April 28, 1887.

Professor STOKES, D.C.L., President, in the Chair.

The Presents received were laid on the table, and thanks ordered for them.

The following Papers were read:—

I. "Note on Dr. G. J. Hinde's Paper 'On Beds of Sponge-remains in the Lower and Upper Greensand of the South of England' ('Philosophical Transactions,' 1885, p. 403)." By EDWARD HULL, LL.D., F.R.S., &c., Director of the Geological Survey of Ireland. Received March 17, 1887.

In a valuable communication read before the Society in May, 1885, Dr. Hinde has given an account of the bands of siliceous material, generally in the form of "chert," found at intervals in the two Greensand formations of the Cretaceous period throughout the south of England—clearly indicating the extent to which siliceous sponges contributed to the formation of the successive sea-beds of this period; an extent to which, as the "Challenger" soundings show, has its parallel in some parts of the ocean at the present day.

In discussing the origin of the chert and chalcedonic bands in which the spicules are imbedded, or out of which they have been dissolved, leaving cavities in their place, Dr. Hinde states his opinion that "There can scarcely be room for doubting that the beds and irregular masses of chert . . . have been derived from the silica of these sponge-remains; and *from the same source has also originated the silica** which, in many of the deposits—more particularly in the Blackdown Hills—has replaced the shells and tests of the mollusca and other calcareous organisms." He proceeds to say, "The theory has, however, been advocated that the silica of the chert has been derived rather as a direct deposit of this mineral from solution in sea-water, than as the product of the decomposition of the siliceous structure of the sponges. Thus Dr. Bowerbank held that the sponges imbedded in the chert of the Greensand possessed horny and not siliceous skeletons, and that the silica in the chert in which they were imbedded was attracted from the exterior medium by the animal matter, and not secreted from the living sponge. Professor T. Rupert Jones maintains the view that the silica of the chert is derived

* The italics are not in the original.

directly from sea-water; and similar opinions as to the origin of the chert bands in the Upper Carboniferous limestones of Ireland have been put forward by Messrs. Hull and Hardman, and by M. Renard,* with respect to the *phthanites* in rocks of the same age in Belgium. It is a significant fact, however, in connexion with the chert-beds of the Irish Upper Carboniferous strata that some have been discovered filled with sponge-spicules like the chert of the English Greensand, and this indicates a similar origin for the silica, and negatives the supposition of Professor Hull that it was deposited "from warm shallow water charged with silica in solution, in which chemical reactions would be at once set up, favoured and promoted by tidal and other currents."†

I have taken pains to quote the entire passage in Dr. Hinde's paper in order to avoid the possibility of misrepresentation; and I must confess my inability to understand the reasoning of the author. He regards the sponge-spicules as "the source" of the silica, and by their decomposition in the presence of sea-water as having given origin to the beds of chert; but the question arises, from what source did the sponge-skeletons themselves derive the silica from which they were formed? This could not have been from repeated solution and reconstruction, because by this process the supply of silica would have been used up. The statement, therefore, that "the beds and irregular masses of chert have been derived solely from the silica of the sponge-remains instead of from that held in solution by the sea-waters themselves" is altogether unintelligible. The real "source" of the silica is that small amount of this mineral which is always present in ocean waters; from this source the sponge-structures have been derived by organic agency, and without that agency the silica would seldom be solidified. Sponge siliceous skeletons are in reality the result of the presence of silica in sea-water—not its cause. If there had been no soluble silica there had been no siliceous sponges. But I am only here concerned with a defence of the views arrived at, after full in-

* Dr. Hinde, in referring to Prof. Renard's Memoir ('Bulletin de l'Académie Royale de Belgique,' vol. 46, 1878, p. 471), goes so far as to question the author's determination of the nature of the "circular sections" shown in one of the figures (fig. 2) accompanying the paper. The author identifies them as crinoid stems, Dr. Hinde suggests that they are really sponge-spicules; a view that no one so well acquainted with the Carboniferous Limestone as Professor Renard will for a moment admit.

† Dr. Hinde does not mention his authority for the statement of the abundance of sponge-spicules in the Carboniferous Limestone of Ireland, and I suspect that he has in this case, as in that of the phthanites of Belgium, mistaken the sections of crinoids for those of sponge-structures. There is no doubt some difficulty in distinguishing sections of sponge-spicules from ill-preserved segments of crinoid stems such as occur in chert; so that their identity must be determined by the forms which are prevalent in the ordinary limestones.

vestigation by my colleague, Mr. Hardman, and myself,* and corroborated by the independent investigations of M. Renard in Belgium;† and I wish to show how improbable it is that siliceous sponges could, by their dissolution, have taken any important part in the formation of the chert-beds of the Carboniferous Limestone either of Ireland or Belgium, or as far as I am aware of any other country. My argument will be based on the fact that the development of sponge-life in the seas of the Carboniferous period was insignificant, and quite inadequate to account for the existence of bands and masses of chert, sometimes constituting almost a half or a third of the entire mass of the Upper Limestone.‡

Let us now enquire what are the relative proportions of the genera and species of siliceous sponge-structures to those of calcareous forms both in Carboniferous and Cretaceous strata—assuming that the genera and species indicate to some extent the numerical development of these respective forms. In this comparison I shall omit from consideration the mollusca and molluscoidea—though in themselves very important, and altogether lime-forming organisms. In drawing up the following table (p. 307) I have availed myself of the lists published recently by Mr. Etheridge, F.R.S., which make the comparison simple and easy.§

The contrast of the non-molluscan fauna of the two periods will be at once apparent (1) in the enormous proportion of siliceous sponges in the Cretaceous as compared with those of the Carboniferous periods; and (2) in the predominance of corals and crinoids in the Carboniferous period. The insignificant representation of siliceous sponge-structures in the Carboniferous seas as compared with the calcareous foraminifers, corals, and crinoids will also be apparent. As compared with the development of these forms in the Carboniferous period, it will be seen that the species of siliceous sponges might almost be counted on the fingers of the two hands; both in genera, species, and individuals they are quite unimportant as compared with the calcareous organisms of that period, and totally inadequate to supply material for the formation of such beds of chert as are formed in the Carboniferous Limestone formation. The enormous predominance of the calcareous organisms in this formation is a fact which cannot be

* "On the Nature and Origin of Beds of Chert of the Upper Carboniferous Limestone of Ireland." 'Scientific Transactions of the Royal Dublin Society,' vol. 1, 1878.

