NEWS FROM THE RESEARCH SCHOOL OF BIOLOGICAL SCIENCES AUSTRALIAN NATIONAL UNIVERSITY

BIOLOGIC

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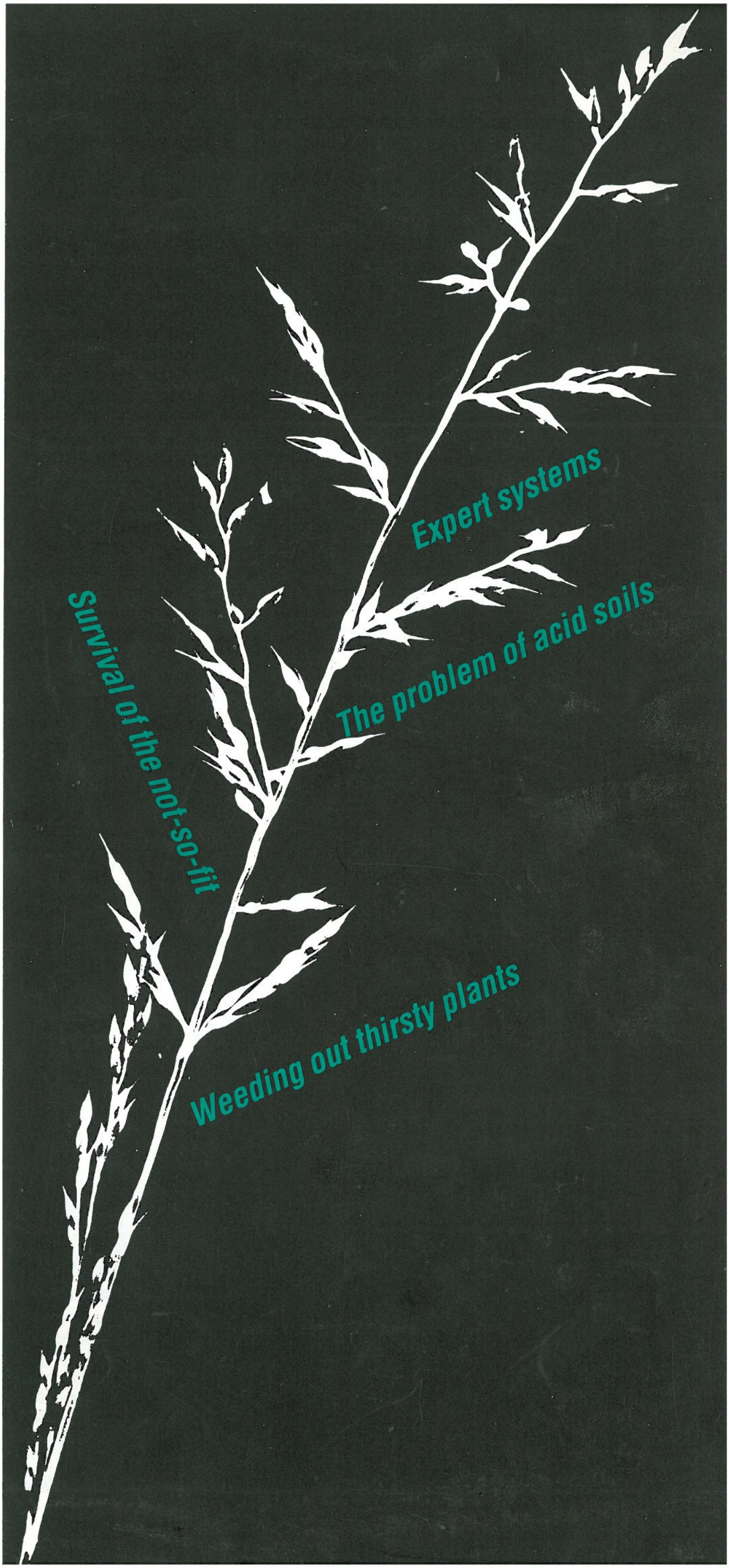

Expert systems

The problem of acid soils

Survival of the not-so-fit

Weeding out thirsty plants

BIOLOGIC

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FROM THE DIRECTOR'S DESK

The period since the last issue of *Biologic* has been one of intense activity, culminating in the restructuring of the School into flexible research groups to replace the previous departments and the development of a strategic plan to guide the overall research direction.

The restructuring has involved tenured members of the School's academic staff and their research colleagues associating themselves into groups focused on particular areas of biological research. Eight such groups have been recognised: visual sciences, developmental neurobiology, molecular genetics, plant molecular biology, plant cell biology, plant environmental biology, population genetics and ecosystem dynamics. The orientation and composition of the groups will change in the future as the challenges in biological research change, with staff members moving between groups, or establishing new ones, as appropriate. We all feel that the new structure will provide a very stimulating basis for our future research.

