that the ice plucked them from outcrops in the bed of a former North Sea; also that these outcrops show the continuity of the North Yorkshire Basin with that of North-Western Germany. The list appended to the paper supports this statement, for it shows that many gaps are now filled, which are obvious when Hyatt's lists for the two regions are compared.

The Middle and the Upper Lias afford much material, but the types are closer to those of North Yorkshire. The Oolites are very scantily represented, although the Lower Cretaceous is abundantly represented both by Ammonites and by Belemnites. Again, there is a great difference between the state of preservation of a collection made from the Drift and that of one which can be made now from the Speeton Clay in situ. Hence, the existence of a wide spread of these clays to the east is confirmed.

The Chalk Belemnites belong to a zone higher than any known in Yorkshire; therefore they probably came from the sea-bed.

CORRESPONDENCE.

FOSSIL BEADS (?) FROM THE GRAVEL OF BEDFORDSHIRE. ARE THEY EVIDENCE OF HUMAN WORKMANSHIP?

SIR,—As I was searching in a gravel-pit some few weeks ago one of the workmen brought me some very curious beads, which I enclose to you. They lay in various positions in the gravel, and were not all in one place, but scattered about in different parts of the pit, and they varied in size from that of a large marble to that of a pea. The supposition is that they are sponges, but possibly some of them may have been artificially fashioned and drilled for stringing. Advantage may have been taken in the case of the others of a natural perforation formed by the decay of the nucleus round which the sponge was formed, and the hole enlarged by one of those flint-borers which are often found, to admit of stringing on a sinew or a strip of hide. I am told that Palæolithic implements have been found in this pit, though I was not so fortunate as to find any. May I not pertinently ask, does not the occurrence of these beads point to a higher state of development in Palæolithic man than is generally conceded? Indications are not wanting which strongly support this view. Witness the cave-paintings of Altamira in Spain, and the occurrence of highly worked Palæolithic implements in caves of Aurignacian age in France, and lately of similar flints at Duston, Northants. While on this subject may I ask why there should not have been in Palæolithic times men of different stages of development living in different parts of the world as at the present day? The tendency has been to class all these ancient races as under the same degree and state of development. It is probably in southern regions where the earliest traces of the higher-developed Palæolithic man are to be found, climatic conditions in the north in those early times being less favourable to their development, if not precluding their existence altogether. I may say

that the locality is Willington, Bedfordshire, and the formation river-gravel.

J. T. Banton.

Kingston Rectory, Cambridge.
January 18, 1913.

P.S.—The Rev. O. Fisher M.A., F.G.S., and Professor J. E. Marr, Sc.D., F.R.S., who have seen the beads, both support the view of their having been used as personal ornaments. They are often, though by no means always, perforated naturally. There is strong reason for supposing they have been used as beads.—J. T. B.

Note by the Editor on the so-called 'Fossil Beads'.

In reply to Mr. J. T. Banton's letter it may interest some of our readers to learn that the so-called fossil beads were figured by Dr. G. A. Mantell in his *Geology of Sussex* in 1822 from the Chalk near Brighton; and in 1829 by Professor J. Phillips in *Geology of Yorkshire*. In 1833 Samuel Woodward in his *Outlines of the Geology of Norfolk* figured several examples from Norwich and from Holt as *Millepora globularis* (now known as *Porosphæra globularis*, Phillips, sp., a small globular species of Calcisponge from the Chalk of England and the Continent). Their history is very extensive, and has been most carefully set forth by Dr. G. J. Hinde, F.R.S. (see Journ. Roy. Micro. Soc., 1904, pt. i, pp. 1–25, pls. i and ii), who describes and figures six species.

In Mr. James Wyatt's paper in the *Geologist* (vol. v, pp. 233–5, 1862) the writer says he first became acquainted with these objects about fifteen years earlier (1847) when uncovering some Anglo-Saxon remains in the Kempston gravel-pit, near Bedford, when several round stones perforated were met with; he adds, "so strongly was I impressed at the time that they were the personal ornaments of the ancient chieftain just exhumed that I actually presented them to the Archæological Society as Saxon beads . . . Subsequent examination of the Drift gravels convinced me that the balls were of an earlier period than the Anglo-Saxon, whether works of art or natural productions. They are described by naturalists as specimens of the Chalk fossil *Coscinopora globularis*, but the question is, how did they become perforated?" Mr. Wyatt, after having examined a great number of specimens, concludes the perforation in these small globular bodies to be *artificial*. In this opinion he was supported by Dr. Rigollot,[1] who wrote that "les petites boules avaient servi à former des colliers à l'usage des peuple sauvages"; but subsequently a strong objection was taken to this opinion by M. Albert Gaudry, who[2] denies that there is any evidence for the assertion that these are works of art, and asserts that they are found *in the Chalk* perforated in the same manner as those specimens found in the Drift.

