The formation of earthy detrital matter [Erdkrume] by mechanical disintegration and chemical decomposition of rocks, proceeds rapidly at the highest summits. Its accumulation, however, and the covering up of the neighboring flat areas, are prevented by the steep declivities and the isolated situation of such points:—9. Vegetation is always highly essential for the fixing of earthy matter on the inclined sides of mountains; hence, at great heights, and in the absence of the growth of grass, the occurrence of humus, even on slightly inclined spots, is but very occasional and isolated:—10. In the Alps, particularly in the case of the crystalline slate rocks, the composition of the earth and its physical properties are very favorable to vegetation. Its proportion of humus is very considerable, even at great altitudes:—11. The glaciers not only aid in producing superficial changes by the transport of their moraine-masses, but also by giving rise to an immense quantity of fine sand, which can usually be carried far away by the rivers:—and lastly, 12. That the loosening of great masses of rock by the weather and water cause vast land- and mountain-slips; and the streams traversing the bottoms of the longitudinal valleys, owing to these fan-shaped, wide-spread masses of rubbish, are subject to frequent and considerable variations in their course.

In concluding this notice, we must mention that in the succeeding chapters, forming the 3rd and 4th Divisions of the work, several points closely connected with geognosy occur; especially on the comparison of the isothermal lines of the air with those of the earth, in chap. xiii, and on the connection of vegetation with geological conditions, in chap. xxi. T. R. J.

Art. XXXVI.—*On the Reproduction and supposed Existence of Sexual Organs in the Higher Cryptogamous Plants;* by Arthur Henfrey, F.L.S.*

Having been prevented by the pressure of other engagements from complying with the request which the Association did me the honor to make last year, that I should assist Prof. Lindley and Dr. Lankester in preparing a Report on Vegetable Physiology, I venture to present a fragmentary contribution on the subject, relating to a branch of the science to which my attention has been recently strongly attracted, in the pursuit of my own investigations. I was the more induced to devote the short time at my disposal to drawing up a summary of the state of knowledge of the reproduction of the higher flowerless plants, by the importance of the discoveries which have recently been made in this department, tending completely to change the general views which have hitherto been entertained by most botanists as to the extent to which sexuality exists in the vegetable kingdom, and in connection with other new facts relating to the Thallophytes, to indicate that the existence of two sexes is universal.

Under the name of the higher Flowerless Plants, I include all those classes which are distinguished on the one hand from the Thallophytes or Cellular plants by the presence of a distinct stem bearing leaves, and on the other from the Monocotyledons and Dicotyledons by the absence of the organs constituting a true flower; they are, the Hepaticæ, Musci, Equisetaceæ, Filices, Lycopodiaceæ, Isoëtaceæ, and Marsileaceæ or Rhizocarpeæ.

On no subject has more discussion been maintained than on the existence of sexes among the Cryptogamous families. The dis-

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* From the Report of the British Assoc. for the Advancement of Science for 1851.

covery of the two kinds of organs, the *antheridia* and *pistillidia*, in the Mosses and Hepaticæ, and of the peculiar organs containing analogous spiral filaments in the Characeæ, were for a long time the chief facts brought forward by those who supported the sexual hypothesis; and in the endeavor to carry out the view into the other tribes, a similar nature to that of the *antheridia* was attributed to most varied structures in the ferns and other plants. These attempts to find distinct sexual organs were in some instances pursued with so little judgment, that the opinion had of late years fallen in some degree into discredit, and two circumstances contributed still further to strengthen the doubts which were entertained. The first was the exact analogy, pointed out by Prof. von Mohl, between the mode of development of the spores of the Cryptogamia and the pollen-grains of the flowering plants, which interfered very importantly to prevent any comparison between the sporangia and ovaries, and apparently determined the analogy of the former to be with anthers. The second was the discovery by Prof. Nägeli, of organs producing spiral filaments, therefore analogous to the *antheridia* of the mosses, on the germ frond, or *pro-embryo* developed from the spores of the ferns.

At the same time, the facts observed in *Pilularia* were altogether equivocal. Mr. Valentine* traced the development of the the larger spores, exhibiting in germination an evident analogy to ovules, from cells closely resembling the parent-cells of pollen and spores; while Prof. Schleiden stated that he observed a fertilization of these supposed ovules by the smaller spores resembling pollen-grains, and thus seemed to remove the ground for attributing a fertilizing influence to the spiral filaments contained in the so-called *antheridia* of the Cryptogams.

In this state the question remained until 1848, when Count Suminski† published his observations on the germination of ferns, showing that the researches of Nägeli had been imperfect, and that two kinds of organs are produced upon the pro-embryo of the ferns; one kind analogous to the *antheridia*, and the other to the *pistillidia* of mosses; from the latter of which the true fern stem is produced, like the seta and capsule from the same organ in the mosses; further stating that he had actually observed a process of fertilization. Soon after this, M. G. Thuret‡ discovered *antheridia* like those of the ferns in the Equisetaceæ; Nägeli§ had previously published, in opposition to Schleiden's observations, an account of the production of spiral filaments from the small spores of *Pilularia*, and finally M. Mettenius|| discovered them in the small spores of *Isoëtes*. Thus they were shown

* Linnean Transactions, vol. xvii.
† Entwickelungsgeschichte der Farrenkräuter. Berlin, 1848.
‡ Ann. des Sci. Nat., ser. 3, vol. xi, 1849.
§ Zeitschrift für Wiss. Botanik, Heft 3. Zurich, 1846.
|| Beiträge zur Botanik, Heft 1. Heidelberg, 1850.

to exist in all the families above enumerated, with the exception of the Lycopodiaceæ, in which they have recently been stated to exist by M. Hofmeister.* Before entering into a detailed account of their discoveries, it may be mentioned, that, besides their well-known occurrence in the Characeæ, which most authors consider as Thallophytes, antheridia are stated by Nägeli to exist in the Florideæ, among the Algæ; and peculiar bodies to which the same nature has been attributed, were recently discovered by M. Itzigsohn in the lichens; a discovery confirmed by Messrs. Tulasne, who state that analogous bodies exist in many fungi. Our knowledge of these latter points is, however, far less definite than that concerning the higher tribes, and I shall not include them in the following summary.

One of the most remarkable circumstances concerning the antheridia of the leaf-bearing Cryptogams, is the very varied nature of the time and place of their development; so great indeed is this, that it is only their essential structure, and the production of the moving spiral filaments in particular, which warrants the assumption of their identity of function in the different families. In order to make these variations clearly comprehensible, it will be necessary to describe the characters exhibited in the germination of the spores in each tribe, as it is only by this means that the important peculiarities of each case can be made evident. It will be most convenient to give a separate sketch of all that is known of the process of reproduction in each family, taking these separately and in succession; after this we shall be in a position to compare them together, and trace out their differences and analogies; the advantage of recalling all the essential facts to memory, will, I trust, serve as an apology for the introduction of much that is already familiar to most botanists.

Mosses.—The antheridia of the mosses occur in the axils of the leaves or collected into a head, enclosed by numerous variously modified leaves, at the summit of the stem. They are produced either on the same heads as the pistillidia, or in distinct heads on the same individuals, such mosses being called monœcious; or the heads are found only on distinct individuals, such mosses being termed diœcious. The structure of the antheridium is exceedingly simple; it consists of an elongate, cylindrical or club-shaped sac, the walls of which are composed of a single layer of cells, united to form a delicate membrane. Within this sac are developed vast numbers of minute cellules, completely filling it, and, the sac bursting at its apex at a certain period, these vesicles are extruded. When the nearly perfect sacs are placed in water, the vesicles within appear to absorb water, and swell so as to burst the sac of the antheridium, and often adhering together, they collectively appear to form masses larger than the

* Flora, 1850, p. 700.

cavity from which they have emerged. Through the transparent walls may be seen a delicate filament with a thickened extremity, coiled up in the interior of each vesicle. Often before the extrusion, but always shortly after, a movement of this filament is to be observed when the object is viewed in water under the microscope. The filament is seen to be wheeling round and round rapidly within the cellule, the motion being rendered very evident by the distinctness of the thickened extremity of the filament, which appears to be coursing round the walls of the cellule in a circle. According to Unger, this filament breaks out of its parent cellule in Sphagnum, and then appears as a spiral filament moving freely in water, in fact, as one of the so-called spermatozoa.

The pistillidia of the mosses are the rudiments of the fruit or capsules. When young, they appear as flask-shaped bodies with long necks, composed of a simple cellular membrane. The long neck presents an open canal like a style, leading to the enlarged cavity below, at the base of which, according to Mr. Valentine,* is found a single cell projecting free into the open space. This single cell is the germ of the future capsule; at a certain period it becomes divided into two by a horizontal partition, the upper one of these two again divides, and so on until the single cell is developed into a cellular filament, the young seta; the upper cells are subsequently developed into the urn and its appendages, and as this rises, it carries away with it, as the calyptra, the original membrane of the pistillidium, which separates by a circumscissile fissure from the lower part, the future vaginula. These observations of Valentine are not exactly borne out by those of Schimper† in some of the detail points. According to this author, the lower part of the pistillidium (the germen of Dr. Brown) begins to swell at a certain time, when a capsule is to be produced, becoming filled with a quantity of what he terms "green granulations." As soon as the thickness has become about that of the future seta, the cell-development in the horizontal direction ceases, and its activity is directed chiefly to the upper part, which begins to elongate rapidly in the direction of the main axis. This elongation causes a sudden tearing off at the base, or a little above it, of the cell-membrane enveloping the young fruit, and the upper part is carried onwards as the calyptra; the lower part when any is left, remains as a little tubular process surrounding the seta. While the young fruit is being raised up by the growth of the seta, the portion of the receptacle upon which the pistillidium is borne, becomes developed into a kind of collar, and at length into a sheath (the vaginula) surrounding the base of the seta which is articulated into it there.

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* Linnean Transactions, vol. xvii.

† Recherches Anatomiques et Morphologiques sur les Mousses. Strasbourg, 1848.

M. Hofmeister,* again, describes the details much in the same way as Mr. Valentine. He states that there exists at the point where the 'style' and 'germen' of the pistillidium join, a cell, developed before the canal of the style has become opened. In those pistillidia which produce capsules this cell begins at a certain period to exhibit very active increase; it becomes rapidly divided and subdivided by alternately directed oblique partitions into a somewhat spindle-shaped body formed of a row of large cells. Meanwhile the cells at the base of the germen are also rapidly multiplied, and the lower part of the pistillidium is greatly increased in size. The spindle-shaped body continues to increase in length by the subdivision of its uppermost cell by oblique transverse walls, and the opposition which is offered by the upper concave surface of the cavity of the germen, causes the lower conical extremity of the spindle-shaped body to penetrate into the mass of cellular tissue at the base of the germen, a process which resembles the penetration of the embryo into the endosperm in the embryo-sac of certain flowering plants. The base of the spindle-shaped body, which is in fact the rudiment of the fruit, at length reaches the base of the pistillidium, and penetrates even some distance into the tissue of the stem upon which this is seated. The growth of the upper part going on unceasingly, the walls of the germen are torn by a circular fissure and the upper half is carried upwards, bearing the calyptra, the lower part forms the vaginule. The upper cell of the spindle-shaped body then becomes developed into the capsule, and the calyptra often becoming organically connected with this, as the base of the seta does with the end of the stem, it in such cases undergoes further development during the time it is being carried upwards by the growing fruit.

The view now entertained by Schimper, Hofmeister, and others, of the reproduction of the mosses is, that the antheridia are truly male organs, and that they exert, by means of the spiral filaments, a fertilizing influence upon the pistillidia, it being assumed that those bodies, or the fluid which they are bathed in, penetrate down the canal of the style or neck-like portion of the pistillidium to reach the minute cell, the supposed embryonal cell, situated in the globular portion or 'germen' of the pistillidium, and thus render it capable of becoming developed into a perfect fruit.

No such process of fertilization has actually been observed in the mosses, and therefore all the evidence is at present merely circumstantial; but this is very strong. In the first place it is stated as an undoubted fact by Schimper and Bruch, that in the diœcious mosses, those on which the antheridia and pistillidia

* Botanische Zeitung, 1849, 798. Botanical Gazette, vol. ii, p. 70.

occur in separate plants, fruit is never produced on the so-called male plants, and never on the so-called female unless the males occur in the vicinity; several examples are cited in the work of Schimper above referred to; when the sexes occur alone, the increase of the plant is wholly dependent on the propagation by gemmæ or innovations.

By the discovery of the antheridia and pistillidia in the other higher Cryptogams, the arguments from analogy greatly strengthen the hypothesis of the sexuality of mosses.

Further observation is required, then, for the direct proof of the occurrence of a process of fertilization in the mosses; but the facts now before us all tend to prove their sexuality if we argue from analogy, and the probabilities deduced from the negative evidence above referred to in regard to the diœcious species.

It is unnecessary to give any account of the well-known structure of the moss capsules; yet in order to render the comparison with the phenomena of the life of the mosses with those of the other leafy Cryptogams complete, it may be worth while to allude to the germination of the spores. The spore is a single cell, with a double coat, like a pollen-grain; this germinates by the protrusion of the inner coat in the form of a filamentous or rather tubular process, which grows out and becomes subdivided by septa so as to form a confervoid filament. The lateral branches bud out from some of the cells, some elongating into secondary filaments, others at once undergoing a more active development, and by the multiplication of their cells, assuming the condition of conical cellular masses, upon which the forms of moss leaves may soon be detected; these cellular masses becoming buds from which the regular leafy stems arise.

Hepaticæ.—The genera comprehended in this family present a wonderful variety of structure in the reproductive organs, but in almost all of them the existence of the two kinds of organs called pistillidia and antheridia have long been demonstrated, and in most cases the development of the sporangia from the so-called pistillidia has been traced. In those genera in which the plants most resemble the mosses in the vegetative portion, as in *Jungermanniæ*, the pistillidia are very like those of the mosses; this is also the case in *Marchantia;* but in *Pellia*, *Anthoceros*, and other genera, the rudiment of the sporangium bears a striking resemblance to the so-called ovules of the Ferns, Rhizocarpæ, &c., occurring upon the expanded fronds very much in the same way as those bodies do upon the pro-embryo of the said families. It would occupy too much space to enter into a minute detail of the various conditions that are met with. It is sufficient to say that in all cases the physiological stages are analogous to those of the mosses; since the pistillidia produced upon the fronds or leaf-bearing stems developed directly from the spores, go on to produce a *sporangium alone*, in which the new spores are developed, without the intervention of the stage of existence presented by the pro-embryo of the Ferns and Equisetacæ, where the pistillidia and antheridia occur upon a temporary frond, and the former give origin to the regular stem and leaves of the plant.

Ferns.—This class formed for a long time the great stumbling-block to those who sought to demonstrate the existence of sexuality in the Cryptogamous plants. The young capsules were generally considered to be the analogues of the pistillidia of the mosses, and the young abortive capsules which frequently occur among the fertile ones were supposed by some authors to represent the antheridia. Mr. Griffith,* shortly before his death, noticed a structure which he was inclined to regard as the analogue of the antheridium in certain of the ramenta upon the petioles.

In the year 1844, Prof. Nägeli† published an account of his observations on the germination of certain ferns, and announced the discovery of moving spiral filaments closely resembling those of the Charæ, on certain cellular structures developed upon the pro-embryo or cellular body first produced by the spore. It is not worth while to enter into an analysis of his observations, as they have since been clearly shown to have been very imperfect; it is sufficient to state that he only described *one* kind of organ, and from his description it is evident that he confounded the two kinds since discovered, regarding them as different stages of one structure. The announcement of this discovery seemed to destroy all grounds for the assumption of distinct sexes, not only in the ferns but in the other Cryptogams, since it was argued that the existence of these cellular organs, producing moving spiral filaments, the so-called spermatozoa, upon the germinating fronds, proved that they were not to be regarded as in any way connected with the reproductive processes.

But an essay published by the Count Suminski‡ in 1848, totally changed the face of the question, and opened a wide field for speculation and investigation on this subject, just as it was beginning to fall into disfavor. Count Suminski's paper gives a minute history of the course of development of the ferns from the germination of the spore to the production of the regular fronds, and he found this development to exhibit phenomena as curious as they were unexpected. The cellular organs seen by Nägeli were shown to be of two perfectly distinct kinds, and moreover to present characters which gave great plausibility to the hypothesis that they represented reproductive organs; moreover, this author expressly stated that he had obtained absolute proof of sexuality by observing an actual process of fertilization

* Posthumous Papers, Journal of Travels, 444.
† Zeitschrift für Wiss. Botanik. Heft 1. Zurich, 1844.
‡ Zur Entwickelungsgeschichte der Farrenkräuter. Berlin, 1848.

to take place in the so-called ovules, through the agency of the spiral filaments or spermatozoa.

The main points of his paper may be briefly summed up as follows. The fern spore at first produces a filamentous process, in the end of which cell-development goes on until it is converted into a Marchantia-like frond of small size and exceedingly delicate texture, possessing hair-like radicle-hairs on its under side. On this under side become developed, in variable numbers, certain cellular organs of two distinct kinds. The first, which he terms antheridia, are the more numerous, and consist of somewhat globular cells, seated on and arising from single cells of the cellular marchantia-like frond. The globular cell produces in its interior a number of minute vesicles, in each of which is developed a spiral filament, coiled up in the interior. At a certain epoch the globular cell bursts and discharges the vesicles, and the spiral filaments moving within the vesicles at length make their way out of them and swim about in the water, displaying a spiral or heliacal form, and consisting of a delicate filament with a thickened clavate extremity; this, the so-called head, being said by Count Suminski to be a hollow vesicle, and to be furnished with six or eight cilia, by means of which the apparently voluntary movement of the filament is supposed to be effected.

The second kind of organ, the so-called 'ovules,' are fewer in number and present different characters in different stages. At first they appear as little round cavities in the cellular tissue of the pro-embryo, lying near its centre and opening on the under side. In the bottom of the cavity is seen a little globular cell, the so-called embryo-sac. It is stated by Count Suminski that while the ovule is in this state one or more of the spiral filaments make their way into the cavity, coming in contact with the central globular cell. The four cells bounding the mouth of the orifice grow out from the general surface into a blunt cone-like process, formed of four parallel cells arranged in a squarish form and leaving an intercellular canal leading down to the cavity below. These four cells become divided by cross septra, and grow out until the so-called ovule exhibits externally a cylindrical form, composed of four tiers of cells, the uppermost of which gradually converge and close up the orifice of the canal leading down between them. Meanwhile the vesicular head of one of the spiral filaments has penetrated into the globular cellule or embryo-sac, enlarged in size and undergone multiplication, and in the course of time displays itself as the embryo, producing the first frond and the terminal bud whence the regular fern stem is developed. In considering the import of these phenomena, the author assumes the analogy here to be with the process of fertilization in flowering plants as described by Schleiden, regarding the production of the embryo from the vesicular head of the spermatozoa as representing the production of the phanerogamous embryo from the end of the pollen tube after it has penetrated into the embryo-sac.

The promulgation of these statements naturally attracted great attention, and since they appeared we have received several contributions to the history of these remarkable structures, some confirmatory, to a certain degree, of Suminski's views, others altogether opposed to them.

In the early part of 1849, Dr. Wigand* published a series of researches on this subject, in which he subjected the assertions of Suminski to a strict practical criticism; the conclusions he arrived at were altogether opposed to that author's views respecting the supposed formation of the organs, and he never observed the entrance of the spiral filaments into the cavity of the so-called ovule.

About the same time M. Thuret† published an account of some observations on the antheridia of ferns. In these he merely confirmed and corrected the statements of Nägeli respecting the antheridia, and did not notice the so-called ovules.

Towards the close of the same year, Hofmeister‡ confirmed part of Suminski's statements and opposed others. He stated that he had observed distinctly the production of the young plant (or rather the terminal bud for the new axis), in the interior of the so-called 'ovule,' but believed the supposed origin of it from the end of the spiral filament to be a delusion. He regards the globular cell at the base of the canal of the 'ovule' as itself the rudiment of the stem, or embryonal vesicle (the embryo originating from a *free* cell produced in this), analogous to that produced in the pistillidia of the mosses. He also describes the development of the ovule differently, saying that the canal and orifice are opened only at a late period by the separation of the contiguous walls of the four rows of cells.

About the same time appeared an elaborate paper on the same subject by Dr. Hermann Schacht,§ whose results were almost identical. He found the young terminal bud to be developed in the cavity of one of the so-called 'ovules,' which were developed exactly in the same way as the pistillidia of the mosses. He stated also that the cavity of the 'ovule' is not open at first, and he declares against the probability of the entrance of a spiral filament into it, never having observed this, much less a conversion of one into an embryo.

In the essay of Dr. Mettenius already referred to,‖ an account of the development of the so-called ovules is given. His obser-

* Botanische Zeitung, vol. vii, 1849.
† Ann. des Sci. Nat., Jan., 1849, ser. 3, vol. xi, Botanique.
‡ Botanische Zeitung, 1849.
§ Linnæa, vol. xxii, 1849.
‖ Beiträge zur Botanik, 1. Heidelberg, 1850. Zur Fortpflanzung der Gefäss-Cryptogamen.

vations did not decide whether the canal of the 'ovule,' which he regards as an intercellular space, exists at first, or only subsequently, when it is entirely closed above. Some important points occur in reference to the contents of the canal.

The contents of the canal in a mature condition consist of a continuous mass of homogeneous, tough substance, in which fine granules, and here and there large corpuscles, are imbedded. It reaches down to the globular cell or 'embryo-sac,' and is in contact with this. This mass either fills the canal or diminishes in diameter from the blind end of the canal down to the 'embryo-sac;' in other cases it possesses the form represented by Suminski, having a clavate enlargement at the blind end of the canal, and passing into a twisted filament below. In this latter shape it may frequently be pressed out of isolated 'ovules' under the microscope, and then a thin transparent membrane-like layer was several times observed on its surface. In other cases the contents consisted of nucleated vesicles, which emerged separately or connected together.

The embryo-sac consists of a globular cell containing a nucleus, and this author believes that the commencement of the development of the embryo consists in the division of this into two, which go on dividing to produce the cellular structure of the first frond.

With regard to the contents of the canal the author says,—

"Although I can give no information on many points, as in regard to the origin of the contents of the canal of the 'ovule,' yet my observations on the development of the 'ovule' do not allow me to consider them, with Suminski, as spiral filaments in course of solution; just as little have I been able to convince myself of the existence of the process of impregnation described by that author. It rather appears to me that the possibility of the entrance of the spiral filaments and the impregnation cannot exist until the tearing open of the blind end of the canal in the perfectly-formed ovule, as after the opening of the so-called 'canal of the style' in the pistillidia in the mosses."

Another contribution has been furnished by Dr. Mercklin,* the original of which I have not seen, but depend on analyses of it published in the 'Botanische Zeitung,'† and the 'Flora' for 1851,‡ and further in a letter from Dr. Mercklin to M. Schacht,§ which appeared in the 'Linnæa' at the close of last year.

He differs in a few subordinate particulars from M. Schacht in reference to the development and structure of the *prothallium* or pro-embryo, and of the antheridia and spiral filaments; but these do not require especial mention, except in reference to the vesicu-

* Beobachtungen aus dem Prothallium der Farrenkräuter. St. Petersburg, 1850.
† Botanische Zeitung, vol. xxxiii, 1850. ‡ Flora, vol. xxxiii, p. 696, 1850.
§ Linnæa, vol. xxiii, p. 723, 1850.

lar end of the spiral filament described by Schacht, which Mercklin regards as a remnant of the parent vesicle, from which the filament had not become quite freed. The observations referring to the so-called ovule and the supposed process of impregnation are very important; they are as follows:—

"1. The spiral filaments swarm round the 'ovule' in numbers, frequently returning to one and the same organ.

"2. They can penetrate into the 'ovule.' This was seen only three times in the course of a whole year, and under different circumstances; twice a spiral filament was seen to enter a still widely open young 'ovule,' then come to a state of rest, and after some time assume the appearance of a shapeless mass of mucilage; the third case of penetration occurred in a fully-developed 'ovule,' through its canal; it therefore does not seem to afford evidence of the import of the spiral filament, but certainly of the possibility of the penetration.

"3. In the tubular portion of the 'ovule,' almost in every case, peculiar club-shaped, granular mucilaginous filaments occur at a definite epoch, these filaments, like the spiral filaments, acquiring a brown color with iodine. These mucilaginous bodies sometimes exhibit a twisted aspect, an opake nucleus, or a membranous layer, peculiarities which seem to indicate the existence of an organization.

"4. These club-shaped filaments are swollen at the lower capitate extremity, and have been found in contact with the 'embryo-sac' or globular cell which forms the rudiment of the future frond.

"5. The spiral filaments, which cease to move and fall upon the prothallium, are metamorphosed, become granular and swell up."

Hence the author deduces the following conclusions:—

"That these clavate filiform masses in the interior of the 'ovule' are transformed spiral filaments, which at an early period, while the ovule was open, have penetrated into it; which leads to the probability that—

"1. The spiral filaments must regularly penetrate into the 'ovules,' and

"2. They probably contribute to the origin or development of the young fruit frond (or embryo). In what way this happens the author knows not, and the details on this point given by Count Suminski remain unconfirmed facts."

An important point in this essay is the view the author takes of the whole process of development in this case. He regards it as not analogous to the impregnation in the Phanerogamia, since the essential fact is merely the development of a *frond* from one cell of the *prothallium*, which he considers to be merely one of the changes of the individual plant; while all the other authors who have written on the subject, with the exception of Wigand, call the first frond, with its bud and root, an *embryo*, and regard it as a new individual, or at all events a distinct member of a series of forms constituting collectively the representatives of the species.

Finally, Hofmeister, in his notice of this essay in the 'Flora,'* declares that the development of the so-called 'embryo' or first frond commences, not by the subdivision of the globular cell or 'embryo-sac,' but by the development of a free cell or 'embryo vesicle' in this, like what occurs in the embryo-sac of the Phanerogamia; and he asserts that this is the first stage of development from the globular cell in all the vascular Cryptogams, including that found in the pistillidia of the mosses.

Equisetaceæ.—The first discovery of the analogy between the developments from the spore in germination, in the Ferns and Equisetaceæ, is due to M. G. Thuret,† who saw the spores of the latter produce a cellular pro-embryo somewhat like that of the ferns, and in this were developed antheridia of analogous structure, emitting cellules containing many spiral filaments.

This announcement was confirmed by M. Milde,‡ whose observations extended over some months, during which time no 'ovule' was produced, but he saw what appeared to be the rudiment of one. Dr. Mettenius§ states that he has met with decaying 'ovules' precisely like those of the ferns, upon the pro-embryo of an equisetum, and thus the evidence is completed, so far as the occurrence of the two kinds of organs is concerned.

(To be continued.)

Art. XXXVII.—*Facts and Principles Relating to the Origin and the Geographical Distribution of Mollusca;* by Thomas Bland, F.G.S., London.

In preparing this paper, the following works have been particularly consulted, viz,—*Introduction to the Mollusca of the United States Exploring Expedition.* By A. A. Gould, M.D. December, 1851; and *Catalogue of Shells collected at Panama, with Notes on their Synonymy, Station, and Geographical Distribution.* By C. B. Adams, Professor of Zoology, &c. in Amherst College, Massachusetts. New York, 1852.

We estimate these works as highly valuable contributions to science, and especially so with respect to the subject of the geographical distribution of Testaceous Mollusca.

The attention of these authors has for some years been directed to this question. It is discussed by Dr. Gould in his "*Report on the Invertebrata of Massachusetts,*" dated March, 1840,—also

* 1850, p. 700.
† Ann. des. Sci. Nat., 1849, vol. xi, 5.
‡ Linnæa, 1850.
§ Beiträge zur Botanik, 1850, p. 22.

in his paper on "*The results of an examination of the shells of Massachusetts, and their Geographical distribution,*" read in February, 1841, before the Boston Society of Natural History, (published in the third volume of the Society's Journal,) and in his subsequent works.—Professor Adams takes up the subject in his "*Second Annual Report on the Geology of the State of Vermont,*" dated October, 1846, as well as in his later publications.

The latter author has had the particular advantage of working somewhat extensively in the wide field of nature. His labors in Jamaica, when confined to the *terrestrial* shells, revealed to him the existence of a distinct, though limited zoological province, and enabled him to demonstrate, that the area of the marine Caribbean province, comprises several distinct terrestrial insular faunas. On extending his inquiries to the *marine* shells of the coasts of this country, of Jamaica and the neighboring island, and of Panama, he found means of approximately defining the limits of two marine zoological provinces, viz, the "Caribbean," and "Panama." An important step towards this object is gained, as regards the latter, by the publication mentioned at the commencement of this article, and the author is now employed, we understand, in the preparation of a more complete work, illustrative of the former.

We desire to shew the interest and value which are attached to the question of the geographical distribution of shells,—not only generally, as part of the animal kingdom, but in its especial reference to geology. Although it may appear that much has been discovered and written on the subject, it will be equally apparent that very much remains to be worked out.

