shortened. It was stated that man is more sensitive to fluoride than experimental animals but that some adaptation could occur, for example, industrial workers exposed to fluoride showed more severe symptoms after a period of absence.

Dr. W. T. C. Berry discussed "Medical Effects especially in Relation to Fluoridation Levels". The average daily fluoride intake in Britain had been estimated as 0.6 mgm. for children, 1.3 mgm. for women and 1.8 mgm. for men. If the water contained 1 p.p.m. of fluoride, these intakes were approximately doubled for children and rose 70-80 per cent for adults. The diet of primitive man probably contained more fluoride than do modern diets, as presumably bones were chewed and, where salt was used, it was sea salt. The first sign of excessive intake in man was mottled enamel, suggesting that the ameloblast was the most sensitive cell. It had been found in several countries that another type of enamel marking ('idiopathic mottling') decreased in incidence as the fluoride of the tap-water rose from zero to about 1 p.p.m., although evidence of a causal relationship (for example, a fall in incidence after a town water supply was fluoridated) was inadequate. There were preliminary reports that

osteoporosis was unusually common in areas where water-borne fluoride was zero and that calcium balances in osteoporosis and Paget's disease improved with large intakes of fluoride.

No evidence had been produced in recent work to suggest that any harmful effects followed the fluoridation of water at the level of 1 p.p.m. At higher intakes, as with certain workers in the aluminium industry, gastritis and increased density of bone had been reported. Bone lesions had been found in the absence of reported evidence of renal damage, indicating that increased bone density occurred before renal change.

The symposium revealed the contrast between knowledge of the effects of fluoride and ignorance of the mechanisms, and the need for multi-disciplinary work. It was pointed out that even the well-known inhibition of enolase provided an uncertain explanation for the reduction of glycolysis by salivary bacteria. The observed effect was reduced acid production, whereas if enolase were inhibited the expected result would be the accumulation of one acid (phosphoglyceric) in place of the normal acid end-product (lactic), presumably with little effect on pH.

G. N. JENKINS

SPECIATION IN THE SEA

AT a symposium arranged by the Systematics Association and the Challenger Society, and held at the Plymouth Laboratory of the Marine Biological Association of the United Kingdom, during September 27-29, the practical difficulties in examining the processes by which new species develop in marine habitats were comprehensively examined.

Throughout the meeting two factors were continually emphasized as restricting the progress towards a true appreciation of the problems of speciation. These were the need for more extensive taxonomic study of the plants and animals and the severe limitations on experimental work which the sea as an environment imposes. The contrasting features of the open ocean, the inter-tidal zone and benthic regions exposed fundamental differences of approach to the problem, with resultant divergence of opinion as to primary and secondary causes.

In the zooplankton, an example from the North Pacific Ocean illustrated the necessity for very large collections now available and for the genetical examination of living populations, unfortunately not yet possible. J. A. McGowan reviewed his work in that ocean on the pteropod *Limacina helicina* which occurs there in two forms: *A*, high spired, with striations, inhabiting the Sub-Arctic water mass; and *B*, short spired, with no striations, living in the Transition Zone, the Alaskan Gyral and the California Current. A form intermediate between *A* and *B* may occur in overlapping areas. The water circulation in the North Pacific is such that form *B* must have been derived from *A*. Only those specimens, the genetic make-up of which allows them to inhabit Transition Zone water, survive there, and these, form *B*, become progressively more adapted to this water, and unsuitable genotypes of the parent populations tend to be eliminated. Eventually reproductive isolation may occur here.

A genetical study of the actual populations involved is of course a necessity to a full understanding of

this problem. Whether or not the differences which separate these populations are genotypic or phenotypic is fundamental. This aspect of the subject was stressed by a number of speakers.

