THE AUSTRALIAN NATIONAL UNIVERSITY 35/1968

RESEARCH SCHOOL OF BIOLOGICAL SCIENCES

Introduction

by

The Director

(Professor D.G. Catcheside, M.A., D.Sc., F.A.A., F.R.S.)

In 1966 Council determined that there should be a Research School of Biological Sciences within the Institute of Advanced Studies. Council also appointed an Advisory Committee with the function of making specific recommendations concerning the development of this new School until such time as the most senior appointments had been made. The Advisory Committee has consisted of the Vice-Chancellor, the Deputy Vice-Chancellor, the Head of the John Curtin School of Medical Research, Professor F. Fenner, Professor J.D. Smyth and Professor L.C. Birch and Dr. D.F. Waterhouse, with Professor Catcheside as Chairman. It will continue until early March 1968 when a Faculty Board will take over its functions.

In the development of the School, biology is seen as an integrated subject which is best conceived in terms of levels of complexity or integration of the biological problems to be considered. The fields thus separated form convenient units for organisation, outside of which may be small units in special subjects, but there are no real boundaries between them. Initially, work in the four important areas of molecular biology and biochemical genetics, cellular and developmental biology, environmental and population biology and behavioural biology is being established.

Professor D.J. Carr has been appointed to a foundation Chair concerned with developmental biology and he will take up his appointment on 1 January 1968. He comes from the Professorship of Botany at the University of Belfast. He is well known for his research in developmental biology, especially upon the structure and development of the chloroplast, the hormonal regulation of

growth and development in the higher plant and the physiology of transition from vegetative growth to flowering. He also has strong interests in the biology and taxonomy of eucalypts, in which work he has collaborated with his wife, who will hold an Honorary Fellowship in the School.

Dr. R.O. Slatyer was appointed to a foundation Chair, to develop work in the area of environmental and population biology. He was Chief Research Scientist and Associate Chief of the Division of Land Research, CSIRO, Canberra, and took up his appointment on 4 December 1967. He has an international reputation as a plant physiologist and ecologist and is a world leader in the study of environmental biology, to which he has applied physical and mathematical methods.

Professor Catcheside became Director of the School on 1 October 1967. The major part of the Department of Genetics which he headed in the John Curtin School of Medical Research has been transferred to the new School. This association of genetics with the new School is a natural sequel to the way the Department of Genetics was developed and accords with the structure of biological science. Much of the work of the Department has been concerned with molecular and biochemical genetics, so that the group will form a suitable nucleus from which to develop molecular biology in this area.

An Electoral Committee, appointed by the Council of the University, is at present engaged in a search for a foundation Professor to develop work in behavioural biology and it is hoped that it will be possible to announce an appointment sometime in 1968.

DEVELOPMENTAL BIOLOGY

Professor-Elect:

Professor D.J. Carr, M.Sc.(Melb.), Ph.D.(Manc.)

ENVIRONMENTAL AND POPULATION BIOLOGY

Professor:

Professor R.O. Slatyer, M.Sc., D.Sc.(W.Aust.), F.A.A.

Research Fellows:

K.P. Tognetti, B.E., M.Eng.Sc.(N.S.W.)

C.B. Osmond, M.Sc.(N.E.), Ph.D.(Adel.)

C.K. Pallaghy, B.Sc.(Melb.), Ph.D.(Tas.)

Queen Elizabeth II Fellow:

H.R. Bustard, B.Sc.(St. And.), Ph.D.

RESEARCH PROGRAMME

This group is being formed to study the effect of environment on the physiological performance and ecological distribution of various animals and plants. It is hoped that it will develop broad ecological perspectives and will be able to make contributions to present day understanding of such important phenomena as adaptation, competition, productivity, succession and distribution. However, the approach to ecological problems will primarily require research skills in mathematics, physics and physiology, the core of the programme being centred around environmental physiology. Members of staff with interests ranging from applied mathematics to cellular biophysics have already been appointed.

It is envisaged that emphasis will be given to the biological problems of extreme environments and to the mechanisms of tolerance of environmental stress. The Australian environment is characterised by a high degree of aridity and it is likely that water and heat relationships will feature in many projects. Saline and marine environments also pose challenging problems associated with water and ion balance regulation.