We propose also to refer to the causes of error on the subject, and to the question of the origin of species, which is intimately connected with the fact, that different regions of the globe, both of land and water, are inhabited by distinct groups of animals and plants.

It being our wish to excite increased attention to these subjects, we have preferred quoting largely from works of authority, to offering a summary of views and opinions in language of our own.

Buffon first pointed out the want of *specific* identity between the land quadrupeds of America, and those of the old world. Humboldt demonstrated that zones of elevation on mountains correspond to parallels of latitude, the higher with the more northern or southern, as the case might be. But for a lucid and succinct account of the progress and extent of our knowledge of the geographical distribution of species, both of plants and animals, we must refer to the admirable chapters relating to it, in Sir Charles Lyell's *Principles of Geology.*

That author justly observes, that "the extent of this parcelling out of the globe amongst different *nations*, as they have been termed, of plants and animals—the universality of a phenomenon so extraordinary and unexpected, may be considered as one of the most interesting facts clearly established by the advance of modern science."—p. 590. (*Eighth edition, London*, 1850.)

The geographical distribution of shells (to which portion of the animal kingdom our remarks will be confined) has received, and continues to receive much attention on the part of American naturalists,—indeed more so, it would seem, than from those of Europe. We may mention, by way of illustration, the total absence of all allusion to the topic, in the interesting "*Introduction to Conchology*," of Dr. George Johnston. (*London*, 1850.) The first direct reference to the subject in works of authors of the United States, is, we believe, in Dr. Gould's *Report on the Invertebrata of Massachusetts*, (*Cambridge, U. S.*, 1841.) In his Introduction, he says,—"No attempt has hitherto been made to give an account of all the shells of any particular region on this continent. No book exists in which we may find descriptions of any considerable proportion of the whole number of the shells of the United States." In his "Recapitulation," Dr. Gould particularizes the following instance of geographical limitation occurring in the state of Massachusetts: "Cape Cod, the right arm of the Commonwealth, reaches out into the ocean some fifty or sixty miles. It is nowhere many miles wide; but this narrow point of land has hitherto proved a barrier to the migrations of many species of Mollusca. Several genera and numerous species which are separated by the intervention of only a few miles of land, are effectually prevented from intermingling by this Cape, and do not pass from one side to the other." p. 315. Dr. Gould asserts, that of the 197 marine species then known, 83 do not pass to the south shore, and 50 are not found on the north shore of the Cape.

Professor Adams in his "*Second Annual Report on the Geology of the State of Vermont*," (*Burlington*, 1846,) notices particularly the geographical distribution of species as a subject of great importance in its application to geology. He enters on the question of the former existence of gigantic mammalia on this continent, and the time when they flourished, a subject variously treated by other authors, and refers to the evidence afforded by an examination of fossil shells. He concludes that those quadrupeds, although found "to have been mired in shell marl, which consists of the same species of freshwater shells, which now inhabit our waters," did not belong to the present geological period.

In 1848, Professor Agassiz and Dr. Gould published the first part of their "*Principles of Geology*," (*Boston*, 1848,) in which a chapter is devoted to a consideration of the "Geographical distribution of Animals." "Notwithstanding," say the authors, "the uniform nature of the watery element, the animals which dwell in it are not dispersed at random; and though the limits of the marine may be less easily defined than those of terrestrial faunas, still, marked differences between the animals of great basins are not less observable. Properly to apprehend how marine animals may be distributed into local faunas, it must be remembered that their residence is not in the high sea, but along the coasts of continents, and on soundings." p. 191. And farther,—"A very influential cause in the distribution of aquatic animals is the depth of the water; so that several zoological zones, receding from the shore, may be defined, according to the depth of the water; much in the same manner as we mark different zones at different elevations in ascending mountains. The Mollusks and even the fishes found near the shore in shallow water, differ, in general, from those living at the depth of twenty or thirty feet, and these again are found to be different from those which are met with at a greater depth."—p. 192.

In the various numbers of his "*Contributions to Conchology,*" (No. 1, published in Sept., 1849, and No. 10, the last, in Nov., 1851,) Professor Adams describes the curious local distribution of the terrestrial shells of Jamaica, and corrects many errors with regard to them. He found some species improperly attributed to Jamaica, and other species peculiar to that island, referred to other localities. It is now satisfactorily proved, that of the 357 species, the whole number of strictly terrestrial shells at present known to inhabit Jamaica, not more than 10 species are found in other islands.

In "*Contributions*" No. 4, Professor Adams remarks, "With this extremely local distribution of the terrestrial Mollusca in the West Indies may be associated the great fact of their geological history,—that these islands have, since the later tertiary periods, been in the process of elevation,—that they are the harbingers of a future continent, unlike the groups in the Pacific, which are the remains of ancient continents. Coincident with these two general facts in the West Indies is also a third,—that their coral reefs are all fringing, and that coral islands are wanting."

In August, 1850, the Professor read, (at the meeting of the American Association for the Advancement of Science,) a paper "*On the nature and origin of the Species of the Terrestrial Mollusca in the island of Jamaica,*" (republished in "*Contributions*" No. 10.) From this paper we make the following extract: "Notwithstanding the difficulty of exploration in tropical regions, the island of Jamaica presents remarkable facilities for the investigation of subjects which are connected with the geographical distribution of species. Among the *terrestrial shells,* typical forms exist in great profusion. These forms are of every conceivable grade of value, from varieties up to genera and families.

They have also a determinate geographical distribution. The facts on these subjects are even more numerous than those which are expanded over the whole temperate regions of North America. In this respect, therefore, the island is a miniature continent. Probably the same is true of each of the larger Antilles."*

We now refer to the work of the late Dr. Binney, on "*The Terrestrial Air-Breathing Mollusks of the United States*," (*Boston*, 1851,) published, since his death, under the able editorship of Dr. Gould. This work is indeed an imperishable record of the talents and love of science of its author,—a noble legacy to his country.

Dr. Binney highly appreciated the value of a study of the geographical distribution of shells. His first volume contains some interesting chapters relating to the subject,—we refer especially to the eighth. In that, and other parts of the book, various comparative tables of the habitats of shells are introduced, and the value of a complete series, including especially those of limited districts which present strongly marked topographical or climatal peculiarities, is pointed out.

The ninth chapter is devoted to "Geological relations." The most important inference, with respect to the geological history of this continent, deduced by Dr. Binney from his consideration of its fossil terrestrial shells is thus stated:—

"That our existing species of land Mollusks were living at a period which, though recent in a geological sense, was anterior to the last geological revolution, when the surface of this portion of the earth was brought to its present condition, and to the existence of the higher orders of animals which now inhabit it, and even to that of the extinct mammalians which are known only by their gigantic remains."—p. 185.

Stimpson, in his "*Shells of New England*," (*Boston*, 1851,) displays the growing interest attached to the subject before us, in his notes on the geographical, and bathymetrical, or horizontal and vertical range of each species. The observations of this author on the anatomy of the animals of many species of shells are very valuable.

The remarks of Dr. Gould in his "*Introduction to the Mollusca of the United States Exploring Expedition*," (*December*, 1851,) are eminently worthy of notice, as the following extracts will abundantly prove.

"The doctrine of distinct zoological regions evidently appertains to the Mollusks, and is well illustrated by them. In nearly every work, containing any considerable catalogue of shells, the same species will be found quoted as being found in widely distant regions, in different oceans, and even on opposite sides of the globe. The many thousand localities carefully noted on the records of the Expedition go to prove beyond dispute, that no such random or wide-spread distribution obtains."—p. ix.

"Another point of interest extensively elucidated by the collections of the Expedition is the occurrence of analogous species in co-ordinate regions. It is now a received fact that the animals and plants of the northernmost zones are, for the most part, identical throughout the whole circuit; and that the species gradually diverge from each other towards the equator, on the three continents; and that after passing the equator towards the south, there is not a return to the same species, and rarely to the same genera, as we should expect if variation of forms depended mainly on difference of temperature. There is, however, a return to mollusks of a kindred character and form, and oftentimes to the same genera. The analogies of specimens from distant regions are much stronger when reckoned by isothermal longitude than by isothermal latitude. In the latter case we may have analogous genera. Along our northern seas, some of the most characteristic shells are *Buccinum*, *Tritonium*, *Fusus*, *Terebratula*, *Rimula*, &c. Around Cape Horn are shells of the same types, so closely allied that they have not yet been separated as distinct genera, though peculiar in many important respects. But this resemblance does not descend to species. In the first case, however, not only have we the same genera, but the species seem to repeat each other: so that species brought from great distances east or west, are scarcely to be distinguished upon comparison."—p. xii.

Dr. Gould gives, in illustration, a list of species from Oregon, and from the Eastern States, and observes that "mingled with these are others very different in type, which mark the two localities as constituting very different zoological regions." He adds, "the same comparison holds good between the shells of the Gulf of California and the Gulf of Mexico."

We would quote also the following:—

"From a consideration of the land shells collected on the Pacific Islands, it seems possible to draw some fair inferences as to the relations of the lands which once occupied the area of the Pacific Ocean, and whose mountain peaks evidently now indicate or constitute, the islands with which it is now studded. By obobservation of the species, we think there are strong indications that some groups of islands have an intimate relation to each other, and belonged, at least, to the peaks of the same mountain ranges, before they were submerged; while the indications are equally strong that other groups had no territorial connection." —p. xiv.

Drawing inferences from the land shells, Dr. Gould considers that the Samoa and Friendly Islands are more intimately related to the Society Islands, though at a much greater distance, than to the Feejee Islands, and that the Feejees are more nearly allied to the islands to the westward,—such as the New Hebrides, than to the Friendly Islands on the east, though so much nearer.

The "*Catalogue of Shells collected at Panama,*" (*New York*, 1852,) by Professor Adams, now claims our attention.

The Preface commences with the following passage:—

"The reader of the Introduction to this work, and of Dr. Gould's Introduction to his great work on the shells of the United States Exploring Expedition, may be struck with the coincidence of opinions relating to the geographical distribution of species, and to errors in the statement of habitats, and in the distinctive characters of species. The coincidence is so exact, that it might naturally be supposed that these opinions originated in a single source. Such was their origin; but that source was the book of Nature. It was not until after both Introductions had been written, that opportunities occurred for a free interchange of views with Dr. Gould. It is therefore with the liveliest satisfaction that we derive assurance of their correctness both from the extent and accuracy of Dr. Gould's knowledge, and also from the coincidence of the results of independent investigations."

Professor Adams visited Panama at the end of 1850, and in the space of six weeks collected there, and in the immediate vicinity, and at the Island of Taboga, no less than 516 species of Mollusks, of which 158 are described in the Catalogue as new, and 64 are enumerated as undetermined. He states that besides the object of making additions to the Museum of Amherst College, he desired "to ascertain, with the certainty of personal observation, what and how many species of shells exist at Panama. Having formerly collected about 500 marine species in Jamaica, near the centre of the Caribbean Zoological Province, it was thought that a comparison of these authentic materials would not be without interest."

In the Introduction, we have the result of such comparison; but our limits will admit of little more than the following extract:—

"Panama is situated near the middle of a well defined marine zoological province. Perhaps none of the species of testaceous Mollusca (to which part of the Fauna our remarks are limited) which inhabit the neighboring seas, exist south of 22° S. lat., or north of 28° N. lat., or west of the Gallapago Islands. All of the few examples of species, which are supposed to have a wider range, are more or less doubtful. Some species which inhabit the northern part of the province, and others which inhabit the southern part, may overlap the boundaries between this and the adjacent provinces. But these species present only the usual difficulty in attempting to define the limits of a zoological province.

The most definite and satisfactory method of defining the limits of this province, is to place the boundaries at the extreme limits of the range of about 99 per cent. of the species which inhabit its middle regions. Thus it will be seen that several of the species which inhabit Panama also inhabit Guaymas, in the Gulf of

California, nearly in 28° N. lat.; but none of them inhabit San Diego, which is near 33° N. lat. In the same manner the southern limit is found near the boundary between Peru and Chili, between 22° and 24° S. lat.

The reason why the range of the species south of the equator is several degrees less than on the north side, is obvious in the Antarctic current, which sets along the west coast of South America. In like manner, on the eastern coast of North America, a polar current appears to extend the Arctic Fauna of marine shells to 41° N. lat., and the cold current along the shores of the Middle and Southern States seems to limit the tropical Fauna to about 26° or 28° N. lat. on the coast, although on the east side of the Gulf Stream it extends to the Bermuda Islands in latitude 32° N.

It will also be seen in the following pages, that a large number of the species which occur at Panama were collected by Mr. Cuming at the Gallapago Islands. But if any of the species occur in the Polynesian Islands, the number does not exceed three or four, and in these cases the specific identity of the shells is very doubtful. The western boundary of the Panama province may therefore be made to include only the Gallapago Islands."—p. 5.

Professor Adams gives a list of 20 species collected by him at Panama and Taboga, which occur also at the Gallapago Islands, from which it appears, that a larger proportion of the littoral than of the pelagic known species are common to the Gallapago Islands, and the main land; and of the pelagic species, all which are known inhabit moderate depths.

With regard to the limits of the Caribbean province, Professor Adams remarks that very few of the Caribbean species "occur north of the Bahamas, or south of Brazil, although from various sources of error many of them have been reputed to inhabit England, and various other parts of the world. Although there are several analogous species in the two provinces, in general there is a great dissimilarity."

The author thus concludes his Introduction:—

"A great amount of valuable materials, for interesting generalizations on the number and distribution of the species of marine Mollusks, has been collected by public and private expeditions. But when we consider the immense profusion of species and of individuals in tropical seas, and the confusion of the habitats of many as exhibited in the present literature of conchology, so that the plan of distribution is misrepresented,—that which has been done only stimulates the curiosity to know more, and to know more accurately. An expedition of circumnavigation, with the specific object of investigating the distribution of the testaceous Mollusks, through several tropical marine provinces, would accomplish more than the discovery of many new species: it would determine the distribution of a much greater number, in a manner which would justly inspire confidence.

Taking up British authors, we refer in the first instance to Lyell's "*Principles of Geology.*"

Lyell, in chapter 40, refers to the influence of climate on the geographical distribution of Mollusks, and to the greater uniformity of temperature in the waters of the ocean, than in the atmosphere which invests the land, as a cause of the extensive diffusion of many marine species. He mentions that some genera are peculiar to warm latitudes, others to limited regions, but admits that we cannot as yet define the submarine provinces of shells, as botanists have the provinces of terrestrial and even subaqueous plants.

In treating of the great range of some species, Lyell is rather unfortunate, in some at least of those which he selects by way of illustration. He gives various habitats, implying a very wide range to *Sanguinolaria rugosa*, Lam.: we feel confident, however, that analogous, but distinct species, have been confounded.

The *Cypræa moneta*, he says, "a Mediterranean shell, occurs also in South Africa, the Isle of France, the East Indies, in China, the South sea, and even as far west as Otaheite." It is possible that an inhabitant of the Indian Ocean may have a wide range, even as far east as Otaheite, but as regards the Mediterranean as a *habitat* of this shell, we would refer to the following editorial note on the species, in Lamarck's *Anim. sans Vert., edition of Deshayes and Milne Edwards*, vol. x, p. 537:—

"Cette espèce est mentionée dans les catalogues des coquilles de la Méditerranée: elle se trouvait à Toulon, en Corse, en Sicile; mais personne ne dit avoir vu l'animal vivant. Cette coquille, ainsi que le *Cypræa annulus*, etaient, il y a peu d'anneés, l'objet d'un assez grand commerce, parce qu'elles servaient de monnaie dans la traite des noirs. N'est-il pas possible que des événemens maritimes, comme des naufrages, par exemple, soient la cause de la présence de ces espèces dans les régions de la Méditerranée les plus fréquentés par le commerce, car elles ne se rencontrent pas dans les régions sauvages des Côtes de Barbarie."

Lyell also observes, that *Helix putris* (*Succinea putris*, Lam.) "so common in Europe, where it reaches from Norway to Italy, is also found in Egypt, in the United States, in Newfoundland, Jamaica, Tranquebar, and, it is even said, in the Marianne Isles."

We venture to assert that this shell does not inhabit Jamaica. Professor Adams has personally, and with much care, collected terrestrial and freshwater shells in Jamaica, aided during several years, by the zealous exertions of many friends, but all have failed in meeting with *Succinea putris*.

Dr. Binney, in his work already mentioned, refers to this shell as "not uncommon" in the United States, on the authority of Forbes and Férusac, but only as an introduced species.

Darwin, in his admirable "*Journal of Researches*," comments on the distribution of shells in the Galapagos Archipelago, and no more instructive instance of the value of the study can be afforded. The author observes:—

"The natural history of these islands is eminently curious, and well deserves attention. Most of the organic productions are aboriginal creations, found no where else; there is even a difference between the inhabitants of the different islands; yet all shew a marked relationship with those of America, though separated from that continent by an open space of ocean between 500 and 600 miles in width. The archipelago is a little world within itself, or, rather, a satellite attached to America, whence it has derived a few stray colonists, and has received the general character of its indigenous productions."—p. 145.*

Darwin, after the above generalization, enters into particulars of the peculiar fauna and flora of these islands, from which we make the following extract:—

"Of land shells I collected sixteen kinds, (and two marked varieties,) of which, with the exception of the Helix found at Tahiti, all are peculiar to this archipelago: a single freshwater shell (***Paludina***) is common to Tahiti and Van Diemens Land. Mr. Cuming, before our voyage, procured here ninety species of sea shells, and this does not include several species not yet specifically examined, of Trochus, Turbo, &c. He has been kind enough to give me the following interesting results; of the ninety shells, no less than forty-seven are unknown elsewhere: a wonderful fact, considering how widely distributed sea shells generally are. Of the forty-three shells found in other parts of the world, twenty-five inhabit the western coast of America, and of these eight are distinguishable as varieties; the remaining eighteen (including one variety) were found by Mr. Cuming in the Low Archipelago, and some of them also at the Philippines. This fact of shells from islands in the central parts of the Pacific occurring here deserves notice, for not one single sea shell is known to be common to the islands of that ocean, and to the west coast of America. The space of open sea running north and south off the west coast separates two quite distinct conchological provinces; but at the Galapagos Archipelago we have a halting place, where many new forms have been created, and whither these two great conchological provinces have each sent several colonists. The American province has also sent here representative species, for there is a Galapageian species of Monoceros, a genus found only on the west coast of America; and there are Galapageian species of Fissurella and Cancellaria, genera common on the west coast, but not

* Prof. Edw. Forbes alluding to the fauna and flora of the Galapagos Islands, observes, "We have distinct systems of creatures related to those of the nearest land by *representation*, or *affinity*, and not by identity."—*Mem. Geol. Soc. of Gt. Britain*, vol. i, p. 402, *Note.*

found, (as I am informed by Mr. Cuming,) in the central islands of the Pacific. On the other hand, there are Galapageian species of Oniscia and Stylifer, genera common to the West Indies and to the Chinese and Indian seas, but not found either on the west coast of America, or in the central Pacific. I may here add, that after the comparison by Messrs. Cuming and Hinds of about 2,000 shells from the eastern and western coasts of America, only one single shell was found in common, viz., the *Purpura patula*, which inhabits the West Indies, the coast of Panama, and the Galapagos. We have, therefore, in this quarter of the world, three great conchological sea-provinces, quite distinct, though surprisingly near each other, being separated by long north and south spaces either of land or of open sea."—p. 162.

Professor Edward Forbes in his able paper, "*On the connection between the distribution of the existing Fauna and Flora of the British Isles, and the Geological changes which have affected their area, especially during the epoch of the Northern Drift,*" published in the first volume of the "*Memoirs of the Geological Survey of Great Britain,*" (*London*, 1846,) gives a sketch of the distribution of marine Mollusca on the British shores, chiefly the results of his own observations. Prefatory to this sketch, he observes,—

"Our knowledge of the species and distribution of the British Mollusca is very complete, and sufficient to enable us to apply it to the elucidation of geological problems with safety and effect. When we consider the perfect state in which the testaceous species are preserved, and the facility of specific identification afforded by their shells, this becomes of great importance. In all questions respecting the age of sedimentary strata, the evidence afforded by the fossilized remains of the Mollusks must, from its completeness, always take precedence of that derived from any other class of animals. Though our native existing species have been well determined, there is no one work upon them, to which the geologist can be referred with safety, nor any comprehensive essay as yet published on their distribution."

Having cursorily traced the progress which has been made in the study of the geographical distribution of shells, (so far as a reference to a limited library would permit,) with the particular view of shewing its value, and at the same time the incompleteness of our knowledge with regard to any one zoological province, we would point out the causes which have given rise to many errors of fact and opinion on the subject, and seriously tended to impede its advancement.

These causes unquestionably are, to use the language of Dr. Gould, (*Introduction to the Mollusca of the Expedition Shells,*) that "reliable notes of localities have not been taken," and that shells "are regarded as specifically identical, which, on careful comparison, are found not to be so." To these, we think, a third may very justly be added,—the confined views entertained by authors as to the origin of species.

With respect to the first, Dr. Gould remarks truly:—

"A voyage is made to the Sandwich Islands, and all the shells brought home by the vessel are said to be shells from the Sandwich Islands, though they may have been obtained at California, the Society Islands, New Zealand, and, perhaps, half a dozen other places quite as remote from each other. A sea captain purchases a collection at Calcutta or Valparaiso, for his friends at home; and all the shells are marked as denizens of the port where they were purchased, though they might not have lived within thousands of miles. Purchased shells cannot be relied on for localities; for this end a shell must have been found containing the animal, or else dredged, or picked up on the shore, and labelled accordingly."—p. ix.

In support of his view as to the second cause of error, Dr. Gould gives various instances, shewing the difficulty which is frequently experienced in the detection of specific differences, and offers remarks deserving the anxious attention of conchologists. He writes:—

"When, therefore, we have before us shells from widely diverse regions, apparently identical, they should be subjected to the most careful scrutiny for structural differences. If no obvious ones are detected, we may not consider the question as settled, unless the animals have been compared; and we may go even further, and require that their internal structure, as well as external features, should be examined. The number of instances where this apparent ubiquity obtains is fast diminishing, as in the cases already mentioned, in those of Cyprea exanthema, Cervina and Cervinetta, &c. A large proportion of the shells inhabiting the eastern and western shores of the Atlantic, have been regarded as identical; and many of them are really so. But the closer the comparison, the more it tends to diminish rather than increase the identical species. The same is found true in regard to other classes of animals. In fact the doctrine of the local limitation of animals, even now, meets with so few apparent exceptions, that we admit it as an axiom in zoology, that species strongly resembling each other, derived from widely diverse localities, especially if a continent intervenes, and if no known or plausible means of communication can be assigned, ***should be assumed as different, until their identity can be proved.**** Much study of living specimens must be had before the apparent exceptions can be brought under the rule."—p. x.

* Collectors, whose attention has not been directed to geographical distribution, are frequently misled, and may unconsciously mislead others, by their habit of labeling a shell found in the *province* in which they reside, with the identical name given to a shell from a totally *different province*, because it agrees generally with the figure and description met with in some conchological work, perhaps itself not particularly distinguished for accuracy as regards habitat.

Professor Adams, in his catalogue of Panama shells, carefully adds the *stations*, and *habitat* of each species, from the authorities to which he refers in its *synonymy*,* as well as from his own experience,† and distinguishes *original*, from other testimony. He remarks in the Introduction, "on errors respecting the habitat of species," from which we subjoin extracts,—we refer our readers to the work itself for various useful illustrative notes.

"Those who are familiar with the frequency and magnitude of the errors which occur in the works of the most celebrated authors respecting the habitats of species, will not probably accuse us of presumption for the little ceremony with which we have treated such statements. Hearsay testimony has often been received without sufficient scrutiny. In addition to the errors likely to occur in the verbal communication of statements respecting habitat, naturalists at home are of course subject to all the mistakes which the original collectors have made. These persons often mix the collections made in various places, and depend on memory for the localities, although they are often unable to distinguish the species when placed side by side.

Another class of errors, we fear, must be laid to the charge of the writers themselves. When we see a marine species affirmed to inhabit the Mediterranean, Senegal, the Indian Ocean, New Holland, &c., we may often suspect the error to arise more or less from erroneous testimony. But when one species is referred to two distinct zoological provinces, which are known to contain analogous but not identical species, we must sometimes suspect the author of confounding such species."—p. 24.

"For all these causes of error there is but one remedy, and that is not infallible. Rejecting the testimony of careless and incompetent observers, and all hearsay testimony, we must rely on the testimony of competent observers. We may hope for accuracy when they shall remember, that a very few errors may essentially change the aspect of the plan of distribution, and prevent all correct generalizations."—p. 25.

It would be unfair to withhold a statement of the opinion of Dr. Binney on this branch of our subject. His chapter in the work previously mentioned, we refer to vol. 1, chap. iii, entitled "Of some of the obstacles impeding the study of zoology, and the means of overcoming them," is unquestionably replete with interest. In his comments, contained in that chapter, on the hy-

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* The plan pursued by Professor Adams as regards *synonymy*, is worthy of universal adoption. The synonyms are *arranged* in chronological order, and the dates of the authorities *referred to* are added.

† *Station*, says Lyell, speaking of plants, indicates the peculiar nature of the locality where each species is accustomed to grow,—by *habitation* is meant a general indication of the country where a plant grows wild. The terms so defined, he adds, express each a distinct class of ideas, which have been often confounded together, and which are equally applicable to zoology.—*Principles of Geology.*

pothesis, "that the animals of the respective continents, however near their affinities may be, are in every case specifically distinct from each other," he observes:—

"The question of the identity of these closely allied species must eventually be decided by their anatomy, but in the mean time we believe it to be perfectly safe to adopt this axiom, that species, whencesoever derived, possessing the same characters, are identical. We view this to be a more rational course than to consider them to be the *analogues* of each other, a convenient but indefinite mode of expression, which may be used to cover every degree of similitude from a general analogy to a close affinity hardly admitting of distinction."—p. 76.

We are quite alive to the danger which exists of the abuse, by naturalists, of the hypothesis which Dr. Binney deprecates, but we must not argue against its use, from its abuse.

Judging from the general tenor of Dr. Binney's work, we do not hesitate to assert our belief, that had he lived to pursue the subject further, he would not only have concurred in the views expressed by Dr. Gould, and entertained by him in common with many of the most eminent men of the day, but himself have largely contributed to our knowledge of *analogous* species.

Our limits do not permit us to enter as fully into the question of the origin of species, as its very important connection with that of geographical distribution demands.

Professor Forbes, in his before-mentioned paper in the "*Memoirs of the Geological Survey of Great Britain,*" takes for granted, at the outset, "the existence of specific centres, i. e., of certain geographical points from which the individuals of each species have been diffused." He adds:—

"This indeed must be taken for granted if the idea of a species, (as most naturalists hold,) involves the idea of the relationship of all the individuals composing it, and their consequent descent from a single progenitor, or from two, according as the sexes might be united or distinct."—p. 336.

Again, he writes, "My main position may be stated in the abstract as follows, viz., the specific identity to any extent, of the flora and fauna of one area with those of another, depends on both areas forming or having formed, part of the same specific centre, or on their having derived their animal and vegetable population by transmission, through migration, over continuous or closely contiguous land, aided, in the case of alpine floras, by transportation on floating masses of ice."—p. 350.

Lyell, in his *Principles of Geology*, refers most of the exceptions to the general rule, that distinct groups of species occupy separate regions, to "disseminating causes now in operation," and proposes the following hypothesis:

"Each species may have had its origin in a single pair, or individual, where an individual was sufficient, and species may have been created in succession, at such times, and in such places as to enable them to multiply and endure for an appointed period, and occupy an appointed space on the globe." p. 642.

We see in the writings of these authors a constant recurrence to *physical agents*, as the sole cause of the distribution of the individuals of a species,—no suggestion that the contemporaneous introduction of several original individuals was part of the Divine plan of the Creator. "There will be no *scientific* evidence of God's working in nature," says Professor Agassiz, "until naturalists have shown that the whole creation is the *expression of a thought*, and not the *product of physical agents*."—*Lake Superior*, (*Boston*, 1850,) p. 145.

"However active physical agents may be, it would be very unphilosophical to consider them as the source or origin of the beings upon which they show so extensive an influence. Mistaking the circumstantial relation under which they appear, for a causal connection, has done great mischief in natural science, and led many to believe they understood the process of creation, because they could account for some of the phenomena under observation."—*Lake Superior*, p. 142.

May we not fairly remark, that Lyell, Forbes, Darwin, and other writers, overlooking the theory, that the existing species were introduced by the creation of many individuals, have been often driven to forced constructions, and applications of the effects of physical agents, to support their views as to the unity of the origin of species, and other opinions.

Dr. Binney adopted the theory of several distinct centres or foci from which species radiated, and, in his work already cited, remarks that the axiom in the philosophy of zoology, that distinct zoological regions exist, has been greatly fortified by it.

After reasoning on the subject, he adds:—"Having thus adopted the theory of distinct zoological centres, and admitting that as successive portions of the earth's surface emerged from the waters, and became adapted to sustain the different classes of animals, those races which were fitted for the then physical condition of things, were brought into being by the prolific hand of nature, we find no difficulty in supposing that under the same or similar conditions, the same species may have been created at different centres. In this way the presence of species in every part of the earth may be accounted for, and thus only can we satisfactorily explain the diffusion of the species that have been under consideration."—Vol. I, p. 148.

