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IN RETROSPECT: THE INSECTS AND THE ENTOMOLOGISTS

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Abstract

The insect fauna of Queensland is traced from three sources: the old Mesozoic inhabitants isolated after Australia broke from Antarctica; the elements that swept in from the north when the continent met the Indonesian-Pacific island-arc system in late Tertiary; and the insects that have arrived since 1770. The entomologists are also treated in three series: explorers, including Banks, Cunningham; pioneers, including Diggles, Illidge, J. Bancroft, Tryon, Pound, T. Bancroft, Johnston; and later teachers, naturalists, collectors and taxonomists, including Perkins, the Barnards, Dodd, Turner, Franzen, Hacker, Girault, Hardy. The societies that brought them together are noted.

THE INSECTS

Some two years ago, one of us (Marks 1972) asked the question: Who bit *Euryzygoma*, a giant Queensland marsupial of Pliocene times? The answer was illuminating, so we are tempted to approach the general insect fauna in the same way, using the reconstruction of Dietz and Holden (1970) as our palaeogeographical background. Other palaeogeographers (e.g. Veevers, Jones and Talent 1971) have made somewhat different reconstructions and different estimates of chronology, but these do not materially affect the present discussion. Moreover, it will be sufficient for our purposes to begin with the Cretaceous from 130 to 65 million years ago. So far as possible, we will confine our enquiry to Queensland.

Cretaceous

Australia was firmly united to Antarctica and central Queensland lay in about 50° S latitude. There was no ice at the pole, climatic zones were diffused, both geographically and seasonally, and the mild climate of Antarctica is attested by the Jurassic and mid Tertiary floras listed by Plumstead (1962). Queensland was extensively covered by epicontinental seas, later becoming lakes, the climate was warm, angiosperms were developing, and swampy and lacustrine vegetation was abundant.

All the principal orders of insects had evolved by the time Pangaea began to break up in the Triassic about 200 million years ago. All could have been present in Queensland, and the fossils obtained from beds of that age near Ipswich prove that many of them were. Within the orders, however, Queensland could have had only those sections that had evolved in, or spread to, the more southern of the supercontinents (Gondwana) and especially those that developed in the longest-persisting zone of contact provided by Chile-Patagonia, Antarctica and Australia-New Zealand. By the end of the Cretaceous they included many families and a substantial number of genera and subgenera that have survived—an abundant but slowly diversifying fauna which was decidedly lopsided in comparison with what we find in the same area today. Thus, there was a variety of cockroaches, but possibly *Mastotermes* alone among the termites; a few stoneflies, Orthoptera and lacewings dating back to the Triassic; many Carabidae, but few other families of beetles; mosquitoes and March flies, but comparatively few robber flies and possibly no blowflies; numerous caddisflies and some moths, but few or no butterflies; and so on.

A more comprehensive faunal list could be built up from the fossil evidence and a critical study of the faunal elements in all the orders, but enough has been said to indicate the kinds of insects a student would have encountered if he had been free to wander through Queensland seventy million years ago.

Tertiary-Pleistocene

Australia broke from Antarctica and drifted rapidly north to run aground on the island arc-trench system that extended from south-east Asia into the Pacific. Estimates of the timing of these events have varied, earlier authors generally dating the break with Antarctica at about 60 to 70 million years ago and recent ones (e.g. Veevers 1971) at about 45 to 50 million years; the impact with the island arcs appears to have

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occurred between 10 and 20 million years ago. In any case, the important point is that Australia was completely isolated from other regions for something between 30 and 50 million years.

For the first two-thirds of the Tertiary, Australia was a country of low relief, with a diffusely zoned equable climate which became progressively warmer as the continent moved north. Queensland appears to have had a warm temperate to subtropical climate, with a generally better distributed rainfall than it has today (refs. in Marks 1972). Angiosperms and marsupials were radiating extensively, but for the insects it was a period of evolutionary quiet (Mackerras 1960). In fact, there is evidence to suggest that many of the older insect inhabitants of Australia have changed remarkably little over the past 80 million years.

The last 20 million years or so brought three important changes: the development of strongly zoned climates; mountain building; and the entry of a new flora and fauna from the north.

