manure and ammonia salts) *P. pratensis* gave 22·67 per cent. of the total produce, and *P. trivialis* only 0·64; on plot 14 (mineral manure and nitrate of soda) *P. trivialis* gave 24·76, and *P. pratensis* only 2·57 per cent. It is suggested that the relatively shallow-rooting *P. trivialis* predominates on the nitrate plots by reason of its fine surface-roots arresting and taking up the nitrate before it has had time to penetrate too deeply; this plant invariably makes rapid growth upon the application of the nitrate of soda in the spring.

The remaining portion of the memoir is devoted to a discussion of the botany of each separate plot in each season of complete botanical separation, and is carried out with the same elaborate detail as the earlier portion. No one can read this memoir without being impressed with the great power, too frequently overlooked, possessed by the subterranean members of the plant body in deciding the struggle for existence; much of the internecine warfare is carried on in the dark.

It is quite possible, and indeed probable, that, had a similar series of experiments been simultaneously carried out in another part of England with a slightly different climate, and on a different kind of soil, the results might have differed, but only in slight details. Such a splendid series of experiments on grass land has never before been consummated, and the memoir embodying the results will well repay the most careful study and perusal not only of the agriculturist, but of the botanist, the chemist, and the evolutionist. It may perhaps be long before the great lessons learnt in Rothamsted Park have filtered down to those to whom they should be of most practical value, but we do not despair of a time coming when the intelligent manuring of grass lands for very specific objects will form a part of ordinary agricultural practice. Those who will put their hands to the plough in the field of agricultural research must be content to trudge along, laboriously and unnoticed, in the furrow. Their discoveries cannot be made in a week, or a month, as are many in electricity or in chemistry, but, like those at Rothamsted, which are now in their twenty-eighth year, and are still going on, they can only be looked for, even after the expenditure of much thought and of unflagging industry and perseverance, as "the long result of time."

W. FREAM

PALÆOLITHIC MAN—HIS BEAD ORNAMENTS

EVERY one who has noticed the objects found in caves of Palæolithic date knows the evidence which supports the idea that cave men wore bracelets and necklaces, but the evidence that the older river-drift men wore similar ornaments is more obscure. Still, when one notices the extreme beauty and precision of make of some Palæolithic implements, one cannot help surmising that the more ancient savages of our old river sides also had sufficient personal pride and ideas of ornament to sometimes decorate their bodies with beads in a similar fashion with the cave dwellers.

Dr. Rigollot (" Mémoire sur des Instruments en Silex," p. 16) refers to the well-known foraminiferous fossil from the chalk—*Coscinopora globularis*, D'Orb. (sometimes found in river gravels with Palæolithic implements), as beads probably used by Palæolithic men; and Sir Charles Lyell (" Antiquity of Man," p. 119) says: " Dr. Rigollot's argument in favour of their having been used as necklaces and bracelets, appears to me a sound one. He says (Dr. Rigollot) he often found small groups of them in one place—just as if, when swept into the river's bed by a flood, the bond which united them together remained unbroken." Mr. James Wyatt of Bedford, in describing these bead-like fossils (*Geologist*, 1862, p. 234), says he had examined more than two hundred specimens, and on making sections of some of them he saw markings which appeared to indicate " drilling with a tool after the object was fossilised." In specimens from the chalk the hole through the fossil, though commonly straight, exhibits of course no artificial drilling but shows the structure of the foraminifer.

I am not aware of any confirmation hitherto made of the two curious observations noted above, but so little is at present known of the habits of river-drift men that the following notes may prove of some interest. Where there is so much darkness the slightest glimmer of new light is welcome.

After long searching for the Coscinopora at Bedford without result, I lighted on many examples at Kempston in 1880. In this year I found in a few days over two hundred examples; they occurred with unabraded implements and flakes and carbonised vegetable remains. After this date the Coscinopora again ceased, and from then till now I have met with but few examples. The finding of the above-mentioned large number of specimens all congregated tegether appeared to lend some confirmation to Dr. Rigollot's view, for it seems unreasonable to believe that so large a number could by any natural possibility find a position in one place in any river gravel.