Prof. Agassiz in a paper on the "Geographical distribution of Animals," in the *Christian Examiner*, (*Boston, March*, 1850,) examines, in a masterly manner, the question of the plurality of origin of species. The following is his view of the natural distribution of animals;—"that they originated primitively over the whole extent of their natural distribution; that they originated there, not in pairs, but in large numbers, in such proportions as suits their natural mode of living, and the preservation of their species; and that the same species may have originated in different unconnected parts of the more extensive circle of their distribution."—p. 192.

Professor Agassiz enters upon the same subject in an article in the July number of the *Christian Examiner*, to which we also refer our readers.

Prof. Adams states in his *Contributions*, No. 6, the conclusions at which he had arrived from a careful study of the land shells of Jamaica.

"The distribution of the terrestrial Mollusks in Jamaica, (and probably of all Mollusks in all parts of the world,) is most easily accounted for by the following hypothesis:—that the introduction of the existing races was effected by the creation of many individuals, and that they were modelled after certain types, which were mostly local, and between which there existed, as at the present day, unequal differences, from those which merely distinguish individuals, to those of varieties, of species, of groups of species, of genera," &c. The author subsequently observes, "of course the doctrine of contemporaneous origin must have a geological latitude."

We add the explanatory statement from No. 10:—"The proof of this proposition is found in the geographical distribution of the varieties. In the great majority of species, the varieties are so distributed, that the space which is occupied by one of them coincides with that of other two or more. Now, if the circumstances of locality had produced the local types by modifications of one original type of the species, then all the varieties which inhabit a locality should have been affected. In that case, all the varieties in any given place would have the same geographical limits. But the contrary more frequently occurs. Each variety has its own limits of distribution. If a few coincide in the boundary of their province, on the other hand one is often found to have an extent of distribution, which is equal to that of two or more other varieties. But such a geographical coincidence of one variety with several other varieties is inconsistent with any other theory than that of an original constitutional peculiarity of character in each variety. This inference is confirmed by the occasional intermingling in one locality of varieties, which differ from each other as much as those which occupy distinct regions. If then we assume the original independent creation of all the varieties, each originally represented by at least several individuals, the facts of distribution become explicable with the greatest facility. The same statements might be made respecting entire species, and even groups of species and genera. Some are very local, and others, more widely distributed, occupy the ground of several local species. We have then indistinct varieties, distinct varieties, doubtful species, good species, and groups of species, and all the intermediate types, distributed in the same manner."

ART. XXXVIII.—*On the Satellites of Uranus;* by ELIAS LOOMIS, Professor of Mathematics and Natural Philosophy in the University of the city of New York.

URANUS was discovered to be a planet by Sir William Herschel in 1781; and in 1787 he discovered two satellites whose periods were satisfactorily determined by his subsequent observations. In 1797 he announced the discovery of four additional satellites, viz., one within the orbits of both the former two; one intermediate between the two; and two exterior to both of them, but the periods of these satellites he acknowledged to be very uncertain. In his last paper on this subject communicated to the Royal Society in 1815, he says, "that there are additional satellites besides the two principal large ones, I can have no doubt; but to determine their number and situation, will probably require an increase of illuminating power in our telescopes."

In 1834, Sir John Herschel published a paper containing a thorough discussion of his father's observations, together with his own, upon the two satellites first discovered; and he adds, "of other satellites than these two I have no evidence."

In the year 1838, Dr. Lamont of Munich published a few observations of the two brighter satellites of Uranus, and stated that he had seen only one additional satellite and that in but a single instance. This satellite he considered to be the most remote of the six enumerated by Herschel.

With the exception therefore of the solitary observation of Dr. Lamont, the only evidence we have had (until recently) of the existence of more than two satellites of Uranus was derived from the observations of Sir William Herschel; and he would not pronounce a decided opinion as to their number or their periods of revolution.

At last in the autumn of 1847, Mr. Lassell of Liverpool and M. Struve at Pulkova, obtained unequivocal evidence of the existence of a third satellite. The orbit of this satellite was evidently smaller than that of either of the two bright ones; yet the period indicated by Lassell's observations did not agree with that deduced by Struve; and both differed from the interior satellite of Sir William Herschel. While Lassell's observations indicated a period of about two days, Struve deduced from his observations a period of four days; and the time assigned by Herschel to his interior satellite was nearly six days. Thus the question seemed involved in total confusion, and the honest inquirer might well be puzzled to decide whether there existed three satellites, or only one, interior to the two brighter ones.

Finally in the autumn of 1851, Mr. Lassell succeeded in settling this vexed question. On ten different nights in the months of October, November and December, he saw simultaneously four satellites and recorded their positions. The intervals are so short as to enable us to identify each satellite without danger of mistake. These satellites are the two brighter ones already mentioned, and two interior ones whose periods are about two and four days respectively.

The following are Lassell's observations of the nearest satellite, which I shall call satellite A. The distances and angles of position were not measured with a micrometer, but estimated by the eye, generally from the measured positions and distances of the two brighter satellites. The observations are copied from No. 812 of the Astronomische Nachrichten.

Observations of Satellite A.

Greenwich mean time.			Position.	Distance.	Greenwich mean time.			Position.	Distance.
1847.	Sept.	14·567	350°		1851.	Nov.	17·437	337°	
		27·408	326				18·5	186	
	Nov.	6·429	346	11″			21·489	123	
1851.	Oct.	24·437	163				22·483	332	
		28·5	325				27·480	345	
		30·479	35	10		Dec.	11·375	150	
	Nov.	2·5	320	12			16·413	160	13″·5
		12·437	332						

All the observations of 1851 are well represented by supposing a daily motion of 142°·76. The observations of 1847 indicate a daily motion of 143°·09. The observations of the two years taken independently indicate a daily motion of 142°·92. If with this daily motion we compute the movement from the observation of Nov. 6, 1847 to that of Nov. 27, 1851, we shall find it to amount to 588 revolutions and 134 degrees. Supposing the number of revolutions to have been exactly 588 we obtain a daily motion of 142°·829, which corresponds to one revolution in 2·52049 days.

The following are Lassell's observations of the second interior satellite, which I shall call satellite B. They are taken from No. 812 of the Astronomische Nachrichten.

Greenwich mean time.			Position.	Distance.	Greenwich mean time.			Position.	Distance.
1847.	Oct.	1·521	348°		1851.	Nov.	12·437	131°	
	Nov.	6·429	126	10″			17·437	47	
1851.	Oct.	24·437	354				18·5	316	
		28·5	350				21·489	63	
		30·479	169				22·483	329	
	Nov.	2·5	273	13·8″		Dec.	16·413	70	14″

All the observations of 1851 are well represented by supposing a daily motion of 86°·90. The observations of 1847 indicate a daily motion of 86°·39. The observations of both years taken independently indicate a daily motion of 86°·69. If with this daily motion we compute the movement from the observation of Oct. 1, 1847, to that of Oct. 28, 1851, we shall find it to amount to 358 revolutions and 112 degrees. Supposing the number of revolutions to have been exactly 358, we obtain a daily motion of 86°·612, which corresponds to one revolution in 4·15634 days.

The following are Struve's observations of an interior satellite, copied from No. 623 of the Astronomische Nachrichten. The distances, to which the letter E is annexed, were estimated by the eye.

Struve's Observations.

Greenwich mean time.			Position.	Distance.
1847.	Oct.	8·393	180°·8	14″·2 E.
	Nov.	1·338	192 ·2	17 ·8
		28·298	202 ·8	16 ·8
	Dec.	9·394	218 ·6	13 ·7 E.
		10·169	181 ·1	17 ·0

I am unable to reconcile all these observations with a daily motion of 142°·829 or 86°·612. The interval between the first and the last observations correspond very well with 25 revolutions of satellite A, and the positions assigned by Struve correspond with the position of this satellite as computed from Lassell's observations in 1847. The observation of Nov. 1, corresponds with the place of satellite B as computed from Lassell's observations. The observations of Nov. 28 and Dec. 9, appear irreconcilable with either orbit except upon the supposition of very large errors; and Struve informs us that the latter observation was marked in his book as doubtful. We conclude then that two of Struve's observations were made upon satellite A, one upon satellite B, and the two remaining observations we must consider as doubtful.

Let us now examine the observations of Sir William Herschel, and see what light is shed upon them by the information already obtained. There are four instances in which he observed what he called "an interior satellite." These observations are as follows:

			M'n time.		Position.	Remarks.
1790	Jan.	18	9h	32m	12° s. f. or 102°	About two diameters of planet following.
1794	March	27	11	19	North or 0	
1798	Feb.	15	11	41	85 n. f. or 5	
1801	April	17	10	30	81 s. p. or 189	At half the distance of the first satellite.

Inasmuch as there are now known to be two interior satellites, we cannot assume that the preceding observations were all made upon the same body. I have not been able to reconcile them all with the supposition of a daily motion of 142°·829 or 86°·612; but the intervals between the last three observations correspond very well with the daily motion of satellite B. The first observation was probably made upon satellite A.

There are five instances in which Herschel observed what he called "an exterior satellite." These observations are as follows:

	M'n time.	Position.	Remarks.
1790 Feb. 9.	9h 19m	61° s. f. or 151°	About twice the distance of the second satellite.
1791 Jan. 31.	11 5	78 n. p. or 348	About double the distance of the second.
1792 Feb. 26.	11 30	tow'ds the south	At double the distance of the first.
1796 March 5.	10 53	72 n. p. or 342	Its distance exceeded that of the second.
1798 Feb. 11.	11 46	89 n. f. or 1	Excessively faint.

These observations are all tolerably well represented by supposing a daily motion of 9°·6596, corresponding to a period of 37·2686 days. The period which Herschel assigned to this satellite is 38·075 days; but this period was derived from the computed distance of the satellite, and not from any estimate of the number of revolutions performed in the interval between the observations.

There are four instances in which Herschel observed what he called "the most distant satellite." These observations are as follows:

	M'n time.	Position.	Remarks.
1794 Feb. 28.	8h 15m	24° n. f. or 66°	
1794 March 27.	11 19	South.	Only lucid glimpses.
1797 March 28.	10 36	Near its greatest north'n? elong'n.	About four times the distance of the second satellite.
1798 Feb. 16.	11 12	83 s. p. or 187	Near its greatest southern elongation.

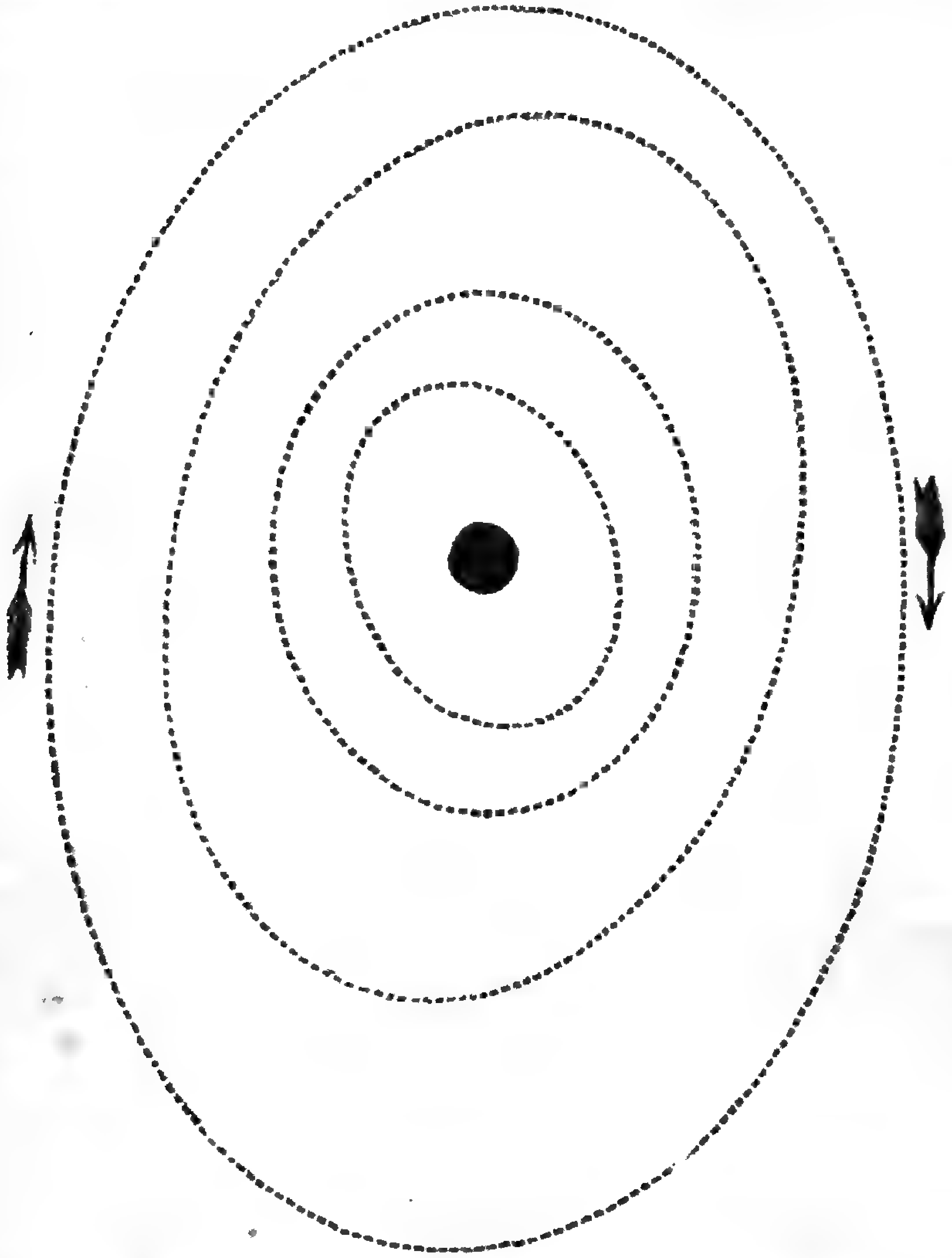
I am unable to reconcile the second of these observations with the others upon the supposition of any period approaching to that which Herschel assigned, viz., 107 days. Moreover the observation appears very uncertain, for Herschel only professed to have "lucid glimpses of two stars at a good distance." The other three observations are very well represented by a mean motion of 3°·91305, corresponding to a period of 91·9998 days.

In one instance, March 26, 1794, Hershel saw what he has called "an intermediate satellite," and he thought he caught a glimpse of the same object again on the 27th; but without further observations we can form no definite judgment of its period.

The following are the final results for Lassell's two satellites, and the two brighter satellites discovered by Herschel. The periods of the two latter were determined by Littrow, but the mean distances have been slightly corrected to make them accord with the periods of revolution. The elements of the two outer satellites are rudely determined from Herschel's observations.

Satellite.	Period.	Daily motion.	Mean distance.
	d.	°	"
1.	2·52049	142·829	13·37
2.	4·15634	86·612	18·62
3.	8·705886	41·35117	30·55
4.	13·463263	26·73928	40·86
5.	37·2686?	9·6596?	80·56?
6.	91·9998?	3·91305?	147·13?

The following diagram represents the apparent orbits of the first four satellites for 1847.



APPARENT ORBITS OF THE SATELLITES OF URANUS FOR 1847.

Of the two satellites discovered by Lassell, the second is the faintest; the inner one, notwithstanding its greater proximity to the planet, being generally more easily seen.

Sir John Herschel has proposed a nomenclature of the satellites derived from fairy mythology. The inner satellite is denominated Ariel, the second Umbriel, the third Titania, and the fourth Oberon. Oberon was king of the fairies; Titania was queen of the fairies; Ariel was an airy spirit; and Umbriel was probably a shadowy spirit. If proper names are required for each of the satellites, the preceding are perhaps as innocent as any; but the members of the solar system have now become so numerous, that it has become a serious tax upon the memory to retain in mind the names of all the planets and the satellites.

If we speak of the satellite Oberon, hardly any one will attach the right idea to the name, until we state its distance from the primary, or its period, or some circumstance by which it may be distinguished from the other satellites. The common sense of mankind has decided that in cities which are regularly laid out, it is much more convenient to designate the streets by numerals than by specific names. The only objection which is known to have been urged against applying the same system to the satellites is that the order is liable at any time to be changed by the discovery of new satellites. The history of the satellites has not shown this objection to be of a very serious nature. The numbering employed in any work must always be understood to be that which was true at the time the work was written. Any supposed ambiguity arising from the use of letters of the alphabet or of numerals may be avoided by specifying (once for all) the approximate period of the satellite. Thus if we wished to refer to the satellites of Uranus we might say, satellite C (period 8 days); or satellite D (period 13 days). Such a reference would be perfectly unambiguous, and would be much more readily comprehended by the uninitiated than the formidable names of Titania and Oberon.

It appears then that the periods of four of the satellites of Uranus have been pretty accurately determined; and there is strong reason to believe in the existence of two others whose periods are about 37 and 92 days. It is quite possible that other satellites may exist, but we have no satisfactory data for forming even a probable estimate of their times of revolution. The planet Uranus is now approaching the position most favorable for observations in the Northern hemisphere, having at present a north declination of 13°, which will continue to increase until 1866. The orbits of the satellites also, which in 1840 appeared as straight lines, now appear as ellipses of moderate eccentricity, and will soon become sensibly circular. We anticipate that this period will be marked by the confirmation of Herschel's observations of at least two additional satellites.

Art. XXXIX.—*On some modern Calcareous Rock-formations;* by James D. Dana.

In the last number of this Journal,* Prof. Horsford has presented his views on the consolidation of the coral rocks of the Florida Reefs, and on the sources of lime in the growth of corals. As this author has shown some misconception of facts stated by the writer,† and is somewhat in error in his chemistry, it appears

* Page 245 of this volume; from the Proc. Amer. Assoc., vi, (Albany meeting,) 207 and 412.

† The writer's observations will be found in his Geol. Rep. Exp. Exped., Chap. III, cited in this Journal, [2], xi, 357, xii, 25, 165, 329, xiii, 34, 185, 338, xiv, 76.

to be a duty to science to pass the principal points of his paper in review.

Prof. Horsford, after describing the coral rocks of the Florida reefs as of two kinds, a subaerial and submarine, the former stated to be a kind of *crust deposit,* the latter oolitic, alludes to a calcareous crust, mentioned by the writer as occurring in the Pacific, as a case of the former kind. We remark, in the first place, that this distinction, imputed to the West Indies, does not exist in the Pacific, as will be gathered from the author's descriptions; and the crust instead of being the *subaerial* coral formation, is merely an exterior coat upon certain parts of some subaerial beds. These beds are sometimes sixty or seventy feet thick. They consist of the sands thrown into drift heaps by the winds, on the windward coasts of islands; and the successive driftings as well as the devastations of the rising heaps by gales are now registered in the consolidated rock. The crust simply covers some very small portions of the surface, conforming to its undulations and not to the lamination of the rock itself, and occurring especially in depressions. Whatever may be true therefore of the rock in the West Indies, it is erroneous to speak of the crust, which the author has described, as an example of the subaerial rock. The submerged coral rock of the Pacific is far harder and more compact than the subaerial rock; and although sometimes conglomerate in character, it is frequently as solid and as free from grains as any Silurian limestone of the United States.

Among the modes of consolidation of limestone or carbonate of lime, the following are enumerated by Prof. Horsford:—1. the common mortar-process; 2. that of hydraulic cements; 3. that of deposition from calcareous springs. Of the last, he says,—the waters containing carbonate of lime held in solution by an excess of carbonate of lime, "upon reaching the surface under less pressure and the influence of a high temperature," give up the carbonic acid so that a precipitation of the carbonate of lime takes place. But is this pressure or a higher temperature needed? The common deposition of carbonate of lime from the waters dripping through the roofs of caverns is evidence to the contrary. Such caverns may be above the ordinary level of a country, in the sides of hills; they may be but a few rods in depth: and still stalactites and stalagmites form. The island of Matea, an elevated coral island, consisting wholly of coral rock, has its precipitous bluffs so fluted by the waters trickling down their front, and so streaked with stalagmitic incrustations, that at a short distance at sea they appeared to be made up of basaltic columns: and the open excavations or caverns in its cliffs abound in stalactites of huge size, some enclosing recent Helices that have been covered over and entombed while hybernating. Through the elevated reef of Oahu there are numerous caverns but a few feet below the surface, and they abound in calcareous depositions. But such facts are too well known to require enumeration.

The possibility of any such depositions taking place *from the sea* is denied by Prof. Horsford as well as the presence of carbonic acid in sea water. It is not admitted that sea water washing over a reef will take up carbonate of lime and deposit it again, and any such means as this of consolidating coral sands is consequently set aside. Darwin states a fact observed at Ascension Island, bearing on this point which we here cite.

In his Journal, p. 588, he says:—"Lieutenant Evans informs me that during the six years he has resided on this Island (Ascension) he has always observed that in the months of October and November, when the sand [of a calcareous beach] commences travelling towards the southwest, the rocks which are situated at the end of the long beach become coated by a white, thick, and very hard calcareous layer. I saw portions of this remarkable deposit, which had been protected by an accumulation of sand. In the year 1831 it was much thicker than during any other period. It would appear that the water charged with calcareous matter, by the disturbance of a vast mass of calcareous particles only partially cemented together, deposits this substance on the first rocks against which it impinges. But the most singular circumstance is, that in the course of a couple of months, this layer is either abraded or redissolved, so that after that period, it entirely disappears. It is curious thus to trace the origin of a periodical incrustation, on certain isolated rocks, to the motion of the earth with relation to the sun; for this determines the atmospheric currents which give direction to the swell of the ocean, and this again the arrangement of the sea-beach, and this again the quantity of calcareous matter held in solution by the waters of the neighboring sea."

The author in his Geological Report, mentions different examples of incrustations of carbonate of lime on seashores, and similar cases are described by other authors. A single case will suffice. On the island of Oahu the isolated pebbles of a beach were observed by the writer to be milked over with a very thin calcareous incrustation, and there was a gradual passage to the agglutination of pebbles and grains by the process into a mass. Such facts not only prove that atmospheric and sea water may take up carbonate of lime when running over calcareous deposits, but that such dissolved lime may be deposited again on sea shores; and that depositions are sometimes formed on shores from the spray of the sea, or from the evaporation of the waters upon the retreat of the tides. The calcareous beach sands of a coral island are in the proper position to be thus consolidated, and below an exterior of loose material, the "beach sand-rock" is found.

Prof. Horsford assumes that consolidation is due to the agency of the sulphur present in the animal matter mixed with the coral sand or mud. The analyses he publishes make out that there are 20 per cent. of animal matter in the coral material examined, that is, one-fifth part by weight is animal. But is this a common proportion? We are satisfied that we do not compromise the truth in saying that in the coral sands of a beach, which to the eye and touch (as often observed) are as pure as the siliceous sands of other beaches, the proportion of animal matter is exceedingly small. In the sands of drift heaps, which are blown up on a coast by the winds, the proportion must be smaller still. The waters of the sea upon such a coast are as pure as the waters of other breakers, the beach as clean, the pebbles as untainted. Or when we find a single pebble incrusted with lime, we should need some definite investigation as to the animal matter that the sea would leave upon such a pebble, and the capability of its decomposition if so left, before we could admit the sulphur in this animal matter to be requisite for the deposition of the lime. It is evident, that if animal matter is not necessary in the case of these pebbles, nor in that of the wear of Matea and the formation of its stalactites, it may not be necessary in the agglutination of the sand grains of the drift heaps or beach sands. We may hence be right when we say with Mr. Darwin, that "beds of such debris may become consolidated by the percolation of water containing calcareous matter in solution."*

As to the animal matter in the coral mud beneath the water, we have not definite analyses. We only observe that the mud when dried is generally white like chalk or sand and nearly to all appearance as pure; it could not be *one-fifth* animal matter without showing it in an offensive odor, as observed by Prof. Horsford with reference to the Florida material.

Instead of the "dying animals falling upon and mingling with the coral mud of the bottom," a considerable part undergo complete decomposition; another part are washed away by the sea; and much the larger portion serve as nutriment to other animals, and thus continue the round of organic life on a coast; for this life may be viewed as a continued series, each link supported to a large extent by that before it.

One-fifth part by weight is a large proportion even for the living coral. A living Madrepora, Astræa or Porites is alive only over its exterior surface for a very small depth, the rest being

* Mr. Darwin, speaking of a large beach of calcareous sand composed of comminuted and rounded fragments of shells and corals at Ascension, says, "The lower part of this, from the percolation of water *containing* calcareous matter in solution, soon becomes consolidated and is used as a building stone; but some of the layers are too hard for fracture, and when struck by the hammer, ring like flint. Journal, p. 587.

dead coral. The proportion between the living part of a Porites one foot in diameter and the dead portion is about as 1 to 50, and of the living part, a very large proportion is calcareous, and much of the rest is water and the liquids of the body.

But we may proceed and enquire whether the animal matter if present would accomplish the result demanded of it.

In the *first* place, 20 per cent. of animal matter contains but 0·3 p. c. or *one-seventieth* of its weight of sulphur, taking as datum Prof. Horsford's own determination of the proportion;* and if the sulphur of the sulphate of lime present be added, the whole is only 0·5 p. c., or taking the mean of Prof. Horsford's determination, 0·4 p. c. The amount therefore is not as large as would appear from the statement at the bottom of page 250; which should be, for 100 parts of the coral material,

Organic matter, ...	5·0	20·16
Sulphur, ...	0·1	0·4

In Prof. Horsford's second column, 2·05 is not the amount found with 20 per cent. of organic matter, but with 100 per cent., and hence the discrepancy. Here then, taking the most favorable case, and supposing the animal matter *one-fifth* the whole material of the mud, the sulphur that can be counted upon is only four-tenths of one per cent.

In the *second* place, the transformations supposed in the new theory are not possible even if there were ten times the amount of sulphur present. But before considering the "easy explanation," we may examine the chemical processes by which it is supposed to be sustained.

The analysis described on page 247 was made, as appears from the account, out of *sixteen* different portions of the material, and of the seven ingredients contained, no two were estimated out of the same portion. This method, however satisfactory for homogeneous substances, will not answer for heterogeneous, where every portion, as found, differs widely from others in the proportion of the ingredients. But supposing the method good, the presence of *hydrate of lime* is still not proved; on the contrary there is *carbonic acid enough to neutralize the lime.* In the tabulated results of the analysis on page 247, the amounts obtained are expressed in per cents. In the first place there are 43·99 and 45·51 for the minimum and maximum of *volatile* matter, as ascertained by prolonged ignition of the material—which volatile matter includes the sum of the water, organic matter and carbonic acid. Now adding up the amount of carbonic acid, water and organic matter which follow, as obtained by the *special trials,* we find

* This volume, p. 250, where he makes the amount of sulphur in 100 parts of organic matter 1·45 p. c.

only 36·34 and 42·85 for the minimum and maximum of volatile matter. Whence this discrepancy? What has become of 7·65 per cent. of volatile matter in one case, and 2·66 in the other? If, again, we deduct the total amount of water and organic matter as determined by special analyses, namely 2·33 p. c. and 3·91 p. c., from the total of volatile matter, it leaves 41·66 and 41·60 per cent., being a little *more* carbonic acid than the minimum of lime requires, and about what the maximum demands, to form a neutral carbonate. The author says that "the carbonic acid was determined in an evolution flask-glass: the results with different specimens varied greatly and are far from being satisfactory;" and so we think, especially for basing any deductions with regard to the presence of hydrate of lime.

Other points might be touched upon. We merely allude to a singular discrepancy in the results on page 250. The loss by prolonged ignition, or amount of volatile matter, is stated as follows:

I. 0·8270 gr. lost 0·4870 gr.—II. 1·9020 gr. lost 0·8000 gr.

The proportion hence deduced is 59 and 42 per cent. But, a few lines below, the author gives as the total volatile matter 41·17, 42·06 and 41·58 per cent.

We pass now to the point of the theory (see page 248); and it is no fault of ours if it prove to be at variance with the known principles of chemistry. We take no pleasure in this criticism of one whom we highly esteem, and should gladly have avoided it, as was our inclination when we introduced simply a brief word in a note to a former page of this volume. But as we have allowed the author the privilege of presenting his views in full, the writer feels bound to express his dissent, and that of the editors, from the errors which, either from oversight or otherwise, are contained in his paper.

We would ask, How can organic matter, including carbon, oxygen, hydrogen, nitrogen and sulphur, when this matter is in process of decay, evolve *pure* sulphuretted hydrogen and not hydrosulphuret of ammonium? But suppose that the pure sulphuretted hydrogen is evolved: Would it under the circumstances change to sulphuric acid? Suppose it to change to sulphuric acid, and this to combine with lime to form the sulphate of lime, as the theory states: Is it then possible that *uncombined ammonia* should be formed from animal matter containing the elements of both carbonic acid and sulphuretted hydrogen? Such a subversion of chemical laws can hardly be expected, even for the benefit of the coral reefs of Florida. But suppose the uncombined ammonia to be formed during the decomposition: Will this ammonia *precipitate the hydrate of lime from the solution of the sulphate?* On the contrary, ammonia does not precipitate the hydrate of lime from any of its soluble salts, and moreover it is constantly used in chemical analysis, on this very account, for separating alumina, peroxyd of iron, &c., from any solution in which a soluble salt of lime is present, by adding an excess of the volatile alkali. Again, in one step, the bicarbonate of lime is formed, and in the next, hydrate of lime for the purpose of cementation: But would not the hydrate at once change the bicarbonate to carbonate again? So says chemical science.

