have originated by the collapse of the shell in the shrinking nucleus of the globe, once these have been flattened out longitudinally by this earth creep.

The subject first suggested itself to me when working on the rocks of Tristan da Cunha, and the map here reproduced is taken from my paper on "The Rocks of Tristan da Cunha brought back by H.M.S. Odin, 1904, and their bearing on the question of the Permanence of Ocean Basins".¹ Dr. Katzer, in his "A fauna devonica do rio Maecuru, e as suas relações com a fauna de outros terrenos devonicos do globo",² drew his "Continente atlantico-aethiopico" on more or less the same lines, but terminated it to the south by a shore running latitudinally, parallel with the southern extremity of South Africa, deriving his sediments in the Falkland Islands from a "Continente meridional". The sediments in the Falkland Islands, however, are so similar to those in the Bokkeveld Beds in South Africa that I am inclined to think they must have been derived from the same continent. The important point to notice is that Dr. Katzer, working from Brazil, arrived at the same distribution of land and water in Devonian times as I did working from the other side of the Atlantic.

II.—ON THE JAW APPARATUS OF *DISCOIDEA CYLINDRICA* (LAMARCK).

By HERBERT L. HAWKINS, B.Sc., Mark Stirrup Scholar in the University of Manchester.

(PLATE VI.)

WHILST searching through the duplicate drawers in the Manchester Museum I found recently a specimen of *Discoidea cylindrica* which contained the dental apparatus in a very good state of preservation. The softness of the matrix within the test made it possible to develop and extract the jaws, and thus to detect several new features of interest.

The jaws of *Discoidea* were described in 1892 by Lovén, who gave good figures of the maxillæ both in the text (p. 53) and on plate x (figs. 114, 115). In this paper he discusses the two distinct types of perignathic girdle that occur in *Discoidea cylindrica*. He states that in the depressed form (*forma vulgaris*) the ambulacral processes ('auricles') are low, and connected by interrarial ridges ('walls') which are of almost the same height; whereas in the tall form (*forma elatior*) the processes are much more prominent than the ridges. The jaws he describes are from the form he designates as the "more normal", but it is hard to determine to which type he refers in this phrase. There is no mention of the teeth or of the epiphyses in Lovén's paper, but both these structures are preserved in the specimen about to be described.

It will, perhaps, be best to proceed with the description of the specimen, and subsequently to consider the differences from Lovén's description.

The specimen, which is one of a pair of small *Discoidea* collected

¹ Trans. Phil. Soc. S.A., Cape Town, 1905, vol. xvi, p. 19.

² Boletim do Museu Paraense, 1895, vol. ii, Para, Brazil.

by the Rev. A. Dixon from the Lower Chalk of Sewell, in Cambridge-shire, is what would be usually described as a young form, the cylindrical character of the sides of the test of adult forms being scarcely perceptible. The dimensions of the test are: Breadth of base, 38.75 mm.; height of test, 22.25 mm. At one point the test was broken away, and by careful development sufficient was removed to expose the five pairs of hemi-pyramids with their teeth, all lying in the left anterior interradius (Fig. 1).

The *maxille* are small and lanceolate in form, with their adoral ends strongly curved inwards. The inter-pyramidal joint-face (Fig. 3) is broad, being 6.6 mm. long and 3.2 mm. wide at its greatest breadth, which extends from about 2 mm. above the oral end, almost to the aboral end of the face. Its aboral margin slopes very slightly outwards and downwards. The transverse ridges are almost parallel to the aboral margin; they are straight and very fine, being about seven to each millimetre. The *fossa arcualis* is high, and about .75 of the breadth of the aboral margin of the inter-pyramidal face. The outer surface (Fig. 2) is slightly narrower, and strongly convex adorally. Its length is 8.1 mm. and its greatest width 3.1 mm. The external margin is sharp and elevated into a flange. The admedian outer plane is very narrow aborally, but becomes widened into an inward sloping plane, 1.0 mm. wide adorally. It crosses the marginal flange, and is continued as a strongly incurved process for about .75 mm. beyond it. The *fovea magna externa* is narrow and deep below, with a distinct facet on the outer side of the admedian plane, but it rapidly becomes shallower upwards, and, save for a slight depression aborally, it forms a broad, somewhat concave surface. The symphyseal face is narrow (.9 mm. wide near the upper end), becoming somewhat broader at the incurved adoral end. The length of the symphysis is 5.4 mm. (chord measurement), and the full height of the maxilla is 8.1 mm.; the ratio of symphysis to maxilla is therefore .67. The internal face has a deep concavity partly divided by a carina at the aboral end. The dental slide is concave and rather deep. It extends to within .6 mm. of the angle of the supra-alveolar process. The adoral region of the internal face is smooth.

