The final section of the conference dealt with the receptors. Dr. Fernandez Moran described the structure of the insect retina, which is of particular interest in view of the ability of insects to orient themselves by polarized light. Dr. George Wald summarized the relation of visual pigments to the process of vision, and Dr. G. Svaetichin gave an analysis of the receptor potentials from single cones. Dr. E. F. MacNicholl gave an account of the subliminal slow potentials recorded from the eye of *Limulus*, and Dr. H. Autrum an electrophysiological analysis of the visual systems of insects. Drs. Forbes and Deane presented electrical studies of colour vision in the turtle. The physiology of olfactory, sound and taste receptors was described by Drs. D. Ottoson, H. Engstrom and Y. Zotterman. Drs. K. Porter and G. Palade discussed membrane-limited systems, in particular the endoplasmic reticulum in the cytoplasm, and paid special attention to its manifestations in striated muscle, where it was suggested it may play a part in transmitting depolarization from the sarcolemma to the myofibrils.

Membrane resting potential of muscle was considered by Dr. J. W. Woodbury, the morphology of muscle fibres with different conducting properties by Dr. H. Ruska and ciliary co-ordination in Protozoa by Dr. L. E. Roth. Dr. L. U. C. Junquiera gave a statistical account of the number of nerve cells and ganglia in the different parts of the intestinal plexuses, and Prof. J. Runnström analysed the cytoplasmic changes occurring upon fertilization in the sea urchin egg.

It is obvious that a wide field was covered, and all taking part were agreed that the symposium was a considerable success. On the Saturday following the conclusion of the symposium, the President of Venezuela visited the Institute, met the participants and spent most of the morning talking with them. There is no doubt that the Venezuelan Institute for Neurology and Brain Research has been scientifically launched and that it is embarking upon a series of fundamental investigations on the nervous system which cannot fail to make it the outstanding Institute of its kind in the world. GEOFFREY H. BOURNE

CYTO-TAXONOMY

THE Linnean Society of London held a whole-day session on cyto-taxonomy on May 3. Dr. W. B. Turrill introduced the symposium. He pointed out that the study of chromosomes was only one branch of cytology, and expressed a hope that cell contents other than the nucleus would receive due consideration. There is no doubt that cytological data can often be used by the taxonomist, but they have to be correlated with characters from many other branches of botany and zoology and taxonomically evaluated in connexion with these. Insufficient numbers of species have so far been adequately studied cytologically, especially in tropical and sub-tropical floras, for wide taxonomic generalizations validly to be made on the basis of cytology. Many taxonomists are whole-heartedly in favour of synthetic taxonomy and welcome any contribution that cytologists can make towards elucidating the problems of taxonomy. The number of biologists who regard cytologists as queer and perverse ultra-modernists who "peer down a microscope and count their own eye-lashes" is dwindling. They are, however, irritated by those cytologists who, from ignorance, scorn the basic work of taxonomists and appear to believe that scoring the chromosomes tells one everything one needs to know about a plant. Exaggerated claims or extreme criticisms made by taxonomists or by cytologists are to be deplored. What is needed is co-operation based on an understanding of each other's aims and methods and expressed in attempts to synthesize results.

Mr. J. L. Hamerton, in his paper, "Problems in Mammalian Cytotaxonomy", began by reviewing the advances in technical methods which had occurred during the past ten years and which had led to the development of modern techniques for the study of mammalian chromosomes, so that rapid and accurate chromosome counts, and detailed studies on chromosome morphology were now possible. It was emphasized that for comparative work counts of chromosome number alone were not sufficient and that studies

should embrace all aspects of chromosome morphology.

The concept that the chromosome number must necessarily be constant throughout the range of a morphological species was discussed and rejected, and it was pointed out that it was the population which was of major importance in cytogenetical work rather than the morphological species.

The relative importance of aneuploidy, polyploidy and structural change was considered in respect of mammalian evolution, and it was emphasized that there was not necessarily any direct relationship between chromosomal and morphological change, though there are certain obvious exceptions to this. Mr. Hamerton considered that the main result of chromosomal change was the introduction of discontinuity leading to some degree of isolation or variation which in turn might lead to eventual phenotypic differences of a specific nature.

The results of chromosomal change in mammalian evolution were considered at both the inter-specific and intra-specific levels. Data on experimental polyploidy in the mouse were reviewed briefly, and the evidence for polyploid evolution in the hamsters was discussed. It was considered that insufficient evidence was available to determine whether polyploid evolution had occurred here or not. Further detailed morphological studies on the chromosomes were required, and some attempt should be made to produce hybrids and back-crosses, perhaps by artificial insemination, for subsequent cytological analysis.

Chromosomal polymorphism and the existence of chromosome races or cryptic species in mammals was discussed, and their evolutionary significance considered.

Dr. A. J. Cain stated that although there is general agreement that chromosomes are important in taxonomy there has been little analysis of what is meant by taxonomic importance. The study of chromosomes can contribute three main classes of

data, namely, substitute breeding data, comparative data, and substitute phyletic data. These classes must not be confused and the possibilities of convergence and mistaken homology must be remembered. Illustrative examples were provided by researches on earthworms.