[1] See account of Dr. Rigollot's observations (*Mémoire sur les instruments en silex*, etc., p. 16, Amiens, 1854). See also Lyell's *Antiquity of Man*, 4th ed., 1873, pp. 165–6, fig. 22.

[2] Trans. Inst. France.

In the same volume of the *Geologist* (pp. 235–6) Professor T. Rupert Jones points out that these bodies, so common in the gravel of Chalk districts, particularly in Bedfordshire and at St. Acheul, have all been, originally, derived from the Chalk in which they are *abundantly found*, either perforated or solid, or with a more or less shallow hole in their substance. They occur in the Chalk itself; on the beaches under Chalk cliffs (as at Ramsgate, etc.) and in drift beds, the materials of which have been furnished by the Chalk, and in the decomposed chalk along the bottom slopes of the North and South Downs.

"The concavity of the typical variety (*Porosphæra globularis*) becomes in many of the globular forms a small cavity, a hole, or even a neat cylindrical perforation. The roundness of the specimens and their holes and tubular cavities," says Professor Rupert Jones, "appear to have suggested to the old Flint-folk of the Valley of the Somme, that they might be used for beads; such perforated forms are frequent in the gravel that yields the flint axes. I may add" (he says) "that the imperforate forms occur in the gravels just as

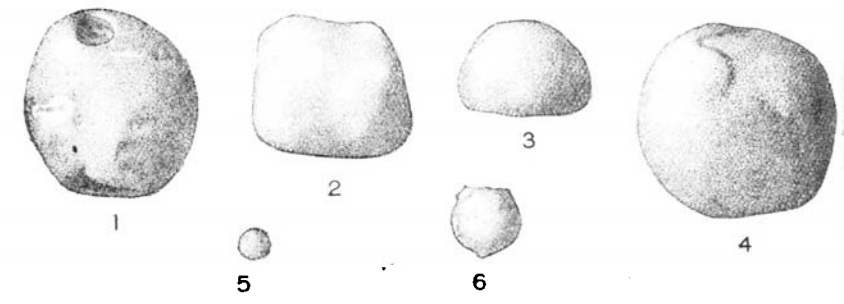

FIG. 1. *Porosphæra globularis*, Phillips, reproduced by the author's kind permission from pl. i of paper by Dr. G. J. Hinde, F.R.S. (Journ. Roy. Micro. Soc., 1904, p. 1–25).

much as the perforate. Also that the perforation of the non-drifted specimens in the Chalk is often just as smooth and straight as if artificial; the interior surface is *not worn*, however, but consists of the natural structure of the organism." (April 22, 1862.)

Dr. G. J. Hinde, F.R.S., in his valuable memoir on *Porosphæra* (Journ. Roy. Micro. Soc., 1904, pp. 1–25, pls. i and ii) says that Dr. A. W. Rowe, F.G.S., in his researches on the fossils from the different zones of the Chalk on the east and south coasts of England has met with many hundred examples of *Porosphæra* which he had placed in Dr. Hinde's hands for examination. This little sponge is common in the chalk cliffs of Yorkshire, Kent, Sussex, Isle of Wight, Dorset, and South Devon.

Dr. Hinde writes: "I may mention that within the limits of a moderately-sized garden situated on the slope of a chalk down at Croydon, Surrey, I have during the last sixteen years picked from the surface-soil 632 specimens of different forms of *Porosphæra* which have all been derived by slow weathering from the underlying Chalk."

