

PAPER BY THE REV. J. E. TENISON WOODS, F.G.S., F.L.S., &c., READ DECEMBER 19, 1865.

SUBJECT—"THE TERTIARY ROCKS OF SOUTH AUSTRALIA."

PART IV.--FOSSIL ECHINIDÆ.

In the sub-kingdom of Radiata and Class Echinodermata there are eight orders, of which two—the *Sipunculoidea* and *Holothuridea*—are, in consequence of their soft organization and almost total absence of shell, never found in a fossil state. Two more, the *Blastoidea* and *Cystidea*, are exclusively fossil orders, which have not survived into the secondary periods of geology. The *Crinoidea* are nearly all fossil, and more common in Palæozoic and early secondary formations. Of the three remaining orders—the *Ophiuroida*, *Asteridea*, and *Echinidea*—specimens of the two latter alone have been found in a fossil state in Australia.

The *Echinidea* are distinguished by their rounded form and the absence of any arms; their hard covering, together with their habit of living in sand, has been the means of preserving them very extensively in the geological record. As "sea urchins," or "sea eggs," they are probably familiar to every rambler on the sea-beach, where the handsome arrangement of their tubercles and the various colours of their spines make them prized objects for collectors. For particulars as to their anatomy I must refer to the various works on natural history in which they are described, especially "Carpenter's Zoology," "Echinodermata," in "Cyclopædia of Anatomy and Physiology," by Dr. Sharpey, and in a popular form in "Knight's Cyclopædia of Natural History."

In the *Echinidea* the calcareous matter is deposited within their integument, so as to form plates of polygonal shells fitting into each other with exquisite exactness, and regularly arranged in a series with a view to the spheroidal form of the whole. These plates are perforated or covered with highly ornamented tubercles, and nothing can exceed the beauty with which these are arranged on the surface in some of the species. Between the tubercles there are generally rows of pores for the protrusion of suckers or feet; and these are the only orifices in addition to the mouth and vent and the ovarian pores on the apex whence the eggs are extruded. The classification of these interesting animals has been made to depend principally on the position of the mouth and vent; but, as Professor Forbes remarks, the work has fallen into so many hands that there has been a very needless multiplication of genera. The principal naturalists engaged on the work have been Breyn, Klein, Linnaeus, Leske, Lamarck, Cuvier, Gray, Desmarest, Goldfuss, Von Buch, Desmoulins, Agassiz, E. Forbes, Desor, DeFrance, D'Orbigny, Cotteau, Wright. Three species are common to the Mount Gambier Lower Pliocene rocks belonging to different genera, and none of them, so far as I am aware, exist in the present day, nor are the types now living on our coast in any way similar to them. This may be accounted for by observing that the shells found on our shores are, except in rare instances, always littoral in character, while those of the rocks are peculiar to a deep sea. No doubt urchins similar to those to be described might now be found in the deep waters of a warmer latitude, but I am inclined to think not of the same species as those found in a fossil state. We are not at present well informed as to why these singular creatures should frequent deep seas. It may be that they find there in the largest quantity For-

minifera on which to feed—a fact which is quite borne out by the fossils—or it may be that they have drifted from shallower beds, which is hardly credible, considering the way in which the remains are found. At any rate it is a singular circumstance that the first living animal which was dredged up from enormous depths in the northern seas belonged to this class, so some theory must be found which will account for geological evidence and observed facts, and at the same time conform with the known habits of these strange animals.

The common fossils of this class belong to three genera, which are thus described:—

Echinolampas—Grey (Living and Tertiary).—Test, ovoid or discoid; petals, wide, long, nearly reaching the border; vent, transverse, infra-marginal.

Echinolampas Gambierensis, new species. Plate III., Fig. 1. A, upper surface; B, lower surface; C, side view. Test, elongated, depressed, wider behind than before, upper surface convex, rounded, base convex at the margin, convex towards the peristome, ambulacral summit excentral; petaloid ambulacra increasing in width, extending completely over the dorsum; single ambulacrum narrower than the others, and very indistinct; poriferous zones narrow and continued in gradually-diverging lines to the edge of the peristome; interporiferous zones elevated; pairs of pores slightly oblique; outer series slit, and connected with the inner by distinct sulci; apical disc small or excentral; pores two in number, large and distinct, and posterior to the madreporiform body; tubercles closely set, small, immersed, with well-defined scrobicula, those on the base being larger and better defined; vent, infra-marginal, oblique, wide, transversely oblong; peristome opposite the disc, large, excentric, and transversely oval, surrounded by fine short expansions of single rows of pores. Length, $1\frac{1}{2}$ inches; breadth, $\frac{1}{2}$ inches.

