There are now something near 2000, and we are augmenting them all the time. I have found many myself: if they were distributed through the days of the year I think in some years I should have had several every day. But the accessions to knowledge which are constantly being made make it unsafe to indulge in any prophecies that, because such and such things have not been found, therefore such and such things cannot be; for we find such and such things really have been and really are discovered.

The successive changes that we have in the mammalia have taken place in the feet, teeth, and brain, and the vertebral column. The parts which present us the greatest numbers of variations are those in which many parts are concerned, as in the limbs and feet. In the Lower Eocene (Puerco) the toes were 5–5. In the Loup Fork fauna some possess toes but 1–1. Prior to this period no such reduction was known, though in the Loup Fork fauna a very few species were 5–5. Through this entire series we have transitions steady and constant, from 5–5, to 4–5, to 4–4, to 4–3, to 3–3, to 2–2, to 1–1. In the Puerco period there was not a single mammal of any kind which had a good ankle-joint, which had an ankle-joint constructed as ankle-joints ought to be, with tongue and groove. The model ankle-joint is a tongue-and-groove arrangement. In this period they were all perfectly flat. As time passes on, we get them more and more grooved, until in the Loup Fork fauna and the White River fauna they are all grooved. In the sole of the foot, in the Puerco fauna, they are all flat; but in the Loup Fork fauna the sole of the foot is in the air, and the toes only are applied to the ground, with the exception of the line of monkeys, in which the feet have not become erect on the toes, and the elephant, in which the feet are nearly flat also, and the line of bears, where they are also flat. As regards the ungulation between the small bones of the palm and of the sole there is not a single instance in which the bones of the toes are locked in the Lower Eocene, as they are in the later and latest Tertiary.

When we come to the limbs, the species of the Puerco fauna have short legs. They have gradually lengthened out, and in the late periods they are nearly all relatively long.

(*To be continued.*)

## SOCIETIES AND ACADEMIES

### London

**Royal Society**, Dec. 13, 1883.—"On the Figure of Equilibrium of a Planet of Heterogeneous Density," by G. H. Darwin, F.R.S., Plumian Professor of Astronomy in the University of Cambridge.

If a rotating planet be formed of compressible fluid, the strata of equal pressure are of equal density, and the ellipticity of the strata increases from the centre outwards. Since it is supposed that the earth consolidated into its present form from a fluid or semi-fluid condition, the determination of the arrangement of internal density and of the law of ellipticity in such a planet is often called the problem of the figure of the earth. When the law of compressibility of the fluid is known, the laws of density and ellipticity are determinate, but the differential equations involved are of such complexity that only one solution of the problem is well known, viz. that associated with the names of Legendre and Laplace.[1]

In this solution the modulus of compressibility varies as the square of the density, but the assumption of this law appears to have been dictated more by the necessity of solving a certain differential equation than by physical considerations.

The comparison of the solution of the problem with the observed facts with regard to the earth may be made in several ways. The constant which determines the rate of the earth's precessional motion gives us information with regard to the arrangement of density in the interior, and the ellipticity of the surface is determined by geodesy and by the amount of a certain inequality in the moon's motion. Now, in order that the solution of the problem of the earth's figure may be satisfactory, the same arrangement of internal density must give the observed amounts both to the precessional constant and to the ellipticity of the surface.

Laplace's solution is highly satisfactory in this respect; and at the same time it makes the mean density of the whole earth about twice as great as the density of the surface stratum. The density of rock is about 2·8, and that of the whole earth is about 5·6.

In this state of our knowledge another solution of this celebrated problem possesses some interest, even if its results are not quite so satisfactory as those of Laplace's theory.

In the present paper such a solution is offered. The law of compressibility of the fluid is such, that the modulus varies as a power of the density, which power may range from negative infinity to $\frac{4}{3}$. When the power is zero, we have constant compressibility; and when the power is unity, we have the same law of compressibility as in a gas.

The solution is expressible in a far simpler algebraic form than that of Laplace, and it differs from his solution in placing a far larger proportion of the mass of the planet in the central regions.

It is remarkable that this solution affords for the case of the earth a correspondence between the precessional constant and the surface ellipticity equally good with that of Laplace. To obtain this correspondence we have to assume the compressibility of the fluid to be nearly constant.

