Angular Correlation Experiments

Measurements have been made of the angular correlation between the alpha-particles and gamma-rays emitted in the reaction $^{10}B(n,\alpha)^{7}Li(\gamma)^{7}Li$, and between fission fragments and gamma-rays in the slow-neutron fissions of uranium-235. In the boron experiment[12], the distribution was spherically symmetrical to 2 per cent; there was therefore no evidence from this experiment that the spin of lithium-7 is other than $\frac{1}{2}$. In the fission experiment, significant deviations from symmetry up to 20 per cent were observed, and in addition a delayed gamma-ray, of half-life between 10^{-8} and 10^{-7} sec., was observed.

Thin layers of the separated isotopes boron-10 and lithium-6 have been irradiated in a gridded ionization chamber filled with an argon – carbon dioxide mixture, and a 'kicksorter' is used to measure the ionization produced by the disintegration particles relative to that of polonium alpha-particles. The energy-loss to produce one ion pair is found to depend on the velocity of the ionizing fragment.

The gridded ion-chamber technique has also been used to study the alpha spectrum from the break-up of beryllium-8 following the beta-decay of lithium-8. A neutron beam passes through a rotating shutter with equal on and off times of 0·5 sec., and strikes a foil of natural lithium. The delayed alpha-particles are recorded in a thirty-channel 'kicksorter' when the shutter is closed. The alpha-spectrum was studied between 0·5 and 8 MeV., and only the broad excited level of beryllium-8 at 3 MeV. seems to be involved. From a comparison of the total number of delayed alpha-particles, with the number of prompt events from the $^{6}Li(n,\alpha)$ reaction, recorded with the shutter open, a value of 0·042 barn has been obtained for the capture cross-section of lithium-7.

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VERTEBRATE PALÆONTOLOGY AND EVOLUTION

A DISCUSSION on "Vertebrate Palæontology and Evolution" was held jointly by Sections C (Geology) and D (Zoology) of the British Association on August 10 at Edinburgh. Prof. T. S. Westoll (Newcastle upon Tyne) began by stressing that only a few selected parts of a very productive field of inquiry could be dealt with at the meeting. Palæontology, essentially a historical and observational discipline, must strive to correlate its findings with the potentially or actually experimental investigations of living organisms.

There is good evidence from the fossil record of evolutionary changes of different orders of magnitude—from phyletic ('micro-') evolution of slow change without extensive reorganization of structural pattern, to adaptive radiations involving the emergence of new structural patterns of divergent adaptive importance. Branches in an adaptive radiation may, after a comparatively short period of relatively rapid divergence, survive through a long period of little further essential change, in which phyletic evolution can often be traced. Adaptive radiations can occur at a great variety of systematic levels, from assemblages of orders (for example, Placoderms) or sub-orders (for example, Perissodactyls) through families (Percoidea) and genera and species (Darwin's finches), probably down to demes. The important question is whether mega-evolution, involving really striking modification of structural pattern, is different in nature.

Orthogenesis is a concept long applied to palæontological series. Closer investigation frequently shows greater complication than was at first thought. Furthermore, the more or less vitalistic or metaphysical language in which orthogenesis is so often befogged is found unnecessary by many recent workers. The imperfect geological record and incomplete fossil remains have contributed to an oversimplification in many evolutionary studies.

In cases of 'macro-' and 'mega-evolution' the fundamental problem is in the stability of structural pattern. Phyletic evolution involves the 'plastic' modification of the same pattern; in the other cases a presumed ancestral pattern has been modified beyond its limits of 'elasticity', so that great modifications and adjustments have been made and then stabilized. In such cases, because of limitations imposed by genetic constitution, development-mechanics and structural factors, independent parallel evolution is not infrequent (secondary palate in Theriodontia, cannon-bones in Artiodactyls, etc.); and the essentially *adaptive* nature of the process is shown by convergence in such cases as Equidæ and Litopterna. Organism and environment each exert 'pressure' on the other; and within the limitations of his field the palæontologist must appreciate this dynamic relationship.

