A similar remark applies to temperature, the range experimentally treated for water and for sea-water being only 0° to 15° C. Also it has been stated that the recording indices are liable to be washed down the tube, to a small extent, during the relief of pressure, so that the results given are probably a little too *small*.

Compressibility of mercury, per atmosphere ... ... 0·0000036
,, ,, glass ... ... 0·0000026

Average compressibility of fresh water per atmosphere—

[At low pressures	$520 . 10^{-7}$	$- 355 . 10^{-9}t$	$+ 3 . 10^{-9}t^2$]
For 1 ton = 152·3 atm.	504	360	4
2 ,, = 304·6 ,,	490	365	5
3 ,, = 456·9 ,,	478	370	6

The term independent of t (the compressibility at 0° C.) is of the form—

$$10^{-7}(520 - 17p + p^2),$$

where the unit of p is 152·3 atmospheres (1 ton-weight per square inch). This must not be extended in application much beyond $p = 3$, for there is no warrant, experimental or other, for the minimum which it would give at $p = 8{\cdot}5$.

The point of minimum compressibility of fresh water is probably about 60° C. at atmospheric pressure, but is lowered by increase of pressure.

As an *approximation* through the whole range of the experiments we have the formula—

$$\frac{0{\cdot}00186}{36 + p}\left(1 - \frac{3t}{400} + \frac{t^2}{10000}\right);$$

while the following formula exactly represents the average of all the experimental results at each temperature and pressure—

$$10^{-7}(520 - 17p + p^2) - 10^{-9}(355 + 5p)t + 10^{-9}(3 + p)t^2.$$

Average compressibility of sea-water (about 0·92 of that of fresh water)—

[At low pressures ...	$481 . 10^{-7}$	$- 340 . 10^{-9}t$	$+ 3 . 10^{-9}t^2$]
For 1 ton ...	462	320	4
2½ ,, ...	447·5	305	5
3 ,, ...	437·5	295	5

Term independent of t—

$$10^{-7}(481 - 21{\cdot}25p + 2{\cdot}25p^2).$$

Approximate formula—

$$\frac{0{\cdot}00179}{38 + p}\left(1 - \frac{t}{150} + \frac{t^2}{10000}\right).$$

Minimum compressibility point, probably about 56° C. at atmospheric pressure, is lowered by increase of pressure.

Average compressibility of solutions of NaCl for the first p tons of additional pressure at 0° C. :—

$$\frac{0{\cdot}00186}{36 + p + s},$$

where s of NaCl is dissolved in 100 of water.

Note the remarkable resemblance between this and the formula for the average compressibility of fresh water at 0° C., and $p + s$ tons of additional pressure.

[Various parts of the investigation seem to favour Laplace's view that there is a large molecular pressure in liquids. In the text it has been suggested, in accordance with a formula of the kinetic theory of gases, that in water this may amount to about 36 tons-weight on the square inch. In a similar way it would appear that the molecular pressure in salt solutions is greater than that in water by an amount directly proportional to the quantity of salt added.]

Six miles of sea, at 10° C. throughout, are reduced in depth 620 feet by compression. At 0° C. the amount would be about 663 feet, or a furlong. (This quantity varies nearly as the square of the depth). Hence the pressure at a depth of 6 miles is nearly 1000 atmospheres.

The maximum-density point of water is lowered about 3° C. by 150 atmospheres of additional pressure.

From the heat developed by compression of water I obtained a lowering of 3° C. per ton-weight per square inch.

From the ratio of the volumes of water (under atmospheric pressure) at 0° C. and 4° C., given by Despretz, combined with my results as to the compressibility, I found 3°·17 C. ; and by direct experiment (a modified form of that of Hope) 2°·7 C. The circumstances of this experiment make it certain that the last result is too small.

Thus, at ordinary temperatures, the expansibility of water is increased by the application of pressure.

In consequence, the heat developed by sudden compression of water at temperatures above 4° C. increases in a higher ratio than the pressure applied; and water under 4° C. may be heated by the sudden application of sufficient pressure.