The density of the surface layer appears however to be 3·7, and this is considerably greater than that of ordinary rocks. This result tells adversely to the acceptability of the proposed solution, but the discrepancy is not so serious as might appear at first sight. It appears from pendulum experiments on the Himalayan plateau and on the Andes, that there is a considerable deficiency of density underneath those great ranges. This would favour the view that our continents are a mere intumescence of the surface layers. In this case there must be a somewhat abrupt change in the law of density at only a few miles below the surface. The theory of the earth's figure can take no account of a sudden change of density on passing into a swollen superficial layer, and the value of the surface density to be used is that which is to be found immediately below the swollen part.

The author therefore points out that whilst the solution now offered cannot be held to be quite as satisfactory as that of Laplace, yet its inferiority is not of a kind to render altogether unacceptable the contention that it may be somewhere near the truth.

**Linnean Society**, December 20, 1883.—Alfred W. Bennett, M.A., in the chair.—Messrs. N. Cantley, W. Dobson, F. G. Smart, and Rev. R. Thom were elected Fellows of the Society —Mr. S. O. Ridley exhibited and made remarks on a series of 177 vertical sections of sponges collected in the neighbourhood of Point de Galle, Ceylon, by Dr. W. C. Ondaatje, F.L.S., and transmitted to England by him in letters. They are in most instances sufficient for the identification of the genera and some species.—Mr. F. Maule Campbell showed the web of a spider (*Tegenaria guyonii*) which had been spun in the centre of a pasteboard cylinder, the peculiarity being the manner in which the solid part of the web was medially swung, whereas in this species of spider it is more usually on the sides of objects.—A paper was read by Mr. F. O. Bower on the structure of the stem of *Rhynchopetalum montanum*. The plant is a native of Abyssinia, growing in districts 11,000 to 13,000 feet above the level of the sea. It differs from its ally Lobelias in being perennial. Internally it is succulent when young, but afterwards the surface becomes scarred as the leaves drop off, and exteriorly is hardened by a thick corky deposit. *Rhynchopetalum*, the author shows in detail, has certain peculiarities in the arrangement of the tissue of its leaf bundles, since the cortical system does not consist of branches of bundles of the leaf trace, but are cauline bundles, in this respect differing widely from such forms as *Lathyrus casuarina*, many *Begonias*, &c. *Rhynchopetalum*, moreover, has the cortical bundles running obliquely, and forming a regular four-sided meshed network related to the leaf bases and bundles of leaf trace. In these respects it approaches *Cycas*, in which latter the bundles of the accessory cortical system are not so regular and are almost vertically arranged. Some Cycads and *Rhynchopetalum* also agree in the exterior appearance of their stem, so that palæontologists might be deceived in their judgment if two well-preserved specimens were examined by them.—A communication was read on the auditory ossicles of *Rhytina stelleri* by Alban Doran. This was based on skeletons obtained by the *Vega* expedition, and shown at the late International Fisheries Exhibition by the Swedish Government. The author arrives at the conclu-

[1] The late M. Roche seems to have also solved the problem in 1848, and his paper is published in the *Memoirs of the Academy of Montpellier.*

sion that the malleus of *Rhytina* is larger than in *Manatus*, and therefore it is the largest and bulkiest malleus to be found in the whole section of the animal kingdom where such a bone exists, that in the characters of its body it resembles *Manatus* rather than *Halicore*, and that in the manubrium it differs from the other Sirenia, and is far more generalised. The incus is of the *Manatus* type, and so is the stapes, which is also the largest and bulkiest stapes to be found in any animal.—A paper on the organs of secretion in the Hypericaceæ, by Mr. J. R. Green, was read. He concludes (1) that the view advocated by Link, Martinet, and De Bary, of the lysigenous origin of the reservoirs of ethereal oil in these plants is the correct one; (2) that there exists in many parts of the plants a series of ducts or passages differing only slightly from these reservoirs, the differences being that they are not globular and isolated, but are generally connected more or less intimately with each other, and that their secretion is not a clear ethereal oil, but a viscid or resinous liquid, the points of agreement being those connected with their development and function; (3) that at least in some species there is also a series of schizogenous ducts confined to certain portions of the phloem; (4) that the dark glands which have been described are in intimate relationship with the fibrovascular system; (5) that the formation of resin and kindred secretions in these plants is confined to the parts where metabolism is active, and where there is a primary meristem. That all such parts give evidence of such formation with the exception of the roots.—A paper on the glands of *Coprosma baueriana*, by Mr. Walter Gardiner, was read. These glands are externally well developed and very typical. The so-called stipular body is placed immediately behind each leaf, and in the young condition the stipule arches over the leaf, and the glands with which it is provided secrete copiously a mucilaginous fluid, which bathes and surrounds the young leaf structure. As to the development of the glands, they arise as protrusions of the stipule parenchyma, which are covered by an epidermis. Each epidermal cell then rapidly grows out at right angles to the protuberance. In *Coprosma* the glands are situated on the sides of the stipules, but it more usually occurs in other genera that they are distributed over the inner face of the base of the stipular organ.—The last paper taken was on the development of starch grains in the laticiferous cells of the Euphorbiaceæ, by M. C. Potter. It is pointed out that while the discovery of the existence of starch-forming corpuscles had been made by Kruger, yet he had failed to interpret their function, which Mr. Potter's researches now fully prove in the case of the Euphorbiaceæ, where the development of rod or spindle-shaped grains of starch lying within cell protoplasm has been clearly demonstrated.

