

## IMPROVING ACCESS TO MUSEUM SERVICES IN QUEENSLAND

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For more than 20 years, the State-supported Queensland Museum has recognized its obligation to improve state-wide access to its services. It has decentralised its facilities, collections and expertise through development of branches. This will continue to expand through a range of outreach activities that includes direct and extension education services, specimen and kit loans, travelling exhibitions, and support for local museums including staff training, attachment of professional staff and administration of a project funding grants scheme.

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Queensland is the second largest Australian state, with an area of 1.7 million km<sup>2</sup>. Its population of more than two million people is broadly decentralised but is generally concentrated along the eastern coastline and along three, major inland rail and road accesses running from the State capital, Brisbane and from Rockhampton and Townsville. More than 47% of Queensland's population lives in Brisbane and environs. Fifteen other centres have populations about 10,000 or more. Brisbane, in the southeast corner, is 1750 km from Cairns in the north and over 2000 km from Camooweal in the northwest, but less than 100 km from the well populated Northern Rivers district of New South Wales.

Museum services in Queensland are provided through a variety of publicly and privately operated institutions. The largest of these, the Queensland Museum, was established in 1862. It covered natural sciences until 1970, when it was given the mandate to include the pure and applied sciences, history and technology. Operation of the Queensland Museum is defined by the *Queensland Museum Act 1970-1989* and *Queensland Museum By-laws 1986* and is largely financed from state revenue.

The Queensland Museum was redeveloped in an 18,000 m<sup>2</sup> Queensland Cultural Centre building which opened to the public in October, 1986. The Centre also includes the Queensland Art Gallery, the State Library of Queensland and the Queensland Performing Arts Trust as semi-autonomous statutory authorities and each is governed by specific legislation. The Centre is vested in The Queensland Cultural Centre Trust, which has responsibility for building maintenance, operation of common facilities and

provision of common services. Directors of constituent institutions form a majority of the Cultural Centre Trust. Each member body has State-wide obligations which each addresses differently.

This paper defines the Queensland Museum's approaches to provision of services and support away from its main facilities in Brisbane. This approach includes the following strategies:

- . developing Branch museums
- . improving community access
- . promoting outreach projects through
  - .. direct education
  - .. travelling exhibitions
  - .. loan services
- . supporting local museums
- . providing training for regional personnel
- . appointing professional staff for local museums

### DEVELOPING BRANCH MUSEUMS

The Museum's Act includes:

"25. Branches. (1) The Board either alone or by agreement and in conjunction with any other person or body may establish, maintain and control branches of the Museum within Queensland.

(2) An agreement between the Board and any other person or body shall not be entered into for the purposes of this section unless the Governor in Council has first approved of the terms of the proposed agreement."

This provision is an effective tool in establishing permanent bases away from the main Museum.



FIG. 1. "Woodworks" Branch, Gympie, the main reception and display building.

Planning, in 1970, for the Bicentennial celebrations to commemorate the discovery of the east coast of Australia by Captain James Cook included the suggestion that a display train might be developed to tour the State.

A display train had been used in connection with the 150 year celebrations of Queensland's Statchood in 1959 and a similar suggestion for 1970 was a serious suggestion for the program. Unfortunately, a fully costed analysis showed that the tour would not be cost effective in a State as decentralised as Queensland, especially when hire and conversion of carriages, charges for use of locomotives, salaries and travelling allowances for accompanying teaching/maintenance staff and display design and construction costs were taken into account. It was intended to stop at centres with a population of 1,000 or more for a few days in each. It would have taken more than a year to travel once over major State rail routes. Facilities at railway stations were frequently inadequate to serve the needs of the exhibition or of large numbers of visitors.

Expenditure on such an enterprise, if adopted as a permanent feature of decentralised Museum services after the Cook Bicentennial year, would have been about the same as for a later alternative suggestion for permanent display and other facilities to be developed in regional centres every three or four years. Given some centralised

support, it was expected that such facilities would generate income to offset most maintenance and running costs. This proposal did not eventuate and further consideration of regional museum facilities did not occur until well into the 1970s.

The Board of Trustees, established by the Act in 1970, considered that Branches should be either general or specialised thematic facilities. Such classification blurred as the number of Branches increased and has been abandoned.

The Board recognised the importance of the inland rail and road routes emanating from Brisbane, Rockhampton and Townsville and the major national and international tourist destination centred on Cairns. Accordingly, the Board set out to convince the Government of the advantages of expanding services to regional Queensland by improving the situation of the main museum in Brisbane and by progressive development of Branches in Rockhampton, Townsville and Cairns. Proposals for Rockhampton and Townsville each included exhibition, education, collection storage and research facilities, while that for Cairns centred on display and educational aspects.

The established Tertiary educational institutions in Townsville and Rockhampton influenced these proposals. Universities and the then Colleges of Advanced Education not only

create the collections that might form the basis for continuing regional research projects and attendant storage requirements but would obviate the establishment of expensive libraries and laboratories. They would also provide the opportunity for academic interchange to satisfy the professional development needs of branch staff.

#### "WOODWORKS" BRANCH, GYMPIE (Fig. 1)

In the early 1980's the Forestry Department sought the Museum's assistance to establish a permanent display of Forestry activities and the timber industry that incorporated varied uses of timber and timber products. The Branch was established 3 km north of Gympie, 166 km from Brisbane, on the northern coastal highway.

The Branch was established on the basis of an agreement and administrative arrangements that shared responsibility for the facility. The Forestry Department provided the land, the building, including the landscaping and the staff, initially attached personnel and later permanent Manager, administrative assistant and other support staff. The Queensland Museum incorporated and maintained the Forestry collection, produced the displays and audiovisuals, provided a legislative base, gave access to the Museum's Trust Fund to accommodate income, grant and sponsorship monies and appointed additional temporary staff.

The Branch was opened in March, 1984, with the name, "WoodWorks", chosen through a schools' competition to define an appropriate title. It has been expanded subsequently by the addition of a blacksmith's shop and a functional steam sawmill and now comprises 1000m<sup>2</sup> of public display space. Further expansion is planned to include an administrative and sales area, a woodturner/cabinetmaker shop, an extension to the area devoted to transport of timber and a storage building.

The Board established a Management Committee to be responsible to the Board in the first instance and Forestry for day to day running of the Branch and for policy, planning, support funding, exhibits and programs, to the extent of delegations defined by the Board. Committee membership reflects community (especially Local Government), Forestry and Museum interests.

A feature of the public program at "WoodWorks" has been the demonstrations on aspects of the timber industry. Retired timber workers

living in Gympie operate a variety of hand tools and other equipment, including the steam driven sawmill, for organised groups and on special occasions. A more extensive range of Forestry skills is demonstrated on "open" days and such days have attracted more than 8,000 visitors. Branch visitor numbers (excluding open days) totalled 12,677 in 1989/90. A minimal entrance fee is levied and income received is applied to the Branch programs. Entrance on the first Monday each month is free to all visitors.

#### MUSEUM OF TROPICAL QUEENSLAND, TOWNSVILLE

Developed in Townsville, this second Branch was initially the North Queensland Branch. A community group entitled the Great Barrier Reef Wonderland Association Inc. had proposed the creation of a major joint project involving Government at State and Commonwealth levels and private enterprise to develop an important tourist and public educational facility in Townsville. This development, initially to include a world-quality aquarium, an Omnimax theatre and commercial shop and office tenancies, was expanded at the suggestion of the Association to invite the Queensland Museum to include a Branch. Total funding of \$6M for the non-commercial elements was provided jointly by the Commonwealth and State Governments as part of Australia's 1988 Bicentennial celebrations.

The Queensland Museum Board commissioned a feasibility study through a Cairns-based consultancy group to ascertain the most appropriate location for the Museum's initial northern Branch; this study recommended Townsville. Not only was Townsville the largest population centre with a more diversified commercial base, but it also contained the James Cook University of North Queensland, the headquarters of the Great Barrier Reef Marine Park Authority and had the Australian Institute for Marine Sciences in close proximity.

The Great Barrier Reef Wonderland Association offered \$1M towards the Branch establishment costs. This did not cover the total proposed building, and a two stage development was suggested to the Queensland Government, the first to be built and opened with the rest of the Great Barrier Reef Wonderland and the second stage, of approximately the same size, to be completed in the mid-1990's. The GBRW Committee raised an additional \$1M from local industry and the public. This was directed



FIG. 2. "Museum of Tropical Queensland" Branch, Townsville, facade of the building from Flinders Street, showing the reconstruction of *Muttaburrasaurus*.

towards completion of the exhibitions in the Aquarium. A shortfall of \$124,000 in the fitout budget for the initial Branch component was met by the State Department of Works which, in addition, contributed expert advice on design and construction.

Because of the complexity of the relationships involved in the Wonderland, the Board insisted on control over title for the land upon which the Branch had been built. This was excised from the overall parcel of land used for the total development, property which was controlled by the Townsville Harbour Board, later the Townsville Port Authority. It was then vested in the Museum Board as Trustees for a new Reserve for Museum Purposes. The site is close to the commercial centre of the city on the bank of Ross Creek. It is also close to the Breakwater Casino and ferry terminals for access to Magnetic Island and Barrier Reef cruises.

The Board believed that the Branch should firstly serve the local population and that in achieving that end it would also serve tourists to the region. The latter were seen as critical in providing income to cover operating expenses. Initial exhibitions were a mixture of traditional systematic zoological, geological, anthropological and applied arts subjects, together with an

ecological display of the Townsville Common and another on North Queensland rainforest. Also present was an audiovisually-based presentation on historic shipwrecks in the vicinity and display of the ship's tank in which the final chapter of the tragic Mrs Watson story was enacted in the late 1800's, after her escape from an Aboriginal attack on Lizard Island.

Stage one included 880 m<sup>2</sup>, approximately half of which was devoted to collection storage, research and other staff facilities. All exhibitions were designed and produced in Brisbane, although the Branch now produces small, temporary exhibitions of local interest and others that supplement school holiday programs. Visitor numbers have grown steadily to 60,000 in 1989/90. A modest entry fee was introduced at the time of opening and, to encourage repeated use of the Branch by local residents, entrance to the facilities on the first Monday each month is free.

At its opening in June, 1987, the building was staffed by a Curator, a Curatorial Officer, an Administrative Assistant and three Museum Attendants. This staff establishment was later supplemented by temporary appointments of Board officers, as opposed to Public Servants, and there has been wide community support through ap-

pointment of honorary staff, broadening the expertise available. Further staffing has come from research and other grants and through secondments, especially from the Queensland Department of Education.

A Management Committee was established by the Board and given delegated authority for the day to day operations of the Branch. This Committee has representation of the local business and academic community and of the Museum. The Committee has successfully introduced in-house and extension educational services and gained access to funds through local foundations and businesses. It has developed the brief for the second stage of the Branch and promoted accountability for the operation through Corporate Planning and associated performance indicators. The Branch has attracted an extremely significant collection of modern corals from assembled by AIMS as the basis for its reference collections and has growing marine invertebrate and vertebrate spirit collections. The staff, both permanent and honorary are publishing significant research results.

The display space had been designed to enable rotation of displays from the main Museum to Branches with a minimum of modification. One of the most popular exhibitions in Brisbane, on dinosaurs, marine reptiles and other fossils from marine Cretaceous rocks inland from Townsville was transferred to the Branch in 1989. A model of the Queensland dinosaur, *Muttaborrasaurus*, was erected in the garden at the branch (Fig. 2). A joint ticketing arrangement with the Aquarium and Omnimax components of the Wonderland is part of a centralised marketing strategy for the whole complex; the attraction is promoted widely both locally and interstate by the central agency and by member bodies.

#### COBB AND CO. BRANCH, TOOWOOMBA (Fig. 3)

Following the death of Mr. W.R.F. Bolton, the owner of the transport company Cobb and Co., his family was attempting to place his major collection of horse-drawn vehicles and associated items, including two original Cobb and Co. coaches, with an organisation that would maintain them in perpetuity. Following protracted negotiations, during which time ownership of the collection was transferred to another family owner, Banks Pty. Ltd., the Cobb and Co. collection was donated to the Queensland Museum under the name of the "Cobb and Co. Collection of W.R.F. Bolton". In

accepting the donation the Board undertook to use its best endeavours to house the collection in the eastern Darling Downs area, the region from which much of it had been drawn.

The collection had narrowly escaped destruction by fire while in its original location and the Board was assisted by the Toowoomba City Council, which provided temporary accommodation in a Council store until leased storage could be organised in Toowoomba. At this time, the Toowoomba Showgrounds were relocated from a central city site to the city outskirts. The original showgrounds reverted to Government use earmarked for extension of the Toowoomba Technical and Further Education College. On this site the existing Floriculture Pavilion, constructed in cement block, was remodelled to become the Cobb and Co Branch. The Department of Works extended it at a cost of \$775,000 to include secure outdoor display space, a blacksmith shop, a woodwork shop, toilets and a paved car parking area. The Building was given an architectural appearance (colonial) in keeping with its proposed usage. The land was subsequently designated as a Reserve for Museum Purposes and placed under the Trusteeship of the Board.

The Board provided permanent staff of a Curator and Curatorial Officer. Six casual staff, appointed since, are an Administrative Assistant and five part-time Interpretation Officers.

At its opening in December, 1987 all major elements of the Cobb and Co. Collection were accommodated and several horse-drawn vehicles were added from the Museum in Brisbane. Interpretive exhibitions and audiovisuals were developed in Brisbane. The Branch has a small lecture/meeting room, a sales area and lounge and an administrative area. The Branch occupies 1570m<sup>2</sup> of covered space, most of which is environmentally controlled.

This Branch was originally regarded as a specialist facility. It has become evident that the Branch must provide broader programs if it is to continue attracting local visitors as well as tourists. A vigorous, in-house, educational program ensures a continuing value to different student age groups and avoids the "once only" visit approach from local schools. This is of paramount importance considering that Toowoomba is an educational centre. Further, the Curator has ensured involvement in a wide range of heritage events to advertise the Branch. School holiday activities assist in diversifying the subject matter covered and through a com-



FIG. 3. "Cobb and Co." Branch, Toowoomba, front entrance with an operating replica coach as a temporary attraction.

bination of such approaches the Branch enjoys an increasing patronage to 15,977 in 1989/90.