The *epiphysis* (Fig. 6) is very minute and slender. Its horizontal length is 2.7 mm., its height at the outer end 1.5 mm. It is reduced to a narrow bar towards the inner end. The inter-pyramidal surface is horizontally ribbed, with a rounded prominence at about 1 mm. distance from the inner end. The surface of articulation with the maxilla is almost smooth.

No recognizable trace of a *rotula* or of a *compass* can be determined, but the rounded prominence on the epiphysis indicates the existence of a *rotula*, as this articulation is the chief one between these two pieces in most Regular Echinoidea.

The *teeth* are narrow and but slightly curved. There is a strong keel on the concave side, and a less conspicuous rounded ridge along the convex side, as in *Echinus*. The cutting edge of the tooth seems not to have been very sharp, but to terminate in a blunt chisel edge rather than in a point. The tooth is, however, a far more effective cutting instrument than the short stumps of the Clypeastroid jaws.

The length of the tooth extracted for examination is 6.2 mm. (measured along the chord), and the breadth from side to side is uniformly .9 mm.

The relative length of the symphysis as compared with the maxilla in Lovén's specimen was .74, whereas it is .67 in the present example. That this proportion increases with the age of the individual seems certain; thus, in a series of measurements I have taken of these lengths in small specimens of *Echinus miliaris*, the proportion varied from .52 (in a very minute specimen, the total length of the maxilla of which was only 2.3 mm.) to .61 in a specimen with a maxilla 3.1 mm. long. But the two specimens of *Discoidea* now under comparison have maxillæ of precisely equal length, namely, 8.1 mm., so that the difference in the relative length of the symphyses (.07) is not of necessity due to difference in the age of the individuals. The general proportions of the maxillæ in the new specimen are considerably more slender than those of Lovén's specimen.

The method of articulation with the perignathic girdle is comparable to that of the Clypeastroids. The narrow adoral end of the *fovea magna externa* is deeply depressed, and articulates perfectly with a radial process of the perignathic girdle. Interradially the pyramid seems to have leaned against two somewhat approximated radial auriculæ, and to have had very small possibilities of movement.

As has been previously mentioned, Lovén points out the striking differences between the two types of perignathic girdle in *Discoidea cylindrica*, and assigns the type with prominent auricles to the cylindrical *forma elatior*. His two figures ("Echinologica," pp. 48, 49) exhibit the characters of the girdle in both types very clearly. He shows that the tall form not only has more prominent auricles than the depressed form, but that in it the characteristic interradian ridges that radiate from the peristome to the sides of the test are more strongly pronounced.

The specimen of *D. cylindrica* here described is undoubtedly one of the low or depressed forms. A comparison of the outline in Fig. 1 with that in Wright's monograph of the Cretaceous Echinoids referred to by Lovén (Wright, Pal. Soc., Cret. Ech., 1874, pl. xlv, fig. 2a) shows it to be almost identical in form with that typically depressed specimen. But the characters of the perignathic girdle in my specimen (and also in the companion specimen, which is identical with it in shape and size) conform more or less completely to those ascribed by Lovén to the elevated form. Except for the fact that the auricles are not quite so prominent in the case of the example from Sewell, the drawing in "Echinologica" (p. 49) would serve as a representation of this specimen. This correspondence in the perignathic features of the high and low forms of *D. cylindrica* tends to break down the distinction between them.

It has usually been stated (see Wright, 1874, p. 206) that the hemispherical form of *D. cylindrica* is the young stage of the true cylindrical form, but Lovén suggests that there may be a specific difference between the two forms. The present example seems to me to lessen the probability of the existence of any fundamental distinction between the two forms, and to give confirmation to the older belief. Lovén does not give the sizes of the specimens he describes, so that it is

impossible to judge certainly as to the relative ages of the specimens, but the fact that the auricles in my example are not quite so fully developed as in the original of Lovén's figure on p. 49 seems to indicate that my specimen is the younger of the two. Assuming that the jaws described by Lovén are those of the tall form, then the smaller symphyseal proportion in the present specimen lends confirmation to this belief.

Perhaps the most striking feature of the 'lantern' of *D. cylindrica* is its strongly 'regular' character. In many respects the structures closely resemble those in *Cidaris papillata*. The slightly less elevation of the outer faces of the pyramids, the internal keel of the tooth, and the slanting position on the perignathic girdle, are the only obvious differences, save for a slight tendency in the epiphyses of *Cidaris* to converge to form an arch. The epiphyses of *Discoidea* are very like those of the Diademine genus *Asthenosoma*, but in that form again the tooth is grooved on the concave side.