**Chemical Society**, Dec. 6, 1883.—Dr. Perkin, president, in the chair.—The following gentlemen were elected Fellows:—F. A. Blair, T. J. Barr, C. J. Baker, L. Briant, R. G. Durrant, Kamchundra Datta, L. L. Garbutt, A. E. Harris, T. Hart, W. Irwin, S. Johnson, R. Jackson, H. C. Lee, W. H. Martin, C. E. Potter, B. M. K. Rogers, C. W. Stephens, P. H. Wright, H. A. Wetzel, and W. G. Whittam.—The following papers were read:—On the constitution of the fulminates, by E. Divers and M. Kawakita. When moist mercury fulminate is treated with much strong hydrochloric acid, hydroxyammonium chloride and hydrocyanic acid are formed; if the fulminate be dry, no prussic acid is formed. The carbon is completely converted into formic acid. No oxalic acid is produced.—Theory of the constitution of the fulminates, by E. Divers.—On Liebig's production of fulminating silver without the use of nitric acid, by E. Divers and M. Kawakita. When nitrous acid is passed into an alcoholic solution of nitrate of silver, crystals separate; these are not, as Liebig stated, fulminating silver, but nitrate of silver.—Note on the constitution of the fulminates, by H. E. Armstrong.—Experimental investigation on the value of iron sulphate as a manure for certain crops, by A. B. Griffiths. The author obtained from an experimental plot of land manured with ferrous sulphate fifty-six bushels of beans; a similar plot in its normal state gave thirty-five bushels. The ash of the plants also contained more iron and phosphoric acid in the first case.

**Physical Society**, December 8.—Prof. G. Carey Foster, in the chair.—New members:—Major McGregor, R.E., Mr. James Walker, M.A., Mr. W. B. Gregory, B.A.—Prof. Silvanus P. Thompson, D.Sc., read a paper on the static induction telephone as an instrument of research. The author had employed Dolbear's telephone in investigating the action of influence machines such as those of Holtz and Wimshurst or Toepler. This was done by holding the end of a wire (connected to one terminal of the telephone) near the electrified parts of the machine, for example the "carriers" in the Toepler apparatus. The carriers induced a change in the telephone, whose other terminal was to earth, as they passed, and the pitch of the note heard in the telephone increased with the speed at which the machine was driven. Useful results were obtained leading to modifications of some machines. The same telephone was also applied to the measurement of capacities of condensers arranged like the resistances of a Wheatstone balance, and the telephone taking the place of a galvanometer. For the "divided coil" of the balance Prof. Thompson substituted a double condenser, or rather two condensers, so joined that the earth-plates were separate, while the other plates were in one. This device was made from two glass tubes with tinfoil round their outsides and a brass tube sliding into both interiors in such a way that the relative capacities of the two condensers thus combined could be altered by sliding the tube between them. A modification of this plan was suggested by Mr. Starling, the author's assistant, which was analogous to Prof. Foster's arrangement of the Wheatstone balance, that is to say, six condensers were used, the two extra ones being included between the battery connections and the sliding tube. The battery was in this case an induction coil having no condenser, as a discontinuous current is necessary to give sounds. The author also showed that the Dolbear telephone could be used instead of the quadrant electrometer in such experiments as those of Mr. J. E. H. Gordon on specific inductive capacity. The author also showed how he had applied it to explore the equipotential surfaces round conductors charged statically by an induction current. With two wires from the terminals of a telephone silence is produced when both ends are on the same equipotential surfaces; and sounds when they are not.—Prof. Thompson then read a note on a new insulating stem. This consisted of a glass tube with one end blown into a flat foot, which was planted on the bottom of a glass bottle and cemented there by a little wax paraffin. The upper and open end of the tube served to hold the stems of brass plates, or other electrified bodies. Paraffin oil or strong sulphuric acid could be used in the bottom of the bottle. A cap of rubber or percha made to slide up the stem served as a dust cover.—Prof. Thompson next made a communication on the first law of electrostatics, and illustrated his remarks with experiments showing how a series of floating magnet poles of like name repelling one another tend to produce equal distribution of the poles. Prof. Thompson, arguing from the second law of electrostatics (inverse squares), sought to explain the first law in a rational manner, on the hypothesis of self-repelling molecules, which tend to uniform distribution. When there is a surplus in one part and a deficit in another, the molecules are urged towards each other, *i.e.* attract. This was shown by putting a surplus of floating magnets at one part of the basin. By the movements of these magnets when confined by barriers, and with surplus and deficit purposely made, the author imitated the effects of a Leyden jar, induction, a battery current, &c., the motions and arrangement of the poles illustrating the hypothetical behaviour of electricity. The author was led by the hypothesis to infer that either the ether is electricity, or that the ether is electrified, and the former seemed the simpler conclusion.—Dr. Monkman showed some experiments illustrating the attraction and repulsion of bodies in motion. The attraction of a light balanced body to a vibrating tuning-fork was shown; also the attraction between two disks of paper revolving parallel and in the same direction. The author showed that two smoke-rings travelling abreast in the same direction attracted each other, and that two paper rings revolving in the same direction close together attract, while if revolving in opposite directions they repel.—Mr. Walter Baily exhibited his new integrating anemometer in action by means of a small electric motor, which took the place of the Robinson cups. The apparatus sums up, or integrates, the wind velocities on the lines of the four cardinal points. An electric counter is attached.

