$\pi$-mesons, the mass of the neutral $V$-particle is about 950 $m_e$.

The third event of the same type consists of a positive particle at minimum ionization with momentum $1 \cdot 5 \times 10^8$ eV./$c$ and a short unmeasurable negative particle.

We conclude that the photographs provide strong evidence for the existence of two types of unstable neutral particles, one of greater and one of less than the proton mass, probably decaying according to schemes (1) and (3). This conclusion can only be avoided by assuming the existence of the negative proton.

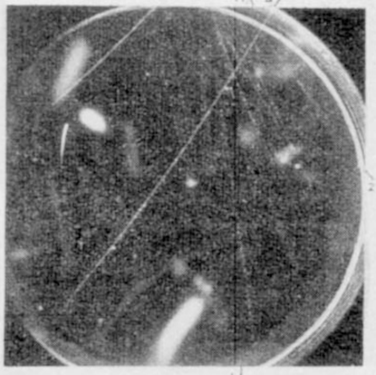

Fig. 3

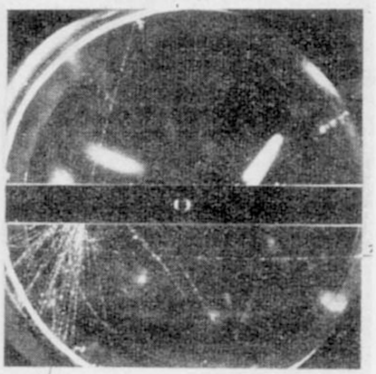

Fig. 4

The data on the charged $V$-decays are very meagre, but some provisional conclusions and a detailed discussion of one event will be given. Six charged $V$-tracks are due to the decay of new unstable particles, but measurements can be made only on four of the events. The four charged secondary tracks can be measured; one is positive and could be a proton, and three are negative and are probably mesons. The tracks of three of the unstable particles are too short for measurement, but one negative particle traversed the top half of the chamber and decayed below the plate, producing a meson and a neutral particle, which afterwards decayed, forming a neutral $V$-track. This event will be described in detail in a later paper; provisionally, we conclude that the neutral particle from this charged decay may be a neutral $V$-particle.

One of the charged $V$-particles decayed when travelling slowly in the chamber; it is shown in Fig. 4. A high-energy nuclear interaction occurred in the plate and a short heavy track (1) was produced, the ionization of which is more than four times minimum. Thus the velocity of the initial particle must be less than $0 \cdot 45\ c$. The single charged decay product (track 2, on right) is at minimum ionization. The decay point is not seen easily on a single photograph owing to the presence of many other tracks, but is clearly visible stereoscopically. Track (2) has a momentum of $-(1 \cdot 4 \pm 0 \cdot 1) \times 10^8$ eV./$c$; it makes an angle of 100° with track (1) and is probably a negative $\pi$- or $\mu$-meson. The decay process cannot be either a $\pi \rightarrow \mu$ decay or a $\mu \rightarrow e$ decay. The unknown neutral particle may be a $V^0$-particle, a neutron or a $\pi^0$-meson. The mass is found by assuming the decaying particle to have the maximum momentum consistent with the observed specific ionization. The results of these calculations are shown in Table 4.

Table 4. Mass of the Charged $V$-particle

| Assumed charged secondary | Assumed neutral secondary | Mass ($\times m_e$) |
|---|---|---|
| $\pi^-$ | $V^0$ (2,300 $m_e$) | 2,750 |
| $\pi^-$ | $V^0$ (800 $m_e$) | 1,300 |
| $\pi^-$ | $n^0$ | 2,350 |
| $\pi^-$ | $\pi^0$ | 920 |
| $\pi^-$ | $\nu^0$ | 820 |

A more detailed discussion of the measurements on all the $V$-tracks will be published in due course; meanwhile, we can summarize the main results of the present investigations as follows.

(*a*) The occurrence of $V$-tracks in the chamber has again been confirmed.

(*b*) Probably not more than 10 per cent of the $V$-tracks can be explained by processes other than the spontaneous decay of new unstable particles.

(*c*) Momentum measurements on fifty-four secondary particles from neutral $V$-decays have been made and, together with ionization estimates, make it possible to identify with certainty both protons and mesons.