Out of the large series of 2,902 specimens of *Porosphæra* examined and determined by Dr. Hinde, about two-thirds, he says, were obtained by Dr. A. W. Rowe, F.G.S., whose researches on the fossils of the different zones of the Chalk of England have become a classical work to all students of Cretaceous geology. In Dr. Hinde's opinion we find only 3 examples named *Porosphæra Woodwardi*, Carter, sp., from the Lower Chalk (Cenomanien) of Dover and the Dorset coast. 109 were obtained from localities in the Middle Chalk (Turonian), 99 of which are referred to *P. globularis*, 3 to *P. patelliformis*, and 7 to *P. arrecta*. But the majority of specimens, 2,770, were obtained from the Upper Chalk (Senonian), which yielded 2,244 examples of *P. globularis*, 257 of *P. nuciformis*, 149 referred to *P. pileolus*, 94 to *P. patelliformis*, 7 to *P. arrecta*, and 19 to "irregular forms of *Porosphæra*"; while of zones unknown, 14 are referred by Dr. Hinde to *P. globularis*, 1 to *P. pileolus*, 4 to *P. patelliformis*, and 1 an irregular form. In all, 2,902 were examined and determined by him, of which 2,357 are referred to *P. globularis* and 545 to the six other species. If we except the Lower Chalk, *P. globularis* occurs throughout the Middle and Upper Chalk, and is very abundant at Dover; in Devon, Seaford and Newhaven, Croydon, Margate, Brighton, Sewerby, and on the Dorset coast. These localities do

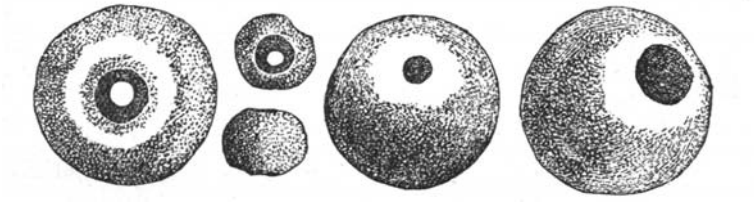

FIG. 2. *Porosphæra globularis*, Phillips, a small bead-like fossil sponge, derived from the Chalk, and found abundantly in the old river-valley gravels of Bedfordshire. The above figures are reproduced from an article by Mr. James Wyatt, F.G.S. (see the *Geologist*, vol. v, pp. 233–5, 1862).

not include the vast number met with in the Bedfordshire gravels and elsewhere *derived* from the Chalk, whilst it is abundant in the gravels at Amiens and Abbeville in France, and is present almost everywhere in the Chalk of Middle and Northern Europe. Dr. Hinde adds: "In form these sponges are generally rounded like peas or marbles, but are sometimes oval, loaf- or cushion-shaped, without any distinctive base; they are mostly free and unattached, but in many cases they grew round foreign bodies, which have been incapable of fossilisation, and these sponges now exhibit cylindrical hollow tubes which extend partly or entirely through them [see 1, Fig. 1]. Generally increase of growth is uniform over the surface, but in some instances fresh layers are formed so as only to cover portions of the surface at once [see 4, Fig. 1]. Small specimens are found of about 1 mm., the larger forms range to 34 mm. in diameter." (Op. cit., p. 19.)

In another place (p. 11) Dr. Hinde says: "Numerous specimens of *P. globularis*, and also of *P. nuciformis*, are penetrated by cylindrical

tubes, some of which extend quite through, so that the specimen becomes a natural bead, whilst others reach only to the central portion of the fossil or beyond to near the opposite side, but without passing through it completely [see 1, Fig. 1]. The tubes generally pass straight through the centres of the rounded forms, but they are not definitely orientated in the cushion- or pear-shaped fossils through which they extend either longitudinally, transversely or obliquely. Out of 1799 specimens of *P. globularis* . . . 321 or about 18 per cent were perforated; 147 being completely perforated, or natural beads, whilst 174 were partially perforated. Of *P. nuciformis* there were tubes in 32, 6 of which extended through, whilst 26 only reached to varying depths in the fossils."

In a letter just received from Dr. Hinde, the writer says: "I do not doubt in the least that the perforations are *natural* and I think it is a mistake to suppose that they have been artificially produced. Numbers of specimens from the surface soil of my garden still have the holes solidly infilled with chalk and I have had to pick out the material with a needle, so that in these examples, at least, the holes were present when the fossil was imbedded in the chalk ooze of the sea-bottom."

