modern streams. Its plateau character is not given by a continuous stratum of hard rock parallel to the general surface, but has been produced by the uniform erosion of a system of plicated strata. Such uniform erosion could only have been accomplished by streams flowing at a low angle. Second, the eastern boundary of the range or plateau is a line of faulting; and the orographic movement producing the range consisted of a displacement along this fault-line, and a consequent inclination of the plateau-like mass to the westward. That this movement belongs to late geologic history is strongly indicated by the fact that it is incomplete. Some unpublished observations by Mr. I. C. Russell show that a part of it has occurred since the date of the quaternary lakes of the Great Basin; and the Inyo county earthquake brings it down to 1872.

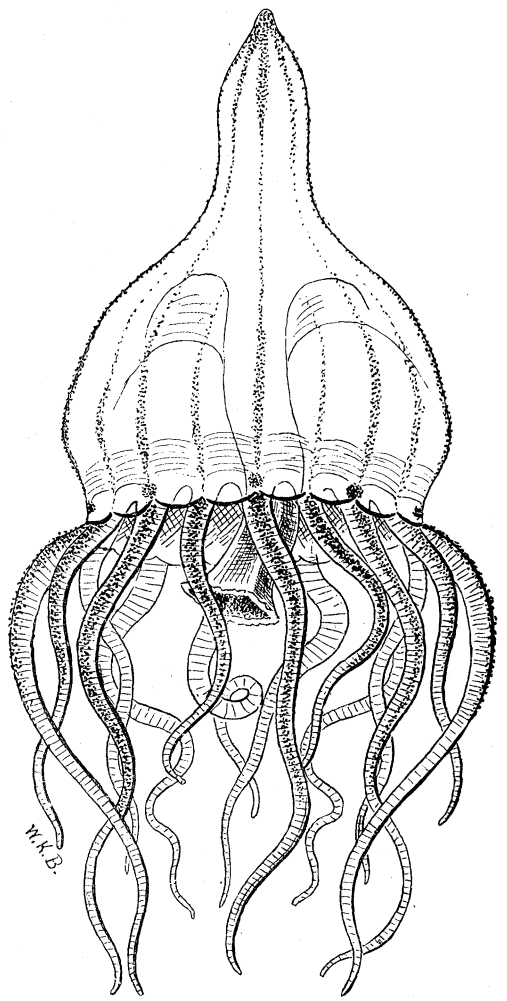
If a rise of temperature is not favorable to glaciation, if a fall of temperature does not make deserts drier, and if river-terraces are not indicative of waning precipitation, it might seem that our author's theory is badly off; but the case is not hopeless. The paleontologic evidence, and the doctrine of the dissipation of solar energy, remain; and if he will now devote himself to the investigation of the glaciers that are known to have recently increased, to the dry countries in which civilization and wealth have supplanted barbarism and poverty, and to the rivers that are engaged in filling up the valleys they once excavated, he may yet find in recent history the evidence he seeks of a secular change. G. K. GILBERT.

DEEP-SEA MEDUSAE.

Report on the deep-sea Medusae dredged by H.M.S. Challenger during the years 1873–76. By Prof. ERNST HAECKEL. London, 1882. 105 + 154 p., 32 pl. 4°.

THE expedition obtained only eighteen Medusae from deep water; and some of these, such as the beautiful Margelid, shown in plate 1, are undoubtedly surface-forms. But the value of the collection must not be estimated by its size: for some of the species are very primitive forms, or ancestral types, and are therefore of the greatest scientific interest; while others present unique and remarkable modifications of structure to adapt them to their life on the bottom.

Among the latter are the Pectyllidae, — a new family established by Haeckel, to include three genera of Medusae, obtained by the Challenger at a great depth in the Arctic Ocean, the Antarctic the Indian Ocean, and the Mediterranean. They bear a close resemblance to the Trachynemidae; but they are furnished with great numbers of ambulatory tentacles, which are wonderfully like the sucking-feet of echinoderms, terminating, like these organs, in expanded sucking-disks. As Haeckel has obtained living specimens of the Mediterranean species, and has thus been able to supplement his account of the anatomy by observations of the living animal, we have an interesting account of its habits in confinement. He says that it usually lies on its back, extends a portion of its sucking-feet stiffly out around it, and thus attaches itself to the bottom of the glass: the other sucking-feet play freely in the

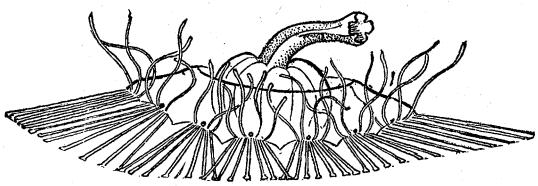


Tesserantha connectens in profile, ten times the natural size. Outline-sketch from Haeckel's Deep-sea Medusae, Pl. 15, Fig. 1.

water, as if feeling and fishing for prey, while the open mouth projects vertically upwards. It also climbs the sides of the aquarium, using its feet like a starfish.