The strategic plan, within which the new groups have been established, resulted from three major reviews of the entire School program over a period of about 18 months. The reviews identified strengths and weaknesses and highlighted areas of collaboration, within the School and with other organisations in Australia and abroad. The last review, conducted early this year, evaluated the plant sciences and provided strong support for major developments focused on the molecular analysis of plant performance and on ecosystem dynamics.

The former development is spread across three of the new research groups and we hope it will act as a major spur to internal co-operative activity. The latter involves a substantial strengthening of the School's existing work in ecology and is planned to foster collaboration with ecological research groups in other parts of the University. Both are being funded through a substantial re-allocation of resources from other areas within the School.

R.O. Slatyer

Review committee- front row (left to right):Dr Olle Bjorkman of the Carnegie Institution of Washington; Professor Eric Bachelard, the Chairman of the Board of The Faculties; Professor Paul Green of Stanford University; Professor Ralph Slatyer, Director of RSBS; Dr TJ Higgins of CSIRO Division of Plant Industry; Professor Immanuel noy-Meir, from the Hebrew University of Jerusalem; Professor AB Wardrop of La Trobe University. Back row (left to right); Mr Chris Buller, School Secretary of RSBS; Dr Eldon Ball, a Fellow in Developmental Neurobiology Group in RSBS; and Dr Adrian Gibbs, a Senior Fellow and leader of the Plant Molecular Biology group, RSBS.

The new order

Mrs Chris Frylink (left), Mr Les Watson and a PhD student, Ms Vindhya Amarsinghe

Biological research produces a vast amount of information about many different species of plants, animals and other organisms. Ordering this to make it most useable has presented many practical and theoretical problems.

A taxonomist in the School, Mr Les Watson, has long argued the need for plant descriptions to be organised effectively. In 1971 Mr Watson, in conjunction with Dr H.T. Clifford at the University of Queensland, started compiling a database for the 200 genera of Australian grasses. This stimulated further interest in computerised taxonomy.

In the late 1970s Mr Watson began working with Dr Mike Dallwitz of the CSIRO Division of Entomology. Dr Dallwitz wrote a set of computer programs, called DELTA, that organised taxonomic data efficiently and was able to be used by biologists and others not expert in the use of computers.

An early result which RSBS published in 1980, was *Australian Grass Genera: Anatomy, Morphology and Keys.* On microfiche the database can be easily distributed, offering a valuable service for researchers in countries with poor libraries. The database is easily kept up-to-date and is relatively easy to translate into other languages.

DELTA is still the only means to automate taxonomic descriptions. In Canberra it has been applied to grasses, legumes, viruses, corals and insects. In 1986 Mr Watson, Dr Dallwitz and a technical officer in RSBS, Mrs Chris Frylink, set up a new system of classification for grasses, and published detailed descriptions of the world's 728 grass genera. Using this database, Mr Watson has prepared descriptions and keys for the grasses of Botswana, Bhutan, southern Africa and Greece. The basic list of grass characteristics has been used to make French-English descriptions in Canada, and is now being translated into Greek.

The next step is to extend the database of grasses to species level. The Australian Bureau of Flora and Fauna funded a Postdoctoral Fellow in the School, Dr Robert Webster, to computerise details of the 270 species (90 genera) of the Paniceae. Dr Webster is now working for the US Department of Agriculture in Washington, encouraging the department to take up the DELTA system to prepare a new flora of North America. Meanwhile Mr Watson, assisted by Mrs Frylink, has completed a second database for a sub-family of 177 legume genera.

Also, PhD student, Mr Jeremy Bruhl, is presently working on the 90 genera (4,000 species) of sedges.

In another part of the School's Plant Molecular Biology Group, Dr Adrian Gibbs and others are using the DELTA system to organise data on viruses. The Australian Centre for International Agricultural Research (ACIAR), a federal aid organisation, has funded the Virus Identification Data Exchange (VIDE) project. This project, which links over 400 plant virologists around the world, is building a databank for plant viruses which lists 500 characteristics for each of the 1,000 or so viruses and their hosts.