† "Recherches lithologiques sur les phthanites du calcaire carbonifère de Belgique." Par M. A. Renard. 'Bulletin de l'Académie Royale de Belgique,' vol. 46, 1878.

‡ As in the case of the Upper Limestone of Florence Court, near Enniskillen, altogether 400 feet thick, of which perhaps 150 are formed of chert-bands, intercalated with those of limestone.

§ Phillips' 'Manual of Geology,' Edit. 1885, Part II.

Table showing the Genera and Species of Invertebrata, other than Mollusca, in the Carboniferous and Cretaceous Periods.

	Carboniferous.		Cretaceous.		Observations.
	Genera.	Species.	Genera.	Species.	
Protozoa { Siliceous sponges	6	12	74	162	There is a slight uncertainty regarding the numerical proportion of the siliceous and calcareous sponges of the Carboniferous period.
Protozoa { Calcareous „	2	2	13	50	
Foraminifera	15	43	39	171	
Hydrozoa	2	3	?	?	
Actinozoa	39	144	37	76	
Echinodermata { Echini, &c.	9	30	43	188	
Echinodermata { Crinoids	18	109	5	13	
Annulosa	11	34	4	14	
Crustacea	28	137*	40	110	
Polyzoa	..	..	59	114	
Total { Siliceous sponges	6	12	74	162	
Total { Calcareous organisms	121	514	240	736	

* Chiefly Entomostraca of the Upper Carboniferous stage.

disputed by those who have had opportunities of studying its characters, either in the north of England, in Ireland, or in Belgium, where whole beds may be observed composed almost entirely of crinoid stems and corals; while the microscope generally reveals other calcareous forms, such as those of foraminifera, which are invisible to the naked eye, or under the lens. If, then, these original calcareous structures have become silicified, whence could the silica have been derived if not from the circumambient waters of the ocean under certain special and favourable conditions of temperature?

In his paper on the origin of the beds and nodules of chert (phthanite) in the Carboniferous limestone of Belgium, M. Renard expressly identifies crinoid structures, not only in circular disks of the cross-section of the stems or ossicles, but in the more solid and structureless masses of the chert when treated with acid;* and he expressly states that the silicification has supervened in the case of an originally calcareous rock-compound chiefly of foraminifera, crinoids, and corals;† and, as Dr. Hinde himself admits, M. Renard distinctly states that there is no evidence that the infiltered silex into the limestone is derived from the decomposition of sponge-spicules or frustules of diatoms. Surely such a statement from so competent an observer is entitled to more consideration than that accorded to it by Dr. Hinde,

* *Loc. cit.*, p. 492.
† *Ibid.*, p. 196.

who considers that M. Renard has mistaken sponge-spicules for crinoid stems.*

In conclusion, it may be asked what is the evidence which Dr. Hinde can assign for his statement—that the silica of Carboniferous chert has been derived from sponge-spicules? Absolutely none, except a fanciful analogy between these peculiar masses and the sponge-beds of the Cretaceous formation. On the other hand, it has been shown that no such analogy exists, inasmuch as there was a marked contrast between the organic beings in the waters of the Carboniferous seas as compared with those of the Cretaceous period. In the former siliceous sponges were exceedingly rare; in the latter they abounded; so that, whatever part they may have played in the construction of the Cretaceous bands of chert, it is clear they could have taken no important part in the formation of the chert-bands of the Carboniferous Limestone. The relative weight of opinion as expressed in the papers dealing specially with this subject must be left to individual judgment; in forming this judgment, however, it will not be overlooked that identical conclusions have been arrived at regarding the mode of formation of the Carboniferous chert-bands by two sets of observers working independently, one in Ireland the other in Belgium, almost at the same period, and both using chemical and microscopical appliances.

I trust, therefore, that I have succeeded in showing that there are good grounds for the opinion of those who consider that the beds and nodules of siliceous material in the Carboniferous Limestone have been formed by a direct replacement of original calcareous matter of the limestone itself by silica held in solution in the ocean-waters, and that, consequently, Dr. Hinde is not justified in referring them for their origin to sponge-structures.

II. "Note on Professor Hull's Paper." By EDWARD T. HARDMAN, of the Geological Survey of Ireland. Communicated by E. HULL, F.R.S. Received April 5, 1887.

Dr. Alleyne Nicholson, a palæontologist of no small repute, refers to this subject in his work on the 'Ancient Life History of the Earth,' p. 34. He considers that the silica which has surrounded and infiltrated the fossils which flint contains, must have been deposited "from sea-water in a gelatinous condition, and subsequently have

* Dr. Hinde's words are: "There are shown, however, in one of the figures (fig. 2) accompanying M. Renard's paper, circular sections which more nearly resemble those of sponge-spicules than of crinoid stems, to which they are assigned." Note, *loc. cit.*, p. 433.