We have followed the theory far enough. The reader may be prepared to doubt Professor Horsford's *first* and *second* inferences on page 253. "Infiltration of finely powdered (not dissolved) carbonate of lime" and "mucilaginous matter" can hardly be admitted as the means of solidifying the "submerged oolitic rock;" and the "chemical decompositions and recompositions" detailed are not attributable to nature's elaborations.

The second part of the memoir, bearing upon the origin of the lime of corals, remains for consideration.

On page 252 it is said, that "the total want of carbonic acid in a water in which coral life is so luxuriant suggests naturally that the stone plant, as well as the coral animal, possesses the power of abstracting lime from the sulphate; the change being due to double decomposition with carbonate of ammonia excreted from the plant and animal yielding carbonate of lime quite insoluble, and sulphate of ammonia of the highest solubility." The objections to this sentence are as follows.

1. Facts show that there is not a total want of carbonic acid (or carbonate of lime) in sea water about coral reefs.

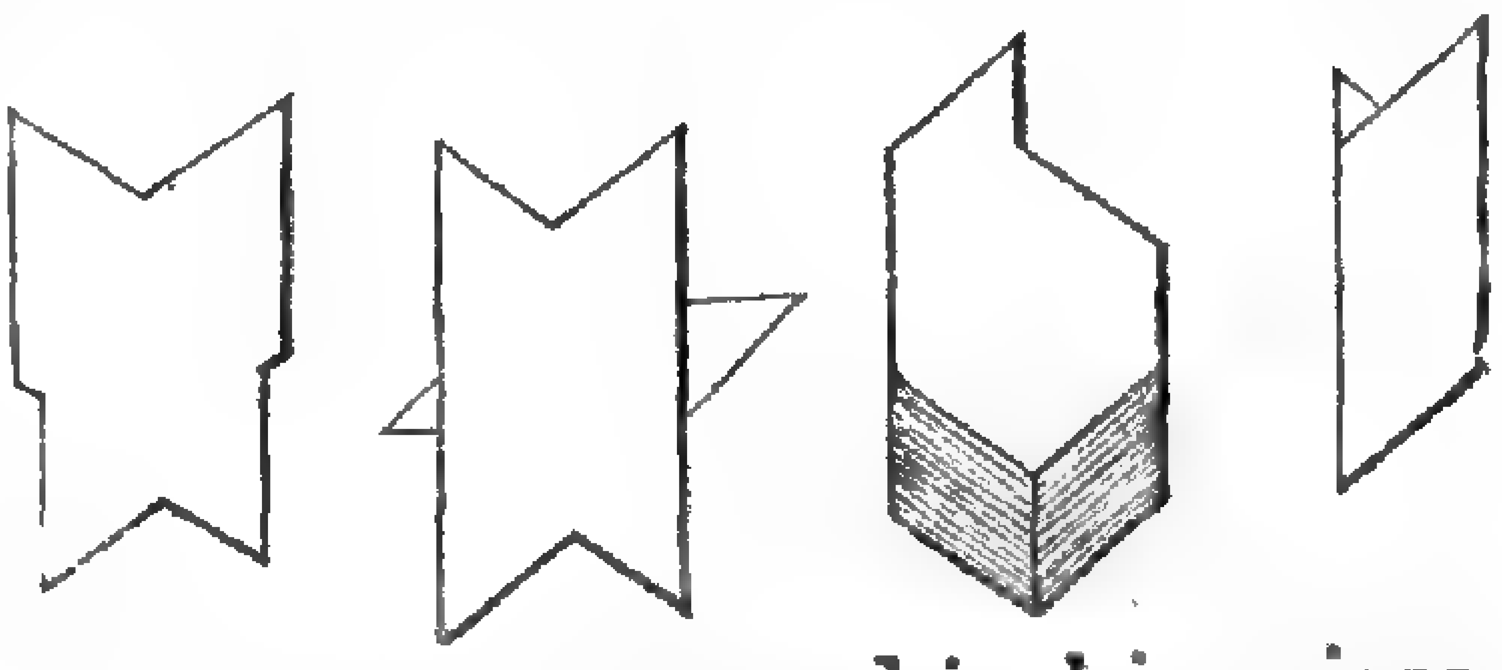
2. The stone plant and coral animal are spoken of as distinct; whereas, in fact, the stone plant is contained within the animal and is a part of it, and has no independent functions, and no mode of increase except such as it receives through secreting action within the coral animal.

3. The excreted carbonate of ammonia must either produce the carbonate of lime in the water about the animal, or within the tissues immediately where the secretions take place. If the former, the waters could not show the "total want of carbonic acid" claimed in the outset. As to the latter, it is hard to believe. No physiologist claims to have found carbonate of ammonia at work in the tissues producing the secretions helping the deposition of lime. Neither can the excretions turn about and aid in the secretory processes. It is also implied that the process is partly inorganic, taking place upon the so-called "stone-plant" apart from the animal—a condition of the stone-plant not known in nature, until its life and growth have ceased. Such a mode of growth by accretion would be indicated by the absence of all cellular structure, and by a crystalline texture in the deposition: but a thin slice of coral examined with the highest magnifying

powers by polarized light shows, as the writer has observed, no distinct crystalline texture.

If coral zoophytes require the medium of carbonate of ammonia, so must also mollusca, as they derive their carbonate of lime from the same waters; and so also fishes and Cetacea, except so far as they may receive it from animals taken as food. The process is essentially alike in all.

Although the presence of carbonate of lime in sea water about coral reefs cannot be doubted, it is still true that the lime is mainly in the state of sulphate. The writer has presented evidence on this point in his Report which is overlooked by Prof. Horsford. He adds a few forms that were obtained from the evaporation of a single drop of sea water under the microscope while engaged in examining a minute Crustacean. The re-solution and re-crystallization of gypsum was often repeated in his microscopic examinations.



In view of the above considerations, we may refuse our assent to the *third* conclusion on page 253, which supposes the presence of sulphate of lime to be so important to the formation of coral that its absence may occasion the disappearance of coral zoophytes; and which considers the excretion of carbonate of ammonia and a double decomposition with sulphate of lime *essential* to the coral secretions. The carbonate of ammonia produced by animal excretions may, by this double decomposition, be *one* source of carbonate of lime in the sea; but if so, this carbonate of lime should abound most about coral reefs, as it could not be wholly abstracted by the animals from the moving waters.

A few other statements in Prof. Horsford's paper require a brief remark.

Prof. Horsford states on page 249, "that the exceeding fineness of the coral mud is due to the stone-plants which flourish in the waters within the reef and which admit of ready reduction to a powder of extreme fineness." The correct explanation, as has appeared to the writer,* is, that it is owing to the trituration of whatever coral fragments and shells may be deposited in places where the motion of the water is gentle, while the coarser sand and pebbles are found where the waters are subject to more violent agitation, as in the face of the breakers. The same would happen under like circumstances if the rock material were granite instead of coral. The corals within most lagoons are as solid as those elsewhere formed.

* Expl. Exped. Geol. Rep., p. 107, and this Journal, [2], xii, 333.

The inference that corals would soon die in bodies of salt water wholly cut off from the ocean, because they would thus fail of the requisite amount of *sulphate of lime*, may or may not be just; but it follows for another reason, even more obvious, viz.: the excessive saltness of the water from evaporation in the dry seasons of the year, and also its excessive freshness in the rainy seasons,—either condition unfitting it for the growth of marine species.

In the analyses of corals given in Prof. Horsford's paper, no mention is made of the presence of fluorine or phosphoric acid. This will not be received as any reason for discrediting Prof. Silliman's determinations of these ingredients. The author has in his hands plates of glass that were etched by this chemist with the date of his experiments, from fluorine afforded by corals from the Pacific.*

Prof. Horsford by ascertaining the specific gravity of the coral of the interior of a Meandrina and comparing it with that of the exterior, endeavors to determine whether the interior is absorbed for the formation of the new coral. In very many species, as we have had occasion often to observe, the process is the reverse. The exterior is comparatively porous, while the interior is solid or nearly so, the secretions of lime in progress filling up even the interstices occupied by the animal membranes, as the animal dies at its inner extremity. The process of absorption as far as is known does not appear to belong to the lower and dying extremity of the polyp; this function is performed by the parts above from the food and sea water taken into the stomach and internal cavity of the animal.

Art. XL.—*Analysis of Fowlerite;* by W. Camac, M.D.

Having some good specimens of Fowlerite at command, I subjected the mineral to a careful analysis in order to determine its formula. It was broken into small pieces, which were selected with care, in order to avoid the presence of the least trace of any other associated minerals. The external characters of cleavage, hardness, &c., agreed with the description usually given of it, except that the streak was of a delicate salmon color.

The analysis was made partly by fusion with carbonate of soda, for the ingredients generally, and partly by fluohydric acid to determine the alkali, as well as some of the constituents by way

* We learn from Prof. Agassiz, that the Millepora analyzed by Prof. Horsford, this Journal, [2], p. 249, was a Nullipore.

of confirmation. The only peculiarity in the analysis consisted in separating alumina, zinc, manganese and iron, by sulphid of ammonium, and after redissolving the sulphids, passing their heated solution into a boiling solution of potassa, whereby the alumina and zinc were held in solution and the other two precipitated. The zinc was separated from the alumina by passing sulphohydric acid through the potassa solution, whereby sulphide of zinc was precipitated. The iron and manganese were separated by carbonate of baryta. The following are the results of the analysis.

	Found.	Corrected result.	Calculated result.
Silica, - - -	44·50	42·197	43·214
Protoyxd of manganese,	25·37	25·370	25·370
" " iron, -	11·00	11·002	11·266
Oxyd of zinc, -	4·15	4·150	4·250
Lime, - -	9·66	9·660	9·893
Magnesia, - -	5·27	5·268	5·395
Alumina, - -	0·67	——	——
Potassa, - -	0·60	Feldspar 3·556	——
	101·22	101·203	100·000

Since all the bases are protoxyds, and the amount of alumina is very small, it either acts with the silica, or forms a part of a foreign silicate. Because the 0·6 potassa requires 0·653 alumina to make feldspar, i. e., the amount found by the analysis, and because potassa does not belong to the isomorphic bases in the mineral, it is most probable that both of these bodies belong to a little feldspar which is accidentally present. Calculating them as feldspar, they abstract 2·30 silica from the amount found, and give the above corrected result. The calculated result, omitting the feldspar, is given in the third column. The proportion of protoxyd bases to silica in the calculated result, is 1·85 : 1 or 11 : 6, and even if the original result, as given in the first column, be adopted, the proportion is 1·76 : 1 or 7 : 4. Neither of these satisfies the formula adopted for Rhodonite, which is 3 : 2. Fowlerite is therefore either a peculiar silicate, not Rhodonite, or a mixture of Rhodonite and other silicates of manganese. Its formula very nearly satisfies the assumption of its being a half silicate, $2RO, SiO_3$. If Rhodonite be separated from it, the formula is $3RO, 2SiO_3 + 4(2RO, SiO_3)$. From my analysis, then, I should infer either, that the formula adopted for Rhodonite is incorrect, or that Fowlerite is a distinct species.

SCIENTIFIC INTELLIGENCE.

I. Chemistry and Physics.

1. *On the motion of Fluids from the Positive to the Negative Pole of the closed Galvanic Circuit.*—Wiedemann has communicated to the Prussian Academy of Sciences, a memoir on the mechanical action of the voltaic circuit which is of essential interest and importance. The apparatus employed consisted of a porous earthernware cell, closed at the bottom and terminated above by a glass bell firmly cemented to the upper edge of the cylinder. Into the tubulure of the bell a vertical glass tube was fitted, from which a horizontal tube proceeded so as to permit the fluid raised to flow over into an appropriately placed vessel. A wire serving as the negative pole of a battery passed down through the glass bell into the interior of the porous cylinder, where it terminated in a plate of platinum or copper. Outside the porous cylinder another plate of platinum was placed and connected with the positive pole of the battery. The whole stood in a large glass vessel, which, as well as the interior porous cylinder, was filled with water. The intensity of the current was measured by a galvanometer. As soon as the circuit was closed, the liquid rose in the porous cylinder and flowed out from the horizontal tube into a weighed vessel. The results obtained by means of this apparatus were as follows:—

(1.) The quantity of fluid which flows out in equal times is directly proportional to the intensity of the current.

(2.) Under otherwise equal conditions, the quantities of fluid flowing out are independent of the magnitude of the conducting porous surface.

To avoid any uncertainty arising from the laws of the flow of liquids through small orifices, Wiedemann measured the intensity of the mechanical action of the current by determining the height of a column of mercury which would hold the transferring force in equilibrium. For this purpose a graduated tube or manometer filled with mercury was attached to the extremity of the horizontal tube above mentioned: with different currents and porous surfaces of different extent, the mercury in the manometer rose to different heights. By the measurements of these heights the following results were obtained:—

(3.) The height to which a galvanic current causes a fluid to rise, is directly proportional to the intensity of the current and inversely proportional to the extent of the free porous surface.

The mechanical action of a galvanic current may also be referred to its simplest principles by the following proposition:—

(4.) The force with which an electric tension, present upon both sides of a section of any given fluid, urges the fluid from the positive to the negative side, is equivalent to a hydrostatic pressure which is directly proportional to that tension.

In this manner therefore we obtain a simple measure of electric tension and its mechanical action in terms of atmospheric pressure and consequently of gravity.

The above laws hold good only for fluids of the same nature. When different fluids are subjected to the action of the currents, the mechanical action is greatest upon those which oppose the greatest resistance to its passage. The requisite data are still wanting to determine the precise connection between the mechanical action and the resistance, but observations made with solutions of sulphate of copper of different degrees of concentration, appear to show that the quantities of fluid transferred in equal times by currents of equal intensity, are nearly proportional to the squares of the resistances.—*Monatsbericht der K. P. Akademie der Wissenschaften, March*, 1852, 151.

2. *Mechanical Equivalent of Heat.*—KUPFFER has communicated a memoir on the mechanical equivalent of heat which is of interest as affording by a new and distinct mode of determination, a confirmation of the results obtained by Mayer, Joule, and Clausius. The principle of the method employed by Kupffer consists in the comparison of the mechanical extension produced in a given metallic wire, with the expansion produced in the same wire by a given number of units of heat. The wires employed were of iron, brass, platinum, and silver; the coefficients of elasticity were determined by direct experiment as well as the densities of the metals themselves. The specific heats and expansion by heat appear to have been taken from the tables in works on physics. Measured statically, the author found for the mechanical equivalent of heat 71441 Russian pounds upon the square inch, or more than 4327 atmospheres. Measured dynamically, it was found that one unit of heat (the quantity of heat which is necessary to raise the temperature of one kilogramme of water from 0° to 1° Cent.) is capable of lifting 453 kilogrammes to the height of one meter. (Joule found the mechanical equivalent of heat, 423 kilogrammes raised one meter; Clausius, by a different method, 425.)—*Pogg. Ann.*, lxxxvi, 310.

3. *New Organic Radical containing Tin.*—CAHOURS and RICHE have discovered a new radical containing tin and the elements of ethyl, and which they term stannethyl. Tin filings are to be heated with iodid of ethyl in a sealed glass tube to a temperature of from 160° to 180° C. At the end of twenty-four hours the whole solidifies to a mass of large crystals; from this alcohol separates a substance crystallizing in long and brilliant needles and fusing at 38° to a limpid liquid. This substance is the iodid of stannethyl, C_4H_5SnI, and its chemical relations are precisely those of the soluble metallic iodids. With nitrate and sulphate of silver the iodid gives crystalline salts having the formulas C_4H_5SnO, NO_5, and C_4H_5SnO, SO_3; ammonia precipitates from these salts a white amorphous powder which is the oxyd of the new radical C_4H_5SnO. Chlorhydric acid gives with the oxyd a beautiful crystalline chlorid C_4H_5SnCl. Heated with iodid of methyl, tin yields a similar methyl radical which the authors term stan-methyl, but the iodid of amyl treated in the same manner appears to undergo no change even after a contact of ten or twelve days.—*Comptes Rendus*, xxxv, 91

4. *Preparation of Magnesium.*—BUNSEN has observed that fused chlorid of magnesium is readily decomposed by the voltaic current, so that it is possible in a short time, and by the employment of a battery composed of a few pairs only, to obtain a mass of metal weighing several grammes. For the preparation of the chlorid, Liebig's method is recommended; particular care must be taken, however, in drying the

mixture of magnesia and sal-ammoniac to avoid the formation of a basic chlorid. As a decomposing cell, Bunsen employs a porcelain crucible divided into two parts by a diaphragm reaching to half the depth of the crucible. In this manner the chlorine set free at one electrode is prevented from again combining with the magnesium deposited upon the other. The electrodes used are of carbon, in the form in which it is prepared for Bunsen's battery; into the surface of the negative pole kerfs are cut to prevent the magnesium set free from floating to the surface of the fused liquid and there taking fire. To determine the quantity of magnesium formed in a given time, the author introduces a tangents-compass into the circuit and deduces by a well known formula the relation between the chemical and the magnetic effects of the current, so that the latter being observed, the former may easily be calculated. Magnesium as obtained by electrolysis is upon a fresh fracture sometimes faintly crystalline in large plates, at others fine grained; in the first case it is silver-white and very brilliant, in the last more bluish gray and without lustre. Its hardness is nearly that of calc-spar. It fuses at a moderate heat: in dry air it is wholly unchangeable and does not lose its lustre; in moist air it soon becomes covered with a coating of magnesia. Heated to whiteness in the air it takes fire and burns with an intense white light; the evolution of light by combustion in oxygen is of unusual intensity—about 500 times that of a wax candle. The metal decomposes pure cold water very slowly, acidulated water rapidly. Thrown upon aqueous muriatic acid the metal instantly ignites. Concentrated sulphuric acid dissolves it slowly; a mixture of nitric and sulphuric acids has no action in the cold. The density of magnesium was found to be 1·7430 at 5° C. Calculated from this, the atomic volume of magnesium is 86, or exactly double that of nickel. The metal as obtained by electrolysis may easily be filed, bored, sawed or somewhat flattened by hammering, but is hardly more ductile than zinc at ordinary temperatures. The magnesium obtained by means of potassium contains a small quantity of that metal and is ductile; that reduced by electrolysis almost always contains traces of aluminum and silicon. —*Ann. der Chemie und Pharmacie*, lxxxii, 137.

5. *Adulteration of Beer with Strychnine.*—Graham and Hofmann at the instance of a prominent English brewer, Mr. Alsopp, and in consequence of reports, originating in Paris, that English ale and beer occasionally derived its bitterness from strychnine, have carefully tested various specimens of these beverages, but without discovering a trace of the poisonous alkaloid. Strychnine when present in no greater quantity than $\frac{1}{1000}$ of a grain may be detected by the following process. The suspected powder is to be moistened with a drop of undiluted sulphuric acid and a few fragments of bichromate of potash added. An intense beautiful violet color immediately appears at the points of contact which quickly spreads through the whole fluid, and after a few minutes again vanishes. The presence of small quantities of organic matter prevents this reaction; in testing beer the authors adopted the following process. Half a gallon of beer to which $\frac{1}{2}$ grain of strychnine had been added was shaken with two ounces of animal charcoal, and the fluid allowed to stand over night. The next day the beer was found almost free from bitterness, the strychnine having been precipita-

ted with the coal. The coal was thrown on a filter, washed, boiled with alcohol and the alcoholic filtrate distilled. The residue in the retort was shaken with a few drops of a solution of caustic potash and about an ounce of ether. The etherial solution evaporated on a watch glass gave a mass in which the presence of strychnine was easily detected by the test above given.—*Ann. der Chemie und Pharmacie*, lxxxiii, 39.

[NOTE.—It is perhaps not generally known that large quantities of strychnine are manufactured in this country or imported from abroad for the purpose of destroying wolves, foxes and other wild animals, without injuring the skins. In travelling in Upper Canada about four years since the writer found that strychnine was well known to the settlers in that part of the British possessions, and was frequently employed by them during the winter season when the wolves became bold enough to approach human habitations. Probably the officers of the Hudson's Bay Company could communicate interesting details as to its efficiency and as to the amount consumed.—W. G.] W. G.

II. MINERALOGY AND GEOLOGY.

1. *On Diopside and Molybdate of Lead, furnace products*; by J. FR. L. HAUSMANN, (Acad. Sci. Göttingen; L'Institut, No. 956, April 28, p. 131.)—The crystals of diopside were from a Swedish furnace at Gammelbo in Westmannland. They are two or three lines long; translucent or transparent; grayish-pearly to greenish or reddish-gray. G. = 3·127. H. = 6. Composition,

$\dddot{Si}$	$\dddot{Al}$	$\dot{Mg}$	$\dot{Ca}$	$\dot{Fe}$	$\dot{Mn}$	$\dot{Na}$	$\dot{K}$
54·69	1·54	15·37	23·56	0·08	1·66	1·94	1·15=100

corresponding to the general formula, $\dot{R}^3\,\dddot{Si}^2$.

The molybdate of lead was found in a reverberatory furnace at Bleiberg in Carinthia, in crystals very much like the natural crystallizations.

2. *Formation of Arragonite and other minerals.*—M. BECQUEREL some time since showed that calc spar may be obtained in primary rhombohedrons, through the slow reaction of a solution of bicarbonate of soda, feeble in degree (2°), on laminæ of sulphate of lime or gypsum. On experimenting with a solution marking five or six degrees, the carbonate of lime crystallized in the trimetric system, or in other words, as arragonite. It is hence not surprising that arragonite should be found in gypseous and saliferous deposits, like those of Spain, Salzburg, and elsewhere.

Calc spar may also be obtained by the action of a solution of potash, marking 10°, on gypsum, the solution being contained in a flask imperfectly closed. In this case the carbonic acid is derived from the atmosphere.

Brochantite (subsulphate of copper) is easily obtained, looking like native specimens, by putting a piece of porous limestone in contact with a saturated solution of sulphate of copper. The brochantite is deposited upon the limestone in small crystalline tubercles along with crystals of gypsum.

Malachite ($\dot{Cu}\,\ddot{C}+\dot{Cu}\,\dot{\dot{H}}$) may be obtained by the reaction of coarse porous limestone on a solution of nitrate of copper, marking 12° or 15°, and when the action ceases, by plunging the mass into a solution of an alkaline bicarbonate marking 5° or 6°. The piece of limestone in the first case becomes covered with subacetate of copper, and this subacetate, in the next step, changes to malachite; or if prolonged, to a double carbonate of copper and soda. The malachite is in small silky globules.

3. *On the artificial formation of Malachite;* by M. HENRI ROSE, (Königl. Preuss. Akad., Oct., 1851.)—When a solution of sulphate of copper is precipitated in the cold by carbonate of soda or potash, the precipitate is at first voluminous, and of a blue color, but left for a while and then washed, it becomes more dense and of a green color. It has the composition of green malachite as found in nature.

4. *On the supposed Dimorphism of Zinc,* (Königl. Preuss. Akad., Jan., 1852.)—M. GUSTAF ROSE has examined the supposed pentagonal dodecahedrons afforded by the zinc furnaces of Silesia, and upon which M. Nickles announced this as one of the forms of this metal, and has pronounced them aggregations of grains instead of simple crystals, and concludes that we have yet no sufficient evidence of the dimorphism of zinc.

5. *The Quader-Formation of Germany.*—On page 151 we have given the title of two works of M. Geinitz on the Cretaceous formation, called by him the Quader-formation, of Germany and Saxony. The following abstract of some of the results detailed by M. Geinitz, we cite from the Quarterly Journal of the Geological Society, viii, 54, (1852.) It was communicated to the Geological Society by Sir C. Lyell.

"The north side of the Hartz, where the Upper Quader-sandstone is so powerfully developed, has lately thrown a new light on the relations of this rock with the Upper Quader-marl. Professor Beyrich, of Berlin, who is now publishing a geological map of the above-mentioned district, lately invited me to re-examine it with him and in company with M. von Strombeck, of Brunswick, and some other geologists.

The Upper Quader-sandstone near Heimburg is bounded by sandy Upper Quader-marl. The greensand, or green sandy marl, above and below the sandstone, has similar characters and the same fossils as the greensand of Aix-la-Chapelle, of the Salzberg near Quedlinburg, and of Kieslingswalda in Silesia; and as the Upper Quader-sandstone itself.

LIST OF THE FOSSILS.

Callianassa antiqua, *Otto.*
—— Faujasi, *Otto*
Serpula filiformis, *Sow.*
Belemnites quadratus, *Bl.*
Turritella sexlineata, *Röm.*
Rostellaria papilionacea, *Goldf.*
—— vespertilio, *Goldf.*
Cardita Goldfussi, *Müll.* (=Pholadomya caudata, *Röm.*)
Crassatella arcacea, *Röm.*
Venus faba, *Sow.*
Trigonia aliformis, *Park.*
Arca (Cucullæa) glabra, *Sow.*
Pectunculus sublævis, *Sow.*
Cardium Ottoi (C. Ottonis), *Gein.*
Gervillia Solenoides, *Defr.*
Ostrea laciniata, *Nilss.*
etc. etc.

The grey chalk-marl (kreide-mergel) of the hill (Schlossberg) at the village of Heimburg, comprising the Trümmer-kalk (the Conglomerate of the Sudmerberg, near Goslar,) is connected with the green sandy marl below it by similarity of organic remains, in the same manner as the Upper Quader-sandstone is united with the Upper Quader-marl in one and the same cretaceous series. This series of sandstones (the Lower and Upper Quader of M. Beyrich), greensand and green sandy marls,* and grey and yellow chalk-marls (Kreide-mergel, and the conglomerate of the Sudmerberg with its Maestricht corals), is the equivalent of the tuff-chalk of Maestricht, and the upper chalk with firestone of other countries.

I am likewise of opinion, that the Lower Quader-marl (lower flags or marl- and sandstone-flags, also the variegated marl, and lower green-sand of Essen) is the equivalent of the Lower Quader-sandstone, and not of the Upper or chalk-flags, which are the equivalents of the Lower chalk of Kent.

Consequently I obtain the following arrangement of the series :—

I. Upper Quader { 1. Upper Quader-sandstone / 2. Upper Quader-marl } = Upper Chalk.

II. Middle Quader-marl (Pläner-kalk) = Lower Chalk.

III. Lower Quader { 1. Lower Quader-marl / 2. Lower Quader-sandstone } = Tourtia.

IV. Hils-clay = Neocomian.

Professor Beyrich has represented in his Map the Upper Quader in six subdivisions."

6. *New Zealand*—According to recent accounts from this interesting country, true palæozoic coal has been discovered in the north part of the Middle Island. The accounts are too vague to be entirely decisive of the important question, whether in those remotest masses of dry land, remains of the ancient carboniferous floras are buried. Fossils are stated to have been found in a white fine sandstone grit, but their nature is not specified, except that remains of some kinds of *Pecopteris* and *Sphenophyllum* were mentioned, but the species are not named.

In the south and southwest regions of the Middle Island, Mr. Walter Mantell, in an arduous exploration for three months, as government Surveyor and Commissioner, in the almost uninhabited and dreary tracts of that country, kept up an active search for the rare indigenous birds, and for fossils; but with the exception of a large parrot, believed to be unknown to naturalists, no additions were made to the fauna of New Zealand. A diligent hunt for vestiges of the Moas, and for a live specimen of Notornis, was unattended with success. The last accounts from Mr. Walter Mantell at Otago, (March 20,) stated that the servants he had sent out to the localities which native traditions pointed out as the habitat of the Notornis, had returned birdless, and reported that the wild dogs occupied the country to such a degree, that it was hopeless to expect the wingless birds could escape. The stuffed specimen of Notornis in Dr. Mantell's possession (in London), bids fair therefore, like the last of the Dodos, to be the sole representative of its race.

7. *On the Tertiary Strata of Belgium and French Flanders*; by Sir C. Lyell, (from the Quarterly Jour. Geol. Soc., viii, pp. 277–368; Aug., 1852.)—The object of the investigations detailed in this elaborate paper was principally to ascertain the geological relations of the Belgian and British Tertiary. The various beds had received Belgian names, derived from some prominent locality, by Mr. Dumont; and their cor-

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* Sand of Münchenhof and of the Salzberg near Quedlinburg, and the flags of the Plattenberg near Blankenburg.

relatives in the general tertiary series as recognized in other countries was not understood. The distinguished author, after extensive researches has well unravelled the network before him, by a comparison of large suites of fossils collected by him, with the collections in England. The following table presents at a glance the results arrived at.