Observations.—Closely resembling *Echinolampas scutiformis* (Leske), but differing from it in its concave base and diverging poriferous zones, which are much larger in this specimen. It is allied to many characteristic Miocene forms. *E. scutiformis* is found in the upper limestone of Malta, which is, I believe, recognised as Upper Miocene—a formation which, as I have already said, is so intimately connected with the Lower Pliocene that every new exploration among the fauna of either makes their separation more difficult. The fossil figured is very common at Mount Gambier, while *Hemipatagus Forbesi*, to be afterwards mentioned, is the prevailing form elsewhere.

Hemaster—Desor (Tertiary extinct).—Inflated urchins, with heterogeneous ambulacra, and distinctly petaloid in the dorsal portions, and often lodged in depressed spaces; mouth excentric and bilabiate; vent, terminal, petals circumscribed by a slightly undulating fasciole, which is not repeated on the base; tubercles uniform, and not distinguished by large primary ones, as in *Eupatagus*, *Spatangus*, *Hemipatagus*. The above description is nearly all taken from Professor E. Forbes's monograph on the fossil Radiaria of the London clay (*Palæontog. Soc. for 1852*), and he adds that all the known species are from the Secondary or Eocene formations; but since that

time specimens have been found in the Upper Miocene at least, closely allied to the one I am now about to describe.

Hemaster Archeri. (This specimen is named after my friend Mr. W. H. Archer, Registrar-General of Victoria—a scientific man of eminent learning, whose accomplishments in natural history researches have been of much service to me in these investigations.) Plate III., Fig. 2. A, upper or dorsal surface; B, ventral ditto; C, posterior end; D, side view. Test, tumid, much elevated, truncated posteriorly, wider anteriorly; dorsal surface convex, round; ventral surface slightly convex, ambulacral summit excentral, petaloid expansions lanceolate short and inserted in deep depressions, single ambulacrum shorter and not so well defined; antero-laterals slightly longer than the postero-laterals, poriferous zones oblong, pairs of pores numerous and oblique, slit, and connected by sulci, which are divided by single rows of small tubercles, an indistinct sinuous fasciole only faintly visible at the end of the postero-laterals in the adult specimens; apical disc excentral, with three large and distinct reproductive pores; peristome opposite the disc with an indistinct fasciole or rather vacant space; mouth, bilabiate, transverse, oblong; vent, small, sub-oval, placed high upon the truncated posterior surface; tubercles scattered, uniform upon the dorsal surface, thicker set and larger on the base, sides, and round the vent, all surrounded by rings of small granules. Length, $2\frac{1}{2}$ inches; breadth, $1\frac{1}{2}$ inches. Mount Gambier, rather common.

This species has many resemblances to the genus *Eupatagus*, except in the presence of the primary tubercles. It may, however, be confidently referred to the genus *Hemaster*, species of which are found at Malta in the Upper Miocene beds. Its presence there has been regarded as quite exceptional, and it is not a little remarkable that the same or similar genus has been found at Mount Gambier. This points to similar conditions of life, which are worth attention, and which connects two geological districts which are geographically very widely separated.

Hemipatagus—Desor (Tertiary).—I have now to describe one of the commonest fossils in the whole of the Lower Pliocene formations, but perhaps best represented at Mount Gambier. It has been described by Dr. Duncan, in the "Annals of Natural History" for September, 1864; but as that publication is but little known in Australia, I reproduce to the Society the diagnosis, with my own figures.

Hemipatagus Forbesi.—Woods and Duncan. Synonyms—*Spatangus Forbesi*.—Woods (*Geol. Obs.*, p. 75). *Spatangus Hoffmanni*.—Sturt (*Two Expeditions*, &c. Lond., 1833. Vol. ii, pl. 3). Plate III., Fig. 3. A, dorsal surface; B, ventral surface; C, posterior view; D, lateral view. "This common Echinoderm," says Dr. D., loc. cit., "has been confounded both with the *Hemipatagus Hoffmanni*, Goldfuss, of Bünde, and with the *Hemipatagus Grignonensis*, Agassiz, whose synonym, *Spatangus Ormalii*, Galeotti, will be recognised as denoting a form described by E. Forbes, in the Belgian Eocene. The Rev. J. Tenison Woods has called it *Spatangus Forbesi*, but I cannot find any description of it, although it is figured (p. 75, *S. Australia*, Woods). The species

is clearly not *H. Hoffmanni*, and Sturt's mistake was corrected by Mr. Woods. Mr. Woods having figured the species, I append his name with my own."