Research at the Branch concentrates on the transport industry; the historical account of the coaching company, Cobb and Co., in Queensland, has been a significant and popular achievement (Tranter, 1990). The Board established a Management Committee, to represent the Museum and the local community and delegated to it responsibility for day to day operation of the Branch.

The Cobb and Co. Branch will need to expand in the future if it is to fully satisfy all of its potential as a community and tourist resource. Discussions have been initiated with the adjacent TAFE Council to determine ways in which the objectives of both organisations can be achieved on the available sites.

#### COOMERA BRANCH

In 1985, the Government enacted legislation to transfer, to the Board, responsibility for "Queensland Transport and Technology Centre" which became the Queensland Museum Coomera Branch. This was a museum-type development that had been partially implemented on a site on the main highway between Brisbane and the Gold Coast.

The site comprises a reserve for museum purposes of 33ha that includes two brick residences and an airstrip that could be used for light aviation purposes. It had been the intent of the Board of the previous body to have the airstrip used on open days for demonstrations of various aircraft, particularly vintage types. Apart from primary landscaping, some fencing and signage, little else had been achieved. Responsibility for repayment of a significant loan made by the Board of the Queensland Transport and Technology Centre was transferred to the Queensland Museum Board, with repayment fully supported by the Government. The Board has seen this Branch as an opportunity to develop facilities for display of industrial technology and other topics that cannot be covered adequately in the main Museum.

No public function is currently conducted at the Branch and an independent study suggested that financially viable operation of display and other public functions could only occur at Coomera when there is a sufficiently large population base nearby to promote use of the Branch by regular as opposed to tourist patronage. The major tourist attraction, "Dreamworld", directly across the highway means that, for the Branch to compete, the development must

itself open as a significant and completed attraction. It is unlikely that the Board will fully develop the Branch until the late 1990's at the earliest.

In the meantime, the Board established a storage facility for items of heavy technology in the form of a 945m<sup>2</sup> building, built by the Department of Works, at a cost of \$798,600, and opened in June, 1989. Both existing residences are leased and one of these is occupied by a tenant who, for a reduction in the rental, provides on-site supervision. Costs are minimal and are generally restricted to mowing, minor maintenance and services to the storage building.

An unoccupied storage building at the old main Museum site in Gregory Terrace, Brisbane is earmarked for relocation to Coomera by 1993. This structure when in place will add a further 350m<sup>2</sup> of good quality storage space to the site.

#### SCIENCENTRE. BRISBANE

Early in 1989, a report by the Institution of Engineers Australia (Queensland Branch) identified that declining interest in the pursuit of science and mathematics subjects at high school and in engineering and science courses at Tertiary level could be redressed, in part, by establishment of a science centre. At the time, no firm proposals were made as to how such a facility might be developed or run.

The Museum's design policy since 1985 had been to incorporate interactive displays wherever possible. This approach recognised the need to include such new display techniques because inflexibility of traditional museums had resulted in establishment of new competitor institutions elsewhere in the world. The idea that the Queensland Museum might take up the recommendation of the professional body and foster a science centre as a Branch was in accord with the institution's mandate.

The Board was made aware that, as part of the Government's program to restore many of its fine old buildings in the centre of Brisbane, the original Government Printery, was to be available for reuse after renovation; the Government Printing Office having been relocated to a new, industrially designed building. Discussions had taken place with the Government Printer and, with the approval of Cabinet, the building was earmarked for occupancy by a Branch featuring communications, especially the printing industry. The Board was convinced that a science centre had greater ramifications for the future

economic well-being of the State and, for that reason presented the case to Government that the "Old Printery" should become an interim home for the State's science centre.

Containing only 1000 m<sup>2</sup> of space, approximately 800 m<sup>2</sup> of which could be used for interactive displays, it was obvious that the "Old Printery" would not be a permanent long-term solution for the science centre needs of a State the size of Queensland. It could, however, serve the immediate function of establishing a facility that would begin to address the problems identified by the Institution of Engineers Australia (Queensland Branch) and give a breathing space to allow for assessment and planning for the longer term.

Restoration of the "Old Printery" was undertaken by the Department of Works to extremely high standards. The three story structure was modified to accommodate air conditioning plant, a passenger/goods lift and improved fire escape capacity. Loading bay and official parking facilities were provided through basement access as part of adjacent Government work. Total expenditure on the building amounted to \$2.1M.

The challenge for the Museum designers was to merge a very upmarket function like interactive science into a heritage building. The budget for displays was only \$120,000. Because of an extremely short lead time, the Museum had to reduce its involvement in production and purchased a limited number of standard treatments from other science centres. It also engaged outside display consultants to produce some units. Most of the 80 or more interactives in the opening exhibition were designed and produced in the main Museum's workshops. They were executed using open, metal support structures so that visitors could see that there was no "black box" involved in the presentation. Maintenance has proven to be only a fraction of that expected from experience elsewhere.

The Branch opened in October, 1989 as the "Sciencentre". The Department of Education provided a senior science teacher on secondment to develop the educational exhibition components. A full-time position for a Curator/Manager was established shortly afterwards and filled by the seconded officer. Two Museum Attendants were attached to the Branch from the main Museum and an Administrative Assistant, a Technician, three Interpretation Officers and two Shop Assistants were added; funding comes from the entry charge. The Department of Education continued its support by providing



FIG. 4. "Sciencentre" Branch, Brisbane, showing a school group using the interactive "slippery air".

another seconded Teacher to assist with the use of the Branch by educational groups.

An Advisory Committee was established under the Chairmanship of the Vice-Chairman of the Board, with membership drawn from a wide spectrum of community interests. The Advisory Committee was to investigate medium and long term needs of the Sciencentre and advise the Board on how to ensure that the Branch would continue to meet the requirements of the community. It undertook to achieve this within 15 months of its inception.

Shortly after opening, the Advisory Committee became aware of the Government's desire to find a use for the much larger George Street printing building, adjacent to the "Old Printery", that had been occupied by the Sciencentre. Following extensive negotiations, the Government decided that the Branch would be relocated to the Printery as soon as its heritage building restoration was completed. An allocation of \$4.5M has been committed by the Government towards this restoration work. It was estimated by the Committee that more than \$500,000 should be sought from industry and the community for displays in the larger accommodation and for an outreach service to take Sciencentre programs to other parts of the State.

Transfer of functions to the 3,000 m<sup>2</sup> Printery

is expected to begin towards the middle of 1992. More than 58,500 people attended the Branch in the first four months of operation (Fig. 4); an annual attendance in excess of 250,000 is expected in the more spacious building. Success of the Sciencentre has been due in no small measure to the more than 100 trained, volunteer "Explainers" who are rostered to assist visitors interact with the exhibits.

Following submission of its Report, the Advisory Committee was disbanded and replaced by a permanent Management Committee to run the facility.

#### GLENLYON DAM DISPLAY CENTRE, NEAR STANTHORPE

Work had been undertaken by the Museum in the area to be inundated by the Glenlyon Dam, near Stanthorpe, as a project for the Dumaresque-Barwon Border Rivers Commission. A display was established at the dam site in 1976 to interpret the natural history of the area and to display the development models.

In October, 1986, an Agreement was reached with the State Water Resources Commission and approved by the Governor in Council to have the display centre maintained in future as a Branch. Although establishment costs in an existing site



building were estimated at only \$20,000 and, regardless of the fact that the Branch occupies only 80 m<sup>2</sup>, the dam is a popular camping and recreational area. More than 24,600 people visited the Branch in 1989/90. Maintenance of the unmanned facility is minimal and day to day attention is provided by the resident dam staff.

#### LANDS, MAPPING AND SURVEYING BRANCH, BRISBANE

Numerous historical items associated with the exploration and mapping of Queensland accumulated over many years in the Department of Lands, Mapping and Surveying. When that Department transferred to its new building at Woolloongabba, it sought to display its collection for the public, especially school groups. The Surveyor General approached the Museum to consider development of a Branch that would enable the Department to have access to the museum's expertise, Trust Fund provisions and collections and to give permanent collection status to the Department's holdings as part of the State Collection under the care of the Queensland Museum. A formal Agreement was achieved in August, 1988, with the endorsement of the Governor in Council.

The Branch occupies 112 m<sup>2</sup> of high quality, fully air-conditioned space and is manned by a Curator provided by the Department of Lands. A small Advisory Committee drawn from the Department and from the Queensland Museum, supervises Branch operations. Total running expenses are provided through the Department of Lands, with the exception of minor funding through the Museum's Trust Fund. Visitor numbers have been low and in 1989/90, the Branch was viewed by 2,300 persons.

#### LARK QUARRY ENVIRONMENTAL PARK, NEAR WINTON

In August, 1971, a joint field party from the Queensland Museum and the American Museum (Natural History), New York, was shown evidence of dinosaur trackways in the Late Cretaceous Winton Formation, to the south of Winton, central western Queensland. A subsequent Queensland Museum excavation revealed the trackways of a herd of small to medium sized ornithischian dinosaurs, stamped by a large carnosaur.

A complete latex peel was made and the excavated surface was duplicated in fibreglass for display in Brisbane. A small part was lifted as a

permanent scientific record while the remainder of the site became vulnerable to weathering. It was declared an Environmental Park, jointly administered by the National Parks and Wildlife Service, the Winton Shire Council and the Queensland Museum. It provides protection for one of the most interesting relics of the "Age of Reptiles" anywhere. The QNPWS protects the site, the Museum provides the scientific interpretation and conservation of the trackways, and the Winton Shire Council provides access and site maintenance.

A steel shelter has been erected by QNPWS and the area is fenced to keep stock and wildlife from using the shelter to the detriment of the trackway surface. Modifications to the structure continue to be made from time to time to overcome problems identified with experience. The Lark Quarry Environmental Park attracts enthusiasts to its remote situation, as evidenced by the several hundred new signatures that are added to the visitor's book each year. The Museum's involvement amounts to at least one trip to the site annually to monitor and remedy deterioration and vandalism.

#### FUTURE BRANCH DEVELOPMENTS

The Queensland Cabinet decided in 1990 that any Government Department that wishes to develop a museum must first discuss the proposal with the Queensland Museum, with a view to making the development a Branch of the Queensland Museum. Also, Departments maintaining collections of objects that wish to dispose of them must now offer them firstly to the Queensland Museum for inclusion in the State's official collections, if appropriate. The first proposal involves the Transport Department wishing to establish a Railway Museum for smaller items of memorabilia in a delightful building at Ipswich. This building, close to the city centre, already houses railways historical archival material, and is separate from the Transport Department's display of large, steam and steam-related rolling stock exhibited at Redbank, half-way between Ipswich and Brisbane, a facility maintained in part by the Railways Historical Society.

Apart from possible branch developments in Rockhampton and Cairns, already mentioned as Board initiatives, there is a possibility that the Government itself might promote further developments in connection with tourism and environmental matters.



FIG. 5. A range of popular Museum publications and other products.

The Board considers that existing Branch infrastructure is providing acceptable levels of service away from the main Museum. It is also aware that its activities through the Branches and the standards it promotes through the quality of its exhibitions, the interpretation of its collections, the integration of its programs with the educational needs of local communities and the research bases it gives in the regions are having a marked influence on encouraging locally organised museums to improve their services.

#### IMPROVING COMMUNITY ACCESS

Although display galleries in Brisbane are only conveniently available to residents of southeastern Queensland, the Museum provides a range of more widely available services. The public outside the southeastern corner of the State, obtains free advice and information from the Museum through correspondence and telephone to the extent of 10,000 units of service each year.

Many enquiries include samples for identification and, in an area of the world where the "age of discovery" is still very much with us, it is not uncommon for the public to participate in finds that are new to science. The frequency of en-

quiries on common subjects at particular times of the year led to a large series of popular Information Leaflets. When it becomes apparent that a large number of incoming enquiries relate to the same topic, a leaflet is developed to merge the authority of the Museum's expertise with the flair of the educator and scientific journalist. Costs are offset by making the same leaflets available to public visiting the Museum, with an honour system at a nominal "donation". Compilations of related groups of leaflets are marketed, especially as project kits and to educators interstate. Income for the service has always far exceeded its costs.

Staff members have also been encouraged to popularise the subject matter of their sections by writing books and booklets and through production of other items that help interpret the Museum's fields of interest (Fig. 5). The majority of such material is published or manufactured through the Museum and is distributed to the public through the Museum's wholesale and retail outlets. The Museum has adopted a number of strategies to increase the reach of these products. For example, a large percentage of sales is achieved through mail orders from country and interstate patrons. This is encouraged by media launches and by use of wide-



Fig. 6. Maori dancers with the Hon. Wayne Goss, M.L.A., Premier of Queensland at the O.T.C. sponsor's night for the international travelling exhibition, "Taonga Maori".

ly distributed catalogues. Run-ons of covers, with ordering details on the reverse are sent to known interest groups and teacher librarians. Some publications are developed to meet specific curriculum needs and may be joint ventured with the educational authorities. In such cases, initial sales can be in excess of 40 000 copies, with the guarantee that the information will be distributed to every primary or secondary school in the State. Specialist publishing to explain the subject matter of Branches is also encouraged. Use of Branches in this way and as additional sales distribution points adds to the range and penetration of Museum publications and products.

The collections of the Museum, whether housed in the main Museum or in Branches, provide an invaluable asset for use by specialists and the general public. Now that collection data are in the institution's computerised data base, access is available without physically visiting the facilities. Commercial or extended enquiry and use of the data base are charged at a realistic rate but reasonable free access is encouraged by the general public.