Synoptical Table of Tertiary Formations of Belgium and French Flanders.

	Names adopted in this memoir.	Nomenclature used by M. Dumont in his Map of Belgium.	British equivalents.	French equivalents.	Periods.
A....	Loess and Alluvium.	Limon Hesbayen.	Brick-earth, drift, &c.	Alluvions and Loess.	Post-pliocene & Pleistocene.
B. 1.	Antwerp Crag.	Système Scaldesien.	Red and coralline Crags of Suffolk.	Crag de Carentan, Normandie.	Pliocene.
B. 2.	Sands of Diest.	S. Diestien.			
C.....	Bolderberg Sands.	S. Bolderien.	Wanting.	Faluns de la Loire.	Miocene.
D. 1.	Upper Limburg Beds, or Rupelmonde Clay.	S. Rupelien.	Upper freshwater and upper marine of the Isle of Wight.	Calcaire de la Beauce. Sables de Grès de Fontainebleau. Marnes à Ostrea cyathula. Marnes supérieurs au gyps.	Upper Eocene (Lower Miocene of many authors).
D. 2	Middle Limburg, or Fluvio-marine.	S. Tongrien supérieur.			
D. 3.	Lower Limburg.	S. Tongrien inférieur.			
E. 1.	Laeken Beds, or Upper Nummulitic (*Nummulites variolarius*).	S. Laekenien.	Barton Clay.	Sables moyens ou Grès de Beauchamp.	Middle (or Nummulitic) Eocene.
E. 2.	Brussels Beds, or Middle Nummulitic (*Nummulites lævigatus*).	S. Bruxellien.	Bagshot and Bracklesham Beds.	Calcaire grossier.	
E. 3.	Lower Nummulitic beds (*Nummulites planulatus*).	S. Paniselien? & S. Ypresien, étage supérieur		Sables Soissonnais, partie supérieure.	
F. 1.	London Clay.	S. Ypresien, étage inférieur.	London Clay proper.	Wanting.	Lower Eocene.
F. 2.	Plastic Clay and Sands.	S. Landenien supérieur.	Lower London Tertiaries.	Lignite Soissonnais.	
G. ...	Glauconite and Tufeau of Lincent.	S. Landenien inférieur.	Wanting.		Intermedi'te between Eocene and Cretaceous.
H....	Marls and Glauconite of Heers.	S. Héersien.	Wanting.		
I......	Maestricht Chalk.	Calcaire de Maestricht.	Wanting.		Cretaceous.

The several beds here enumerated are described with fulness, their fossils enumerated, and their condition of origin discussed. Among the observations we find that the three divisions of the middle (or Nummulitic) Eocene are characterized, the upper, by the *Nummulites variolarius*, the middle by the *N. lævigatus*, the lower by the *N. planulatus*. Several species of Eocene Echinoderms are described in the paper by

Prof. E. Forbes, and illustrated with lithographic figures. There are also descriptions of the fossil fruits of Palms of the genus Nipadites. The nut has some little resemblance in shape to a cocoanut and is often six inches long. Thirteen species are enumerated by Mr. Bowerbank from the London clay of the Isle of Sheppey; and among the Belgian fossils this author recognizes four of the English species. Both the Echinoderms and Palm fruits are from the Middle Eocene.

III. Botany and Zoology.

1. *The Botany of the Antarctic Voyage: II. Flora of New Zealand;* by Joseph Dalton Hooker, M.D., F.R.S. Part I. London: Reeve & Co. 1852. 4to. pp. 80, tab. 1–20.—This work was announced in a recent number of this Journal (vol. xiii, p. 51), and a full notice of the earlier *Flora Antarctica* was given in vol. viii, 161. The plan of the last-named work is adopted in the present, with some modifications, which are explained in the Introduction. The *Flora Antarctica* being addressed to scientific botanists alone, the descriptions as well as the characters were written in Latin, and well-known plants were merely enumerated, without being described, except where the characters required considerable emendation. But the *Flora of New Zealand*, being that of an important British colony, is planned so as to be most useful to the colonial student, as well as to the learned botanist. The author has therefore wisely given it somewhat of an elementary character, has defined both the genera and the species throughout in Latin, and has printed the detailed descriptions in English, and "in the simpliest language that can be applied to botany." Even the derivation of the generic names is given. Dr. Hooker remarks that, "During a residence in our colonies and foreign possessions, I have observed that the residents are invariably anxious to acquire the names of the plants around them; they regret not having learned the rudiments of botany in their youth, and are most desirous that their children should be instructed in them; feeling that their practical knowledge, however accurate or extensive, is useless beyond their own sphere. On my return to England I was no less struck with the fact (which, as a juror was prominently brought before me), that, for want of a little botanical knowledge on the part of the exhibitors, large collections of vegetable produce, sent to the Great Exhibition, were rendered all but valueless; and that, amongst these, the contributions of New Zealand were conspicuous." It will not be Dr. Hooker's fault if this want is not remedied. The text of Part I. runs from the *Ranunculaceæ* to the *Saxifragaceæ*. The excellent plates go a little further, and include two umbelliferous plants; one of which is figured under the name of *Eustylis geniculata*. In the letter-press, it is to be hoped that another name will be applied to this genus, as there is already a genus *Eustylis*, published some years ago, in *Plantæ Lindheimerianæ*, founded on a Texan Irideous plant.

The second part of this work has just come to hand. The letter-press extends from the Saxifragaceæ to Ericaceæ; the plates, xxi–xl, from Panax through Compositæ. Shawia is referred to Eurybia, and Brachyglottis with Bedfordia, to Senecio, a view which is perhaps sufficiently borne out. The genus Eustylis, proposed on plate xx, in the first part, is in the text now reduced to a subgenus of Anisotome. A. G.

2. *The Botany of the Voyage of H. M. S. Herald, under the command of Capt. Henry Kellett, R. N., during the years* 1845–51; by Berthold Seemann, Naturalist of the Expedition. Part. I. 4to. pp. 56. Plates 1–10. London: Reeve & Co.—The botanical collections of this voyage were made on the shores and islands of Western Arctic America, in North Western Mexico, on the Isthmus of Panama, in China about Macao and Hong-Kong, at Oahu, Kamtschatka, in Ecuador and the northern part of Peru. These collections are to be treated in succession; and the first part is occupied with a Flora of Western Eskimaux-land, comprising all the plants known to occur on the American coast and islands, from Norton Sound to Point Barrow. Of this interesting arctic flora, it has already been remarked by Sir William Hooker, that the recent voyages and explorations, and the full collections of Mr. Seemann, have not added a single entirely new species. This flora comprises 242 Phænogamous plants, 3 Ferns, 2 Lycopodiaceæ, 2 Equisetaceæ, 30 Musci, 1 Liverwort, 21 Lichens, 2 Fungi, and 12 Algæ.

A. G.

3. *On the Microscopic Life of the Sediment of the Mississippi;* by M. Ehrenberg, (Monatsb. Königl. Berlin Acad.)—Ehrenberg's samples of the Mississippi sediment were received from Lieut. Maury of the Washington Observatory. They were from Memphis, Tennessee;—sample D, was sediment from the surface near the middle of the stream, during high water; E, same from a depth of 30 feet, at the same time; F, from the surface of the stream at low water; G, from the water at a depth of 20 feet, during low water.

The following is a list of the species observed.

Polygastrica: 44.	D	E	F	G
Arcella Globulus,				*
Cocconeïs borealis ?	*?			
lineata,		*		
Placentula,		*		
Cocconema Lunula,	*	*		
—— ?		*?		
Difflugia lævis,		*		
Oligodon,	*			
Eunotia amphyoxys,	*			
Dianæ ?		*?		
gibba,				*
granulata,		*		
Sphærula,		*		
Zebra ?		*		
—— ?			*?	*?
Fragilaria Rhabdosoma,	*		*	
Gallionella distans,	*?		*	*?
lævis,	*	*	*	
Glœonema —— ?	*?	*?	*?	*?
Gomphonema Augur,		*		
clavatum,		*		
gracile,	*			*?
Himantidium Arcus,			*	*
Navicula amphisphenia,		*		
gracilis,	*	*		*
Platalea,			*	
Sigma,		*?		*
—— ?	*?	*?	*?	

TABLE CONTINUED.

	D	E	F	G
Podosphenia Pupula,	·	*		
Pinnularia amphioxys,	*	*		
borealis subacuta ?	·	·	* ?	
decurrens,	* ?	*	·	* ?
gibba,	·	·	·	*
Legumen,	·	*		
Semen,	·	·	*	
Silicula,	·	·	·	*
viridis,	·	*		
Surirella Cocconeis,	*			
Librile,	·	*		
pygmaea,	*			
—— ?	* ?	* ?		
Synedra Ulna,	*	*	*	*
Tubellaria —— ?	*			
Trochelomonas lævis,	·	·	·	*
	18	25	11	14
PHYTOLITHARIA: 37.	34		20	
Lithodontium angulatum,	·	·	*	*
biemarginatum,	·	·	*	
Bursa,	·	·	*	*
emarginatum,	*	*	*	*
furcatum,	*	*		
nasutum,	*	*	*	*
Platyodon,	*	*		
rostratum,	·	·	*	*
Lithomesites Pecten,	·	*		
Lithosphæridium irregulare,	*	*	·	*
Lithostylidium Amphiodon,	·	*		
angulatum,	*	*	*	*
biconcavum,	·	*	·	*
bidens,	·	·	·	*
clavatum,	*	*	*	*
cornutum,	·	*		
crenulatum,	·	·	*	
curvatum,	*	*	*	*
denticulatum,	·	*	*	*
irregulare,	·	·	*	*
lacerum,	·	*	·	*
læve,	*	*	·	*
obliquum,	·	·	·	*
ovatum,	·	*		
quadratum,	*	*	*	*
Rajula,	·	·	·	*
rude,	*	*	*	*
Serra,	*	·	*	*
sinuosum,	·	·	·	*
spiriferum,	·	*		
Trabecula,	*	*	*	*
triquetrum,	·	*		
unidentatum,	*			
Spongolithis acicularis,	*	·	*	* ?
fistulosa,	·	* ?	*	
foraminosa,	·	*	*	
mississippica,	*	*	*	*
	16	24	20	24
POLYTHALAMIA.	27		28	
Rotaliarum fragmenta,	·	·	·	* ?
Textilaria globulosa,	·	·	·	*

IV. Astronomy.

1. *New Planet.*—Mr. J. R. Hind of London, discovered another planet on the 22d of August, 1852. It resembled a star of the ninth magnitude, and its place August 22, 1852, $11^h\ 35^m\ 39^s$ Gr. m. t. was R. A. $22^h\ 22^m\ 29^s{\cdot}74$, and N. P. D. 97° 32′ 14″·1.

2. *The Planet Melpomene*, (Astr. Jour., No. 48.)—The planet discovered June 24, 1852, by Mr. J. R. Hind, has been named *Melpomene*. The following elements of its orbit are computed by Messrs. Schönfeld and Thormann in Bonn, from observations of June 24, July 16, and August 12.

Epoch 1852, July 0, m. t. Berlin.

Mean longitude, - - -	284° 24′ 33″·97	
Longitude of perihelion, - -	15 10 57 ·10	M. Eqx.
" " asc. node, - -	149 57 53 ·72	of epoch.
Inclination, - - - - -	10 9 38 ·04	
Angle of excentricity, - -	12 33 45 ·70	
Log. of semi axis-major, - -	0·3612018	
" " mean daily motion, -	3·0082039	

3. *Second Comet of* 1852, (Astr. Jour., No. 48.)—On the 24th July, 1852, Dr. Westphal, at the Observatory of Göttingen, discovered a telescopic comet near *f Piscium*. The following elements are by Sonntag, from observations of July 29 and Aug. 7 and 16.

Time, 1852, Oct. 11·35920 m. t. Berlin.

Long. of perihelion, - -	42° 47′ 4″·9	M. Eqx.
" " asc. node, - -	346 44 30 ·9	Aug. 1.
Inclination, - - - - -	41 39 36 ·7	
Log. perihelion dist., - -	0·1015642	
Motion, - - - - -	direct.	

4. *Comet.*—Prof. Secchi at Rome while searching for *Biela's* comet, discovered about 3½ A. M., Aug. 26, 1852, a small nebulous comet in the constellation *Gemini*.

It is somewhat uncertain whether this is a new comet, or a portion of Biela's, which was divided about the beginning of the year 1846. Dr. Petersen and Dr. Gould are however of opinion that it is undoubtedly the comet of Biela. The fate of this comet, since the division, is a matter of great interest.

5. *Shooting Stars of August* 9–10, 1852.—At the meteoric epoch in August of the present year the weather at New Haven was very unfavorable for observation. During the night of the 9th, the sky was almost entirely overcast, and the following night was rainy, and observation wholly impossible. On the night of the 9th, Mr. John Edmands watched here between 2^h and 3^h A. M. (10th) and within forty minutes ending at $2^h\ 40^m$, observed *nineteen* shooting stars, which with one or two exceptions moved in paths which traced back would meet in the constellation Perseus. During these forty minutes, the sky was generally overcast except a small opening about ten degrees in diameter a little south of the zenith. He estimated that had the sky continued through the whole time of his observation as it was at the most favorable moment, he could not have seen more than one-fifth of the meteors that fell, and owing to the clouds he saw less than one-half that fell in

the space visible at the best moment. From these data, it may safely be inferred that the meteoric sprinkle of August did not fail this year.

M. Coulvier Gravier reports (*Comptes Rendus Acad. Sci.*, Aug. 16, 1852) that according to his observations at Paris from June 18 to Aug. 13, 1852, the average hourly number of shooting stars seen (by one observer?) at midnight was in the first half of July about 8, from the 16th to the 21st, 11; from the 22d to 27th, 21; from Aug. 2d to 6th, 38; on the 10th, 63; on the 11th, 50; on the 12th and 13th, 45.

E. C. H.

V. Miscellaneous Intelligence.

1. *British Association.*—The twenty-second meeting of the British Association opened at Belfast on the 1st of September. The Report of Dr. Royle, the General Secretary, states that the recommendation of the Council in favor of the publication of Mr. Huxley's zoological and anatomical researches, made during the voyage of H. M. S. Rattlesnake, failed of obtaining an appropriation from the government, the past year, and the Council recommend that the application should be repeated; also, that Dr. Hooker is already engaged under government in arranging his materials on the Botany of India for publication, and the first of the three volumes will not be ready before November, 1852; also, that Capt. Strachey has assistance from the government to enable him to publish his Explorations in the Himalaya mountains and in Thibet, with maps and illustrations. The method of investigating the tides of the Atlantic and a plan for the same, recommended by the Council, is next given in this Report. Among the foreign corresponding members added this year to the list, we observe the names of G. P. Bond and Dr. Asa Gray of Cambridge.

From the General Treasurer's Report, we learn that the receipts for the year past, (from July 2, 1851 to Sept. 1, 1852,) have been £1690 17*s.* 6*d.*, and the disbursements, £1450. Of the latter, £207 were for expenses of the Ipswich meeting, 300 for printing the last Report, 17 for engraving, 525 for salaries of the Assistant General Secretary and Accountant (18 months), 100 towards Dove's Isothermal lines, 234 for maintaining the Establishment at Kew Observatory, 20 for Experiments on the influence of Solar radiations, &c.

The address of the President, Col. Sabine, passes in review recent investigations in Physical science, especially such as have been made in England, or now deserve the special attention of the Association. The establishment of an Observatory in the southern hemisphere for the examination of the nebulæ of the southern heavens, to be devoted exclusively to that branch of sidereal astronomy, is recommended. The spiral nebulæ are supposed to reveal the probable existence in the distant universe of forces with which we are unaquainted, the nature of which, Col. Sabine remarks, "the highest authorities are unable even to conjecture." The "Physical features of the moon as compared with those of the earth," is another topic for astronomical investigation, commended to attention, and it is observed that Lord Rosse has expressed his willingness to undertake the research with one or two other gentlemen, if the desire of the Association be expressed to that effect. The publication, now in progress, of the "Markree Catalogue of Ecliptic

Stars," and the results of the "Observations at the Armagh Observatory," is announced.

With reference to the *Mathematical and Physical Theories of Light*, the President observes:—"The discussions will derive a more than usual interest at this meeting from the remarkable discovery recently made by Prof. Stokes, that under certain circumstances a change is effected in the refrangibility of light,—and from the advantage we possess in having amongst us on this occasion the eminent mathematician and physicist by whom this most important contribution to the science of physical optics has been made. His researches took their origin from an unexplained phenomenon discovered by Sir John Herschel, and communicated by him to the Royal Society in 1845. A solution of sulphate of quinine examined by transmitted light, and held between the eye and the light, or between the eye and a white object, appears almost as transparent and colorless as water; but when viewed in certain aspects and under certain incidences of light, exhibits an extremely vivid and beautiful celestial blue color. This color was shown by Sir John Herschel to result from the action of the strata which the light first penetrates on entering the liquid; and the dispersion of light producing it was named by him epipolic dipersion, from the circumstance that it takes place near the surface by which the light enters. A beam of light having passed through the solution was to all appearance the same as before its entrance; nevertheless, it was found to have undergone some mysterious modification,—for an epipolized beam of light—meaning thereby a beam which had once been transmitted through a quiniferous solution, and had experienced its dispersive action—is incapable of further epipolic dispersion. In speculating on the possible nature of epipolized light, Prof. Stokes was led to conclude that it could only be light which had been deprived of certain invisible rays which in the process of dispersion had changed their refrangibility and had thereby become visible. The truth of this supposition, novel and surprising as it at first appeared, has been confirmed by a series of simple and perfectly decisive experiments; showing that it is in fact the chemical rays of the spectrum, more refrangible than the violet, and invisible in themselves, which produce the blue superficial light in the quiniferous solution. Prof. Stokes has traced this principle through a great range of analogous phenomena, including those noticed by Sir David Brewster in his papers on "Internal Dispersion;" and has distinguished between "cases of false internal dispersion" or "opalescence," in which the luminous rays are simply reflected from fine particles held in mechanical solution in the medium, and those of "true internal dispersion," or "fluorescence," as it is termed by Prof. Stokes. By suitable methods of observation the change of refrangibility was detected, as produced not only by transparent fluids and solids, but also by opaque substances; and the class of media exhibiting "fluorescence" was found to be very large, consisting chiefly of organic substances, but comprehending, though more rarely, some mineral bodies. The direct application of the fact, as we now understand it, to many highly interesting and important purposes, is obvious almost on the first announcement. The facility with which the highly refrangible invisible rays of the spectrum may be rendered visible by being passed through a solution of sulphate of quinine or other sensitive medium, affords peculiar advantages for the study of those rays; the fixed lines of the invisible part of the solar spectrum may now be exhibited to our view at pleasure. The constancy with which a particular mode of changing the refrangibility of light attaches to a particular substance, exhibiting itself independently of the admixture of other substances, supplies a new method of analysis for organic compounds which may prove valuable in organic chemistry. These and other applications of the facts as they are now explained to us, will probably form subjects of notice in the Chemical and Physical Sections; and a still higher interest may be expected from the discussion of the principle itself, and of the foundation on which it rests. A discovery of this nature cannot be otherwise than extremely fertile in consequences, whether of direct application, or by giving rise to suggestions branching out more and more widely, and leading to trains of thought and experiment which may confer additional value on the original discovery by rendering it but the first step in a still more extensive generalization."

Mr. Joule's researches with reference to heat are briefly alluded to, and mention is then made of some experiments in progress under the direction of Mr. Hopkins, *for determining the influence of pressure on the temperature at which substances in a state of fusion solidify*—"an inquiry which was shown by Mr. Hopkins, in a report recently presented to the British Association, to have an important bearing on the questions of the original and present state of the interior of the earth. It is well known that the temperature of the earth increases as we descend, and it has been calculated that at the rate at which the increase takes place in such depths as are accessible to us, the heat at a depth of eighty or one hundred miles would be such as to fuse most of the materials which form the solid crust of the globe. On the hypothesis of original fluidity, and assuming that the rate of increase known to us by observation continues farther down, and is not counterbalanced by a considerable increase in the temperature of fusion occasioned by pressure, the present state of the earth would be that of a solid crust of eighty or one hundred miles in thickness enveloping a fluid nucleus. Mr. Hopkins considers this state to be inconsistent with the observed amount of the precession of the equinoxes, and infers that if the temperature of fusion be not increased considerably by pressure, the hypothesis of internal high temperature being due to primitive heat cannot be correct; whilst, on the other hand, if the temperature of fusion be considerably heightened by pressure, he considers the conclusion to be unavoidable, that the earth must be solid at the center.

Mr. Hopkins is assisted in these experiments, which are carried on at Manchester, by the well-known engineering knowledge of Mr. Fairbairn, and the equally well-known experimental skill of Mr. Joule. The principal difficulties attending the experiments with substances of low temperatures of fusion have been overcome, and strong hopes are entertained of success with substances of more difficult fusibility. The pressures employed are from three to four tons to eight and ten tons on the square inch. The latter is probably equal to the pressure at several miles beneath the earth's surface."

On the subject of *Terrestrial Magnetism*, Col. Sabine remarks :—

"We recognize in terrestrial magnetism the existence of a power present everywhere at the surface of our globe, and producing everywhere effects indicative of a systematic action; but of the nature of this power, the character of its laws, and its economy in creation, we have as yet scarcely any knowledge. The apparent complexity of the phenomena at their first aspect may reasonably be ascribed to our ignorance of their laws, which we shall doubtless find, as we advance in knowledge, to possess the same remarkable character of simplicity which calls forth our admiration in the laws of molecular attraction. It has been frequently surmised,—and the anticipation is, I believe, a strictly philosophical one,—that a power which, so far as we have the means of judging, prevails everywhere in our own planet, may also prevail in other bodies of our system, and might become sensible to us—in the case of the sun and moon particularly—by small perturbing influences measurable by our instruments, and indicating their respective sources by their periods and their epochs. As yet we know of neither argument nor fact to invalidate this anticipation; but, on the contrary, much to invest it with a high degree of probability. Be this, however, as it may, we have in our own planet, an exemplification of the phenomena which magnetism presents in one of the bodies of our system, on a scale of sufficient magnitude, and otherwise convenient for our study. Accordingly, the first object to which the British Association gave its attention was, to obtain a correct knowledge of the direction and amount of the magnetic force generally over the whole surface of the globe corresponding to a definite epoch.

It has been customary to represent the results of magnetic observations by three systems of Lines, usually called isogonic, isoclinal, and isodynamic lines. (Lines of equal horizontal direction, of equal vertical direction, and of equal force.) In the maps of these lines existing in 1838, large spaces of the earth's surface were either blank, or the lines passing across them were very imperfectly supported by observations. In the more frequented parts, where observations were more numerous, the discrepancies of their dates impaired their suitability for combination; for the position and configuration of the magnetic lines have been found to undergo a *continual process of systematic change*, with the causes of which we are as yet wholly unacquainted, but which has obtained the name of *secular* change, to distinguish it from periodical variations of known and limited duration. Amongst the most marked deficiencies in these maps, were the greater part of the extratropical portion of the southern hemisphere,—the British possessions in North America, and British India;—magnetic surveys of these were expressly recommended, and the practicability and advantage of making the observations on ship-board, and of thus extending them over the surface of the ocean, were pointed out.

It is most pleasing to recall to recollection, and gratifying to acknowledge from this chair, the favorable manner in which the recommendations of the British Association were received by her Majesty's Government and by the East India Company, and how promptly and effectually they have been carried out. The blanks in the southern hemisphere have been filled up by maritime Expeditions appointed expressly for the purpose. Magnetic surveys have been completed of British North America at the expense of our own government,—and of the Indian Archipelago at that of the East India Company,—and India itself is now in progress; whilst owing to the zeal of our naval officers, contributions have flowed in from almost every accessible part of the ocean. The co-ordination and mutual connection of so large a mass of materials is necessarily a work of time, but is progressing steadily towards completion, and when presented in one connected view, will form the groundwork on which will securely rest a "general theory of terrestrial magnetism" corresponding to the present epoch. Until these combinations and calculations are performed, it would be obviously premature to speak of numerical values by which the magnetic forces at one part of the globe may be compared with those of another, or with forces of other descriptions; and for the same reason it is desirable to abstain for the present from notices of the geographical positions which particular lines, or, as some may deem them, critical points in the magnetic resultants, may occupy on the earth's surface at the present epoch. Such notices could only be as yet provisional, and liable to the amendments which more exact and extended calculation must be expected to produce. But thus much may be safely stated in reference to the general character of the three systems of lines which have been spoken of, that when derived afresh and exclusively from the observations of the last few years, they do most fully confirm the general conclusions derived from the observations of earlier date, which were submitted to the British Association in the Report on the 'Variations of the Intensity of the Magnetic Force at different Points of the Earth's Surface,' which preceded the Recommendation of 1838.

The magnetic phenomena, or as it is now customary to call them, the three magnetic elements, appear to be everywhere and in both hemispheres the resultants of a duplicate system of magnetic forces, of which one at least undergoes a continuous and progressive translation in geographical space, the motion being from west to east in the northern hemisphere, and from east to west in the southern. It is to this motion that the secular change in all localities is chiefly, if not entirely, due; affecting systematically and according to their relative positions on the globe, the configurations and geographical positions of the magnetic lines, and producing conformable changes in the direction and amount of the magnetic elements in every part of the globe. The comparison of the earlier recorded observations with those of the present epoch gives reason to believe, that viewed in its generality, the motion of the system of forces which produces the secular change has been uniform, or nearly so, in the last two or three centuries. Under favorable conditions, the regularity of this movement can be traced down to comparatively very minute fractions of time. By the results of careful observations, continued for several years at the Observatory of St. Helena,—where, in common with the greater part of the district of the South Atlantic, the secular change of the declination exceeds eight minutes in the year, and from its magnitude therefore may be advantageously studied,—every fortnight of the year is found to have its precise aliquot portion of the annual amount of the secular change at the station. This phenomenon of secular change is undoubtedly one of the most remarkable features of the magnetic system; and cannot with propriety be overlooked, as it too frequently has been, by those who would connect the phenomena of terrestrial magnetism generally, mediately or immediately with climatic circumstances, relations of land and sea, or other causes to which we are assuredly in no degree entitled to ascribe secular variation,—and who reason therefore as if the great magnetic phenomena of the earth were persistent, instead of being, as they are, subject to a continual and progressive change. It may confidently be affirmed that the secular magnetic variation has no analogy with, or resemblance to, any other physical phenomenon with which we are acquainted. We appear at present to be without any clue to guide us to its *physical causes*, but the way is preparing for a future secure derivation of its *laws* to be obtained by a repetition, after a sufficient interval, of the steps which we are now taking to determine the elements corresponding to a definite epoch.

The periodical variations in the terrestrial magnetic force, which I have before adverted to as distinguished from its secular change, are small in comparison with the force itself; but they are highly deserving of attention on account of the probability that by suitable methods of investigation they may be made to reveal the sources to which they owe their origin and the agency by which they are produced. They formed accordingly the subject of distinct recommendation from the British Association, which met with an equally favorable reception. To investigate these variations by suitable instruments and methods, to separate each from the others, and to seek its period, its epochs of maximum and minimum, the laws of its progression, and its mean numerical value or amount, constituted the chief purposes for which magnetic observatories were established for limited periods at certain stations in Her majesty's dominions, selected in the view that by a combination of the results obtained at them, a general theory of each at least of the principal periodical variations might be derived, and tests be thus supplied whereby the truth of physical theories propounded for their explanation might be examined. We are just beginning to profit by the collocation and study of the great body of facts which has been collected. Variations corresponding in period to the earth's revolution around the sun, and to its rotation around its own axis, have been ascertained to exist, and their numerical values approximately determined in each of the three elements, the Declination, Inclination, and Magnetic Force. We unhesitatingly refer these variations to the sun as their *primary source;* since we find that in whatever part of the globe the phenomena are observed, the solstices and equinoxes are the critical epochs of the variations whose period is a year, whilst the diurnal variation follows in all meridians nearly the same law of local solar hours. To these unquestionable evidences of solar influence in the magnetic affections of the earth, we have now to add the recently ascertained fact, that the magnetic storms, or disturbances, which in the absence of more correct knowledge were supposed to be wholly irregular in their occurrence, are strictly periodical phenomena, conforming with systematic regularity to laws in which the influence of local solar hours is distinctly traced.