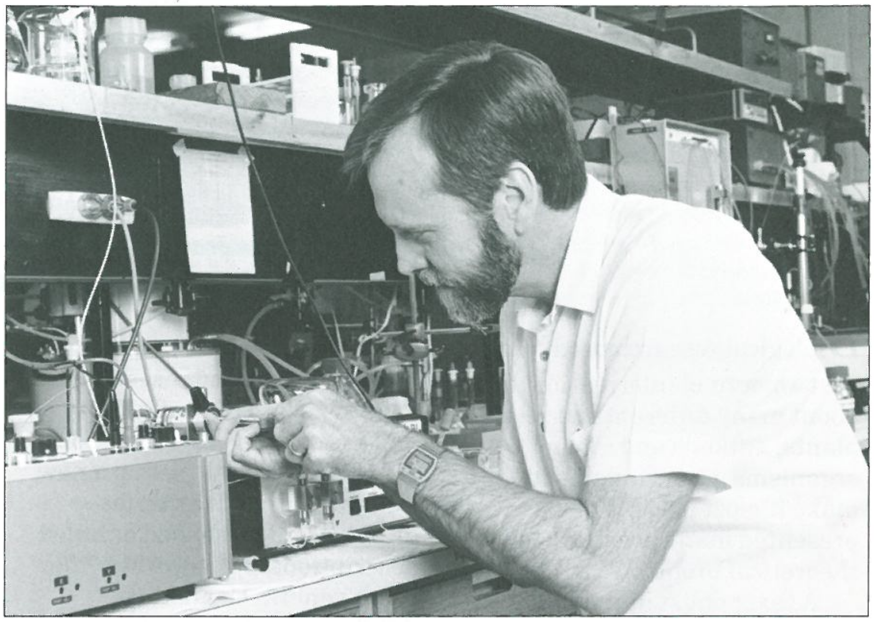
The first stage of the VIDE project, collecting data on the viruses of legumes, was largely completed in 1983. The descriptions of 107 legume viruses are being used for the identification of disease in crops in Thailand, India and Britain. A Visiting Fellow funded by the Reserve Bank, Dr Cornelia Buchen-Osmond, and a research assistant, Mrs Karen Crabtree, are collecting data on all 165 viruses that have been found, so far, in Australian plants.

Work has recently began collecting data on the viruses infecting tropical crops. A Visiting Fellow from the Glasshouse Crops Research Institute in the UK, Dr Alan Brunt, is organising descriptions and keys for these viruses.

Dr Gibbs hopes to have all 1,000 to 1,200 plant viruses in the database within three years. However, he fears the project could be threatened by cuts to Australia's foreign aid budget and hence to ACIAR.

Survival of the not-so-fit

D-ribulose 1,5-bisphosphate carboxylase-oxygenase Rubisco is the most abundant protein in nature, 'I suspect by a long margin,' a Visiting Fellow in the School's Plant Environmental Biology Group, Dr John Andrews, said recently.



Dr John Andrews, Visiting Fellow

Rubisco, an enzyme in plants and algae, is the protein with which plants accumulate carbon dioxide from the air to use in photosynthesis. 'It's the gate from the inorganic world to the organic world,' said Dr Andrews. A vast amount of the world's nutrient nitrogen is bound up in *Rubisco*. In green leaves the enzyme makes up as much as half the soluble protein.

There is so much *Rubisco* because it is so inefficient as a catalyst. Despite its abundance, *Rubisco* is often the factor that limits the speed of photosynthesis.

The evolution of *Rubisco* is a surprising story. All the existing forms of this ubiquitous enzyme are similar. They evolved from a common ancestor which may have been like ancient blue-green algae. Fossilised products of these algae are as old as the world's oldest rocks- about 3,500 million years old. So *Rubisco* probably appeared before the earth cooled, when the atmosphere contained little, if any, oxygen and was rich in carbon dioxide.

At the time, early life forms lived on the traces of carbon found in the chemicals of the primeval soup. The appearance of *Rubisco* gave all subsequent life access to the huge resources of carbon in the atmosphere. So living things proliferated and transformed the earth, using up much of the carbon dioxide in the atmosphere and producing oxygen.

In spite of the enzyme's age, abundance and importance, natural selection seems to have been slow to improve *Rubisco's* performance. After billions of years of evolution, the *Rubisco* in the most advanced green plants is only slightly better at fixing carbon dioxide than that found in anaerobic bacteria.

Dr Andrews and others have identified what seem to be two gross inefficiencies in *Rubisco*. One is the enzyme's incredible slowness. It takes half a second to complete a cycle of catalysis, adding a molecule of carbon dioxide to a substrate chemical and making a product which is eventually converted to sugar. *Rubisco* is 1,000 times slower that other enzymes that catalyse similar chemical reactions.

Rubisco's second apparent inefficiency is its lack of discrimination between carbon dioxide and oxygen. As well as fixing carbon dioxide, the enzyme binds an oxygen molecule to the chemical substrate, making a waste product. Because the atmosphere now contains much more oxygen than carbon dioxide, this reaction causes serious problems for plants. Dr Andrews and others discovered this strange reaction in 1971-72, but no useful function for it has been found since. In an atmosphere free of oxygen, where the oxygen-fixing reaction does not occur, *Rubisco* can increase the rate of photosynthesis by 50 per cent.