The Museum undertakes extensive field work projects around the State and every opportunity is taken to have staff involved in such work

interrelate with individuals and groups in the communities visited. Talks to local service clubs are encouraged and, in the case of a particularly impressive excavation of a Cretaceous ichthyosaur in central Queensland, many members of a small town and surrounding area visited the site and had the process explained to them.

Community access is not initiated solely by the Museum. Groups and individuals use the facilities of the main museum and Branches to promote their interests to the community. The Queensland Museum has provided the facilities and assisted in the presentation of specialist lectures and temporary displays, some of the latter occupying in excess of 600m<sup>2</sup> for periods of 2-5 weeks. The topics displayed cover such subjects as industrial design and medical research from local universities; advances in scientific knowledge as a result of current research from the Commonwealth Scientific and Industrial Research Organisation; historical collections of Queensland militia by individuals, military units and groups; and displays from spinners and weavers, woodcraftsmen and other craft organizations. Outback craft awards were recently presented in the Museum by the Australian Stockman's Hall of Fame and Outback Heritage Centre, which is located in Longreach.

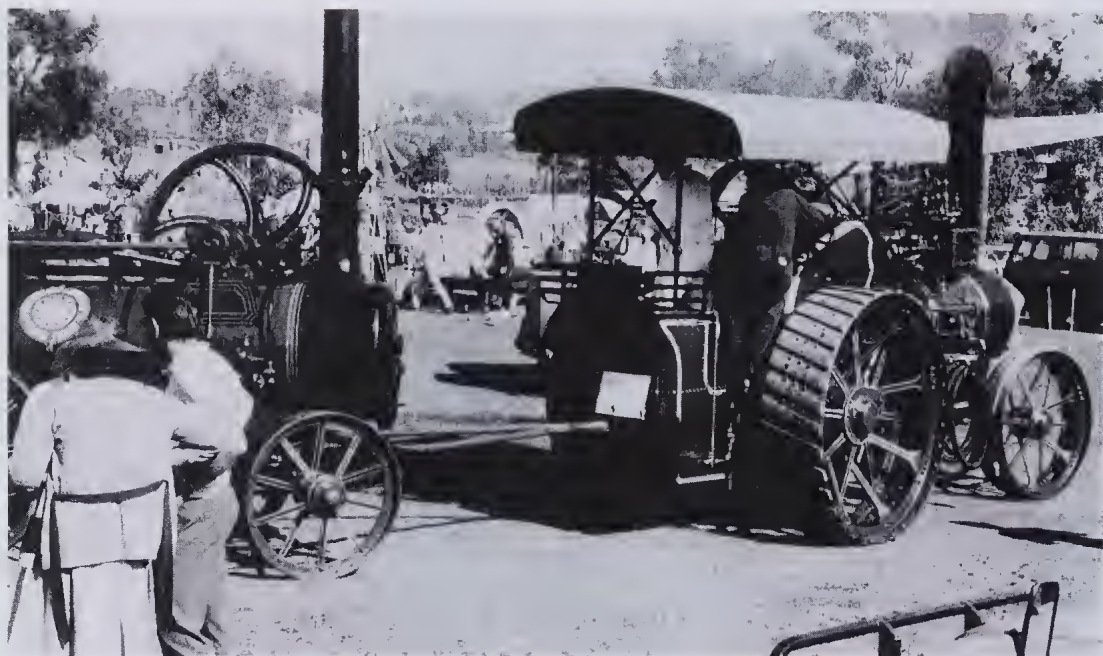


FIG. 7. The Museum's fully restored Garrett steam traction engine and its portable Ransomes, Sims and Jefferies steam engine at an antique machinery show.

Particular groups reflecting Queensland's cultural diversity are encouraged to participate widely in planning and activities that are associated with major travelling and permanent exhibitions. The Museum hosted the exhibition "Ancient Macedonia" and the local Greek community and club co-operated fully to add Greek music, dance, food and wines to the occasion. Similar involvement of the local and New Zealand Maori communities occurred in connection with the cultural experience, "Taonga Maori" (Fig. 6), resulting not only in a better appreciation by the whole community of Maori culture but also increasing access by the Maoris themselves to their Taonga. Aboriginal advice and concurrence was sought and accepted in the presentation of the Museum's major, permanent exhibition on the "Rainforest Aboriginals". The Museum is extending this process by establishing an Aboriginal and Torres Strait Islanders Advisory Committee to advise the Board on policies relating to all aspects of maintenance, development and use of the State's collections of Aboriginal and Torres Strait Islander anthropological and archaeological items. Several special exhibitions of contemporary Aboriginal Arts and crafts, at which the items displayed were available for purchase by visitors, were

staged to increase awareness of the modern cultural expression of Aboriginal artists and to assist in the commercial development of their works.

Opportunities that presented themselves for the Queensland Museum to increase access to particular parts of its collections have been taken up regularly in such events as antique, operating machinery shows and at the Royal National Association Exhibition, an annual event that runs for 10 days in Brisbane. Items such as a 13 tonne, fully restored steam traction engine (Fig. 7) and smaller operating exhibits such as a hot-air engine have been used widely in both types of event. Until the recent cessation of the historical agricultural display component of the RNA Exhibition, exposure at such events ran to hundreds of thousands of viewers each year. Even the occasion of the relocation of the main Museum to its new building in the Queensland Cultural Centre allowed the institution an opportunity to relocate for several months the biplane, the Avro Baby in which the famous Queensland aviator, Bert Hinkler, made many of his pre-1920 record breaking flights, to his home town of Bundaberg.

It has always been the philosophy of the Museum that the institution exists for the public and that the staff are present to assist the community in the care and interpretation of the

public's collections. Because of this, the Museum was interested in the links and use that could be established through encouragement of the Queensland Museum Association Inc., a society that grew out of an earlier body, the Queensland Hall of Science, Industry and Health Development Committee. The Queensland Museum Association, of over 400 members, provides regular volunteer workers in many areas of the Museum. Honorary workers interact between the institution and the community and extend beyond the members of the Association to include eminent research workers often with grant support, persons with particular interests in field-based projects such as maritime archaeology, work-experience students and display gallery explainers. Altogether, the Museum has more than 250 such honorary staff.

#### DIRECT EDUCATION

The main Museum maintains a range of in-house, well-staffed, educational programs and each Branch is involved in direct programs. Increasingly, direct educational activities in the main Museum concentrate on teaching teachers to maximise effectiveness of their use of the facilities and resources in connection with class visits to the public galleries. Visitors in the younger age groups are specially provided for during school holiday periods in all of the Museum's venues where trained educators are employed.

In the Sciencentre and Cobb and Co., the Curators are trained teachers and are well placed to promote direct educational programs. Even so, the Sciencentre is supported in its educational initiatives by a seconded teacher, which enables the Branch to cater for nine class groups, approximately 270 students each day during school semesters. The Cobb and Co. Branch has a program that enables visiting groups to use the same material for a variety of curriculum purposes for different age groups, this being of paramount importance where repetitive use of the facility is necessary for its financial viability. The Museum of Tropical Queensland appointed an Education Officer using funds made available from the local Gluyas Trust. This enabled the Branch to develop educational group visit procedures and a variety of activities for different age groups.

In all cases, the service and procedures for booking a visit are advertised each semester to all schools, both State and private. Other avenues for promoting the Museum and its Branches and

their educational facilities, such as journals distributed to teachers and schools, are provided with articles for publication and paid advertisements. Every effort is made to ensure that school visits are planned for maximum effectiveness and are no longer a holiday for students and teachers alike. Computerized scheduling of visits ensures that minimal overlap with other groups is likely to occur and that the density of school groups does not spoil visits for members of the public. The Museum caters for 180 000 students each year in its formal educational programs and, of these, nearly 80,000 are served through the Branches.

From 1979, the Museum trialled an education program to take objects and programs to schools in distant and disadvantaged areas. The Department of Education seconded out a teacher, each for a two year term, together with all allowances and travelling expenses, while the Museum provided a light van, specimens and other teaching aids and all running expenses. The program included private and church schools, preschools and kindergardens and even served adult groups in more remote centres. Initially, one unit operated and most visits were made to schools within 300 km of Brisbane; occasional trips were made to the far north, west and northwest. As a result of the outstanding success of the initial trial service in southern Queensland, the Education Department seconded a further teacher to operate out of the main Museum from the end of 1990.

The Museum of Tropical Queensland successfully negotiated a similar service through the Priority Country Area Program with the Northern Regional Office of the Education Department in mid-1990 to serve the Townsville hinterland, together with part-time support of an additional teacher to assist with organisation of the service. Funds to decorate the extension vehicle were given by a local milk company and the highly visible presence of the Branch in isolated communities quickly raised the image of the whole Museum in the region.

Topics covered by the service include dinosaurs, Australian mammals, birds, reptiles and amphibians, Australian inventiveness, pioneer life, Aboriginal life, what is a museum?, Australian transport, coral reef ecology, rocks and minerals, observation skills, venomous Australians, life cycles, skeletons and many more. The service visited 190 schools in 1989/90 and reached in excess of 25,000 students.

As with in-house education, the extension ser-

vice is widely advertised each semester and is virtually booked out within weeks of notification in the educational literature. Visits are scheduled to accommodate similarity of subject matter requests and clumping of destinations. Extension Officers attempt to return home at least each weekend and to include vehicle servicing and other maintenance into their itinerary. Being members of the State's teaching service, they work to the school timetable, rather than to that of the Museum.

The Museum has recently instituted training courses for teachers to link with curriculum-based booklet production. This was specifically intended to augment a Museum insect activities booklet that had been distributed by the Department of Education to all primary schools. Initially, some 200 teachers attended a two-day training seminar at the main Museum, run on a cost recovery basis. So successful was the experience that a similar program, presented by Curatorial, Education and Display staff, was run from the Cobb and Co. Branch in Toowoomba. Further workshops are now intended to be conducted in other regional centres to coincide with display in those centres of a travelling display on insects.

#### TRAVELLING EXHIBITIONS

The Museum acknowledges that the public visits museums because they present real objects that are otherwise only seen in publications or on television. Any travelling exhibition that concentrates only on two dimensional reproductions or replicas is unlikely to have the same impact as evinced through access to the Museum's permanent facilities. At the same time, travelling exhibitions of original works of art, especially paintings, are considerably easier to pack, move from venue to venue, install and dismantle than are the more awkward, traditional "museum" displays. The latter frequently involve bulky and fragile display cases as well as the items that are the subject of the exhibition.

The Museum's first attempts at circulating displays in recent times involved a wildlife photography exhibition, contained in a demountable, free-standing, aluminium panel system and financial support from the Arts Council of Australia. The Kern Corporation, which was involved in the construction and operation of major shopping centres in provincial cities, provided space and staff to erect, dismantle and supervise the display. Shopping centres, with

their daily attendance of thousands of customers, proved to be ideal as temporary exhibition venues, especially where material of a non-eritcal nature in regard to security is involved.

More recently, the Museum established a major temporary exhibition in its main gallery spaces in Brisbane that was designed to travel to regional and interstate venues after its Brisbane showing. The exhibition resulted from a curatorial project to conserve and fully catalogue a collection of 126 watercolour paintings of Queensland wildflowers by the renowned artist, Ellis Rowan. A selection of 90 of the paintings became the core of the display, and was presented in the manner of a late 19th century exhibition with an anteroom containing a brief history of the artist, together with some of the zoological collections she had used to add other dimensions to her "in situ" botanical renditions. The paintings were organised in a stacked situation, in keeping with the illustrations of the original presentations of her work.

The majority of the Brisbane presentation went on tour with financial support from the Regional Galleries Association and the Arts Division of the Premier's Department. The exhibition was shown at the well-appointed art galleries at the Gold Coast, Rockhampton and Townsville. The exhibition's interstate tour commenced in early 1991 in Sydney and it will be shown later in the Northern Territory Museum and Art Gallery and the Tasmanian Museum and Art Gallery. This exhibition was accompanied by a well illustrated, high quality booklet that covered the experiences of Ellis Rowan in Queensland and all of the Museum's holdings (McKay, 1990), a series of art prints based upon four of the paintings that were fully sponsored by the paper and printing industries, a range of letter cards and a series of post cards.

The most recent intrastate travelling exhibition was the Dodd collection of butterflies and other insects, the material that made the reputation of "the butterfly man of Kuranda". The collection is extremely fragile, comprising thousands of dried and pinned insects in glass-fronted boxes. Transportation was organised by road using air-cushioned art transporters but it was assessed that purchase of an enclosed van that would have been sold at the end of the tour was an option that was almost as cost-effective. Again, the venues chosen were the regional art galleries, these having controlled environments and spaces that can be used much more conveniently than local museums or meeting halls.

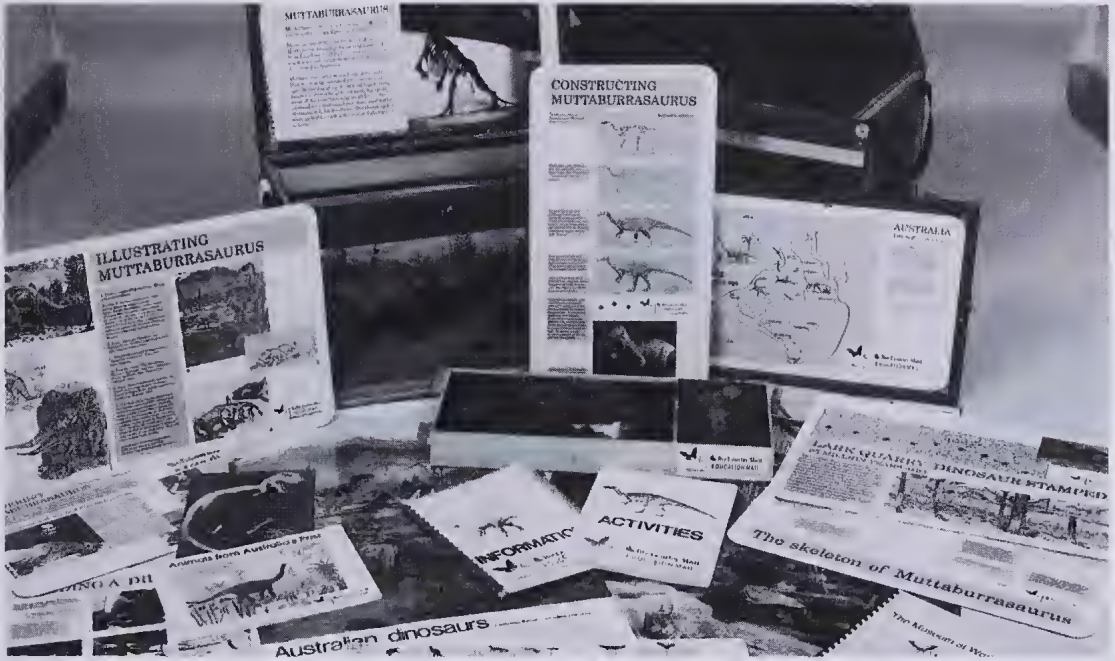


Fig. 8. Queensland Newspapers sponsored loan kit showing the comprehensive range of objects and other material included in the "Australian Dinosaurs" kit.