One of the most interesting deep-sea forms is Tesserantha connectens, one of the simplest and oldest representatives of the family Tessaridae.

In his *System der Medusen*, Haeckel has given his reasons for regarding this family as the primitive form from which all the Acraspeda are descended, and he has given a figure of this species in the same place. Tesserantha is little more than a Scyphostoma, which becomes sexually mature in this larval stage. Unlike a Scyphostoma larva, it is a locomotor form, which has become adapted to a free-swimming life by the change of its oral disk into a sub-umbrella, and its basal peduncle into an apical process. In place of the simple peripheric gastric space of the Scyphostoma, it has a chamber divided by partitions into four radial pouches. This interesting



Pectythis asteroides, anchored on its back, magnified ten diameters. Outline-sketch from Haeckel's drawing of the living animal, Deep-sea Medusae, Pl. 8, Fig. 7.

medusa, which is undoubtedly a deep-sea form, was captured in the South Pacific in 2,160 fathoms of water.

A magnificent specimen of Periphylla mirabilis, a mature male, was captured by the expedition, near New Zealand, in 1,100 fathoms of water; and it has furnished Haeckel with the material for a minute and valuable description (illustrated by eight plates) of the anatomy of this remarkable family, which shows many points of close relationship to the very simple and primitive Tessaridae and to the Cucernariadae, although it is in other respects the most highly organized of the coelenterates.

Half of the eighteen species of Medusae in the collection were Craspedotae, and half Acraspedae; and, as they represent eighteen genera and thirteen families, they present a great range of diversity, and represent most of the important types of medusa structure. Haeckel has therefore prefaced his description by a general introduction, which sets forth briefly and clearly the present state of our knowledge of the anatomy, histology, embryology, and systematic zoölogy of the Medusae as a whole. This introduction, written in English, is of great value to those who are not specialists, but yet wish to know the results of modern research on this subject. It is only proper to point out to such readers the fact, that the paper contains many statements which are not accepted, without qualification, by all naturalists: such as the assertion (on p. xxv), that, "as the formation of the gastrula by invagination of the blastula in the Medusae has been observed in very different groups, we may assume that it happens universally in this class; and supposed exceptions (e.g., Geryenia) are founded on erroneous observation." Most embryologists would certainly hesitate to believe, without verification, that Metschnikoff's careful study of the development of Liriope involves a fundamental error; and many would be disposed to doubt whether the statement on p. xv, that the Ctenophorae are derived from an Anthomedusa (Ctenaria), is fully proven.

The presence of a number of uncorrected typographical errors also detracts from the value of the paper for general readers. For instance: p. viii contains the statement, that, "as regards the two sections or sub-classes, the Craspedotae are more probably of monophylitic origin; the Acraspedae, of polyphylitic;" while other sections especially devoted to this point (11 and 14) show that the author really holds the opposite view, and believes that the Craspedotae are of polyphylitic, and the Acraspedae of monophylitic origin.

Haeckel's very extensive and minute acquaintance with all forms of Medusae qualifies him, to an exceptional degree, for speculating upon the origin and ancestral relationship of the various orders and families; and his attempt to trace the evolution of the various forms is therefore interesting to all zoölogists. In sects. 10–14 he gives a phylogenetic classification of the Medusae, the outline of which is essentially as follows: the scypy-polyps and hydro-polyps diverged from each other; and the latter became evolved along three divergent lines, thus giving rise to the tubularian hydroids, the campanularian hydroids, and a third imaginary 'trachylarian' hydroid, before any true Medusae were evolved. The Acraspedae are the descendants of the scypy-polyps, of which their Scyphostoma larva is the ontogenetic recapitulation; while the three great groups of Craspedotae are the independent descendants of the three kinds of hydro-polyps, —the Anthomedusae (e.g., Margelis), from the tubularian hydroids; the Leptomedusae (e.g.,

Encope), from the campanularian hydroids; and the Trachomedusae (e.g., Liriope) and Narcomedusae (e.g., Cunina), from the 'trachylarian' hydroids. The resemblances between the Acraspedae and the Craspedotae, and the similarity between the various orders of Craspedotae, he believes to be due to secondary modification, rather than to inheritance by descent from a common ancestral medusa.

He regards the Ctenophorae and the Siphonophorae as divergent stems from the Anthomedusae.

WEEKLY SUMMARY OF THE PROGRESS OF SCIENCE.

ASTRONOMY.

