especially when recently fixed barnacles were present. This suggests an olfactory stimulus which can act at a distance. The range of dispersal is probably not great, since heavy settlement occurred only near previous barnacle groups. It is known that the cypris stage makes exploratory campaigns before finally settling.

That the larvæ of some worms are sensitive to the physical nature of the substratum on which they settle was admirably shown by Wilson (1948). Messrs. H. Barnes and H. T. Powell have studied the settlement of barnacle and *Pomatoceros* larvæ on several types of glass fibre cloth, and found that these larvæ will not attach themselves to a staple cloth from which short fibres project in 1-mm. lengths, though they will do so on a smooth or continuous cloth from which the long fibres do not project. *Tubularia larynx*, however, is unaffected by the variation in the surfaces of the cloths tested.

Dr. J. A. C. Nicol has worked on the responses of *Branchiomma vesiculosum* to light. These tube worms live in groups in dark niches at extreme low tide, and in shallow water in estuaries. The branchial crown expands in light and in darkness, though feeding occurs during the day-time, the branchiæ being then turned towards the light. A worm removed from its tube turns away from the light. Response is most sensitive in weak light, to a decrease in light intensity but not to an increase, and to moving intensity changes such as the passing of a shadow, though the worms tire after repeated stimulation. It is suggested that the reaction to photic stimuli is partly a feeding response and partly a means of evading the attacks of predaceous flatfish, such as the sole and lemon dab, which bite off the branchial crown of an expanded worm.

The life-history of many of the commonest marine animals is still imperfectly known, and it is surprising that *Nereis diversicolor* should have been one of these, until Dr. R. Phillips Dales studied its breeding habits on the Essex coast. Artificial fertilization provided the early stages up to the young chætigerous larvæ, which could then be recognized from filtered water in trenches dug in the muddy area in which the adult worm lives. Spawning occurred in the middle of February, the weak trochophores developing chætæ when about two weeks old, and living in the mud, where they crawl but retain their cilia and swim at intervals. They feed at about seven weeks, when ten chætigerous segments are developed, and wander in search of food. There is thus no pelagic larval stage, and it has long been known that the epitoquous stage is also absent from this species. The adult burrows in the mud at ten weeks old.

The early stages and distribution of *Octopus vulgaris* are the subject of an interesting paper by Dr. W. J. Rees, illustrated by a photograph of the egg strings by Dr. D. P. Wilson, and by drawings of the larvæ by Mr. G. L. Wilkins. The range of the adult octopus is almost confined to the coast of the English Channel, and, since it does not normally breed there, the British population is an immigrant one from warmer waters. Major H. W. Hall kindly lent his motor yacht *Manihine* for the investigations in the Channel, and young larvæ of the octopus were taken in plankton hauls to the north of the Channel Islands. The planktonic larval life probably lasts from one month to three months. Good weather conditions over a succession of years raise the sea temperature just sufficiently to extend the breeding-range of the octopus, and may result in plagues along the south coasts of England, as occurred in 1899, 1900, 1913, 1922 and 1948.

Two papers on marine algæ appear in the current number. Dr. W. A. P. Black has studied the seasonal variation in the cellulose content of common Scottish Laminariaceæ. He found that this increased with depth of immersion and with the season, the two maxima being in spring and autumn, the minimum in June and July. There is more cellulose in the stipe than in the frond. Comparing these results with the Fucaceæ, similar results were found for *Fucus vesiculosus* and *F. serratus*, but in *Ascophyllum nodosum*, *F. spiralis* and *Pelvetia canaliculata* a more constant content obtains, though *F. spiralis* shows a modification in summer owing to water intake preparatory to gamete shedding.

Dr. M. Knight and Dr. M. Parke have made a careful study of *Fucus vesiculosus* and *F. serratus* at stations on the west coast of Argyll, the south-west corner of the Isle of Man and south Devon. In the last-named area the range extends to a lower level than in the more northerly stations. Plants of both species normally live three years, but there is a very heavy mortality-rate. *Fucus vesiculosus* reproduces in spring and summer, *F. serratus* in autumn and winter, large plants producing at least a million eggs. After reproduction the part of the frond bearing the receptacle is shed, and new frondage is developed by dichotomous branching of non-fruiting fronds. The rate of growth varies with the environment and is least in exposed areas; but the rate of forking is encouraged by exposure. The repopulation of cleared areas is very rapid, despite the depredations of gastropod molluscs. Cutting of the weed yearly, or twice yearly as in France, produces less frondage than that arising from germlings.

Dr. R. H. Millar describes a new didemnid tunicate, *Lissoclinum argyllense*, from Scotland, and Mr. P. S. B. Digby has investigated the life-histories of nine small planktonic copepods at Plymouth. Six of these are abundant in summer and produce five generations during the year; three commence breeding in August and produce three broods late in the year. Twenty tables of detailed results accompany this paper.

Two welcome news items appear in the report of the Council. The Director's monograph on the medusæ of the British Isles is now in the press, and there is an increase in the number of members of the Marine Biological Association. N. B. EALES

RADIATION GENETICS

THE application of nuclear energy on a large scale brings with it numerous problems, among which the most far-reaching is the biological and particularly the genetical aspect. It had already been shown in 1927 by H. J. Muller that the genes, the physical basis of heredity, can be altered by ionizing radiation and that the rate of the natural mutation can be increased, the magnitude of increase depending on the amount of radiation received. After this great discovery, intensive studies were carried out by geneticists in order to throw light on the mechanism underlying the production by irradiation of various mutational changes in the chromosomes and genes. From these investigations an impressive amount of data has been accumulated and forms the foundation of 'radiation genetics'. Thus, on the establishment of the Atomic Energy Commission, the study of the genetical effects of the new and extremely powerful radiations was able to proceed on the lines already laid down.