P. M. David gave a detailed account of the distribution of species of *Sagitta*. Bathypelagic species are more widely distributed than epi- and meso-planktonic ones. *Sagitta macrocephala*, for example, is found from the Arctic to the sub-Antarctic at a depth of 1,000-1,500 m. It does not occur south of the Antarctic Convergence. *Sagitta gazellae*, which occurs on both sides of the Antarctic Convergence, provides an interesting example of incipient speciation as a result of a spatial barrier. It has formed two morphologically distinct races on the two sides, neither of which is numerous, in the region of the Convergence which separates them.

Analysing the data from the oceans of the world, he showed that the normal number of species found at any one station is about ten, and that in each oceanic area there is one species which is dominant. In cold waters the diversity is low and the dominant species accounts for as much as 85 per cent of the total chaetognath population compared with 40-50 per cent in warm waters. Comparing the distributions of species in oceanic waters with those in neritic and mixed waters, Mr. David suggested that the species of the oceanic group, which are by far the most numerous, are the most closely adapted to their environment. Neritic and mixed-water groups are more capable of surviving in fluctuating conditions, and their less specialized adaptations are not able to survive competition against oceanic forms in the open ocean. Species are probably controlled by physical and chemical factors, not acting alone but in combination with biological factors including competition with other species.

J. M. Colebrook and G. A. Robinson discussed the specific treatment of data from the planktonic recorder and referred to the sub-speciation of *Calanus finmarchicus*.

G. A. Knox was able to give a number of examples of speciation in Bivalvia from the coasts of New Zealand. Not only was he able to compare species north and south of the Sub-tropical Convergence, which to-day lies athwart New Zealand, but also from a study of the Tertiary molluscan fauna he was able to trace the past history of species and to deduce the earlier positions of the Sub-tropical Convergence. It appears that the nucleus of the New Zealand molluscan fauna dates from the late Cretaceous. During the early Miocene, the Sub-tropical Convergence ran far south of its present position and there was an influx of warm-water Indo-Pacific species. After this, the line of the Convergence moved northwards and by the mid-Pliocene was more northerly than it is now, and cold-water species were brought in by the Tasman Current with Australian fauna in the late Pliocene.

Prof. Knox considers that in most cases the preliminary factor in speciation was geographical separation, the present pattern of species having been brought about by changes in the configuration of coast-line, fluctuations in the position of the Sub-tropical Convergence and changes in the current systems affecting the dispersal of larvae or adults. Populations became isolated and diverged to such an extent that when they have afterwards come to overlap they have remained reproductively isolated.

J. H. Day gave evidence from grab samples from South African waters which shows that although warmer waters are poorer in individuals than cold waters, they are much richer in species and there is a much higher proportion of carnivores. As an example of complexity, he said that the animal turf from a single square metre from a rock face at a depth of a few metres in False Bay contained more than 120 separate species, and stressed that the complexity of the biotic environment provides more ecological niches and thus promotes sympatric speciation.

G. M. Spooner was one of the few to refer to the genetic isolation that may be associated with host specificity. He gave as an example differences in colour patterns of the polynoid *Harmothoe lunulata* according to the host with which it is commensal; the implication being that these colours reflect genetic differences of physiology or behaviour which adapt each form to its particular host.

A. Graham with V. Fretter also discussed variation in colour pattern, particularly with regard to *Patina pellucida* and *Nucella lapillus*, relating them to the habitat, food or exposure of the individual.

C. M. Yonge brought his researches on evolution of the Bivalvia from the point of view of functional morphology down to species-level when describing the five British species of *Nucula*; and he gave details of their adaptations to the different particle size of the substrata into which each burrowed. Because fertilization in the bivalves is external (even when incubation occurs) species cannot be locally isolated. Distinct breeding seasons and specificity of gametes are barriers, but speciation is also due to factors influencing metamorphosis. Thus the larvae of *Teredo* and allied genera are alone in being stimulated to settle and metamorphose by the presence of wood. Less easily defined factors doubtless account for the differential settlement of sand and mud burrowers or of rock borers. Less specialized species tend to separate out after metamorphosis as the ecological needs of the adult become compulsive.