Queensland became progressively more tropical, not only by simple latitudinal effects, but, even more, by intensification of global patterns of atmospheric circulation. Climatic zonation became more marked, with wetter tropics separated by belts of relative aridity from more equable climates in higher latitudes, and the contrasts became stronger when polar ice caps of sufficient size compressed these belts towards the climatic equator. This was a fluctuating cyclical process, probably beginning before the end of the Cretaceous, with the fluctuations gradually increasing in frequency and amplitude until they culminated in the alternating glacial and interglacial phases of the Pleistocene epoch in the last couple of million years. Willett's (1953) estimate that we are now about three-quarters of the way between a glacial and an interglacial phase provides a base-line from which we can form a notion of what those past climates were like.

The old Queensland fauna clearly came under considerable stress, and there were only three things it could do: it could die; it could adapt; or it could find refugia.

There is abundant evidence of extinction in the marsupials, but almost none in the insects, although the Cretaceous dragonfly family Aeschnidiidae and some other Mesozoic groups did disappear. Adaptation *in situ* certainly occurred, both to temperature and to aridity, and in both directions it seems to have been achieved mainly by adjustments in the life history and the use of diapause, although other mechanisms have operated in some groups (Norris 1970). However, except for a few genera of cockroaches, it does not seem to have been a major factor in survival of the older faunal element in Queensland. Concentration in more temperate refugia was much more important, and it was aided, at the most critical time, by the progressive uplift of the eastern ranges in the last few million years. It is here that the older inhabitants have survived and thrived, and from here that a clear trickle of species can be traced to the warmer coast, the drier inland, and north into New Guinea. Even now, after all the vicissitudes through which it has passed, this element still contains representatives of almost all the surviving orders of insects.

To return to the problem of aridity, it is necessary to emphasise that the time available for adaptation to extremes has not been long. Jessup and Norris (1971) have put the position succinctly in relation to the Lake Eyre basin: "Throughout the Caenozoic there was an alternation of relatively humid and dry periods, but true aridity and internal drainage did not appear until the Quaternary." It is to seasonal rainfall of low reliability that inland insects have been exposed for long periods, and to which they have become adapted in the ways indicated above. This, no doubt, prepared some of them to respond to true aridity when it developed.

With the old inhabitants and their living conditions so disposed of, we may turn to the second major element in the Queensland fauna. Actually, there were two, an older Eastern Gondwana element and a younger Oriental element, but they can be considered together. The pathway of dispersal was provided by the complex series of island arc-trench systems between south-east Asia and the Pacific, where the Australian plate was being consumed as the continent moved north. There is distributional evidence that this route was operative into the Pacific before Australia came under its influence. Continental crust is too light to be consumed, so, when Australia and southern New Guinea arrived at the trench, they piled up like a ship on a reef, and the high mountains of New Guinea are the result.

It is important to appreciate that, if modern concepts of plate tectonics are correct, Australia cannot have received any floral or faunal contributions from Asia (except by air or sea) between, roughly, 200 and 20 million years ago. If follows, too, that the whole of the local evolution of northern-element insects, including differentiation of endemic genera and families, must have taken place within, at most, the past 20 million years.

This wave of immigration brought an array of plants, of which the tropical rain forest was the most conspicuous, nearly all our eutherian mammals and birds, and most of our reptiles, but only a few frogs. Filtration was marked, as shown by the fact that the rain forest left most of its characteristic fauna behind (Harrison 1962). Almost all orders of insects are represented, even including Zoraptera, which occur in New Guinea though they have not yet been found in Queensland. Within the orders, there are some generalized groups, but mostly the younger, higher divisions of the various orders and families. Thus, in the Diptera these include many mosquitoes, the genus *Tabanus*, most of our asilids and nearly all our Cyclorrhapha, and in the Lepidoptera all our higher families of moths and butterflies. Latest in the series, during the Pleistocene, came man, the dingo, and a significant faunal exchange between Australia and New Guinea, where many of the insects had been isolated for long enough to develop a distinctively Papuan facies. *Anopheles farauti* Laveran, the principal vector of malaria in Australia, was one of these.

