BIOLOGIC

NEWS FROM RESEARCH SCHOOL OF BIOLOGICAL SCIENCES AUSTRALIAN NATIONAL UNIVERSITY

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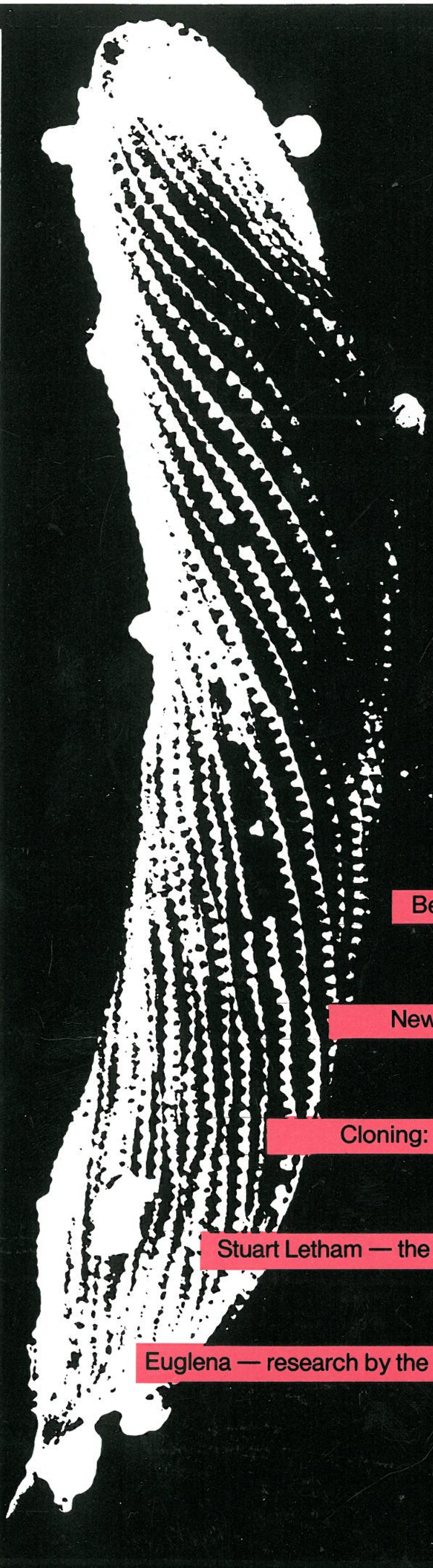


Sex in crocodiles

Bees may help robots see

New test for dieback fungus

Cloning: the ability to fix nitrogen

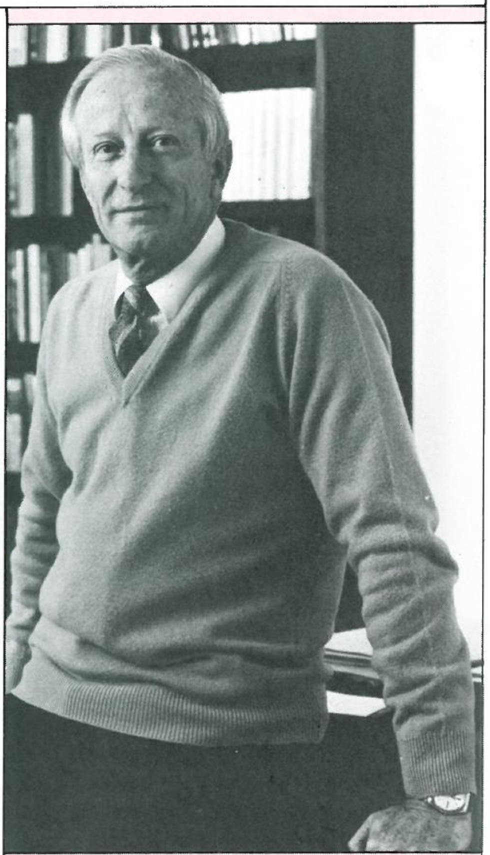
Stuart Letham — the discoverer of cytokinins

Euglena — research by the winner of top ANU prize

BIOLOGIC

FROM THE DIRECTOR'S DESK

Welcome to *Biologic*.



The Director is Professor Ralph Slatyer, AO, FAA, FRS, who has been a member of the School since 1967.

This newsheet will be a regular production, informing people about the current work of the Research School of Biological Sciences.

The School's aim is to be a leading centre for biological research and graduate training and to maintain a position at the forefront of international developments.

We endeavour to concentrate on a selected range of key topics. Where possible, we develop research programs in areas not strongly represented in other Australian universities and, when appropriate, we use the distinctive features of the Australian biota. We interact with other research groups, including CSIRO, so as to increase the value and effectiveness of Australian biological research.

In all this work we attempt to take full advantage of the unique nature of the Research Schools at the Australian National University which allows the development of well-structured research teams funded directly from the University's recurrent grant. In my view such teams are essential for rapid progress in leading areas of research. The ANU alone amongst Australian universities can offer such programs.

The corollary is that we have to be very sure about the areas we wish to pursue and the School is part-way through a review process aimed at helping us identify and meet research goals for the next five years. We are seeking a greater focus on teamwork and on areas of biology in which the School can become a leader.

Through this first edition of *Biologic*, I introduce you to some of the work and the people who are part of the Research School of Biological Sciences.

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Symbiosis shows potential for agriculture

The genetic engineering of a soil bacterium by ANU biologists may allow acid-tolerant pasture legumes to grow in acidic soils, biologically produced fungicides and anti-bacterial agents to reach only the roots of particular crop species, fix nitrogen on the roots of non-leguminous plants to allow them to thrive in poor soils.

One of the major research projects in the Research School of Biological Sciences concerns several strains of the soil bacteria, *Rhizobium*. *Rhizobium* strains infect plants, mainly legumes, and establish a nitrogen-fixing symbiosis in their roots. This makes the plant hosts valuable as soil fertilisers.

The Rhizobium research team, under a Senior Fellow in the Department of Molecular Biology, Dr Barry Rolfe, is investigating the ways the bacteria recognise and interact with their hosts. The studies include identifying the genes in the bacteria that control the symbiosis, analysing the chemical signals that pass between the bacteria and the host plant which enable the infection to go ahead, and studying the role of sugars on the surface of the bacteria which 'camouflage' the bacteria, preventing them from being recognised and rejected by the host plant.