Analysis of some selected case-histories was undertaken by Prof. Westoll, and he showed that the evolution of the horses was not orthogenetic, but that at least three succeeding adaptive offsets have taken place. Factors involved in the radiation of actinopterygian and placoderm fishes were discussed in relation to adaptive modification of pattern. A new analysis of the history of the Dipnoi (a remarkably clear and simple 'mega-evolution' at ordinal level) reveals an integration of finite steps of offset from the early stock, with more-or-less persistent groups settling down at certain stages until replaced by more fully adapted forms. The history of emergence of a major group must be very complex, but there is reason to believe that it took place also by the integration of successive offsets. It was noted that growth-studies are of great importance in this field.

Dr. W. E. Swinton (British Museum, Natural History) reviewed the geological history of dinosaurs, a group usually regarded as diphyletic. The two groups—the Saurischia (large herbivores and bipedal carnivores) and Ornithischia (bipedal and armoured quadrupedal herbivores)—both developed from small, bipedal Triassic Thecodonts. These last had only light armour of bony plates on the back. Though many dinosaurs attained very large size, this is not universal.

Giantism is well shown in the Saurischia. One line culminates in the late Cretaceous *Tyrannosaurus*. The Sauropoda, mainly of Jurassic age, reached some thirty tons in weight, partly compensated by their aquatic habit. The Ornithischia show greater adaptive diversity but less extreme growth in size. Bone-development is often striking. Thus, while the duck-billed *Anatosaurus* (*Trachodon*) has no special outgrowths, late Cretaceous relatives (*Corythosaurus, Lambeosaurus, Parasaurolophus*) developed remarkable outgrowths of the premaxillaries or nasals or both, which carry the nasal passages and may have served as air-storage tubes during diving. This is an allometric modification of existing bone. Other bipedal Ornithischia (*Troödon-Pachycephalosaurus*) show no excessive growth, but have massive thickening of the frontals and parietals. Brain-casts indicate enlarged pituitary bodies, suggesting acromegalic hyperostosis. The Ceratopsian skull has a characteristic frill of bone over the neck region, with variable development of nasal and supraorbital horns. These are developments of the skull-bones. Again, a large pituitary body is indicated by brain-casts. The relatives of *Stegosaurus* show no thickening of skull-bones, but remarkable plates are found on the body. The pituitary body, so far as known, is small.

It is suggested, continued Dr. Swinton, that very great body size or abnormal bone-development may be hormonally controlled, hereditary and without sex-linkage. Jurassic Saurischia show giantism but no hyperostoses; Cretaceous Ornithischia show hyperostoses but no real giantism. These developments correlate with two widespread Mesozoic temperature minima. This 'phylogenetic pituitarism' suggests that the diphyletic origin of the dinosaurs needs reconsideration.

The relationship between mammals and Synapsid reptiles were then examined by Mr. F. R. Parrington (Cambridge). The Permian and Triassic mammal-like reptiles, especially those of South Africa, first discovered about a century ago, have long been known to resemble Monotremes in their post-cranial skeleton and to develop mammal-like cranial and dental characters. There is general agreement that mammals originated from the later (Triassic) Theriodont members of the Synapsida, but precise origins are obscure. This is largely because of the paucity of fossil theriodonts and mammals from about the end of the middle Triassic through the Mesozoic.

Two upper Triassic skeletons described by Broom showed remarkably close approaches to mammalian conditions, and were placed in the new sub-order Ictidosauria. To this sub-order are now referred a few fragmentary fossils once regarded as advanced Cynodonts, and the remarkable *Tritylodon* and its allies, long regarded as mammals. *Bienotherium*, a Chinese Tritylodontid, was described by Young, and shown by Watson to retain the reptilian jaw-articulation and to be probably a Cynodont derivative. Kühne has fully confirmed this by his study of the European relative *Oligokyphus* (Rhætic and Lower Lias of Somerset, etc.). The Ictidosauria so defined show a variety of tooth-crown structure.

Certain teeth from Rhætic – Lower Liassic deposits in Britain and Switzerland are still more mammalian in appearance, and suggest comparison both with Symmetrodonts and with Pantotheres, two orders of Mesozoic mammals, the rare remains of which have been fully monographed by Simpson. Two other orders—Triconodonts and Multituberculates—have been regarded as of unknown but separate Theriodont origin, but since then the Tritylodontids, earlier regarded as Multituberculates, have turned out to have reptilian jaw-articulations.

