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A COMMON FELLOWSHIP OF ENDEAVOUR

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Abstract

Aspects of communication in science are illustrated from the author’s professional career, from the experience of the Australian Entomological Society during its first decade, and from Australian mosquito research since 1955. With some notable exceptions there has been good communication between scientists at the personal level, between entomologists and their Society, and between scientific bodies. On the other hand, important information on Australian mosquitoes has remained unpublished, or been disregarded because of inadequacies in communication between entomology and other disciplines.

Introduction

The title of this address is a phrase from a message to members by the first President of the Australian Entomological Society (Mackerras 1965) that epitomises what I believe should be both the motivation and the result of communication in science. I will follow this theme along three paths linked by my own experience, relating it firstly to a career in science, secondly to this Society, and thirdly to Australian mosquito research.

Lessons from a career in science

We all at some time stand apart from ourselves, as it were, and wonder how we came to be where we are. I have been asking myself how have I come to be importuning Commonwealth Ministers and the Australian Academy of Science on behalf of Australian entomologists and discussing mosquitoes in a presidential address to a national society. The answers are relevant to my theme.

The influences were many: a childhood allowing frequent outings with naturalists; a B.Sc course in the University of Queensland, with three years of a fixed zoology course that was strong in morphology and systematics, devoid of experiment, and had only part of one year devoted to insects; an Honours course determined by the chance to study under Ronald Hamlyn-Harris and F. A. Perkins with whom I felt community of interest and who conveyed their own enthusiasm to their students; Honours in Parasitology because a prerequisite for Entomology Honours was the extended course in entomology then available only to agriculture students. Not surprisingly, my parasitology had a strong bias to medical entomology. Hamlyn-Harris, as Brisbane’s City Entomologist from 1928 to 1933 (the only appointment of that kind ever made in Australia), had worked extensively on mosquito biology and one of my projects was the detailed description of an anopheline larva.

All this was preparatory, with the flow of communication almost entirely in one direction, from expert to novice. The next three years in a Pathology Museum provided only occasional opportunities to assist Perkins in teaching mosquito identification. Then, in 1943, following movement of the war to New Guinea and an epidemic of malaria in Cairns, the Queensland Government established a Mosquito Control Committee, whose functions included advising on mosquito control, education, and research. A grant to support one investigator was made through the Health Department to the University of Queensland, which provided facilities for the programme, and the Committee appointed me to carry out research under Perkins’ direction.

Thus the novice entered a well-established and intensely active research field. Entomologists in the Australian armed forces were investigating many aspects of the biology, vector potential, and control of mosquitoes. Taxonomic studies were centred in the University of Sydney where the School of Public Health and Tropical Medicine (SPIITM) had been opened in 1930 by the Commonwealth Department of Health. The School’s entomologist, F. H. Taylor, was the doyen of Australian mosquito workers. In the Zoology Department, A. R. Woodhill (then in the Army) and D. J. Lee were reviewing and describing the anopheline mosquitoes of Australia and New Guinea,
and Lee (who was subsequently appointed to SPHTM in 1948) was producing a guide to identification of culicine larvae.

Perkins was then Officer Commanding the School of Malaria Control which had been established by the Australian Army in association with the University of Queensland to train service personnel for malaria control units and to provide them with advisory services. The need to recognize all stages of many Queensland mosquitoes, requests for identification of New Guinea collections from members of the Australian and U.S. forces who had passed through the School, the enthusiasm and skill of the School’s field instructor, J. L. H. Wassell, and an opportunity to work in Sydney with two experienced mosquito taxonomists, D. J. Lee and Colonel W. V. King, U.S. Army, combined with Perkins’ encouragement to establish my interest in taxonomy. Mainly owing to the efforts of F. N. Ratcliffe and I. M. Mackerras (both then in the Army), the identification services became an object lesson in prompt direct communication between units in the field and Australian mosquito specialists in Sydney and Brisbane, bypassing cumbersome “normal channels”.

A congenial and satisfying job, with extended leave for overseas study, sustained my continuing work on mosquitoes. This provided much experience in communication with fellow scientists and in extension work, but none at the administrative level. That came in other ways.