Dr Barry Rolfe and the RSBS *Rhizobium* team.

Much of the research has been into the bacterium, *Rhizobium trifolii*, which forms a symbiosis with many clovers. The results are applied to other *Rhizobium* strains to analyse their genetic make-up and agricultural importance.

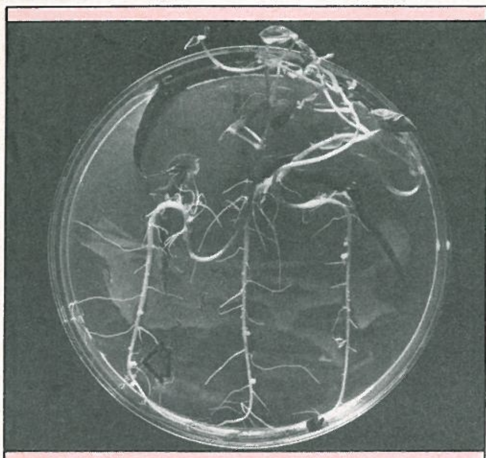
Research with mutant strains has shown that the relationship between the soil bacterium and its host plant is much like the human response to infection. Host-specificity genes limit the bacterium to a narrow range of potential plant hosts. The surface of the bacterium, like that of a virus in humans, determines the host's reaction. A repeating sugar structure coats the bacterium. Only certain sugar structures are allowed past a plant's defences. The plant quickly termines invasion by bacteria with the wrong sugar coat.

The research team is accumulating a set of genetically engineered mutants to illuminate the system of acceptance and rejection. Varying the genes which control the bacterium's host range may make the *Rhizobium* acceptable to a wider range of plants.

One strain of *Rhizobium* has the potential to fix nitrogen in symbiosis with a non-leguminous tree in New Guinea. The team is seeking to understand the extension of this bacterium's host range. Such research may show how to extend, genetically, nitrogen-fixing symbiosis to a wide range of non-leguminous crop plants. This symbiosis would reduce crop-fertiliser needs and have a significant impact on agriculture.

Another aspect of the relationship between *Rhizobium* bacteria and their hosts is the appearance of chemicals, called flavones, which the bacteria recognise and respond to. The roots of potential host plants release minute quantities of flavones which flick a genetic switch in the appropriate bacterium. When this switch is on, the bacterium's genes responsible for attachment to and invasion of the host begin to act.

One of the important agricultural applications of the *Rhizobium* research could be to genetically engineer bacteria with cloned anti-fungal or anti-bacterial genes. Cloned toxin-producing genes in *Rhizobium*



Induction of nitrogen-fixing nodules (arrow) on the tropical legume siratro. Part of the work of Dr Barry Rolfe on *Rhizobium*.

bacteria could be coupled to a flavone-operated switch. Thus the toxin genes would only be turned on by the particular plant's presence. In a field the anti-fungal or anti-bacterial effect would be limited to an area around the roots of a specific crop plant. Other plants would not be affected.

Another important agricultural problem is the increasing acidity of Australian soils. This is affecting pasture legumes because most *Rhizobium* strains will not form effective symbioses in acidic soils. Since liming is not feasible over the large areas affected, a means of biological control has been sought.

The RSBS researchers suspect that the acid in the soils may be having an effect on the bacteria's response to flavone signals. Acid-tolerant strains of *Rhizobium* found in Victorian soils are now being examined with genetic techniques. If a few genes are found to control acid-tolerance in these strains, these genes could be transferred to other *Rhizobium* bacteria which are used commercially to inoculate legumes. So the nitrogen-fixing ability of pasture legumes could be made acid-tolerant.

Apart from Dr Rolfe, members of the RSBS Rhizobium research team include a Research Fellow in the Department of Developmental Biology, Dr Jacek Plazinski, three postdoctoral fellows in the Department of Molecular Biology, Dr Michael Djordjevic, Dr Murali Nayudu, and Dr Jeremy Weinman and a large number of postgraduate students. The team is collaborating with others at Macquarie University in Sydney, and in laboratories in Europe and the USA.

Bees' eyes may help robots see

ANU research into the vision of bees and other insects may help overcome some of the major problems that plague artificial vision devices.

Experiments in the Department of Neurobiology, in the Research School of Biological Sciences, have indicated that insects use a simple means to detect motion.

Insect models could be used by companies and research institutions to make simpler forms of robot vision than those using human models, which researchers around the world are presently investigating.

A popular research subject for many years has been the means of navigation, using the sun, of the domestic honey bee, *Apis melifera.* A team in the Department of Neurobiology, set up by Professor Adrian Horridge and led by Dr Mandyam Srinivasan, have concentrated on the bee's means of perception.

The bees have been trained to fly from a hive to a sugar feeder. As the feeder is moved down a tunnel, the bees follow. Gradually, the feeder is moved behind striped cards of varying colour, orientation and stripe-width. In seeking the sugar, the bees learn to distinguish between two patterns, such as horizontal and vertical stripes.

By changing the distance of the stripes from a junction where the bees have to make their decisions, the researchers can measure the distance from which different patterns can be recognised. The width of the stripes allows a measure of the bees' visual acuity.

It turns out that the grain of the facets making up the bees' compound eyes determines the limits of the eyes' resolution. The limit is where one facet scans one stripe and the next facet the adjoining stripe.

The limit shows that all of the information captured by the eye is being passed to the bee brain. The brain has a detailed memory for patterns in space and can match what it sees to the memory.

The bee's ability to recognise patterns is called its form vision. Though bees can detect three primary colours, useful in distinguishing flowers, form vision seems to operate on only one colour channel. Thus, in recognising patterns, bees are 'colourblind'. Their detection of motion also appears to be colourblind.

Humans use stereo vision to estimate distance and detect movement. Because bee eyes are so close together they can only use stereo vision for very close objects. For objects further away they have to rely on other cues, such as relative motion.

Dr Srinivasan suspects that bees use motion parallax to gauge the distances of objects. By measuring the apparent motion of an object relative to its background, a moving insect can infer the distances of the various objects around it. So bees can avoid objects coming towards them or avoid flying into nearby objects. Using parallax cues the bee's brain does not have to recognise the object, just its motion. Knowing its own speed and the apparent angular velocity of the object, the bee can calculate its distance and know whether that distance is far enough for safety.