Those engaged on the genetical aspect of ionizing radiations had several opportunities, during and after the War, to meet and pool the knowledge gained; but many of these meetings and the results discussed were covered by security restrictions. Now a group of papers, given at the first unclassified information meeting for Biology and Medicine (March 26–27, 1948), sponsored by the Biology Division of the Oak Ridge National Laboratory, has been published*. These papers deal with basic knowledge of extreme importance in the understanding of radiation effects, and in the evaluation of their consequences. In this respect—though some of the ideas expressed in the papers have already been superseded by later knowledge—lies the significance of this publication.

The discussions are grouped around two main topics. The first deals with phenomena which can be observed after irradiation in the hereditary mechanism of the cell, either by genetical or cytological analysis. The second subject of the symposium is the genetical effect of radiation on the human population.

The most extensive paper is that of H. J. Muller, who discussed several questions of general interest, many of which have bearings on the estimation of radiation hazards. He directs attention to the fact that the genetic effects are of two kinds: there are those, such as gene-mutation and chromosome-deletion, which are 'one-hit' phenomena due to a single ionization; and others, for example, chromosome interchanges, which are 'two-hit' events. Muller emphasizes the fact that gene-mutations are directly proportional to the dose, no matter how low it is, or of what intensity. This conclusion is based on extensive experimental evidence obtained from the study of radiation-induced sex-linked lethal gene-mutations in *Drosophila*. The complexity of the effect-dosage relationship has also been stressed. By discussing the various possibilities responsible for the apparent proportionality of lethal frequency to dosage at higher doses, Muller argues that it must be attributed to a 'composite effect' produced by the combination of 'one-' and 'two-hit' events. Because at present there are no criteria by which we can calculate the expectation of the various types of rearrangement, it is not possible to determine how much they are responsible for the composite effect. One of the reasons for such limitation is that the genetical analysis of the radiation-induced effects in *Drosophila* is based on highly selected samples, as a result of which the estimation of primary effects can never be complete.

Direct cytological study of radiation injuries in cells such as the pollen grains of *Tradescantia* or neuroblasts of grasshoppers is more suitable for revealing the immediate result of ionizing radiation. Using *Tradescantia*, Sax has demonstrated that the 'one-hit' chromosome injuries increase in direct proportion to dosage, while the 'two-hit' types of alterations (interchanges) tend to increase as the square of the dose. A linear proportionality of the 'two-hit' phenomena, as was found by Giles and Conger after irradiation with fast neutrons from uranium fission, reveals differences in ion-density in the track of the ionizing particles emitted by the various radiations.

The observation of Carlson on living cells of grasshoppers has shown that even so small a dose as 4 roentgens affects the cells by suppressing mitosis. If the radiation is given at very low intensity (0·25 roentgen per minute), the recovery process may be able to keep pace with the gross mutation effects; but the possibility remains that gene-mutation might have been induced even by such a treatment. Several of the participants, for example, Sax, Carlson and Kimball *et al.*, stress the fact that there is a variation in radiation sensitivity which is related to the developmental stage of the cell and to environmental conditions. This fact has been borne out by the report of Randolph, who described the cytological and phenotypical effects of the Bikini atom explosion on maize.

The meeting also discussed the possible mechanisms which may be responsible for the biological effect. Wyss and collaborators, starting on the assumption that in the event of gene-mutation some chemical or physical change must be responsible for the modification of a gene, examined the effect of ultra-violet irradiation on the culture medium of *Staphylococcus*, and found that hydrogen peroxide may be an intermediate agent. Their investigation has opened up a new and fruitful line of research into the analysis of mutagenesis. Mazia and Blumenthal, on the other hand, took a different approach and, on the assumption that the activity of enzyme systems depends on structural organization, argued that the structure may be involved in the radiation reactivity. They studied the effect of radiation on monomolecular films, comprised of enzyme-substrate (albumin–crystalline pepsin), and, by using the time of digestion as a measure, found that as little as 50–100 roentgens had slowed down this process. From their experiments the conclusion is drawn that sensitivity to radiation may be a consequence of the molecular topography.

The second main topic of the conference was the possible effects of mutagenic agents on the human population. Ionizing radiation increases mutation-rate; hence its application on a large scale can have far-reaching repercussions in the genetic structure of our race. Since experimental evidence shows that nearly all induced mutations are deleterious, any increase in the mutation-rate is of great concern. The fact that many human diseases have a genetic basis (for example, 112 genes are known to be responsible for skin diseases and nearly as many for eye diseases) argues sufficiently against any further increase in the number of deleterious genes. The various difficulties in calculating the radiation hazards in human population are discussed by Prof. S. Wright. Though there are great gaps in our knowledge, yet sufficient data have been gathered to draw the conclusion, expressed by H. J. Muller, that we must weigh the immediate benefit derived from the application of radiant energy against any detriment to the human race which may accrue, at no matter how distant a future.

The conference shows clearly that those responsible for atomic energy research are well aware of the biological hazards involved. The papers and discussions demonstrate the need for more information and in particular the necessity of additional cytogenetical research. There is no doubt that the symposium will stimulate further investigations into the more basic aspect of radiation effects. P. C. Koller

* Symposium on Radiation Genetics, *J Cell. and Comp. Physiol.*, 35, Supp. 1, 1950.