THE RELATIONSHIP OF PALÆONTOLOGY TO STRATIGRAPHY

IN his presidential address to Section C (Geology), Dr. C. J. Stubblefield points out that Oxford is a shrine of British palæontology, for from Oxford came the first printed illustrations of British fossils. These appeared in the "Natural History of Oxfordshire", published in 1677, from the work of the first curator of the Ashmolean Museum, Robert Plot. Oxfordshire has other claims for pilgrimage. It contains the birthplace of William Smith; a man whose discovery, that the fossils contained in rocks could be the means of identifying strata, gave a new approach to stratigraphy. Furthermore, the richly fossiliferous Jurassic rocks of which the county is composed have here and elsewhere, by their fossils, provided the key to many basic principles of stratigraphy.

The stratigrapher produces geological maps showing the identification and disposition of the strata in available areas; he describes the geology of the earth's crust. The palæontologist works to ensure accurately determined fossils, with knowledge of their conditions of life, structure, relationships and distribution.

At the time of William Smith's discovery, palæontology was very young; but it was nurtured by three distinguished French biologists, Lamarck, Cuvier and Brongniart. The first two noticed in mapping and tracing upwards the rock succession in the Paris basin that the fossil Mollusca became progressively more like living forms; this observation eventually became perpetuated in the formational names Eocene, Oligocene, Miocene and Pliocene. On a broader basis the changing pattern of life revealed by what is now known to be a quarter or less of the history of the earth's crust is also expressed in J. Phillips's terms Palæozoic, Mesozoic and Cainozoic.

The most striking aspect of the application of palæontology to stratigraphy has been in the classification of the stratal column into successively smaller divisions and in correlating rocks found in different parts of the world.

Palæontology, coupled with an appreciation of lithological changes in contemporaneous deposits, played a prominent part in the establishment of the Devonian or Old Red Sandstone System; in the founding of the Ordovician System the faunas were also an important consideration. Stratal divisions known as stages were formulated by d'Orbigny entirely from palæontological studies, and, in revised and extended form, are useful standards of comparison for regional correlation particularly when considered as unit sequences of zones, that is, of rocks containing successive assemblages of fossils. Such sequences of zones have also helped stratigraphers to find evidence of stratal gaps, and of folding and faulting.

While a geological map is the published outcome of a particular local geological study, in Britain it is now regrettably rare to find, in the accompanying account, pictures of the fossils on which critical age determinations are based. On the other hand, the typical large-scale geological map is required to show the distribution of the different lithological units for several purposes, some non-geological. Though palæontology is used for ensuring accuracy in the local correlations, the mapped divisions should not be too subjectively palæontological. Nevertheless, when such maps are combined for reduction to smaller scales, palæontological data are appreciated as being vital for regional correlation of the rock units.

ARCHAEOPTERYX AND EVOLUTION

IN his presidential address to Section D (Zoology), Sir Gavin de Beer states that the specimen of *Archaeopteryx* preserved in the British Museum (Natural History) has been subjected to a complete re-investigation with the help of modern methods. Making use of the fact that fossil bone shows fluorescence under ultra-violet light whereas the matrix does not, the sternum has been discovered and its bony nature confirmed by X-rays. It is flat and accords with all the other features of the fossil to show that in life it was incapable of active flapping flight but glided from branch to branch of trees. The endocranial cast of the brain has been studied, and Dr. Tilly Edinger's surmises have been confirmed. The cerebral hemispheres were smooth, elongated, and narrow. The cerebellum was small and situated behind the mid-brain, instead of overlapping it from behind and pressing it down to a more ventral level as in modern birds. For the purposes of its limited powers of flight *Archaeopteryx* did not require a high degree of cerebellar co-ordination. Portions of additional vertebræ have been found, confirming that the articulation between their centra was simple.

It has long been realized that *Archaeopteryx* presents a beautifully intermediate condition between reptiles and birds. In principle, an organism intermediate between two groups might be intermediate in structure in all or many of its parts; or it might be composed of a number of structures completely characteristic of one group, a number of other structures equally characteristic of the other group, and few or no features intermediate in structure at all. It is quite clear that the transition from reptiles to birds exemplified by *Archaeopteryx* conforms to the latter alternative, for *Archaeopteryx* is a mosaic of typical reptilian and typical avine characters. The reptilian characters are: the long tail of twenty free vertebræ, the simple articulation between the vertebral centra, the short sacrum involving six vertebræ, the separate metacarpal bones and the presence of claws on all digits of the hand, the separate metatarsal bones, the simple ribs and gastralia, the simple brain with elongated narrow cerebral hemispheres and small cerebellum behind the optic lobes. The avine characters of *Archaeopteryx* are: the feathers identical in structure with those of modern birds, the arrangement of the feathers on the arm identical with that in modern birds, the fusion of the clavicles to form the furcula, the backwardly projecting pubes, and the opposable hallux of the foot.

The transition from reptiles to birds is therefore regarded as providing an example of a mode of evolution termed mosaic evolution, and the question arises whether this mode is also found in the transitions between other classes of vertebrates. The structure of the Ichthyostegalia suggests that this was in fact the case in the evolution of amphibia from fish, and *Seymouria* provides evidence of the same thing in the evolution of reptiles from amphibia. The transition from reptiles to mammals is more complicated to follow, largely because the conventional definition of mammals as vertebrates possessing hair and a squamosal-dentary articulation of the jaws has led to the retention within the reptilian class of