XVI.—**Note on an Algal Limestone from Angola.** By Mrs M. F. Romanes, late Harkness Scholar, Newnham College, Cambridge. *Communicated by* Professor J. W. GREGORY, F.R.S. (With One Plate.)

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The specimens here described were collected by Professor J. W. GREGORY in Angola, and belong to the series described in the paper by him on the geology of that country.

The horizon of the beds from which the limestone was obtained is Albian.

The specimens are of a yellowish pisolitic limestone. In hand specimens the weathered surface has a warty appearance—the diameter of each knob being about 1 cm. A fractured surface shows circular forms varying in size and having decided concentric markings. These concentric markings are, however, less evident in microscopic sections, and this is probably due to the effects of preservation. A similar case has been described by Mr H. YABE,* where the genus *Metasolenopora* is affected in this way. These circular forms make up the greater part of the rock, and are cemented together by a fine calcareous paste in which are fragments of shell and quartz grains, with occasional grains of other minerals, such as felspar and muscovite. The specimens of limestone examined varied to some extent in texture, some being more compact, and even slightly siliceous, but the contained organisms are present in similar amounts regardless of the texture of the rock.

With care, small roughly circular nodules can be extracted from the looser varieties of the limestone.

In thin section, under the microscope they are seen to consist of algal growth round a nucleus. The substance of the nucleus varies, and may be the plate of an echinoid, or more commonly is the fragment of a spine. In some cases a group of quartz grains serves as a centre round which growth has taken place. Instances of this have been noted by Mr WETHERED† among the pisolites of the Jurassic. Sometimes also small bodies, *cf.* calcispheræ,‡ help to form a nucleus. Some also occur scattered throughout the matrix of the rock. Their possible presence in this limestone is interesting in view of the fact that the association of calcispheræ with abundant plant remains has already been noted.§

Two different genera of algæ have been determined making up the pisolitic nodules. The genus present in the greatest abundance has been identified as *Girvanella* Nich.||

* H. YABE, *Sci. Rep. Imp. Tohoku Univ. Sendai*, Japan, vol. i, No. 1, 1912, p. 2.

† E. WETHERED, *Geol. Mag.*, dec. 3, vol. vi, 1889, pp. 196–200.

‡ E. J. GARWOOD, *Q.J.G.S.*, vol. lxxviii, 1912, p. 580, pl. xlvii, “Carboniferous Succession in N.W. England.”

§ R. C. M'LEAN, *Proc. Camb. Phil. Soc.*, vol. xvi, pl. vi, 1912, p. 512, “Group of Rhizopods from Carboniferous Period.”

|| A. NICHOLSON and R. ETHERIDGE, *A Monograph of the Silurian Fossils of the Girvan District*, Edin., 1878, p. 23, pl. ix, fig. 24.

The tubuli of this organism form the centres of all the nodules, and can be distinguished amongst the fine calcareous material, in association with the quartz grains, etc., which form the nuclei of the nodules. The average diameter of the tubuli is 6μ . Their length it is not possible to measure, as they twist and bend, the same cell-thread passing to different levels in the section.

Sometimes they appear to branch dichotomously. They form an anastomosing bundle of cell-threads in the centre of the nodules, and have no concentric arrangement till towards the outside, and here, owing to the state of preservation, it is frequently impossible to distinguish them. The boundary of each pisolitic grain is, however, clearly defined against the cementing matrix. In every respect the tubuli are comparable with the smaller varieties described by Mr WETHERED* in his papers on *Girvanella*. The dimensions of the tubuli in these species are as follows:—*G. minuta*, 7μ ; *G. intermedia*, 10μ ; *G. incrustans*, 10μ . The first two occur in the Coralline oolite of the Jurassic; and the third, together with *G. sinensis*, described by H. YABE,† and having tubuli 10μ in diameter, is confined to the Carboniferous. This species from the Albian beds of Angola is, therefore, the smallest so far described, and may be known as *Girvanella minima*, n. sp.

The genus is now accepted as a calcareous alga, although its systematic position has not yet been definitely ascertained. There is reason to believe that it is most nearly related to the Siphonæ.‡ So far, *Girvanella* has been described as ranging from the Cambrian to the Jurassic; but, as Mr CHAPMAN remarks, “others, no doubt allied to fossil forms, exist at the present day.” It is not surprising to find it in Cretaceous rocks which have been deposited under suitable conditions.

The second genus has been identified as *Lithothamnion* Phil. This alga occurs towards the circumference of the nodules, frequently as little excrescences, and can be detected on nodules that have been freed from the matrix. In longitudinal section the cells have a width of from 8μ – 12μ , and their length is greater than this; but measurement is difficult, as there is reason to believe that the transverse walls have suffered more by replacement than the longitudinal walls. The quadratic form of the cells, characteristic of *Lithothamnion*,§ is not so clearly developed as in some species, but can be made out, and the lack of clearness is almost certainly due to the state of preservation. The thallus is made up of cells, somewhat radially arranged; branching takes place at different levels, so that the whole assumes a fan-shaped form growing from a point. The edges, where growth has been last in process, are irregular and lobate. This applies equally to sections cut tangentially near the growing point.

