M A-Schneider

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ENTOMOLOGICAL SOCIETY OF QUEENSLAND

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THE ENTOMOLOGICAL SOCIETY OF QUEENSLAND

JOINT MEETING

Entomology and Plant Pathology. The meeting was held on the 22nd October at the University of Queensland.

ATTENDANCE

P.J. McFadyen (President), B. Angus, J. Barrett, B. Cantrell, V. Davies, C. Freebairn, D. Foley, I. Galloway, M. Harris, E. Hassan, N. Heather, A. Hill, D. Holdom, G.H.S. Hooper, B. Kay, D.S. Kettle, R.E. McFadyen, E.N. Marks, D. Morgan, T. Passlow, R. Piper, B. Pyke, J. Rogers, P. Room, D. Sands, M. Schnieder, P. Twine, K. Walker, G. White, R. Wylie.

VISITORS

Professor van Emden

APOLOGIES

P. Boreham, E. Dahms, J. Grimshaw, C. Hagan, G.B. Montieth, M. Muller, R. Raven, E.J. Reye, B. Sabine, E. Sinclair, C. Wild.

MAIN BUSINESS

The main business of the evening was a joint address by Mr. John Rogers, Entomology D.P.I., Kingaroy entitled

"Developing Plant Resistance to Pests"

and Dr. John Irwin, Plant Pathology D.P.I., Indooroopilly entitled

"Potential and Problems of Developing Plants for Disease Resistance"

DEVELOPING PLANT RESISTANCE TO PESTS

John Rogers

Introduction:

Plant resistance to insect pests was known as far back as the 18th century but deliberate efforts to search for and develop resistant crop varieties did not begin until the 1900's. The widespread recognition of host plant resistance (H.P.R.) as a means of reducing the importance of insect pest problems has been fairly slow, even though some fairly spectacular examples of resistance were reported in the USA in the 1920's and 1930's.

The benefits that can come from the use of resistant varieties are substantial. It has been estimated that in the USA the planting of insect resistant cultivars of maize, barley, sorghum and lucerne results in an annual saving of approximately 29 million kilograms of insecticide and $650 million. Insect control techniques that can produce savings of this magnitude cannot be ignored, particularly in crops which are currently heavily dependent on insecticide use.

Host Plant Resistance and Integrated Pest Management:

Over the last decade or so insect control has been emerging from an era of "squirt gun entomology" to a realisation that insecticides alone do not constitute a reasonable or permanent solution to an insect problem. The future of insect control seems to be in integrated pest management. It is within this strategy of I.P.M. that H.P.R. must find

a place in the future. It has become obvious that even low to moderate levels of resistance can make a significant impact on pest problems, particularly when the resistant variety is part of an I.P.M. strategy.

H.P.R. has a number of inherent advantages that make it very suitable for use as part of an I.P.M. strategy. These include (1) It is specific to the pest with no detrimental effects on beneficial organisms (2) It has a cumulative effect over successive generations (3) It is persistent (4) Once developed, it is easy to adopt and (5) It is compatible with other I.P.M. tactics.

Host Plant Resistance - The traditional view:

Host plant resistance - those heritable characteristics possessed by the plant which influence the ultimate degree of damage done by the insect. From a practical point of view, resistance is the ability of a certain variety to produce a larger yield of good quality than other varieties at the same initial level of infestation and under similar environmental conditions. Painter recognised three basic components of resistance - nonpreference, antibiosis and tolerance.

These 3 components have formed the basic framework for entomologists working on H.P.R. for more than 30 years and still provide a useful basis for classifying resistance mechanisms. Nonpreference and antibiosis are responses of the insect to the plant while tolerance is a plant response to insect attack. Another aspect that may be of use in some situations is "ecological resistance". This involves such things as phenological asynchrony and "escape resistance".

The characteristics that confer insect resistance in crop plants are many and varied. Both physical and chemical factors are involved in non-preference and antibiosis resistance. The plant responses that result in tolerance are equally varied but rather less studied.

The understanding of resistance mechanisms is not an essential prerequisite to the utilisation or resistance. H.P.R. to insects can, and has, been selected for solely on an impirical base. However, if there is an understanding of resistance mechanisms involved in a pest - host interaction, more efficient and successful plant breeding programs should be possible. Studies on the chemical factors involved in resistance to insects appears to be a neglected area of research. Any work in this area would be highly likely to pay worthwhile dividends.

Problems Associated with Developing Plant Resistance to Insects:

There are a number of problems associated with utilising H.P.R. in commercial crop varieties.

The problem that H.P.R. breeding has in common with other "defect correction" type of breeding programs is the problem of transferring the resistance into a commercially acceptable line.

Probably the most important question in relation to H.P.R. to insects is how durable is the resistance likely to be. In general, plant resistance to insects has proved to be more durable than disease resistance.

The reasons for this are not clear, but pest species may not have been exposed to the same intensive selection pressure to develop "fit" resistance-breaking variants as have many plant pathogens. Another reason may be that insects usually have fewer propagules than plant pathogens. A host plant may support millions of pathogenic bacterial cells or produce hundreds of thousands of fungal spores. In contrast, the numbers of individual pest animals, per plant can generally be measured in hundreds rather than thousands. This very great discrepancy between pathogens and animal pests, in the number of individual propagules

per plant, is probably one of the major factors contributing to the relative unimportance of resistance-breaking biotypes of animal pests.

A third factor is that resistance of crop plants to pests is usually not responsive and is attributable to resistance mechanisms which existed in the host plant before the pest came into contact with it. This situation contrasts with the hypersensitivity type of responsive resistance mechanisms which are frequently encountered in interactions between fungi, bacteria and viruses and their host plants. An animal pest is therefore unable to circumvent most resistance mechanisms easily, and many types of pest resistance are, equivalent to non-race-specific types of resistance to plant pathogens.

Another factor that probably operates in oligophagous and polyphagous species is that any selection that occurs on the resistant variety would be dissipated during reproduction on the other host plants.

Two main types of insect biotypes have been recognised in relation to host plant resistance. They are the true resistance breaking biotypes and vigorous biotypes. The resistance breaking biotypes can attack previously resistant varieties and there is a specific interaction between the genotypes of pest and host. In contrast, vigorous biotypes exhibit a higher than normal reproductive potential on all varieties. Such biotypes colonise both resistant and susceptible host plants more effectively than other biotypes. There is no specific adaption to a particular plant genotype.