In the early stages of the Group's development, it seems likely that three areas of research will be identifiable, respectively environmental studies, population ecology and physiological processes. The first will probably be concerned with the evaluation and understanding of physical phenomena which have special relevance to energy, water and gas exchanges in the biosphere. These studies will be largely theoretical but may involve some experimental work, possibly in collaboration with other organisations. The second area will probably be developed

around studies of population dynamics, ecological distribution and succession of species and communities of special interest. This work will also have a strong theoretical component but will involve extensive field activity. The third area will comprise physiological studies of key biological processes and will depend almost entirely on laboratory experiments. Projects already envisaged include studies of the mechanism of stomatal movement in higher plants, studies of water and salt balance regulation, and related studies of water and ion transport across biological membranes.

Throughout it is planned that research will be oriented towards the mathematical simulation of physiological and ecological processes. Most mathematical models at present in use are generalised and simplified to a considerable degree and in consequence do not possess the degree of realism required for effective prediction of biological phenomena. It is hoped that the concepts to be developed in the Group, as well as the experimental parameters obtained, will permit more sophisticated ones to be developed which should have much greater realism and effectiveness.

GENETICS

Professor:

Professor D.G. Catcheside, M.A.(Cantab.), D.Sc.(Lond.)., F.A.A., F.R.S.

Senior Fellows:

E.H. Creaser, M.A., Ph.D.(Cantab.)

C.H. Doy, B.Sc.(Wales), Ph.D.(Melb.), F.R.A.C.I., F.R.I.C.

Research Fellows:

D.E.A. Catcheside, A.R.C.S., B.Sc.(Lond.), Ph.D.(Birm)

K.K. Jha, B.Sc.(Delhi), Ph.D.(Alberta)

K.D. Brown, M.Sc.(Melb.), Ph.D.(N.Y.) (8 April 1967)

D.J. Bennett, B.Sc.(Leic.), Ph.D.(Birm.) (8 December 1967), Research Assistant (12 October 1965).

Visiting Fellow:

Hiroto Naora, D.Sc.(Tokyo) (23 August - 20 October 1967)[1]

Head Technician:

D. Hardman, F.I.M.L.T. (to 10 March 1967)[2]

RESEARCH WORK

Introduction

Molecular biology has arisen from the attempt to relate the structure of the molecules in organisms, expecially the complex macromolecules, to their functions. A major contribution to the development of the subject came from biochemical genetics in seeking to discover the nature of genes, their structure, mode of change and manner of action. In recent years, work with bacteria and viruses has been predominant in contributing to new knowledge in this area. It is assumed that the mechanisms of heredity, of its expression and of its control are universally the same. Nevertheless, close study of these properties in higher organisms is important not only to verify the truth of the assumption, but also to determine whether there may be other mechanisms of control. Higher organisms develop and differentiate so that their parts come to exhibit different properties. The genetic control and regulation of this process is but dimly understood.

Although the work of the Department includes study of bacterial genetics, the major effort has continued to be directed towards understanding some of the fundamental processes of life in a fungus, as a representative of a higher organism capable of convenient management in a laboratory. The advantages of such an organism include ease of growth, of biochemical analysis and of the genetic analysis of very large populations. The particular problems being studied include changes in proteins consequent upon mutation and their correction by further genetic change, genetics of complex aspects of metabolism and the control of the production of enzymes and of their activities.

Genes controlling recombination

(Catcheside, Jha, E. Minson, Smyth and Thomas)

Work has continued on the effects of rec-1 and rec-3,

which result in 10-30 fold increases in recombination respectively between his-1 alleles and am alleles. Since these genes have now been located in their linkage groups, it has become possible to incorporate them into stocks of other mutants in order to determine whether either affects other loci. Thus rec-1, which is located between inos and asp in linkage group V, has been transferred to stocks containing mutants at a number of loci affecting histidine biosynthesis. So far it has been shown that rec-1 does not affect recombination at his-3. However, there are other recombination genes which are operative on the his-3 locus, although their respective effects and their interactions cannot yet be described completely. Jha has shown that rec-4^{+}, the location of which is unknown, produces a two to three fold reduction in recombination between his-3 alleles. Another factor causes an additional reduction in prototroph frequency in the presence of rec-4^{+}. Recently, Catcheside has found a further factor, rec-5, which produces very large effects at the his-3 locus.

In the course of studies to determine with what reliability the effects of rec-1 and rec-3 can be measured, it has been found that further genetic factors alter the frequency of recombination at the his-1 and am loci by a factor of about two. The relation of these to one another and to rec-4 is unknown.