The Queensland Museum is aware that its current solutions to travelling exhibitions can only serve centres that have sufficiently large population bases to support high quality venues. It is addressing design of units that can be circulated to more widely available situations, such as local libraries or local government facilities. Such units should be capable of changing from transportation to display units and be able to link together to form limited thematic topics as well as stand-alone subjects.

### LOAN SERVICES

Every museum has available a range of specimens that are not suitable for inclusion in the permanent collections for one reason or another. In some instances, such specimens are acquired by donation or collection, while others are relegated through reassessment of existing collections to an educational role. In the mid-1960's, the Queensland Museum began loaning such items, especially to teachers. The service began in the Brisbane area and was required to be collected and returned by hand. These individual specimens joined a small selection of boxed, mounted specimens of reptile, bird and mammal specimens that had been available for

many years and which had been one of the Museum's first extension initiatives.

These specimens greatly extended the outreach services. Certain materials, such as minerals or shells, could be linked to provide greater spread and depth of subject coverage; they could be packaged and sent to any part of the State. Standard, hard cardboard suitcases, fitted with foam plastic sheets cut to contain the particular items, met the key criteria of strength, portability and economy. Some items that did not normally reach the educational collections (e.g., Aboriginal implements) were purchased. Material, such as examples of adaptations for flight, was specifically prepared to augment the loan collection. Volunteers organised and registered into a separate system all the isolated specimens that constitute the bulk of the loan collection.

Original arrangements were amended to reduce the overall cost of maintenance of the service by altering the system of free access to material sent by road or rail transport to have the Museum cover charges associated with outward movement and to require the borrower to meet the return costs. A further modification to the borrowing arrangements resulted from the developing relationship between the Museum

and the Department of Education. Collections of loan items were located in each of the Department's regional offices and access to the material within each region was organised by the regional staff. This obviated the Museum from any requirement to contribute to any part of the distribution beyond the initial location of the loan items to the regional offices.

In 1989, Queensland Newspapers Pty.Ltd. sponsored a comprehensive suite of loan kits that met many more of the curriculum needs of teachers in the more inaccessible parts of Queensland. The three year sponsorship of \$700 per month is matched on a \$ for \$ basis by the Queensland Museum Board. The kits involve a major "diorama" mounted specimen or other key items, together with 35mm slides, specially prepared information cards, Museum booklets and information sheets, hands-on specimens, audio tapes, activities sheets, teacher's notes and other aides (Fig. 8). The package is designed in a wooden crate that is part of the presentation. A fitted cardboard cover provides protection and advertising for the contents, extending the life and public knowledge of the kit.

It is anticipated that more than 30 loan kits will be completed on the sponsorship; as they are completed they are immediately distributed. Kits are rotated from region to region each semester. Queensland Newspapers intend to publish a broadsheet page of educational information, prepared by the Museum, on each topic covered; this will be released through their major daily and its weekly education supplement. Run-ons of the sheets will be used for distribution to students using kits.

In 1989/90, the service reached 118,500 students in 1900 schools and involved 18,485 items and kits on loan.

#### SUPPORTING LOCAL MUSEUMS

Queensland is well served by a wide variety of smaller museums, some of which are privately owned but with the majority, more than 170, operated by societies and other community groups. The number is increasing at a rate of nearly one per month. Some now achieve standards comparable with those of the Queensland Museum. For example, in 1988, the Stockman's Hall of Fame and Outback Heritage Centre was opened in Longreach. This \$6M display and events centre was funded from Commonwealth and State Bicentennial funds, with a large component donated and subscribed by the Australian

community. Exhibition items were largely provided on loan from the Museum of Australia in Canberra and from the Museum of Victoria in Melbourne. Display work was undertaken by commercial contract.

Most local museums, however, do not aspire to developments of this magnitude. Many are by-products of the activities of small historical societies that acquired collections of items and associated archival documents and photographs. Most grew in an unplanned way and there was overlap in collection coverage from one centre to the next. Curation was frequently almost non-existent as was any attempt to extend the life of the collection items through application of controlled atmosphere or materials conservation treatment. Few maintained storage facilities and all items held, regardless of condition or duplication, were presented in minimally interpreted exhibitions.

While there was financial support available to the arts community generally for both capital development and for annual programs, local museums were specifically excluded from such assistance. Direct help was provided through the permanent loan of excess display furniture and this became a significant contribution when the Museum disposed of its complete compliment of furniture from its old building in 1986.

In 1982 the Board convinced the Government to introduce a granting scheme to assist local museums (that complied with the ICOM definition of a "museum") to improve museum services in their area of the State. Funding support has been at a relatively low level and does not capital works. Currently, support is restricted to a maximum of \$3000 in any year in response to a formal application and can only be applied towards non-recurring projects. Some funding can be provided towards building modifications where these are needed to ensure better protection for collections. Work to insulate a building or to reduce ultraviolet light values is acceptable but repairs to steps are not. Support for payment for professional planning or to permit attendance at conferences or work experience placement at the Queensland Museum or relevant tertiary institutions can be accommodated by the scheme.

Administration of the Grant Towards Local Museum Activities Scheme is undertaken by the Queensland Museum and technical advice is given freely to all local museums in the State. Funds currently reach more than 70 local museums each year and there has been an appreciable improvement in the quality of the ac-



tivities addressed by local museums since the scheme's inception. This has not only been because of the funding provided but also reflects the more regular contact with and advice from professional Queensland Museum staff. Further, community museums must now be incorporated under the Associations Incorporation Act and this has meant that the previously loosely composed constitutions under which they operated have been considerably strengthened in favour of the long-term protection of collections held in the public interest.

Existence of Branches of the Queensland Museum in regional centres, presented as they are at the same standards as in Brisbane, has established a level that local museums must attempt to match. Certainly, there is an increasing tendency for local museums to identify what is unique or important in their areas and to present more specialised exhibitions that are increasingly more different from those in nearby centres. This in itself is bound to increase their viability in an ever more competitive field.

An attempt is being made by the Queensland Museum to locate important material back to the areas from which it was drawn. With financial support from Kelloggs, the Museum duplicated the mounted skeleton of the ornithischian dinosaur, *Muttaburrasaurus* and erected it in a display centre in Hughenden. Similar assistance has been offered to the Richmond Shire Council in regard to display of marine reptiles collected for that area of the State.

#### TRAINING REGIONAL PERSONNEL

In May, 1978, the Queensland Museum organised a weekend training seminar for local museums; it aimed to improve services by providing access for participants to a full range of professional and technical advice and expertise. This was supplemented by several specialist, practical training weekends on topics such as display planning and production. The Museum has consistently provided staff to participate in workshops organised by the Museums Association of Australia and more localised groupings of museums and like institutions.

At the same time, a number of small, existing museums and some seeking to establish themselves, sought and received approval to locate honorary staff in the Museum with a view to having them experience a range of training in curatorial and preparatorial techniques. In-house work experience is also offered to a number of

senior secondary students each year, together with tertiary students from museum studies courses around the country. International links have been established in the same way through acceptance of trainee workers for extended periods from Asian and Pacific nations, including Sarawak, Papua New Guinea, Tonga, Niue and the Solomon Islands.

The most recent project in the area of museological training was to bring together a group of interested Aborigines from areas as far afield as Mt. Isa and Cairns. There has been a growing interest among the Aboriginal community in the development of cultural centres and the Museum felt that it would be of benefit to those who may ultimately be involved to have first hand experience of the range of skills needed to successfully plan and run specimen based services for community and tourist use.

#### SUPPLYING PROFESSIONAL STAFF

The Australian Stockman's Hall of Fame and Outback Heritage Centre recognised shortly after the opening that professional staff would be needed on site to oversee the collections, improve the information component of the initial displays and develop collection policies and collections from them. It was also recognised that, because of the isolation of the facility, any appointee would be severely disadvantaged regarding professional development and maintenance of standards. The Queensland Museum was approached to appoint a curatorial officer to the staff of the Museum for attachment to the Hall of Fame for two years. All costs associated with the appointment would be borne by the Hall of Fame and the officer would enjoy the same conditions of employment as Museum staff.

The Museum considered that the proposal mutually beneficial. The arrangement provided the opportunity for a much closer relationship than could otherwise be achieved with the Hall of Fame, as the largest of the community-run "museums" in the State. It also encouraged co-operative ventures, especially in the public program area. From the Hall of Fame's viewpoint, not only was a professionally linked officer present in Longreach but also, the Museum was available to oversee the Hall of Fame's collection documentation and development program and give expert advice on conservation and building modification needs.

Now in its second year, it is unlikely that this type of arrangement could be readily duplicated

by other local museums because of their restricted income bases.

### CONCLUSION

The Queensland Museum has progressively increased access to its services by as many of the residents of Queensland and visitors to the State as possible. While much remains to be done, the services now implemented are considered to address the problems of distance and decentralisation to an extent that is significantly greater than most other medium-sized museums within Australia and elsewhere. By establishing a philosophy that identified the rights of access by all of the residents of Queensland to the material

and information held in trust within the Museum, it has been possible to act both proactively and opportunistically to develop cost effective programs that continue to expand and that have high public acceptance.

### LITERATURE CITED

- McKAY, J.M. 1990. "Ellis Rowan - A Flower-Hunter in Queensland". (Queensland Museum: Brisbane) 91p.
- TRANter, D. 1990. "Cobb and Co. - Coaching in Queensland". (Queensland Museum: Brisbane) 159p.

# ARCHAEOLOGICAL EXCAVATIONS AT YIWARLARLAY 1: SITE REPORT

BRUNO DAVID, IAN MCNIVEN AND JOSEPHINE FLOOD

David, B., McNiven, I. and Flood, J. 1991 08 01: Archaeological excavations at Yiwarrlarlay 1: site report. *Memoirs of the Queensland Museum* 30(3): 373-380. Brisbane. ISSN 0079-8835.

Yiwarrlarlay 1, the Lightning Brothers site, was excavated by the authors in 1989. The site contained evidence of human occupation dating back to the last 700 years or so, although it is not until the last 150 years, after the arrival of Europeans, that there is any *in situ* evidence for artistic activity in the shelter. In this paper we record the Lightning Brothers Dreaming story as was recorded by the authors in 1989, and present complete lists of materials excavated at the site. □ *Archaeology, Northern Territory, rock art, aboriginal site.*

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## YIWARLARLAY AND WARDAMAN SOCIAL LANDSCAPE

150km SSW of Katherine lies a Dreaming place important to the Wardaman people of the Northern Territory. This is Yiwarrlarlay, the land of the Lightning Brothers. Yiwarrlarlay itself contains an impressive sandstone outcrop jutting out of flat sandy plains. Amongst the outcrop are several rockshelters, many of which were, during various episodes in the past, painted and engraved. The engravings themselves generally (but not always) appear to be older than the paintings, as the former underlie the latter, and most of them are considerably patinated. Together, the plains, sandstone outcrop, rockshelters and rock art consitute to the Wardaman people part of the Dreaming-scape of the Lightning Brothers.

It is the landscape itself which, to the Wardaman people, expresses the essence of the local Dreaming. The art is part and parcel of this landscape; it is considered *buwarraja* (Dreaming), as are the surrounding rocks, hills, etc., and the paintings and engravings are not believed to be the result of human actions (although humans may make them 'look good' by retouching) (Merlan, 1989). The paintings themselves are numerous, and have been undertaken in various styles, but the central images are two huge figures, one of which is over four metres tall, of human-like beings. These are the Lightning Brothers, Yagjagbula and Jabirringgi (Fig. 1).

In the Dreaming Yagjagbula, the younger brother, is tall and handsome, whilst Jabirringgi is short and not so attractive. Both brothers are of the Jabijin skin. Yagjagbula has a wife, Gulliridan, whilst Jabirringgi is married to Ganayanda. Every day the brothers go hunting; one day Yagjagbula hunts for food, the next it is Jabirringgi's turn. One day Jabirringgi returns from a hunting trip to hear his wife whispering with Yagjagbula in a secluded break in the rock (Fig. 2). He immediately becomes suspicious and investigates to find them copulating. He throws a spear at Yagjagbula, who evades it. A fight breaks out, with each brother taking a position on the plains at Yiwarrlarlay, whence they throw spears and boomerangs at each other (Fig. 3). In the process they produce lightning, which



FIG. 1. The Lightning brothers as they appear at Yiwarrlarlay



FIG. 2. Break in the sandstone where Yagjagbula and Ganayanda are caught

at one stage strikes the sandstone outcrop and splits the rock in two. The frogs come up from the south to watch the fight, as does the rain (*wiyan*), who was heading up to the Yingalarri waterhole, but gets distracted as it passes near Yiwalarlay (at the same time, the Rainbow Serpent, Gorondolni, flashes at the rain to warn it not to advance to Yingalarri).