Resistance-breaking biotypes of a pest circumvent or neutralize a resistance mechanism - they do not "overcome" the resistance genes themselves, but the mechanisms that the genes control. The number and type of mechanisms involved in resistance to a pest affect the stability or durability of resistance and are therefore much more important than the number of genes which control these mechanisms. In general, oligogenic and polygenic types of resistance will be more stable or durable. Most of the types of resistance which have been "overcome" by resistance-breaking pest biotypes have been those which are controlled by major genes. However, some types of monogenic resistance to crop pests have not been overcome by resistance-breaking biotypes, even when resistant varieties have been exposed extensively to pest attack for many years. These tend to be based on grass morphological features of the host plant such as pubescence or solid stems.

While there are many advantages in using complex types of resistance that involve several different resistance mechanisms, complex resistance has some counterbalancing disadvantages. The main one is that it is more difficult to handle in a breeding program. Monogenic resistance to a pest particularly if it is a dominant character, is simple to use in a breeding program and differences between resistant and susceptible plants is usually clear cut. Most types of resistance that have been used are controlled by one or a few genes.

Many of the resistance breaking biotypes have been aphids. Part of the reason for this lies in their ability to reproduce both sexually and asexually and in their high reproductive rates. They have the facility for the recombination of genes followed by massive propagation of the resistance breaking biotypes. In other insect groups, resistance breaking biotypes are uncommon.

The Australian Situation: Present and Future:

Table 1: Studies on host plant resistance to insects in Australia.

State	Crop	Insect Pests
W.A.	Lucerne	Blue green aphid (B.G.A.), spotted alfalfa aphid (S.A.A.)
	Subterranean clover	B.G.A., S.A.A., red legged earth mite.
	Serradella	Red legged earth mite.
	Soybeans	Lucerne crown borer
TAS.	Pastures	Root feeding scarab larvae
	Rape	Cabbage aphid
N.T.	Cassava	Giant termite
S.A.	Lucerne	B.G.S., S.A.A., pea aphid (P.A.), Sitona weevil, lucerne flea.
	Annual medics	B.G.A., S.A.A., P.A., Sitona weevil.
N.S.W.	Lucerne	S.A.A., B.G.A., Heliothis.
	Cauliflower	Cabbage moth.
	Rice	Bloodworms.
	Strawberries	Mites.
	Sorghum	Sorghum midge.
QLD.	Lucerne	S.A.A., B.G.A.
	Sorghum	Sorghum midge
	Cotton	Heliothis
	Soybeans	Heliothis
	Navybeans	Heliothis, Jassids
	Pasture legumes	S.A.A., B.G.A.
	Cauliflowers	Cabbage moth
	Tomatoes	Heliothis
	Sweet potato	Sweet potato weevil

Table 1 summarises the studies on host plant resistance to insect pests in Australia at the present time. While I have attempted to include all current work I have without doubt overlooked some studies.

Many of the studies are quite limited in size or are just being iniated. Relatively few represent major research inputs into developing resistant varieties. The arrival of the lucerne aphids in Australia in 1977 was responsible for a major increase in interest in resistant varieties because of the ready availability of a range of aphid resistant varieties from overseas. If the lucerne aphids increase our awareness of the potential of resistant varieties and encourage us to look seriously at other pests and crops they will have done Australian agriculture a service! Research on H.P.R. to lucerne pests, sorghum midge and Heliothis on cotton and grain legumes appear to be the areas of greatest research input at the present time.

If there is going to be a substantial increase in work on H.P.R. to pests there is one area that may need attention. This is the difficulty of agricultural scientists gaining expertise in both entomology and plant breeding. While it is possible to obtain training in both plant pathology and plant breeding it appears difficult to achieve some competence in

both entomology and plant breeding. A related problem is the relative isolation of scientists with differing areas of expertise, from one another. This makes the interdisciplinary studies that are an essential part of H.P.R. work fairly difficult. If there was more research involving plant breeders, entomologists and chemists working in close association, progress would undoubtedly be faster. Similarly if persons with expertise in more than one area could work freely in all their areas of interest more rapid progress would be achieved.

Resistant varieties will probably play an increasingly important role in the control of crop pests. They are most likely to be used as part of an I.P.M. strategy that utilises resistant varieties, cultural and biological control and the strategic use of chemical pesticides.

John Rogers
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Kingaroy. Q. 4610.

POTENTIAL AND PROBLEMS OF DEVELOPING PLANTS FOR DISEASE RESISTANCE

John Irwin

Breeding for resistance offers the most feasible method of controlling diseases of many crop species. For diseases of many field crops and pastures, it is not economic to use fungicides. Even in crops where the use of fungicides is the norm, disease resistance should now be considered as a possible alternative control measure. An example of this is apple scab, where several monogenic resistances have been identified. Disease resistance is also an environmentally acceptable means of pest management.

In the pre-Mendelian era, several notable disease resistance studies, based on sound empiricism, were made. Biffen, in 1905, was the first person to demonstrate that the inheritance of disease resistance in plants obeyed Mendel's laws. Since then, our understanding of breeding for disease resistance has paralleled our understanding of Mendelian genetics. Today, it is generally agreed that we still do not understand the process of disease resistance, from either a fine structural genetic, or physiological point of view. The primary products of resistant genes have not been determined. This still makes breeding for disease resistance largely an empirical process.

Resistance to disease in plants can be broadly classified into two types. With the first, the host resists the establishment and subsequent development of a successful parasitic relationship by restricting the infection site and the infection process, resulting in a hypersensitive response. The hypersensitive response is characterized by the rapid death of host cells, and usually death of the parasite. This type of resistance has been called vertical resistance, major gene resistance, hypersensitive resistance and race specific resistance. With the other form of expression of resistance, the host resists colonization and growth of the parasite, subsequent to a successful infection, even though the infection process, culminated by reproduction of the parasite, is completed. This resistance has been described by such terms as generalised resistance, horizontal resistance, polygenic resistance, minor gene resistance, rate reducing resistance, and race non-specific resistance.