Both nature and nurture involved me in societies. My father, a long-time councillor of scientific bodies, introduced me to the Queensland Naturalists’ Club and the Royal Society of Queensland. Perkins*, also a consistent supporter of societies, brought me into the Entomological Society of Queensland, through whose founding father, G. H. Hardy, I became a member of the Linnean Society of New South Wales, for he had persuaded me that the professional scientist has an obligation to support publishing societies.

The councils of those Queensland societies faced the common problems of finance, membership, meetings and publication. They interceded with Ministers or other authorities when the need arose, but seldom sought publicity. Council meetings, bringing together naturalists from diverse occupations, scientists from varied disciplines, entomologists from different institutions, provided a stimulating interplay of ideas. The Entomological Society of Queensland was given an additional, more onerous task in consulting entomologists and societies all over Australia as a prelude to the formation of a national society (Mackerras and Mackerras 1972).

Another valuable experience came more directly from my scientific work. Mosquito identifications for Ratcliffe (p. 359) led, through interchange of views on conservation, to a part in the formation of the Australian Conservation Foundation and three years on its Executive Committee. That introduced me to a new dimension in committee work. The President was Sir Garfield Barwick, Australia’s Chief Justice and formerly a Commonwealth Cabinet Minister, and the committee included scientists with experience as heads of government instrumentalities and executives from business and industry. Policy at that time was to work through President-to-Minister correspondence, with thoroughly researched submissions, and press releases seldom came before negotiations were completed or had broken down.

Discussions in that committee provided an understanding of the responsibilities and workings of government, and of the ways in which a national body might seek to have its views considered, knowledge which has helped me in our Society’s negotiations with the Australian government. However, I have also learned that no President of our Society need fear deficiencies of personal experience if he is prepared to draw on the wealth of wisdom and experience available among its members and friends. Most of all, this term of presidential office has heightened my awareness of the responsibilities that entomologists have both to their science and to their profession.

*Of 23 members who have held office in the Australian Entomological Society, 11 were students of F. A. Perkins.
The Society's first decade

Nine months ago the Australian Entomological Society entered into its second decade, making this & AGM in Hobart an appropriate time to consider its development since it last met here for its inaugural meeting on 17 August 1965. Since then the Executive has been based in Brisbane (until August 1969), Canberra (until January 1975), and Melbourne, and each period has had its particular impact—during the first the Society established communication with Australian entomology, during the second with international entomology, and during the third with Australian science.

I do not intend to trace details of progress but rather to assess how the Society has met the four responsibilities of a new scientific body, as defined by its first President (Mackerras 1965). These were: it should acquire wealth so that it can rise above mediocrity; it should strive for the highest attainable standards of excellence in everything that it does—"we should always be attempting something that seems, at the moment, beyond our capacity"; its central purpose and source of inspiration should be to add to knowledge and understanding—to raise the peak of true scholarship in entomology; and it should exist not for what it can get but for what it can give—"let us...try to draw all other bodies with similar interests and aspirations into a common fellowship of endeavour".

A Society that meets only twice in three years needs special means to draw its own members together and the good communication established between the Executive, the membership, and the affiliated societies through the News Bulletin has been a major source of strength. It has given the Executive confidence to attempt objectives that seemed at the time beyond the Society's capacity.

As to the Society's first duty, the most obvious signs of acquisition of wealth—and strength—are the growth of membership from 278 to 551, accompanied by a threefold increase in the annual subscription, and growth of the Journal from 156 pages in 1967 to 444 pages in 1975, with non-member subscribers rising from 151 to 218. It has received no government grants. On the other hand, the Agricultural Chemical Industry subsidised our first Miscellaneous Publication (Hely 1968) and ten firms have enrolled as sustaining associates. Essentially, though, the Society's wealth has been self-generated and this seems likely to continue. Thus, its first Handbook (Norris 1966) on methods of collecting and preserving insects was so popular and profitable that a revised edition (Norris and Upton 1974) has been issued. Similar publications that fill a need in secondary and tertiary biology teaching hold out the best immediate prospects of acquiring more wealth.