Eventually Yagjagbula hits Jabirringgi across the forehead with his boomerang, knocking off his headdress and winning the fight (Fig. 4). Some Wardaman people say that Jabirringgi is decapitated across the forehead, whilst others say that only his headdress is knocked off. In the event, the headdress falls to the ground, where it is transformed into a conspicuous rock which, until it was stolen by Europeans recently, could be seen at Yiwalarlay.

#### ARCHAEOLOGICAL INVESTIGATIONS

Yiwalarlay contains what is perhaps the most renowned Aboriginal rock art site in Australia. The site and its related Dreaming Story has been reported by a number of authors (e.g. Harney,

1943; Arndt, 1962), and was made famous to the non-archaeological public by Eric von Daniken (1971) who said that the main painted figures on the walls of the shelter were extra-terrestrials. It was not long after that J.P. White (1974) devoted a whole chapter of his book to the Lightning Brothers in his debunking of von Daniken's rather fanciful flights of imagination.

Yet despite the archaeological and public awareness of the art at Yiwalarlay, until very recently very little was known about the antiquity and nature of occupation at the site. The first archaeological investigations there did not take place until 1989, when the authors undertook Earthwatch-funded research in the region (Fig. 5). This paper reports on the excavations undertaken at Yiwalarlay 1, being the rockshelter housing the paintings of the Lightning Brothers. Other shelters with signs of occupation occur at Yiwalarlay, and these will form the subject of a separate study (see David et al., in press, for further information on archaeological work in 1988 and 1989).

Yiwalarlay 1 was partly excavated by David, McNiven and Earthwatch volunteers in mid-1989. A series of 16 contiguous 50cm x 50cm squares were excavated below the painting of Yagjagbula (Fig. 5) (David et al., 1990b). Excavated squares were set as a four by four grid, referenced by an alpha-numeric system. Excavation of the outer 10 squares (C18, D18, E18, F18-21, E21, D21, C21) did not extend below Stratigraphic Unit (SU) 2, as these were excavated solely to protect the main excavation from contamination by in-falling loose, surface sediments. By excavating the periphery squares down to compact sediments, such contamination



FIG. 3. Place on the sandy plains where Jabirringgi stands in his fight with Yagjagbula.



FIG. 4. Jabirringi, with his head-dress knocked off.

could be minimised. The maximum depth of excavation of the periphery squares was 6.6cm.

All squares were excavated in bucket spits following the site's stratigraphy (Johnson, 1979). All stone artefacts, bones, shell, ochre, contact materials, and exfoliated wall cortex observed during the excavation were recorded in 3-D and bagged separately, whilst the rest of the cultural material was sieved in 3mm sieves and subsequently sorted. Sediment samples were taken from each spit (XU) from each square. Bedrock was reached at a maximum depth of 56cm below surface. Four well-marked stratigraphic units were identified (Fig. 6):

SU1: loose surface material with much organic material present (e.g. leaf litter, macropod faeces). Cultural materials present include charcoal, stone artefacts, European objects, ochre, ash, bone and shell. Sediment is a greyish-red ashy sand.

SU2: similar to SU1 but more compact. Includes cultural materials, and there is significantly less leaf litter and macropod faeces than in SU1. European objects present. Compact greyish-red ashy sand.

SU3: grey ash with similar range of cultural materials as SU2, although here no European objects were found. Interface between SU2 and SU3 is 1cm thick. SU3 contains three localised lenses (sub-units 3b-3d), where sediment colour

and ash content differ from generalised SU3a. At base of SU3a, a well-defined thin, compact crust of ash appears (SU3b). It is up to 3mm thick where present. SU3c and SU3d are concentrations of white-grey ash.

SU4: the change-over to SU4a is sudden. This unit is a yellowish-pink sand which gradually gives way to a white sand (SU4b). Numerous sandstone blocks appear in SU4. Some very localised termite-damaged areas were identified in situ, and these are well-defined, compact, crusty areas. They could be easily traced during the excavation, and were isolated from surrounding uncontaminated sediments (Appendix 1).

#### RADIOCARBON DATES

Two radiocarbon dates (David et al., 1990) will only briefly be recounted here.

Wk-1549: Modern; a charcoal date from the basal spit of SU3 in Square D19 (XU7).

R11882, NZA860:  $444 \pm 87$ BP; a charcoal date, combining charcoal from Square D19 XU11 and XU12b, Square E19 XU10b and XU11b, and Square E20 XU 10b and XU14 (near base of SU4).

Cultural materials were excavated from all stratigraphic units (Appendix 1). Deposition



FIG. 5. Excavations at Yiwarrlarlay 1.

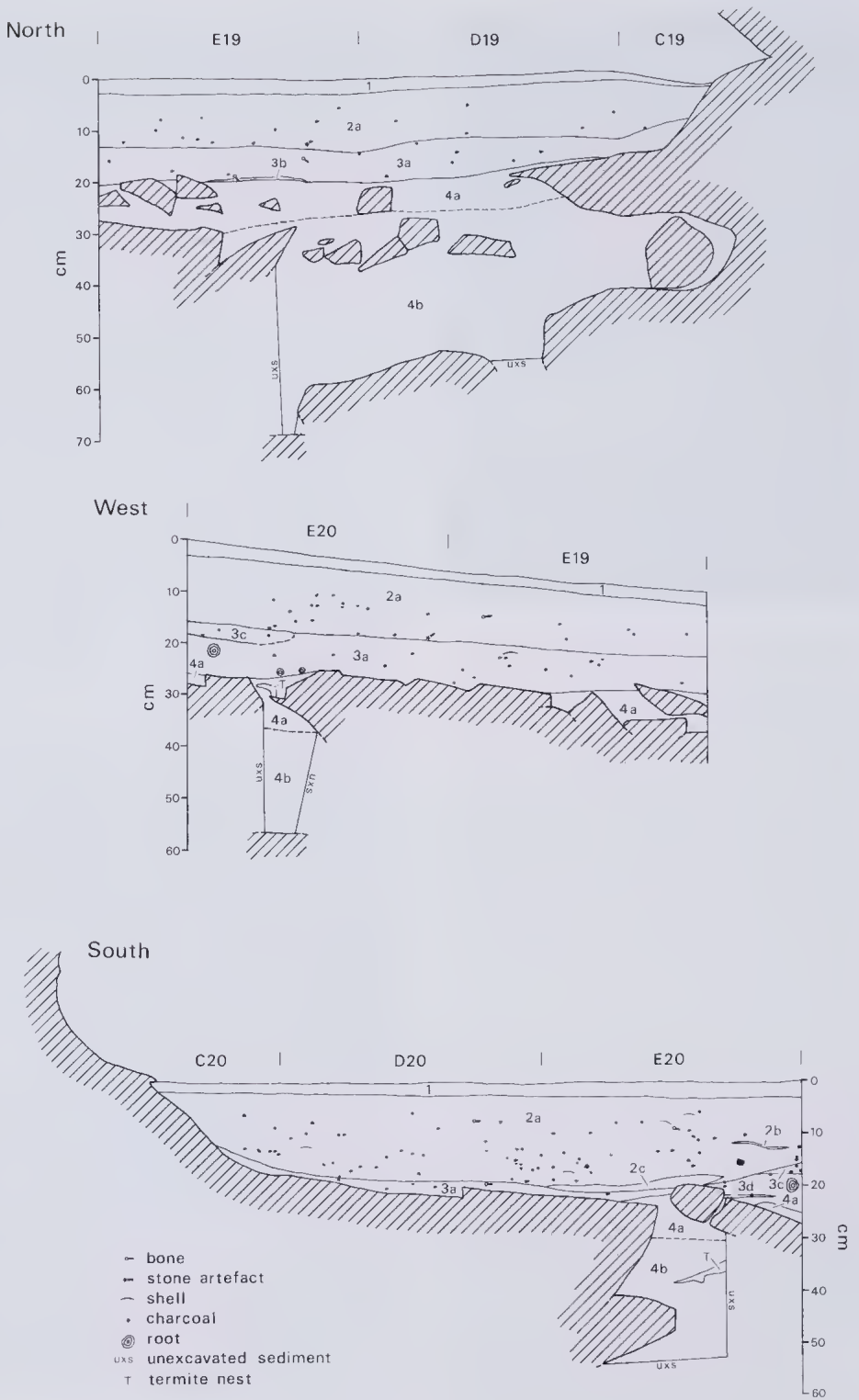


FIG 6. Yiwarrlarlay 1 section drawings.

rates of the various cultural materials changes significantly immediately after European contact (beginning of SU3), when increases in all cultural materials are noted (David et al., 1990, table 1). The post-contact period sees the first appearance of in situ ochres and of exfoliated painted wall cortex (five tiny fragments of ochre were found in spits immediately underlying SU3. These are likely to be post-depositional intrusions, as are the fine particles of charcoal in the upper spits of SU4). The ochres and the exfoliated painted wall cortex deposition rates continue to increase through the 19th century, and peak during the first half of the 20th century. Unpainted exfoliated wall cortex occurs throughout the deposits, implying that the surface of the rock wall has been unstable and exfoliating at least since humans first started camping at the site. The ochres and painted wall cortex only in post-contact levels imply that the paintings at Yiwarralarlay 1 are a post-contact phenomenon. This is especially the case with respect to the paintings of the Lightning Brothers given that the excavation pit was located immediately beneath them (David et al., 1990).

A human burial occurs in eroding sediments in a crack in the rock situated towards the southern end of the shelter. Fragments of ochred bone, similar to those of the eroding burial, were found in situ in the excavated deposits, from SU1 down to SU3 (inclusive). All such bones are very small fragments. It is likely that the burial which is currently eroding has been doing so since the beginnings of deposition of SU3, as fragments occur in the deposits since then. The burial is located in close proximity to the excavation squares, and slightly up-slope, although elsewhere the surface of the shelter floor is flat. Given the post-contact nature of SU3, the burial itself is also likely to have been deposited during post-contact times (no ochred bone fragments have been found in SU4).

## CONCLUSION

Archaeologically, Yiwarralarlay 1 does not show in situ evidence of human occupation before approximately the thirteenth century A.D. Since then, low intensity occupation has prevailed until the arrival of Europeans sometime during the 19th century. In association with this event Aboriginal use of Yiwarralarlay 1 increased dramatically. This is expressed not only in a proliferation of stone artefacts, ochred bone

(burial) and food refuse, but also in the beginnings of painting at the site.

Yet underlying the paintings on the walls of the shelter are numerous peckings and abraded grooves, most of which are highly patinated and therefore likely, though not necessarily, to have considerable antiquity. It is possible that such engravings were made at a time before people camped at the site itself; in other words, before the deposition of anthropogenic materials at the site. For this reason, in part, archaeological investigations in other rockshelters at and around Yiwarralarlay could prove useful in understanding the antiquity of the rock art at Yiwarralarlay 1 and beyond. Such excavations will be published at a later date.

## ACKNOWLEDGEMENTS

We would like to thank the many Wardaman people who showed us and allowed us to record and excavate some of their sites. Special thanks go to Ruby Alison, Riley Birdun, July Blatcher, Daisy Gimin, Lily Gingina, Queenie Ngabijiji, Tarpot Ngamunagami, Elsie Raymond, Oliver Raymond, Barbara Raymond, Michael Raymond, Lindsay Raymond and Tilley Raymond. The Lightning Brothers story recounted in the Introduction of this paper was told to us on-site in 1989 by Elsie Raymond, with Tarpot, Lily, and Riley also present.

We would also like to thank the 1989 Earthwatch team for helping with the excavation and sorting of Yiwarralarlay 1, and Earthwatch for financing the expedition. Thanks also to Francesca Merlan and Robin Frost for useful discussions in the field, and to Sandra Cochrane, Tracey Barrett and Nicole Hayley for helping to sort the Yiwarralarlay 1 material. Last but not least, thanks go to the Australian Institute of Aboriginal and Torres Strait Islander Studies and the Australian Heritage Commission for funding of the radiocarbon dates.

## LITERATURE CITED

- ARNDT, W. 1962. The interpretation of the Delamere lightning painting and rock engravings. *Oceania* 32: 163-177.
- DAVID, B., McNIVEN, I., FLOOD, J. AND FROST, R. 1990. Yiwarralarlay 1: archaeological excavations at the Lightning Brothers site, Delamere station, Northern Territory. *Archaeology in Oceania* 25 (2): 79-84.
- DAVID, B., McNIVEN, I. AND FLOOD, J. in press.

The Lightning Brothers Project: 1988 and 1989 field seasons. Australian Archaeology.

HARNEY, W.E. 1943. Taboo. (Australasian Publishing Company: Sydney).

JOHNSON, I. 1979. 'The getting of data'. Unpublished PhD thesis, Australian National University: Canberra.

MERLAN, F. 1989. The interpretive framework of

Wardaman rock art: a preliminary report. Australian Aboriginal Studies 1989 (2): 12-24.

VON DANIKEN, E. 1971. 'Chariots of the Gods: unsolved mysteries of the past'. (Transworld: London).

WHITE, J.P. 1974. 'The past is human'. (Angus and Robertson: Sydney).

## APPENDIX

List of materials retrieved from all excavation squares. Note that glass flakes are included in the "Stone Artefacts" columns. SU=Stratigraphic Unit (Layer); XU=Excavation Unit (spit).

### SQUARE C18

XU	SU	1	2	3	4	5	6	7	8	9	10	11	12
1	1	4.8	0.30	1	0.08	9.05	35.44	0.17	2	1.26	1	1.37	5
2	2	3.1	0.45			11.98	7.92	0.17					11

1=BONE (GM); 2=MUSSEL SHELL (GM); 3=OCHRE (#); 4=OCHRE (GM); 5=CHARCOAL (GM); 6=OTHER ORGANICS (GM); 7=OCHRED BONE (GM); 8=OCHRED CORTEX (#); 9=OCHRED CORTEX (GM); 10=UNOCHRED CORTEX (#); 11=UNOCHRED CORTEX (GM); 12=STONE ARTEFACTS (#).