Making *Rubisco* without one or both of its inefficient mechanisms is a tantalising possibility for genetic engineers. Small 'improvements' could allow huge gains in plant productivity. Plants would need much less water, light and nitrogen if it was not for *Rubisco's* confusion and sluggishness. They could grow in darker, drier or less fertile places.

'This enzyme is in the box seat as far as plants are concerned,' said Dr Andrews. Perhaps a better *Rubisco* could evolve, but 3,500 million years has not been long enough for it to happen.

As a result, the School is investing much effort in discovering details of *Rubisco* structure and mechanism, to see what controls the basic performance. Limited understanding of these details is likely to frustrate attempts to engineer an improved *Rubisco*. 'If we knew what needed to be fixed, and whether it was fixable, we now have the tools to fix it,' said Dr Andrews.

Dr Andrews is collaborating with another Fellow in the group, Dr Murray Badger, and Dr Matthew Morell, as newly-arrived National Research Fellow, to look at the two sub-units that make up *Rubisco* and their interaction. Using experiments with cloned genes they hope to see into the enzyme's active site, and see whether some way can be found to increase its speed or discriminatory ability.

The improvement of nature is the challenge. But Dr Andrews is aware of the danger of hubris in the genetic engineer. 'We may find that nature has already found the best compromise between conflicts we don't yet understand,' he said. 'When we open that last box we may find that *Rubisco* is already perfect.'

Seminar interrupts honeymoon

One of the School's graduates recently returned to give a seminar. Dr Jonathon Howard, presently working in San Francisco, visited New Zealand and Australia on honeymoon with his wife, a cell biologist, Ms Karla Neugebauer. The leader of the School's Developmental Neurobiology Group, Dr David Blest, took the opportunity to invite Dr Howard back to the School to deliver a seminar.

Dr Howard began his studies as an undergraduate in applied mathematics at ANU. After graduation he moved to RSBS to do his doctorate in the former Department of Neurobiology. His mathematical skills were applied to the study of the compound eyes of insects. By the time he gained his PhD in 1983, Dr Howard was a proficient electrophysiologist.

He moved to Bristol University in England and changed his area of study to the mechanics of hearing. But after a year he decided he did not like Mrs Thatcher's Britain and moved again, this time to the United States.

Dr Howard is now doing research in the Department of Physiology at the University of California Medical School in San Francisco. The department includes one of the world's top laboratories in auditory physiology.

Dr Howard has made important advances in the biophysics of hearing. During the seminar at RSBS he discussed the controversy about how sounds are converted into electrical signals in nerves. These signals ultimately pass to the brain, allowing all animals to discriminate between sounds and humans to perceive speech.

Delegation from China

A delegation from Sechuan Province in the People's Republic of China visited the School in May to look at biotechnology techniques. The delegation is pictured here with three members of RSBS- a Professorial Fellow in the Molecular Genetics Goup, Dr Hiroto Naora, second from left, and two PhD students in the School, Mr Shou-wei Ding, fifth from left, and Mr Yu-guang Shi, at right.

Moving with Grace

One of the most familiar and welcome faces around the School has been that of Mrs Grace Wind, tea lady at RSBS from July 1983 to May 1987.

'The tea room is one of the most important parts of a research school, a place for the exchange of ideas,' said one of the senior staff. 'Grace's friendliness and efficiency greatly improved its effectiveness.'

'I was interested in the students, the staff and what they were doing,' Grace told *Biologic* recently. She enjoyed talking to the variety of people who worked in and visited the School. 'There were so many people from different parts of the world and different cultures.' The appreciation of students and staff was shown by the very large turnout for a presentation when Grace left.

Last year, Grace decided it was time to do something different. 'I thought I'd like to learn a few new skills,' she said. She applied for a job as a clerk in the University's records office and beat the competition to win it. Now she works in the Chancelry, dealing with staff employment files. She has learned about filing and computers and someone else makes her tea!

First Robertson Symposium

Sir Rutherford Robertson, Lady Robertson and Professor Slatyer before the symposium

The first Robertson Symposium took place in the School in February.

The symposium was the first of a series of small informal gatherings of leaders in a particular field of biology. The Director of RSBS, Professor Ralph Slatyer, said he hoped the symposia would be at the cutting edge of knowledge. There would probably be one symposium each year.