Dr Srinivasan said recently that this basic research into how insects see and process information from the outside world could be applied to robotics. Most artificial vision reseachers around the world try to imitate human stereo vision. But this creates problems in recognising and comparing the images from two eyes. It is too hard for existing computers.

It may be relatively simple to build parallax detectors into robots, using one 'eye' to detect motion against a background. Dr Srinivasan said the department was keeping an eye on the robotics industry, with a view to possible collaboration. An Adelaide company was already interested in the possible application of the department's research to movement detectors for burglar alarms.

Dr Srinivasan and his group, who also work with drone flies, dra-

Dr Srinivasan with two members of his team.

gonflies, butterflies and locusts, said insects were 'stripped-down forms of higher organisms'. Though they had five orders of magnitude, fewer neurones in their brains, and form vision 60 times worse than humans, insects still thrived. 'They must have some elegant solutions,' said Dr Srinivasan. One solution, employed by bees, was to use at decreasing distances, colour, then pattern, then scent, to locate a chosen flower.

He also said that the research to discover these solutions was much simpler with insects. There were no problems with attention and volition, insects behaved very predictably. They also had large neurones which were easier to pick out with glass microelectrodes.

Much of the work in the Department of Neurobiology is carried out in electrophysiology rooms, where banks of amplifiers, oscilloscopes, tape recorders, computers and plotters have been built around tiny insects. The microelectrodes are inserted into nerve cells and the responses to stimuli measured. To analyse visual respones, lights and electronic pattern generators are set up in front of the insect and responses monitored. The particular functions of individual neurones can then be worked out.

For example, one nerve cell in a bee's brain may only respond to movement in one direction. Dye is injected into the cell through the microelectrode that registered the response and the cell can be identified in later dissection. In this way, the experimenters can ensure that they record from one cell in each preparation. Recording from two cells simultaneously—one in the eye and one in the brain—can reveal linked responses.

Dr Srinivasan said that even though insect eyes worked differently to human eyes, the image-processing systems in the brain were similar. This meant that his insect work would ultimately benefit humans.

As one researcher pored over a spotlit locust with five glass electrodes in its nerves and muscles and a very strong reading on the oscilloscope, Dr Srinivasan said that though some researchers argued insects did not feel pain, the question had not yet been firmly resolved.

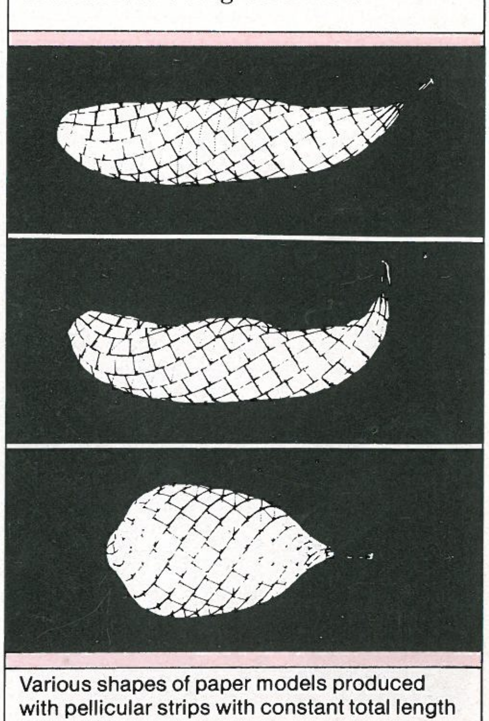
Others working on insect vision with Dr Srinivasan and Professor Horridge are a Research Fellow, Dr Richard Guy, Postdoctoral Fellows, Dr Ted Maddess, Dr Robin Findlay and Dr David Reye, Visting Fellows, Professor Ken Singarajah and Dr Miriam Lehrer, research assistance, Ms Ljerka Marcelja, and PhD students, Mr Andrew James, Mr Eric Warrant, Mr Shi Jian and Mr Zoran Aleksic.

Crawford Prize to RSBS student

A PhD student who recently completed his studies in the Department of Developmental Biology, Dr Toshinobu Suzaki, was awarded the J. G. Crawford Prize for his doctoral thesis. The Crawford Prize was established in 1973 to recognise the contribution of Sir John Crawford to ANU as Vice-Chancellor and Director of the Research School of Pacific Studies. Dr Suzaki's thesis was on the mechanisms of euglenoid movement.

Euglenas are microscopic single-celled organisms that live in water and swim with the aid of a flagellum. Like algae, some *Euglenas* have green chloroplasts, but like animals, their flexible cells can bend and change shape. *Euglenas* are distantly related to both plants and animals, but most closely related to trypanosomes, the parasites that cause sleeping sickness.

Dr Suzaki showed that *Euglenas* change their shape by moving strips of hard plate on their surface relative to one another. Electron microscopy showed the shapes of these plates and computer simulation showed how the plates could change the shape of the organism without themselves being deformed.



Various shapes of paper models produced with pellicular strips with constant total length and width.

NEW PUBLICATIONS

Pests and Parasites as Migrants—an Australian Perspective

Dr Adrian Gibbs and Dr Roger Meischke

The First Fleet in 1788 was more than just an invasion of Australia by European human beings. The fleet also brought exotic plants, animals and diseases from the Old World to a new and uncontaminated one.

The Australian Academy of Science has recently published a collection of articles based on papers given at a symposium in Canberra in 1984. The symposium, on the introduction and control of exotic pests and diseases in Australia, was part of the ANZAAS conference that year. The symposium attracted scientists, farmers and government officials from Australia, New Zealand, Europe and North America.

The book is called *Pests and Parasites as Migrants—an Australian Perspective.* The collection has been edited by the Acting Head of the Department of Evolutionary Biology, Dr Adrian Gibbs, and a former veterinarian with the Australian Agricultural Health and Quarantine Service, Dr Roger Meischke.

The book includes many cautionary tales of pests and parasites which have affected, or might affect, humans, animals and plants in Australia. It also discusses the controversial issue of the deliberate importation of some parasites for research or biological control.

The editors note: 'The tales here are by no means exhaustive, several sets of other, quite different cautionary tales could have been assembled in this book, such is the scale of the problem that confronts Australians seeking to decide with which other organisms they wish to share their continent.'

Pests and Parasites as Migrants will be published in Britain by Cambridge University Press.