This element was already adapted to life in a hot to warm climate. It radiated widely in Australia, and some of its members, notably the acridoid grasshoppers, proved to be as adaptable to semi-arid conditions as any of the older inhabitants. There is no evidence from the insects that the newcomers have competed directly with the older inhabitants. Rather it seems that each element has thrived in the environment to which it is best adapted, and that when their distributions overlap they live together without difficulty. The following figures, from groups with which we are familiar, give a fair indication of the way the Queensland fauna is made up.

Group	Origin	Proportion of Australian species in Queensland
Culicidae	Predominantly northern	78%
Tabanidae	Predominantly southern	50%

The findings for some smaller groups are similar.

Tabanini	Northern	78%
Scionini	Southern	47%
Nemestrinidae	Predominantly southern	52%
Pelecorhynchidae	Southern (cool temperate)	10%

Recent introductions

We may complete the picture, and introduce some of the later contributions, by mentioning a few of the insects that became established in Queensland after 1770. *Culex fatigans* Wiedemann, the vector of filariasis, may have arrived in Sydney with the First Fleet, and in Queensland—along with domestic cockroaches, bed bugs, human lice and houseflies—when the convict settlement was established in Moreton Bay; *Aedes aegypti* (L.) was later, and had not reached its full distribution, even in southern Queensland, at the time of the 1905 epidemic of dengue fever; the cattle tick, *Boophilus microplus* (Canestrini), crossed the Northern Territory border in 1890, but the buffalo fly, *Haematobia exigua* (De Meijere), not until 1928 (Seddon 1951a,b); and the sheep blowfly, *Lucilia cuprina* (Weidemann), spread from New South Wales about 70 years ago. Collectively, these and other introduced pests of agriculture, horticulture, stored products, and so on have promoted as much research as the whole of the native insect fauna.

THE ENTOMOLOGISTS

The history of Australian entomology was divided into four periods by Mack-

erras (1949), but we propose to use three rather broader divisions here. The following dates will provide a topical background for the story.

1770. East coast of Queensland discovered by James Cook.
1824. Moreton Bay penal settlement established.
1842. The settlement opened to free settlers.
1859. Colony of Queensland proclaimed.
1859. Queensland Philosophical Society founded.
1862. Queensland Museum established.
1883. Royal Society of Queensland founded.
1892. Natural History Society of Queensland founded.
1906. Queensland Naturalists' Club founded.
1911. University of Queensland established.
1923. Entomological Society of Queensland founded.
1971. Museum Society of Queensland founded.

We will be concerned mainly, though not exclusively, with the collectors, naturalists and taxonomists who have laid the foundation of a biological survey of Queensland and who are not covered elsewhere in the Symposium. Space will not permit more than passing reference to collectors from abroad, such as Amalie Dietrich and E. Dämel in 1852-75, or to workers from elsewhere in Australia, such as G. Masters, R. J. Tillyard and G. A. Waterhouse, all of whom contributed substantially to our knowledge of Queensland insects.

The explorers

Joseph Banks, D. C. Solander and Sydney Parkinson landed at Bustard Bay, Thirsty Sound and Endeavour River between May and July 1770. They made observations on green tree ants (*Oecophylla smaragdina* (Fabricius)), ant-plants (*Myrmecodia*) and butterfly swarms (probably of *Euploea core corinna* Macleay), and the insects they collected were described by Fabricius in 1775.

Allan Cunningham travelled with Oxley in 1817 and with P. G. King on his coastal survey from 1818 to 1822. He collected insects as well as plants, those from King's survey being described by W. S. Macleay in 1826. It is possible that insects were also collected in Queensland by the Leichhardt and Kennedy expeditions, but all their specimens were lost.

SILVESTER DIGGLES

ROWLAND ILLIDGE

The pioneers

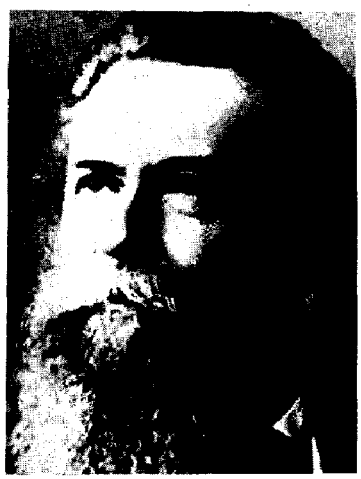
Silvester Diggles (1817-1880), a gifted amateur, first of the field naturalists, came to Brisbane in 1854, and helped to found the Queensland Museum, of which he was unofficial curator for several years. He collected insects extensively, especially Lepidoptera and Coleoptera, and sent many of them to Francis Walker at the British Museum. He also bred out many species of both orders and illustrated their life histories and food plants in unpublished notebooks (Marks 1963).

