7. NOTES on the RADIOLARIA of the LONDON CLAY. By W. H. SHRUBSOLE, Esq., F.G.S. (Read November 21, 1888.)

MICROSCOPICAL examination of London Clay from wells in Sheppey and elsewhere, and from pit-sections at the same horizon in different parts of the London Basin, continued for some years, has afforded proof of the existence near the base of this formation of a Diatomaceous zone, which was constant so far as the examination extended. It yet remains for some one to ascertain whether this zone continues throughout the full extent of the London-Clay area. The list of specimens given in my paper "On the Diatoms of the London Clay" (Journ. Royal Micr. Soc. vol. i. p. 381) has since been considerably enlarged by Mr. Kitton and others, from washings supplied by myself.

In a paper "On the New Town Well at Sheerness" (Proc. Geol. Assoc. vol. v. p. 355), I had previously called attention to 60 species of Foraminifera and some other microzoic forms not specifically mentioned. Among these latter were some reticulated fragments suggestive of Radiolaria, but no specimens occurred sufficiently perfect to be described. My friend Dr. Bossey, F.R.M.S., of Redhill, was more fortunate in this respect than myself, for in 1881 he saw and sketched a Radiolarian skeleton, apparently nearly perfect, which he had found in some London-Clay washings sent to him by me.

The formation of a well for the Queenborough Cement Company in 1885, near the Railway Station, gave me another opportunity of searching for new forms of Tertiary life. In accordance with previous experience, after passing through a zone rich in Foraminifera, a few solitary Diatoms only were found, until at 225 feet from the surface the Diatoms occurred in great abundance in brightly glittering patches, causing the clay to assume a somewhat laminated character.

On washing some of the clay from this level, I found not only the familiar Diatoms, but also some fairly good specimens of Radiolaria. This material I distributed among correspondents, and have not been able to get any more.

Fortunately Mr. A. L. Hammond, F.L.S., had, with his usual exactitude, made sketches of some specimens he had seen.

I had sent some of the Radiolarian material to Prof. Ernst Hæckel, with regard to which he says that "he found a large number of fragments of Tertiary Radiolaria, and but few well-preserved specimens. These appertain to the three families of Sphæroidea, Discoidea, and Cyrtosidea, and seem to be identical with those described in 1880 by Emil Föhr, from the Tertiary beds of Grotte in Sicily*." There is no new species among the recognizable forms, but perhaps there may be among the numerous fragments."

Wanting more precise information as to the species, and being unable to find in the 'Palæontographica' any forms similar to those I had found in the London Clay, I sent Mr. Hammond's sketches to

* See 'Palæontographica,' vol. xxvi. 1880, p. 71.

Prof. Häckel, respecting which he wrote, on Dec. 6, 1885 :—"The Radiolarians of the London Clay, the sketches of which I return enclosed, are not identical with any species known, living or fossil. I can therefore give only the names of genera enumerated in my 'Prodrömus,' published in 1881 *.

"Fig. 11, *Cenosphæra*, sp. (Monosphærida); figs. 2 and 2b, *Spongodiscus*. Figs. 1, 8, and 10 are Cyrtida, probably Monocyrtida (with a single joint); Fig. 1 perhaps the upper part of a *Cyrtocalpis*, figs. 8 and 10 of an *Anthocyrtis* or *Cornutella*.

"But when there are two joints separated by a transverse stricture or an internal flange (as you describe), it may belong to Dicyrtida (*Sethocorys* or *Anthocyrtis*, the latter with a corona of terminal spines). The large spines in your figs. 5a and 5b may be apical spines of those or of other Cyrtida, or perhaps radial spines of Sphærida.

"If the apex and the mouth of the shell is not complete, it is not possible to determine with certainty the genus of Cyrtida.

"Since Radiolaria occur in great numbers in all seas (in warmer, however, more frequently than in colder), and in open seas as well as near the shore, no certain inferences can be drawn from their presence in the London Clay."