The symposia have been named in honour of the eminent plant physiologist and

Participants in the First Robertson Symposium

biochemist, Emeritus Professor Sir Rutherford Robertson. Professor Robertson was the Pro-Chancellor of ANU from 1978 to the end of last year and Director of RSBS from 1973 to 1978. He was present to open the first symposium.

Professor Robertson took the opportunity to reminisce about science, the pleasure of discovering new knowledge, the importance of science and the problems facing scientists. He made the point that for Australia to increase its income from world markets it had to be more clever than its competitors.

Professor Robertson, who has advised a number of governments on science policy, outlined the establishment of the Australian Research Grants Committee in the late 1960s and the Australian Science and Technology Council in the early 1970s. He said that scientists had to be involved in such activities, even though they might resent the time spent away from research.

The subject of the first Robertson Symposium was the ecology of photosynthesis in sun and shade. Speakers came from different parts of ANU, CSIRO, China, West Germany and the United States; they included the eminent photosynthesis researcher from the Carnegie Institution and Stanford University, Professor Olle Bjorkman. The first symposium was organised by the Department of Environmental Biology in RSBS.

The team working on water-use efficiency in plants. From left, Dr Susanne von Caemmerer, Dr Kerry Hubick, Mr Wesley Keys, Mr Francis Fox, Dr Chin Wong, Dr Graham Farquhar, Mr Derek Millar, Miss Sue Wood.

Weeding out the thirsty plants

Researchers and plant breeders in Australia, Asia and North America are taking advantage of one of the School's most important discoveries of the last few years.

The discovery of a method to find thirsty plant varieties, is being applied to crop plants in Canberra, New South Wales, Queensland, California, India, Indonesia and Thailand.

Australian breeders have long been world leaders in adapting crop varieties to semi-arid conditions. The new method has the potential to extend the range of agriculture in Australia and developing countries and to improve crop yields.

Most of the water used by plants during growth evaporates from leaves through small openings, the stomata. By closing the stomata in dry weather, plants can reduce water loss while continuing to grow.

Until recently, biologists measured the efficiency with which plants used water by measuring the amount of water in the soil and the amount evaporated from the leaf. These experiments were tedious and cumbersome. They were also inaccurate. The experimenters concluded that, within one plant species, there were no genetic differences in the efficiency of water use.

Dr Graham Farquhar, who is now a Senior Fellow in the Plant Environmental Biology Group, thought differently. With his background in mathematics and physics, he predicted in 1982 that the use of water by plants could be measured more simply. Experiments with mistletoe, tomatoes and wheat bore out his theory.

The new technique, which was tested in collaboration with a wheat breeder from the CSIRO, Dr Richard Richards, depended on the ability to measure different isotopes of carbon in plants. In the atmosphere, about 1 per cent of carbon dioxide is made from the stable heavy isotope, carbon-13, and about 99 per cent from carbon-12. When plants close their stomata they take up a greater proportion of the heavy13-carbon dioxide molecules to use in photosynthesis. The molecules are incorporated into the plant tissue. Because plants with closed stomata are more thrifty with water than plants with open stomata, carbon-13 in the plant provides a measure of the efficiency of water use. Of two plants grown in the same atmosphere, the one with the higher level of carbon-13 is the more efficient water user.

To measure carbon-13 ratios, dry plants are burnt, the carbon dioxide produced is collected and passed through an isotope-ratio mass spectrometer, which indicates the proportions of heavy and normal carbon. This procedure, which becomes laborious when there are many samples to test, has recently been speeded up. The University has installed a modified mass-spectrometer which automatically processes the specimens and measures the CO_2 and prints the carbon-12 and carbon-13 ratio.This machine offers the possibility of mass screening of plants.

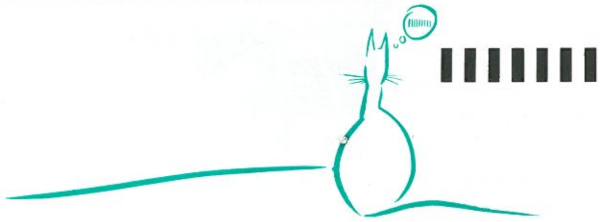
The initial research program has been extended to test water-use efficiency in peanuts, oil-seeds, barley, cotton, eucalypts, poplars and mangroves. A Research Fellow in the group, Dr Kerry Hubick, is funded by the aid agency, the Australian Centre for International Agricultural Research. Rural industry research funds have paid for work on barley, cotton and oilseeds. The School's work on peanuts is being conducted with the QueenslandDepartment of Primary Industry's Joh Bjelke-Petersen Research Station in Kingaroy. Wheat research continues with Dr Richards of CSIRO. Collaborat-ion on barley is with the Wagga research station of the NSW Department of Agriculture and the Waite Agricultural Research Institute in South Australia. Others are measur-ing the water-use efficiency of cowpeas in California, peanuts in India and various legumes in Queensland.