(*d*) Assuming that only two particles are produced by the neutral decays, two schemes are suggested to explain the photographs: $V^0 \rightarrow p^+ + \pi^-$, with the $V^0$ mass in the range (2,000–2,500) $\times\ m_e$; $V^0 \rightarrow \pi^+ + \pi^-$, with the $V^0$ mass about 1,000 $m_e$. The relative frequency of these two processes will be discussed in a later paper, but the evidence is already strong for the existence of two types of $V^0$-particle.

(*e*) Six charged decays have been observed, but no definite conclusions have been reached about the mass of the charged $V$-particles.

We wish to thank Prof. P. M. S. Blackett for his great interest and help in this work and for the excellent laboratory facilities he has given us. We are also much indebted to Prof. J. Rösch, director of the Observatoire du Pic-du-Midi de Bagnères-de-Bigorre, who gave permission for, and carried out with extreme efficiency, the installation of the 11-ton magnet in the mountain observatory. In addition, Prof. Rösch and his staff have been of the greatest assistance during the running of the apparatus. Our thanks are due to the Nuffield Trustees and the Department of Scientific and Industrial Research for financial assistance. We also wish to thank Dr. G. D. Rochester and Dr. J. G. Wilson for many helpful discussions.

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# PHYLOGENY IN RELATION TO CLASSIFICATION

THE Systematics Association held a discussion on "Phylogeny in Relation to Classification" in the rooms of the Linnean Society on December 14. Prof. Alan Boyden, of Rutgers University, opened the discussion after being welcomed to Great Britain by Capt. C. Diver from the chair.

Prof. Boyden said that the new systematics is in danger of losing its perspective. The tendency to identify systematics with phylogeny, which began after the publication of Darwin's "Origin of Species", has developed into the present attempt to identify systematics with the detail of genetical and evolutionary mechanisms. This attempt is well exemplified in Huxley's statement that, "Fundamentally, the problem of systematics, regarded as a branch of general biology, is that of detecting evolution at work". It is also to be found in the current definitions of species such as those given by Dobzhansky or Mayr, which define species as stages in evolution or as interbreeding populations, but make no reference to kinds of organisms.

Of the two, taxonomy and phylogeny, so Prof. Boyden continued, it is taxonomy which is the more universal and significant sector of biology, for several reasons. The inadequacy of the fossil record for most groups of organisms, and the slow rates of even "explosive evolution", mean that taxonomists will, at any time, be more largely concerned with the collecting, describing, naming and comparing of the results of a thousand million years of evolution than with the witnessing of the production of new species or the tracing of the ancestry of old species. Furthermore, the grand object of classification everywhere is the same, namely, to put essentially like things together and to separate unlike things. No other basis for a classification of organisms will enable the human mind to deal effectively with a million or more species of animals. Whether the fossil record is adequate to make a plausible phylogeny possible, or whether there are no fossils known, *all* animals must be classified. Taxonomy, "the science of arranging the myriad forms of life", must be universal.

Mr. E. J. H. Corner began his contribution by emphasizing the significant difference between artificial classification by contrast and natural classification by affinity. The former, providing the easier means of identification, prevails in floristic works and seemed to him to be the basis of J. C. Willis's recent attack on phylogenetic morphology ("The Birth and Spread of Plants", 1949). Natural classifications, which it is the endeavour of world monographs to present, reveal the gradations in structure which orthodox phylogeny would expect and do not support Willis's contention of evolution by divergent dichotomous mutation. Mr. Corner believes firmly in the morphological method of phylogeny, so long as it is supported by fundamental microscopical analysis, and he cited, as examples, *Pæonia* and the Leguminosæ, in particular, and the seed structure of Angiosperms in general. Mr. Corner then went on to explain why he considers that the evolution of Angiosperms has been the evolution of tropical dicotyledonous rain-forest, beginning with megaphyllous pachycaul plants of low stature and ending with highly specialized leptocaul trees of vast stature. Thus, the evolutionary environment of Angiosperms appears to have been created by themselves in ever-increasing complexity as the forest canopy was elevated.

