

The recognition of alien life at the level of macroscopic morphology

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Living systems which attain a macroscopic scale (i.e. from about one order of magnitude above to about three orders less than that of our bodies) may be expected to produce shaped objects which may in some circumstances provide very strong evidence for the existence of life. These objects are of two main kinds. One category comprises persisting parts of the living systems themselves, e.g. bones, shells, etc. There are possibly some characteristics which differentiate such products of living systems from natural objects of similar size. It is doubtful, however, whether such a criterion could ever be convincingly applied to a shape of which only a single example was known; but the argument would become much stronger if one found a number of very similar examples of a shape which was difficult to account for in terms of natural processes.

The other category of life-produced shapes are those of artefacts, external to the living system. Here again, repetition of a shape would provide good evidence that it had been produced by a living being. Some human artefacts are, of course, of such a character that even a single example would be a convincing demonstration of the existence of life, e.g. a complex mechanism such as a watch.

In this article I shall discuss whether there are any types of observations, which might be made on objects of macroscopic scale, which would provide substantial evidence for the existence of systems which we would be entitled to describe as living. I shall not be concerned with properties which would justify us in applying the word 'living' to the very objects being observed. These would, of course, involve studies of its metabolism, the energy flows through it, conceivably its capacity for movement, and so on. Here I shall be dealing only with objects which could not themselves be called living, but which might provide evidence suggesting that their production had involved the intervention of living systems. The size range being considered is that from about three orders of magnitude less to, say, two orders of magnitude more, than that of our own bodies, i.e. from about 1 mm to 200–300 m.

Within this range there would seem to be two main categories of object which might provide evidence of life. One type would be non-living things which had at some time formed part of a living system, for instance, bones, shells and the like. The other type would consist of artefacts which had always been external to the living system, but which had been produced by it.

Forms not suggestive of life

The main reason why we might be tempted to infer the existence of life from the morphology of objects in this size range would be that their shape could not be plausibly accounted for in terms of the physical properties of the substances of which they are made. Physical objects formed without the intervention of life very often exhibit nothing which can be recognized as a definite form or pattern; examples are, clods of earth, many formless rocks, and so on. If they do have a recognizable form, this is, I suggest, always a derivative of one or other of two alternative types. In the first type, the form arises under the influence of a rather small number of well defined physical forces. This is obviously the case, for instance, in crystals, where the form is a very direct expression of a small number of interatomic or intermolecular forces. One can also get rather regular patterns, for instance in drying mud, or cooling volcanic molten rocks; and here again the forces which have brought the regular pattern into being are small in number, though they may be quite various in kind in different instances.

There is, however, also a category of regular shapes, not involving life, which are brought about by the action of statistically large assemblages of component activities. Perhaps the most obvious examples are the rather regular shaped pebbles which may be formed when stones are rolled along the bed of a river. The general shape, which may appear in a fairly considerable range of sizes, is the result of very numerous collisions acting on an inert material. This may not be internally homogeneous, but may have, for instance, a semi-fibrous nature which will contribute to the final shape, which need not therefore approach the spherical.

Natural materials not produced by life may also consist of large assemblages of units, each of which has some degree of form of one or other of the above kinds – which we might call the crystalline or the pebble-like, using both those two terms in very broad senses. Some degree of macroscopic pattern may be imposed on such aggregates by geo-morphological forces; for instance, the shaping of rock masses by volcanic action, the laying down of sediments, sculpture by flow of water or of wind, as in sand dunes, or the characteristic wind-shaped trihedral stones, found in deserts. Recognizable orderly patterns are produced by such forces again only when the number of forces operating is small.

Parts of living systems

If, with these examples of inorganic forms in mind, one looks at a typical structure produced by a living system, such as a bone or a shell, I think one is almost always led to suppose that the life-produced structure could only have been molded by a number of forces which were intermediate between those which produce crystalline shapes and those which produce pebble-like shapes. A human femur, for instance, has a complex modelling of swellings and hollows, which could only be produced by more forces than are required in the production of a crystal,

but which still are not numerous enough to reduce it to an ovoid pebble-like shape.

It is true that there are certain shapes produced by life which have a considerably greater simplicity. Examples are birds eggs, and some of the more geometrically perfect snail shells, such as the well known British snail *Cyclostoma elegans*. Here we might be tempted to look for only a small number of moulding influences. However, these influences would have to be of a kind not easily attributable to non-living nature. The bird's egg would perhaps be the most difficult to distinguish from a non-biological form, namely a pebble; but one would have to imagine some type of collision strong enough to mould it, but not strong enough to break it. In the case of the snail shell, one would have to consider some force which could produce an expanding helix. It is not impossible that some such inorganic mechanism might be dreamt up. For instance, some rotating force might coil a thin cylinder of substance into a tight helix, then, say by the inhibition of water which caused swelling of the material differentially from one end of the structure, this might be converted into the expanding helix shape we encounter. But I think it would be difficult to make such explanations very convincing.