I must here note that Dr. Duncan inadvertently gives me credit for a discovery which does not belong to me. Sturt's mistake was corrected by Professor McCoy as paleontologist to the Victorian Geological Survey. The learned Professor did not publish any diagnosis, and I really forget now how his determination reached me. Dr. Duncan's diagnosis is as follows:—Test, depressed, rather cordiform, nearly as broad as long, rounded and sulcated in front, rather angular laterally and truncated posteriorly. It is highest posteriorly where it is roof-shaped, and it slopes gradually anteriorly. The ambulacral summit is nearly central. Inferiorly the test is slightly concave and irregular, the plastron is smoother than the rest; the peristome is transverse, semilunar, and there is a prominent posterior lip. The anterior sulca is broad, shallow, and rounded. The ambulacral areas are lanceolate, the anterior being wide apart. The poriferous zones are sunken and broad, are slightly raised, and are faintly tuberculated. There are four generative pores, the anterior pair being closer than the posterior. There are no larger tubercles in the posterior inter-ambulacral spaces. The very small tubercles of the posterior space are very crowded. The larger tubercles which are seen inferiorly are also nearly cylindrical, perforate but not crenulate; the scrobicula is deep, and the tubercles are often in contact with one part of the scrobicular circle. Height of

specimen, half-inch; length, one inch; locality, the Murray, Mount Gambier, South Australia. In the collection of the Geological Society. The species is closely allied to *H. Hoffmanni*, Goldf.; but it has not crenulate tubercles, which have a tendency to touch the scrobicular circle. It is easily distinguished from the Javan tertiary species and from the *H. Grignonensis*. It appears to be a common fossil in the South Australian tertiary. The genus is separated from *Spatangus* by Desor on account of the defective fascioles, and of the absence of large tubercles on the posterior inter-ambulacral area. The European species are found in Eocene and Miocene strata; the nearest alliance of the new form is from Malta and Bünde. The species from the Java tertiary are not closely allied to the Australian. In a note Dr. D. adds, "Since the completion of this paper I have received Karl A. Littel's '*Fossile Molusken und Echinodermen aus Neu Seeland*.' The *Hemipatagus tuberculatus* therein described, and decided to be specifically distinct from *H. Forbesi*, is very closely allied."

General Observations.—The connection seen in these fossils between the Malta upper tertiary and those of our continent has been already pointed out. It certainly is very singular that two remote formations should possess in common new and unusual features which connect them in an exceptional manner with much older deposits by characteristic forms not possessed by intermediate formations. I do not know whether this peculiarity reigns out of the Echinoderms, but at any rate it does not extend to

these fossils, which are almost neighbouring in Europe, nor to the same in Java, which are as near to us. It may be that the Java beds are older, and they are, I think, admitted to be Miocene. The presumption would be somewhat strong that the Mount Gambier and the Malta beds are of the same period, but differences of climate and geography may account for the successive nature of such formations without forcing the hypothesis derived from mere similarity of fossils. At any rate, the evidence from the Echinoderms make it decisive that our Mount Gambier rocks are certainly not older than the Upper Miocene at the very utmost. The reappearance of such a genus as *Hemaster* here and at Malta is paralleled in the Mollusca by the occurrence of *Nautilus ziczac*. I shall take another opportunity of pointing out how all this evidence goes to show a greater uniformity in molluscan life in the earlier geological periods than exists at the present day.

Note.—The authors for the three genera above quoted may be consulted as follows:—

"Abhandlungen zur Naturgeschichte, &c., von Nath. Gfrd. Leske, Leipzig, 1779."

"Synopsis des Echinides Fossiles, par Desor, 6, Livraisons, Paris, 1857."

"An Arrangement of the Families of Echinidae," in *Proceed. Zool. Soc. Lon.*, xxiii., 1855, p. 35.

Lamarck describes many of the Echinidae of our coast. The common sea egg is *Echinus ovum*. See Lamarck, 1st ed., vol. 3, p. 48, for that and some other species.