The effects of rec-1 and rec-3 on the distribution of hybrid DNA at the his-1 and am loci formed in heterozygotes is being studied (by Thomas and Smyth) by measuring the frequencies of flanking markers among prototrophs. In each case all types of hybrid DNA are reduced in frequency by rec-1^{+} and rec-3^{+}, but the reduction is greatest in the proximal parts of the loci. This suggests that the recombination genes regulate crossing over, but it is difficult to believe that they have no other effects. So far, however, no other effects have been discovered. In the case of rec-4, there are no effects on the distribution of flanking markers.

Studies of mutants of Neurospora which are sensitive to ultra violet light or resistant to caffeine are continuing with the object of identifying steps in the synthesis, recombination and repair of DNA.

Regulation of glutamate dehydrogenase

(D.E.A. Catcheside)

There are two glutamate dehydrogenases in Neurospora, specified by independent genes. One enzyme, NADP-GDH, is repressed by the addition of nitrogenous compounds to the growth medium while the other, NAD-GDH, is induced. Structural mutants (functionally o^c) of the am-1 gene, which specifies NADP-GDH, reduce the repressibility of the enzyme, indicating that the site of control of enzyme production is probably at the stage of translation of the RNA message into protein. The rec-3 gene, which specifically alters the frequency of recombination between am-1 alleles, has no effect upon the repressibility of NADP-GDH. Nor is there interaction between the o^c mutants and rec-3. It is thought that the control of rec-3, operating at the gene level, may also be concerned in the control of differentiation. Mutants of the am-2 gene, which specifies NAD-GDH, have been obtained and will allow this study to be taken further.

Protein synthesis in Neurospora

(H. Naora)

A purified microsome fraction, in the presence of other soluble cell fractions, amino acids and an energy generating system, has been found to stimulate the incorporation of labelled amino acid into acid insoluble material. This in vitro system provides a tool for elucidating the in vivo mechanism controlling the rate of synthesis of specific proteins.

Control of aromatic biosynthesis

(Doy, Brown and Halsall)

In both Escherichia coli and Neurospora crassa the first step in the aromatic pathway, involving the formation of 3-deoxy-

D-arabinoheptulosonate 7-phosphate (DAHP), is catalysed by three discrete DAHP synthetases. Each enzyme is inhibited or repressed in a distinct way by phenylalanine, tyrosine and tryptophan and they may interact; the patterns are different in each organism. Each enzyme is determined by a different gene and mutants defective in each isoenzyme have now been obtained in both organisms.

For the enzymes in Neurospora (Doy), cobalt is a cofactor and may participate in protein-protein interactions between sub-units. The reaction is ping-pong with regulatory overtones. Phosphoenolpyruvate adds first and is therefore the initiator of aromatic biosynthesis. The active sites inhibited by phenyl-alanine, tyrosine and tryptophan have differing physical properties. For example the one inhibited by tryptophan is preferentially heat stable. Tryptophan is an inhibitor in the absence of other negative modifiers and homomolecular cooperation occurs between at least two allosteric sites. Three isoenzymes have been recognized, one inhibited completely by tryptophan (DAHP synthetase (Trp)), another by tyrosine (DAHP synthetase (Tyr)) and the third by phenylalanine (DAHP synthetase (Phe)). They differ markedly in estimated molecular weight (150-165,000, 79,000 and 48,000). Each may represent an equilibrium mixture of isoenzymes. None corresponds to the multifunctional protein specified by the arom gene cluster.

In Neurospora two of the genes concerned (Halsall) are independent of one another and also of the cluster of arom genes which are concerned with later steps in the biosynthesis of aromatic amino acids. Mutation of the gene for DAHP synthetase (Tyr) causes a requirement for the vitamin 4-aminobenzoate in the presence of the three aromatic amino acids. This suggests either that DAHP synthetase (Tyr) regulates 4-aminobenzoate synthesis or that the polypeptide specified by arom-6 is also functional in the 4-aminobenzoate pathway. A mutant defective in chorismate mutase has been obtained, but has normal DAHP synthetase activity as have various arom and try-1 mutants.

Since DAHP synthetase is an enzyme function specified by at least three genes and regulated by the interaction of the isoenzymes, with at least six ligands, it is evident that control depends on the function as an integrated whole, in turn dependent on a number of allosteric interactions.