He adds: "Mr. G. Crick gave me, some years ago, numerous specimens of *P. globularis* from the Bedfordshire gravels, in which they are so common as to serve as playthings for children! These gravel-specimens have their holes wider and larger as a rule than those obtained direct from the Chalk"—having been *waterworn*. "I quite agree with you that there is no definite evidence that they were used as beads by prehistoric man, although they might have been so used."

Referring to the abundance, origin, and wide distribution of this little sponge in the river-valley gravels of the Ouse, Mr. Horace B. Woodward, F.R.S., writes me: "The *Porosphæra* may well have come from the Chalk of Bedfordshire, which rises up in the Dunstable and Luton Downs—a continuation of the Chiltern Hills. It may also quite possibly have come indirectly by way of the 'Chalky Boulder-clay', which covers large tracts of the Bedford Vale resting on Oxford Clay, bordering the Valley Gravels. The gravel is largely made up of chalk-flints, but it also contains a good deal of Oolitic limestone, derived from the Great Oolite, etc., or from the Boulder-clay."

From the foregoing observations I think we may conclude—

1. That the cylindrical perforations, so commonly present in specimens of *Porosphæra*, *are natural*, *not artificial*, being met with as frequently in specimens obtained directly from the Chalk as in those met with in the Valley Gravel.

2. That their great abundance, scattered promiscuously through the gravel of Bedfordshire and elsewhere, affords no evidence in favour of their having been adopted as ornaments by prehistoric man.

3. That there is no case known or recorded in which they have been so used.

On the other hand, the shells of *Nassa neritea* and teeth of stag bored for suspension probably as a head-dress or necklace were found

with the skeleton of a prehistoric man, probably of Neolithic age, in a cave at Mentone.[1]

There are some interesting notes by Dr. Robert Brown, F.L.S., F.R.G.S. (1868), and Mr. Alexander C. Anderson (Vancouver Island) on shells used by prehistoric people and modern North American Indians as ornaments (see *Reliquiæ Aquitanicæ*, by E. Lartet and H. Christy, edited by T. Rupert Jones, 1865–75, p. 296). In the same work also at p. 70 a shell-necklace from Cro-Magnon Cave is figured on B, pl. xi, composed of *Littorina littorea*, *Purpura lapillus*, *Turritella communis*, etc.

In the Cavern of Bruniquel explored by the Vicomte de Lastic in the Valley of the Aveyron *fossil shells* were found *perforated*, which had evidently been used as personal ornaments (see op. cit., p. 70); the collection is now preserved in the British Museum.

H. W.

SEA-WATER AND CRITICAL TEMPERATURES.

Sir,—How very true the parable of the moat and the beam is, and what a good example thereof is afforded by the letter of Mr. A. R. Hunt in your last number! He accuses his fellow-workers in geology, after a disquisition on the knowledge of foreign languages, of neglecting the researches of Daubrée and other workers abroad. Yet, although he has written on the subject of sea-water in volcanic and metamorphic action, he has apparently never read some dozen or more papers of mine on that subject, written years before (1892–4), though his own countryman.

I have distinctly shown that the critical point of water has nothing whatever to do with the question, and that we have to consider the physical conditions of the gas H_2O *in solution*, under varying pressure in fused silicates and oxides. I have urged the alkalinization of magmas by the assimilation of the alkaline salts in sea and other water, and accompanied by the liberation of the acid radicles in the form of the enormous emanations at volcanic vents. Furthermore, as mineralizers and fluxes, I have mentioned over and over again saline substances as being great agents in metamorphism. I laid down the fundamental principles of eruptive activity, which have never been controverted or controvertible because they are demonstrated and illustrated in all volcanic regions, principally by the nature and characters of the fragmentary ejecta of volcanoes.

Strangely enough, geologists and petrographers steadily and uniformly ignore the invaluable lessons taught by a study of fragmentary ejecta, while they cover thousands of pages with hypothetical, chemical groupings of massive rocks, ornamented by the most astoundingly complicated nomenclature, which, in the end, adds naught to our knowledge. Almost equally uselessly, they make elaborate calculations of percentages of different hypothetical felspars, and are blind to other structures that really record the vicissitudes between the primitive, purely vitreous paste and the consolidated rock.

[1] See *Comptes Rendus*, No. 26, p. 1597, June, 1872; also Geol. Mag., Vol. IX, pp. 272–4, 1872 (with a figure); also op. cit., p. 368, and article by Professor John Morris, *Pop. Sci. Review*, July, 1872.