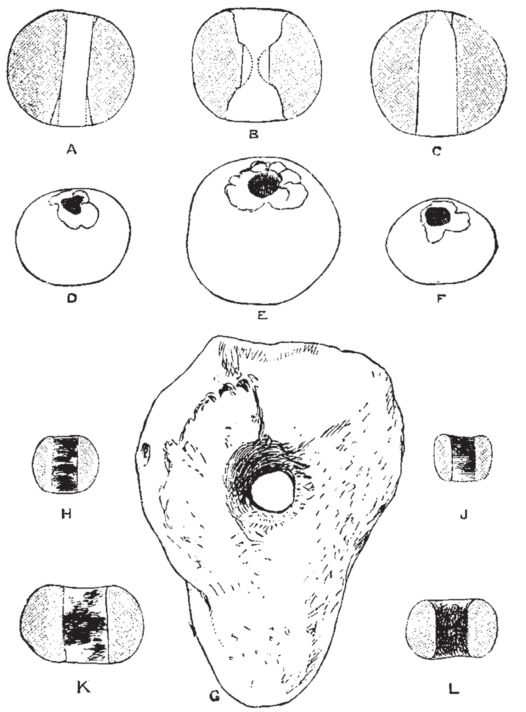
As my examples were found at Bedford, at a place where Mr. Wyatt must at one time also have found a considerable number, I naturally examined the specimens carefully to see if I could trace any artificial drilling or enlargement of the natural hole. I speedily noticed that the surface round each orifice in many of the beads was abraded as if by the constant contact of the bead next on a string. A few of the beads also had the hole artificially enlarged, sometimes at both ends, as at section A, sometimes in the middle, as at the section B, and sometimes at one end only, as at the section C. The dotted lines in these illustrations show the original natural orifice, the solid lines near the dotted ones show the enlargement by artificial drilling. The illustrations are all actual size. In most of the instances the drilling appears comparatively fresh, in others less so, but it must be remembered that the implements found with them were mostly unabraded, and vegetable remains were found. These specimens were found by myself. They were not touched or manipulated by the workmen. Other examples of these beads had one end near the orifice broken away as if in an attempt to enlarge the opening by breaking the substance of the fossil away as at D, E, F.

Whilst looking through the fallen material in the pit, the piece of naturally perforated fossil shell, illustrated actual size at G, attracted my attention. The hole is probably due to a shell-boring mollusk, but when I saw the object in the drift I distinctly noticed that a black substance entered at one side of the hole and emerged at the other; at the moment of picking the object up, this material fell to dust with part of the very friable surface of the fossil shell.

Some of the beads (as seen in section at H, J, K, L) also bore very distinct traces of a similar black substance within the orifice, although not seen till the sand and part of the black substance itself had fallen out. This black material I took to be the remains of part of the ligament on which the beads were originally strung by their Palæolithic owner, and with this idea in mind I sent some to an analytical chemist, who examined the material for me with the following result:—

" The testing for nitrogenous organic matters, of which animal tissues are composed, was tested in the same manner as testing water for such matter, that is, by converting it into ammonia; precautions were of course taken to eliminate from the results any ammonia already existing. The amount of ammonia was strikingly evident and showed with each bead examined separately. The blackening of the organic matter in the holes of the beads may have taken place in a manner similar to that of the formation of coal."

On testing the beads, which consist chiefly of carbonate of lime or chalk, without the black material in the orifice, the chemist reported that, "when treated in the same manner as those originally sent, they show the presence of a considerable amount of heterogeneous or animal organic matter, as was to be expected from their origin—but not, I think, so much as those with the black deposit."



Palæolithic Bead Ornaments (*Coscinopora globularis*, D'Orb.), showing traces of the original ligament and artificial enlargement.

Mr. A. Clarke, analytical chemist of Huddersfield, who also made an analysis for me, reported as follows :—

"I divided the bead into three portions. No. 1. The thin dark crust forming the internal portion of the ring; this is most certainly organic matter. No. 2. A powdery part between No. 1 and the main body of the ring, consisting of small quantities of carbonates of iron and lime. No. 3. The outer main body of the ring, mostly carbonate of lime, and a small quantity of silica; here there is only a trace of organic matter, but it is most distinctly present."