All of our understanding of breeding for disease resistance has come from our knowledge of race specific resistance. When races of the pathogen interact differentially with host cultivars, we know that the host resistance is race specific. Generally, with race specific resistance, the interaction can be categorized as either resistant or susceptible, with the resistant interaction often being conditioned by a single dominant gene. Flor, over the period 1940-1970, made one of the most significant contributions of this century to a better understanding of breeding for disease resistance. Working with flax and its rust Melampsora lini, he showed that for each gene conditioning resistance in the host, there was a corresponding gene conditioning virulence in the parasite. In the host, resistance was conditioned by a single dominant gene, and in the parasite, virulence was controlled by

a single recessive gene. Where it has been possible to conduct genetic studies of both the host and the parasite in parallel, a gene for gene relationship has been demonstrated in several other host-parasite combinations. A knowledge of the genetics of virulence in the parasite is equally as important to our understanding of breeding for disease resistance as is a knowledge of the host genetics.

Several workers have noted that with two alleles at a locus controlling resistance (R = dominant allele for resistance, r = recessive allele for susceptibility), and two at a corresponding locus controlling virulence, (V = dominant allele for avirulence, v = recessive allele for virulence), there are four possible interactions, and their tabulation is referred to as a quadratic check, which is presented below.

	R	r
V	Resistant (incompatible)	Susceptible (compatible)
v	Susceptible (compatible)	Susceptible (compatible)

Only one interaction, the combination of the dominant allele for resistance (R), and the dominant allele for avirulence (V), leads to the expression of a resistant, or incompatible interaction. Each of the three other possible combinations will give rise to a susceptible or compatible interaction.

In a host with a series of resistance genes interacting with a parasite on a gene for gene basis, the resistant interaction is epistatic to (overrides) the susceptible interaction. Thus, the disease reaction of a host of genotype R_1R_1, r_2r_2, r_3r_3, r_4r_4, r_5r_5, interacting with a parasite of genotype V_1V_1, v_2v_2, v_3v_3, v_4v_4, v_5v_5 will be resistant. If we consider the interaction between a host of genotype R_1R_1, R_2R_2, R_3R_3, R_4R_4, R_5R_5, and a parasite of genotype V_1V_1, V_2V_2, V_3V_3, V_4V_4, V_5V_5, before the parasite can cause disease on this host, a simultaneous mutation to the recessive allele is needed at each of the five loci controlling virulence. If the probability of a mutation at a single locus in the parasite is 1×10^{-5}, then the probability of a simultaneous mutation at each of the five loci is 1×10^{-25}. This is the scientific basis behind the concept of gene pyramiding, which today is the most widely practised method of breeding for resistance to variable pathogens.

One of the major limitations of gene pyramiding is that in the host, there are usually few independent loci controlling resistance, with a large number of alleles at each locus. In the parasite, virulence genes are usually at independent loci, and only loose linkage has been reported. This confers a marked advantage to the parasite, since theoretically there is no limitation to the number of virulence genes that any parasite can accumulate. The limitations imposed by allelism in the host can be overcome through the development of multilines (backcrossing the alleles into an agronomically desirable cultivar, then blending the isolines to compose the multiline), or by regional gene deployment.

With race non-specific resistance, the relative ranking of cultivars remains the same across all isolates of the pathogen. When measuring race non specific resistance, an assessment has to be made of relative amounts of disease present. Some of the variables that can be measured to assess this include % leaf area necrotic, length of the lesion, number of spores/lesion, generation period, and length of the latent period. Since assessments have to be made of relative amounts of disease present, large coefficients of variation which

lower the precision of the experiment are often obtained. This type of resistance is sometimes influenced to a large extent by the environment, giving rise to large genotype x environment interactions. The results can be largely influenced by plant age and the inoculum concentration, and it is often not possible to screen for race non-specific resistance in a greenhouse environment.

Several leading workers have proposed that the two types of resistance are actually the same. Before the advent of agriculture, there was a co-existence between the host and parasite in their centres of origin, with small fluctuations in both selection pressure and populations of both partners. When man commenced deploying a host with monogenic resistance over wide areas, there was an increased selection pressure on the parasite for a gene to match the resistance gene, and when this occurred, the population of this host genotype declined, while the selection pressure was now high on the host for another resistance gene. After several cycles of alternating increased and decreased selection pressures on the host and parasite, during which there occurred an accumulation of resistance genes in the host and an accumulation of the corresponding virulence genes in the parasite, a situation of co-existence, or race non-specific resistance was attained. This implies that resistance genes that have been matched by virulence genes in the parasite, can interact to confer race non-specific resistance. The Solanum demissum - Phytophthora infestans interaction has been used to support the above argument. S. demissum is a wild relative of Solanum tuberosum. Although it sustains disease, it still manages to survive in the Toluca Valley of Mexico, where S. tuberosum is devastated by P. infestans. Several single genes have been transferred from S. demissum to S. tuberosum, and on their own they are quickly matched by new races of P. infestans. However, when together in the same genome, they interact to confer race non-specific resistance.

Today, the dangers of exposing monogenic resistances to protect our agricultural crops against the ravages of disease are well realised. For important crop species, there recently has been a recognition of the importance of assembling and characterising sources of natural resistance. With the ever increasing development of technology in the field of tissue culture, it is anticipated that more use may be made of it in the development of disease resistant crop species. Often, the embryo resulting from a wide cross aborts, due to abnormal development of the endosperm. By removing the embryo to tissue culture, this limitation is overcome. With the use of tissue culture methods, we may be able to more effectively utilise natural sources of resistance in the wild relatives of crop species.

When the sources of resistance have been characterised, we must endeavour to present the parasite with a diverse set of host resistance genes, either through pyramiding, multilines, regional gene deployment, race non-specific resistance, or different combinations of these. Until the products of resistance genes have been determined, the above mentioned strategies are the best that we can employ. We should be attempting to pyramid functionally different genes, but at the present time we do not know which genes are functionally the same, and which are functionally different. When this question can be answered, breeding for disease resistance will be on a more sound basis than it is at present.

Dr. John Irwin
Plant Pathology Branch D.P.I.
Indooroopilly. Q. 4068.

VOTE OF THANKS

Professor van Emden proposed the vote of thanks for two very interesting and informative accounts on 'Developing Plant Resistance to Pests and Diseases'. He remarked on the two different 'languages' of the speakers. The Entomologists talk about the mechanics of Resistance while the Plant Pathologists refer to the genetic basis of Resistance.

GENERAL MEETING

Minutes of the General Meeting of the Entomological Society of Queensland Inc., held in Room 323 of the Hartley Teakle Building, University of Queensland on Monday 10th November, 1980 at 8.00 p.m.

