The important point is, whether equally good definition can be attained with these two extra reflections. Experience alone can decide this with certainty; but up to the limit already tried in the Paris instrument, about ten inches aperture, we have the strongest evidence of its possibility. Dr. Gill, astronomer at the Cape of Good Hope, in describing to the Royal astronomical society a flying visit to continental observatories, speaks of the Paris equatorial coudé as follows:—

"One fine night, about eleven o'clock, we went to the observatory, and set on γ Leonis; and I am bound to say I never saw the diffraction-disks of a star better defined than in that instrument. They were perfectly circular. The disks came as sharply to focus as any I ever saw; and I would not have believed, if I had not seen it, that it was possible to make an instrument in which, after two reflections, such definition could be found. I am bound to say I never saw better definition in any instrument, and I never measured a double star so pleasantly and easily before."

Dr. Gill's well-known investigations in stellar astronomy give to whatever he says in this line great weight, and no stronger testimony could be desired.

When it comes to the question of the largest apertures, it would seem, *a priori*, that there should be no difficulty in making a glass mirror — where the internal constitution of the glass is not in question, and only one plane surface is demanded — 1.41 times as large as an objective, in which the glass of the two lenses must be homogeneous throughout, and four perfect surfaces are required.

Also it would seem, that if large lenses, whose thickness is limited, can be supported at the rim so that the distortions due to gravity are not appreciable in the definition, then mirrors whose thickness is unlimited, and which can be supported in every possible way at the rim, and all over the back surface, might be made sufficiently rigid to resist distortion. To be sure, the effects of distortion are of quite a different order in the two cases, the effect of gravity in increasing the curvature of one side of a lens being partly counteracted by the diminished curvature of the other side, while the distortion of a single reflecting surface appears with its full effect in the definition. But the far greater facilities for making the mirrors rigid should make up for this in a large degree. At any rate, the French opticians seem to have full confidence in their ability to do this, and it is certainly to be hoped that they will succeed.

Washington. H. M. Paul.

EQUATORIAL COUDÉ AT THE PARIS OBSERVATORY. (Reproduced from *l'Astronomie.*)

THE ECHINODERMS DREDGED BY THE TALISMAN.[1]

Among the deep-sea echinoderms, some of the holothurians attain a large size, one being seventy centimetres long. The mouth is situated at one end of the body, although near the termination of the

[1] Abridged from the French of H. Filhol in *La Nature.*

intestines, which open at the other end of the creature, are the orifices of branching tubes forming the respiratory organs. When holothurians are disturbed (as on being caught, for instance), they contract, and suddenly shoot out their viscera. But what is more singular and inexplicable is, that after some time these organs are reproduced. It would seem that the life of these animals, at whatever depth, would pass in perfect quiet; yet the holothurians living near the surface, as well as those between four and five thousand metres, are harassed by a swarm of parasites. Thus some of them, as Van Beneden says, are transformed into a kind of living hotel; some lodge in their respiratory organs little fishes (Ferasfer) with a body as long as that of an eel, but contracted; others shelter one or more couples of the little crabs called Pinnotheres, or carry in their intestines the worms called Anoplodium. But besides these parasites, which do not live at the expense of the host, of whom they demand only a home, there are others which live on the host.