In the general discussion which followed, Dr. W. B. Turrill expressed the view that phylogeny, so far as plants are concerned, is largely a matter of speculation. There is a great need for relevant data based on fossils. In the living Angiosperms there is evidence of reticulate relationships, whereas phylogenetical relationships, if they are known, will be linear. He was sceptical of the value of phylogeny in classification, although he welcomed phylogenetical speculation as a stimulus to research. Dr. B. P. Uvarov was another sceptic, doubting whether we should ever have adequate knowledge on which to base phylogenetical trees. Zoologists, he said, are expected to speculate on the phylogeny of their groups; but it might be better to keep to classification. Dr. Errol White, taking up the challenge, suggested that no palæozoologist would publish a classification that was not based on phylogeny, even if part of it was speculation. There is considerable evidence bearing on the origin of most groups of fishes, although the various lines of Teleosts appeared very quickly; and their immediate ancestors are not in many cases easy to identify. In spite of this, the picture is becoming much clearer, and Dr. White said that he regarded Dr. Turrill's antipathy as a case of special pleading.

Mr. P. C. Sylvester-Bradley said that phylogenetical lineages must be speculative in the absence of fossil evidence. Most palæontologists would agree that, even when the best fossil evidence is available, all but the smallest steps of a lineage are to some extent speculative. But one thing at least is becoming clearer: the more we learn of invertebrate phylogeny, the more widespread do we find the phenomenon of parallel evolution. Specialists in all invertebrate fossil groups are constantly discovering 'homeomorphs'—groups which, once regarded as monophyletic, are now put forward as polyphyletic. New classifications are often based on such discoveries and hypotheses. The effect is sometimes catastrophic. Thus, Salfeld's theory of "iterative evolution" in the ammonites, if adopted in their classification, would "bid fair to defeat most of the objects of nomenclature"[1]. It is not surprising, therefore, to find that there is in certain quarters a strong and growing feeling of reaction against a classification that is entirely governed by phylogeny[2]. It seems that some compromise must be found between the needs of a classification which aims at recording the course of evolution and one which aims at grouping together forms of like morphology.

The suggestion was made by Dr. O. W. Richards that the work of the taxonomist is to discover the essential characters of organisms. What is this, he said, but an attempt to find their position on a phylogenetic tree? It is often difficult to decide the limits of species without introducing evolutionary ideas into the definition of species. Whether or not Dr. Uvarov's scepticism is justified, phylogenetical ideas stimulate the search for further morphological details and one's outlook often affects what one sees or overlooks.

In spite of Dr. Turrill's agnosticism, Mr. B. L. Burtt considered that phylogeny has a part to play in plant taxonomy. In the larger groups, relationships appear to be reticulate, and in practice characters are weighted in accordance with presumed phylogenetical relationships in order to devise any system of classification at all.

Mr. H. W. Parker considered that any attempt to make a classification without a motive is a waste of time. Phylogeny, in expressing what we think has taken place, supplies a motive. It is doubtful whether, in the end, there would be much difference between classifications based upon the correlation of the greatest number of characters and phylogenetical classifications. Characters by which groups differ are readily picked out, but it is difficult to assess the far greater number held in common except in a phylogenetical system.

Dr. R. Melville agreed with Mr. Corner on the divergence between the Leguminosæ and Rosaceæ, but referred to palæobotanical and physiological evidence for the derivation of the compound pinnate leaf, prevalent in the Leguminoseæ, from comparable Pteridosperm leaves. Then the legume may have been derived from a terminal leaflet, and other floral members from successive leaflets along a pinnule. Some of the complex inflorescences in this family correspond with a compound leaf, itself evolved from a branch system. Dr. Melville said that he differed in believing that Angiosperms are derived mainly from herbaceous ancestors, basing this opinion on the fact that the palæobotanical record consists predominantly of woody plants ; yet, so far, no fossils have been discovered that throw light on this problem.

In summing up, both Mr. Corner and Prof. Boyden further stressed difficulties in the way of arriving at a phylogenetical classification. Mr. Corner said it is not easy to decide what is primitive and what is advanced, simple organisms, such as *Wolffia*, being often not primitive but extreme examples of specialization and reduction ; and Prof. Boyden pointed out that the blood cells and other cells of the body differ from one another, though they have the same phylogeny and carry the same genes.