The maximum density coincides with the freezing-point at − 2°·4 C., under a pressure of 2·14 tons.

SCIENTIFIC SERIALS.

IN the *Journal of Botany* for August and September, a considerable portion is occupied by the continuation of papers, to which reference has already been made—Messrs. Britten and Boulger's biographical index of British and Irish botanists, and Mr. G. Murray's catalogue of the marine Algæ of the West Indian region.—Mr. W. H. Beeby records an addition to the British Phanerogamic flora in *Callitriche polymorpha*.—Mr. A. Fryer has some critical remarks on *Potamogeton fluitans*.—A number of new ferns from Western China, and from Manipur, in India, are described by Mr. J. G. Baker and Colonel Beddome.

THE numbers of the *Botanical Gazette* for June–August contain quite an unusual number of articles of general interest. Bryologists will find a description of eight new species of moss from North America, each illustrated by a plate; in fact, the plates in these three numbers are very numerous and excellent.—Mr. Chas. Robertson discusses the origin of zygomorphic flowers from the point of view of evolution.—Of flowering plants, we have descriptions of new species from Western America (chiefly Umbelliferæ) and from Guatemala, by Messrs. Coulter and Rose and Mr. J. D. Smith.—Mr. F. C. Newcombe describes the mode of dissemination of the spores of Equisetum in the splitting of the sporange and the carriage of the spores by means of the elaters.—Mr. A. F. Förste describes (with a plate) the adaptation to cross-fertilization in various species.

American Journal of Mathematics, 1888 (Baltimore, Johns Hopkins University).—The object of M. R. Liouville's paper, "Sur les lignes géodésiques des surfaces à courbure constante," with which vol. x. No. 4 opens, is stated by him to be "d'indiquer la signification géométrique des équations différentielles du second ordre ayant leur intégrale générale linéaire par rapport aux constantes arbitraires, et de former leurs invariants pour toutes les substitutions qui ne changent point, soit l'inconnue, soit la variable indépendante" (pp. 283–292).—The following memoir, on the primitive groups of transformations in space of four dimensions, by James M. Page, is likely to be very serviceable, as it is the first continuous account in English of the researches of Sophus Lie on the theory of groups of transformations. Lie himself has developed the theory in a series of papers which date from 1873, and has not published any connected work on the subject (pp. 293–346).—W. C. L. Gorton writes on line congruences. He treats the subject by quaternions, and obtains all Kummer's results (*Crelle*, vol. lvii.), and is enabled by his method to carry out certain steps which are only indicated by this writer (pp. 346–367).—The volume closes with a notelet by Prof. Franklin, entitled "Some Theorems concerning the Centre of Gravity." This contains "almost instantaneous" proofs of Lagrange's two theorems on the centre of gravity.

With vol. xi. No. 1, we have what strikes us as being an admirable likeness of the great French mathematician, Charles Hermite. We have previously expressed our pleasure at this new departure of the editors of this journal, and hope their catering for mathematicians will meet with material approval.—The first communication is a memoir on a new theory of symmetric functions, by Captain P. A. Macmahon, R.A. This prolific young mathematician is doing excellent work, and the pages of the journal are just suited to present his results in the most effective form. The paper is intimately connected with a recent one, by the same writer, communicated to the London Mathematical Society, in which he gives a sketch of an extension of the algebra of the theory of symmetrical functions, and establishes the basis of a wide development. "The main object of the memoir is to show clearly