The research has found that individual plants vary by as much as 50 per cent in their efficient use of water. The differences are also genetically determined.

This knowledge has taken much of the trial and error out of breeding crop plants for dry conditions. Varieties of wheat and barley that use water effic-iently have been identified and crossed and their productivity is being measured in field trials. The screening of other crop varieties is accelerating.

Dr Farquhar's team and the plant breeders are looking closely at the genes which determine water-use efficiency to see how many there are and what other inherited factors are linked to them. In the future, Dr Farquhar envisages attempts to clone the gene or genes. That way the use of water in many plants could be transformed.

New centre for visual sciences



Researchers from groups studying vision at ANU have been brought together in the interdisciplinary Centre for Visual Science. The new Centre is unparalleled in the world and its members are expected to improve on their already outstanding contribution to international research.

The core of the new Centre will be three distinguished professors at ANU: the Head of the Visual Sciences Group in RSBS, Professor Adrian Horridge, the Head of the Visual Neurosciences Unit in the John Curtin School of Medical Research (JCSMR), Professor Bill Levick and the Head of the Optical Sciences Centre in the Research School of Physical Sciences (RSPhysS), Professor Allan W. Snyder, together with the research colleagues and their resources. The Executive Director of the Centre is Professor Horridge.

From next year the Centre for Visual Sciences will be housed in new laboratories and offices to be built adjacent to RSBS. The Centre is part of the strategic plan to regroup resources within the University. It will promote interaction between different parts of the University through task-oriented groups and is affiliated with the new Centre for Information Sciences.

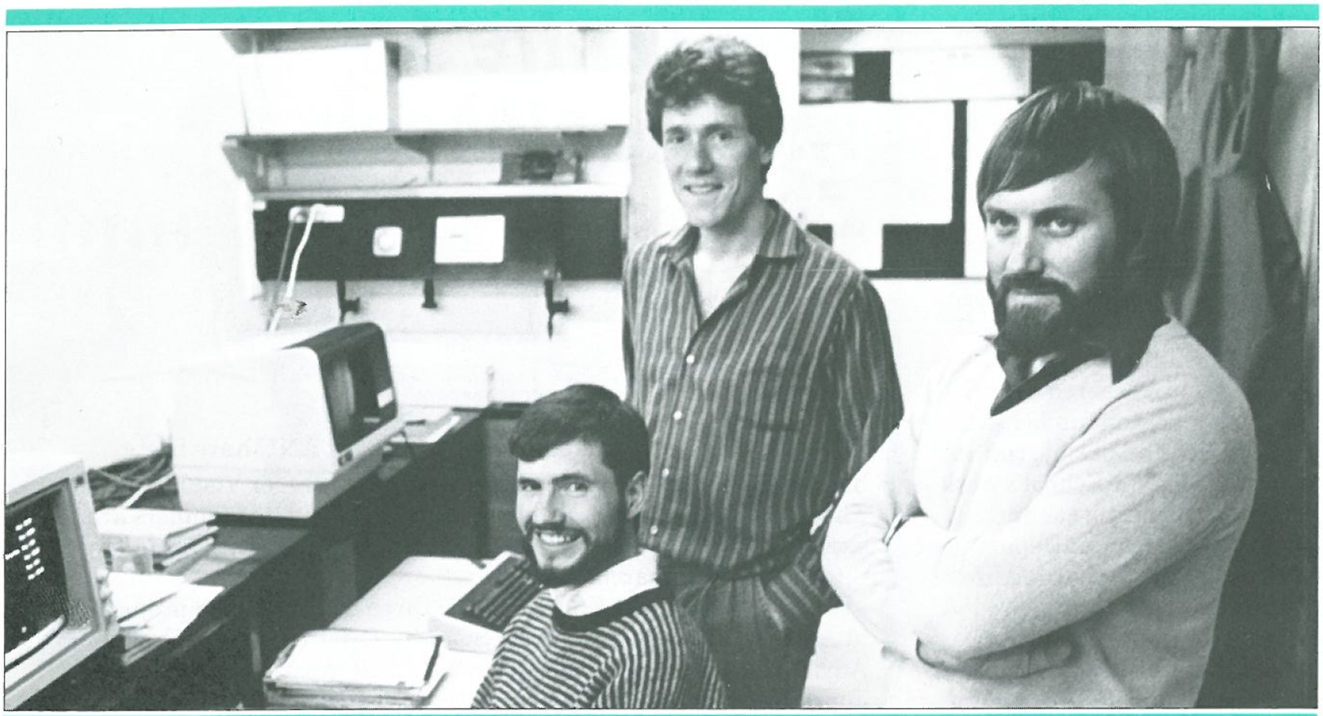
The Centre will have physiologists, psychophysicists and mathematicians working with the latest techniques in many disciplines.