ATTENDANCE

P.J. McFadyen (President), A. Arthington, A.C. Arvier, B. Cantrell, J. Grimshaw, C. Hagan, M. Harris, W. Jorgensen, J. Just, R.E. McFadyen, E.N. Marks, D. Morgan, R. Piper, P. Room, B. Sabine, E. Sinclair, B. Stone, T. Wright, M. Zalucki.

VISITORS

J. Graff, J. Jorgensen.

APOLOGIES

P. Boreham, E. Dahms, G. Daniels, E. Galloway, J. King, E. Reye, M. Schneider, K. Walker.

MINUTES

Minutes of the General Meeting held on the 8th September and circulated in News Bulletin Vol.8 No.6 were not presented at the October meeting as it was a combined session with Plant Pathology. It was moved Chris Hagan, seconded Rachel McFadyen that the minutes be accepted.

NOMINATION

The following nomination was received:-

For Associate membership -

Ms Natalie Newman	Nominated T. McRae
'Bunyula'	Seconded H. Lake
Kerry. 4285.	

In accordance with the Society rules the election will be held over until the next meeting of the Society.

MAIN BUSINESS

The main business of the evening was an address by Dr. Angela Arthington of the School of Australian Environmental Studies at Griffith University, entitled:-

THE EFFECTS OF SEWAGE EFFLUENTS ON THE INSECT COMMUNITY OF BULIMBA CREEK, QUEENSLAND

Angela ARTHINGTON and Diane CONRICK

A serious water pollution problem in Australia involves small urban streams. Largely, the pollution is caused by sullage and septic tank overflow, but controlled discharges from sewage treatment plants are also fairly common. These latter wastes generally receive secondary treatment (trickling filter or activated sludge methods) to reduce solids and to convert nitrogen, phosphorus and sulphur into oxidised salts. Trace metals are not removed and the effluent is treated with chlorine gas or soluble chlorine salts to destroy pathogenic bacteria and viruses.

In Australia, little is known of the precise effects of sewerage effluent pollution on freshwater systems, although this is a well-researched field in the northern hemisphere. There have been only four major studies on organically polluted creeks, these being Bulimba Creek, (Hailstone, 1979), Moggill Creek (McIvor, 1976), Farmer's Creek and Cox's River, New South Wales (Jolly and Chapman, 1966) and Dandenong Creek, Victoria (Campbell, 1978). These studies all focused on the invertebrate fauna of the bottom substrates. This community is studied more often than any other in pollution assessment because the animals are relatively immobile and seem to reflect the quality of the water flowing over them, they are long-lived, have low mortality, and varied responses to pollution and are amenable to toxity testing.

The four Australian studies have shown general trends of community response to organic pollution similar to those observed overseas, but much more needs to be known about individual species responses. All of these studies suffered from incomplete taxonomic analysis of the invertebrates, including insects.

We believe that the field needs to be developed for two main reasons. Firstly, to protect water resources we need detailed knowledge of the effects of different types and levels of pollution on water quality and aquatic biota. Secondly, to effectively manage water resources, we need reliable methods for monitoring the type and level of pollution.

Water quality monitoring programmes are routine in most parts of Australia and rely heavily on standard physical and chemical tests, plus tests for the level of the bacterium Escherichia coli. Yet pollution is essentially a biological problem through its effects on aquatic life, especially fish and their food items, and on man through contaminated water supplies, food items and impaired recreational facilities. It should follow that we establish water quality criteria and monitor water pollution using biological methods, as well as chemical and microbiological tests. Present Australian water quality standards are derived mainly from overseas data on responses to pollution, although conditions here are very different.

Biological methods of water quality monitoring mean are extremely varied, involving bioassay tests, use of the indicator species concept, pollution zones, various biotic indices incorporating autecological knowledge of species found, community heterogeneity indices (commonly but inaccurately termed diversity indices) and more sophisticated analytical techniques. One of the common complaints from water quality engineers and chemists is that biological monitoring is too complicated, too many methods have been promoted and there is no single, straight-forward biological test everyone can apply, comparable to the standard dissolved oxygen test, or the routine monitoring of E. coli levels. A good look at the literature soon reveals that these tests too have their problems, depending upon when and where the measurements are made. The role of the biologist in water quality management will be discussed again at the end of this paper.

The Bulimba Creek Study began in a preliminary way in 1977, with funding from a Griffith University Research Grant. In 1978 the School obtained a 3-year grant from the Australian Water Resources Council to study Bulimba Creek as an example of an urban creek polluted by discharges from a sewage treatment plant. The aims of the study were as follows:

1. To measure physical and chemical conditions in Bulimba Creek so as to obtain an assessment of the effects of organic pollution on water quality, flow regime etc.

2. To monitor community diversity, population abundances and the biomass of invertebrate animals living in creek substrates (benthic macroinvertebrates) in order to assess the effects of the stress conditions induced by organic pollution on this invertebrate community.

3. To develop biological and/or combined chemical and biological methods of assessing organic pollution in urban creeks.

THE STUDY AREA

We chose Bulimba Creek because of its accessibility and the presence of a sewage treatment plant in the upper part of the catchment, providing a suitable study area well within the freshwater section of the creek. The Mimosa Creek plant serves a population of approximately 17,000 people, from the suburbs of Eight-Mile Plains, Macgregor, Mt. Gravatt, Nathan, Robertson, Runcorn, Sunnybank and Upper Mt. Gravatt. Effluent from the plant dramatically alters the character of this urban creek, introducing organic materials as suspended solids, plus nitrates, phosphates, ammonia, residual chlorine and heavy metals. Our strategy was to select two control sites unaffected by sewage or any other major discharges, and a series of sites extending from immediately below the effluent outfall downstream to the recovery zone, which is just above a second sewage treatment plant. The length of this part of the creek is 10.14 km and the study sites within it are separated by distances ranging from 1.31 km to 2.38 km. Our sites were riffles, or fairly shallow, fast flowing stretches, within sandy gravel substrates, and we took great care in their selection, to minimize the differences between them and permit changes due to water quality to show clearly.