The measurements of the cells in tangential sections vary from $8\mu \times 10\mu$ to

* E. WETHERED, *Q.J.G.S.*, vol. xvi, 1890, p. 270, “On the Occurrence of Genus *Girvanella* in Oolitic Rocks”; also *Geol. Mag.*, dec. 3, vol. vi, 1889, p. 196, “On the Microscopic Structure of Jurassic Pisolite.”

† H. YABE, *op. cit.*

‡ F. CHAPMAN, *Rep. Aust. Ass. Adv. Sci.*, vol. xi, 1907, p. 377.

§ A. ROTHPLETZ, *Zeit. deutsch. Geol. Ges.*, vol. xliii, 1891, p. 302, “Calcareous Algæ.”

$12\mu \times 16\mu$. The outline of the cells in some of the sections is polygonal, often with five sides. Some of the tangential sections show large polygonal markings; these are due to growth having taken place from different adjoining centres, with the resulting compressional structure (Plate).

The most characteristic feature of the species is the presence of reproductive organs, which have been observed in several sections, and in sections made from one specimen they were very abundant.

The conceptacles have a distinctive shape, as will be seen from the plate. Their dimensions bear a close resemblance to those of species which are mentioned by Dr ROTHPLETZ in his paper on "Calcareous Algæ."* In *L. ramosissimum* Reuss. the measurements for the conceptacles are given as 280μ long $\times$ 80μ high, in *L. suganum* Rothp. as 250μ long $\times$ 100μ high, and in *L. torulosum* Günt. as 400μ long $\times$ 150μ high. From the plate it will be seen that owing to the curved shape of the conceptacles measurement is not satisfactory, but an average of well-formed examples, reckoning from edge to edge, gave 350μ long $\times$ 125μ high. The conceptacles occur most usually towards the edge of the thallus. Although they are usually isolated and are situated most commonly on the same circumference, it seems that sometimes they may be so close together as to coalesce in forming a band of "conceptacle tissue," with the loss of individual shape. In a single thallus, isolated conceptacles can be seen to pass into the conceptacle band. No spores have been observed in the conceptacles, although they contain a certain amount of structure, suggesting canals. When writing on the classification of the *Nelobesieæ*, FOSLIE† distinguishes between those *Lithothamnion* in which the sporangia are grouped in conceptacles, and those in which they are not, placing the former in subgenus *Eulithothamnion*. This subgenus he divided into two sections according to whether the conceptacles remained superficial or not. In the species under discussion the material of the thallus subsequently grows round the conceptacle, so that this species falls into the section *Innatæ* Fost., to which section also belong *L. ramosissimum*, *L. suganum*, *L. torulosum*. The conceptacles in the first two are smaller, and in the third larger, than in this species. It resembles those three which are Tertiary most nearly, but is distinguished from them by the characteristic shape of the conceptacles. The specific name of *Lithothamnion angolense*, n. sp., is proposed for it.

Girvanella forms the largest proportion of the nodules, but the two have been observed in association in all the sections examined. It appears that bundles of *Girvanella* tubes have first been formed, enclosing fragments of echinoid plates or quartz grains, and that subsequently *Lithothamnion* has begun to grow on the nodules so produced. Its growth has, however, been arrested at an early stage, for in no instances are large masses found, and the original outlines of the *Girvanella* nodules are only slightly modified.

* A. ROTHPLETZ, *op. cit.*

† H. FOSLIE, *Kongl. Norske Vidensk. Selsk. Skr.*, 1900, No. 5, p. 12.

Localities.—The limestone is from beds near Lobito Bay in the province of Benguella. The localities from which the specimens were obtained are given below—the numbers refer to Professor GREGORY's collecting list.

- 8 and 10. Catumbella dam. This rock is cream-coloured and very compact.
264. Hanha Gorge. The matrix in this specimen is coarser, and contains much quartz and some felspar, both oligoclase and microcline. The specimen is weathered, and the nodules stand out clearly, some attaining a length of 1·8 cm.
271. Beach, one hour S.W. of the mouth of the Hanha River. This specimen is greyer in colour than the rest, and is partially polished. The algæ were here associated with *Schloenbachia*, n. sp.
290. Coastal Plateau, at the foot of the scarp of the Second Plateau, about 6 miles from Old Lobito, on the track to Hanha. This specimen is compact and deep yellow in colour. The material from here gave the best conceptacles.
297. This limestone is less compact, and contains a greater number of shell fragments forming nuclei.

The specimens are so similar, especially microscopically, that there seems no reason to suppose they do not all belong to one bed.

Throughout the observations recorded in this note I have been indebted to Professor GREGORY.

EXPLANATION OF PLATE.

- Fig. 1. *Girvanella minima*, sp. nov. Section of 264 × 66.
- Fig. 2. *Lithothamnion angolense*, sp. nov. Longitudinal section of 290 × 33.
- Fig. 3. " " " Transverse section of 290 × 66.
- Fig. 4. " " " Transverse section of 290 × 66, showing lines produced
by compression, due to growth.
- Fig. 5. " " " Group of conceptacles in 290 × 24.
- Fig. 6. " " " Conceptacles which have coalesced, forming a band, in
290 × 66. This shows structure suggesting canals.

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FIG. 1.

FIG. 2.

FIG. 3.

FIG. 4.

FIG. 5.

FIG. 6.