Though the Centre itself will not be working on robots that can 'see', the results of the research could be applied by others to a wide range of practical situations where a 'smart' visual sensor could greatly enhance automated control. Such sensors could recognise intruders, prevent vehicle collisions, control quality on production lines, automate other factory functions, and sense objects in many other commercial and industrial activities. As there is presently no such technology, the variety of uses and commercial potential would be enormous. The means of artificial vision is waiting to be found in biological systems, according to Professor Horridge.

'One day soon we hope that artificial, pre-programmed seeing eyes will be cheap and available for a thousand as yet unimagined uses,' he says.

Other senior academic staff in the Centre for Visual Sciences are Dr Srinivasan from RSBS, who has been concentrating on the visual discrimination abilities of bees, Dr Ian Morgan from RSBS, who is working on the transmitters and neural circuitry of the vertebrate retina, and Dr Henry from JCSMR, who is finding the organisational plan of the mammalian visual cortex, the vast assembly of nerve cells at the pinnacle of the visual system.

The Centre will have about eight research and postdoctoral fellows, technical and secretarial staff and postgraduate students. The new group is keen to attract graduate students and visiting fellows from around Australia and overseas.



Mr Andrew Moore, Mr Mike Strasser (PhD students), and Dr Ian Noble, leader of the group

Expert system predicts vegetation changes

One of the School's research teams is using sophisticated computer programs to predict the effect of land-management decisions on vegetation.

The team, led by a Fellow in the Ecosystem Dynamics Group, Dr Ian Noble, is applying so-called expert systems to study vegetation change in national parks and state forests.

Expert or knowledge-based systems are computer programs that incorporate the knowledge and logical steps of experts. Expert systems which can be applied to practical problems - land management, disaster relief or military command - are becoming popular around the world. Such systems, a part of artificial intelligence research, may also be a means of transferring expertise to countries with few highly trained technicians.

Dr Noble and two PhD students, Mr Mike Strasser and Mr Andrew Moore, are seeking to understand and predict the vegetation changes that occur after fire, grazing or logging. Their expert system has built on the experience of fire managers in Kakadu National Park and South West Tasmania, but may be applied to other national parks, state forests or pastoral lands in Australia and overseas.

Dr Noble began modelling forest succession and regeneration in the late 1970s with Professor Ralph Slatyer, now Director of RSBS. Up to that time, computer models of vegetation change started with details of growth and nutrient cycles and tried to analyse the very complex set of processes involved. The initial data required time-consuming field studies; the processing used up much expensive computing time.

In 1980, Dr Noble and Professor Slatyer produced a 'vital attributes' model of vegetation change, which incorporated only that information needed to predict the presence or absence of species during successional changes. This information is readily available from local experts. The model can logically be extended to predict changes in more detail, but it becomes very difficult for managers to use. Expert systems are a means to overcome this problem. Empirical knowledge can be combined with ecological theory in a computer program which will advise what to do and what not to do to make a forest or a farm flourish. The quality of the advice, of course, reflects the quality of the expertise fed into the computer system.

The vital attributes model is now in the text books. Since 1980, Dr Noble has refined the program to incorporate new automated deduction techniques. The model can now deal with more types of disturbances, such as cyclones, and make more detailed predictions of vegetation change, including the species composition and structure of the subsequent forest or woodland. The structure can be graphically displayed in space and time. Trends over centuries and the human impact on vegetation can be quickly seen.

Dr Noble distinguishes two types of knowledge that can be used in an expert system:-deep and shallow. Shallow knowledge is expressed as a simple rule, for example, do not burn in spring. Deep knowledge explains why not to burn in spring, taking into account weather, fuel loads and other qualities. The deep knowledge gives the user more confidence in a programmed rule and helps expose additional implications and conflicts of logic in expertise that may be added later.

The models have already been applied to the regeneration of eucalypt forest in areas of Western Australia mined for bauxite, to the regrowth of Tasmanian rainforest after fire, and to advise foresters in China. Current projects include fire management in Kakadu National Park, an assessment of arid land grazing in central Australia and the management of forests and water catchments in south-eastern Australia.

Dr Noble predicts that expert systems will have a major impact on applied ecology. When expertise is needed quickly and in a number of different fields, the programs could have spectacular results. Attempts to link the many diverse areas of ecology using expert systems could also encourage theorists to seek unifying concepts of ecology.