Dr. M. Fischberg dealt with the effects of out-crossing on the chromosome number in vertebrates. Chromosome differences may change the physiology enormously. In mice heteroploid embryos occurred if individuals from different inbred lines were crossed. In Amphibia the percentage of young with abnormal chromosome number increased with increasing genetical variation of their parents. If polyploids are produced and if they hybridize with diploids an explosion-like variation of genotypes may result. Even if there be a very high mortality of the variants some may survive and start new evolutionary lines.

Prof. Irene Manton gave an extensive outline account of the chromosomes and classification in ferns. Some ten to fifteen thousand species of ferns are known taxonomically and are classified into about three hundred genera. Prof. Manton had examined cytologically about five hundred species belonging to approximately a hundred genera. The majority of the species are tropical. Chromosome numbers can be accurately counted, and it has been found that with few exceptions the species within a genus have the same basic number. The exceptions may be due to mistakes in taxonomy or to shifts in one chromosome. The classification proposed by Copeland was subject to criticism especially in the Pteridaceae and Aspidiaceae. There is no doubt that the study of chromosomes can lead to improvements in classification in the ferns.

Dr. T. G. Walker considered in some detail the cyto-taxonomy of a tropical fern complex (the *Pteris quadriaurita* complex). The large complex of ferns centred around *Pteris quadriaurita* Retz. has been the source of much taxonomic confusion. Many members of the complex have been made the subject of a cyto-taxonomic and genetical investigation and some of the results for the Ceylon members were reported. It has been found that there are in Ceylon several species which, although possessing a similar gross morphology, are cytologically distinct and remain distinct as species under natural conditions. Such species can, however, be recognized by several relatively small morphological characters, the diagnostic importance of which has been overlooked in the past.

Two species were then discussed which contrasted strikingly with the other Ceylon members of the complex. These two species in gross morphology are very different from one another (but cytologically similar) and in Nature frequently meet to produce fully fertile hybrids. Such hybrids segregate into a wide range of morphologically different but not true-breeding individuals, several of which in the past have been described as new species by herbarium botanists. Observations made in the field in Ceylon relevant to the ecology of these species and their hybrid swarms were also reported.

Dr. A. B. Acton pointed out that the minute differences that accumulate in animals which are destined to become specifically distinct may be indistinguishable from uninherited, and consequently less important, variations. The banding-patterns of giant chromosomes are an exception. The chromosomes of *Chironomus tentans* larvæ in a single population differ from each other by inversions.

The chromosomes of larvæ in nearby populations contain, as a rule, exactly the same inversions, but at different frequencies. This is true of populations as far apart as Sweden, Austria, and Britain.

The chromosome banding-patterns in *C. tentans* larvæ from Canada differ from those in Europe. Not only do some of the inversions by which the chromosomes of European and Canadian larvæ differ occur as heterozygotes (in Europe), but there are certain inversion heterozygotes which are found in both areas. There are no external differences between either larvæ or imagines; hybrids can be made and these appear to be perfectly viable. The situation is intermediate between the one found to exist between individuals of a single species and those of two distinct species. Even though it is possible to detect minute differences between the giant chromosomes of different larvæ, it may still be no easier to decide the taxonomic status of the animals concerned, and it will continue to be necessary to appeal to the 'competent taxonomist'.

Prof. D. H. Valentine outlined the cyto-taxonomy of the rostrate violets. The Rostratae form a sub-section (comprising thirty-five species) of the very large section *Nomimum* of the genus *Viola*. Taxonomically they are well defined by their possession of overground leafy stems and by the hooked beak to their style; the basic chromosome number is 10. All species of the sub-section so far tested (fourteen) form viable hybrids with one another and it might be thought that the group constituted a comparium; but, as shown by Gershoy, artificial hybrids with the sub-sections *Stolonosae* ($n = 12$) and *Boreali-Americanae* ($n = 27$) are possible, and wild hybrids with the *Uncinatae* and the *Repentae* (both with $n = 10$) have been recorded. Thus the comparium extends beyond the bounds of a single sub-section.

The relationship of the species within the Rostratae may be tested by crossability and by cytological analysis. The group was divided by Becker into the *Mirabiles* (two species), the *Arosulatae* (nine species), and the *Rosulantes* (twenty-two species). The last are generally chamæphytes with a basal leaf rosette, and the *Arosulatae*, hemicryptophytes without a rosette. Hybridization experiments show that viable interspecific hybrids are produced just as easily between these groups as within them, and there are no significant differences in the fertility of the hybrids, which is always low. Chromosome counts (by various authors) have shown that, of the species investigated (fifteen), ten are diploid. There are three tetraploids and a hexaploid in Europe and one octoploid is reported from North America; no linking species between this octoploid (*V. howellii*) and the remaining North American species, which are diploid, are yet known.

Studies of chromosome pairing in interspecific hybrids between the European species indicates that two (the rosulate *V. riviniana* and the arosulate *V. canina*) are amphiploids and that they have one genome in common. Whether there are further chromosome homologies between members of the rosulate and arosulate groups is not yet known.

The *Rosulantes* have a circumpolar distribution, while the remainder of the group is Eurasiatic. Comparison of the morphology, distribution, and cytology of the North American and Eurasiatic species of the *Rosulantes* may make it possible to work out their evolutionary history and thus to make a contribution to our knowledge of the history and migrations of Tertiary floras. W. B. TURRILL