(APPENDICE)

ON THE NATURE OF SOME FRAGMENTS OF

SILICEOUS ROCK FROM THE BOULDERCLAY OF THE « ROODE KLIF » (RED CLIFF)

on the southern border of the province of Friesland,

By George Jennings Hinde.

PLATE VIII.

The material, sent to me by Dr. H. VAN CAPPELLE Jr, which forms part of the glacial deposit in the boulder clay of the « Roode klif » is a soft white rock, which readily disintegrates into a fine powder. Its present incoherent condition is probably due to certain changes, which have taken place in it since it was deposited in the boulderclay ; for in its present friable state it would not have endured removal and transport from its original position. The material appears to be entirely siliceous, for there is no reaction when it is treated with nitric acid.

For microscopic examination a small quantity of the material was washed in water, so as to separate the very finest particles, and samples of both the coarser and finer portions were then mounted with Canada balsam in the usual way.

Under the microscope the material is seen to be nearly entirely composed of entire and fragmentary spicules of siliceous sponges, for the most part free, but in the case of some of the smaller forms partially cemented together in small grains or flakes. The larger spicules yet retain their originally smooth outlines and show but slight traces of corrosive action, but the surfaces of the smaller forms, when examined under high powers, are pitted and corroded in varying degrees. The spicules in all cases have lost the brilliant glassy aspect, which characterizes those of existing sponges and which is still present in some fossil forms from Tertiary rocks ; they are however much less corroded than those in the powder associated with the flints from the Upper Chalk of England.

Under polarized light between crossed nicols, most of the larger spicules show the lively tints of quartz, whilst the smaller forms and the minute flakes and grains of siliceous material in the deposit are for the most part opaque and thus appear to retain the original

amorphous or opalized condition of the silica. The occurence in the same deposit of spicules, partly of amorphous and partly of crystalline silica, is a peculiar feature of this material, for as a rule, the spicules in similar material are all in the same mineral condition, whether amorphous, chalcedonic or entirely crystalline. It is worthy of note, that, though crystalline, the larger spicules show their forms very clearly when mounted in Canada balsam.

In addition to definite sponge spicules the finer residue of the material consists partly of amorphous grains, probably due to the decay of the smaller spicules, and partly of minute rounded bodies, which appear to be moulds of the chambers of Foraminifera, which have been infilled with the colloid silica, derived from the sponge spicules, whilst their own calcareous walls have been subsequently dissolved away. The only other recognizable organisms in the material are a few radiolarians and minute fragments of Polyzoa whose tests have been silicified. Some of the silica is likewise in the form of minute discs or globules similar to those described by the writer (1) in the sponge-beds of the Upper Greensand of the south of England.

The spicules of which the deposit is mainly composed are extremely various in form and represent all the principal groups of siliceous sponges. The *Monactinellidae* are the most numerously represented and next come the *Hexactinellidae* and the *Tetractinellidae*, whilst the *Lithistidae* contribute only a small proportion of the total number. As a rule the spicules are common, widely distributed forms, and their individual characters are insufficient to allow in most cases of even generic determination, and it is therefore only practicable to give general indications of their systematic position in the larger groups.

1. Monactinellidae

This division is largely represented by straight or curved acerate spicules (*Doppelspitzer*, Vosmaer) (figs 1 — 10, 18, 44) either fusiform and gradually tapering to both ends or subcylindrical with abruptly pointed extremities. They are very variable in length and thickness, ranging from $0^m,25$ to $1^m,6$ in length and from $0^m,016$ to $0^m,058$ in thickness. Usually they are smooth, but some are microspined, the spines being either in rings (fig. 10) or irregularly distributed over the surface (fig. 18). curved cylindrical spicules, with rounded ends are fairly abundant (figs 33-43). Similar forms have been provisionally

(1) *Philosophical Transactions of the Royal Society*. — Part II, 1885, p. 427.

referred to the genus *Reniera*, they are very common in fossil sponge beds, ranging from the carboniferous rocks upwards.

Acuate or styliform spicules *(Stift*, Vos.) (figs. 11-17) are also numerous. both smooth and microspined forms are present ; with them are the nearly allied spinulate forms *(Stecknadel*, V.) (figs. 21-26) with prominent rounded heads.