The duties to maintain standards of excellence and to add to knowledge have been sustained in the Journal which has both generated and absorbed much of the Society's funds. Here we should acknowledge the high standard of the Journal of the Entomological Society of Queensland, which that Society so generously agreed should be merged with the Journal of the Australian Entomological Society, and pay a tribute to the two Chief Editors, B. R. Champ for his ten years with the two Journals and K. L. S. Harley since 1972.

The Society has also encouraged scholarship among students of entomology and currently has 37 student members, though the number of essays and research reports entered for student awards has been disappointing.

Annual meetings, with two exceptions, have promoted good communication of scientific knowledge by inclusion of symposia and papers, and two were extended by joint symposia with the Zoology Section of ANZAAS. The outstandingly successful 2 AGM at Armidale in 1968, with three days of scientific and business sessions followed by an excursion, demonstrated the advantages of holding residential meetings outside the capital cities when there is ample opportunity for members to enjoy informal discussions; three shorter meetings have followed this pattern. If the Society's Annual Meetings are to help to raise the peak of scholarship in entomology, I believe that, when available time is limited, they should be concentrated on scientific sessions that allow discussions of research in progress and where young entomologists may hear and
be heard by some of the leaders in the profession; this should have priority over the link with ANZAAS.

Of all the projects in the Society’s first year, the one that seemed furthest beyond its capacity, but nonetheless was whole-heartedly supported, was the suggestion by J. W. Evans (then Australian representative on the Permanent Committee of International Congresses of Entomology) that there should be an invitation to hold the 14th Congress in Australia in 1972. This was sent through the Australian Academy of Science as joint host, and in August 1968 was accepted by the 13th Congress. The Society undertook responsibility for organising the scientific programme, and the generally acknowledged excellence of the arrangements and overall success of the 14th Congress in August 1972 established the Society as a body of international repute. For this it was largely indebted to D. F. Waterhouse (Chairman of the Organising Committee), C. N. Smithers (Congress Secretary), members of the Executive, and many other Canberra members.

In the following year the Society faced an even greater challenge. The Conference of Australian Museum Directors (CAMD) had decided in 1971 to seek prohibition of the export of insects, ticks and spiders collected in Australia, except under permit, with the object of preventing holotypes designated from such collections from being lodged overseas. The outcome was promulgation of Regulation 13A of the Australian Customs Acts, which remained unknown to all but a few entomologists until stringent guidelines for its operation were issued by the Department of Science in October 1973 (Talbot and Smithers 1974).

Apart from implications of the legislation for scientific freedom and international relations in entomology, or doubts whether the grounds on which it was recommended had been properly documented, there were other noteworthy features highly relevant to my theme. The CAMD included only one entomologist who was at that time President of this Society and President-elect of the International Congress of Entomology. The Museum Directors did not consult the Australian Academy of Science, the entomological societies, the general body of entomologists in Australia, or the International Congress of Entomology. This remarkable failure in communication presented a deeply disturbing situation quite new to Australian biological science.

These events involved the Executive in heavy responsibilities for enquiry and communication at corporate and governmental levels. It first sought members’ views on the Regulation and Guidelines, with results that demonstrated strong opposition to both, and it became apparent at the same time that other biological societies were equally concerned. I was then empowered to negotiate a reasonable compromise with the CAMD. That attempt having failed, two further Executive decisions had to be made in 1975, first to ask the responsible Minister to repeal the Regulation, and second, in the face of his refusal, to continue the Society’s efforts.

Australia’s good name in international entomology may eventually be restored, but the immense amount of senior researchers’ time diverted to this controversial matter is a permanent loss to Australian science. On the other hand, the Society has gained in maturity, strength and unity of purpose, and it has upheld its duty to draw other bodies with similar interests and aspirations into a common fellowship of endeavour. This is a position that it must strive to maintain.

Mosquito research and control

A variety of more technical problems in communication arise in the course of any scientific work, and these may be illustrated from Australian experience in mosquito research and control during the past twenty years.