Three other early naturalists were R. Illidge (1846-1929) who came under the

influence of Diggles as a youth, W. H. Miskin (1842-1913) who arrived in Brisbane in 1866, and T. P. Lucas (1843-1917) who settled in Brisbane in about 1884. Illidge was a notable collector and student of life histories, who was a generous teacher of aspiring entomologists and wrote many papers on natural history. His butterflies went via Lucas to the South Australian Museum and his beetles to the Department of Entomology in the University. Miskin and Lucas were lepidopterists who published numerous taxonomic papers between 1874 and 1902, including description of the huge Atlas moth, *Coscinocera hercules* (Miskin), by Miskin. Miskin's collection was purchased by the Queensland Museum and Lucas' by the South Australian Museum.

Joseph Bancroft (1836-1894), eminent in medical research, has two claims for inclusion here. He founded medical entomology in 1877, when he discovered that microfilarial worms from a patient survived in the stomach of mosquitoes; and he founded agricultural entomology in Queensland in 1876, when he reported on the mite and scale-insect pests of sugar cane to the Board appointed by the government "to Enquire into the Causes of Diseases Affecting Live Stock and Plants" (Mackerras and Marks 1973). He was later Chairman of the Board, which existed until 1882 and was the forerunner of the Department of Agriculture and Stock, now Department of Primary Industries.

HENRY TRYON



JOSEPH BANCROFT

Henry Tryon (1856-1943) was Queensland's first professional entomologist. He was Assistant Curator of the Museum from 1883, appointed Government Entomologist in 1894, Vegetable Pathologist in 1901, and he presided over practically all major developments in economic entomology and plant pathology in Queensland until his retirement in 1925. He had a brilliant brain, a sarcastic tongue and a cantankerous nature, but he was also an erudite and versatile scientist (Marks 1960). Subsequent developments in economic entomology, and the crucial part that Robert Veitch (1890-1972) played in them, will be described in the paper by Passlow.

C. J. Pound (1866-1946) pioneered veterinary entomology in Queensland when he was appointed Government Bacteriologist in 1893 and began work on tick fevers in north Queensland. In 1910 he was transferred to the recently established Stock Institute at Yeerongpilly, which was the forerunner of the present Animal Research Institute; he retired in 1932. Pound's old laboratory was occupied by C.S.I.R.O. workers from 1945 to 1969 and then returned to the Institute, so it has had a long association with cattle-tick and tick-fever research.

T. L. Bancroft (1860-1933), like his father, merits inclusion on two grounds. On the one hand, his demonstration in 1898 that the filarial larvae completed their development to the infective stage in *Culex fatigans* and his incrimination of *Aedes aegypti* as the probable vector of dengue fever in 1905 complemented overseas work on malaria and yellow fever to confirm the status of medical entomology as a major discipline. On the other hand, his devotion to natural history, which he greatly preferred to medical practice, made him an outstanding field naturalist and collector. He collected a vast number of insects, mostly Diptera and especially mosquitoes

and fruit flies, for the British Museum and Australian specialists, and published a descriptive catalogue of the mosquitoes of Queensland with his own biological notes.

T. Harvey Johnston (1881-1951) was appointed head of the Department of Biology in the University in 1911, and so could be regarded as the founder of academic entomology in Queensland. Actually, he was forced by the financial climate of the time to develop most of the entomological research in his department with an economic flavour. He and Henry Tryon were a Commission of Enquiry into prickly pear, with ultimate results of outstanding value to the State, and he was a member of the first Committee of Enquiry into cattle tick. He had a Walter and Eliza Hall Fellowship in Economic Biology at his disposal, and three of his Fellows did important work: Josephine Bancroft from 1918 to 1920 on cattle tick, potential vectors of bovine onchocerciasis and the transmission of equine habronemiasis; G. H. Hardy from 1922 to 1934 on the biology of blowflies (one of his little known activities was to breed "sterile" maggots for use in surgery); and O. W. Tiegs (1897-1956), who alone undertook basic research that initiated his distinguished later work on the embryology and evolution of terrestrial arthropods. The first two will appear again in the next section.