New opportunities for (fourth-year) honours study in research school

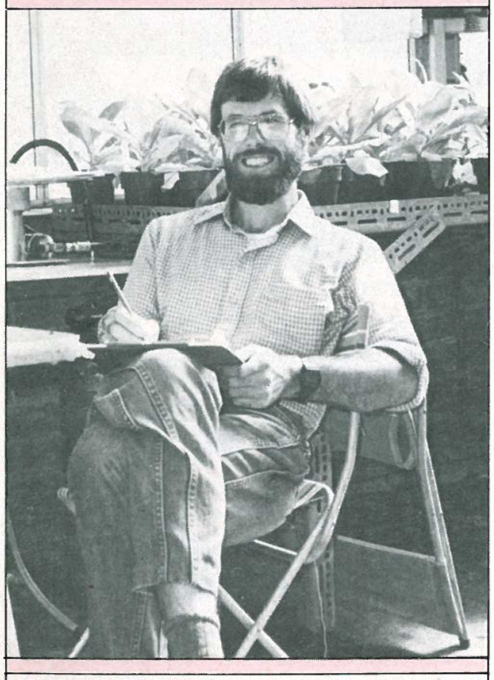
A new fourth-year honours program in cell biology will begin in the Research School of Biological Sciences at ANU next year. The course will be organised in conjunction with the Faculty of Science.

The new course follows the success of the neuroscience honours course that has been offered in the School since 1983. Both honours courses are designed to widen the choice for students and to attract good students to research at ANU.

The cell biology honours program will consist mainly of research, possibly with some lectures and seminars. State university students will be able to transfer to the course for their honours year. The Acting Head of the Department of Molecular Biology, Dr Des Clark-Walker, hopes the new research possibilities in RSBS will attract six to ten students next year.

HIGH TECH INVENTIONS

Gas-exchange machine takes lab into the field



Dr Bruce Wellington

Researchers and technicians in RSBS have designed and built a portable field gas-exchange system that allows the facilities of a biology laboratory to be taken into the field. The machine will allow the accurate study in natural conditions of the physiology of Australian plants, which have been relatively little studied in the field.

The gas-exchange system was designed by a Research Fellow in the Department of environmental Biology, Dr Chin Wong, and built with the assistance of the department's senior technical officer, Mr Win Coupland, and technical officer, Mr Peter Groeneveld.

The field system consists of leaf chambers mounted on a scaffolding. In each chamber environmental conditions can be computer controlled, allowing various combinations of temperature, light, humidity and carbon dioxide levels to be maintained. Biochemical responses to the varying conditions can be monitored. So laboratory accuracy is combined with field naturalness.

A Research Fellow in the department, Dr Bruce Wellington, said the field gas-exchange system was an example of new technology removing the limits imposed by the previous need to work in a laboratory. In the past, photosynthesis had to be studied using potted plants in conditions quite different to nature.

Dr Wellington is using the system to study the water-use efficiency of mistletoe. He is measuring the photosynthetic response of the parasite to varying levels of water in the host tree.

Dr Wellington said the gas-exchange system offered biologists the chance to look at the physiological factors limiting the distribution or regeneration of plants. It also offered the potential to define more clearly the link between ecology and physiology.

Differences between individual plants in the field can be studied to determine the variations in populations of plants.

The neuroscience honours course is designed to give people with the equivalent of a Bachelor's degree in biology or behavioural science an introduction to the multidisciplinary study of the brain and behaviour. The course provides lectures and practical classes followed by research in one of the many neurobiological projects at ANU, in RSBS or the John Curtin School for Medical Research. Some clinical projects have been organised in conjunction with Royal Canberra Hospital.

The Head of the Department of Behavioural Biology in RSBS, Professor Richard Mark, said that the neuroscience course had satisfied a need and had been successful. The honours work had assisted research and about half of the graduates had gone on to postgraduate work at ANU and elsewere. He expected the five-year trial to continue after a review at the end of 1987.

The neuroscience honours course will, from the beginning of 1987, have a part-time administrator. A lecturer in the Department of Psychology in the Faculty of Science, Dr Jacoba Brinkman, will spend half her time with students in the courses.

RSBS swimmers raise $1,300 for Heart Foundation

Swimmers in the Research School of Biological Sciences Swim For Heart team raised over $1,300 for the ACT division of the National Heart Foundation. Thirty-one swimmers from the University spent a total of 30 hours swimming one weekend in July. The team had sponsors for the amount of time spent in the water and so raised $1,300.

The foundation raised a total of $33,000, much more than the $20,000 expected.

The organiser of the RSBS team was a technician and clerk in the Department of Neurobiology, Miss Joan Quinn. She spent 20 hours at the Australian Institute of Sport pool and 2½ hours in the water, filling in some of the early morning gaps when it was hard to find swimmers.

The Department of Neurobiology and the Department of Molecular Biology were well represented by swimmers.

Joan Quinn, RSBS with George Boyan in water

HIGH TECH INVENTIONS

High-speed video display board


Mr Indulis Kradzins, designer

A senior technical officer in the Department of Neurobiology, Mr Indulis Kradzins, has designed a cheap and flexible video display driver for use in the department's experiments. The high-speed video display board generates moving patterns on an XYZ monitor to test the vision of insects.

Most commercially available devices have a refresh rate for the image of 50 cycles a second, which is too slow for the experiments. Mr Kradzins' board can refresh the image at 260 cycles a second—too fast for the insects to see any flicker. The parts for it cost about $1,000 with the cost of programming to be added. It fits directly into the department's DEC LSI-11 computer.

Mr Kradzins, an electronics technician, has spent two years, on and off, designing the prototype. The printed circuit board design, built around a $40 microprocessor, took a month of long days over a light box. A company in Sydney reduced the design photographically, attached the negative to a coated board, etched away areas not needed and plated the holes. That cost about $200. Then Mr Kradzins added memory chips, a signal converter and computer interface chips.

The final product is able to put stripes and bars on the screen, move them about, change the frequency and contrast and split the screen. As well as providing the stimulus for the insects' eyes, the computer can monitor, through microelectrodes, the insects' responses and analyse the results. The board can vary the stimuli according to feedback from the responses.

Mr Kradzins plans to make five more boards. He believes they would be useful for anyone doing vision research and could possibly have wider applications.

Test found for dieback fungus

Dr Adrienne Hardham, Dept Developmental Biology, with a model of the zoospore of the dieback fungus, *Phytophthora cinnamomi*.