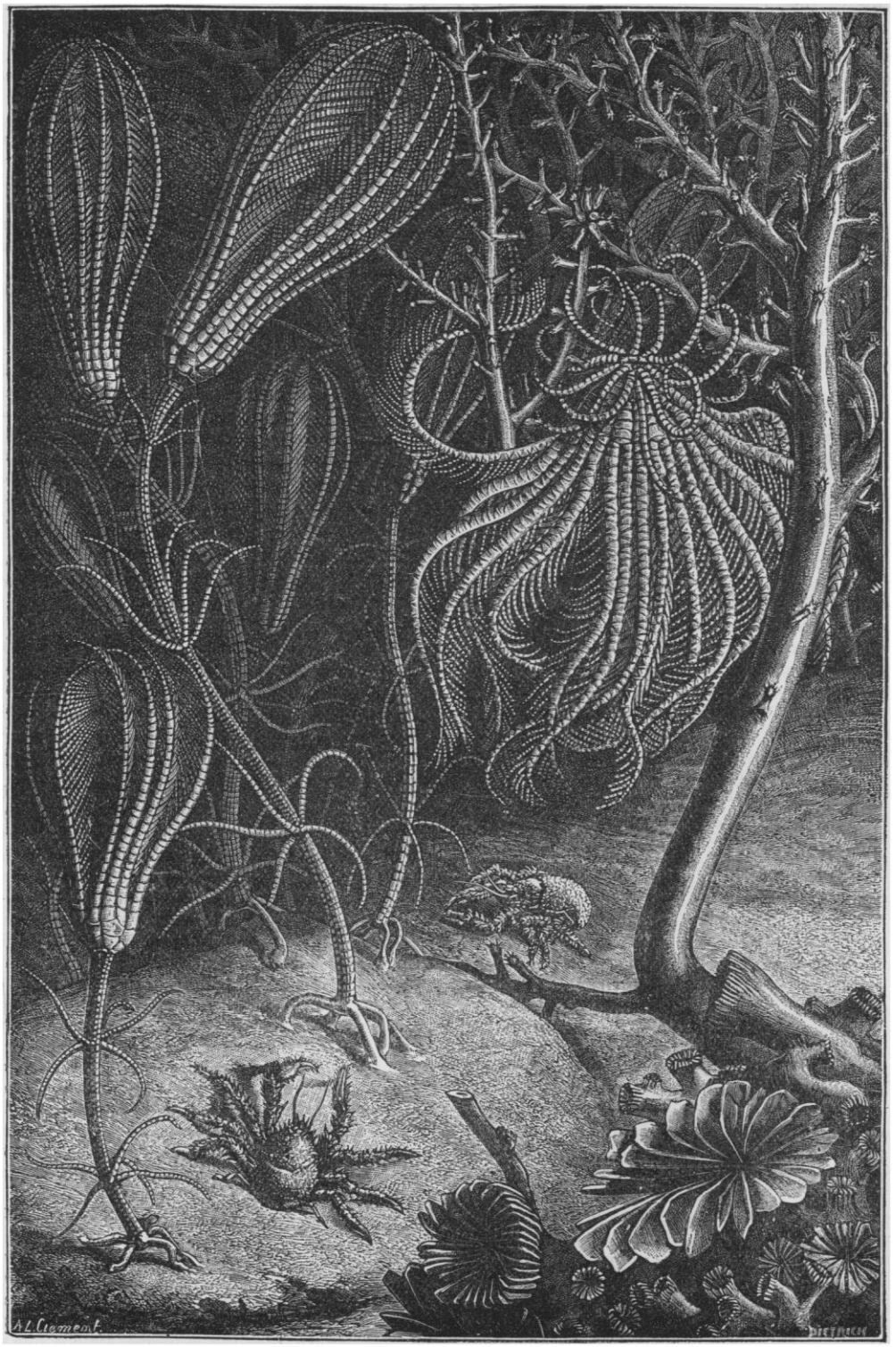
Perrier says, "A holothurian has essentially the form of a five-sided melon with an opening at each extremity. With holothurians of great depths, however, this form almost entirely disappears. Some curve themselves back into a U-shape; others, as Ankyroderma, have the form of an ovoid sac, without the ambulacra which cut the surface of the other holothurians into five arms; the majority, instead of the characteristic radial symmetry of their allies, present a bilateral symmetry as distinct as that of the worms and the vertebrates, and creep on the mire by means of a ventral sole, like slugs, forming a peculiar example of the mode in which two organic types which seem separated by an unbridgable abyss may be found in the same animal."