STUDY DESIGN AND SAMPLING METHODS

Early in the study we decided to put most of our effort into quantitative sampling of the substrate invertebrate fauna, using stratified random sampling, supplemented by kick samples, dip netting amongst marginal vegetation, light trapping and surveys of adult Odonata. We also did a brief analysis of the drift fauna at one control and one very polluted site. Physical and chemical factors were routinely measured at each site as often as possible. These included depth, flow rate, temperature, pH, conductivity, dissolved oxygen, Biological Oxygen Demand (BOD) chlorophyll a, phaeophytin a, nitrate ammonia total and orthoposphate, suspended solids, total organic carbon, residual chlorine and some heavy metals. Because creek substrates varied even within the apparently uniform strata we selected at each site, we always determined the distribution of particle sizes, using the Wentworth Scale, and the organic matter content for each sample of invertebrates. It is more directly meaningful to quantify these features than to measure flow characteristics.

WATER QUALITY

Only very general trends can be indicated in this paper. The BOD level increases significantly after sewage effluents enter the stream and reaches a peak at Site 3, declining thereafter as the materials contributing to BOD are dissipated in the water. The dissolved oxygen 'sag' was usually at site 4, i.e. downstream of the zone of highest BOD. Dissolved oxygen levels were usually high at Site 1 (although not as high as at Sites 6 and 7). After Site 4 and the DO 'sag' reaeration at the surface raised the dissolved oxygen level at Sites 5,6 and 7 to levels equal to and above the site 1 levels. Nitrate and phosphate levels were significantly increased at Site 2. Residual chlorine is present in stream water at Site 2 in sufficient amounts to inhibit bacterial growth, and this probably accounts for the inhibition of the BOD at Site 2. Heavy metals were detectable in the sediments at Sites 2 and 3, including zinc, copper, manganese, cromium, cadmium, nickel and lead. Thus several types of pollution stress are important in Bulimba Creek - low dissolved oxygen levels particularly at Sites 3 and 4, residual chlorine at Site 2, ammonia and heavy metals at Sites 2 and 3. How do these stresses affect the invertebrate community? Only the Insecta are considered here.

THE INSECT FAUNA

Most of our results are included in Table 1, and are coded according to the sampling methods by which the species were obtained. Our objective has been to identify every invertebrate from the creek to species level, or as near to this as possible. With an enormous amount of assistance from taxonomists all over Australia and a number overseas, this has pretty well been achieved. The most difficult insect group has been the Diptera, particularly the Chironomidae, which are numerically one of the two most important groups of animals in the

creek - the other group being the Oligochaeta. The literature available for identification of Australian larval Chironomidae does not often permit species identification of early instars and not enough rearing has been done to relate many larvae to adults. Various other Dipteran groups were problematic, including Tipulidae, of which only Tipulinae could be taken to species level. Ceratopogonidae were identified to generic level but Bibionidae, Rhagonidae, Tabanidae, Stratiomyidae, Empidae, Dolichopodidae and Ephydridae could not be taken beyond family. Fortunately these families were represented by very few individuals throughout the study. Two species of Simulium (nicholsii and ornatipes) turned up often in Site 1 and at times at Site 4. Culicidae were very rarely encountered in substrate samples. Trichoptera larvae could usually be named to generic level, occasionally to species, Ephemeroptera nymphs to genus, Odonata nymphs to species in most instances, Megaloptera and Plecoptera to species, and Corixidae to genus (so far). Coleoptera were taken to genus and species for many adults, but most larvae could not be speciated.

RESPONSES OF INSECTS TO SEWAGE EFFLUENTS

Our results clearly show that the control site has a rich insect fauna, although we have no other study with which to compare ours in detail. Work around Townsville is not directly comparable and the Mogill Creek study named most insects to family only, as did Hailstone (1979). We know that our decision to concentrate on quantitative sampling of the substrates has effectively eliminated species which live in association with marginal vegetation, logs and litter, but we have gained some idea of the diversity of these species from our supplementary sampling (see Table 1 at end of article). Netting of vegetation in particular added cryptic species to the faunal list.

Details of the responses of the insect community to pollution stress are still being worked out, using heterogeneity indices, evenness indices, similarity and dissimilarity analysis, cluster analysis and Principal Component Analysis. These are the methods commonly used to detect and quantify changes in community structure. Heterogeneity indices are used more frequently than any other method because they are relatively easy to calculate and give one index value for each 'community' or sample from it. The usual picture in simple organically polluted creeks is a change in heterogeneity of the total invertebrate community, as measured by the Shannon-Weaver Index, from 3.0 or more at clean sites to less than 1.0 at heavily polluted sites. This scale is derived from Northern hemisphere studies and has yet to be checked in Australia. It is probably not applicable when toxic materials are present in sewage effluents.

The main changes in insect species diversity along Bulimba Creek are summarised in Table 2. These results show that sewage effluents render sites 2,3 and 4 almost totally unsuitable for insect life; only single individuals were found, which could well have been washed downstream from Site 1. Moreover, the creek does not recover from pollution in the biological sense, although high dissolved oxygen levels frequently occur at sites 5,6 and 7. Thus we can conclude that the standard chemical criteria of high dissolved oxygen and low BOD are actually quite misleading methods of monitoring sewage pollution in this creek. We have yet to determine precisely why most insects cannot live downstream of the effluent outfall, even though there appears to be adequate oxygen present, but the dramatic decrease in both species richness and population density is indicative of toxic pollution, probably by metals, chlorine and ammonia.

Particularly interesting results have been obtained for Odonata, to take just one insect group. We did three surveys of adult Odonata along the creek, in December 1979, March 1980 and October 1980.

TABLE 2

Number of Insect Species at each Site over 15 Months (Creek Samples

Insect Order	Site 1	2	3	4	5	6
Ephemeroptera	7	2			2	3
Odonata	12				4	2
Plecoptera	1					
Hemiptera	5		1		1	
Megaloptera	2					
Coleoptera	25	1		2	2	1
Chironomidae	31	7	8	3	12	9
Other Diptera	25	3	1	1	3	2
Trichoptera	10				1	
Total	118	13	10	6	25	17

We found that a small group of stream-dwelling species was well established at Site 1, together with common species which breed in a wide range of standing and slowly flowing waters. Adults of the stream species disappeared almost completely from site 2 and only occasional elderly vagrants of the common species, with tattered wings, were present. Complete lack of teneral adults of any species suggests that Odonata cannot breed at all at Site 2. The complete absence of nymphs at Site 2 confirms this. This could be due entirely to scarcity of food, although one would expect a few individuals to persist by feeding on the drift fauna. We suspect that toxic materials eliminate the nymphs, perhaps even the egg stage. Tests are needed to check these two possible explanations. Whichever factor is the crucial one, we do seem to have, in the stream Odonata, a group of potential indicator value for toxic pollution. One damsel fly species in particular looks very promising - Argiolestes icteromelas. This has conspicuous body colouration and at rest spreads the wings horizontally, unlike the most damselflies. It is very abundant and easily spotted along clean water streams and does not appear to move far down the breeding place, so it is unlikely to be found unless it has bred in situ. Since A. icteromelas has a wide geographic range it seems well worth further investigation as an indicator species. Interestingly, there has been virtually no use of Odonata as an indicator group in pollution monitoring.