An ANU biologist has developed a test that reveals the presence of the dieback fungus that has decimated large areas of Australian forests. The test, which uses the latest immunological techniques, has interested a large American agricultural company.

The dieback fungus belongs to a group of pathogenic fungi which are difficult to identify. Over the last 20 years researchers around the world have attempted to make a simple antibody test to show the dieback fungi's presence in soil. A Research Fellow in the Department of Developmental Biology, Dr Adrienne Hardham, has found a set of antibodies which react with the surface of tiny zoospores of the dieback fungus, *Phytophthora cinnamomi*.

Dr Hardham initially produced the antibodies in mice. Subsequently, antibody-producing cells were isolated, cultured and tested. Using these antibodies to produce strains, *Phytophthora cinnamomi* can now be quickly identified.

Dr Hardham researches the structure and function of plant cell surfaces. She has studied the architectural properties of cell walls and their intracellular components.

At Melbourne University she became interested in the dieback fungus which infects over 1,000 species of plants in 67 countries. Susceptible species in Australia include native plants—eucalypts, banksias and acacias; crops—avocadoes, peaches, pineapples, macadamias; and horticultural plants—camellias, azalias and rhododendrons.

The rapid spread of dieback is aided by the production of vast numbers of motile zoospores. These cells can cover large distances in creeks and waterlogged soils. Once in the vicinity of a potential host root, the zoospores can detect substances emanating from the root and swim up to the root surface. There the zoospore encysts. During this process the cell discards its flagella, deposits a cell wall and secretes an adhesive that bonds the cyst to the root surface. Half an hour later the fungal cell germinates and attempts to colonise the plant root.

Dr Hardham was interested in the way these changes involved different aspects of cell surface biology. The detection of chemicals released from the plant root requires the binding of molecules to the zoospore. The spore's encystment may also require chemical signals from the root. And the interactions between the fungal parasite and its host require numerous surface reactions.

At ANU Dr Hardham has been using the antibodies that have been raised against the fungal cells, not only as diagnostic tools but also to study the fungal cells and the events which occur during the early stages of infection. She has found that the molecular composition of the surface of the cells is not uniform. Some antibodies attach to restricted parts of the surface. This suggests that different areas of the cell surface perform different functions.

Indeed Dr Hardham has found that one antibody, which binds only to the surface of the flagella, causes rapid encystment. This indicates that molecules on the surface of the flagella may trigger encystment, an important stage of the infection.

Many mycologists have become interested in Dr Hardham's use of antibodies. The American company, Agridiagnostics, hopes to market immunological test kits that will use these antibodies to identify pathogenic fungi.

Dr Hardham said recently that the technique needed further development which she hoped could be done at ANU. She already has a Postdoctoral Fellow funded by a National Research Fellowship, Dr Frank Gubler, working on the *Phytophthora* project. ANU holds provisional patents; but corporate sponsorship is needed.

In the field the test for the dieback fungus could help study the distribution of the disease and the effects of control measures. The rapid identification of species and subspecies could help determine the value of chemical or other measures.

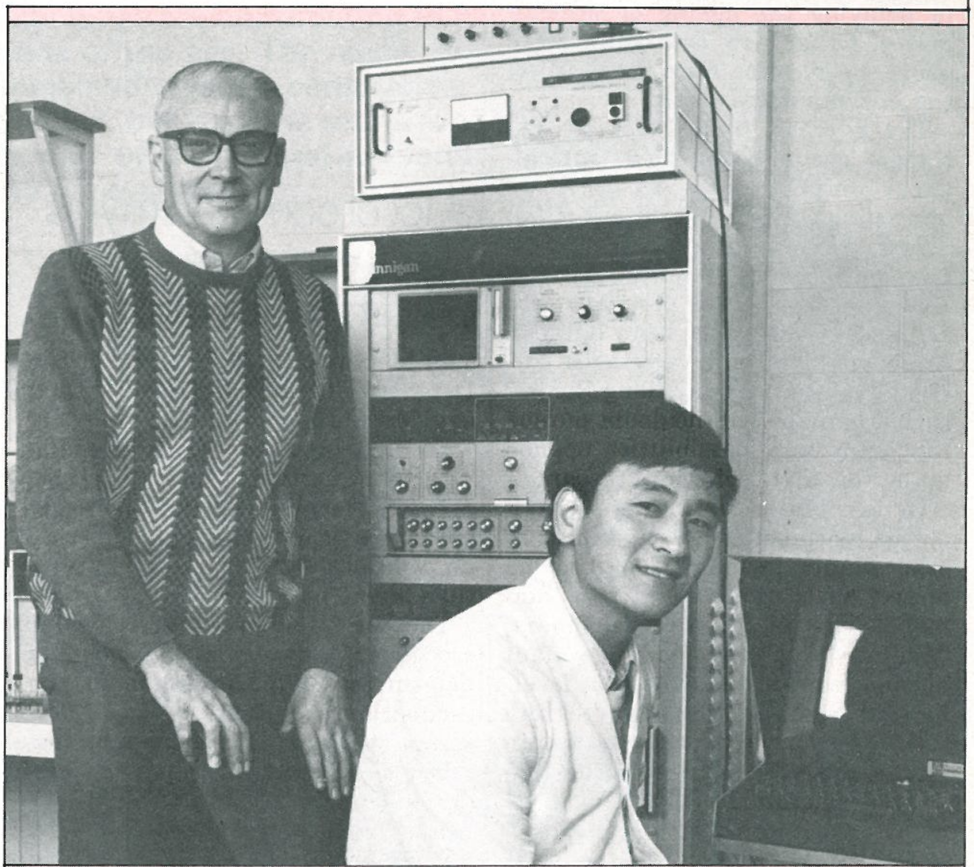
The antibody test could also help identify antigens on the surface of zoospores. Improved understanding of the surface biology could ultimately produce an effective means of control for dieback.

Plant hormones extend life of soybeans

Plant hormones have a chequered history. In 1928 the Dutch botanist, Friedrich Went, discovered a substance that made oat shoots grow. Minute amounts of the substance, auxin, were soon found to be essential for plant cell elongation. Similar synthetic compounds were made and tested and extremely high concentrations were found to inhibit plant growth. Auxins' main contribution to agriculture has so far been in the form of 2, 4D and 2, 4, 5T, the well-known weedkillers and defoliants that make up most of Agent Orange. The other ingredient, a by-product of the auxins' manufacture, is the extremely toxic compound, dioxin.