Acid soils: a growing problem

About 14 million hectares of southern Australia's pastoral land have acidic soil. This follows some decades of sowing subterranean clover and intensive fertilisation to increase productivity.

In symbiosis with the soil bacterium, *Rhizobium trifoli*, subterranean clover increases soil fertility. More than 75 per cent of pastures in southern Australia has been 'improved' by clover in the last 30 years. After about 30 to 50 years of such improvement the soil may be up to one pH unit more acidic. This acidity threatens to restrict the productivity of the country's pastures greatly, at a cost of millions of dollars a year.

'We are potentially on the verge of a huge problem,' a visiting student in the School, Mr Alan Richardson, said recently. Mr Richardson is from the University of Melbourne School of Agriculture and Forestry, where he is enrolled for a PhD, supervised by Dr Richard Simpson.

In Europe, lime is routinely used to alleviate soil acidity. But at a cost of up to $200 a hectare this solution is not realistic for Australia's large areas of pasture. The current value of the land is not high enough to support such an investment.

The other approach is to look more closely at the effect of acidity on the growth of pasture and the ability of *Rhizobium* bacteria to induce leguminous plants such as clover to form root nodules. In these nodules the bacteria change nitrogen from the air into ammonia which the plant can use to grow.

Rhizobium bacteria are sensitive to soil acidity. As the soil becomes more acidic the bacteria grow more slowly, lose the ability to cause nodulation and eventually die.

Researchers, led by a Senior Fellow in the School's Plant Molecular Biology group, Dr Barry Rolfe, have been examining many aspects of *Rhizobium* at the molecular level. Mr Richardson has joined the group to look particularly at acid tolerance.

Among the different strains of *Rhizobium trifolii*, some are naturally more tolerant of acidic soils. These have been collected from field sites in Victoria and supplied by the Gosford research station of the NSW Department of Agriculture. In the laboratory at RSBS, Mr Richardson and a technical assistant, Mrs Elena Gartner, are trying to understand how acidity affects the nodulation of clovers, and to identify the genetic basis of acid tolerance. After isolating and cloning the relevant genes, they will see whether acid tolerance can be transferred to other strains of *Rhizobium*.

Once proven in the laboratory, genetically engineered acid-tolerant bacteria could be tested in the field. If successful, the technique could also be applied to other symbiotic associations between legumes and bacteria that have been affected by acidic soils. The improved productivity of many legumes, for example, lupins, peas, beans and lucerne, could be worth many millions of dollars to Australia's rural industry.

Mr Richardson is keen to maintain an agricultural perspective on his molecular genetics research. His undergraduate training at the University of Melbourne was in agricultural science and he spent the first two years of PhD research looking at pasture on acid soil in East Gippsland. He believes there is a danger in fundamental researchers being too far removed from applied scientists. Particularly in agriculture, there can be a broad gap between researchers and users of research (farmers).

QUICK·TOUR·OF·RSBS

Why?

Biological research seeks answers to basic questions about the evolution, development and organisation of organisms, and their interaction with one another and their environment. The Research School of Biological Sciences (RSBS) at the Australian National University (ANU) also seeks to identify answers which have technological, agricultural, medicinal or environmental applications.

What?

RSBS concentrates on carefully selected research topics. These presently include:

- vision, hearing and the development of the nervous system;
- plant performance, particularly photosynthesis, and the biochemical, physiological and ecological mechanisms that limit it;
- the ecology and dynamics of populations and communities;
- the way genes control metabolism and development, and the sources of variation in genes;
- the interaction between plants and their parasites, analysed at the molecular level;
- plant growth and development, particularly the cellular and hormonal processes that govern it.

How?

The unique organisation of ANU allows Research Schools to pursue fundamental research funded from the University's recurrent grant. Since its formation in 1967, RSBS has become one of the world's leading centres for biological research and graduate training. Well-structured research teams work according to a strategic plan. The School also draws on the distinctive features of the Australian biota, covers areas others are unable to explore effectively, co-operates with other universities and the CSIRO to increase the effectiveness of Australian biological research, and works within and outside ANU to improve graduate training.

Who?

The School has 68 academic staff, 70 postgraduate students and about 170 technical and support staff. At any time there may be another 40 visitors working in the School on a variety of collaborative projects.

AWARD WINNERS

In the last year researchers in the school have won four major awards, three National Research Fellowships and one Queen Elizabeth II Fellowship. These awards have enabled the employment of four post-doctoral researchers. The winners of the awards and the researchers they support are pictured.

Back row (from left): Dr Les Christidis, Dr Wendy Thompson and Dr Layne Huiet. Front row (from left): Dr Matthew Morell, Dr John Andrews, Dr Kieran Scott and Dr Brett Tyler.

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