Since there is much diversity of form of the cheek-teeth both in Mesozoic mammals and in Ictidosaurs and other late Theriodonts, and since there is some parallelism, the question arises whether mammals form a true taxonomic unit, or are polyphyletic. The evidence is equivocal, and has been used to defend quite diverse views. But there can be no doubt that many 'mammalian' skeletal features had already been evolved by the Theriodonts. Only the jaw-articulation and middle-ear structures are clear points of distinction. Much of the argument turns on whether such structures are likely to be similarly modified by parallel evolution. The recent important discoveries give hope that palæontology may before long clarify this problem, and perhaps lead to a solution.

Dr. G. S. Carter (Cambridge) also discussed the problem of mammalian origins by focusing attention on the Monotremes, and by using the methods of comparative morphology. The Monotremes are in many respects remarkable structural intermediates between reptilian and mammalian patterns. The phylogenetic position of the Monotremes has been very diversely argued: at one extreme Brazier Howell, on the evidence of the shoulder-girdle, suggests that they evolved from an early reptilian stock quite distinct from that leading to other mammals; at the other, W. K. Gregory recently maintained that they are aberrant marsupials. The most generally accepted view is that they diverged from an early mammalian stock in Triassic or possibly Jurassic times.

The modern Monotremes are specialized: *Ornithorhynchus* is aquatic, and *Echidna* (=*Tachyglossus*) is believed to be descended from aquatic ancestors. Feeding habits are also specialized. Both Monotremes are mammalian in hair, diaphragm, lungs, breathing, heart and blood system, kidneys and most features of skull and jaws. The physiology, so far as is known, is mammalian except in a few characters. Even the small blood-corpuscles are mammalian in form, an adaptation allowing smaller capillaries and a higher metabolic rate. A few characters are worth special attention. Control of body-temperature is by increase of muscular activity when cold; control by sweating is probably absent or slight, and variation of body-temperature with external temperature is greater than in mammals, but less than in living reptiles. Four striking features of Monotremes were noted: the shoulder-girdle retains coracoids and interclavicles, and the fore-limb shows a reptilian posture—it is suggested that in the latter feature *Ornithorhynchus* is adaptively specialized to swimming by means of the fore-limbs, whereas *Echidna* is thought to have had aquatic ancestors; the female generative system is almost entirely reptilian, but mammal-like features are the relatively small yolk and a crude development of a follicular cavity; the monotreme eye is entirely reptilian except for two features, the chief being the superior oblique muscle which turns through a pulley and has moved its attachment area as in mammals; and finally, though facial musculation is developed in Monotremes, a difference from living reptiles, the pattern is different from that in placental mammals.

Monotremes and placental mammals probably diverged when many characters of the soft parts and physiology as well as the skeleton were mammalian, some still reptilian. Most of the monotreme characters are either completely mammalian or completely reptilian: few are intermediate. This implies a series of consecutive changes rather than a grand simultaneous transformation. Such a view is not opposed by the palæontological evidence.

In the ensuing general discussion Prof. Westoll noted that the Theriodonts show several features indicating the piecemeal acquisition of mammalian characters. If one bases classification solely on the presence or absence of the mammalian temporomandibular joint, then pouch-young of some marsupials and even an occasional lamb at birth are reptiles.

Lieut.-Colonel L. M. Davies spoke as one to whom evolution is a fact yet to be proved, and pointed out the enormous differences between a bird's feather and any reptilian dermal structures. He asked how such things could happen as a result of explosive evolution. It was pointed out that 'explosive' is a word implying comparative rather than absolute speed of evolution, and that in any case the history of the birds is very badly known. Other speakers discussed giantism in various aspects, and a case of genetically controlled hyperpituitarism was mentioned. T. S. W.