In general, however, it seems unlikely that the distinction we have drawn between life-produced and not life-produced forms, namely that the latter are based on the operation of either very few forces or very many, while the former result from the operation of an intermediate number of forces, could ever in itself be applied rigorously enough to provide more than suggestive evidence that life might have been involved, without amounting to convincing proof. The situation would, however, be extremely different if one came across several more or less exact replicas of some form which, as a single example, was suggestive of the existence of life. If one discovered one bone-like object, one might conclude that it looked very like a bone, but one could hardly be totally sure. However, if one came across two, three, four, or many almost exact replicas, the strength of the evidence for a life-derivation would be enormously increased. This evidence would depend, however, not only on the reiteration of the form, but on the form's inherent improbability as a non-biological product. One should remember, for instance, the recent incident of the so-called 'Annelotubulates'. These were small tubular formations which palaeontologists for some time thought sufficiently unlikely to be a biological product, and to show sufficient resemblance to each other, to be evidence for the existence of a phylum of worm-like creatures. However, quite recently opinion has changed, and they are now considered to be 'pseudo-fossils', and non-biological productions after all (Richardson, Gregory & Pollard 1973).

Artefacts

Artefacts made by living creatures also differ from non-living productions in that their shape cannot be deduced from the physical forces likely to have arisen from the nature of their constituent materials, or likely to have impinged on them from any inorganic environment one could suppose them to have been subject to.

There would presumably be no difficulty in realizing the organic origin of a sufficiently complex artefact. If anyone found a wrist watch on the Moon, I think he would be unlikely to doubt that some living creature had been there before him. Similarly if we were to intercept in space a metal tablet engraved with a picture of the complexity of the one which we have recently launched from this Earth, again we would have no hesitation in identifying it as the product of some living system or other. I think the only interesting problem which arises in this connexion is to consider how simple an object we could accept as strongly implying that it had been produced by a living system. If, for instance, we found a perfectly circular flat plate of gold, 6 mm thick, on the Moon's surface, what conclusions could we draw? It is difficult indeed to think how such a block of gold could be formed in that shape by natural processes. However, perfect circles are something which nature can produce without too much difficulty. On the other hand, a perfect cube of any considerable size would be very difficult to explain, unless indeed its constituent material crystallized in that type of symmetry.

Again, repetition would strengthen the evidence offered by any form for which it proved difficult to find a natural explanation. Still greater strength would be lent to such suggestions by the discovery of two unnatural shapes which fitted together. If, for instance, one found a single example of a bolt fitting into a nut, one would be almost forced to conclude that it had been made by a living being and an intelligent one at that; perhaps a sufficiently ingenious sceptic might think up an explanation of one nut and bolt, involving a hurricane or whirlpool, but surely two, of the same pitch, could defeat him.

It is more difficult to decide what we might take as reasonably convincing evidence of the existence of artefact-making living systems of considerably less intelligence than man. In our world many such artefacts, such as birds' nests, insect cocoons and the like, are made of organic materials whose chemical constitution in itself suggests the presence of living things. However, some are not so made; for instance the nests constructed out of mud by wasps, and various other sorts of burrows or hiding places. These present much the same sort of problems as those of shells, or the secreted tubular structures which the *Annellotubulates* mentioned above were supposed to be. I think that here again the strength of the suggestion that living systems have been involved in their production must depend on a combination of the difficulty of finding a non-living process which could produce the structure, and on the precision with which the structure is repeated in a number of different examples of it.

Summarizing, it seems to me that the only type of macroscopic structure from which one could confidently deduce the existence of a living system from a single example would be an artefact produced by an intelligent being. For all other structures, whether they had been parts of a living being, or were artefacts, some suggestion of an origin from life would arise if the form seemed to require for its generation neither quite few physical influences nor a statistically large assembly

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of them, but rather some intermediate number; but this suggestion would not carry much conviction unless reinforced by the discovery of a number of examples of objects in which the form was rather precisely repeated.

REFERENCE (Waddington)

Richardson, E., Gregory, D. & Pollard, J. 1973 Anellotubulates are manufactured 'micro-fossils'. *Nature, Lond.* **246**, 347.