In Escherichia (Brown), the isoenzyme inhibited by phenylalanine is repressed in a multivalent fashion by phenylalanine and tryptophan; the one inhibited by tyrosine is repressed by low concentrations of tyrosine and high concentrations of phenylalanine and tryptophan; the third is repressed by tryptophan. Work is now being directed to an understanding of the repression of enzymes active at later stages in aromatic biosynthesis, to give an integrated picture for the whole system. So far, it is known that 5-dehydroquinate synthetase and 5-dehydroquinase are hardly repressed by aromatic amino acids and that chorismate mutase is strongly repressed by phenylalanine and, to a lesser degree, by tyrosine.

A search for mutants, in which inhibition or repression of enzymes of aromatic biosynthesis is defective, is in progress. Mutations in the regulatory gene, trp R, prevent repression of the tryptophan operon by tryptophan. It has been found that they also prevent repression of the DAHP synthetase, ordinarily regulated specifically by tryptophan, which is determined by a gene (aro H) unlinked to the tryptophan operon.

Control of tryptophan synthesis in Neurospora

(D.E.A. Catcheside and Crawford)

Tryptophan inhibits the activity of the first enzyme, anthranilate synthetase, in the pathway leading to its synthesis. However, in vivo, this control is associated with a stimulatory effect of tryptophan upon the activity of chorismate mutase, an enzyme which catalyses the first step in the synthesis of phenylalanine and tyrosine and which competes with anthranilate synthetase for chorismic acid. A mutant in which chorismate mutase is not stimulated by tryptophan and which excretes

anthranilic acid is being studied.

A large group of mutants, disposed amongst at least four genetic loci, which interfere with tryptophan metabolism are under investigation. Three loci are concerned with tryptophan degradation and one with its permeation. Others may be concerned with control of the activity of the four loci specifying the enzymes of tryptophan synthesis.

Genetic mapping of tryptophan-1, a gene determining several enzymes in the tryptophan pathway, is well advanced.

Phenylalanine mutants of Neurospora

(Jha)

The mutant phen-1, which can grow with the aid of leucine or any aromatic amino acid and some other compounds, may be defective in a transaminase. Growth of phen-1 mutants is altered by yet other compounds. The kinetics and non-competitive nature of inhibition by basic amino acids suggests that the mechanism is different from the competitive interaction at the permease for neutral amino acids.

Biochemical genetics of permeases

(Brown and Ho)

Numerous mutants of Escherichia coli have been obtained (Brown), which are defective in their ability to concentrate various aromatic amino acids and their analogues, which have been used in selecting them. Their genetics and physiology is being studied. Mutants of Neurospora, able to take up histidinol from the medium (Ho), have continued to be studied, with the discovery of two genes, both located in linkage group VII. The inhibitory effects of other amino acids on the uptake of histidine and histidinol by these hlp mutants shows that one is altered in the permease for basic amino acids and the other in a permease available to certain neutral amino acids. Whether the different permeases are functionally completely distinct from one another is uncertain.

Histidinol dehydrogenase

(Creaser, Bennett, A. Minson and Varela-Torres)

The histidinol dehydrogenase (HD) of Neurospora is distinct from that of Salmonella, otherwise the best characterised HD, in a number of features. Especially it performs three of the enzymic steps in the biosynthesis of histidine, is not repressible and exists in several molecular sizes in the cell. For this reason comparison is being extended to a representative selection of other organisms which possess HD, with a view to examining the evolution of this enzyme. In one organism (Salmonella) it is a unit in a ten membered system specified by a tightly controlled operon; in another (Neurospora), without such an operon, the enzyme has two other functions in the same pathway. To date, HD has been partially purified from two yeasts, another fungus and four bacteria, in addition to Neurospora and Salmonella from which completely pure HDs have been obtained.

The constituent polypeptide chains of Neurospora HD have been prepared by reduction of the S-S bridges and aminoethylation. These polypeptides have molecular weights of approximately 10,000 and it is likely that the smallest active HD molecule consists of two dissimilar pairs of these chains. No chain has a free amino termination, but current work indicates that each can be characterised by its C-terminal amino acid. This heteropolymeric nature may account for the observation that, so far, all mutants of Neurospora, defective in the his-3 gene, produce a proteinaceous compound which will cross react with antiserum prepared against pure HD.