Biology and distribution

Much of our knowledge of the biology and distribution of Australian mosquitoes has come from taxonomic studies (p. 359), but considerably more from intensive field investigations of myxomatosis of rabbits, arboviruses of man, and ephemeral fever of cattle. To this may be added a note on laboratory colonies.
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In December 1950, experimental inoculations of rabbits with myxoma virus by CSIRO Wildlife scientists were suddenly rewarded by a spectacular epizootic which spread rapidly to inland areas. Field teams under F. N. Ratcliffe's leadership quickly became engaged in intensive investigation of the ecology and behaviour of the vectors, of which mosquitoes were the most important, in selected areas of New South Wales, Victoria, South Australia and Western Australia.

Nothing like these year-round studies had been attempted before. Adults of many southern species are active for only a short season and the coincident presence of collectors provided unprecedented information about them. Ratcliffe recognised several new species in the collections, and extensive material was sent to specialists for study. Most of this work tapered off about 1955-56, but D. J. Lee, A. L. Dyce, and A. K. O'Gower in a mountain environment in New South Wales, Dyce in coastal foothills further south, and G. W. Douglas in northern Victoria continued monitoring into the 1960's.

Lee and his colleagues (refs in Fenner and Ratcliffe 1965) reported on blood feeds and transmission, E. J. Waterhouse (1959) described his survey of an inland area, and Marks (1972) brought together records of mosquitoes harbouring in rabbit burrows, but the great bulk of detailed information on mosquito behaviour and biology that resulted from the myxomatosis studies remains buried in field notes and departmental records. The entomological findings were, however, admirably summarised by Ratcliffe in Chapters 12 and 16 of Fenner and Ratcliffe (1965), where they provide balance in a definitive monograph but are usually overlooked. It is a pity that this exceedingly valuable information on important pest species is not more readily accessible. But at least it has been published, and those two chapters should be required reading for all Australian mosquito workers.

Further information came from J. E. Wright who in 1966-68, while monitoring myxomatosis, made the first extensive mosquito collections through the seasons in south-western Queensland, relating species occurrence to rainfall and different environments. Sent to Marks for identification, this material provided new species as well as unexpected records as yet unpublished.

Recent arbovirus research in Australia began with the epidemic of Murray Valley encephalitis (MVE) in Victoria that coincided with the dramatic spread of myxomatosis in 1951. It has been frequently reviewed (e.g. Doherty 1974) and I shall confine myself to entomological contributions.

The first isolation of MVE virus from naturally infected Culex annulirostris Skuse was made by the Queensland Institute of Medical Research (QIMR) from mosquitoes collected at Mitchell River Mission (now Kowanyama) in 1960. The area was clearly one for continuing studies and an experienced entomologist was appointed as a full-time member of the arbovirus research team, so that research on the vectors could be integrated into the overall programme. Both dry and wet season collections of mosquitoes and other biting flies have been made at Kowanyama since 1962 and twenty different arboviruses have been isolated from this one locality.

From 1962 to 1970, H. A. Standfast conducted additional field studies in an endeavour to correlate mosquito populations with virus activity. At Innisfail, regular weekly light traps and chicken-baited traps were continued for a year; 56 species of mosquitoes but few viruses were collected (Standfast and Barrow 1969). The results led Standfast to appreciate the need to follow populations by continuous sampling over an extended period. Many new techniques were tried and adapted for local use (e.g. Standfast 1965) and both Standfast and B. H. Kay (who succeeded him in 1970) undertook experimental studies of mosquitoes as virus vectors. Kay has been specially concerned with natural feeding patterns, host preferences, seasonal abundance, and age structure of the populations. The Annual Reports of QIMR contain accounts of these and other activities and some have been reported in scientific journals, but a Ratcliffe is needed to present an overall review. This touches on a question that I shall not pursue—whether an "Annual Report to Parliament" is a scientific publication? At least the information is on permanent record in print, though seldom readily accessible beyond its place of origin.
In 1959 O’Gower of SPHTM collected mosquitoes at Townsville for virus recovery, including *Aedes vigilax* (Skuse) from which Ross River virus was isolated by QIMR and associated by serological surveys with acute polyarthritis in man (Doherty et al. 1963). I. D. Marshall of the John Curtin School of Medical Research, Canberra, leads a team investigating the epidemiology of this and other arboviruses in N.S.W. Their findings include the first isolation of MVE from *Cx. annulirostris* in the Murray Valley, and Ross River virus from several species of mosquitoes at Nelson Bay, but there is no entomologist in this group and consequently little information about the mosquito vectors themselves has accrued.