### SQUARE D18

XU	SU	1	2	3	4	5	6	7	8	9	10	11	12	13
1	1	22.8	1.47	2	0.21	35.57	71.36	0.10	2	0.35	1	0.4	0.01	18
2	2	14.6	1.5			24.11	21.73	0.19	9	1.93				31

1=BONE (GM); 2=MUSSEL SHELL (GM); 3=OCHRE (#); 4=OCHRE (GM); 5=CHARCOAL (GM); 6=OTHER ORGANICS (GM); 7=OCHRED BONE (GM); 8=OCHRED CORTEX (#); 9=OCHRED CORTEX (GM); 10=UNOCHRED CORTEX (#); 11=UNOCHRED CORTEX (GM); 12=EGG SHELL (GM); 13=STONE ARTEFACTS (#).

### SQUARE E18

XU	SU	1	2	3	4	5	6	7	8	9	10	11	12	13
1	1	20.4	2.16	1	0.11	56.13	87.24	6.03*	0.78				0.03	38
2	2	17.0	1.18	3	0.24	33.43	30.83	0.07**	0.82	3	0.11	0.04		31

1=BONE (GM); 2=MUSSEL SHELL (GM); 3=OCHRE (#); 4=OCHRE (GM); 5=CHARCOAL (GM); 6=OTHER ORGANICS (GM); 7=CONTACT OBJECTS (GM); 8=OCHRED BONE (GM); 9=OCHRED CORTEX (#); 10=OCHRED CORTEX (GM); 11=EGG SHELL (GM); 12=LAND SNAIL (GM); 13=STONE ARTEFACTS (#). \*=1 TIN LID + 1 FRAGMENT OF ALUMINIUM FOIL; \*\*=1 FRAGMENT OF ALUMINIUM FOIL.

### SQUARE F18

XU	SU	1	2	3	4	5	6	7	8	9	10	11	12
1	1	32.8	1.12	9	0.50	36.12	106.86	0.10*	0.36	4	0.17	0.07	21
2	2	5.6	0.30	2	0.19	9.83	24.62	0.10**	1.42				8

1=BONE (GM); 2=MUSSEL SHELL (GM); 3=OCHRE (#); 4=OCHRE (GM); 5=CHARCOAL (GM); 6=OTHER ORGANICS (GM); 7=CONTACT OBJECTS (GM); 8=OCHRED BONE (GM); 9=OCHRED CORTEX (#); 10=OCHRED CORTEX (GM); 11=LAND SNAIL (GM); 12=STONE ARTEFACTS (#). \*=1 PIECE OF PAPER + 1 PIECE OF CLOTH; \*\*=2 FRAGMENTS OF ALUMINIUM FOIL.

### SQUARE G19

XU	SU	1	2	3	4	5	6	7	8	9	10	11	12	13	14
1	1	8.4	0.21			8.59	38.29		0.76	4	0.13	1	0.05		6
2	2	5.3	0.22	1	0.05	12.06	15.63		0.05	1	0.04				8
3	2+3A	4.4	1.03	4	0.50	27.58	2.38	0.04	0.10	1	0.09				12
4	3A	5.2	0.20			13.52	3.32								4
5	3A	1.4	0.19	1	0.16	5.12	2.81								3
6	3A+4	0.2	0.05			1.06	0.23								1
7	4B					0.04	0.21			1?	0.042			0.23	3
8	4B					0.07	0.15							0.04	4
9	4B					0.15	11.60								4
10	4B						0.03								

1=BONE (GM); 2=MUSSEL SHELL (GM); 3=OCHRE (#); 4=OCHRE (GM); 5=CHARCOAL (GM); 6=OTHER ORGANICS (GM); 7=CONTACT OBJECTS (GM); 8=OCHRED BONE (GM); 9=OCHRED CORTEX (#); 10=OCHRED CORTEX (GM); 11=UNOCHRED CORTEX (#); 12=UNOCHRED CORTEX (GM); 13=TERMITE NEST (GM); 14=STONE ARTEFACTS (#).

### SQUARE D19

XU	SU	1	2	3	4	5	6	7	8	9	10	11	12
1	1	12.4	0.83	6	0.16	6.80	132.23	0.05	0.81	10	0.90	5	1.31
2	2	10.3	0.72	2	0.13	20.62	36.59		0.92	1	0.05		
3	2	22.9	2.68			45.62	8.65		0.12	1	0.01		
4	2	26.5	2.95	5	0.20	59.52	8.48		0.40				
5	2+3A	28.0	4.33	3	0.12	90.98	0.04		0.40	1	0.04		
6	3A	21.9	1.90	1	0.04	47.49			2.73	2	0.05		



7	3A+3B	6.2	0.55			18.30	1.84	0.01					
8	4A	0.2	0.03	1	0.04	0.53	3.30			2	0.03		
9	4B					0.13	0.56						
10	4B	0.2		2	0.15	0.14	15.15			5	0.19		
11	4B						0.53			1	0.17		
12A	4B					0.14	5.46						
12B	4B						0.18						
13	4B						0.54						

XU	SU	13	14	15	16	17	18
1	1						18
2	2	2.10	0.97				18
3	2						12
4	2			0.01			28
5	2+3A		0.44	0.04	0.01		66
6	3A		2.00		0.01		60
7	3A+3B				0.01		12
8	4A						6
9	4B						2
10	4B					8.97	17
11	4B						8
12A	4B					5.69	4
12B	4B						8
13	4B					0.18	3

1=BONE (GM); 2=MUSSEL SHELL (GM); 3=OCHRE (#); 4=OCHRE (GM); 5=CHARCOAL (GM); 6=OTHER ORGANICS (GM); 7=OCHRED PAPER-BARK (GM); 8=OCHRED BONE (GM); 9=OCHRED WALL CORTEX (#); 10=OCHRED WALL CORTEX (GM); 11=UNOCHRED WALL CORTEX (#); 12=UNOCHRED WALL CORTEX (GM); 13=PIECE OF WOOD (GM); 14=BURN'T EARTH BURN'T STONE (GM); 15=EGG SHELL (GM); 16=LAND SNAIL (GM); 17=TERMITE NEST (GM); 18=STONE ARTEFACTS (#).

## SQUARE E19

XU	SU	1	2	3	4	5	6	7	8	9	10	11	12
1	1	16.0	1.68	2	0.07	107.41	0.04*		1.11	6.37	0.01	T11	
2	2	15.0	0.99			19.35			0.19	31.81			2
3	2	17.4	1.53			10.00	0.02**		0.37	26.25			
4	2	18.1	1.30	1	0.08	2.01	0.25*		0.24	42.47			1
5	3A	27.3	3.92			1.66				75.50	0.01		
6	3A	29.6	2.54	1	0.09	7.18				92.89			
7	3B	10.7	1.14			2.55				31.16		0.01	1
8	4A	0.1	0.03			1.34		2.29		0.58			
9A	4					1.06				0.53			
9B	4***					0.16				0.01			
10A	4B***	0.3				2.63				0.42			
10B	4B					0.23							
11A	4B***					3.74							?
11B	4B					0.01							
12	4B***					0.40						0.01	
13A	4B***					1.64				0.05			
13B	4B					0.09							
14	4B					0.20							

XU	SU	13	14	15	16	17
1	1	5.79	1	0.99	27	
2	2	0.61	1	0.44	16	
3	2				9	
4	2	0.04			17	
5	3A				18	
6	3A				25	
7	3B	0.27	1	0.09	37	
8	4A				9	
9A	4				5	
9B	4***				1	9.99
10A	4B***				11	26.15
10B	4B				2	
11A	4B***	?	1	0.01	1	70.72
11B	4B				1	
12	4B***		2	0.06	5	140.28
13A	4B***		1	0.02	5	41.70
13B	4B				3	0.10
14	4B				4	

1=BONE (GM); 2=MUSSEL SHELL (GM); 3=OCHRE (#); 4=OCHRE (GM); 5=OTHER ORGANICS (GM); 6=CONTACT OBJECTS (GM); 7=BURN'T EARTH BURN'T STONE (GM); 8=OCHRED BONE (GM); 9=CHARCOAL (GM); 10=LAND SNAIL (GM); 11=EGG SHELL (GM); 12=OCHRED CORTEX (#); 13=OCHRED CORTEX (GM); 14=UNOCHRED CORTEX (#); 15=UNOCHRED CORTEX (GM); 16=STONE ARTEFACTS (#); 17=TERMITE NEST (GM). \* = 2 PIECES OF ALUMINIUM FOIL; \*\* = 1 PIECE OF ALUMINIUM FOIL; \*\*\* = XU DISTURBED BY TERMITES.

## SQUARE F19

XU	SU	1	2	3	4	5	6	7	8	9	10	11	12
1	1	9.2	2.23	3	0.35	41.59	87.76	0.03*	2.37	3	0.15	T16	
2	2	12.2	0.41	2	0.37	28.00	32.23	0.10*	0.05	4	1.62	0.08	7

1=BONE (GM); 2=MUSSEL SHELL (GM); 3=OCHRE (#); 4=OCHRE (GM); 5=CHARCOAL (GM); 6=OTHER ORGANICS (GM); 7=CONTACT OBJECTS (GM); 8=OCHRED BONE (GM); 9=OCHRED WALL CORTEX (#); 10=OCHRED WALL CORTEX (GM); 11=LAND SNAIL (GM); 12=STONE ARTEFACTS (#). \* = 1 FRAGMENT OF ALUMINIUM FOIL.

## SQUARE C20

XU	SU	1	2	3	4	5	6	7	8	9	10	11	12	13	14
1	1	8.4	0.31	10.27	36.51		0.22	7	0.19			0.05	1	0.04	4
2	2	9.6	1.00	8.10	21.17		0.16	5	0.09		0.01				9
3	2	11.4	0.32	16.89	6.35		0.15			0.14			1	0.02	10

4	2	22.9	2.81	36.62	4.59	35.58*	0.47					1	0.60	15
5	2+3A	5.49	0.18	9.92	1.17			1	0.06	0.03		2	0.08	7

1=BONE (GM); 2=MUSSEL SHELL (GM); 3=CHARCOAL (GM); 4=OTHER ORGANICS (GM); 5=CONTACT OBJECTS (GM); 6=OCHRED BONE (GM); 7=OCHRED CORTEX (#); 8=OCHRED CORTEX (GM); 9=BURNT EARTH/BURNT STONE (GM); 10=EGG SHELL (GM); 11=LAND SNAIL (GM); 12=OCHRE (#); 13=OCHRE (GM); 14=STONE ARTEFACTS (#). \*=CUT-THROAT RAZOR.

#### SQUARE D20

XU	SU	1	2	3	4	5	6	7	8	9	10	11	12	13	14
1	1	23.3	0.50			27.79	84.67	0.05*	0.64						4
2	2	20.9	1.39			24.02	36.80	0.05**	1.94	6	0.70			6.78	9
3	2	34.3	1.48	4	0.08	41.39	16.12		0.49	2	0.28				10
4	2	57.6	3.03	2	0.16	87.36	8.05	0.05***	1.63			1	0.03		56
5	2+3A	51.4	13.32	9	0.28	98.19	11.67		6.74	2	0.03	2	0.22		38
6	2+3A	53.7	2.79	2	0.10	63.50	1.89								39
7	4A	10.5	1.21	2	0.17	23.31	0.93								47
8	4					0.15	0.35					2	7.81		
9	4					0.01	0.04	0.06****							

1=BONE (GM); 2=MUSSEL SHELL (GM); 3=OCHRE (#); 4=OCHRE (GM); 5=CHARCOAL (GM); 6=OTHER ORGANICS (GM); 7=CONTACT OBJECTS (GM); 8=OCHRED BONE (GM); 9=OCHRED CORTEX (#); 10=OCHRED CORTEX (GM); 11=UNOCHRED CORTEX (#); 12=UNOCHRED CORTEX (GM); 13=LARGE QUARTZ CRYSTAL (GM); 14=STONE ARTEFACTS (#). \*=1 PIECE OF ALUMINIUM FOIL. + 1 MATCHSTICK; \*\*=2 PIECES OF ALUMINIUM FOIL.; \*\*\*=1 PIECE OF ALUMINIUM FOIL. + 1 PIECE OF PLASTIC; \*\*\*\*=1 PIECE OF PLASTIC.

#### SQUARE E20

XU	SU	1	2	3	4	5	6	7	8	9	10	11	12
1	1	7	0.29	28.62	4	0.68	3	1.05	0.94	21.09			70.41
2	2	19	0.11	26.11			1	0.28	1.66	27.05	4	0.14	35.62
3	2	31	0.01	25.36			1	0.03	0.97	27.92	2	0.46	13.75
4	2	20		31.46					3.78	25.36			2.66
5	2	73	0.09	133.41			2	0.65	5.08	65.15			2.26
6	2+3	43		99.99					3.89	28.66	1	0.09	5.13
7	3A	56		37.08					3.32	23.39			6.60
8	4A			0.65						0.06			0.81
9	4B			0.29			1	0.08		0.24			0.60
10A	4B*	2											0.18
10B	4B			0.01									0.21
11	4B*	2		0.01			1	0.01					3.59
12	4B*	5					3	0.15			0.10		1.23
13	4B*	4											6.76
14	4B			0.01									0.78

1=STONE ARTEFACTS (#); 2=CONTACT OBJECTS (GM); 3=CHARCOAL (GM); 4=OCHRED CORTEX (#); 5=OCHRED CORTEX (GM); 6=UNOCHRED CORTEX (#); 7=UNOCHRED CORTEX (GM); 8=MUSSEL SHELL (GM); 9=BONE (INCLUDING OCHRED BONE) (GM); 10=OCHRE (#); 11=OCHRE (GM); 12=OTHER ORGANICS (GM). \*=TERMITE DAMAGE.

