ized that the manufacture and distribution of a new food to wholesalers and retailers were not enough to ensure its use; an advertising and educational programme was essential so that the public can become aware of its availability and how to use it. He outlined the methods followed in promoting the sale of 'Amama', and the difficulties encountered.

Throughout the symposium there were many references to the need for popular education in nutrition, which must accompany all other measures to eliminate malnutrition. The last paper, by Dr. A. T. M. Wilson (Unilever House, Blackfriars, London), on "Nutritional Change; Some Comments from Social Research", dealt mainly with this subject. He quoted effectively a passage in a World Health Organization report about the "baffling maze of tradition, taboo and magic, and the whole system of belief of the people about health and the causes of disease" of which educators must be aware. "In the past", the World Health Organization report continued, "most workers have tried, by repeated blows of didactic teaching, to hammer their way through the maze and break down the resistance to unaccustomed foods and eating practices—with very little success . . . because beliefs about food are part of the whole fabric of the life of a people". It follows that the social and psychological aspects of the campaign against malnutrition are of essential importance, an example being the complex social factors which influence lactation and weaning. Wilson also commented that the campaign called for co-operation between different disciplines and services, always difficult to secure. The epigram "God has not seen fit to divide our problems into the same categories as university chairs" was highly applicable to the problem of nutrition.

The papers and discussions at the symposium gave at least some answers to the questions implied in its title. While the general attitude was optimistic, the speakers recognized that immediate and facile solutions cannot be expected. There was emphasis on the need for action based on research and on an understanding of the complex factors which cause malnutrition. W. R. Aykroyd

GROWTH AND GENETICS OF HIGHER FUNGI

THE higher fungi commonly known as mushrooms, toadstools and bracket fungi and classified in the Basidiomycetes, have certain distinctive biological features which make them a favourable group in which to study their physiology of growth and their genetics. The large fruiting body with its size, shape and form, and in many species with its extraordinary rate of growth, offers opportunities for studying the factors affecting growth, translocation and morphogenesis. The mycelium with its regular growth-pattern, its production of asexual spores and its ability to grow on simple minimal medium has all the properties of mycelia in other groups of lower fungi. The regular formation of a stable dikaryon from the compatible mating of monokaryons provides a system for studying gene action which is intermediate between the regular haploid–diploid cycle of yeast and the variable heterokaryon and homokaryon in *Neurospora* and *Aspergillus*. The complex mating system in the higher fungi, although it can be compared in its genetics with certain incompatibility systems in higher plants, has features that are not found in any other group of plants.

In a symposium organized by the British Mycological Society, under the chairmanship of its president, Miss G. M. Waterhouse, five aspects of the higher fungi were examined: (1) the effects of light and gravity on the growth and form of a fruiting body; (2) the factors, both internal and external to the hyphæ, which govern the regular pattern of growth and branching of the mycelium; (3) the extent of gene action and the transport of exogenous substances along the hyphæ; (4) the genetic and possible biochemical control of the complex mating system; (5) the mosaic structure of populations and sterility barriers in higher fungi.

Dr. B. E. Plunkett (Birkbeck College, London), using the fruiting-bodies of *Polyporus brumalis*, demonstrated components of the complex system of stimuli that operate to keep the cap horizontal and to ensure the production of spores on the lower side. These are factors of importance if the fungus is to distribute its spores efficiently. The stalk of the young fruiting body, before the cap has expanded, grows towards a laterally placed light, but as the cap expands it is no longer attracted to the light but grows upwards under the influence of gravity on the horizontal stem. Light of low intensity obtained by shading the young stem with an artificial cap resulted in upward growth due to gravity. This showed that the geotropic response was present in the early as well as in the later stages of development. The weaker geotropic response is at first overruled by the strong photo-response, but later, as the perceptive region is shaded by the expanding cap, the geotropic response expresses itself. Rotation-with-light experiments demonstrated that the spore-bearing region develops away from the light and the cap develops at right angles to the incident light. These interesting studies in growth and morphogenesis were paraphrased by the statement that according to Corner the cap was an umbrella to keep rain from the spores, but now it could also be a parasol.

Turning from the fruit body to the mycelium, Dr. G. M. Butler (Birmingham) discussed the problems of the hyphal branching system in *Coprinus disseminatus*. Three types of hyphæ could be distinguished, main, primary branch and secondary branch. In Petri dish cultures the main hyphæ had the highest extension-rate and the greatest diameter, the secondary branch had the lowest rate and diameter. The monopoidal branching system and the radial growth of a colony depend on these differential extension-rates of leading and branch hyphæ. A steady rate of growth of a whole branch system is maintained, from which it is concluded that the hyphal tip, the region where extension occurs, is not autonomous but is subject to competition and interaction occurring within the hyphal system. Experiments with two cultures separated by 'Cellophane' and growing out of step showed that under certain conditions there existed hyphal competition or inhibition transmitted in the culture media, but this external effect, even at its greatest intensity, was too small to account for the difference between the main and branch hyphæ in extension-rate and diameter. Little is known about the main control of hyphal growth, which is internal, either in its extent along the hyphæ or in its mode of action, but it appears to operate on cell extension rather than on nuclear division.