In the 1940s Japanese researchers isolated another group of plant hormones, called gibberellins, from a fungus that caused rice plants to elongate dramatically. Gibberellins were applied to agriculture, promising larger fruit, the delayed ageing of fruit and a means to modify sexual reproduction. But there were problems. So far these growth regulators have not made an important contribution to agriculture.

In 1963 an organic chemist in the New Zealand Department of Scientific and Industrial Research, Dr Stuart Letham, while searching for another group of plant hormones, called cytokinins, isolated the first natural cytokinin, zeatin. Zeatin was found in the immature kernels of maize, *Zea mays*. The next year he worked out the chemical structure of zeatin crystals.



Dr Stuart Letham and postgraduate student Zhang Ren

Since the early 1960s Dr Letham's work has significantly contributed to the use of cytokinins as promoters of cell division in plant tissues. He came to ANU in 1970 and is now a Professorial Fellow in the Department of Developmental Biology in the Research School of Biological Sciences.

Despite his eminence, Dr Letham, 59, tells his story in a quiet, self-effacing way. In New Zealand he had been studying the cell division that occurs in apples for a short period after flowering. It was seen as horticulturally important to extend the period of cell division.

Synthetic compounds known at the time were ineffective and so Dr Letham set out to identify natural compounds which caused plant cells to divide. This led to the search for cytokinins, substances which induced cytokinesis (cell-division), and the identification of zeatin. Dr Letham's work with maize was reported, among other places, in the London *Times* in 1964.

Cytokinins were later found to control many aspects of plant development, including the ageing of leaves. One of Dr Letham's recent projects has been to study the control of soybean leaf ageing with plant hormones. His co-workers in this have been two postgraduate students, Zhang Ren and Santokh Singh, a research officer, Dr Choon Wong, and others in the CSIRO Division of Plant Industry.

Soybean leaves go into decline when seeds develop. When seeds are removed the plants can keep growing up to a height of nine metres. If the leaf senescence could be delayed, soybean yields might be increased and the composition of soybean seed improved.

Cytokinins were found to retard leaf ageing in soybeans. But when a hormone was put on the plants, enzymes in the soybean plant inactivated the hormone. Dr Letham thought that if the action of the inactivating enzyme could be blocked, the hormone would be more effective.

Study of the metabolism of cytokinins in soybean leaves resulted in the identification of the enzyme product that inactivated the cytokinin. Synthetic compounds were designed to inhibit the enzyme. These were tested on soybean leaves. A new xanthine derivative, synthesised by a former PhD student, Mr Charles Hocart, was found to best enhance the action of the cytokinin in delaying the ageing of soybean leaves. Other new cytokinins were synthesised; some were found to resist enzyme inactivation.

The soybean findings of Dr Letham's group could have agricultural importance. As well as improving the protein content of the beans, the treated plants, with leaves still green, could be used as fodder for animals or ploughed into soil as fertiliser after bean harvest. There are many wild varieties of soybean in China. When Zhang Ren returns there, he will no doubt pursue the many new possibilities opened up by the ANU cytokinin research.

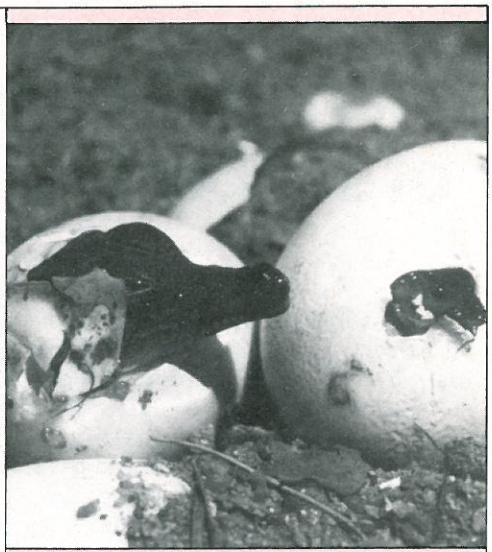
Dr Letham is continuing to work on the biochemistry of cytokinins in other plants, including tobacco. One motive is to understand how hormones control plant development. 'We know very little about how plant hormones act at the molecular level,' he said. So he is studying cytokinin biosynthesis and movement within plants to understand how the hormones co-ordinate plant development.

Looking back over the history of plant hormones, Dr Letham observed that basic research, 'by a strange twist, can often lead to very great advances in seemingly unrelated fields of great practical importance'.

He thought the future promised more than the past. Knowing how hormones act would have great significance for plant breeders and geneticists. Genetic engineers may eventually be able to transfer cytokinin genes to improve plant growth, possibly producing soybean plants that did not senesce readily. This was an area to which he and his group would like to contribute, he said.

Dr Letham constantly plays down the importance or immediate impact of his research. When asked why a yellowing soybean leaf was featured on the front of a collection of RSBS research reports, he said, 'Well, it's colourful'.

Crocodile sex


Crocodiles in their own territory

'A lot of common myths about crocs are a fair way from the truth,'

said a postgraduate student in the Department of Evolutionary Biology, Mr Anthony Smith.

He had in mind recent crocodile attacks in northern Australia. However, his research into how the sex of crocodiles is determined is testing an American theory that may also turn out to be a myth.

The sex of Australian freshwater crocodiles, *Crocodylus johnstoni*, is determined by the environment: the incubation conditions of eggs determine the sex of the hatchlings. American researchers have suggested that crocodiles and other animals with environmentally determined sex, such as alligators, some fish, some turtles and many invertebrates, use the mechanism as a way of improving species survival prospects. Larger male crocodiles have a better chance of reproducing than smaller ones, while for females size does not matter.

The theory holds that the egg's incubation determines the ultimate size of the adult. The sex appropriate to size should then be adopted during incubation. But Mr Smith's research suggests that the biggest and strongest hatchlings may not always be the males.

Freshwater crocodiles lay 10 to 15 eggs in the sand banks of billabongs and small streams in late August and early September. Then the eggs are covered with sand and forgotten. In October and November the nests start 'calling'—a high-pitched quacking indicates the eggs are ready to hatch.