But whilst we recognize the sun as the primary cause of variations whose periods attest the source from whence they derive their origin, the mode or modes in which the effects are produced constitute a question which has been and may still be open to a variety of opinions; the direct action of the sun as being itself a magnet—its calorific agency in occasioning thermo-electric and galvanic currents, or in alternately exalting and depressing the magnetic condition of substances near the surface of the earth or in one of the constituents of its atmosphere,—have been severally adduced as hypotheses affording plausible explanations. Of each and all such hypotheses the facts are the only true criterion; but it is right that we should bear in mind that in the present state of our knowledge, the evidence which may give a decided countenance to one hypothesis in preference to others, does not preclude their possible co-existence. The analysis of the collected materials and the disentanglement of the various effects which are comprehended in them, is far from being yet complete. The correspondence of the critical epochs of the annual variation with the solstices and equinoxes rather than with the epochs of maximum and minimum temperature, which at the surface of the earth, in the subsoil beneath the surface, or in the atmosphere above the surface, are separated by a wide interval from the solstitial epochs, appears to favor the hypothesis of a direct action; as does also the remarkable fact which has been established, that the magnetic force is greater in both the northern and southern hemispheres in the months of December, January, and February, when the sun is nearest to the earth, than in those of May, June, and July, when he is most distant from it: whereas if the effect were due to temperature, the two hemispheres should be oppositely instead of similarly affected in each of the two periods referred to. Still, there are doubtless minor periodical irregular variations which have yet to be made out by suitable analytical processes, which, by their possible accordance with the epochs of maximum and minimum temperature, may support in a more limited sense, not as a sole but as a coördinate cause, the hypothesis of calorific agency so generally received, and so ably advocated of late in connection with the discovery by our great chemist and philosopher of the magnetic properties of oxygen and of the manner in which they are modified and affected by differences of temperature. It may indeed be difficult to suppose that the magnetic phenomena which we measure at the surface of the globe should not be in any degree influenced by the variations in the magnetic conditions of the oxygen of the atmosphere in different seasons and at different hours of the day and night; but whether that influence be sensible or not, whether it be appreciable by our instruments or inappreciable by them, is a question which yet remains for solution by the more minute sifting of the accumulated facts which are now undergoing examination in so many quarters.

To justify the anticipation that conclusions of the most striking character, and wholly unforeseen, may yet be derivable from the materials in our possession, we need only to recall the experience of the last few months, which have brought to our knowledge the existence of what may possibly prove the most instructive, as it is certainly at first sight the least explicable of all the periodical magnetic variations with which we have become acquainted. I refer to the concurrent testimony which observations at parts of the globe the most distant from each other bear to the existence of a periodical variation or inequality, affecting alike the magnitude of the diurnal variations and the magnitude and frequency of the disturbances or storms. The cycle or period of this inequality appears to extend to about ten of our years; the maximum and minimum of the magnitudes affected by it being separated by an interval of about five years, and the differences being much too great, and resting on an induction far too extensive, to admit of uncertainty as to the facts themselves. The existence of a well-marked magnetic period which has certainly no counterpart in thermic conditions, appears to render still more doubtful the supposed connection between the magnetic and calorific influences of the sun. It is not a little remarkable that this periodical magnetic variation is found to be identical in period and in epochs of maxima and minima with the periodical variation in the frequency and magnitude of the *solar spots* which Mr. Schwabe has established by twenty-six years of unremitting labor. From a cosmical connection of this nature, supposing it to be finally established, it would follow, that the decennial period which we measure by our magnetic instruments is, in fact, a *solar period*, manifested to us also by the alternately increasing and decreasing frequency and magnitude of obscurations on the surface of the solar disc. May we not have in these phenomena the indication of a cycle or period of *secular change in the magnetism of the sun*, affecting visibly his gaseous atmosphere or photosphere, and sensibly modifying the magnetic influence which he exercises on the surface of our earth?"

Some observations follow on the measurements of the figure and dimensions of the globe—on the tides of the ocean—and on the isothermal lines of Dove. It is also stated that "the facts derived a few years since from the barometrical observations at St. Helena, showing the existence of a *lunar atmospheric tide*, have been corroborated in the last year by a similar conclusion drawn by Capt. Elliot, of the Madras Engineers, from the barometrical observations at Singapore. The influence of the moon's attraction on the atmosphere produces, as might be expected, a somewhat greater effect on the barometer at Singapore, in lat. 1° 19′, than at St. Helena, in lat. 15° 57′. The barometer at the equator appears to stand on the average about 0·006 in. (more precisely 0·0057, in lat. 1° 19) higher at the moon's culminations than when she is six hours distant from the meridian."

The subject of *Scientific Pensions* has received successful attention from the Parliamentary Committee appointed at Ipswich, and already some pensions have been granted by recommendation of the President of the Royal Society, viz., to Mr. Hind, the Astronomer, to Dr. Mantell, the Geologist and Palæontologist, and to Mr. Ronalds, who has been for many years engaged in electrical researches. Another subject before this committee was that of "a more *cheap and rapid international communication of scientific publications*," respecting which it is said that "the credit of the first move towards the accomplishment of this desirable object is due to the government of the United States; by whom an arrangement was made for the admission duty free of all scientific books addressed as presents from foreign countries to all institutions and individuals cultivating science in that country,—such books being sent through the Smithsonian Institution, by whom their further distribution to their respective destinations was undertaken. This arrangement was notified to our government through the British Minister at Washington, and a similar privilege was at the same time requested for the admission duty free into England, of books sent as presents from the United States to public institutions and individuals cultivating science in this country, under such regulations as might appear most fitting. This proposition gave rise to communications between the President of the Royal Society and the Chairman of the Parliamentary Committee on the one part, and the Treasury and the principal Commissioner of Customs on the other; the result of which has been, the concession of the principle of admission, duty free, into England of scientific books from all countries, designed as presents to institutions and individuals named in lists to be prepared from time to time by the Royal Society, after communication with other scientific societies recognized by charter,—under the regulation, however, that the books are to be imported in cases addressed to and passing through the Royal Society. This arrangement has come into operation; and it may be interesting to notice, as giving some idea of its extensive bearing, that the first arrival from the United States which has taken place under these regulations, consists of packages weighing in all no less than three tons. There is another branch of the same subject which is more difficult to arrange,—viz., the international communication *by post* of scientific pamphlets and papers at reduced rates of postage; the Parliamentary Committee have directed their attention to this part of the subject also, and I earnestly hope that their exertions will be successful."

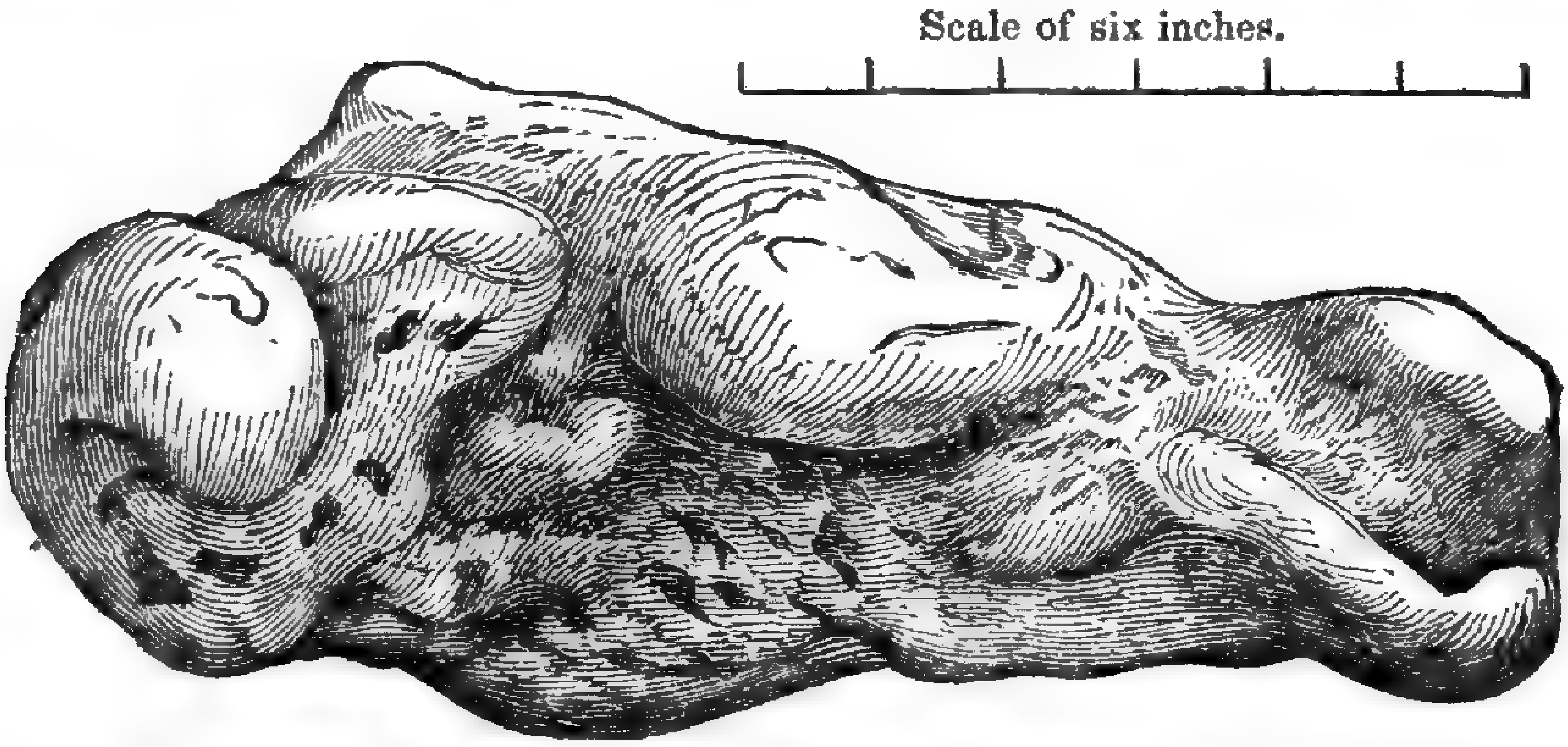
Col. Sabine closes with some remarks on *a direct representation of science in Parliament*, sometimes suggested, concerning which he gives his individual opinion that "the possible gain would be incalculably outweighed by the too certain evils; and that scientific men cannot too highly value and desire to retain the advantage they now possess in the undisturbed enjoyment of their own pursuits, untroubled by the excitements and distractions of political life."

2. *On a mass of Meteoric Iron from near Seneca River, N. Y.;* by Prof. O. Root.—A mass of malleable iron weighing nine pounds, was found last fall in digging a ditch on a farm near the free bridge on the Cayuga side of the Seneca River. It was drop shaped, about four inches in diameter and seven inches in length. When found it was coated with oxyd of iron.

The surface was uneven, and some of the prominent parts were terminated by planes of octahedral crystals. Through the kindness of Jacob Crowningshield and Leroy Partridge of Seneca Falls, I am in possession of a piece of the iron weighing three pounds, being the middle section of the original specimen. The internal structure of the mass was very obvious from the lines of crystallization presented on the faces cut by the saw in dividing. After the faces were smoothed and etched the figures were very distinct and beautiful, resembling those on the Texas meteorite in the Yale Cabinet. When filings of the faces cut were dissolved in nitric acid and the iron precipitated by ammonia, the solution, on adding potash, gave very manifestly the reaction of nickel, and hence the specimen is undoubtedly *meteoric iron.*

It may be an interesting fact, that the locality where this iron was found is only a few miles from Waterloo, in Seneca county, where a meteorite fell in 1827, as has been stated by Prof. Shepard.

3. *The "King of the Nuggets," the largest specimen of pure Gold found in Australia.*—In the engraving annexed, we delineate a lump of pure gold, weighing 27*lbs.* 6*oz.* 15*dwts.*, which was found in the diggings at Forest Creek, Mount Alexander, in the colony of Victoria.



LUMP OF GOLD FROM AUSTRALIA.—VALUE, $5500.

This marvellous lump of precious metal was, according to letters received from Port Phillip, regarded with extraordinary interest even in that gold-ridden community, and is the largest nugget yet found in Australia. It was shipped by Mr. Joseph Herring, of Port Phillip, to Messrs. Herring, of Old Broad-street, London; and was brought with a very large consignment of gold, in the barque *Posthumus*, Davidson, master. Amongst the gold brought by the *Posthumus* were several nuggets, weighing upwards of a pound each, and one of 1*lb.* 8*oz.* 6*dwts.*; these smaller lumps, however, contain quartz, whilst the "king of the nuggets" seems a massive lump of pure gold of a very fine color. Our engraving is considerably smaller than the nugget: we therefore give a scale of six inches to enable our readers to judge of the real proportions of the piece of gold, which is eleven inches in length, by five in breadth, at the widest part.—*Mining Journal.*

4. *On the Influence of Suggestion in modifying and directing Muscular Movement, independently of Volition;* by Dr. W. B. Carpenter, (Roy. Institution, March 12; Athenæum, No. 1281,)—Public attention has recently been so much attracted to a class of phenomena which have received the very inappropriate designation of *Electro-Biological* or simply *Biological*, and so much misapprehension prevails regarding their true nature and import, that it becomes the physiologist to make known the results of scientific investigation, directed in the first place towards the determination of their genuineness, and in the second, to the elucidation of the peculiar state of the nervous system on which their production depends. With regard to the genuineness of the phenomena themselves, the lecturer stated that he could entertain no doubt whatever; since they had been presented to himself and to other scientific inquirers, by numerous individuals, on whose honesty and freedom from all tendency to deceive themselves or others implicit reliance could be placed. But from the account commonly given of these phenomena—to the effect that the *will* of the "biologized" subject is

entirely subjected to that of the operator,—he entirely dissented. All the phenomena of the "biologized" state, when attentively examined, will be found to consist in the occupation of the mind by the *ideas* which have been suggested to it, and in the influence which those ideas exert upon the actions of the body. Thus, the operator asserts that the "subject" cannot rise from his chair, or open his eyes, or continue to hold a stick; and the "subject" thereby becomes so completely possessed with the fixed belief of the impossibility of the act, that he is incapacitated from executing it, *not* because his will is controlled by that of another, but because his will is in abeyance, and his muscles are entirely under the guidance of his ideas. So again, when he is made to drink a glass of water, and is assured that it is coffee, or wine, or milk,—that assurance, delivered in a decided tone, makes a stronger impression on his mind than that which he receives through his taste, smell, or sight; and not being able to judge and compare, he yields himself up to the "dominant idea." The same is true of what has been designated "control over the memory." The subject is assured that he cannot remember the most familiar thing, his own name for example; and he is prevented from doing so, not by the will of the operator, but by the conviction of the impossibility of the mental act, which engrosses his own mind, and by the want of that voluntary control over the direction of his thoughts which alone can enable him to *recall* the desiderated impression. The same with the abolition of the sense of personal identity.

Now, almost every one of these peculiar phenomena has its parallel in states of mind whose existence is universally admitted. Thus, the complete subjection of the muscular power to the "dominant idea" is precisely what is experienced in *nightmare;* in which we are prevented from moving so much as a finger, notwithstanding a strong desire to do so, by the conviction that the least movement is impossible. The misinterpretation of sensory impressions is continually seen in persons who are subject to *absence of mind*, who make the most absurd mistakes as to what they see or hear, taste or feel, in consequence of the preoccupation of the mind by some train of thought which renders them unable rightly to appreciate the objects around them. In such persons, too, the memory of the most familiar things—as the absent man's own name, for example, or that of his most intimate friend—is often in abeyance for a time; and it requires but a more complete obliteration of the consciousness of the past, through the entire possession of the mind by the intense consciousness of the present, to destroy the sense of personal identity. This, indeed, we often do in effect lose in ordinary *dreaming* and *reverie.* The essential characteristic of both these states, as of the "biological" condition, is, the suspension of voluntary control over the current of thought, so that the ideas follow one another *suggestively;* and however strange or incongruous their combinations or sequences may appear, we are never surprised at them, because we have lost the power of referring to our ordinary experience.

There is one phenomenon of the "biological" state, which has been considered preëminently to indicate the power of the operator's will over his subject; namely, the induction of sleep, and its spontaneous determination at a given time previously ordained, or by the sound of the operator's voice, and that only. It is well known that the *expectation* of sleep is one of the most powerful means of inducing it, especially when combined with the withdrawal of the mind from everything which could keep its attention awake; both these conditions are united in an eminent degree in the state of the biologized subject whose mind has been possessed with the conviction that sleep is about to supervene, and is closed to every source of distraction. The waking at a particular time may also be explained by the influence of expectation. Thus, however strange the phenomena of the "biological" state may at first sight appear, there is not one of them, which, when closely scrutinized, is not found to be essentially conformable to facts whose genuineness every physiologist and psychologist is ready to admit. It is not, however, in any large proportion of individuals that this state can be induced; probably not more than one in twenty, or at most one in twelve. Males appear equally susceptible of it with females; so that it cannot be fairly set down as a variety of "hysterical" disorder.

The lecturer proceeded to inquire, whether any such physiological account can be given of this state as shall enable us to refer it to any of the admitted laws of action of the nervous system; and in order to prepare his auditors for the reception of his views, he gave a brief explanation of those phenomena of "reflex" action (now universally recognized by physiologists) in which impressions made upon the nervous system are followed by respondent automatic movements. The movements which we term *voluntary* or *volitional* differ from the emotional and automatic, in being guided by a distinct conception of the object to be attained, and by a rational choice of the means employed. And so long as the voluntary power asserts its due predominance, so long can it keep in check all tendency to any other kind of action save such as ministers directly to the bodily wants, as the automatic movements of breathing and swallowing. The *cerebrum* is universally admitted to be the portion of the nervous system which is instrumentally concerned in the formation of ideas, the excitement of the emotions, and the operations of the intellect; and there seems no reason why it should be exempted from the law of "reflex action," which applies to every other part of the nervous system. And as the *emotions* may act directly upon the muscular system through the motor nerves, there is no *à priori* difficulty in believing that *ideas* may become the sources of muscular movement, independently either of volitions or of emotions. Now, if the ordinary course of external impressions—whereby they successively produce sensations, ideas, emotions, and intellectual processes, the will giving the final decision upon the action to which they prompt—be anywhere interrupted, the impression will then exert its power in another direction, and a "reflex" action will be the result. This is well seen in cases of injury to the spinal cord, which disconnects its lower portion from the sensorium without destroying its own power; for impressions made upon the lower extremities then excite violent reflex actions, to which there would have been no tendency if the current of nervous force could have passed upwards to the cerebrum. So, if sensations be prevented by the state of the cerebrum from calling forth its ideas through its instrumentality, they may re-act upon the motor apparatus in a manner which they would never do in its state of complete functional activity.

This the lecturer maintained to be the true account of the mode in which the locomotive movements are maintained and guided in states of profound abstraction, when the whole attention of the individual is so completely concentrated upon its own train of thought, that he does not *perceive* the objects around him, although his movements are obviously guided by the impressions which they make upon his sensorium. On the same grounds, it seems reasonable to suppose that when *ideas* do not go on to be developed into emotions, or to excite intellectual operations, they, too, may act (so to speak) in the transverse direction, and may produce respondent movements, through the instrumentality of the cerebrum; and this will of course be most likely to happen when the power of the will is in abeyance, as has been shown to be the case in regard to the direction of the thoughts in the states of electro-biology, somnambulism, and all forms of dreaming and reverie. Thus the *ideo-motor* principle of action, as contrasted with the excito-motor and sensorio-motor, finds its appropriate place in the physiological scale,—which would, indeed, be incomplete without it. And when it is once recognized, it may be applied to the explanation of numerous phenomena which have been a source of perplexity to many who have been convinced of their genuineness, and who could not see any mode of reconciling them with the known laws of nervous action. The phenomena in question are those which have been recently set down to the action of an "od-force,"—such, for example, as the movements of the "divining-rod," and the vibration of bodies suspended from the finger; both which have been clearly proved to depend on the state of *expectant attention* on the part of the performer, his will being temporarily withdrawn from control over his muscles by the state of abstraction to which his mind is given up, and the *anticipation* of a given result being the stimulus which directly and involuntarily prompts the muscular movements that produce it.

5. *Motion in the Bunker Hill Monument through the action of the Sun's heat*, (from the Proc. Amer. Assoc., vi, 81.)—Prof. Horsford in the course of some experiments with the pendulum at the Bunker Hill Monument observed that the ball of the pendulum at rest did not hang permanently over the same spot. The monument is an obelisk of granite 221 feet high, and 30 feet square at base; the cavity within is 7 feet across at bottom and 5 feet at top. The pendulum was suspended at the center of the roof. The departure of the ball from the center commenced before 7 o'clock A. M. on a sunny day; at this hour it was to the westward; at noon to the northwest; and at evening to the eastward. In the progress of the afternoon it had twice the amount of motion observed in the morning. During the night, it was gradually restored to the central position. The greatest diameter of the irregular ellipse described by this movement was nearly half an inch, and the least less than a quarter of an inch. The direction of the change at noon is attributed to the position of the monument, its sides varying 20° from the cardinal points. In cloudy days there was no motion of the pendulum point; and a shower one afternoon so cooled the monument as to produce a reverse movement which was apparent in a few minutes. The speedy effect of the shower shows that the heat, to which the expansion is due, penetrates to but a small distance.

6. *Spots on the Sun.*—The following results of observations by H. Schwabe, at Dessau, (from the Astr. Nachr.) are published in a paper on the sun, by Alfred Gautier, in the Bibliothèque Universelle de Genève for July, 1852.

Results of 26 years of Observations on the Spots of the Sun, by H. Schwabe, at Dessau.

Date.	Days of observations each year.	Number of groups of spots each year.	Epochs of maximum & minimum groups of spots.	No. of days each y'r when no spots were observed.
1826	277	118		22
1827	273	161		2
1828	282	225	Maximum.	0
1829	244	199		0
1830	217	190		1
1831	239	149		3
1832	270	84		49
1833	267	33	Minimum.	139
1834	273	51		120
1835	244	173		18
1836	200	272		0
1837	168	333	Maximum.	0
1838	202	282		0
1839	205	162		0
1840	263	152		3
1841	283	102		15
1842	307	68		64
1843	324	34	Minimum.	149
1844	320	52		111
1845	332	114		29
1846	314	157		1
1847	276	257		0
1848	278	330	Maximum.	0
1849	285	238		0
1850	308	186		2
1851	308	151		0
Mean of 26 years	268 days of observations.	164 groups.		

In making his observations, M. Schwabe, on each clear day, counts the number of distinct groups of spots which he perceives, assigning at the same time a number in order to each group, and counting the same one only once in a single rotation of the sun. The table is remarkable in presenting a decennial periodicity in the appearance of the spots. The number of spots seen in 1826 was 118; from this there was an increase to 161 in 1827 and 225 in 1828, and then a decrease to 33 in 1833. The number again increased, and was 333 in 1837, 282 in 1838, and 34 in 1843. Again it increased and after five years in 1848, it was 330, since which there has again been a decrease. Moreover at the time of minimum the spots are much smaller than at the maximum. In 1844 the largest was hardly 4′ broad. While in 1848 three groups were 8½′ across, and one spot appeared for seven or eight consecutive rotations.

M. Gautier observes that he has remarked a singular connection between this decennial period in the spots, and a decennial period in the variations of the magnetic needle recently pointed out by Dr. Lamont of Munich.* According to this astronomer, since August, 1840, the mean annual amplitude of the diurnal variation of magnetic declination between 8 A. M. and 1 P. M. augments regularly for *five* years and then diminishes for five years. The epoch of the *minimum* of this amplitude corresponds to the middle of the year 1843, and that of the *maximum*, to the middle of 1848. He has also found, from the Göttingen observations a *maximum* in 1837, corresponding with the above observations on the spots.

The results of Dr. Lamont have been confirmed by M. Reslhuber at the Observatory of Kremsmünster in Austria. Thus in 1843, the annual mean diurnal variations of declination and intensity have been respectively 6′ 28″·6 and +0·00088; and in 1844 they were 6′ 14″·9 and +0·00138. In 1848, they were 10′ 55″·4 and +0·00273; in 1849, 10′ 39″·5 and 0·00230.

M. Schwabe has deduced from eight observations with regard to the period of rotation of the sun, 25·07 days as the shortest, 25·75 as the longest; the mean of his results gives 25·507 days. He remarks that some of the spots have a brownish red color; one was examined with glasses of different colors, to avoid any source of error; its north side was reddish-brown, more red than brown. The next day it had much changed and the border had the usual gray color.

M. Rodolphe Wolf, of Berne, has been registering the spots since 1847; and he concludes that the number through a year so varies, that if a curve be drawn to express the variation, this curve has undulations, the more regular of which correspond each to a period of about 27⅓ days, or the period of the sun's rotation with relation to the earth. As bearing on this subject, the author states that M. Buijs Ballot† of Utrecht has concluded from thermometric observations at Harlem, Zwanenbourg and Dantzig, (see Pogg. Ann., 1851, Dec.,) that during a number of years, at each period of 27·7 days there is at these places a small elevation of temperature and at the intermediate period a diminution.

7. *On the Freezing of Vegetables.*—In connection with an abstract of Prof. J. LeConte's paper On the Freezing of Vegetables, (this Journal, volume xiii, 84,) published in the Bibliothèque Universelle for June, 1852, the following note is inserted by M. A. de Candolle, showing that the action of freezing on vegetation for some years has not been altogether misunderstood by botanists. "In 1838, I published in the Bulletin de la Classe d'Agriculture de Genève (No. 120, p. 171), in an article on the intense cold of January, 1838, the following remarks—after first alluding to the observations of Pictet and Maurice who found the temperature of the centre of a chesnut tree below zero, and also the experiments of M. Ch. Coindet, who after a prolonged cold had extracted from the middle of a large tree, small crystals of ice:—'These trees are however not dead. I have myself, after a cold but little intense, seen crystals of ice in the interior of the buds of several trees which have not suffered from it. Young branches, the buds of many trees, and the leaves of the plants of our country are in winter often penetrated beyond doubt with a cold several degrees

* This coincidence, as M. Gautier afterwards observes, is mentioned by Sabine as a deduction from the observations made at Hobarton from 1841 to 1848.

below zero (centigrade); and although the viscous liquids of the slender tubes congeal with difficulty, it must frequently happen that congelation takes place, without the plant or the organ perishing. Thus cold does not kill vegetation by a mechanical action proceeding from the congelation of the liquid as some naturalists pretend. We must recognize rather a physiological action; that the vitality of the tissue is destroyed by a certain degree of cold followed by a certain degree of heat, according to the peculiar nature of each plant. The vegetable and anima! kingdom, according to this view, will act alike. In the same manner as the gangrene that sets in after the thawing of a frozen part causes the death of an animal tissue, so the change or putrefaction which follows a rapid thawing will be the principal cause of the death of the vegetable tissue. It is well known in practice how to manage the transitions of temperature to preserve the organs of vegetables.'

Since 1838, until my connection with the Academy of Geneva ceased, I stated in my annual lectures that cold may act in two ways on vegetation:—either *physically*, by the contraction or congelation of the liquids, which often does not kill them; and *physiologically*, by an action upon the tissues and upon vegetable life, which the laws of physics do not account for. The most striking example of this last, is the immediate death of hot-house plants when exposed to a temperature of $+1$ or $+2°$ C., which causes no congelation. The action of the same degree of temperature is very different on two allied species, and sometimes on two varieties of the same species."

8. *Medals of Creation.*—Dr. Mantell is engaged on an entirely new edition of his "Medals of Creation, or First Lessons in Palæontology," which will be brought up to the present state of the science and enriched with many new illustrations. It will be printed uniform with the sixth edition of the Wonders of Geology, the Geology of the Isle of Wight, and the "Petrifactions and their Teachings;" the series will thus form six volumes comprising the most important and recent works of the author.

9. *On the Cereus Greggii;* by Dr. Engelmann.—[The following observations, were sent in as a substitute for a sentence on page 339, but were received too late for insertion at that place.—Eds.]

The curious *Cereus Greggii*, E., has been noticed from the Pecos river east to the Mimbres Mountains west of El Paso, and from Chihuahua towards the mouth of the Gila, but always in isolated specimens, very scattering and rare. The fruit which was figured in Emory's Report, is deep scarlet, succulent, with short spines on the pulvilli; it is oval, sessile and attenuated at base, and *not stipitate*, but long acuminate, and with the long tube of the flower curved downwards, remaining attached to its point. The seeds are black and opaque, rugose and pitted, and about one line in diameter. The root is large, turnip-shaped, and produces many stems, 2–4 feet high. The young plants raised from seeds are dark purplish; triangular root not yet enlarged.

Collections of Cactaceæ have also been recently made by Dr. John M. Bigelow of the Boundary Commission, who has sent them to me for examination. My collection under study includes about 12 species of Mamillaria, 8 Echinocacti, 12 Cerei and 12 Opuntiæ, most of which are new forms.

St. Louis, Sept. 7th, 1852.

10. *On the Oscillations of Suspension Bridges;* by J. H. Röhrs, Esq., M. A., (Lond. Edin. and Dub. Phil. Mag., iii, p. 316, 1852.)—In this paper the oscillations of a chain suspended at two points were discussed, with a view to explain the causes of fracture in suspension-bridges, by vibration arising from the tramping of troops, gusts of wind, &c., as well as to suggest means for obviating the mischief under those circumstances. The following were some of the most remarkable results arrived at:—

1st. That if the tension at the ends of the chain where it is suspended be kept constant by allowing play at those points, the variation of tension due to vibration at any other point of the chain will be but small.

2ndly. That if the chain be tied at the points of suspension so that it can have no motion there, a slight extent of vibration will produce comparatively a great increase of tension.