G. P. Wells discussed barriers and speciation in the caudate Arenicolidae, the lugworms. He showed

that they are distributed in three temperature zones, a northern cold-water, a warm-water and a southern cold-water. Except for a little overlap at the boundaries, no species is found in more than one zone. Several species are widely distributed in their particular zones and each zone appears to have at least one endemic group of closely related species. This suggests that the three-zone picture has existed for long enough to allow a considerable degree of speciation to take place within each zone.

When discussing speciation in shore-fishes, R. Rosenblatt spoke of ecologically correlated patterns which appear repeatedly: the tendency for forms in cool waters to have more segments or those from a few fathoms depth to have less melanin, more delicate bodies, fins and skins, and larger eyes than littoral forms. This applies at specific and generic levels as well as within species. In *Scorpaena gutta*, form and depth of habitat are closely correlated over the major range of the species in the temperate San Diego area, but there is an anomalous population in the north of the Gulf of California which is of the deep-water form though it lives in shallow water. Dr. Rosenblatt suggested that this population reached the Gulf in the Pleistocene when there was sufficient cooling of the deeper waters but not of the surface waters for the deep-water form to reach the Gulf around the tip of Lower California which now forms a barrier.

Comparison of sibling species of fishes of various families on both sides of North America or species inside the Gulf of California with species outside, indicates that speciation occurs more rapidly in small fishes living at shallow depths among rocks than in large fishes characteristic of shallow sand or mud-bottom waters. Adaptations to life in rock crevices such as small size, short life, territorial habits and viviparous reproduction, markedly restrict vagility. Gene-flow would be expected therefore to be restricted between populations of such fishes, and a detailed study of *Enneanectes sexmaculatus* supports this. On the other hand, with larger fishes not tied to this habitat, the great mobility as adults, the pelagic eggs or larvae and the long life-span all tend to maintain a genetic homogeneity within a species.

N. B. Marshall described the diversity of distribution of deep-sea fishes and remarked that the opportunities for speciation in the environment which has remained homogeneous and stable for a very long time are relatively limited.

Bathypelagic fishes which have spent their larval life in surface waters tend to have wider distributions than deep-sea species, most of which do not have surface-dwelling larvae. He compared the deep-sea fishes of the Red Sea with those of the Mediterranean. The conditions in the Red Sea are more extreme than those in the Mediterranean, and differentiation of species is correspondingly more marked. Basin conditions, such as those of the Sulu Sea and Gulf of Mexico, have favoured species formation and the development of distinct communities of macrurid fishes. The early colonizers of deep waters, coming mostly from tropical, shallow areas, probably lived in the more productive oceanic regions in equatorial waters and over continental shelves, living at first not far under the productive photic zone. When the favourable environment near the thermocline had been fully exploited, pressure on living space would become more severe and less-productive waters would be invaded. Mutant dwarf forms with reduced food requirements may even be able to survive in the gyrating central water masses poor in food, and if these formed populations

breeding in the new deeper living space they would become genetically isolated from the parent form. A forced exploitation of the deeper levels leading in this way to considerable speciation and adaptive radiation will have produced the elaborate and stable eco-systems now found in deep warm waters.

P. S. Dixon, H. T. Powell and T. J. Hart discussed speciation in Rhodophyta, *Fucus* and Diatomacea, respectively. All three were of the opinion that an unparalleled confusion existed in these groups because of a shortage of good taxonomists. It was made clear that more attention will have to be given to a study of the plant in life at all seasons before a study of speciation can be attempted.

C. F. A. Pantin, in summing up, considered that the papers had shown the need for further research

into the nature of the physical environment, and in order to understand the significance of this for the individual species physiological study of the organisms in relation to their environment is also needed. The very constancy of the environments of the sea makes it easier for us to appreciate that the environment, which directs selection, includes biological factors which, since they are evolving all the time, do not reach final equilibria. He likened these apparently constant environments to dynamic equilibria in open systems.