Our results for Chironomidae are also fascinating. So far 40 different species have been named or separated from about two thirds of our material and we have the data needed to examine the relationships of these 40 species with water quality and substrate characteristics. Chironomidae have been advocated as a key indicator group for both organic and heavy metal pollution overseas, so our results could be very revealing.

Biological monitoring as a concept has received a great deal of criticism recently from many fronts. The major criticisms are largely justified. Calculating a diversity index of dubious theoretical validity, which most are, from semiquantitative data crudely collected without regard to sample size, season or the many other factors which also influence diversity, is simply not sound biology. Diversity indices reveal nothing about the species present, only how many there are and how individuals are distributed amongst them, and they do not do this particularly well. Much more sophisticated methods are needed to detect changes in community structure in response to pollution and these analyses must be supported by sound biological observations and autecological knowledge. There is no substitute for the trained biologist if we wish to make full and accurate use of biological information to assess water pollution or any other type of environmental stress.

REFERENCES

1. Campbell, I.C. 1978. A biological investigation of an organically polluted urban stream in Victoria. Aust. J. Mar. Freshwater Res. 29: 275-291.

2. Hailstone, T.S. 1979. Aust. Soc. Limnol. Special Publication No.3: 77-90.

3. Jolly, V.H. and Chapman, M.A. 1966. A preliminary biological assessment of the effects of Pollution on Farmer's Creek and Cox's River, New South Wales. Hydrobiologia 27: 160-192.

4. McInvor, C.C. 1976. The effects of organic and nutrient enrichment on the benthic macroinvertebrate community of Moggill Creek, Queensland. Water 3(4): 16-21.

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CODE FOR METHOD OF COLLECTION

A - Adult	LT - Light trap	S - Scoop
P - Pupa	AC - Adult collection	N - Net
L - Larva		K - Kick
Ny - Nymph		NE - Netting Edges
SI - Subimago		D - Drift
		MIS - Miscellaneous collection

TABLE 1

Insects from Bulimba Creek

CLASS INSECTA			COLLECTION CODE
Order EPHEMEROPTERA			
Family Baetidae			
	Baetis	sp	Ny:S,N,K,NE,D;SI(LT)
	Cleon	sp	Ny:S
Family Caenidae			
	Tasmanocoenis	tillyardi	A(LT)
		sp	Ny:S,N,K,D
Family Leptophlebiidae			
	Atalophlebia	australasica	Ny:S,K,NE,MIS,SI(LT)
	Atalonella	Sp 1	Ny:S,N,K,NE,D;SI(LT)
		Sp 2	Ny:S,NE,D
Order ODONATA			
Suborder ZYGOPTERA			
Family Protoneuridae			
	Isosticta	simplex Martin	AC
	Nososticta	solida Selys	AC,LT
Family Coenagrionidae			
	Agriocnemis	pygmaea (Rambur)	AC
		sp	AC
	Argiocnemis	rubescens Selys	AC
	Austroagrion	cyane (Selys)	AC
	Ceriagrion	aeruginosum (Brauer)	AC

Family Coenagrionidae (contd.)			
	Ischnura	heterosticta (Burmeister)	AC,LT
		sp	Ny:D
	Pseudagrion	aureofrons Tillyard	AC
		ignifer Tillyard	AC,Ny:S,N,K,NE
		microcephalum (Rambur)	AC,Ny:S,NE
		sp	Ny:NE,D
	Xanthagrion	erythroneurum Selys	AC
Family Megapodagrionidae			
	Argiolestes	griseus Selys	AC
		icteromelas Selys	AC,Ny:S
Family Lestidae			
	Austrolestes	leda (Selys)	AC,LT,Ny:D
Suborder ANISOPTERA			
Family Gomphidae			
	Austroepigomphus	praeruptus (Selys)	AC,Ny:S,N,K
	Austrogomphus	guerini (Rambur)	Ny:S
Family Aeshnidae			
	Austroaeschna	unicornis	Ny:S,N,K,NE,D
		sp	AC
	Hemianax	papuensis (Burmeister)	AC
Family Synthemidae			
	Choristhemis	flavoterminata (Martin)	AC,Ny:S,N,K,D
Family Corduliidae			
	Hemicordulia	australias (Rambur)	AC,Ny:S,K,NE
		continentalis Martin	AC
		tau Selys	AC,Ny:K
		sp	AC
Family Libellulidae			
	Brachydiplax	denticauda (Brauer)	AC
	Crocothemis	nigrifrons (Kirby)	AC
	Diplacodes	bipunctata (Brauer)	AC
		haematodes (Burmeister)	AC
		melanopsis (Martin)	AC
	Nannophlebia	risi Tillyard	AC,Ny:S,N,K,NE
	Ortnetrum	caledonicum (Brauer)	AC
		sabina (Drury)	AC
		villosovittatum (Brauer)	AC,Ny:K,MIS
	Rhodothemis	lieftincki Fraser	AC
	Rnyothemis	phyllis chloe Kirby	AC
	Trapezostigma	loewi (Brauer)	AC
		sp	AC
	Zyxomma	elgneri Ris	AC
Order PLECOPTERA			
Family Gripopterygidae			
	Illiesoperla	australis Tillyard	Ny:N,MIS
Order HEMIPTERA			
Suborder HETEROPTERA			
Family Notonectidae			
	Anisops	sp	A:K
Family Pleidae			
	Plea	? brunni Kirkaldy	A:N
Family Naucouridae			Ny:S,D
Family Corixidae			
	Diaprepocoris	sp	A:D,Ny:S,D
	Sigara	sp	A:N,D
	Micronecta	sp	A:S