The great similarity between the dental structures in *Discoidea* and the regular Echinoids tends to confirm the belief that the Discoidiidae are very primitive among irregular Gnathostomata. In the structure of the jaws, at least, these forms might well be regarded as intermediate between the Regularia and the Clypeastrina, for the pyramids bear a strong regular facies, whilst their method of articulation with the perignathic girdle, and the slight modifications that they do present, all seem to tend towards a typical Clypeastrine character.

Summary.—The maxillæ of a specimen of *Discoidea cylindrica* are described, and found to differ somewhat from those described by Lovén in "Echinologica". The epiphyses and teeth of *D. cylindrica* are described for the first time, and are shown to resemble those of several Regular Echinoids.

The differing characters of the perignathic girdle, which were considered by Lovén to be of almost specific importance, are not found to be confined to the different forms of test, and are regarded as differences due to the age of the specimens.

The intermediate character of the family of the Discoidiidae between Regular and Clypeastrine Echinoids is emphasized.

In conclusion, I wish to express my thanks to Dr. Hoyle, of the Manchester Museum, for permission to develop and describe the specimen; also to Dr. Bather for his help and encouragement, and especially for lending me the proof-sheets of his forthcoming memoir.

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EXPLANATION OF PLATE VI.

- FIG. 1.—Side view of the specimen of *Discoidea cylindrica* in Manchester Museum (L. 8806), with the jaw apparatus *in situ*. $\times 1\frac{1}{2}$.
 ,, 2.—Outer surface of a pyramid, A in Fig. 1, the two halves separated along the symphysis and the tooth forced between them. As found. $\times 8$.
 ,, 3.—Inner (inter-pyramidal) view of a pyramid, with the incurved extensions of the halves of the admedian outer plane at the adoral ends. $\times 8$.
 ,, 4.—Tooth; side view. $\times 8$.
 ,, 5.—Inner (alveolar) view of a hemi-pyramid, showing the symphysial surface and half the dental slide. $\times 8$.
 ,, 6.—Epiphysis, inter-pyramidal surface, showing rounded prominence for articulation with a rotula. $\times 15$.
 ,, 7.—Portion of the perignathic girdle of this specimen, showing the processes. $\times 3$.

III.—ON THE COMPOSITION OF 'BOROLANITE' FROM AM MEALLAN, ROSS-SHIRE.

By W. CAMPBELL SMITH, Scholar of Corpus Christi College, Cambridge.

THE peculiar garnetiferous rock occurring to the east of Loch Borolan seems to have been first noted by Dr. Callaway in 1883, and is described by Dr. Bonney in an appendix to Dr. Callaway's paper.¹

The rock was more fully described by Messrs. Horne & Teall in 1892.² The authors give it the name borolanite, defining the typical rock as an aggregate of orthoclase and melanite. The mineral composition is described, with special reference to the white patches, which consist of an aggregate of orthoclase and a substance which is probably an alteration product of nepheline or sodalite. The occurrence of a turbid mineral in micropegmatitic intergrowth with the felspar is noted, and it is suggested that this is an alteration product of nepheline. The theory that these white patches are pseudo-leucites was suggested by Professor Derby, who compared them to the pseudo-leucites of certain Brazilian rocks. It is also pointed out that borolanite appears to be a member of the elæolite-syenite family.

An appendix to this paper of Messrs. Horne & Teall records the discovery of much decomposed borolanite in the Eilean Dhu Limestone at Elphin, and of two vertical dykes in the Torridon Sandstone at Camas Eilean Ghlais. The dyke is of medium texture and brownish-grey colour. Hand-specimens show melanite and lath-shaped cleavage faces of felspar. Sections show the rock to be composed of an aggregate of orthoclase, nepheline (partly decomposed to a substance giving aggregate polarization), melanite, ægirine, and biotite. The melanite is either pale yellow or deep brown, a pale zone often surrounding a dark nucleus. Two bulk analyses were made, one by Mr. Hort Player and the other by Dr. Teall; the latter also analyzed the part soluble in hydrochloric acid, thereby proving the presence of nepheline.

¹ Q.J.G.S., 1883, vol. xxxix, p. 409.

² Trans. Roy. Soc. Edinburgh, vol. xxxvii, p. 163.

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FIGS. 1-7.—Dental apparatus of *Discoidia cylindrica* (Lamk.).