P. F. S. Liehne worked in 1972-75 with N. F. Stanley of the Department of Microbiology, University of Western Australia, collecting twice yearly in the Ord River area, mainly by means of chicken-baited traps. Besides obtaining specimens for isolation of arboviruses, he made a mosquito survey of the Ord Valley. Some of this team’s results are in press.

In 1974, the first major epidemic of MVE since 1951 stimulated a wider interest in mosquitoes, particularly *Cx. annulirostris*. Entomologists at the Victorian Plant Research Institute led by P. G. Shelden are studying the biology of this species and monitoring control programmes against it (see also p. 359), and R. Laughlin of the Waite Institute in South Australia is monitoring its populations on the Lower Murray River. Findings of neither group have yet been published.

An epizootic of ephemeral fever of cattle in 1967-68 and the danger of the introduction of exotic diseases of livestock stimulated the CSIRO Division of Animal Health to appoint a mosquito researcher, H. A. Standfast, to work with A. L. Dyce on potential vectors. They have collected widely in northern Australia, their most important field activity being the establishment of a station at Beatrice Hill, 70 km from Darwin, where light traps, Magoon traps, truck traps, Manitoba traps, and direct collection from bovids have been used regularly for 18 months to study the seasonality of species attacking livestock. Ephemeral fever virus has been isolated from *Anopheles bancroftii* Giles from this site (St George et al. 1976). This study is now ending.

O’Gower (1958) reassessed all records and available specimens from the Northern Territory and north-west of Western Australia, supplementing them from his own collecting. The recent surveys already mentioned, plus collections by P. I. Whelan of N.T. Department of Health, and others, have resulted in a great growth in knowledge of the mosquitoes of northern Australia comparable to the increase in knowledge of the southern fauna in the 1950’s (p. 357). Again there has been stimulating communication between field workers and taxonomists but taxonomic research lags behind the field studies.

One point stands out clearly from the studies of mosquito-borne diseases in Australia, and that is the importance of setting aside voucher specimens of the insects that can be examined and re-examined in the light of changing species concepts.

In a different field, several attempts, mostly unpublished, have been made to establish laboratory colonies of Australian mosquitoes. In collaborative studies by SPHTM, Sydney and the Army’s 1 Malaria Research Unit, Ingleburn, E. C. Kalucy in the 1960’s established and maintained a colony of *Anopheles annulipes* Walker by the induced copulation technique. That colony was used by Kalucy and McMillan (1970) to transmit *Plasmodium berghei* Vincke and Lips. It was later lost, and A. W. Sweeney and I. F. M. Saint-Yves (1974), using the same technique, started a new colony which proved to be almost completely refractory to *P. berghei*. Green’s work (p. 360) suggests that two sibling species of the *annulipes* complex may have been involved.

Sweeney and R. C. Russell (1973) colonised *Anopheles amictus hilli* Woodhill and Lee, discovering that it is autogenous and able to mate in a confined space. This self-perpetuating colony is being used by several members of the joint team to study the pathogenic fungus *Culicinomyces*.

Standfast (QIMR) had temporary success with a colony of *Aedes notoscriptus* (Skuse), but failed with other native species, including *Cx. annulirostris*. Others too have failed with *Cx. annulirostris*, so it has been a notable achievement of the Victorian
team (p. 358) to establish a colony which is now in its fifteenth generation. Again the possibility of sibling species must be considered.

Mosquito colonies of different species are so valuable in research that, not only should voucher specimens of the immature and adult stages be preserved for future study, but the colony itself should be divided between different laboratories as soon as possible to minimise the risk of accidental loss.

**Taxonomy**

The mosquito fauna of Australia, including Tasmania and the Torres Strait islands, known in April 1976 consisted of 15 genera, 258 species and 4 subspecies, of which 3 species are introduced and 54 undescribed. Inclusion of Lord Howe and Norfolk Islands would add two described and one undescribed species. The total includes 41 species described as new since 1955, 19 by Dobrotworsky and 22 by Marks, but the immature stages of many species are still undescribed.