Those who folowed

Thus the stage was set for further developments, most of which have occurred in the lifetime of the Entomological Society of Queensland. Medical, veterinary and general economic entomology will be covered in other papers, so we may complete the story of the University at this point.

F. A. Perkins joined the University in 1922 as a Research Fellow working on fruit flies, and was appointed Lecturer in Entomology in 1926 and head of the Department of Entomology in 1952; he retired in 1965. The founding of a school is an event of critical importance, and this one was due initially to the efforts of Johnston's successor, E. J. Goddard (1883-1948), a man of vigorous personality, known to some as "the professor of political zoology", who was also largely responsible for founding the Faculties of Agriculture, Medicine and Veterinary Science. Perkins taught enthusiastically, on a solid systematic basis, about insects in the field, how they lived and what they did. The research atmosphere swung from veterinary to agricultural entomology. Perkins worked on taxonomy of fruit flies (since studied by A. W. S. May and R. Drew) and later on stoneflies, and he encouraged the taxonomic interests of those who joined his staff. Thus, T. E. Woodward has made the Hemiptera a major field of departmental research, Elizabeth Exley is working on native bees, and G. B. Monteith has built the departmental collection into a first-class entomological museum. Perkins' successors have built on what he created–and they have maintained, too, the close association he developed with the Entomological Society of Queensland. A bibliography of the numerous publications from the Department might be an appropriate way to mark its jubilee in 1976.

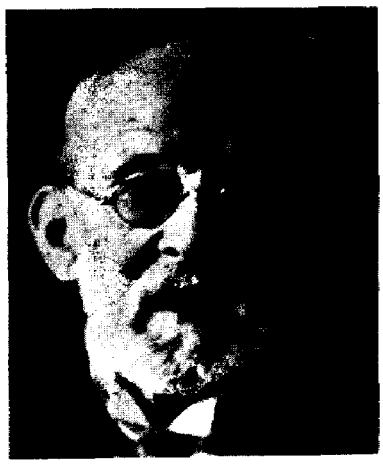
Elsewhere in the University, W. B. Mather has investigated the cytotaxonomy of Australasian species of *Drosophila* in the Department of Zoology, and D. M. Spratt elucidated the life cycle of *Dirofilaria roemeri* in kangaroos and tabanid flies in the Department of Parasitology, where other entomological research is also being developed.

Returning to the naturalists and taxonomists, there are many, both amateur and professional, from whom to choose examples. Among the amateurs, we may begin with George Barnard (1830-1894) and his son, W. B. Barnard (1870-1940), graziers who lived in central Queensland. They amassed a remarkable collection of moths, butterflies and beetles, with paintings by Mrs. G. Barnard of the insects, their larvae and food plants. After their deaths, the older collection went to the British Museum and W. B. Barnard's to the Queensland Museum.

F. P. Dodd (1861-1937) was another who built up a famous collection, which he exhibited at his home in Kuranda. He collected Lepidoptera, Coleoptera, Diptera and Hymenoptera in north Queensland and New Guinea, bred out many species, and published notes on their habits. He made material available to several authors and the type specimens are now in various Australian museums. His son, A. P. Dodd, became a distinguished professional in noxious weeds control and also

published important papers on the taxonomy of proctotrupoid and chalcidoid wasps.

A. Jefferis Turner (1861-1947) was as distinguished a pediatrician as an entomologist (Mackerras 1949). Though apparently frail and shy, he was an assiduous collector of moths (and of other insects for his colleagues), published 121 entomological papers between 1894 and 1947, described about 3,500 new species, and proposed more than 450 new genera and four new families of Lepidoptera; he also reviewed the higher classification of the order. His collection of more than 50,000 specimens is in the Australian National Insect Collection, Canberra.



