indicator (Fig. 1) seems to have distinct advantages, where a simple pointer on a dial is employed, which is dimly illuminated at night.

Echo sounding, as an item of standard equipment, has now definitely come into being, and there is little doubt that with increased experience ships' officers will become more familiar with the technique of using this instrument. As a result, an immensely increased and much more accurate knowledge of the conformation of the bottom of the sea, particularly on regular routes, will be developed; and navigators will find more and more that they can determine their position accurately by this means.

Fossils as Indicators of Continental Drift*

By SIR ARTHUR SMITH WOODWARD, F.R.S.

STUDENTS of fossils are interested in Wegener's theory that the continents are floating on a heavier layer of the earth's crust which, sometimes at least, becomes plastic and allows them to move through different longitudes and latitudes. If there has been such movement during geological time, this may clearly explain the changes of climate in many areas to which fossils bear witness. It affords a possible reason for the occurrence of plants and animals of temperate or even sub-tropical habit among the fossils found in the present arctic and antarctic regions. It also perhaps shows why the land and fresh-water life of the coal period throughout the northern hemisphere was so remarkably uniform.

The use of fossils, however, in testing Wegener's theory and in determining former land connexions is not so simple as it might at first appear. For example, some who have noted the remarkable similarity between the graptolites in the earlier Palæozoic rocks on the two sides of the Atlantic have concluded that western Europe and eastern North America must have been close together when these graptolites lived in a continuous shallow sea. Others, who have studied also the associated life, have decided that the two areas in question were already separated in Cambrian to Silurian times by a great Atlantic Ocean in which sargasso seas sent forth both to the east and to the west the same floating organisms. There are thus two equally plausible interpretations of the facts, one in favour of Wegener's idea that during the Palæozoic era the continental lands were continuous, while the other points to the immense antiquity and the permanence of at least one ocean basin.

Again, the extensive and nearly uniform distribution of many of the Devonian fishes, which must have lived chiefly in fresh-water lakes and rivers, seems remarkable if the continental areas in the Devonian period were as widely separated as they are at present. It must, however, be remembered that there were already other fishes in the contemporary seas, and certain sporadic fossils suggest that the normally fresh-water forms could also live in the sea, like the existing sturgeons. In this case, they could spread along the coasts and attain their strangely wide distribution even if the lands were arranged approximately as they are at the present day.

There is also the great difficulty, that many fossils which look superficially alike and might be regarded as nearly identical, are really parallel developments from common ancestors. This has been recognised for many years by those who have studied molluscan and brachiopod shells, and it is now becoming familiar to those who investigate other groups. The principle is perhaps most easily understood by reference to discoveries of fossil mammals in North America.

The early Tertiary ancestors of the camels in North America were small animals shaped like gazelles with pointed hoofs. According to Prof. W. B. Scott, they divided into two distinct groups, one adapted for browsing on shrubs and trees, the other adapted for grazing. Afterwards, the toes in each of these two groups became blunt, and the characteristic cushioned foot of the modern camels was developed. The camel foot therefore arose independently in at least two separate lines derived from the same stock. According to Prof. H. F. Osborn and others, the Tertiary ancestors of the horses and rhinoceroses in North America also show parallel lines of evolution. The gradual approach to the one-toed foot of the horses and to the horned snout of the rhinoceroses occurred in several distinct groups at the same time, though sometimes at different rates. Prof. Osborn has also pointed out, in his recent great work on the Titanotheres, that these massive horned mammals, which flourished during the middle of the Tertiary era, evolved on several distinct lines, and independently acquired horns and other features which were approximately the same.

Remembering these facts, it is interesting to consider some of the fossil animals which have actually been regarded as proving former connexions of some kind between lands which are now well separated.