WORTHINGTON G. SMITH

IS IKTIS IN CORNWALL, AND DID IRON AND COPPER PRECEDE TIN?

AT Penzance on October 19, 1883, I asserted that the invention of tin-smelting was Cornish, but disputed the claim of St. Michael's Mount to be the sole claimant to the title of Iktis, the tin-shipping port described by Diodorus Siculus 1800 years ago, and I thought the inventions of metals were in this order: (1) iron, (2) copper, (3) tin. We may consider the Romans invaded Britain purposely to obtain its metals, which were then worked extensively by the British inhabitants. I believe the Romans either adopted Celtic names of places or things, or translated their meaning. I find the Cornish district, or Land's End, described by Ptolemy the geographer in the second century as "Belerium," that is the land of mines, "bal" being Cornish for a mine. The word is also met with in Irish. In the same manner the skin boats used by the Cornishmen, which so much astonished the Greek travellers, were described by the Greeks under the name of "coracles," evidently a Celtic word from the Celtic root "cren" or "croen," skin. So tin, I think, is derived from the Irish word "teine," Welsh "tan," teine probably also expressing brightness. Even in the Malay Peninsula, in the East Indies, a word of similar sound, "timah," still stands for "tin," and not the Greek term for that metal "kassiteros."

Then the Cornish term "iarnn," for iron is similar to English "iron," German "Eisen," Welsh "haiarn," Greek "seiderion," in which *ei* is the important syllable. The Latin word "ferrum" is probably a form of "ierrum," and the Sanskrit "ayas" is for iron, metal. Nearly the same word for iron is therefore used in all the Aryan languages, while "æs" or "kalkos" stands for bronze or copper, and has only a comparatively local extension. The wide spread of the name for iron, or *ei*, is important, as it points to iron being the metal made before the division of the Aryan race, and therefore before copper or tin.

There is another and I believe new argument. The most easy process of copper-smelting, which even now is largely used, may have been the only plan known in prehistoric times. To use this process it was necessary to provide iron to precipitate copper from solution. At the present time 6000 tons of iron are sent annually to the Rio Tinto mines in Spain from Great Britain in order to precipitate the copper from solution.

It is possible that the discovery of the art of producing crude iron, which would be useful for precipitating copper, may have preceded the invention of bronze, and yet the art of forging difficult pieces may have been a later invention than that of casting bronze celts in metal moulds.

Iron, if not steel, appears to have been made in Egypt both in hearths and in crucibles certainly before 3124 B.C., but bronze was more used in Greece up to 650 B.C. than iron.

The smith in the sagas and folklore is the important person, not the caster or founder of bronze weapons. Why was the smith so important? Because he melted the small particles of gold found in the streams into small lumps, and with his hammer drew them out into wire and thin plates. Gold was made in such small quantities that it did not require large crucibles such as would be necessary for bronze. As iron was made by a simple welding or forging process, its production appears to be a more ancient art than bronze casting, which required large crucibles and mixing in exact proportions with tin, a process more difficult than in the infancy of metallurgy was likely to be invented. Then one ore of iron, ochre was the first metallic ore collected, long before the discovery of any of the metal. Ochre is found collected for use as a paint to ornament the cave men in the Palæolithic period, and is associated with limestone and charcoal. Accident in the fire might have thus led to the discovery of metallic iron in very early times. Such particles of iron placed in a certain stream in the Island of Anglesea (an early peopled district) would precipitate the copper in solution in that stream in a state of pure copper ready to mix with tin to make bronze.

Another point of great interest in this question is the position of Roman roads, proving a prior metallurgical trade, and therefore some considerable civilisation. The Romans erected their Roman villas and camps always near Roman roads, and these roads appear always arranged for military or metallurgical purposes, never for protecting agriculture, or levying imposts on the Britons. There is historical evidence that the Romans did not introduce metallurgy into Britain.

We may observe there is a great concentration of Roman roads at Winchester (Venta Belgarum). Roads meet at the point of junction from Exeter with this town, for bringing Cornish or Dartmoor tin, or lead and iron from the Mendips, to the Hampshire coast; iron from