N. V. Dobrotworsky provided a shining example of what communication in science should be. In 1951 he was awarded a Georgina Sweet Fellowship in the University of Melbourne, supported by grants from the Science and Industry Fund of CSIRO, to study the mosquitoes of Victoria. This he did, single-mindedly and meticulously, for thirteen years, reporting his results in the *Proceedings of the Linnean Society of New South Wales* from 1953 to 1962, and bringing them together in an admirable 237-page volume (Dobrotworsky 1965), which treats 73 species and subspecies, as compared with 23 species known from Victoria in 1950. A later grant from the Nuffield Foundation helped him to investigate the mosquitoes of Tasmania and Bass Strait islands. He recorded 29 species from Tasmania (Dobrotworsky 1966), including a new *Anopheles* found also in Victoria but not included in the monograph.

In his publications he consistently acknowledged the help of F. H. Drummond, co-author of an early one. I suspect that it is not generally appreciated just what a source of strength this help was to a scientist not communicating in his native language.

The extent to which Dobrotworsky bucked his careful formal taxonomy by studies of the biology of the species he described is, I think, unique in world taxonomy of culicine mosquitoes, and this section of his papers should be required reading for anyone embarking on mosquito studies in Australia. In a gardener’s phrase, he had “green fingers” with mosquitoes—in reality, acute perception and infinite patience. For example, having failed to obtain eggs of *Culicoides* spp. at temperatures of 20–22°C he found that engorged females kept at 8–10°C oviposited regularly, but it took him 4–5 months to rear adults from these eggs; several species were later found to breed in burrows of land crayfish. In other groups, species descriptions were supported by evidence of different larval temperature tolerances. Results of laboratory crosses and observed differences in mating behaviour helped in assessment of specific status in the *Culex pipiens* L. and *Aedes bancroftianus* Edwards complexes.

Dobrotworsky and Marks collaborated happily, testing each other’s manuscripts and exchanging new species and life histories so that descriptions were placed in the most appropriate papers. Much later they embarked on a joint project on New Guinea mosquitoes, which included two new species from north Queensland. Characteristically, Dobrotworsky completed his part of the undertaking before his retirement, but Marks has yet to complete hers.

The research project for the Mosquito Control Committee—on the systematics, biology and distribution of Queensland mosquitoes—was always broadly interpreted as necessarily involving the mosquitoes of the whole of Australia and of New Guinea. Indeed, numerous Papuan species were found during field work on Cape York Peninsula. The two-way communication of enthusiasm between field collector and taxonomist is exemplified in two studies. A suggestion to J. L. H. Wassell that *Aedes (Chactocranium)* spp., which are rarely collected, might be canopy-dwellers led to his discovery of larvae in a tree-hole 7.6 m above the ground, and the specimens he provided stimulated revision of the subgenus (Marks 1963). Identification of *Aedes (Ochlerotatus)* spp. collected by CSIRO Wildlife workers (p. 357) and by E. J. Britten in south-western Australia (Britten 1958), and study of Victorian specimens provided
by Dobrotworsky, led to a review of interspecific relationships (Marks 1957) and
description of new species. However, several species and life histories remain
undescribed and a key to the species of the subgenus, in general use since 1964, is still to
be published. A check list of the mosquitoes of the Australian region, with keys and re-
analyses of many old records, by D. J. Lee, M. M. Hicks and M. Griffiths of SPHTM
and E. N. Marks is also in preparation.

A different type of research programme was initiated by H. E. Paterson in the
University of Western Australia in 1968 as part of a project aimed at the resolution of
evolutionary and taxonomic problems by using cytological, genetical and biochemical
tools. Much of the work was carried out by his graduate students, and the programme
virtually ended when he returned to Africa in 1975.

S. J. Miles completed his study on biochemical polymorphism and evolutionary
relationships in the Culex pipiens complex, using gel electrophoresis to show from field
and laboratory studies that members of the complex behave as good biological species.
His results are in process of publication.

R. J. Irving-Bell, who is completing her project on genetics, ecology and cytology
of ovarian development and egg fertility in the same complex, has shown that the
Australian species of the complex do not have the symbionts of introduced species
(Irving-Bell 1974).