Astronomical applications of photography.— Prof. E. C. Pickering described some photographic work which is now being undertaken at the Harvard observatory. Experiments are being made with various lenses, and on their completion it is intended to take photographs of the whole visible heavens north of 30° south. It is possible, also, that a map will be published. Measurements of the photographic energy of all the brighter stars will be made, down to, perhaps, the seventh magnitude. Besides this, it is proposed to obtain measurements of the color of the stars by using a large lens of heavy flint-glass, giving as much chromatic aberration as possible. In the centre a circular disk of glass will be placed, slightly thinner at one edge than at the other. The effect will be, that every star will have two images placed side by side. By adjusting the sensitive-plate at a certain distance from the lens the blue rays will be brought to a focus; but, in the case of the image formed by the rim of the lens, the violet and ultra-violet rays will be spread over so large an area as to produce comparatively little effect, while in the other image they will have nearly full power. By placing another plate somewhat nearer the lens the violet rays will be focused. A third plate will enable us to focus the ultra-violet rays. By comparing, in each case, the image formed by the edge of the lens with that formed by the centre, a series of quantitative results can be obtained, which will vary according to the spectrum of the star measured. By this method any variations of color as well as of magnitude could at once be detected. —(*Amer. acad. arts sc.; meeting* Feb. 14.) [412

MATHEMATICS.

Riemann's theory.— The present paper, by Prof. Klein, is a continuation and generalization of the methods and results in his memoir, which appeared a year ago, entitled *Ueber Riemann's Theorie der Algebraischen Functionen*, etc. This last contained an extension of the Riemann theory of functions to arbitrarily given closed surfaces. There exist over these surfaces, as the author shows by physical considerations, certan potential functions, the relations between which, expressed in the language of analysis, afford the sought properties in the theory of functions. The physical considerations at first employed in order to obtain tentative results are now abandoned, and the author develops his new theory by more rigorous methods. Instead, now, of considering a Riemann's surface as a closed surface, he regards it as a *bounded* surface, or aggregate of bounded surfaces, where the different portions of the bounding curves may be regarded as being connected in pairs by any assigned law. A so-bounded surface is regarded as a portion of a closed surface; and the author shows how an important general principle is obtained, which he calls the principle of analytical development, and which, in certain special cases, coincides with a principle of Schwarz called the principle of symmetry. The author shows how, by certain particularizations of the ideas, a general notion may be obtained of those functions which have linear transformations among themselves; and a theory is then given of single-valued functions of this kind. The author speaks of a Riemann's manifold, instead of a Riemann's surface, and considers a closed two-dimensional manifold instead of a closed surface, and, upon this manifold, single-valued definite differential expressions, instead of simply the element of length. Numerous references are given to the earlier literature of the subject, in which the investigations of Poincaré stand out most prominently. The present memoir, taken with the previous one above referred to, constitutes one of the most important additions that has ever been made to Riemann's theory of functions. —(*Math. annalen*, xxi.) T. C. [413

Functions of two variables.— M. Poincaré gives a generalization of a theorem of Weierstrass concerning functions of one variable. The theorem in question is, "*If $F(x)$ is a meromorphic function over the entire plane, it can be placed in the form of a quotient of two integral functions.*" M. Poincaré seeks to find the analogous theorem in the case of two variables, and considers a function, F (X,Y), of two imaginary variables ($X = x + iy$, $Y = z + it$). Calling u the real part of a function of X and Y, it is seen that u satisfies a differential equation ($\Delta u = 0$) where

$$\Delta = \frac{d^2}{dx^2} + \frac{d^2}{dy^2} + \frac{d^2}{dz^2} + \frac{d^2}{dt^2};$$

u also satisfies certain other partial differential equations of the second order, which need not be written down. Any function satisfying the equation $\Delta u = 0$ is called a potential function. The aggregate of points satisfying the inequality

$$(x-x_0)^2 + (y-y_0)^2 + (z-z_0)^2 + (t-t_0)^2 < r^2$$

is called a hyperspheric region. The author constructs an infinite number of hyperspheric regions, and considers a point ($x\,y\,z\,t$) as belonging to at least one of these regions, and being common to not more than five of them. The final theorem obtained is as follows: if Y is any non-uniform function of X, — which has no essential singular points at a finite distance, and which cannot, for the same value of X, take an infinite number of values infinitely near to each other, — it can be considered as the solution of an equation, G (X,Y) = 0, where G is an integral function. —(*Comptes rendus*, Jan. 22.) T. C. [414

PHYSICS.

Mechanics.

Motion of a pendulum.— M. Lipschitz, in a letter to M. Hermite, investigates the motion of a heavy body capable of turning freely about a horizontal axis.