An adult crocodile digs out the eggs and helps the hatchlings crawl to the nearby water. In the next three weeks, 50 per cent die, many eaten by adult crocodiles. Only one per cent of hatchlings survive to 10 years of age. Females mature at about 12 years and males at about 15 years. Once they reach adulthood freshwater crocodiles are likely to live to about 50 years.

Mr Smith has been looking at the nest environment, including soil type, temperature and moisture—to see what effect incubation has on the sex, survival and growth of hatchlings for the first two years. He has followed the laying and hatching of crocodile eggs in the McKinlay River area east of Darwin and has moved hatchlings to an accessible pool for study.

His findings so far indicate that the crocodiles which survive longest are those from the largest eggs which are laid early and so have the longest incubation. These crocodiles, which may be of either sex, seem to have their fate most influenced by their mothers. Sex appears to be an unrelated factor.

The problem for Mr Smith is to find a reason, other than reproductive success as an adult, which might explain the crocodiles' sex. Or is the sex-environment link just a primitive mechanism that has not been replaced in crocodiles? Such problems extend to the evolutionary costs and benefits for the species of its sex-determining method and the consequences of having an unstable sex-ratio in the population. Mr Smith's work promises to illuminate such problems in evolutionary theory as well as related research at the molecular level into the determination and differentiation of sexes.

Many methods throw light on retina

New and different biological techniques are contributing to a better understanding of the retina of the eye. The many approaches have recently been combined to give a comprehensive look at how the retina works and, because the retina is a highly ordered and accessible part of the central nervous system, they also show how the brain works.

Two ANU vision researchers, a Research Fellow in the Department of Behavioural Biology in RSBS, Dr Dave Dvorak, and a Professor in the Department of Physiology in the John Curtin School of Medical Research, Professor William Levick, have recently edited a special issue of the international journal, *Trends in Neuroscience* (May 1986), that puts together pieces of the retina jigsaw. The collection of essays includes research methods such as gene cloning, mathematical modelling, biochemistry, anatomy, pharmacology and physics.

The essays show that over the last 10 years a coherent picture has begun to emerge of the structure and capabilities of the retina. The work has implications for medical research, information processing and the design of artificial microcircuitry.

In the Department of Behavioural Biology, Dr Dvorak is part of a multidisciplinary team that is attempting to map retinal circuits, examine the structure of specific cells and, using neurotoxins to eliminate groups of retinal nerve cells, find out what function those groups perform. Other members of the team are a Fellow in the department, Dr Ian Morgan, a Postdoctoral Fellow who specialises in immunohistochemistry, Dr Tom Millar, PhD students, Mr Jan van der Valk and Mr Guang Wang, and MSc student, Mr Marc Golcich.

The aim of the research is to understand how the retina registers visual inputs and codes them into meaningful messages which the ganglion cells transmit to the brain. Using microelectrodes the team is identifying the electrical and chemical processes that allow messages to pass from one nerve cell to the next.

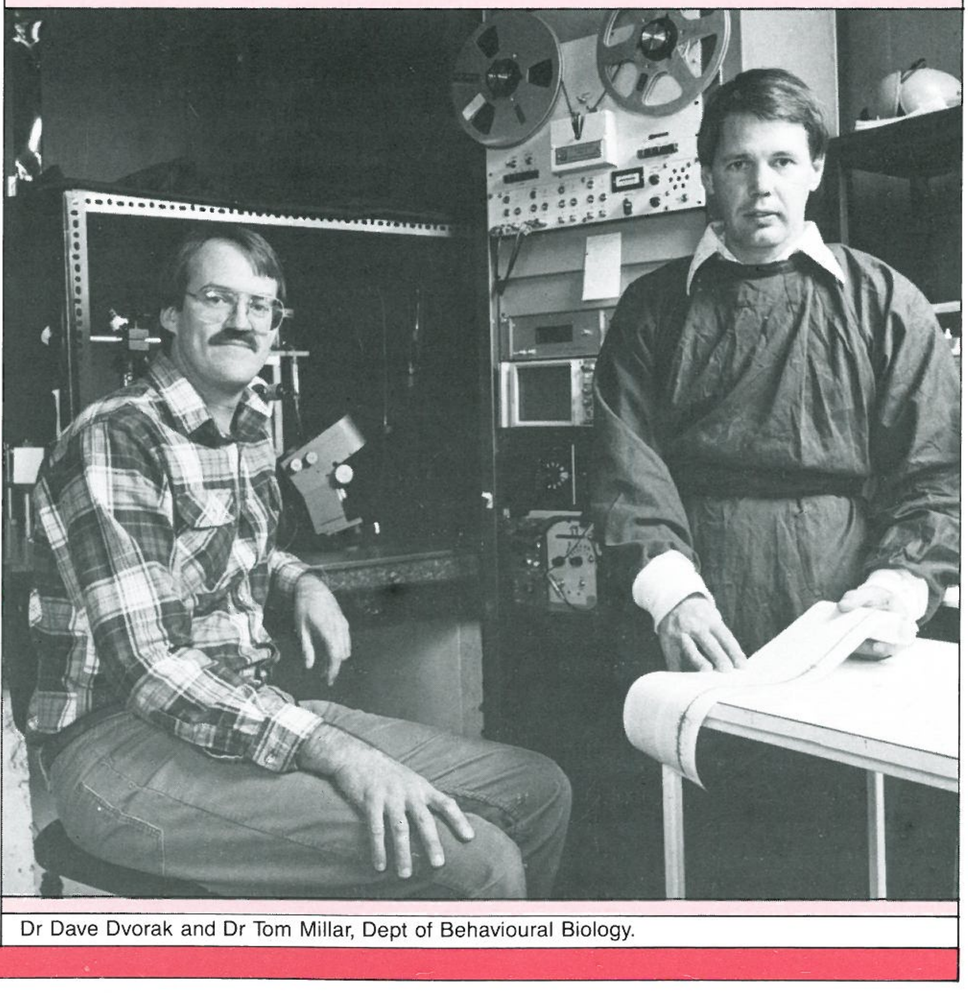
Using antibodies to label specific nerve cells and further antibodies to add fluorescent tags the team can use electron microscopy to identify cell contacts.

By selectively knocking out groups of cells with neurotoxins, Dr Dvorak and Dr Morgan are in a position to examine such retinal functions as direction-sensitive motion perception. This property makes one or two of about 15 ganglion cell types responsive to movement and underlies the neural control of eye position.