Prof. D. Lewis (University College, London) discussed the problem of hyphal tip autonomy from a genetical approach and came to the same conclusion that the tip is not autonomous. A methionine-requiring mutant *me*-1 of *Coprinus lagopus* produced prototrophs not requiring methionine at a frequency of 2 in 10^5 asexual spores. These asexual spores are uninucleate and are cut off from the tips of hyphæ. The prototrophs are the result of recessive mutants of suppressor genes. Monokaryotic mycelia of the *me*-1 stock, when transplanted to minimal media, do not produce prototrophic sectors of growth despite the fact that hyphæ grow for 1 mm. into the minimal medium. The recessive mutant therefore is not expressed in the articulated hyphæ but is expressed in the isolated spore.

A dikaryon which is homogenic for *me*-1 and heterogenic for a suppressor gene will not grow on minimal medium, but each hypha resolves into a monokaryon with the nucleus carrying the suppressor gene. This difference between the monokaryon and dikaryon indicates that the sphere of gene action extends well beyond its own cell in a monokaryon, but in a dikaryon the same gene has a limited field of action and may be limited to its own cell. Experiments on the transport of exogenously supplied methionine in monocaryons and dicaryons did not reveal any difference between the two types of mycelia. Transport was limited to 1–3 mm. in both; this is a fact which may have a direct explanation for the lack of fruiting ability of many biochemical mutants when homogenic.

The unique mating system in the higher Basidiomycetes is controlled by two genetic loci *A* and *B*; one gene controls the migration of the donor nucleus in the receptor hyphæ and the other gene controls the regular synchronous division of the two nuclei and the formation of the clamp connexions which are peculiar to the Basidiomycetes. The *A* and *B* loci in *Schizophyllum commune* have been analysed into two genes in each.

Dr. P. R. Day (John Innes Institute) described a genetical analysis of the *A* complex in *Coprinus lagopus*. Using two auxotrophic mutants linked on both sides of the *A* locus, recombinants of the outside auxotrophic mutants were selected on minimal medium, and among these were a few *A* alleles which were different from the two parental alleles. The frequency of recombination to give these new alleles was 0·07 per cent. The recombining parts have been called sub-units; but whether these sub-units can be considered as two different functional genes or as different sites of the same functional gene cannot be decided. The frequency of 0·07 per cent is a value which is consistent with either alternative, and the important functional complementation test is not possible with this *A* locus in the present lack of knowledge of its action. But if the *A* locus is similar in *Coprinus* and in *Schizophyllum* which has two genes 4–10 per cent units apart, then two genes are indicated. It may be significant for the working of the incompatibility system that in all four species of higher fungi where recombination within the *A* and *B* loci has been tested on a sufficient scale, two sub-units or genes have been found.

Mutations affecting the *A* function were obtained in heterokaryons which had a common *A* allele. These were either changes at the *A* locus itself or at a gene suppressing the *A* function. All the mutants appeared to result in loss of function because monokaryons with these mutations produced spontaneously the clamps which are normally confined to dikaryons. A further analysis of the *A* locus using recombination and mutation should reveal further important details about its structure and function.

Prof. R. A. Raper (Harvard), who has been mainly responsible for the detailed analysis of the *A* and *B* loci in *Schizophyllum commune*, in his paper "An Enquiring Look at Tetrapolar Incompatibility", gave a penetrating and exhaustive review of the possible control systems which could be accommodated into the known facts about the *A*–*B* mating system in higher Basidiomycetes. Such a control system has to account for the high degree of specificity, and at the same time the great variation in the specific control. It also must be consistent with the genetic system, but as was pointed out, such a genetic system would have been subjected to exceptional selective pressures because of the unusual nature of the system, and it is possible that exceptional or even unknown gene action and interaction may be revealed by the system.

Three basic modes of biochemical control were considered: (1) an inhibitor system which is produced by like alleles to cause incompatibility; (2) an inhibitor which is present in the monokaryon, but which is removed by unlike *A* and *B* alleles to give a compatible dikaryon; (3) a complementary action between unlike alleles to elaborate an essential substance for the compatible dikaryon to become established. With our present knowledge of gene structure, function, interaction and complementation there are some difficulties with all three schemes, but Prof. Raper hoped that a solution might be forthcoming from a serological analysis which had already given promising results.

Prof. J. H. Burnett (Newcastle) described his results of surveying natural populations of several species of higher Basidiomycetes for their mating type *A* and *B* alleles. The survey included bipolar and tetrapolar species. The number of different alleles was large, but varied significantly between different groups. The genus *Nidularia* stands out from the rest by having a small number of alleles.

Fruit bodies sampled from the same tree and from the same clump revealed that different dikaryons were mixed together in a mosaic. Several examples of contiguous fruiting bodies were found to be genetically isolated from one another as shown by the failure of their spore colonies to mate. Mosaic cultures were reconstructed in artificial conditions, and it was concluded that the mycelium is not often a single ecological unit but a genetical mosaic.

The mosaic nature of the mycelium, together with the genetic sterility barriers between the components of a mosaic, may have its causative connexion. Genetically isolated components could only form a mosaic, but components not so isolated could fuse to give a dominant single dikaryon. But, like many aspects of higher fungi, whether this frequent isolation barrier has its cause in the unique mating system is not known.

D. LEWIS