### PARIS

**Academy of Sciences**, December 17, 1883.—M. Blanchard, president, in the chair.—Preliminary report on the expedition of the *Talisman* to the Atlantic Ocean, by M. Alph. Milne-Edwards.—On the preparation and manner of employing artificially developed virus attenuated by heat, intended to be used in prophylactic inoculations against charbon, by M. A. Chauveau. —On the remarkable sunsets observed during the months of November and December, 1883, by M. P. de Gasparin. The author considers that these luminous effects cannot be due to falling stars, and must be referred to the solar light acting on an atmosphere charged with particles of matter whose nature has not yet been determined.—On the determination of elastic forces, by M. Fontaneau.—On the processes adopted by M. Mandon and M. Aman-Vigié in the treatment of vines affected by phylloxera, by M. F. Henneguy. The process of Dr. Mandon, which consists in saturating the sap with a solution of phenic acid, appears to have little or no effect on the parasite. That by M. Aman-Vigié, an injection of a mixture of vapours of sulphur and sulphuric acid into the ground, has been tried on too limited a scale to warrant any definite judgment as to its efficacy. but the experiments already made do not appear to have proved very beneficial, because the vapours of sulphuric acid do not penetrate to a sufficient depth into the ground, and evaporate too rapidly.—Observations of the Pons-Brooks comet made at the Paris Observatory with the bent equatorial, by M. Périgaud. —Observations of the planet 235 Carolina and of the Pons-Brooks comet made at the Paris Observatory (west equatoreal in the garden), by MM. Henry.—On the multipliers of linear differential equations, by M. Halphen.—On a point in the theory of elliptical functions, by M. Lipschitz.—On a theorem of M. Liouville in mathematical analysis, by M. Stieltjes. In continuation of his previous paper, the author here shows how the theory of elliptical functions leads to the theorem of M. Liouville.—On algebraic equations, by M. H. Poincaré.—Demonstration of the fundamental properties of the system of geodesic polar coordinates, by M. G. Ossian-Bonnet.—On a method of generating the ovals of Descartes proposed by Chasles in his "Aperçu Historique," by M. Maurice d'Ocagne.—On the measurement of the specific heats and variations of temperature of two bodies in contact, by M. Morisot.—On a practicable method available for the photometric comparison of the usual sources diversely coloured, by M. J. Macé de Lépinay.—On the influence of colour on the sensitiveness of the eye to different degrees of luminosity, by M. Aug. Charpentier.—Researches on the permanence of the solidification of superfused sulphur (continued), by M. D. Gernez.—Second note on chromic selenite; preparation of biselenite, by M. Ch. Taquet. The author has obtained a biselenite of chromium by the action of nitric acid on neutral selenite. It is almost insoluble in water, but soluble in acids, and decomposable by heat.—Note on the action of bromium on pilocarpine ($C_{22}H_{16}Az_2O_4$), by M. Chaasting.—On emetics of mucic and saccharic acids, by M. D. Klein.—Third note to serve as a contribution to the history of the formation of coal; genus *Arthropitus*, Gœppert, by M. B. Renault.—On the artificial reproduction of schistosity and slate layers, by M. Ed. Jannettaz.—Experiment relative to the mode of formation of bauxite and gypsum, by M. Stan. Meunier.—On the glaucous amphibolic schists of the island of Groix, by M. Barrois.—On an anorthite rock discovered at Saint Clément, Canton of Saint-Anthême (Puy-de-Dôme), by M. F. Gonnard.—On the fall of cosmic dust, by M. E. Young.—On the coincidence of the recent phenomenal after-glows with the passage of the cosmic meteors, by M. Chapel.