These various forms of Monactinellid spicules are the skeleton or body spicules of several different genera of this group of sponges. Though it is now impracticable to refer them to particular genera, it may be safely assumed that they represent at least from 20 to 23 different species. Besides these skeletal spicules a few of the more minute flesh-spicules have been preserved; thus there are some small « anchorates » *(Anker*, Vos.) not more than $0^{m},06$ in length (figs. 27, 28, 29) which closely correspond to those in existing sponges ; also *C*-shaped spicules *(Haken*, V.) (fig. 30) like those of *Esperella ;* clasp-hookforms *(Pflugscharspangen*, V.) (fig. 31) belonging to the existing genus *Hamacanthus;* and chessmen spicules or sceptrellas (fig. 32) resembling those of the existing genera *Sceptrella* or *Latrunculia*. Further a minute elongated spined form (fig. 81) may be the flesh spicule of a species of *Spirastrella*.

2. **Tetractinellidae**.

The most numerous of the detached spicules of this division of sponges are the four rayed forms or Calthrops *(Vierstrahler*, Vos.) (figs. 45-51, 53) probably belonging to the genus *Pachastrella*. They vary considerably in size, as may be seen by the figures; the rays are usually smooth, through microspined forms occur.

There are several different forms of the trifidor zone-spicules of *Geodites* and allied genera (figs. 56-70) in which there is an unusually long, slightly curved and gently tapering shaft (generally now broken and incomplete) and three head-rays at its summit, which either project forwards or are recurved. In some spicules the head-rays bifurcate and are widely extended horizontally (figs. 54, 55), whilst the shaft is nearly obsolete.

The ovate or reniform spicules (figs. 71-76), similar to those of the dermal crust of the recent *Geodia*, are very abundant and with them are mingled stellate and globostellate spicules like those of the existing genus *Tethya* (figs. 77-80).

3. **Lithistidae.**

This division is represented by the peculiarly irregular spicules with expanded ends to the rays, which belong to the genus *Doryderma* (figs. 82-88. Similar spicules occur in carboniferous rocks and they are likewise very abundant in cretaceous beds, wherever sponge spicules are present. There is a single elongated spicule (fig. 89), characteristic of the genus *Carterella*. A few nodose spicules (figs. 90-92) are like those of *Plinthosella*, save that they are somewhat smaller. Further there is a single example of a rhizomorine spicule (fig. 93) and a lobate dermal spicule of the *Discodermia* type (fig. 94).

4. **Hexactinellidae.**

This division is mainly represented by detached six-rayed spicules of the normal type (figs. 95-101). They are of various sizes, but in nearly all cases the rays have been broken. These spicules probably belong for the most part to Lyssacine sponges, that is, to sponges in which the spicules are not fused into a connected mesh; of the Dictyonine type there are only one or two small fragments of meshwork (figs. 102, 103). There are also fragmentary five-rayed spicules figs. 105-106) of the same general form as those which stud the surface of the existing *Rossella antarctica*. These spicules are present in the Upper Chalk of England and Westphalia. Other minute spicules, likewise five-rayed, are of the scopiform type (figs. 104, 104*a*) *(Besengabeln*, Vos.). A minute fragmentary spicule is probably the end of an amphidisc flesh-spicule similar to those of the recent genus *Hyalonema* (fig. 107).

RADIOLARIA.

In addition to the sponge-spicules there are a few very fairly preserved specimens of Radiolaria, which can be indentified with *Dictyomitra multicostata*, Zittel, described by ZITTEL from the Upper Chalk (mucronata zone) of Haldem and Vordorf in Westphalia (figs. 108, 109). *Zeitschr. d. deutsch. geolog. Gesellsch.*, Bd. 28, 1876, p. 81, taf. II, figs. 2, 3, 4).

FORAMINIFERA.

These organisms are now in the condition of casts in silica; the most abundant form is a species of *Globigerina*.

GEOLOGICAL HORIZON.

Most of the spicular forms briefly referred to above, are widely distributed in Cretaceous and tertiary sponge-beds, and the majority of them also resemble those of existing sponges, so that it is not possible to make any precise determination from them as to the exact geological horizon, from which they have been derived. In general appearance the material very nearly resembles the fine powder contained in many of the larger flints from the upper beds of the Chalk with flints, which occur, more particularly in the Chalk of Norwich, England, and near Belfast in Ireland, and as it is now found in this boulder clay commingled with flint fragments, there is reasonable ground for supposing, that it may have formed part of the Upper Chalk of Denmark.

Croydon, 21 March 1889.