SURVEYS OF UNDER-DEVELOPED AREAS

THE Duke of Edinburgh referred in his presidential address at the British Association to the various shortages which the world is now facing and which are "partly due to the huge inevitable waste of war and its consequences, and partly to the lack of any comprehensive survey of the world's resources and requirements". "It is only," the Duke continued, "by an accurate knowledge of the world's resources that we can foresee the scope and magnitude of the future problems which science and technology have to meet and which only they can solve." For a whole day, on August 14, an inter-section discussion was concerned with the need for the assessment of the resources of those areas that seem to the rest of the world to be undeveloped or under-developed and about which extravagant claims are often made. At the end of the day one of the speakers commented that, from the dozen or so papers read, one thing stood out most clearly—namely, that as scientific men, all recognized the need for more facts. Especially was there a need for the establishment of the facts by preliminary surveys. To make haste slowly was the speediest, as well as the surest, way of developing areas for the benefit both of their inhabitants and of mankind generally.

The importance accorded by scientific workers to the problems of the economic development of the under-developed parts of the world was shown by the number of Sections collaborating—E (Geography), C (Geology), D (Zoology), K (Botany), M (Agriculture) and F (Economics)—and by the size of the audience throughout the morning session. The problem of these areas has been posed by the politicians, notably by President Truman in Point Four of his address to Congress in 1949 : "We must embark on a bold new program for making the benefits of our scientific advances and industrial progress available for the improvement and growth of under-developed areas". But it falls to scientific workers to show just how these benefits are to be brought to such regions, and the discussion made it clear that there are no short cuts and no easy solutions, and that a tremendous diversity of conditions must be encountered. Prof. L. Dudley Stamp, who opened the discussion, claimed that the huge losses incurred in the Tanganyikan groundnut and the Gambian poultry schemes showed convincingly that, apart from any possible political or financial mismanagement, there is at present inadequate knowledge on which to base development schemes in under-developed lands, especially in the tropics.

Prof. Stamp explained the purpose and organization of the World Land-Use Survey, of which he is director of the Old World Division. He elaborated the aims of this fact-finding survey—to record the existing use of the land and to attempt to ascertain the reasons why the land is used as it is—along lines similar to those of his article in *Nature* of June 23, p. 1010. The need for objectivity, he said, is paramount : if subjective judgments are introduced, the value of such a Survey will be greatly reduced. For these and other reasons, the Survey recommends that any map prepared should be, like the one-inch map, 'survey accurate', even though the final product covering the whole world will be only on the scale of one to one million. The land-use classification drawn up by a Commission of the International Geographical Union is designed to cover as many different categories of land use as possible in regions as diverse and as distant from one another as Thailand, northern Canada and tropical Africa. An essential prerequisite of development anywhere in the world, whether well known and intensively used or unknown and undeveloped, must be a record of the present position and the causes that lie behind it : in Prof. Stamp's phrase, there must first of all be a "synoptic, objective view".

Fifteen years ago the prospects of such a world survey would have seemed meagre indeed, and even to-day the financial problems are large and as yet unsolved. But, as several speakers pointed out, the use of air photographs in mapping now makes possible the covering of much of the world, including many of the under-developed areas. In the absence of Brigadier M. Hotine, the director of Colonial Surveys, Lieut.-Colonel G. J. Humphries described the comprehensive and ever-increasing range of the activities of that Directorate since its establishment in 1946, and discussed some of the difficulties encountered both at headquarters and in the Colonial territories. He explained the adoption of the scale of 1/50,000 as being the one that most nearly meets the requirements of most users of the maps. Contouring remains the chief bottle-neck ; hence the issue of 'preliminary plots' in black-and-white only, and with hachuring to indicate certain relief features ; but fully coloured, contoured maps will be available later once the immediate and pressing demands of the development plans of all British Colonies have been met. Later in the discussion, Mr. T. D. Weatherhead, director and general manager of Hunting Aerosurveys, Ltd., gave illustrations of how his company's photographs have helped agricultural and planning authorities and guided geologists in undertaking their field-work. He believed that the problem of speedy contouring can be overcome by the wider use of aids such as the airborne profile-recorder.

Two geographers spoke of land-use surveys with which they had been associated and thus illustrated both the potentialities and the problems of so vast a project as a world survey of land use. Dr. J. Wreford Watson, head of the Geographical Branch, Department of Mines and Technical Surveys, Canada, showed how geographers are employed by the