#### SQUARE F20

XU	SU	1	2	3	4	5	6	7	8	9
1	1	12.4	0.65	1	0.92	38.71	118.19		0.97	16
2	2	6.9	1.04			11.15	32.81	0.13*	0.03	12

1=BONE (GM); 2=MUSSEL SHELL (GM); 3=OCHRE (#); 4=OCHRE (GM); 5=CHARCOAL (GM); 6=OTHER ORGANICS (GM); 7=CONTACT OBJECTS (GM); 8=OCHRED BONE (GM); 9=STONE ARTEFACTS (#). \*=1 PIECE OF ALUMINIUM FOIL.

#### SQUARE C21

XU	SU	1	2	3	4	5	6	7	8	9	10	11	12
1	1	6.1	0.08	1	0.03	10.71	35.12		0.24	7	0.32		9
2	2	9.9	0.37			6.86	26.47	0.10*	0.28			0.02	9

1=BONE (GM); 2=MUSSEL SHELL (GM); 3=OCHRE (#); 4=OCHRE (GM); 5=CHARCOAL (GM); 6=OTHER ORGANICS (GM); 7=CONTACT OBJECTS (GM); 8=OCHRED BONE (GM); 9=OCHRED CORTEX (#); 10=OCHRED CORTEX (GM); 11=EGG SHELL (GM); 12=STONE ARTEFACTS (#). \*=1 MATCHSTICK.

#### SQUARE D21

XU	SU	1	2	3	4	5	6	7	8	9	10	11	12
1	1	21.7	0.25	33.33	95.01		0.78	11	0.67	3	0.32	0.01	15
2	2	21.2	0.85	34.66	63.18	0.11*	1.96	5	0.17				10

1=BONE (GM); 2=MUSSEL SHELL (GM); 3=CHARCOAL (GM); 4=OTHER ORGANICS (GM); 5=CONTACT OBJECTS (GM); 6=OCHRED BONE (GM); 7=OCHRED CORTEX (#); 8=OCHRED CORTEX (GM); 9=UNOCHRED CORTEX (#); 10=UNOCHRED CORTEX (GM); 11=LAND SNAIL (GM); 12=STONE ARTEFACTS (#). \*=1 PIECE OF ALUMINIUM FOIL. + 1 MATCHSTICK.

#### SQUARE C21

XU	SU	1	2	3	4	5	6	7	8	9	10	11	12	13
1	1	19.0	0.61	5	2.70	32.29	63.40	1.50	2	3.77			22	
2	2	27.9	2.33			40.48	25.41	1.54	9	0.54	3	0.60	0.05	33

1=BONE (GM); 2=MUSSEL SHELL (GM); 3=OCHRE (#); 4=OCHRE (GM); 5=CHARCOAL (GM); 6=OTHER ORGANICS (GM); 7=OCHRED BONE (GM); 8=OCHRED CORTEX (#); 9=OCHRED CORTEX (GM); 10=UNOCHRED CORTEX (#); 11=UNOCHRED CORTEX (GM); 12=LAND SNAIL (#); 13=STONE ARTEFACTS (#).

#### SQUARE F21

XU	SU	1	2	3	4	5	6	7	8	9	10	11	12
1	1	19.8	0.75	1	0.17	29.90	63.29	0.10*	2.16	5	21.93		32
2	2	14.7	2.95			22.36	18.95	0.01**	0.50			4.25	22

1=BONE (GM); 2=MUSSEL SHELL (GM); 3=OCHRE (#); 4=OCHRE (GM); 5=CHARCOAL (GM); 6=OTHER ORGANICS (GM); 7=CONTACT OBJECTS (GM); 8=OCHRED BONE (GM); 9=OCHRED CORTEX (#); 10=OCHRED CORTEX (GM); 11=BURNT EARTH BURNT STONE (GM); 12=STONE ARTEFACTS (#). \*=2 CIGARETTE BUTTS; \*\*=1 CIGARETTE BUTT.

# FAUNAL SURVEY OF NEW ENGLAND III. BIRDS.

HUGH A. FORD AND DAVID MCFARLAND

Ford, H.A. and McFarland, D. 1991:08:01. Faunal survey of New England III. Birds. *Memoirs of the Queensland Museum* 30(3):381-431. Brisbane. ISSN 0079-8835.

The birds of the New England region were recorded between 1978 and 1982; distributions of the 296 species were mapped on a square grid. Maps are provided for 214 species; others were only rarely sighted and their distribution is described. The diversity of birds is attributed to a great diversity of habitats and location of the area near the boundaries of several zoogeographic areas.

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In 1966 staff and students of the University of New England embarked on a faunal survey of the New England region (Heatwole and Simpson, 1986). Briefly, the area encompasses the Commonwealth Electorate of New England as it was in 1975. This falls between latitudes 28° 50' S and 31° 40' S and longitudes 150° 00' E and 152° 40' E.

New England has a diverse topography, ranging from 200 m above sea level to 1500 m asl. Habitat ranges from closed forests on the eastern escarpment of the Great Dividing Range to dry woodland on the western slopes. There are rapidly flowing streams with high waterfalls, sluggish meandering rivers and freshwater swamps, lagoons and lakes, but no sea coast. Extensive areas have been cleared for agriculture, or greatly modified by logging and grazing. Data are available for relief, soils, climate, vegetation, geology and land-use (Figs 1,2; Lea et al., 1977; Heatwole and Simpson, 1986).

Simpson and Staniscic (1986) described the distribution of gastropods. This paper presents the distribution of birds. The distribution of birds in Australia is now reasonably well known, through efforts of the Royal Australasian Ornithologists' Union (1977-1981). Ranges were plotted at the scale of 1° squares of latitude and longitude (Blakers et al., 1984). Other atlases that pre-date the Australia-wide atlas are those in the Adelaide region (SAOA, 1977) and a section of the south coast of NSW (Disney, 1979). Atlases of Tasmania and Victoria have used the RAOU data base (Thomas, 1979, Emison et al., 1987). Morris et al. (1981) described the distribution of birds in New South Wales. Their Northern Tablelands region is wholly within New England, and their North

West Slopes are mostly within the New England region covered by this atlas.

## MATERIALS AND METHODS

Although the aim of the New England survey was to collect data at the level of 5 minute

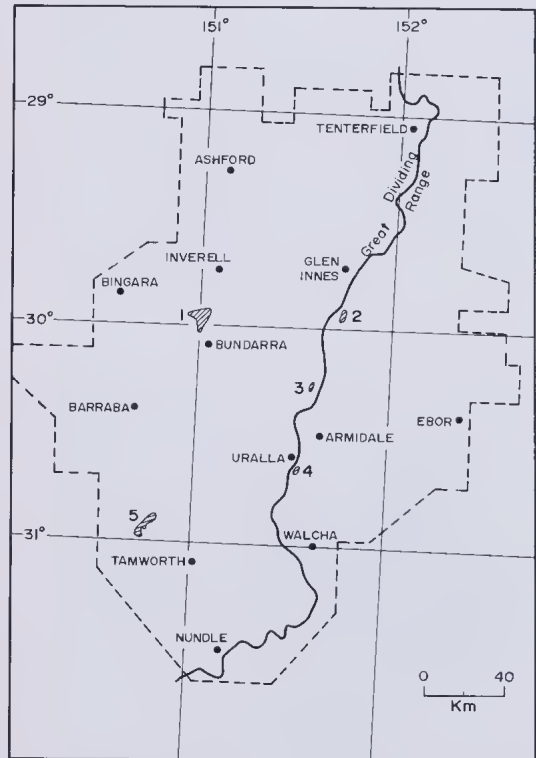


FIG. 1. Collecting grid, with main towns and water bodies: - 1, Copeton Dam. 2, Llangothlin Lagoon. 3, Mother of Ducks Lagoon. 4, Dangar's Lagoon. 5, Keepit Dam.

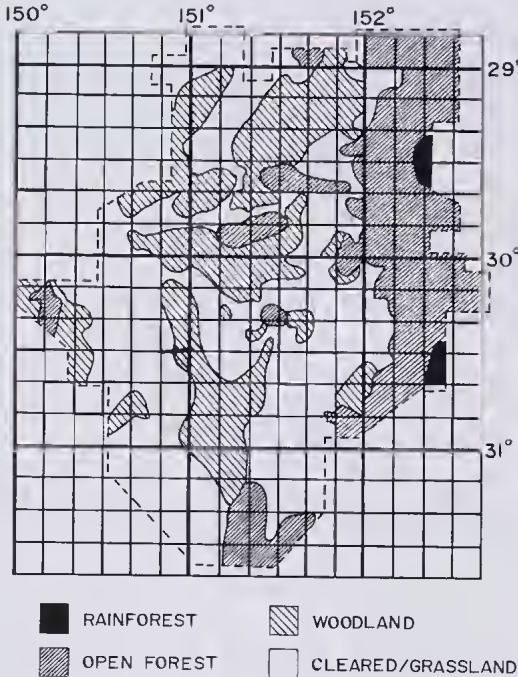


FIG. 2. Vegetation of the New England region.

squares, and gastropods were mapped on this scale, data for the RAOU atlas were collected on 10 minute squares. As we used the RAOU atlas data, distributions of birds in this paper are mapped on that scale. Richard Noske, at that time a postgraduate student in the Department of Zoology at the University of New England, was coordinator of the RAOU atlas for the region from 1977 to 1981. All atlas data were passed through the University of New England to the RAOU. Subsequently the RAOU queried unusual records, which were checked locally, and later sent maps of each species to UNE. These maps are presented and interpreted here. A square is filled in when the species was recorded there during the atlas period. Breeding is indicated by a black dot in the centre of the square.

Compass points and states are abbreviated to first letters. Australia is abbreviated to 'Aust.', New Guinea to 'NG', and New Zealand to 'NZ'. The heading 'RANGE' = the total range of the species.

## RESULTS

Bird distributions are shown, except where a species occurred in fewer than 10 squares, in which case individual localities are identified or the location of clusters described. Distribution

data are from Blakers et al. (1984), unless otherwise stated.

### Emu *Dromaius novaehollandiae*

RANGE: almost throughout Aust.

HABITAT: Most, except for dense forests, waterless deserts and closely settled areas.

N. ENG. RANGE: 9 squares, NW fringe.

### Great-crested Grebe *Podiceps cristatus*

RANGE: E and SW Aust. and T, with a few records from the NW and centre. Also NZ, Europe, Asia and Africa.

HABITAT: permanent freshwater lakes, sometimes on the sea.

N. ENG. RANGE: 5 squares, most frequently Lake Keepit, Dangar's Lagoon.

### Hoary-headed Grebe *Poliiocephalus poliiocephalus* (Fig. 3)

RANGE: almost throughout Aust.

HABITAT: freshwater lakes, lagoons, swamps, saltlakes, coastal waters.

N. ENG. RANGE: mostly lagoons along the Great Dividing Range, Copeton Dam and Lake Keepit. Numbers fluctuate, with up to 100 being recorded at a single site (Gosper, 1973).

### Australasian Grebe *Tachybaptus novaehollandiae* (Fig. 4)

RANGE: Aust., (scarce T), NG, Indonesia and NZ.

HABITAT: freshwater, occasionally saltwater.

N. ENG. RANGE: all water, incl. small farm dams.

### Australian Pelican *Pelecanus conspicillatus* (Fig. 5)

RANGE: Aust., breeding in only a few, mostly coastal, sites. NG, as a vagrant in Indonesia and NZ.

HABITAT: lakes, larger rivers, estuaries and the sea.

N. ENG. RANGE: larger water bodies; one breeding record from Lake Keepit (Morris et al., 1981).

### Darter *Anhinga melanogaster* (Fig. 6)

RANGE: E, N and SW Aust, S Africa, S Asia and NG, vagrant in T and NZ.

HABITAT: freshwater.

N. ENG. RANGE: most larger water bodies and many smaller ones, breeding record from Copeton Dam.

### Great Cormorant *Phalacrocorax carbo* (Fig. 7)

RANGE: cosmopolitan, widespread in Aust., mostly breeding south of 20° S.

HABITAT: freshwater and marine.

N. ENG. RANGE: well distributed, breeding at Copeton Dam.

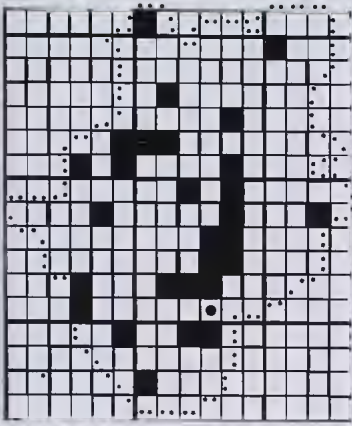


FIG. 3. Hoary-headed Grebe.

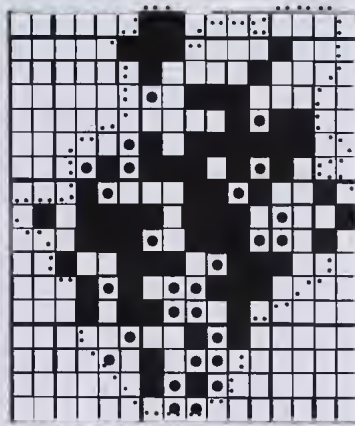


FIG. 4. Australasian Grebe.

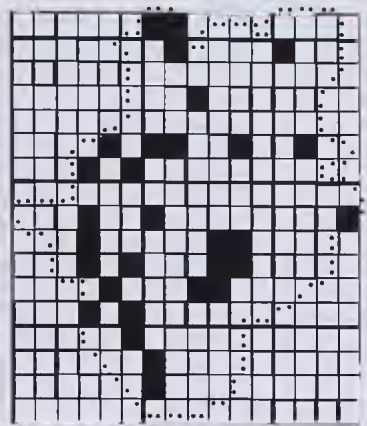


FIG. 5. Australian Pelican.

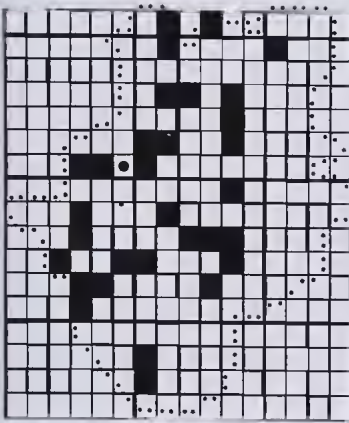


FIG. 6. Darter.