ALFRED JEFFERIS TURNER

A. Eland Shaw (1861-1931), also a medical practitioner, published a series of important papers on Australian cockroaches between 1914 and 1925, including new genera and a considerable number of new species. He does not seem to have been interested in other insects. His collection is in the Queensland Museum.

Ludvig Franzen (1878-1945) came to Queensland in 1898. Like others, he collected butterflies, but he merits inclusion here because his main interest lay in other orders, particularly homopterous bugs and Neuroptera and their life histories, on which he published notes in *The Queensland Naturalist*, where Esben-Petersen also published descriptions of the Neuroptera, filling a significant gap in knowledge of Queensland insects.

Among those who have built up notable collections in more recent years are J. Macqueen and Jean Harslett (Lepidoptera) and J. G. Brooks (Coleoptera), while knowledge of the insects of Cape York Peninsula was greatly increased by the collections of J. L. Wassell (1908-1966) (Marks 1968).

The first of our group of professionals is Henry Hacker (1876-1973) entomologist in the Queensland Museum 1911-29 and in the Department of Agriculture and Stock, but working partly at the Museum, from 1929 to 1943. He was a magnificent collector, with a great knowledge of the habits and biology of Queensland insects, and a skilled insect photographer. He wrote mainly on native bees and bugs.

A. A. Girault (1884-1941) was Entomologist, Bureau of Sugar Experiment Stations 1911-14 and Assistant Entomologist, Department of Agriculture and Stock, 1918-19 and 1923-34. A strange eccentric character (Townes 1973), he described over 3,000 Australian species of parasitic wasps and thrips. Many of his types are in the Queensland Museum to which numerous entomologists have come seeking to solve the puzzles he created.

HENRY HACKER

G. H. Hardy (1882-1966), a man of striking saturnine appearance, quaint speech and rather puckish humour, was, in his day, the doyen of Australian dipterists. He spent two periods in Queensland, as Hall Fellow from 1922 to 1934 plus an interlude of 18 months at Goondiwindi, and from 1941 to 1948 as scientific assistant to E. J. Goddard (Chadwick 1966). He was a keen observer and prolific writer, and he published 173 papers on Australian insects between 1914 and 1967, nearly all of them on Diptera Brachycera. His taxonomy has been considered old-fashioned, but he laid very useful foundations on which others have built.

Finally, to come almost up to date, Josephine Mackerras (1896-1971), daughter of T. L. Bancroft, and F. H. S. Roberts (1901-1972) were two of Australia's most

distinguished parasitologists, war-time associates, and friends for many years. Both did valuable work in medical and veterinary entomology which will be covered in the paper by Wharton, but both were also taxonomists, and Josephine was almost as enthusiastic a collector as her father. She worked on muscoid flies, blackflies (Simuliidae) and, in her later years, extensively on cockroaches. Roberts revised the Australian Bombyliidae (Diptera) in 1928-29, but his taxonomic life-work was on ticks, culminating in his comprehensive *Australian Ticks* published by CSIRO in 1970.

We have written of individual entomologists: what opportunities did they have to meet together? The story is outlined on p. 72.

Diggles and J. Bancroft played leading roles in the Queensland Philosophical Society, as did Bancroft in its successor, the Royal Society of Queensland, of which Tryon, an inveterate initiator of societies, was the first Secretary and Miskin, Lucas, Illidge, Pound and Turner among the early members who published in its Proceedings. Tryon instigated a Natural History Section of the Royal Society, but its activities were botanical. He was also the first President of the ephemeral Natural History Society of Queensland and was followed in that office by Lucas, Illidge and Turner. Half the papers read to this society were entomological and as many as ten enthusiastic members exhibited insects at one meeting. Tryon was again active in founding the Queensland Naturalists' Club, of which Illidge, Turner, Pound, T. Bancroft, Lucas, Franzen and Harvey Johnston were early members. Though it catered for entomologists, this Club's interests were much more varied than those of its predecessor. Lastly, in 1923, G. H. Hardy stimulated the growing number of professional and amateur entomologists in Brisbane to found the Entomological Society of Queensland, with E. J. Goddard as President, J. L. Froggatt Secretary, and Hardy, Treasurer. Illidge and Turner were foundation members, but Tryon believed it would fail and never joined it; today it celebrates its fiftieth anniversary.

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