December 24, 1883.—M. Blanchard, president, in the chair. —The President announced the painful loss sustained by the Academy in the person of M. Yvon Villarceau, member of the Section for Geography and Navigation, who died after a short illness on December 23. Funeral orations on the deceased savant were pronounced by Col. Perrier in the name of the Academy, by M. Faye in the name of the Bureau of Longitudes, and by M. Tisserand in the name of the Paris Observatory.—Separation of gallium (continued): separation from terbium, ytterbium, and the earth provisionally called $y_\alpha$ by M. de Marignac, from scandium and fluor, by M. Lecoq de Boisbaudran.—Observations of the comet Pons-Brooks, made at the Observatory of Algiers by MM. Trépied and Rambaud.—Observations of the same comet made at the Lyons Observatory (Brunner equatorial of 0·160 metre), by M. Gonnessiat.—On a special development of the perturbing function

$$\frac{1}{\Delta^s} = \frac{1}{(r^2 - 2rr' \cos v + r'^2)^{\frac{s}{2}}},$$

by M. O. Backlund.—On the purely trigonometrical series connected with M. Linstedt's new solution of the problem of three bodies, by M. H. Poincaré.—On the generation of geometrical surfaces, by MM. J. S. and M. N. Vanecek.—On the gauging of galvanometers, by M. E. Ducretet.—Researches on the permanency of the solidification of superfused sulphur (continued); production of a new crystallised variety of sulphur, by M. D. Gernez.—On the decomposition undergone in the presence of water by the acid phosphates of the alkaline earthy bases, by M. A. Joly.—Determination of the neutralising heat for the fluorhydric acid of the alkaline and alkaline-earthy bases, by M. Guntz.—On the kreatines and kreatinines, fourth note, by M. E. Duvillier.—Action of ammoniacal gas on the nitrate of methyl, by MM. E. Duvillier and H. Malbot.—Researches on the compound oxygenised ammonias, by M. Reboul.—On some haloid derivatives of ethane, by M. L. Henry.—On the pathologic anatomy of the phlegmon, and especially on the seat of the bacteria in this affection, by M. Cornil.—On the species of Arctic mollusks found by the *Talisman* Expedition at great depths in the intertropical waters of the Atlantic Ocean, by M. P. Fischer.—On the morphology of the plumicole Sarcoptides, by MM. E. L. Trouessart and P. Mégnin.—On a rapid and economical method of treating vines affected by Peronospora, by M. Senderens.—On a parasitic Nematode of the common onion, by M. Joannes Chatin.—On the cultivation of beetroot and some other plants in solutions of organic substances in decomposition, by M. V. Jodin.—On the relations of the Serpentine rocks to saline substances, especially in the Pyrenees, by M. Dieulafait.—On a chlorosilicate of lime, by M. Le Chatelier.—Experimental researches on the velocity of aqueous or atmospheric currents capable of holding in suspense mineral particles, by M. J. Thoulet.—Note on the sunset glows recently reported to the Academy, by M. E. Marchand.—Observation of the after-glows witnessed at Valence on the evening of December 2, by M. P. du Boys.—Remarks on the sunsets observed at Rambouillet on the evenings of December 15 and 18, by M. A. Laugier.—Letter on the sunsets observed at Christiania towards the end of November, by M. Fearnley, director of the Christiania Observatory.

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