C. A. Green studied speciation in the Anopheles annulipes complex, using polytene
chromosome cytology to characterise the types and multivariate analysis to distinguish
morphological characters. By 1973 (Paterson 1973) Green had detected four sibling
species and found no natural hybrids. He did not complete his thesis and so has left the
taxonomy of An. annulipes in a more confused state than he found it.

Looking at the foregoing from the point of view of communication, one is forcibly
reminded of the dictum that no research is completed until it has been published; that
reminder is clearly as necessary for the experienced worker as for the student.

Theses present special difficulties and there is an important aspect of the
investigations they report that is often neglected. Apart from the Western Australian
studies, I know of six theses on Australian mosquitoes submitted in the 1955-76 period
from which nothing has as yet been published; three—by J. L. Reynolds in 1961, J. H.
Bryan in 1962 and P. Kerridge in 1971—are concerned with the biology of the salt-
marsh pest species Aedes vigilax. Inevitably any researcher learns a lot about the
natural history of the animals he investigates. That kind of knowledge is essential to an
understanding of the epidemiology of mosquito-borne disease and to planning
mosquito control measures: the important information is not how the work was done
or what was proved, but, in simple terms, what was learned about the species.
Kerridge, aware from personal contacts that her information on Ae. vigilax would be
useful to health surveyors in coastal Queensland, has an appropriate paper in press. I
feel that supervisors have a responsibility here, to emphasise to students the
importance of general biological information of this kind, and I would like to see good
natural history considered at least as creditable to a budding scientist as an
unpublished thesis.

Public health

R. H. Black (1972) has presented an historical review of malaria in Australia up to
1969 which is a treasure-chest of information. The disease has not been endemic in
Queensland during the past twenty years, but in 1955-57 215 cases of locally contracted
vivax malaria occurred in the Northern Territory, the last indigenous case being
recorded in 1962. No one has yet proved by positive dissection which anophelines are
vectors in the Northern Territory, nor do we know which siblings of Anopheles farauti
Laveran and An. annulipes occur there.

Some deficiencies in interdisciplinary communication have come to light in
relation to malaria. Thus, Marks and Kay in Queensland learned in 1975, not from
their own Health Department but from Black in Sydney, that there had been locally
contracted cases of malaria at Gladstone in 1969 and 1973, and, despite assurance of
prompt advice in future, again learned from Black in 1976 of another case at Roma in 1975. It is unlikely in such cases that an entomologist would find an infected mosquito, but an early visit to the locality should disclose the anophelines present and whether seasonal or man-induced conditions had increased the probability of them feeding on man. Black also told me that he was unable to find any record of *Anopheles* at Roma, and this brought home a deficiency in my own communication, for I had made a survey there in 1968. There are many such typed or mimeographed reports in departments and institutions. The question of how best to process the distribution records amassed in field work so that they are readily accessible at need is currently exercising the minds of mosquito workers in this country.

There has not been an epidemic of dengue fever in Australia since 1955, but WHO, as part of a wider study, provided a supporting grant in 1969 for Marks to survey the status of populations of *Ae. aegypti* in Queensland. This was done with assistance from Kerridge and many health surveyors, but a paper summarising the results is still to be published.

Implementation of mosquito control measures in Australia is usually the responsibility of health surveyors employed by local government. There is good general rapport between entomologists and health surveyors, some of whom have attended courses on mosquitoes organised by the University of Queensland in Brisbane and Townsville, and by the Commonwealth Department of Health in Darwin and Mildura. The communication problems are at other levels. For example, apart from a brief note on *Ae. vigilax* larvae (Standfast *et al.* 1970), no reports have been published on the susceptibility of native species to insecticides, even though two of them, *Cx. annulirostris* and *Ae. vigilax*, have been subjected to large scale chemical control measures. Moreover the allocation of money for mosquito control is a political decision and the extent to which entomological advice may enter into it is a cause for concern.

Thus, in the spring of 1974 a meeting of virologists and public health administrators informed the Commonwealth Health Department that more cases of Murray Valley encephalitis might occur in the following summer. The meeting considered a chemical firm's submission on mosquito control measures and recommended that the Department seek the advice of a group of medical entomologists. However none of these was consulted before the decision was made to spend hundreds of thousands of dollars on aerial and ground applications of Abate to control *Cx. annulirostris* in the Murray Valley; the group was eventually formed at the end of the summer.