Order MEGALOPTERA		
Family Corydalidae		
Archichauliodes	? *guttiferus* (Walker)	L:S,N,D
Family Sialidae		
Austrosialis	*australiensis* (Tillyard)	A(LT)
	sp	L:K
Order COLEOPTERA		
Suborder ADEPHAGA		
Family Haliplidae		
Haliplus	? *testudo* Clark	A:S,N,NE,D;L:S
	? *bistriatus* Wenncke	A:D,L:S
Family Noteridae		
Hydrocoptus	? *subfasciatus* Sharp	A:D
Family Dytiscidae		
Hydrovatus	*ovalis* Sharp	A:D
Antiporus	*bakewelli*	A:D
	sp	L:S
Sternopriscus	sp	A:D;L:S
Necterosoma	*pencillatus* (Clark)	A:S,N,K,D,L:S,N
Platynectes	*decempunctatus* (Fabricius)	A:K;L:K,D
Rhantus	*suturalis* (W.S. Macleay)	A:LT
? *Lancetes*	sp	L:D
Copelatus	*melanarius* Sharp	A:LT
Family Gyrinidae		
Aulonogyrus	*strigosus* (Fabricius)	A:S
Macrogyrus	*australis* (Brulle)	A:N,D,MIS
	oblongus (Boisduval)	A:N
Suborder POLYPHAGA		
Family Hydraenidae		
Hydraena	Sp 1	A:NE
	Sp 2	A:D
Ochthebius	sp	A:N
Family Hydrophilidae		
Enochrus	sp	A:NE
Helochares	sp	A:D
Paracymus	*pygmaeus* (Macleay)	A:LT
Family Helodidae		
Helodid	Sp 1	L:S,N,K,NE,D
	Sp 2	L:S,NE
	Sp 3	L:S,N,K,NE,D
Cyphon	sp	A:D
Family Psephenidae		
Sclerocyphon	*basicollis* Lea	L:S,N,K
Family Helminthidae		
Austrolimnius	? *menopon* Hinton	A:S,N,K
	montanus (King)	A:S,N,D
	variabilis Carter & Zeck	A:S
	luridis Carter & Zeck	A:S
	? *resa* Hinton	A:S
	Sp L10E	L:S,N,K,NE,D
	Sp L34E	L:S,N
	Sp L36E	L:S
Kingolus	sp	A:S
Simsonia	Sp L2E	L:S,NE
Coxelmis	*novemnotata*	L:D

Order DIPTERA		
Suborder NEMATOCERA		
Family Tipulidae		
Ptilogyna	ramicornis	A:LT
Tipulid	Sp 1	L:D
	Sp 2	L:S,N,K,D
	Sp 3	L:S
	Sp 4	L:S
	Sp 5	L:S,N
	Sp 6	L:S
	Sp 7	L:D
Family Psychodidae		P:S,N,D
		L:S,D
Family Culicidae		L:S,D
Family Chironomidae		
Tanypodinae		
Orthocladiinae		
Chironominae		
T:Chironomini		
T:Tanytarsini		
Family Ceratoponogonidae		
Paradasyhelea	sp	L:S,K
Lanatomyia	? miles	L:S
Nilobezzia	sp	L:S
Stilobezzia	sp	L:S
Dasyhelea	sp	L:D
Forcipomyia	sp	L:D
Family Simuliidae		
Simulium	ornatipes	P:S,N,NE,D;L:S,N,K,NE,D
	nicholsoni	P:S;L:S
Family Bibionidae		L:S
Suborder BRACHYCERA		
Div:Orthorrhapha		L:S
Family Rhagionidae		L:S
Family Tabanidae		L:S
Family Stratiomyidae		L:S,N,K,D
? Odontomyia	sp	L:D
Family Empididae		L:N,D
Div:Cyclorrhapha		L:S
Family Syrphidae		
Eristalis	sp	L:D
Family Ephydridae		L:NE,D
Order TRICHOPTERA		
Family Hydropsychidae		
Cheumatopsyche	modica (McLach)	A:LT
	sp	L:S,NE,D,A:LT
Diplectrona	sp	A:LT
Family Hydroptilidae		
Hydroptila	sp	L:S,D
Hellyethira	sp	L:S,N,D
Family Ecnomidae		
Ecnomus	sp	L:S;A:LT
Ecnomina	sp	L:S,D
	sp (PT-720♂)	A:LT

Family Calamoceratidae		
Anisocentropus	*latifascia* (Walk)	L:S,MIS;A:LT
Family Lepiceridae		
Triplectides	*ciuskus* Mosely	L:S,N,K,NE,D;A:LT
	? *australis*	A:LT
	Sp 2	L:S
Symphitoneuria	*exigua* (McLach)	L:S,NE;A:LT
Notalina	sp	A:LT
Notoperata	*maculata* (Mosely)	A:LT
Triaenodes	sp (PT-722♂)	A:LT
Oecetis	*aeloptera* Kimmins	A:LT
	australis (Banks)	A:LT
	? *gilva* Neb.	A:LT
	laustra Mos.	A:LT
	pechana Mosely	A:LT
	sp (new)	A:LT
	sp (minasata gp)	A:LT

Dr. P. Room — As there has been exceptionally low rainfall during your study, what sort of effects do you think this has had on your survey?

Low flows result in high BOD and less dissolved oxygen in water. During periods without rain the substrates are fairly stable and some groups, e.g. Chironomids, establish at sites where they are often absent, e.g. Site 2. Site 1 remained flowing throughout the study and all other sites receive effluent so never dry out.

Dr. B. Stone — You mentioned heavy metal pollution. Could you expand on this as to what types they were and where they were coming from?

Heavy metals included cromium, cadmium, lead, sodium, calcium, nickel, boron, manganese, barium, zinc and copper. Most of these increase significantly downstream of the sewage treatment plant although cromium and zinc were sometimes high at Site 1 and Site 2. All levels drop off as distance downstream of the plant increases. Sources appear to be light industry wastes (metal workshops, garages, etc.), domestic wastes and road drainage channelled into the sewage treatment plant.

Dr. E. Sinclair — Are Odonata used as indicator species in overseas studies?

Odonata are listed as a group which usually disappears downstream of organic pollution outfalls. Only the nymphs are studied. There has not been any use of adult Odonata, to my knowledge, comparable to ours, anywhere overseas.

Mr. R. Piper — What modifications do Chironomids have to enable them to tolerate the high pollution levels mentioned?

Certain Chironomids have haemoglobin in the blood and this enables them to bind and transport oxygen to the tissues very efficiently. Most invertebrates have haemocyanin which does not transport oxygen. Some chironomids actually increase the level of haemoglobin when under pollution stress. The physiological basis of tolerance of metal pollution is not known.