the proper place of the 'symmetric function tables' as studied by Hirsch, Cayley, Durfee, and others, in the algebra of such functions; to point out that the fact of their existence depends upon a wide theorem of algebraic reciprocity which leads to an equally wide theorem of algebraic expressibility, and that they are a particular case, and not the most important case from the point of view of application, of a system of such tables" (pp. 1–36).—Prof. W. W. Johnson contributes a paper on the integrals in series of binomial differential equations (pp. 37–54). "Binomial equation" is here used in Boole's sense.—Some interesting geometrical results are given in the next paper, by M. d'Ocagne, "Sur certaines courbes qu'on peut adjoindre aux courbes planes pour l'étude de leurs propriétés infinitésimales" (pp. 55–70).—Prof. Cayley closes the number with an instalment on the surfaces with plane or spherical curves of curvature (pp. 71–98). The paper is a reproduction in a compact form, with additional developments, of papers by Bonnet (*Journal de l'École Polyt.*, t. xx., 1853, pp. 117–306), and Serret (Liouville, t. xviii., 1853, pp. 113–162).

Engler's Jahrbücher, vol. viii. Part 5, contains:—Contributions to the knowledge of the Cupuliferæ, by K. Prantl. The author concludes that the segments of the cupule are not themselves leaves, but outgrowths of the axis covered with leaves, and that, with the exception of this peculiarity, the male and female catkins are similarly constructed. His views will be stated in Engler's "Die Naturliche Pflanzenfamilien," for which this paper was a preparatory study.—A revision of Bentham and Hooker's "Genera Plantarum," and "Floræ Columbiæ specimia selecta," by H. Karsten.—The rest of the number is taken up with abstracts of botanical papers, and the list of the more important works on classification and geographical botany published in the year 1886.

Vol. ix. contains the following articles:—On the roots of the Araceæ, by Max Lierau. An investigation of the roots of about 130 species from 46 genera of this natural order, leads the author to the result that those histological characters by which the stem and leaf of the several sub-orders of Engler are distinguished recur also in the roots, and thus these organs, though performing the most various physiological functions, have constant characters of systematic value.—In his contributions to the knowledge of the Capparidaceæ, Dr. Ferd. Pax discusses the questions of (1) the part taken by the axis in the construction of the flower; (2) the relation of the Capparidoideæ to the Cleomoideæ, in respect of the androecium. He concludes that the disk, androphore, and gynophore, are of axial nature, and not the result of coalescence of sporophylls; further, that the construction of the androecium is uniform throughout the order, being based upon the presence of two dimerous whorls, increased often very greatly by duplication.—Observations on the organization and biological conditions of northern trees, by F. W. C. Areschoug.—Specilegium canariense, by H. Christ.—Dr. Marloth gives an interesting account of the morphology, anatomy, and biology of the Naras (*Acanthosicyos horrida*, Welw.) of the south-west coast of Africa, and of observations of the peculiar property of the fruit in promoting the coagulation of milk.—On the flora of the German East-Asiatic Protectorate, by K. Schumann.—Contributions to the morphology and classification of the Ranunculaceæ, by K. Prantl. The author distinguishes "honey-leaves" (*Honigblätter*) from the perianth, defining them as "floral leaves, the chief function of which is the secretion of honey, and which have been produced from stamens independently of the differentiation of the perianth into calyx and corolla": thus he would describe the corolla of Ranunculus as consisting of such "honey-leaves," while the calyx would be regarded as a simple perianth. The greater part of the paper is occupied by the classification of the species within the genera.—New contributions to the flora of Greenland, by Eug. Warming.—Contributions to the knowledge of the walnut (*Juglans regia*, L.) by Dr. M. Kronfeld, with two plates.—A posthumous paper, by Dr. Hillebrand, descriptive of the vegetation of the Sandwich Islands.—Orchidaceæ herbarii Dom.-J Arechavatetæ det. et descr., by F. Kränzlin.—Dr. A. Breitfeld, in a paper on the anatomical structure of the leaves of the Rhododendroideæ, attempts to rank anatomical details with the characters of flower and fruit in the classification of the group, and finds the most useful characters in the epidermis.—On continuous and saltatory variation, by Franz Krašan.—Biographical notices on some of the collectors and authors named in the "Plantæ Ryddeanæ," by F. von Herder.—Marine Algæ of Puerto-Rico, by Dr. F. Hauck.—In addition to the above original treatises, the volume for the year contains a list of the papers of 1887 on the classification, description, and geological distribution of plants, as well as abstracts of the most important of these.