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J. P. HARDING
N. TEBBLE

RECENT ADVANCES IN CONSERVATION OF HISTORIC AND ARTISTIC WORKS

THE first international conference on this subject was held at Rome during September 25-29, 1961. The conference was organized by the International Institute for Conservation of Historic and Artistic Works, and attempted in a very full programme to survey all aspects of conservation.

The importance of this conference to readers of *Nature*, who are more aware than most of the difficulties of communicating specialized information, was that topics ranged from the use of refined electronic techniques to a discussion of the aesthetic principles of conservation. There were many who were lost in one or other of these fields, and some who suggested that there ought to be separate sessions at future conferences. But it is likely that in ten or twenty years, as basic scientific knowledge becomes more widespread, whatever the refinements developed by that time, there will be more common ground in such a conference, not less.

It may not be generally realized that many of the world's major museums have attached to them a conservation studio, and sometimes also a scientific laboratory. Notable are the National Galleries of London, Washington, Ottawa and New South Wales, the British Museum, the Victoria and Albert Museum, the Tate Gallery and the chief museums in Boston, Harvard University, Madras, Naples, New York, Prague and Zurich to mention only some. In some countries conservation activities are also centralized within an institute, such as the Istituto Centrale del Restauro (Rome), the Academy of Fine Art (Warsaw), the Courtauld Institute (London), the Doerner Institute (Munich), the Federal Institute for Protection of Cultural Monuments (Belgrade), the Intermuseum Laboratory (Ohio), the Laboratoire de Recherche Archéologique (Nancy), the New York Conservation Center and the Smithsonian Institution Freer Gallery. The heads of all these departments and organizations were among the delegates at the Rome conference.

The Centro Internazionale di Studi per la Conservazione ed il Restauro dei Beni Culturali, more shortly known as the Rome Centre, and the Istituto di Patologia del Libro deserve special mention, for the director of the former, Dr. H. J. Plenderleith, took a very prominent part in the organization of the conference, and the latter were hosts to the delegates,

providing lecture rooms and other facilities. The head of the organizing committee was N. S. Brommelle, head of the Victoria and Albert Museum Conservation Department and secretary-general of the International Institute for Conservation of Historic and Artistic Work; the treasurer of the latter is S. Rees Jones.

The qualifications of restorers and conservators vary greatly in different countries. Museum directors, trained most frequently in humanist disciplines, find it difficult even to-day to judge the value of the contributions from their technical departments. In his opening address, Dr. A. van Schendel, president of the International Institute and director of the Rijksmuseum, Amsterdam—a very modern director in his understanding of the role of conservators—directed attention to the hope of the Institute that conservation is becoming a recognized profession with professional standards of its own to maintain. To this end, fellowship of the Institute is not an easily acquired distinction.

In all attempts to prolong the lives of precious museum objects, the most important study is that of the museum 'climate', to which the opening session was devoted. Air conditioning is by now well established in the major museums, so that the present emphasis in research is on the effects of lighting. L. S. Harrison (United States) described his use of photocells for controlling the light in a museum, and J. Lodewijks (Holland) dealt in general terms with the chemical theory of photolysis and photochemical degradation as it affects museum objects.

Travelling exhibits are becoming increasingly popular and raise problems of packaging, often for conveyance through climates of widely varying humidity and temperature. Dr. N. Stolow (National Gallery of Canada) described some tests on methods of insulation, and Dr. K. Toishi (Japan), who was not able to be present, contributed work on the use of silica gel as a humidity stabilizer within the package. H. Wakefield described packaging methods used by the Victoria and Albert Museum in its many travelling exhibitions.

There were five speakers in the session on physical and chemical methods of analysis. W. J. Young (Museum of Fine Arts, Boston) and Dr. E. T. Hall (Research Laboratory for Archaeology, Oxford)