3rdly. That periodic forces, such as may be taken, for instance, to represent the effect of tramping in time of troops moving across the bridge, are dangerous in the extreme, as if they happen to coincide in period with any of the possible types of vibration, the extent of vibration will increase continuously, till it ceases to be represented approximately by a linear or even an equation of the second order; in this case, the chain will be divided by nodal points where there is no vertical motion.

4thly. That the mere transit, without tramping, of ordinary loads at an ordinary pace would not cause sensible vibration in a bridge of wide span; but that terms not periodic might be introduced by the variable pressure of wind sweeping in rapid gusts along the platform.

11. *Siberian Exploring Expedition.*—The expedition for exploring Siberia, organized by M. Demidoff, for the years 1853, 1854, 1855, will include the following scientific men. For zoology and botany, Prof. Alexander von Nordmann, of the University of Helsingfors, Finland, in 1837 associated with M. Demidoff in the voyage of the Crimea; as aid in zoology and botany, M. Arthur von Nordmann, son of the Professor; for entomology, Dr. Mæklin, of the University of Helsingfors; for mineralogy and metallurgy, M. LePlay, Engineer-in-chief of the mines of France, and a member of the Crimea expedition, and for fifteen years the "Conseil Technique" of the Siberian Mineral Explorations under M. Demidoff; for mineral observations, hygien, &c., Dr. J. B. Laure; for painter of lanscapes, portraits, &c., M. Raffet; for natural history painter, M. Weight of Helsingfors; and M. Alphonse Baudin, son of the admiral, will have charge of the journal of the voyage. A geologist and another person for physics are yet to be appointed. —*L'Institut, No.* 953, *April* 7, 1852.

12. *Rain in the Khassya Hills,* (Murchison's Address before the Geogr. Soc., 1852.)—My friend, Professor Oldham, in writing to me from Churra Poonjee, in the Khassya Hills, north of Calcutta, states that the rainfall is there about 600 inches, or 8½ fathoms, per annum; 550 inches of which descend in the six rainy months commencing in May; and that in one day he measured a fall of 25·5 inches! This remarkable phenomenon was, it appears, previously well known to Drs. Hooker, Thomson, and other scientific men; but as the facts were only recorded in local periodicals, it is well to give them as great a publicity in England as they have obtained in Bengal.

OBITUARY.

John Pitkin Norton, Professor of Scientific Agriculture in Yale College, died at Farmington, the residence of his father, on Sunday, September 5th, 1852, aged 30 years. Prof. Norton was appointed to the place he filled so well, in 1847. His chemical studies were commenced in 1842 at New Haven, where he attended for two seasons the lectures of Prof. Silliman the elder, and occupied himself in study and research in the Analytical Laboratory of B. Silliman, Jr. He had already acquired a thorough knowledge of the duties of a practical agriculturist in the management of his father's estate. After two years spent in chemical and mineralogical investigations in New Haven, he sailed for Scotland, where he studied British agriculture and agricultural chemistry under Prof. James F. W. Johnston at Edinburgh. During this period of nearly two years his chief chemical investigation was upon the Oat, a very comprehensive and able research, which won the prize of 50 guineas from the Highland Society. As this investigation was published at length in this Journal,* it is sufficient to say that he undertook to determine both by qualitative and quantitative experiments, the variations and changes which occur in the amount of water and of mineral constituents contained in the individual organs of the plant during the period of its growth. He subsequently inquired what relation existed between the mineral constituents of the plant and of the soils on which it grew. Returning to America in the summer of 1846, he was appointed in the autumn of that year to the chair which he held until his death. Soon after this appointment he returned a second time to Europe, where he spent nearly another year at Utrecht, under the celebrated Mulder, in the completion of his studies in agricultural chemistry.

In the autumn of 1847 he joined Prof. Silliman, Jr., in the Analytical Laboratory of Yale College, which was now removed to a larger building, and the increased facilities for instruction in agricultural as well as general chemistry, drew to this laboratory an additional number of pupils. In January, 1848, Prof. Norton began his first course of lectures on scientific agriculture to a class composed mostly of practical agriculturists, in addition to the students in special chemistry.

During his term of duty, he published his Elements of Scientific Agriculture, and edited with valuable notes and corrections, Stephens' Book of the Farm, in two volumes. Both while in Europe and after his return he published numerous letters on subjects of agricultural science, chiefly in the Albany Cultivator. These letters were always remarkable for sound judgment, thorough accuracy and fullness, and the lively style in which they were written. Besides the memoirs on subjects of science before alluded to, Prof. Norton published researches and observations on the potato disease,† and on the proteine bodies of peas and almonds.‡ The latter was his chief occupation while under Mulder. After October, 1849, Prof. Norton was sole director of the Yale Analytical Laboratory, in consequence of the appointment of his colleague to a distant post of duty. In the winter of 1851–52, he entered zealously into the plan of establishing a University at Albany, in which agriculture and its connected sciences should receive the direct patron-

* Vol. iii, [2], 100, 318. † Ibid. [2], ii, 281, iv, 70. ‡ Ibid. [2], v, 22.

age of the State. In order to give a course of lectures before this new institution it became necessary for him to travel from New Haven to Albany twice each week, lecturing in each place three times. This exertion proved too much for his strong frame and developed the latent seeds of pulmonary disease, which in an uncommonly brief space cut him down, just as he had fairly entered upon the wide field of his usefulness perfectly fitted for his duties, enjoying the entire confidence of the whole agricultural community, and bound by the strongest ties of personal regard and affection to a large circle of friends.

He was a man of noble generosity and the highest moral excellence, as well as accurate science; we doubt not that death has opened to him a more exalted sphere of happiness, and a wider range of knowledge.

Charles Athanasius Baron de Walckenaer, (Murchison's Address before the Geograph. Soc., 1852.)—Walckenaer died recently at Paris at an advanced age. He was a member of the Academy of Inscriptions and Belles Lettres, and of the Institute of France, of which during the last twelve years he had been perpetual secretary. Though he was the author of works which have procured for him an European fame as a writer on geography, it is to be noted that his first appearance in the world of letters was as a naturalist, and by publishing works on insects (Arachnidæ), he gained for himself the friendship of Cuvier. Soon, however, abandoning that career, M. de Walckenaer edited the first edition of Azzara's 'Voyages dans l'Amérique Méridionale.' Indeed, we learn from himself, that, amidst all his accomplishments, his real passion was comparative geography, and of this he gave a most successful proof in his remarkable work entitled 'Géographie Ancienne, Historique et Comparée, des Gaules Cisalpines et Transalpines,'—a work which obtained for him one of the great prizes of the Institute, and a place in that illustrious body. Eminent geographers, such as Delisle, D'Anville, Rennell, Gosselin, and Vincent, had admitted the vast difficulty of comparing old geography with new, arising in a great degree from the different measures referred to by classical authors; but our perspicuous and indefatigable associate overcame all such obstacles.

M. de Walckenaer published other geographical works on ancient and modern geography, an historical view of the East, Polynesia, and Australia, on the interior of North Africa, besides a general history of voyages and travels and many detached memoirs.

He was also a good biographer, having published the 'Life and Writings of La Fontaine,' the 'Life of Horace,' and the 'Memoirs of Madame de Sévigné;' by the last-mentioned of which works he is perhaps best known to the general reader. The first lines in it show how well he could impart the artistic feeling of a geographer to a literary production; for the old castle of Bourbilly, in which the inimitable authoress was born, is there placed before us by the hand of a master, as surrrounded by its meadows, slopes, rocks, and river.

M. de Walckenaer, who had been employed in the civil administration of Napoleon, became Secretary-General of the Department of the Seine at the Bourbon restoration, and was created a Baron in 1830. He was one of the most frequent attendants at the meetings of the Academy, of which he had been a member since 1813, and was, when he died, a Vice-President of the Geographical Society of France.

VI. Bibliography.

1. *Address at the Anniversary Meeting of the Royal Geographical Society*, May 24, 1852; by Sir R. I. Murchison. 72 pp. 8vo.—This pamphlet commences with a mention of the Explorations of Dr. Rae and Capt. Strachey, the former in northern North America, the latter in the Himalayas, and the presentation to them of the Gold Medals of the Geographical Society. The able address of Murchison, after some introductory remarks, makes mention of the career of several members of the Society who have died the past year: among whom are Vice Admiral Sir Charles Malcolm, who died at Brighton, June 14, in his 69th year; Mr. Bartholomew Frere, born in 1776; the Earl of Derby, for some time President of the Zoological Society of London; Commander Frederick Edwin Forbes, R.N., author of "Dahomey and the Dahomans," who died on the 25th of March at the age of 34 years: and of foreign members, Walckenaer of France, Schouw of Denmark, and Inghirami of Florence. The author next reviews the recent Arctic researches, and the Gold Explorations in Australia, and mentions the researches in Physical and Descriptive Geography made by British investigators, and to some extent those of foreign countries. He makes mention of Johnston's Physical Atlas, Petermann's elementary physical maps, the first on the chief botanic regions of the world, the last on oceanic currents and river systems; also Dr. Smith's Ancient Geography; some researches of the Meteorological Society; and the Ordnance Survey of Scotland. Among the labors on the Continent of Europe, he refers to those of the Imperial Geographical Society of St. Petersburg, the Transactions of which now extend to 5 volumes; a pamphlet by Khanikof and Tolstoi containing various positions in northwest Asia astronomically determined; the explorations of the sea of Azof by Capt. Bukatof, not yet published; the Hypsographical, Mining and Arboreal maps of Sweden prepared by the Crown Prince of Sweden and Norway; the topographical survey of Sweden yet in progress, the triangulation in which unites with that of Russia and so with that of the rest of Europe, in the Aoland isles of the Bothnian Gulf; the levellings from Torneo to Alten in the North Sea; Prof. Than's fourth volume of the description of Sweden; Admiral Klint's Maritime Atlas, now continued by the Swedish Admiralty; the survey of the "Sea Bridge" (Havbroe) or bank, along the coast of Norway, which has resulted in proving that the Jutland bank stretches west and north to about 60° and is separated from the Norwegian bank by a channel nearly 200 fathoms deep, and both represent the "osars" or gravel ridges of the land; the third volume of Admiral Zahrtmann's Danish Expedition round the world; Ritter's second part of the Geography of Palestine; Berghaus's Geographical Annals and 2nd edition of his Physical Atlas; A. Erman's work on the Temperature of Springs; the topographical maps of Bavaria now nearly completed in 113 sheets, on a scale of 1·28 inch to the mile; maps of the Cantons of Appenzell and St. Gallen by M. Zugler, on a scale of 2½ inches to the mile, the topography of which is wonderfully accurate, and beautiful in execution, the lights being thrown in perpendicularly; second part of E. Balbi's "Nuovi Elementi de Geografia;" the geological map of Belgium in course of publication

by M. Dumont of Liege; various charts published under the French government of the South of France, parts of the Pacific, &c.; the Military Map of France, 149 maps of which are completed out of 258, a survey begun in 1818 and to be completed in 1855, the annual expense being about £30,000 per year; a fine map of Greece in 30 sheets, by Col. Peytier of the French Expedition in the Morea.

Some explorations in South America are also alluded to; the Indian researches by Dr. J. D. Hooker, and Capt. Strachey; Craufurd's Memoir on the Geography and Statistics of Borneo; Carter's account of a portion of the Arabian Coast with its Geology, in the Journal of the Bombay Branch of the Royal Asiatic Society for 1851 and 1852; Explorations in Africa of Messrs. Oswell and Livingston, of Mr. Garriott, of F. Galton, and the publication of the work in French of Messrs. Galunie and Ferret on Abyssinnia in 1841–42.

The author appears to have been ignorant that any coast surveys, or explorations of any kind, were in progress in the United States, and alludes only to the extravagant scheme of Whitney for the great Rocky Mountain railroad.

2. *On a Fossil Saurian of the New Red Sandstone Formation of Pennsylvania, with some account of that Formation. Also, on some New Fossil Molluscs in the Carboniferous Slates of the Anthracite seams of the Wilkesbarre Coal Formation;* by ISAAC LEA. (From the Jour. Acad. Nat. Sci., Philad., [2], ii, Part 3.)—The remains of the fossil Saurian here described by Mr. Lea occurred in certain limestone conglomerates in Upper Milford, Lehigh Co., Pennsylvania, where they were found by Dr. Shelly. The species is named the Clepsysaurus Pennsylvanicus. The generic name refers to the very remarkable compression laterally of the vertebræ towards the center. "The teeth are minutely serrated on the posterior edge, but the serratures are not continued to the apex, the superior portion becoming cylindrical; the anterior portion towards the base is flattened, presenting in this part a gibbous form." The bones consist of imperfect vertebræ, ribs, bones of the limbs and teeth. The vertebræ are a little over 2 inches in length; one spinous process was 2¾ inches long, its antero-posterior diameter 1·2 inches, transverse diameter 0·35 of an inch. A centrum 2·1 inches long, had its two diameters 1 inch and 0·3 of an inch. These and the other bones are represented on three lithographic plates and described in the text.

The new carboniferous molluscs described in this paper are named as follows:—*Modiola Wyomingensis* and *minor*, *Posidonia? clathrata*, *perstriata*, and *distans.* The specimens were from shales brought out of a working coal mine above Wilkesbarre, Pa., where they are very rarely met with. They were accompanied with scales of fishes, which species is named by the author *Palæoniscus? Leidyana.*

3. *On the Fossil Footmarks of the Red Sandstone of Pottsville;* by ISAAC LEA, (from the Trans. Amer. Phil. Soc., x.)—These tracks have been noticed in this Journal, in vol. ix, 129, 1850, in a brief account by Mr. Lea, taken from the Proceedings of the Amer. Phil. Soc. The woodcut there given represents the impressions with too much distinctness, judging from the lithographic plates accompanying the memoir. The species is called *Sauropus primævus.* The second plate of the

memoir contains impressions of six double tracks, alternately right and left. The slab from which the view is taken measures thirty-four inches by twenty-one. The general character and sizes of the impressions and their arrangement are mentioned in the account in vol. ix of this Journal, above referred to.

4. *Catalogue of Shells collected at Panama, with Notes on their Synonymy, Station and Geographical Distribution;* by C. B. Adams, (from Annals of Lyceum of Nat. Hist. of N. Y., vol. v.) 334 pp., New York, 1852.—This large volume contains a descriptive catalogue of 516 species of Panama shells, their habitats as to depth, as far as ascertained, and a comprehensive synonymy of the species; with descriptions of new species; lists of localities announced by previous authors; together with observations on the geographical distribution of species. The number of specimens of Mollusks collected at Panama by the author in his journey was 41,830; and of the 516 species 376 were Gasteropods, 139 Acephala, and one a Brachiopod. The new species number nearly 160. The paper by Mr. R. Bland in this volume renders it unnecessary to cite in this place from this very valuable work of Prof. Adams. Such a thorough canvassing of the species of a region, as is given by Prof. Adams, wherever he carries his researches, will tend rapidly to hasten our knowledge of the great principles involved in the present distribution of species over the globe. The plural origin of species among the lower orders of animals is rendered more than probable by the investigations thus far made. We may however doubt the principle that all varieties thus originated. It is not denied that physical causes have their effects on species; and long-continued laborious investigations must yet be undertaken and carried through before we can feel assured that we know the full extent of these effects.

5. *Proceedings of the American Association for the Advancement of Science, 6th meeting, held at Albany, N. Y., August,* 1851. xl, and 411 pages, 8vo. Albany and Washington, 1852.—In vol. xii, p. 305, of this Journal, we have given a list of the papers read before the Association at Albany. The present volume contains these papers either as abstracts or in full, as far as they were received by the Secretary.

6. *Elements of Natural Philosophy;* by W. H. C. Bartlett, LL.D., Prof. Nat. and Exper. Phil. in the U. S. Milit. Acad. at West Point, including, II, Acoustics, III, Optics. 360 pp., 8vo. New York, 1852. A. S. Barnes & Co.—The Elements of Natural Philosophy of Prof. Bartlett are prepared especially for instruction at West Point, and are equally well adapted for use in our colleges. The first part treating of Mechanics appeared in 1851. The volume now issued includes the second and third parts, embracing Acoustics and Optics. Acoustics is placed before optics, because the principles pertaining to waves exemplified in the former of these subjects are an essential part of the theory of light. The treatise on Acoustics commences with a brief chapter, giving an illustration of Boscovich's views with reference to the constitution of bodies and the curves which express the actions of molecules. The author then passes to the subject of waves, the velocity of sound through different media, the interference of waves of sound, the principles of musical tones and intervals, vibrations of plates, strings,

etc. The subject of Optics is presented with unusual perspicuity and with all the fullness required for class instruction.

7. *A Descriptive Treatise upon the Sun, Moon and Planets, including the Solar System, an account of all the recent discoveries;* by J. Russell Hind, Foreign Secretary of the Royal Astronomical Society of London, etc. 200 pp., 12mo. New York, 1852. G. P. Putman.—This excellent work has the merit of being furnished with the latest discoveries in astronomy. It takes up the Sun and Planets with their satellites in order, and treats of them in a lucid style, addressed especially, as the author states in his preface, to general readers desirous of informing themselves of the present state of our knowledge of the heavenly bodies, rather than to the profound astronomer.

8. *A Treatise of Analytical Geometry;* proposed by Rev. Benedict Sestini, S. J., Prof. Nat. Phil. and Astr. in Georgetown College. 210 pp., 8vo. Washington, 1852.—The subject of Analytical Geometry is gaining access to many of our literary institutions, and already a choice of works in this department is before the public. Prof. Sestini's treatise is divided into four parts or books; the first treating of co-ordinates and geometrical loci on a plane; the second of co-ordinates and geometrical loci in space; the third of lines of the second order; and the fourth of surfaces of the same order. The first and second parts are but introductory to the third and fourth parts. In these, as the preface states, the questions are reduced to certain principal heads, "from which, as from a nucleus, the theory of the lines and surfaces of the second order are deduced." All the properties of the lines as well as of the surfaces are derived from the discussion of the simple quadrinomial formula $mx^2+nx+p=q$, or from the trinomial $mx^2+nx=d$, a simplification of the subject brought forward by Cauchy.

9. *An Essay on Organic or Life Force;* by J. H. Watters, A.B. Written for the Degree of Doctor of Medicine in the University of Pennsylvania. 36 pp., 8vo. Philadelphia, 1851. Lippincott, Grambo & Co.—The proposition which the author endeavors to sustain in this memoir is the following—that life, or the actions of an organism are produced by forces which are evolved in the decomposition or decay of that organism. The process of change in living beings is constantly producing decompositions or decay; and such changes necessarily evolve the force requisite to reproduce the same kind of material that is undergoing the decomposition and sustain the growth of the organism; and thus the law of change is the principle of growth. We have not space to follow the author through the course of his argument. The view is also advanced that the force which contracts the muscles is electricity; this electricity not being communicated by the nerves, but evolved by the muscles themselves.

10. *Address delivered at the Anniversary Meeting of the Geological Society of London, Feb. 20th, 1852;* by Wm. Hopkins, Esq., President of the Society. 64 pp., 8vo. London, 1852.—The topic of this address is "Drift"—one abounding in facts and theories or speculations, and of all subjects in geology the least understood. The phenomena of glaciers are reviewed, and the three agencies, glaciers, floating ice and currents are spoken of as essential to the establishment of

sound views in this branch of the science. The leading facts over Europe and America are discussed, the direction of the striæ, the range of surface covered by the phenomena, and the nature of the transported material. The author after speaking of the distribution over Europe, exhibits his own views as follows:—"But it is of more importance to remark, that whatever be the nature of the blocks, they become almost universally smaller and more rounded as we approach the external boundary above indicated. This seems to me conclusive as to the nature of the transporting agency in this outer zone. I can conceive water alone to be capable of giving these characters to the transported materials. On the contrary, as we approach the central portion of this region of drift, we find the blocks of enormous size, perfectly angular, and not unfrequently imdedded in masses of fine drift, indicative of the absence, at the time of its deposition, of any violent currents capable of moving the blocks imbedded in it. In this we recognize the transport by floating ice. And again, on the central land, we recognize glaciers as the source of the floating ice, and the means of transporting large angular blocks from their original sites on the mountains to the level of the ocean." Various papers of recent writers on drift are alluded to and their views are discussed.

The address proceeds to another subject intimately connected with that of the drift—that of the causes of change in the earth's superficial temperature. The views of the author are detailed more at length in a paper in the Proceedings of the Geological Society, mentioned in our last number: and we hope in our next number to find space for part at least of the original paper, as it is one of the most important that has been recently presented to the science.

In a note at the close of the address, it is stated that the *tracks in the older Silurian sandstone of Canada*, brought to light by Mr. Logan, and pronounced by Prof. Owen to be reptilian, are now admitted by the latter on an examination of other specimens to be probably *Crustacean.*

11. *The Mastodon Giganteus of North America;* by John I. Warren, M.D. Boston, John Wilson & Son, 22 School street. Quarto, 219, plates xxvii.—This memoir of the great American Mastodon is a worthy mausoleum of the gigantic mammal it commemorates. The distinguished author has performed a most acceptable service in recording in one well digested and skillfully arranged volume the entire history and anatomical details of the Mastodon. Being himself the possessor of far the finest and most perfect individual of the species ever discovered, and having set up in perfect anatomical juxtaposition not only his own specimen but also the extremely fine one at Cambridge, and examined in detail all the fragments of skeletons in other collections, it seems appropriate that Dr. Warren should become the historiographer of the Mastodon. He has succeeded in giving to his memoir a degree of general interest which relieves the detail of anatomical description. It is our hope to enliven our pages in a subsequent number of this Journal, by some extracts from his text which cannot fail to be generally interesting.

Science is indebted to Dr. Warren for a most munificent and unique contribution to her records. If Dr. Warren had not already become famous as the great surgeon, he would certainly become so as the author of the greatest book on the greatest quadruped.

12. *A Treatise on Mineralogy*; by Charles Upham Shepard, M.D. Third edition, with 488 illustrations. In 2 parts. Part I, 246 pp., 8vo. New Haven, 1852.—Prof. Shepard has issued but the first part of his Treatise, the second and concluding part being yet unfinished. This first part includes the Introduction to the science together with the descriptions of the species through the salts and siliceous species, embracing the orders in Mohs's system (which he continues in the main to adopt) of *Gas*, *Liquid*, *Soluble*, *Haloid*, *Malachite*, *Baryta*, *Ochre*, *Picrosmine*, *Mica*, *Zeolite*, *Spar*, *Gem*. The remaining part will include the orders *Ore*, *Metal*, *Pyrites*, *Glance*, *Blende*, *Sulphur*, *Resin*, *Coal*; together with a chemical classification of species and an Appendix on meteoric minerals with a general account of the author's mineralogical and meteoric cabinet, as at present arranged at Amherst College. The author has added many new figures to the work, and a large number of new species, and to such mineralogists as prefer the system of Mohs, the work is especially adapted. The analyses are given without chemical formulas; and in stating the crystallization of species, the method is adopted of mentioning the primary form instead of the system of crystallization.

13. *Observations on the Genus Unio, together with Descriptions of New Species in the families Unionidæ, Colimacea, and Melaniana*; by Isaac Lea. Vol. v, with numerous plates. Read before the American Philosophical Society, and published in its Transactions.—This volume is well illustrated by 19 lithographic plates, embracing figures of 56 species of Unio and Anodonta, 12 of Melania and 1 of Helix.

14. *A Synopsis of the Family of Naiades*; by Isaac Lea. Third edition, greatly enlarged and improved, 88 pp., 4to. Philadelphia, 1852.

H. J. Brooke and W. H. Miller: An Elementary Introduction to Mineralogy; by the late William Phillips. New edition, with extensive alterations and additions. 700 pp. 12mo. *London*, 1852. Longman, Brown, Green & Longmans.

Geological Survey of Canada: Reports of Progress for the year 1850–51, and for the year 1851–52; by W. E. Logan. 8vo. *Quebec*, 1852.

Report of the twenty-first Meeting of the British Association for the Advancement of Science, held at Ipswich, July, 1851; lii, 372, and 132 pages, 8vo. *London*, 1832. The more important of the Reports included in this volume, are, *B. Powell*, on Luminous Meteors, 52 pages; *A. Henfrey*, on the reproduction and supposed existence of sexual organs in the Higher Cryptogamous Plants, 44 pages; *I. Williams's* Report on British Annelida, 118 pages; *R. Mallet's* Second Report on the Facts of Earthquake Phenomena, 48 pages; *F. Ronalds*, on the Kew Magnetographs and Kew Observatory.

G. & F. Sandberger: Systematisches Beschreibung und Abbildung der Versteinerungen des Rheinischen Schichtensystems in Nassau, mit einer kurzgefassten Geognosie dieses Gebietes und mit steter Berücksichtigung analoger Schichten anderer Länder. Subscriptions are solicited for this work now in progress, published at Wiesbaden by C. Wilhelm Kreidel. The Prospectus, dated March, 1852, states that 4 parts have appeared, and contain 20 lithographic plates in folio, with 136 pages 4to of text. The 5th would contain 17 species of Orthoceras besides the Pteropoda and a part of the Gasteropoda. Price per Part, 2*thlr.* 20*ngr.*

Dr. D. F. Eschricht: Das Physische Leben, in popularen Vorträgen, mit 18 Tafeln und über 150 in den Text eingedruckten holzschnitten. Gr. 8vo gehftet. *Berlin*. Aug. Hirschwald.

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Diagram No. 1

Comparison of curves of sines and diurnal & semi diurnal curves from observation.