SOCIETIES AND ACADEMIES.

SYDNEY.

Linnean Society of New South Wales, July 25.—Dr. J. C. Cox, Vice-President, in the chair.—The following papers were read:—The insects of King's Sound and its vicinity, part 2, by William Macleay. This paper contains a list of all the Lamellicorn insects in the collection made by Mr. Froggatt in the West Kimberley district. Of the seventy-six species recorded, fifty-nine are described as new, but are all referable to known genera. The genera most numerous in species are *Onthophagus* and *Heteronyx*. The sub-family *Cetoniides* is represented by four species only.—Catalogue of the known Coleoptera of New Guinea, &c., part 2, by George Masters, Curator of the Macleay Museum. Part 2 of this catalogue, comprising the Tetramerous and Trimerous divisions, amounting to about 1100 species, completes the list of Coleoptera hitherto described from the region under consideration. The total number of species recorded is 2079.—Malaysian land and fresh-water Mollusca, by Rev. J. E. Tenison-Woods. After some introductory remarks on the extent and physical geography of the region under consideration, and on the characteristic features of its land and fresh-water Mollusca, the author gives a list of about 400 species indigenous to the Malay Peninsula in the States south of Keddah, and the Indian Archipelago, not including the Philippines and New Guinea. A bibliographical list is appended.—Mr. Ogilby exhibited a specimen of a deep-sea fish (*Chlorophthalmus nigripennis*), originally described by Dr. Günther in the *Ann. of Nat. Hist.*, 1878, and figured in vol. xxii. of the "*Challenger* Reports." The original specimens were taken by the *Challenger* naturalists off Twofold Bay, in 120 fathoms; the specimen exhibited was captured quite recently off Port Jackson in 70 fathoms, the only other occasion on which the species has been met with since its discovery.—Mr. Ogilby also exhibited a photograph of *Acanthias Blainvillii*, not hitherto recorded from New South Wales, and one of a variety of *Acanthoclinus littoreus*, originally described by Forster in "Cook's Voyage," the former having been taken in deep water off Port Jackson, the latter under stones between tide-marks at Lord Howe Island.—Mr. Brazier exhibited a spherical stone, about ½ inch in diameter, found in the crop of a Goura pigeon (*G. Albertisi*, Salvad.), from Hall Sound, New Guinea. Also a tube of fresh-water shells (*Segmentina australiensis*, E. A. Smith), from Waterloo Swamps.—Mr. MacDonald showed under the microscope an interesting exhibit of Rotifers (*Megalotrocha* sp.), living in clusters on pond weed.—Mr. Burnell exhibited two living slow-worms (*Typhlops nigrescens*), from Wentworthville, near Parramatta.—Mr. Deane exhibited a remarkable excrescence on a root of *Monotoca elliptica*, found by Mr. J. F. Fitzhardinge in the neighbourhood of Sydney; a specimen of an apodal lizard (*Delma impar*) found by Mr. C. F. Price, of Arable, near Cooma, where the species is said to be abundant in basaltic country; and examples of concretionary nodules occurring abundantly in a slaty rock in a cutting near Bredbo on the Goulburn to Cooma Railway.

PARIS.

Academy of Sciences, October 1.—M. Des Cloizeaux in the chair.—Relative values of the two constituents of the force displayed in the stroke of a bird's wing, deduced from the direction and insertion of the fibres of the great pectoral muscle, by M. Marey. Of the forces in question, one, as shown in previous communications, equals the weight of the bird and enables it to resist gravitation, the other is horizontal and enables it to resist the air. From a study of the disposition of the muscular fibres of the breast, the author now infers that the latter force, contrary to the general opinion, is much greater, and may even be double that of the former.—Positions of Barnard's comet (September 2, 1888) measured at the Observatory of Besançon with the 0·22 m. equatorial, by M. Gruey. The observations cover the period from September 5–15.—Observations of Sawer-