The skeletons of certain fossil Sparassodonts

* Extended account of a contribution to the discussion on "Wegener's Hypothesis of Continental Drift" at the meeting of the Geological Society of London on January 23, 1935.

found in the Lower Tertiary deposits in Patagonia are so similar to the skeleton of the marsupial Thylacine now living in Tasmania, that these animals have sometimes been referred to the same family. They have therefore been interpreted as indicating a former direct connexion between South America and the Australian region. In their palate and successional teeth, however, the Sparassodonts are more nearly similar to some of the early Tertiary primitive Carnivores known as Creodonts, which lived in the northern hemisphere and might well be regarded as also the ancestors of the Australian Thylacine. The Sparassodonts and the Thylacine, therefore, may be merely parallel developments from the same northern source, which migrated southwards by two different land-routes to the remote, widely-separated areas where they are now found.

Among the fossils discovered in late superficial deposits in Australia and some adjacent islands, there are species of a peculiar horned tortoise, *Miolania*, which has the tail armoured with rings of bone. A nearly similar tortoise, which has been referred even to the same genus by some authors, occurs in a rock of uncertain age in Chubut, Patagonia. Here again, at first sight, there seems to be evidence of a former direct connexion with the Australian region and South America. *Miolania*, however, belongs to a sub-order of Chelonians which had a very wide distribution over the northern hemisphere before it became specially characteristic of southern lands. The species found in Australia and South America may therefore be merely independent offshoots of the same source which have retreated south by different routes.

The same explanation almost certainly applies to the little Mesosaurian reptiles which are found in the Permian rocks of South America and South Africa, and have been quoted as part of the evidence that at the end of the Palæozoic era these two lands were directly connected. In the Coal Measures of both North America and Europe, which represent a somewhat earlier geological period, there are ancestors from which the Mesosaurians were possibly derived ; and these reptiles may have gone south in parallel ways down the African and American continents. Similarly, the Dicynodont reptiles, which occur in slightly later rocks in both countries, may have wandered southwards independently, for they are known to have been distributed at the time over Europe, Asia and North America. These fossils therefore do not help to prove that South America and South Africa formed a continuous land when the reptiles in question were living ; and the recent discovery of numerous large Rhynchosauria in the same rocks in southern Brazil suggests that there was no such land-connexion, because no trace of these reptiles has been found in the well-explored corresponding rocks in South Africa.

It is thus evident that when former changes in land-connexions are being discussed, it is not enough merely to compare lists of fossils. The precise relationships of each fossil need first to be determined so far as possible ; and even if this precision can be reached, there are often alternative interpretations which have to be considered.

Obituary

PROF. H. B. BAKER, C.B.E., F.R.S.

THE recent death of Herbert Brereton Baker removes a familiar name from the roll of chemists who made their reputation before the opening of the present century. He was born on June 25, 1862, as the second son of the Rev. John Baker, curate-in-charge at Livesey, near Blackburn—a district in which the distress arising from the cotton famine was then intense, and the relief of which was a real concern of the Baker family. After a period of schooling at Blackburn, both boys were enabled, by sacrifice and rigid economy on the part of their parents, to become pupils at Manchester Grammar School. Beginning on the classical side, young Baker turned over to science, securing later a scholarship at Balliol, as well as a Brackenbury school scholarship. The teaching of chemistry at the Manchester Grammar School was then in the capable hands of Francis Jones, and Baker was always ready to acknowledge his debt to one whom he termed "the best of all teachers".

Baker's tutor at Oxford was H. B. Dixon, and the enthusiasm for investigation which the senior man possessed in an eminent degree was communicated to his pupil. After taking a first class in natural science, Baker was appointed demonstrator at Balliol and private assistant to Dixon ; an association which led him to the main investigations of his life—the effect of moisture on chemical change.

In 1884 Baker was appointed chemistry master at Dulwich College, and on his initiative a science side was developed on the same lines as at Manchester. The chemistry department at Dulwich had already some tradition of research, and equipment for such work had been provided by Baker's predecessor, Alfred Tribe, best known, perhaps, as a collaborator with J. H. Gladstone. The tradition was more than maintained by Baker, and, in spite of heavy teaching duties, he published during this period a great deal of the work with which his name is specially associated. It is indeed a remarkable fact that Baker