Histidinol dehydrogenase, in Neurospora, is the product of his-3, which also controls two other enzymic functions in the histidine pathway, PRAMP pyrophosphorylase and PRAMP cyclohydrolase. A new method of purification results in the three enzymic functions being preserved in the same proportions at all stages of purification. The previous method of purification was accompanied by a serious loss in the activity of the early

functions, although giving a greater yield of HD. It seems clear that all three are associated with the same protein. A comparison, physically and chemically, of the enzymes obtained by the two procedures should show why one results in greatly improved retention of the early functions.

Suppressors

(Catcheside and Angel)

Work is continuing with the object of finding and characterising suppressors which act on a number of unrelated genes. Suppressors both of nonsense and missense mutants are being sought.

Structure and functional organisation of bacteria

(Doy and Cho)

Electron micrography of Clostridium acetobutylicum has revealed complex membranous organelles, consisting of anastomosing tubules and vesicles in all parts of the cytoplasm, often in association with nuclear material. The function of these mesosomes has yet to be discovered; they are not necessarily equivalent to mitochondria, but may be related to Golgi bodies.

TEACHING AND OTHER ACTIVITIES

Ten students are pursuing courses of research leading to the Ph.D. degree; two hold external awards (CSIRO Research Studentship, Commonwealth Postgraduate Scholarship). Miss Dorothy M. Halsall, Mr. D.R. Smyth, Mr. P.L. Thomas and Mr. R. Varela Torres began their courses during the year. Seminars have been held regularly. Dr. Catcheside gave a course of lectures to students of psychology. Professor E. Hadorn (Zurich) lectured on "Cellular determination and differentiation", Professor A.H. Sturtevant (Pasadena) lectured on "The work of T.H. Morgan" and Professor P.M. Sheppard (Liverpool) gave a public lecture on "Protective Colouration". Dr. Naora gave seminars on "Regulation of transcription".

Professor Catcheside represented the Australian Academy of Science at the Centenary celebrations in Wellington of the Royal Society of New Zealand.

Most members of the Department attended the Conference in Canberra (28 August to 1 September) on "Replication and recombination of genetic material"; Professor Catcheside and Dr. Catcheside contributed papers. Seven members of the Department attended the Genetical Society Meeting in Melbourne (13-14 January) and seven members attended the Biochemical Society meetings in Sydney (22-26 May). Dr. Doy attended the 7th International ongress of Biochemistry in Tokyo (19-25 August) and was elected a Fellow of the Royal Institute of Chemistry. Dr. Bennett qualified for the degree of Ph.D. (Microbiology) of the University of Birmingham.

PUBLICATIONS

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CREASER, E.H., BENNETT, D.J. and DRYSDALE, R.B.[4]

'The purification and properties of histidinol dehydrogenase from Neurospora crassa'. Biochem. J., 103, 36-41 (1967)

BENNETT, D.J. and CREASER, E.H.

'Amino acid substitutions in mutant forms of histidinol dehydrogenase from Neurospora crassa'. Biochem. J., 105, 39-44 (1967)

DOY, C.H.

'Control of aromatic biosynthesis in Neurospora crassa'. Neurospora Newsletter, 10, 8-9 (1966)

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'Tryptophan as an inhibitor of 3-deoxy-arabinoheptulosonate 7-phosphate synthetase'. Biochem. Biophys. Res. Commun., 27, 186-192 (1967)

DOY, C.H.

'The regulation of aromatic biosynthesis in Neurospora crassa'. Abst. 7th International Congress of Biochemistry, Tokyo, G-117 (1967)

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BROWN, K.D.

'Regulation of aromatic amino acid biosynthesis in Escherichia coli K12'. Genetics.

CATCHESIDE, D.E.A.

'The mechanism of genetic regulation of recombination and gene expression in Neurospora crassa'. In "Replication and recombination of genetic material" Canberra 1967.

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'The regulation of allelic recombination and gene expression in Neurospora crassa'. Genetics

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'Fine structure of Clostridium acetobutylicum'. J. Bacteriol.

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'Aromatic biosynthesis in yeast II. Feedback inhibition and repression of 3-deoxy-D-arabinoheptulosonic acid 7-phosphate synthetase'. Biochim. Biophys. Acta

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'The nature of 3-deoxy-D-arabinoheptulosonate 7-phosphate synthetase in extracts of wild-type Neurospora crassa: A ping-pong reaction controlled by two activating substrates and three allosteric negative modifiers'. Biochim. Biophys. Acta.

DOY, C.H.

'The control of the common pathway of aromatic biosynthesis particularly with regard to the allosteric enzyme, 3-deoxy-D-arabinoheptulosonate 7-phosphate synthetase'. Revs. Pure Appl. Chem.