The sea-urchins are represented at great depths by forms very varied, and peculiar to certain zones. Some are remarkable for the development and beauty of their spines. For a very long time the remains of a genus of echinoderms called Calveria had been found in cretaceous deposits; but only in 1869, during the cruise of the Porcupine, was the survival of this form at the bottom of our seas revealed to us. "As the dredge was coming in," says Thomson, speaking of this form, "we got a glimpse from time to time of a large scarlet urchin in the bag. We thought it was one of the highly coloured forms of Echinus Flemingii of unusual size; and as it was blowing fresh, and there was some little difficulty in getting the dredge capsized, we gave little heed to what seemed to be an inevitable necessity, — that it should be crushed to pieces. We were somewhat surprised, therefore, when it rolled out of the bag uninjured; and our surprise increased, and was certainly in my case mingled with a certain amount of nervousness, when it settled down quietly in the form of a round red cake, and began to pant, — a line of conduct, to say the least of it, very unusual in its rigid undemonstrative order. Yet there it was, with all the ordinary characters of a sea-urchin, its interambulacral areas, and its ambulacral areas with their rows of tube feet, its spines, and fine, sharp, blue teeth; and curious undulations were passing through its perfectly flexible leather-like test. I had to summon up some resolution before taking the weird little monster in my hand."

The flexibility of the sides of this particular echinus, as was discovered, is due to a peculiar arrangement of the pieces forming the test. As for the palpitation which seems to have so impressed the English naturalists, it is simply due to the ship's rolling or pitching, or else to the vibrations arising from the action of the engines on board.

A group most abundant in new forms is composed of the beautifully formed and often brilliantly colored animals called star-fishes. Attention must be directed first to Brisinga, which sometimes has as many as twenty long, flexible arms. These brilliant orange-red stars often violently detach their arms when they feel themselves caught and drawn up by the movement of the trawl; and it is very rarely that they can be studied in an uninjured state. Absjornsen, who first discovered them on the coast of Norway a little above Bergen, at a depth of 200 fathoms, much admired the phosphorescent light shed by the body and the arms. "Whole and uninjured as I saw it once or twice under the water in the dredge, this animal is peculiarly brilliant, a veritable *gloria maris;*" and he accordingly gave it the name Brisinga, from a jewel of the goddess Freya. Brisinga coronata was obtained at the tropics, hitherto found only in the German ocean. In the cruise of the Porcupine it was found at 914 metres. We found it between 736 and 1,435 metres. Other species occur at depths ranging from 882 to 3,455 metres. All these forms are new, and so abundant that thousands cover the bottom of the sea.

Crinoids, the last echinoderms of which we shall speak, are cup-shaped. From the edges extend simple arms, bifurcated or branched, with pinnules at the sides. From the back grows a jointed rod, which attaches itself to surrounding objects. In Antedon and Actinometra, represented on the plate, this rod exists only during an early stage, the body becoming free at a certain point in their development; while with Pentacrinus, also figured, and with Democrinus and Bathycrinus, it continues during the life of the animal. The crinoids have always been considered by naturalists interesting objects of study, as much on account of their rarity in the present marine fauna, as on account of their great abundance in very old geologic periods. In fact, these animals, which were common during the Silurian period, increased in numbers at the time of the calcareous carboniferous deposits, which are formed almost exclusively of beds composed of their remains. They were found again in abundance in that middle horizon of the triassic deposits called muschelkalk. After this time of extraordinary prosperity, crinoids appear, as Thomson says, to have gotton the worst in the struggle for existence. As they approach the present period, the species become rarer, and are represented by fewer individuals. At one time it was thought that Antedon alone existed at the present time. The discoveries made in the deep-sea explorations resulted



BOTTOM OF THE OCEAN AT A DEPTH OF 1,500 METRES, PEOPLED WITH PENTACRINUS, AND SHOWING ALSO SOME COELENTERATES (MOPSEA AND OTHERS) AND CRUSTACEANS.

in the abandonment of this idea. Certain forms of crinoids, as Pentacrinus, Democrinus, and Bathycrinus, are peculiar to great depths, and form in our seas numerous and widely separated colonies.

A recent species of Pentacrinus, a genus largely represented in the lias and oolite, was brought in 1755 from Martinique to Paris, and described by Guettard. At long intervals rare specimens from the Caribbean Sea have been seen. On the 21st of July, 1870, Gwyn Jeffreys, while dredging from the Porcupine at a depth of two thousand metres, in longitude 39° 42′, latitude 9° 43′, procured a score of specimens. It would seem as if their excellent state of preservation would prove whether they were free or fixed. Thomson, who studied them, believed that the animal lives slightly attached to the soft mud, changing at will its abode, and swimming by means of its feathery arms. On the Talisman, the trawl was twice dropped to depths occupied by this Pentacrinus; and we decided, contrary to the prevailing opinion, that these animals live firmly fixed by the backward-curving tendrils, which grow from the terminal joint of the rod. These hooks, as it were, solder themselves to the bottom, and can be detached only by breaking.