Since the days of Emeritus Professor Sir John Eccles in the John Curtin School of Medical Research in the 1950s, ANU has played a leading role in neuroscience. In the 1960s and 1970s Professor Levick and Emeritus Professor Peter Bishop had, at ANU, one of the most influential vision research laboratories in the world. A review committee has recently suggested that ANU should set up a vision research centre that would bring together researchers presently spread through schools of physics, medicine and biology and attract corporate support for applications in fibre optics, optometry, robotics and other areas.

Dr Dvorak is one who believes the regular discussion of research is very productive and would be enhanced if researchers were gathered together. 'We need to get together every day and toss around ideas,' he said. At present the vision researchers around the campus only meet as a group once a month.

Dr Dvorak said that ANU vision research is carrying on the strong tradition in neuroscience. The roles of cells and chemical neurotransmitters in the retina will not remain mysteries for much longer. 'The techniques are at hand', he said, 'That's the exciting thing.'



Dr Dave Dvorak and Dr Tom Millar, Dept of Behavioural Biology.

THE SCHOOL

The Research School of Biological Sciences (RSBS) was established in 1967 as one of the seven research schools of the Institute of Advanced Studies (IAS) at the Australian National University (ANU). The University was founded in 1946 as a research university and centre of excellence. In 1960 five teaching schools, known as The Faculties, were added to create the ANU as it is today.

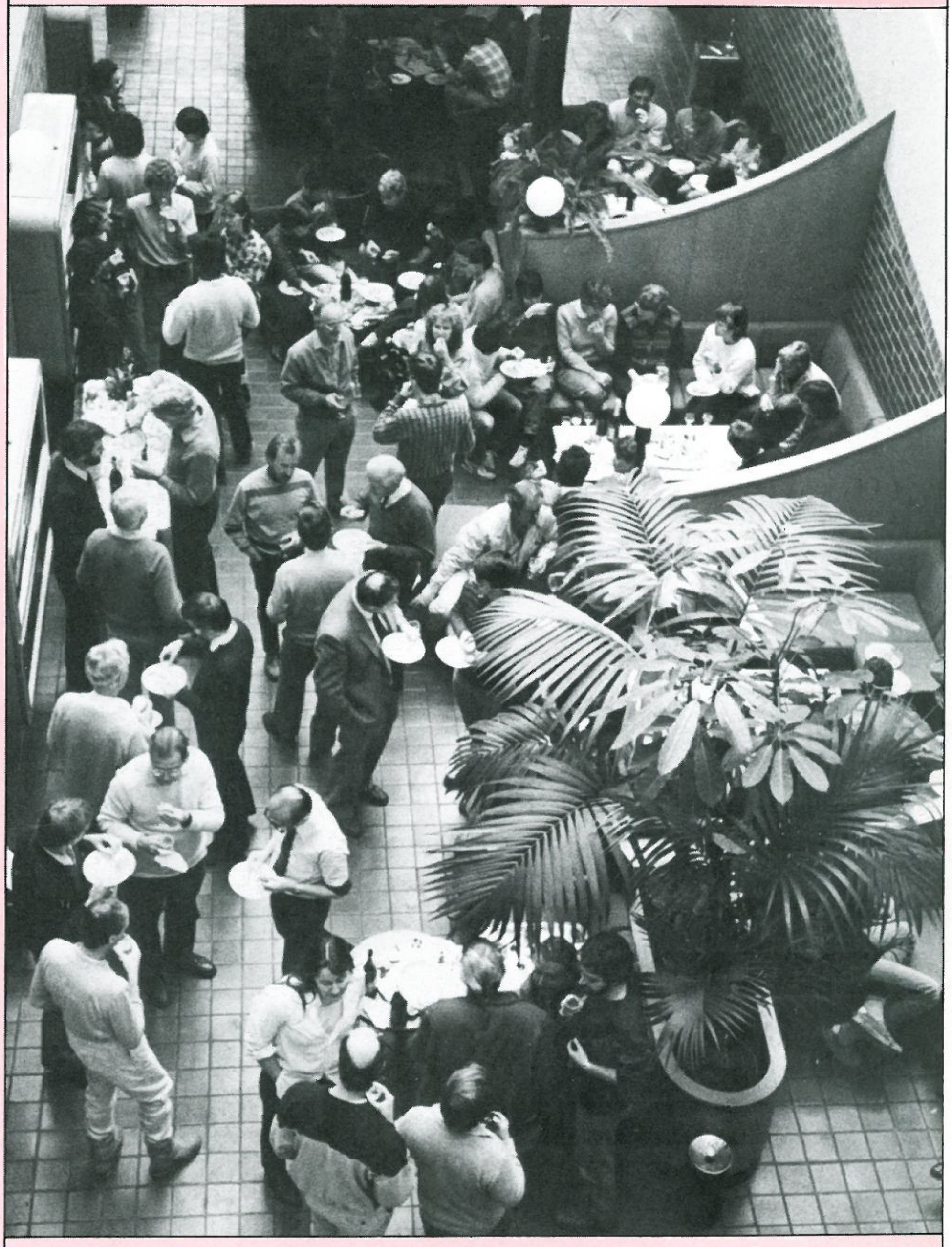
The unique nature of the ANU enables its research schools to concentrate on fundamental research and develop well-structured research teams which are funded directly from the University's recurrent grants.

Since its establishment, the Research School of Biological Sciences has developed into one of the world's leading centres for biological research and graduate training.

A range of key topics of biological research are chosen by the School to ensure that there are adequate resources for each research team. In selecting topics the School aims to explore and utilise the distinctive features of the Australian biota, and concentrate in some areas which are not strongly pursued at other universities.

Biologists of RSBS interact closely with other parts of the University, such as the John Curtin School of Medical Research, and assist with teaching in the Faculty of Science. Close links are maintained with other universities and institutions in both research and graduate training.

The Research School of Biological Sciences has an academic staff of 50 funded from University sources and about 65 graduate students. An additional six academic staff are funded from outside sources.



Celebrating the formation of the two new departments—evolutionary biology and molecular biology—in RSBS.

The School is divided into three main areas, the **plant sciences** which include environmental and developmental biology, the **neurosciences** including behavioural and neurobiology, **evolutionary and molecular biology** which includes genetics, population biology. In addition there is a well developed research support group including the Electron Microscopy Unit, computing, photographics, plant and animal culture facilities and the administration.

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