JHA, K.K.

'Genetic control of allelic recombination at the histidine-3 locus of Neurospora crassa'. Genetics, 57, No. 4 December 1967.

Footnotes:

1. Chief of Biology Division, National Cancer Center Research Institute, Tokyo.
2. Laboratory Manager, Research School of Biological Sciences, since 10 March 1967.
3. Electron Microscope Unit.
4. Department of Microbiology, University of Birmingham.

Developmental Biology

The term "developmental biology" has a wide connotation, covering:

(a) aspects of cell biology (cell genesis, expansion and differentiation) including organelle development;

(b) organogenesis;

(c) environmental, hormonal and nutritional control of development, including aspects of photo- and thermoperiodism, circadian rhythms and light-triggered development;

(d) induction, determination and special topics such as metamorphosis and alternation of generations;

(e) gametogenesis, sporogenesis, fertilisation, germination, dormancy, ageing and senescence;

(f) embryology, wound healing and regeneration;

(g) pathological aspects of development, including teratogenesis, gall and tumour formation.

The view that developmental biology is a study of the mechanisms of expression of gene as character gives even wider scope. The choice of problems and organisms will be personal to individual members of staff but at least initially the section will concern itself with a strictly limited range, building on their current research.

1. Regulation of cell division and cell expansion. This will start from work on cytokinins, regulators of cell division in plant cells.

2. The development of cell organelles, especially plastids and mitochondria. Dr. Leggett Bailey has studied the proteins of the chloroplast and Dr. Clark-Walker has worked on the mitochondrion. It is intended to continue studies, begun at Belfast by Professor Carr's colleagues, on development of the chloroplast induced by light.

3. Attempts are being made to relate ultrastructurel changes to differentiation of cells and tissues (Pickett-Heaps). In particular, different arrangements of cytoplasmic

microtubules have been shown to be spatially associated with several morphogenetic phenomena in plant cells. For example, bands of microtubules predict the plane of cell division, and also the pattern of wall deposition in xylem cells in wheat seedlings. During spermatogenesis in Chara, profound alterations in cytoplasmic organization and the attainment of the typical spiral form are associated with the appearance and growth of another band of microtubules. From these and many other observations, microtubules are believed to be involved in the expression of some genetically-determined patterns of cellular development and in the control of intracellular growth and differentiation.

4. Triggered development. In plants certain developmental sequences can be triggered by exposure to light. In all except the fungi, photomorphogenesis begins with the absorption of red light in the biliprotein, phytochrome. The mechanism by which phytochrome, which is activated by red light and inactivated reversibly by near infra-red, brings about the developmental response is unknown, but the ability to trigger such a response and to follow what happens is valuable experimentally. In one system, the unrolling of the leaf of barley grown in the dark, it has been shown (Carr and students) that an immediate consequence of irradiation is the synthesis of gibberellins. This synthesis begins within minutes of irradiation and can be blocked by inhibitors of protein synthesis; the action of the gibberellins can also be blocked, within a restricted time from their appearance, by near infra-red.

Other triggered developmental sequences are those following fertilisation and in germination. Also, insect metamorphosis can be triggered by ecdysone and this offers a fruitful field of investigation.

5. As in other fields, the possibility of further progress with problems of developmental biology often depends on the development of new techniques. Dr. Pickett-Heaps has made progress with a number of problems in plant cell development using new methods of optical and electron microscopy and further refinement of these methods is desirable.

6. Certain organisms offer special advantages because, for example, of their large cells (Acetabularia), haploidy or regenerative capacity. Among the Australian plants and animals there are many organisms worthy of study both in themselves and for the special advantages they would confer in developmental biology. It is first necessary to be able to raise such organisms in controlled conditions in the laboratory, before they can be used experimentally. The work of defining the conditions of culture is tedious and largely unproductive but justifiable if it makes possible any addition to the range of organisms available for study.

Taxonomy

Studies on the biology and taxonomy of eucalypts. As a group of Australian organisms exhibiting a wide range of adaptation the eucalypts offer problems in biology and taxonomy which have been studied by Mrs. Carr for some years. Investigations of the mode of development, particularly of the reproductive organs, have revealed examples of parallel evolution and illuminate the evolutionary taxonomy of the group. It is hoped to continue this work in collaboration with workers in CSIRO and in the Botany Department. It will fit in admirably with the small Unit of Taxonomy which is being formed in the School.