We have attempted to show in our plate the character of the bottom of the sea on which Pentacrinus lives, as it was shown by the dredging made opposite Rochefort, at fifteen hundred metres. Pentacrinus Wyville-Thomsoni in considerable numbers covers the ground, forming a kind of living meadow, from which rise large Mopseas. The rocky ground was covered with beautiful corals, resembling flowers with the calyx opened; and in the midst of this living world moved hitherto unknown crustaceans (Paralomis microps A. M. Edw.) whose carapace was ornamented with fine spines. Actinometra (crinoids which become detached from their rods after full growth) were floating in the water, or fastened themselves for short intervals by their tendrils to the branches of the Mopseas. Pentacrinus and Actinometra were of a beautiful grass-green, the Mopseas of an orange color, the corals of a deep violet, and the crustaceans of a mother-of-pearl whiteness. This profusion of life, and this prodigality of colors, at fifteen hundred metres below the surface, certainly form two of the most wonderful facts which have been reserved for the naturalist to discover.

In 1827 Thomson found attached to Comatulas (free crinoids with no attaching rod) a Pentacrinus of small size, which he described under the name of Pentacrinus europaeus. This animal seemed to possess, in all the details of its structure, the characteristics of the fossil Encrinus and of the modern Pentacrinus. Ten years later Mr. Thomson, when again examining a small crinoid, was much astonished to see it suddenly abandon its rod, and begin to swim with its arms for some time, and then to reattach itself by its tendrils. Continuing his studies, he saw the arms, originally branched at the summit, gradually assume the character of the arms of Comatula; and he was gradually brought to the knowledge that Pentacrinus europaeus was only a young Comatula.

Comatulas are numerous at certain points on our coast, where they are found, according to their age, gracefully clinging among the sea-wrack, or sheltered under the pebbles accumulated on the reefs. Several species descend to a considerable depth, one being found abundantly at twelve hundred metres. At some places we saw Comatulas existing by thousands, and representing almost exclusively the animal life of the locality.

RECENT PROCEEDINGS OF SCIENTIFIC SOCIETIES.

New-York academy of sciences.

June 3. — Mr. G. F. Kunz read a paper on a new process of cameo or intaglio gem-engraving, in which he said, that, from his first experience in the dental chair, he received the impression that the machine used in tooth-drilling would be the proper one for engraving and cutting on stones similar to cameos and intaglios. In the engraving-lathe at present used, the tool revolves on a horizontal shaft, to which are attached tools of different size and shape; the Italians and French using a screw-thread, while the English make use of a lead head, which is simply fastened in by the revolving of the wheel. A set of tools or drills often numbers over a hundred. Mr. Kunz exhibited the S. S. White improved dental engine, which is somewhat similar to the other machines in use, and may be described as follows: A driving-wheel eleven inches in diameter is set in motion by a foot-treadle; and from this wheel the power is conveyed, by means of a cord of fibre or thin leather, to a pulley-head. To this is hinged a pivot-rod, extending from it as a flexible arm, which conveys the power to the drill through a steel or iron head-piece. The main advantage lies in the revolving-point being allowed so much freedom of motion by the flexible wire arm, that it can be placed in any position desired, and held in any position on the work instead of the work being held on it. Any revolving-tool that can be placed at will on the work, in any desired position, gives the desired result; and this can be attained by a flexible driver, as in this machine. It might, however, be improved. 1°. The points or drills should be made of softer iron, to hold the particles of diamond-dust more readily. 2°. The tool should be arranged to work more steadily, and thus overcome any possible jar in very fine work, although it has drilled a series of holes in a metal plate, which no engraver with the old lathe could place more closely. 3°. The driving-wheel should be heavier and larger, to attain more