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# INTERNATIONAL COMMISSION ON LARGE DAMS

## CONGRESS AT DELHI

THE Fourth Congress of the International Commission on Large Dams was held in Delhi during January 11–16, concurrently with a sectional meeting of the World Power Conference (see *Nature*, March 3, p. 334) and the First Congress on Irrigation and Canals. At the joint inaugural session of the two Congresses and the Conference, the delegates from more than thirty nations were welcomed by Mr. C. Rajagopalachari, Home Minister of the Government of India. Mr. A. Coyne, president of the International Commission on Large Dams, was one among other leading personalities who addressed the joint gathering. An International Engineering Exhibition, organized by the Indian National Committees in association with the three international bodies, was opened on the previous day. This Exhibition was planned as an aid to the promotion of the objectives of the international bodies concerned with the conferences, and numerous countries and research and industrial organizations were represented. It covered not only engineering products but also numerous aspects of hydro-electric power development, irrigation, flood control and other related matters.

The papers for presentation at the four technical sessions of the Congress on Large Dams were circulated in advance, and a summarizing report on each of the four groups was prepared by a general reporter. The subjects of these sessions and the general reporters were as follows :

(1) Design and construction of earth dams and rock-filled dams with their core walls and diaphragms (W. P. Creager ; United States).

(2) Methods for determining the maximum flood discharge that may be expected at a dam, and for which it should be designed. Selection of type, capacity and general arrangement of temporary or permanent outlets and spillways and determination of their capacities (Kanwar Sain ; India).

(3) Concrete for large dams. Properties of concrete, cracking in dams, use in mass concrete of pozzolanas, blast furnace slag, hydraulic lime, etc. (F. M. Lea and H. D. Morgan ; Great Britain).

(4) Sedimentation in reservoirs and related problems (Georges Drouhin ; Algeria).

Nearly a hundred papers in all were presented, and the meetings attracted large audiences and were characterized by vigorous discussion.

The art of building earth dams is an ancient one, and indeed one of the papers presented to the Congress described some of the Indian earth dams built as far back as 1,600 years ago and still in service to-day. With increasing size, however, many new problems have entered into the design and construction of earth dams, and problems of their stability and impermeability have been a subject of vigorous work for several decades. The papers on the design of earth dams dealt with the methods of analysis used in assessing their stability and the internal stresses created in them by water pressure and other forces. While impermeable cores of puddle clay are still widely used in earth dam construction, increasing use is now found of thin reinforced-concrete core walls and of other methods for obtaining a positive cut-off. These matters were dealt with in a group of papers. Others were concerned with the protection of slopes of earth dams, whether by grassing, covering with a layer of stone, or by concrete paving and other methods ; the construction of rock-filled dams, problems arising in their design, and the location of the impervious element of the structure ; and the settlement of dams and the requirements for spillways.

The assessment of the maximum flood discharge which may be expected at a dam is one of the most critical problems that faces the designer. Local data and observation play a most important part in this assessment, but often have to be supplemented by more general climatic, meteorological and geographical information. The general reporter for this second session, in his summary, grouped the methods used for assessment of the maximum flood discharge into three categories : those dependent on probability formulæ, those on empirical formulæ, and those which depend more directly on local observation. It is evident from the papers submitted and from the discussion that general agreement has not yet been reached on the methods which most satisfactorily combine safety with maximum economy. The principles and techniques followed in spillway construction and the relative advantages of the various types for particular circumstances were discussed in a further group of papers. The problems of diversion of rivers during construction of dams, whether by coffer-dams, or diversion tunnels, were illustrated by an account of the methods used in five modern American dams.

The designer of concrete dams has to consider somewhat different factors for each of the three main types—gravity, buttress and arch. For gravity dams high strength is not required, whereas in arch dams the designer has to use high stresses, with buttress dams occupying an intermediate position. Requirement of watertightness is common to all dams. Cracking, which is one of the most serious problems, is, in gravity dams, caused primarily by the rise in temperature which takes place in the concrete after placing and the gradual cooling which occurs later. The temperature rise is a simple reflexion of the fact that the reaction of cement with water is an exothermic one. With arch dams, the volume changes in the concrete arising from drying shrinkage, and