From the above correspondence, it appears more than probable that in the material sent to Prof. Häckel there were some forms that I had not seen. In the absence of specimens or further information, nothing more can now be said respecting them, and attention must therefore be restricted to those forms of which we have the representations.

Nos. 1, 8, and 10 evidently belong to the same species, No. 1 having been less perfectly preserved than the others. These, in some washings, were more abundant than the other forms, and were first found alone at a slightly higher level.

The shell may be described as being conical, with a curved outline, terminating in a solid apical spine tapering to a point, this spine in many specimens being longer than in those figured. Whereas in many of the Cyrtoidæ the apical spine is set obliquely to the centre of the shell, in all specimens of the species under consideration that I have examined the spine is a direct prolongation of the longitudinal axis.

Basal mouth a simple wide opening. Skeletal shell built up of lattice-work, having openings which are hexagonal on the exterior, and circular on the interior surface, and which increase in size towards the mouth. Near the open end is a broad internal flange, pierced with circular holes proportionately large, as if to combine lightness with strength. In many instances the mouth is ornamented with a corona of short spines, which seem to have been removed from others (and from those figured) by abrasion; and in a few I observed traces of a probable further extension of the framework on a larger scale.

* Jenaische Zeitschrift für Naturwissenschaften, vol. xv.

In the absence of full proof that a second joint had existed, I think it better to refer the specimens to *Eucyrtidium*, and I record the species under the name of *Eucyrtidium Hammondi*.

Another and abundant form, Nos. 2 and 2 *b*, has the appearance of a discoidal Diatom, abraded circumferentially, with this difference—the cellulation differs from that of any Diatom known to me, and there are no indications of bivalvular formation. A sectional view shows that the same structure prevails throughout. Any doubt on the point is set at rest by Hæckel, who distinctly refers it to the Radiolarian genus *Spongodiscus*. I have named it *Spongodiscus asper*.

Radiolaria from the London Clay of Sheppey.

- 1, 8, 10. *Eucyrtidium Hammondi*, sp. n., $\times 112$.
 2, 2 *b*. *Spongodiscus asper*, sp. n., $\times 112$.
 11. *Monosphæra toliapica*, sp. n., $\times 112$.
 4. Spherical bodies, probably Radiolarian, $\times 112$.
 5. Fragmentary rods, probably Radiolarian, $\times 112$.

No. 11 represents a globular form of hexagonal lattice-work, the interior being now filled with pyrites; I refer this to the genus *Monosphæra*, under the name of *M. toliapica*. As suggested by Hæckel, the fragmentary styles or rods, Nos. 5 *a* and 5 *b*, probably represent some complex forms that have failed to preserve their

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integrity. Though completely pyritized, they present very smooth, even polished surfaces, indicative of their former siliceous condition.

The pseudomorphous change to pyrites seems to have been as complete in these Radiolarians as in the Diatoms from the same formation.

Sponge-spicules were present in nearly all the washings I examined, and in some material from the Queenborough Well, sent to Prof. W. J. Sollas, F.G.S. &c., he recognized some characteristic Tetractinellid forms, one, like the spicules of *Stelletta*, being a trifid fork with bifurcated rays, and another like the calthrops common in *Pedastrella*.

I have to acknowledge the kind assistance rendered by T. Spenser Smithson, Esq., of Rochdale, in mounting the specimens exhibited.

DISCUSSION.

The PRESIDENT observed that the particular advantage of a paper like the present is that it shows the value of searching. He doubted the advisability of coining new names.

Dr. HINDE asked whether the Radiolaria were uniformly pyritized; also whether the sponge-spicules had undergone a similar change.

Prof. T. RUPERT JONES commented on the rarity of fossil Radiolaria. Some few have been found in the Chalk. Their pyritization would tend to their ready destruction.

The AUTHOR, in reply, said that he was not anxious to apply new names. He was doubtful whether any silica remained in the sponge-spicules or the Radiolaria, although some has been detected in the Diatoms.