Dr. P. McFadyen — Does heavy metal pollution reach high levels?

See answer to similar question from Dr. Stone.

Mr. M. Zalucki — Are there any major differences between the Australian and North American creeks? Do you expect the Australian creek fauna to react differently to the North American?

The Australian creek invertebrate community is generally similar at the family and, in some groups, generic level. The species are, of course, different and have individual tolerances to various pollutants. Simple organic pollution reduces community species diversity and, in general, the same groups disappear whilst the Chironomidae and Oligochaeta become very abundant. Toxic pollution brings about reduction in both number of species and number of individuals of many invertebrate groups in creeks worldwide. Again the differences are at the species level.

Australian running waters differ fundamentally from northern hemisphere systems in several ways. Here, riparian leaf fall is more or less continuous with seasonal peaks, whereas northern hemisphere trees shed leaves in one autumnal pulse. As a result of this, life cycles of Australian stream fauna are less precisely timed and the fauna is less diverse. The full effects of the Australian pattern of leaf fall and of this energy contribution to running water systems are not yet known. Finally, stream discharges are highly variable seasonally and annually compared to northern hemisphere rivers with similar average discharges, and turbidity is also fairly high in many of our rivers.

VOTE OF THANKS

Dr. Peter Room proposed the vote of thanks for an impressive and detailed account of the effects of pollution in the insect life of Bulimba Creek. The vote was carried by acclamation.

There being no further business the President closed the meeting and invited all to supper.

THE MOSQUITO SUB COMMITTEE

Some years ago a sub committee of the Entomological Society of Qld. was set up. This sub-committee was intended to investigate the methods of mosquito control being used by the Brisbane City Council at the time and to advise them on control methods. The sub-committee was headed by Dr. E. Marks and made up of members from many areas of entomology. Prof. Kettle, Drs. Hooper, Moorhouse and Reye, and Messrs. Stone, Wharton, Kay, Standfast, McRae and Ferguson.

The committee achieved its objectives early and since that time has been inactive. At the October 16th council meeting the council members voted to disband this sub-committee until such time as a similar need may arise.

RESIGNATIONS

The council of the Entomological Society of Queensland, regretfully acknowledge the receipt of the resignation of:-

Dr. Sibitani of Lindfield N.S.W.

ABOUT PEOPLE

Bob Pope from the British Museum (Natural History), London, arrived in Australia in late September at Darwin, where one of his hosts was Dr. M. Malipatil (Darwin Museum). He visited Ross Storey (DPI Mareeba) and Alan Walford-Huggins at Julatten before flying to Brisbane for two weeks where he studied the coccinellid collections of the Department of Primary Industries (Indooroopilly), Queensland Museum and University of Queensland. He selected material for borrowing and discussed the taxonomy of Coccinellidae with Ken Houston (DPI Indooroopilly). He also spent a weekend collecting in south-east Queensland with Ken Houston, Bryan Cantrell (DPI Indooroopilly), and Judy Cantrell. From Brisbane Bob flew to Canberra and from there he plans to work his way around the insect collections of Australia before leaving from Perth in March.

John Turner the wandering entomologist of DPI Indooroopilly has recently returned from a trip to India. In India John visited Ludhiana, Simla, New Delhi, Hyderabad and Bangalore. At all tnese centres he met with Indian entomologists and discussed the exchange of insects and ideas on biological control methods. He also fitted in some field collecting. During his visit he was bitten by a rabid dog, out aggressed an aggressive monkey and was involved in an Indian traffic accident which resulted in a broken ankle. Ten stone lighter and two months later he returned to the "safety" of Australia, only to be felled by Delhi-belly. Just a few of the unpublished hazards of biological control.

QLD. SCIENCE TEACHERS ASSOCIATION SCIENCE CONTEST 1980

This year's science contest again attracted a number of entries from school children of various ages. An exhibition of selected entries was on display in the Mall of Indooroopilly shopping town and some members may have seen the array there. The Entomological Society of Queensland awarded a prize this year in the Senior section to Geraldine Tyson of Fairholm College for an exhibit entitled "Backyard Transects and Insect Life". The value of the bursary awarded was $25.00. Geraldine wrote to the council, thanking the society and says she will use the bursary to further her entomological studies.

Aust. Entomological Society A.G.M.1981.

The 1981 Annual General Meeting of the Australian Entomological Society will be held on the Sunshine Coast over the three days 8, 9 and 10 May 1981. A brochure and nomination form is included with this issue.

a Happy Christmas to all our readers, from the Council. Especially to those who live too far away to come to the Barbeque at Griffith Uni. on the 8th of December

NOTICE OF NEXT MEETING

The next meeting of Entomological Society of Queensland will be at 8.00 p.m. on Monday December 8th at Griffith University. This will be a notes and exhibits meeting preceded by a Barbeque in the Australian Environmental Studies area. Barbeque will commence at 6.30 p.m. and will cost $2.50 per dinner and drinks of wine or orange juice at 50¢ per glass.

Cook your own barbeque this time. We need to know numbers so please ring Meron Zaluchi at 2757151 or leave a message for him at the office 2757519 before Friday 5th December.

THE SOCIETY

The Entomological Society of Queensland is an association of over 300 people with a professional or amateur interest in Entomology. It is dedicated to the furtherance of Pure and Applied Entomological Science and, since its inception in 1923, has promoted liaison amongst entomologists in academic, private and governmental institutions. It has a concern for the conservation of Queensland's natural resources. Further information is available from the Honorary Secretary at the address given above.

MEMBERSHIP

Membership is open to anyone interested in Entomology and entitles the member to attend monthly Society meetings, held on the second Monday night of the month and to receipt of the News Bulletin. There are three classes of subscription membership:

Ordinary: persons residing in the Brisbane area ($9.00 p.a.)

Country: persons residing outside Brisbane ($8.00 p.a.)

Associate: persons not in receipt of a full salary ($3.00 p.a.)

THE NEWS BULLETIN

The monthly News Bulletin reports on the Society's monthly meeting, keeps members informed of Society events and news, and provides a vehicle for debate and discussion. Contributions in the form of articles, notes, letters, news clippings and photographs are always welcome, and should be sent to the Convenor of the Publication Committee at the address given above. The deadline for contributions is the Wednesday following the monthly Society meeting.