Again, after a demonstration in 1968 of Dibrom-ULV* spraying against *Ae. vigilax*, the manufacturer accepted entomologists' advice that applications should be timed to occur when the bulk of newly emerged adults were still in the breeding area, and that this required investigation. The company funded a two-year scholarship in the University of Queensland which supported Kerridge's research during 1969-71. However, spraying did not wait on research, for Brisbane City Council undertook Dibrom-ULV aerial applications in the summers from 1969-70 until 1973-74.

Nearby, on the Gold Coast, aerial applications of Abate-sand granule formulations were found by Kay *et al.* (1973) to have many advantages over ULV spraying for control of salt-marsh mosquitoes and in 1973 an Expert Committee on Mosquito Control appointed by the Entomological Society of Queensland recommended this as the most suitable currently available means of controlling *Ae. vigilax*. The Committee then encountered the problem of informing the interested public, for the daily press considered that its reasoned statement was not newsworthy. The Brisbane City Council commenced Abate applications in the 1974-75 summer. The *News Bulletin* of the Entomological Society of Queensland provided a valuable medium for recording the debate by entomologists on aerial application of insecticides to coastal wetlands.

In engineering works, it is noteworthy that an entomologist and a health surveyor, both with considerable experience, were included in the team assembled in 1972 to

*Ultra-Low-Volume.*
furnish an environmental study of Brisbane's new airport development. This contrasted with the situation at Gladstone, where bunding of tidal flats north of the city for a State Department in 1973 led to excessive breeding by *Culex sitiens* Wiedemann in impounded brackish water polluted by leaves from dying mangroves. An entomologist saw this problem only after it had developed and, curiously, did likewise with a precisely similar problem on the south side of Gladstone in 1975, showing that engineers may fail to communicate not merely with entomologists but with one another.

These events collectively make a rather sorry story which is worth the attention of both entomologists and administrators.

**Conclusion**

This address has been concerned with communication at two levels: the advancement of knowledge by exchange of information and ideas between scientists; and the promotion of scientific endeavour through the activities of societies, institutions and governments.

At the first level, I have laid stress on the influences affecting the young scientist, particularly the interest and encouragement of his seniors in direct personal discussions and through society activities. Direct communication between entomologists has generally been good, and this has been especially true of insect taxonomists, who have built their communications on a long tradition of correspondence and exchange with local and overseas colleagues. On the other hand, interdisciplinary communication, as, for example, between entomologists and virologists, has been more difficult to achieve, unless it has been aided by the establishment of mixed teams or by regular meetings in symposia or seminars. The response to a recent suggestion of an Australian mosquito news-sheet indicates the eagerness of scientists to bridge this gap. Publication, the final stage at this level, inevitably lags behind personal contacts, but it reaches a far wider audience and is often indispensable for further progress in the field it covers. I have given enough examples to show that too often it lags so far behind that later work is retarded rather than facilitated. This is a problem that merits the attention of all students of insects.

The scientific societies lie between the two levels, for they have responsibilities, on the one hand, for disseminating scientific knowledge and, on the other, for promoting scientific endeavour and combatting influences that may retard it.

Of the second level, it may be said that relationships between societies have almost always been good, and that they attained an unprecedented level of common fellowship under the threat to scientific freedom posed by Customs Regulation 13A, which was also marked by what was probably the most complete breakdown in communication that has ever occurred in Australian science. Relations between departments and instrumentalities of different governments have not been so close, but could readily be improved by encouraging the principle of communication between "opposite numbers" so usefully employed by the Australian army during the 1939-45 war (p. 354), provided always that the opposite numbers are aware not only of each other's existence but of each other's needs. Finally, as again exemplified by Customs Regulation 13A, the pathway from scientists and their societies to government may be blocked by vested interests, and we must look, with hope, to the Australian Academy of Science to break that barrier down.

We have learned a lot about communication in the last ten years; it is now our duty to use that knowledge to the best advantage of entomological science and its application to human welfare. Let us go forward in a common fellowship of endeavour.

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