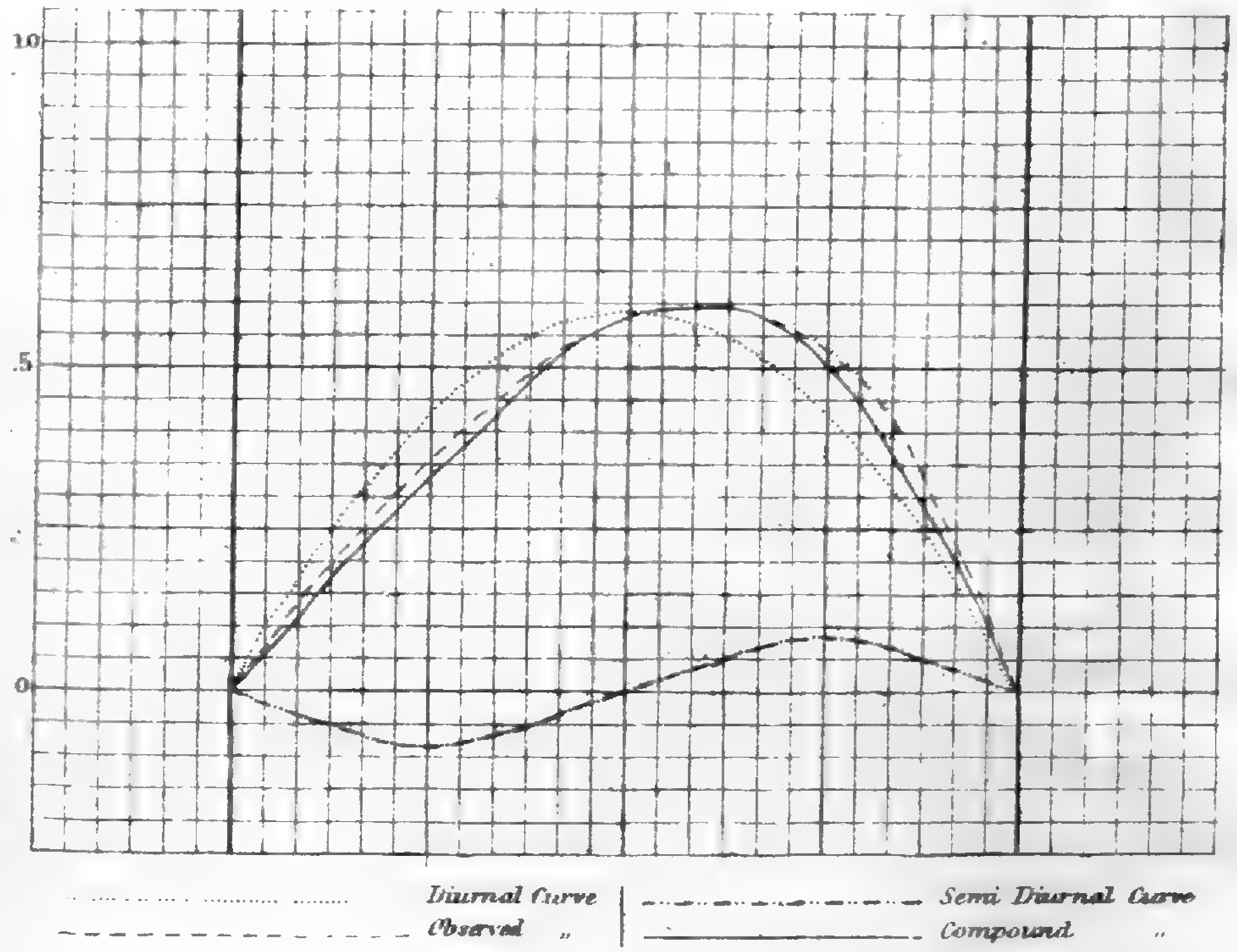


Diagram No. 2

Curves of heights of diurnal wave & of corresponding values of sin 2 δ'

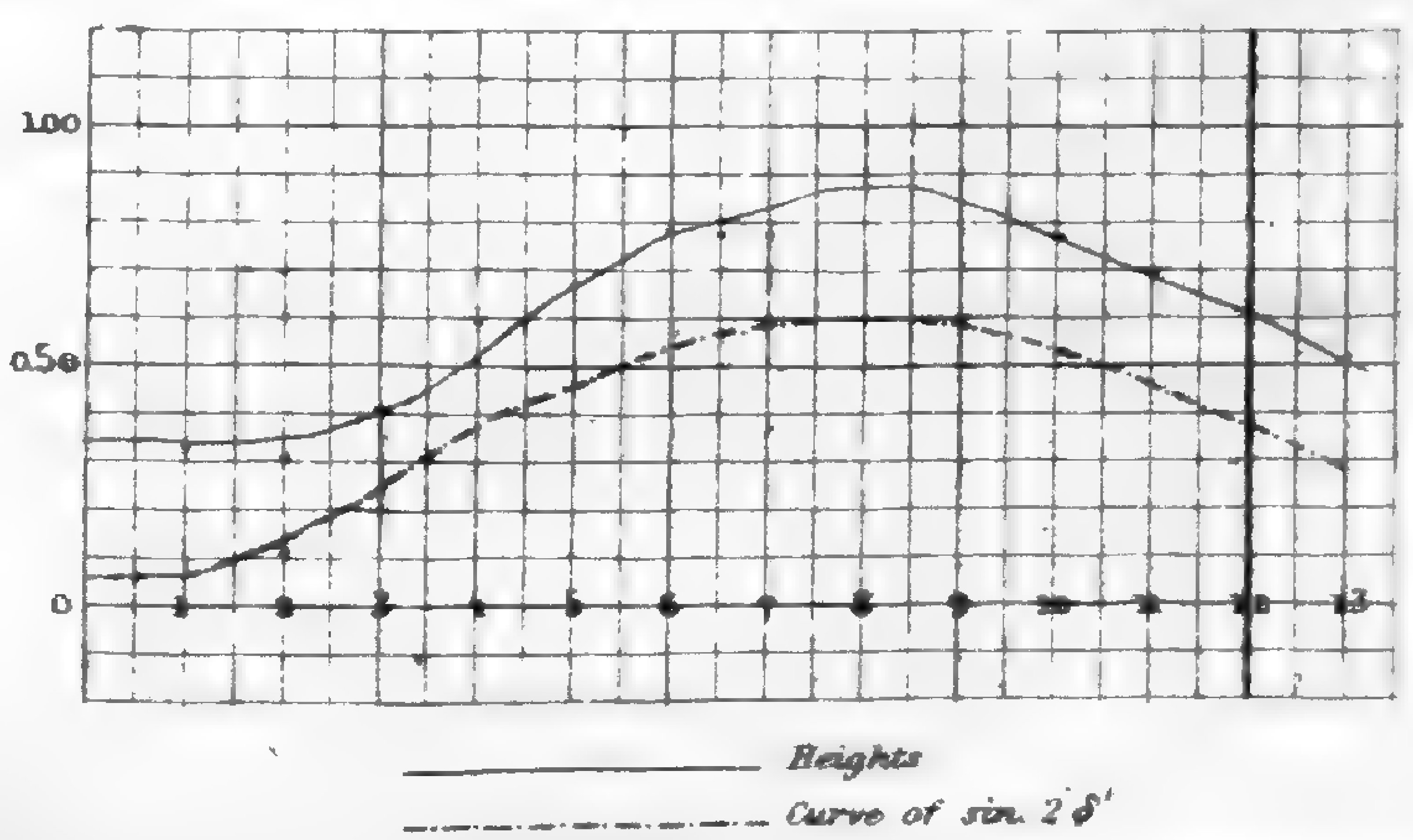


Diagram No. 3

Variation of ordinates of Diurnal Curves with sun's Declination.

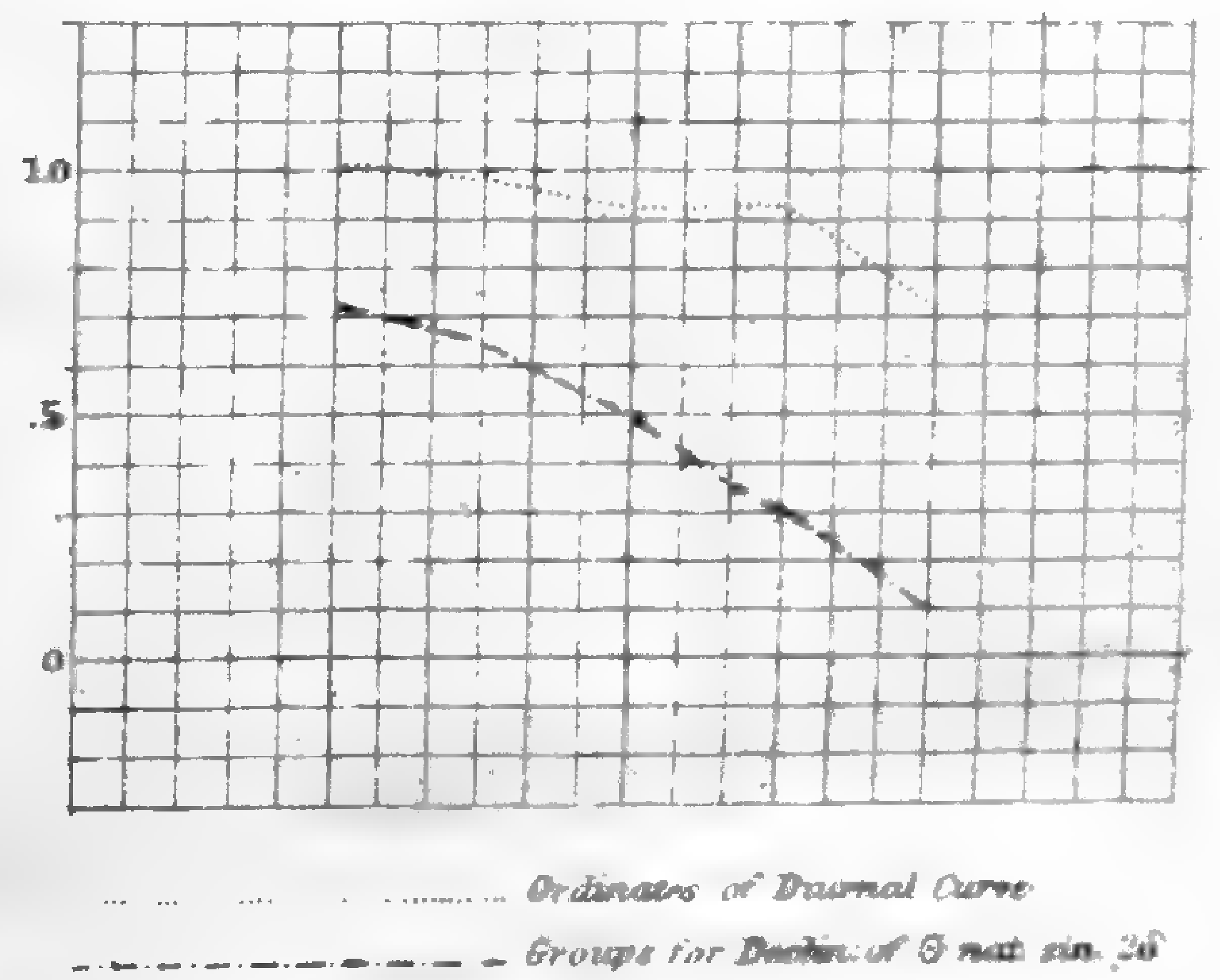


Diagram No. 4

Variation of ordinates of Diurnal Curve with Moon's Parallax.

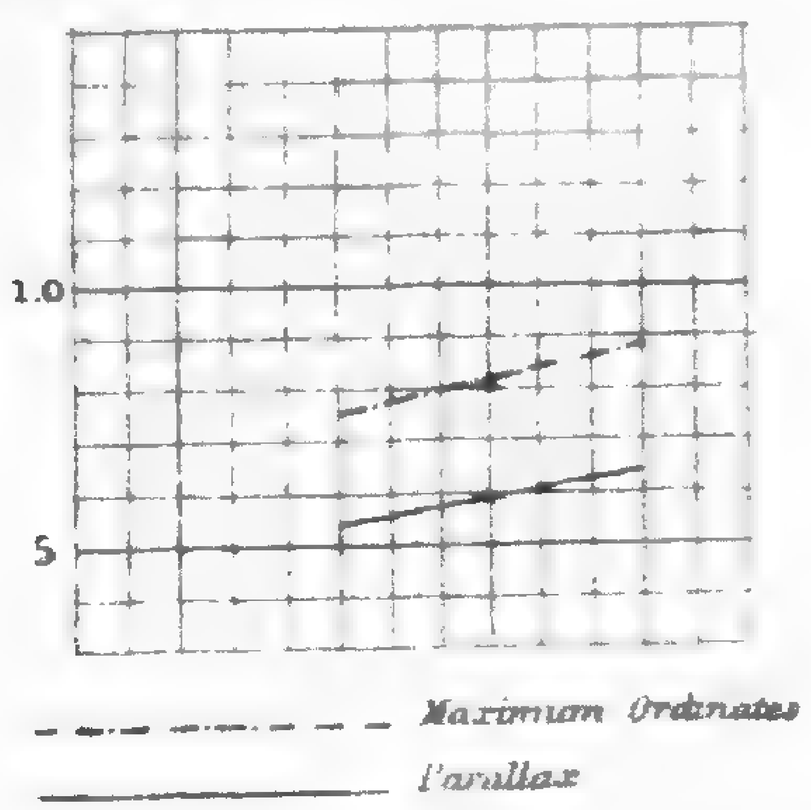
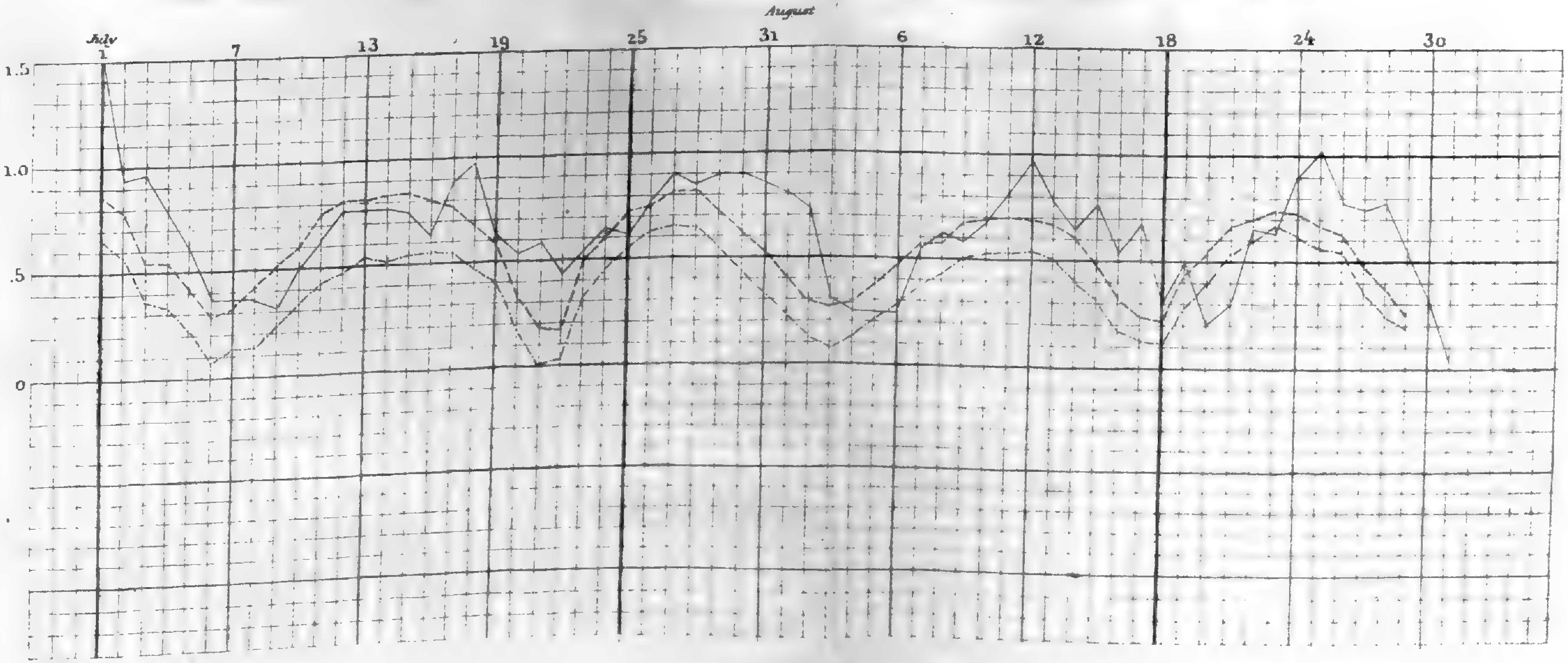


Diagram No. 5

Showing maximum ordinates of diurnal curve, computed from ☽'s Declin: and Parallax and from ☉'s Declin: compared with ordinates from obs^ns for July and August.



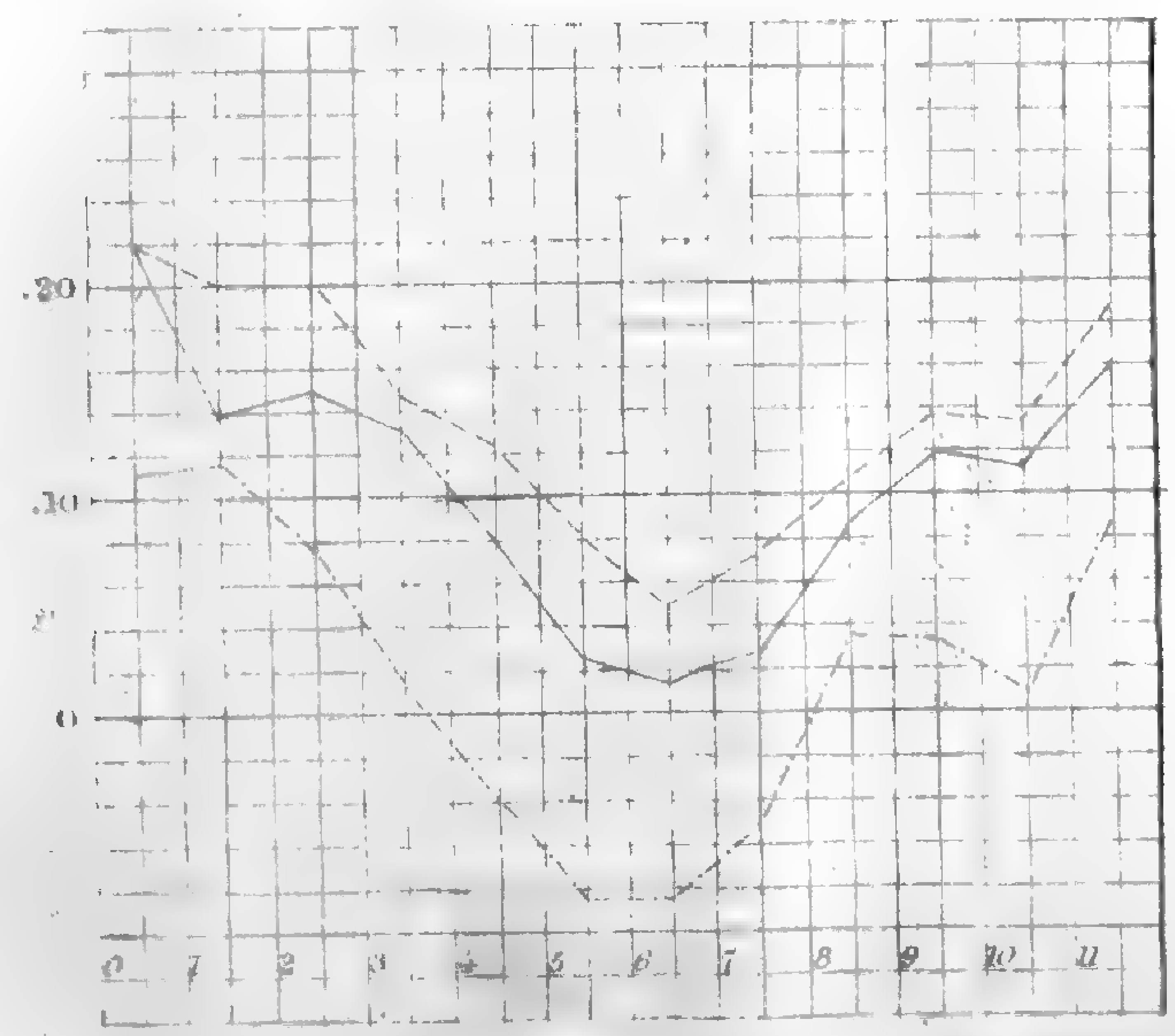
$.96 \frac{P^3}{p^3}$ *sin 2δ'*

Max Ordinate

.26 × sin 2δ

Diagram No. 6.

Showing the residuals from Tables 8 and 12, and the curve of half-monthly inequality from observation.



——— *Residuals from Table No. 8.*
- - - - *do. from Table No. 12.*
- - - - *Curve of half monthly inequality from observation.*

Diagram No. 7.

Points in final residuals. 1846.

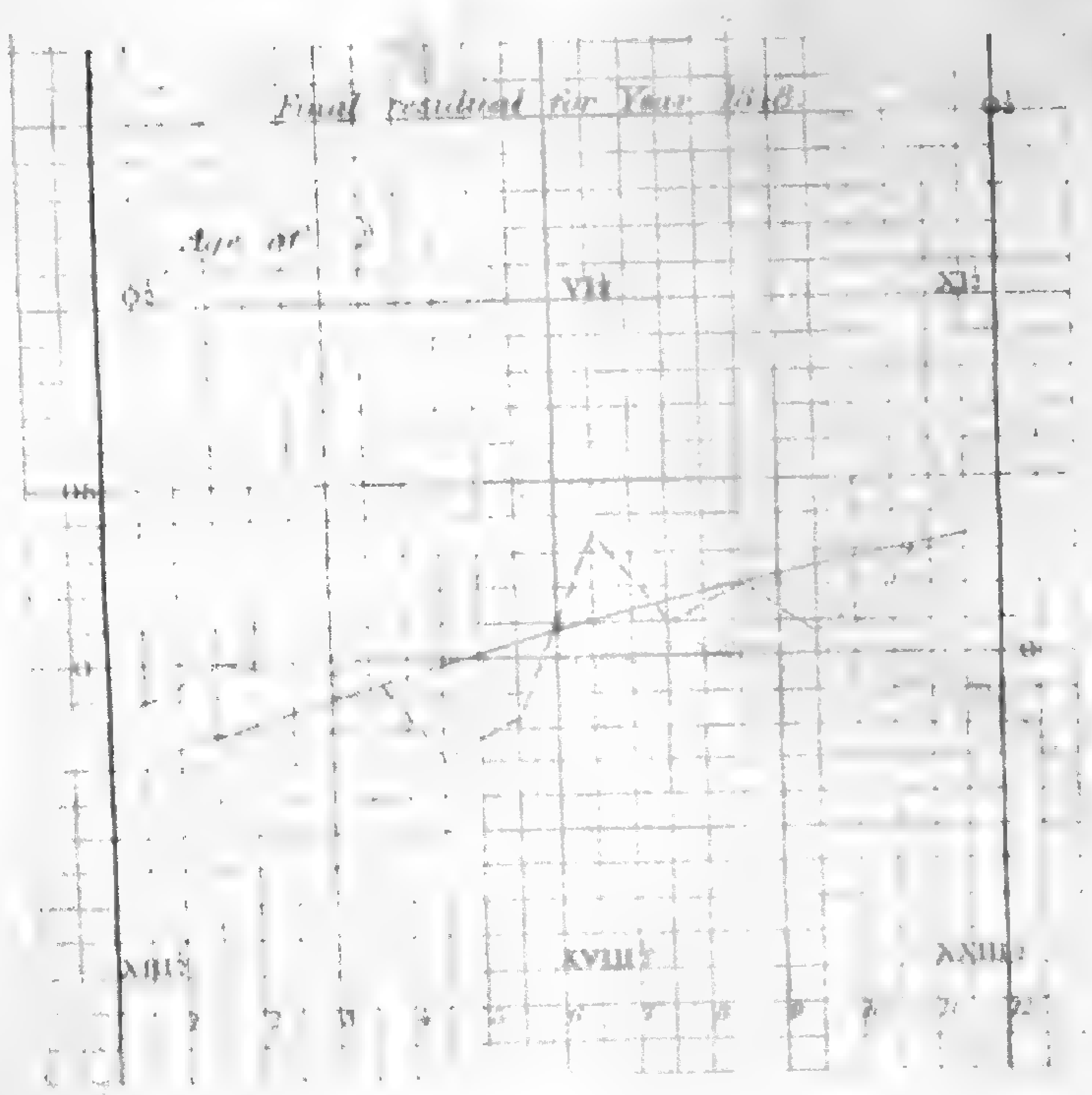


Diagram No. 8.

Curves of observed and computed heights for different ages of Moon semi diurnal wave.
(Half-monthly inequality.

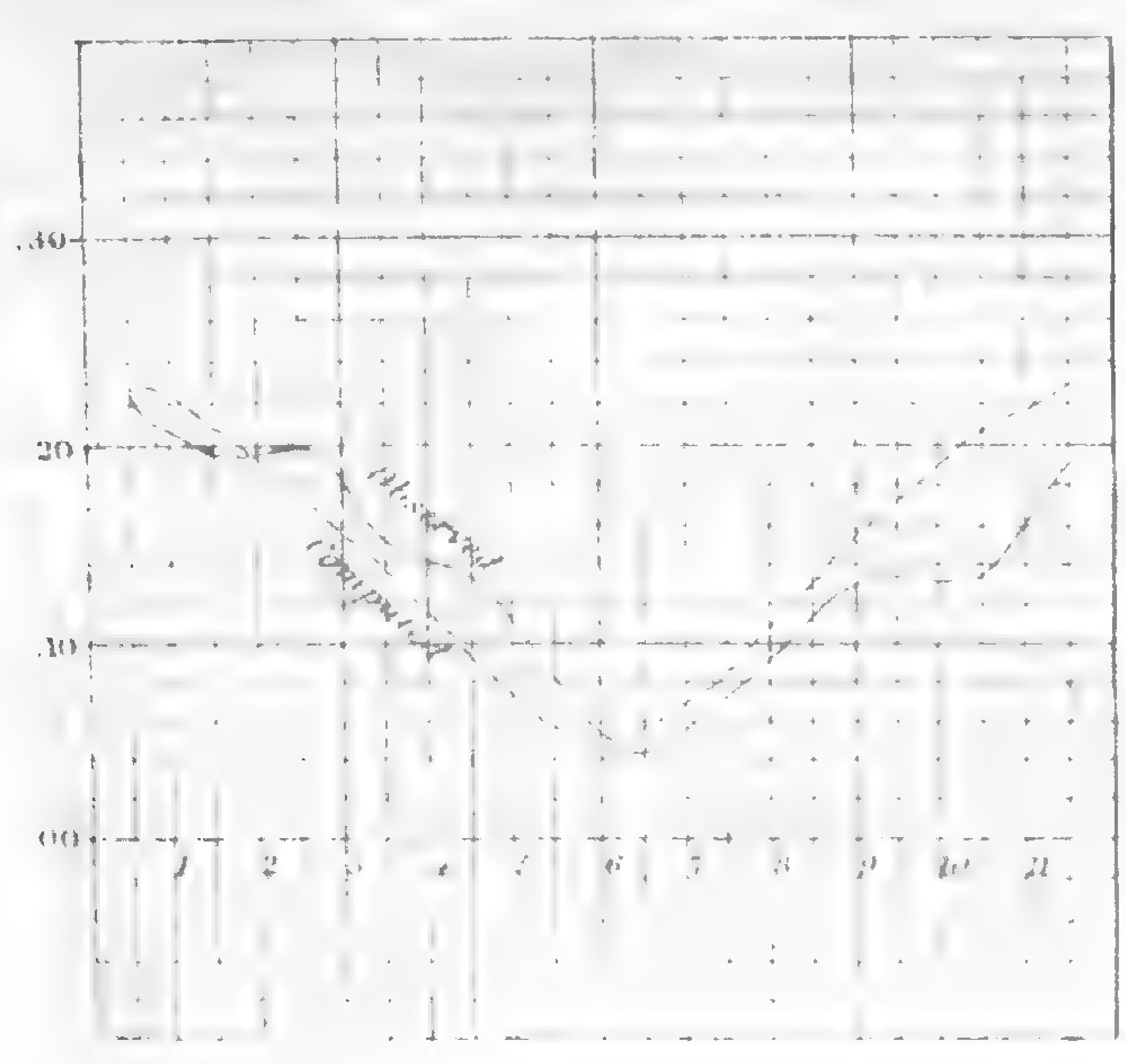
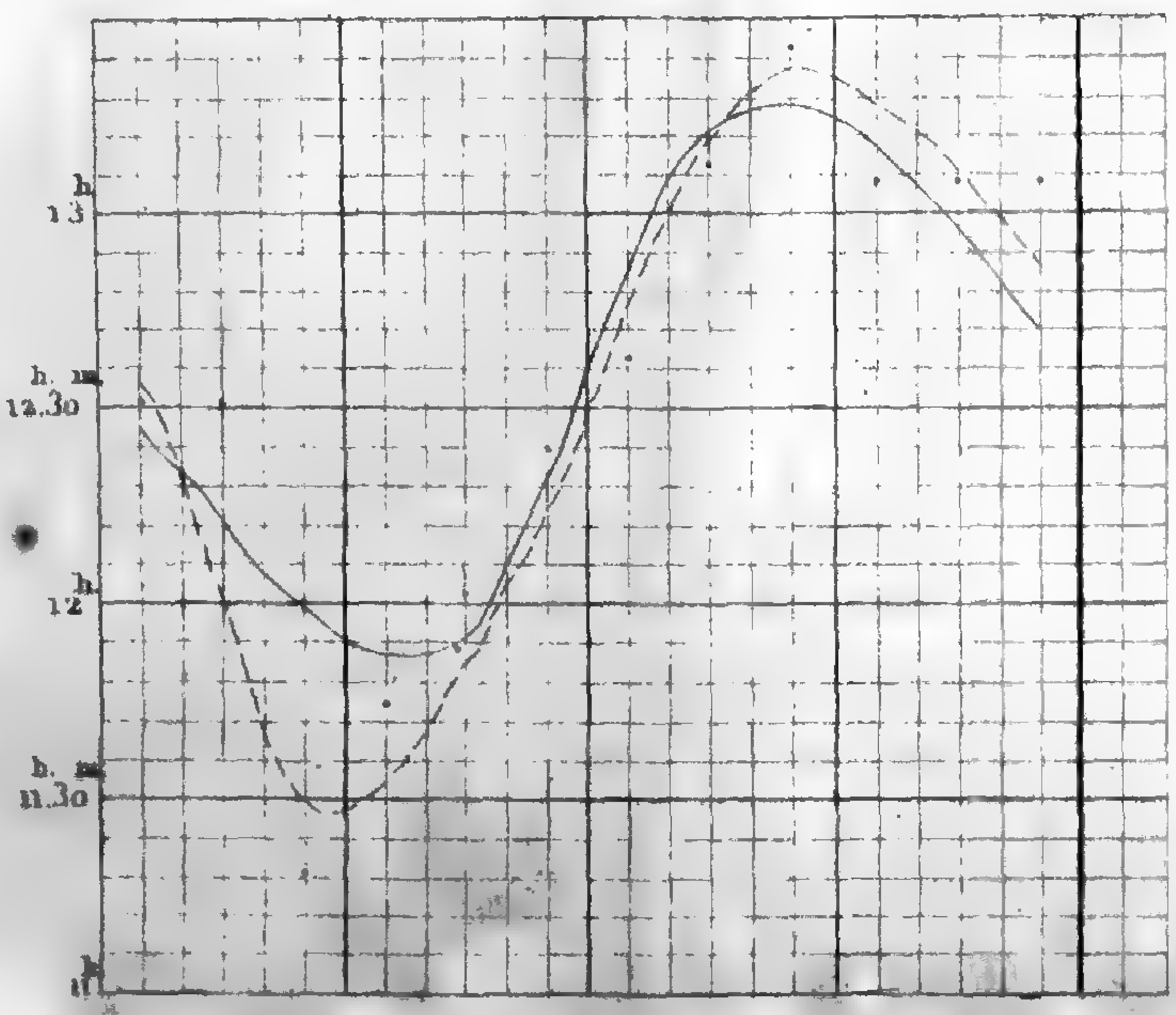


Diagram No. 9

Comparison of the half-monthly inequality in time from observation and by theory.



——— *From the formula*

– – – *From observation (mean curves)*

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