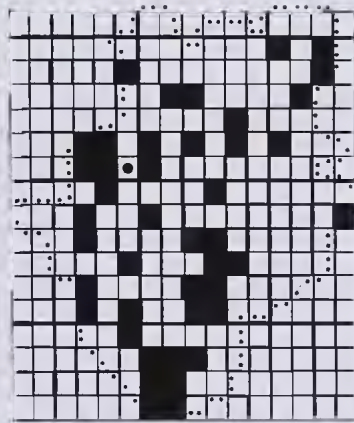


FIG. 7. Great Cormorant.

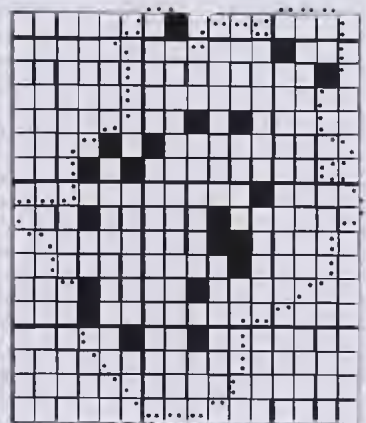


FIG. 8. Pied Cormorant.

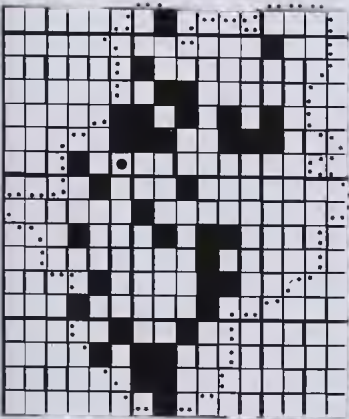


FIG. 9. Little Black Cormorant.

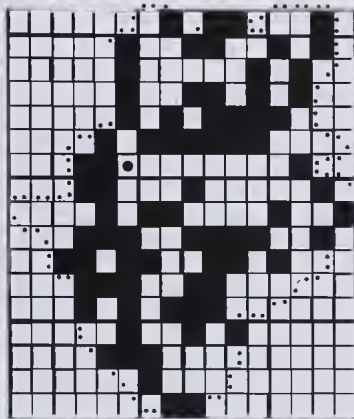


FIG. 10. Little Pied Cormorant.

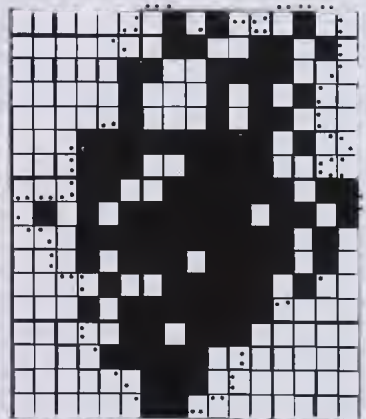


FIG. 11. Pacific Heron.

**Pied Cormorant *P. varius* (Fig.8)**

RANGE: Aust., scarce T, and NZ.

HABITAT: fresh and saltwater.

N. ENG. RANGE: larger water bodies, though less common than other cormorants and no breeding records.

**Little Black Cormorant *P. sulcirostris* (Fig.9)**

RANGE: widespread in Aust., also Indonesia, NG and NZ.

HABITAT: mostly freshwater.

N. ENG. RANGE: common on larger water bodies, single breeding record from Copeton Dam.

**Little Pied Cormorant *P. melanoleucos* (Fig.10)**

RANGE: throughout Aust. and the SW Pacific, some sub-Antarctic Islands.

HABITAT: all water bodies, including small dams.

N. ENG. RANGE: widespread, breeding at Copeton Dam, and probably elsewhere.

**Red-tailed Tropicbird *Phaeton rubricauda***

RANGE: small islands in the Indian and Pacific Oceans, including Raine, Norfolk, Lord Howe, Cocos-Keeling and Christmas Islands and Sugarloaf Rock near Perth.

HABITAT: pelagic outside breeding season.

N. ENG. RANGE: rare vagrant, but in March 1978 the remnants of a tropical cyclone crossed the NSW coast and swept many tropicbirds inland (Morris, 1979). Red-tailed Tropicbirds were found in Armidale, Tamworth and Barraba on 21 March 1978. Others were found further west at Baradine, Bourke, Warrumbungles National Park and Dubbo.

**White-tailed Tropicbird *Phaeton lepturus***

RANGE: small islands in Pacific Ocean, none in Australian waters.

HABITAT: pelagic outside breeding season.

N. ENG. RANGE: The same cyclone that drove Red-tailed Tropicbirds inland in 1978, led to five White-tailed Tropicbirds being found in Tamworth (Morris, 1979).

**Pacific Heron *Ardea pacifica* (Fig.11)**

RANGE: throughout Aust., most breeding colonies inland, vagrant to NG and NZ.

HABITAT: freshwater.

N. ENG. RANGE: widespread, but no breeding records and numbers tend to increase in late summer and autumn.

**White-faced Heron *A. novaehollandiae* (Fig.12)**

RANGE: throughout Aust., small populations in NZ,

New Caledonia and Indonesia, non-breeding visitor to NG.

HABITAT: all types of water body, sometimes paddocks and grassland.

N. ENG. RANGE: widespread, breeding on the tablelands and SW.

**Cattle Egret *Ardeola ibis***

RANGE: native to S Europe, Asia and Africa, and has colonized N and S America. The Cattle Egret probably colonized Aust. in the 1940s, though there had been previous attempts to introduce it. It is now widespread in N, E and SW Aust.

HABITAT: wet pasture.

N. ENG. RANGE: rare visitor to the Northern Tablelands at present, but their populations are expanding on the N coast of NSW, so they can be expected to increase in New England.

**Great Egret *Egretta alba* (Fig.13)**

RANGE: almost cosmopolitan, widespread in coastal Aust. and parts of the inland with substantial bodies of water.

HABITAT: freshwater, estuaries.

N. ENG. RANGE: mostly tableland lagoons and W.

**Little Egret *E. garzetta***

RANGE: almost throughout the Old World and in Aust. mostly in the E and N., has expanded its range recently in S and SW.

HABITAT: freshwater.

N. ENG. RANGE: few records from the tablelands and SW.

**Intermediate Egret *E. intermedia* (Fig.14)**

RANGE: patchy in Africa and Asia, and E and N Aust.

HABITAT: freshwater.

N. ENG. RANGE: most frequent egret on tableland lagoons, a few records from W.

**Rufous Night Heron *Nycticorax caledonicus* (Fig. 15)**

RANGE: SE Asia, Pacific islands and most of Aust.

HABITAT: tree-lined lakes and creeks.

N. ENG. RANGE: widespread and probably under-recorded, breeding near Bingara, just W of the region.

**Australasian Bittern *Botaurus poiciloptilus***

RANGE: SE and SW Aust., T and NZ.

HABITAT: extensive reedbeds and swamps.

N. ENG. RANGE: single record near Bingara.

**Black-necked Stork *Xenorhynchus asiaticus***

RANGE: India, SE Asia, NG and N Aust., including NSW coast and NW Slopes.

HABITAT: extensive swamps and lagoons.

N. ENG. RANGE: one record, from Dangar's Lagoon.

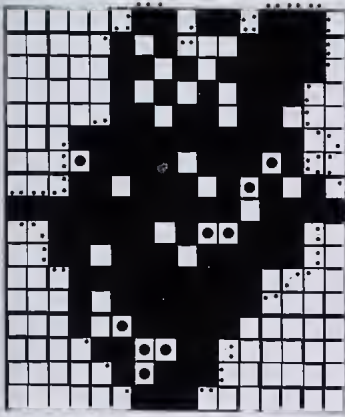


FIG. 12. White-faced Heron.

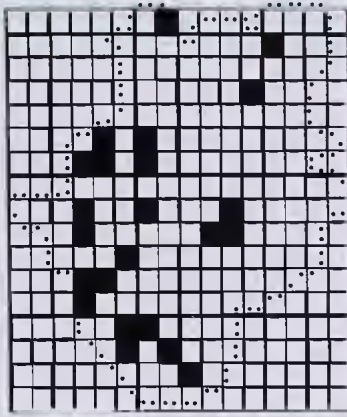


FIG. 13. Great Egret.

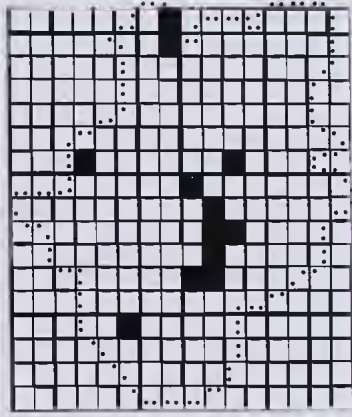


FIG. 14. Intermediate Egret.

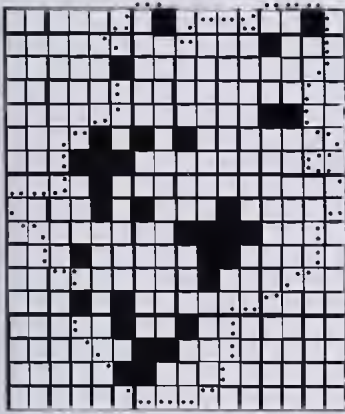


FIG. 15. Rufous Night-heron.

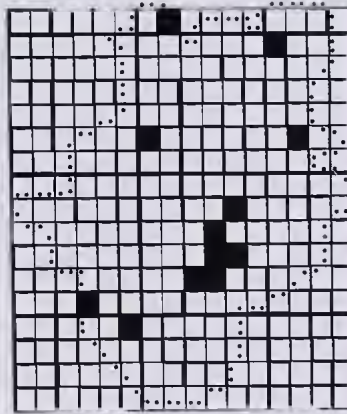


FIG. 16. Glossy Ibis.

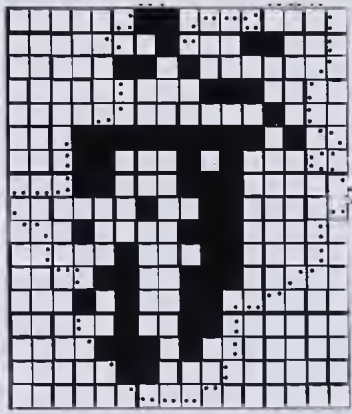


FIG. 17. Sacred Ibis.

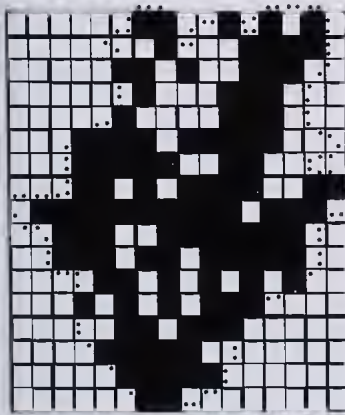


FIG. 18. Straw-necked Ibis.

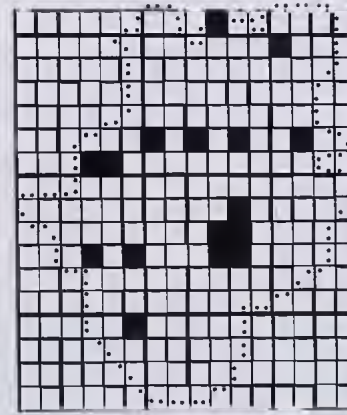


FIG. 19. Royal Spoonbill.

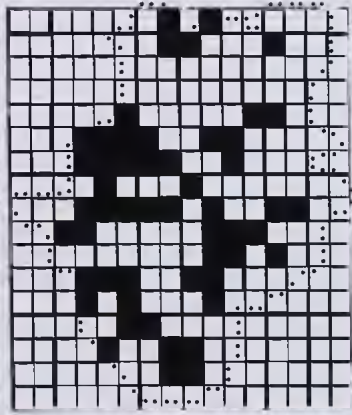


FIG. 20. Yellow-billed Spoonbill.

**Glossy Ibis** *Plegadis falcinellus* (Fig.16)

RANGE: from S Europe to Aust., Africa and America. Widespread in Aust., mostly breeding in the Murray-Darling system.

HABITAT: swamps, lakes and lagoons.

N. ENG. RANGE: infrequent visitor, mostly to tableland lagoons.

**Sacred Ibis** *Threskiornis aethiopica* (Fig.17)

RANGE: Africa, the Middle East, SE Asia, NG and N. E and SW Aust.

HABITAT: lakes, swamps and flooded fields.

N. ENG. RANGE: widespread in suitable wetlands, no breeding records.

**Straw-necked Ibis** *Th. spinicollis* (Fig.18)

RANGE: Aust., rare in T, vagrant in NG.

HABITAT: dry pasture, wet grasslands and marshes. N. ENG. RANGE: throughout N Eng, except forested areas. No breeding records, the Macquarie Marshes probably being the nearest breeding site. Numbers tend to be highest in late summer and autumn.

**Royal Spoonbill** *Platalea regia* (Fig.19)

RANGE: Indonesia, NG and NZ, E and N Aust.

HABITAT: shallow waters, both inland and coastal.

N. ENG. RANGE: small numbers on larger waters.

**Yellow-billed Spoonbill** *P. flavipes* (Fig.20)

RANGE: Aust., except deserts and T.

HABITAT: all types of inland water bodies.

N. ENG. RANGE: more widespread than previous species, even on farm dams.

**Plumed Whistling-duck** *Dendrocygna eytoni*

RANGE: N Aust., through Q and in Murray-Darling system. Vagrant in NG and NZ.

HABITAT: swamps, lagoons, flooded grassland.

N. ENG. RANGE: 6 squares, on several tableland lagoons and the western fringes of the region. Sometimes moderate flocks occur.

**Black Swan** *Cygnus atratus* (Fig.21)

RANGE: most of Aust., scarce in far N and centre. Introduced to NZ, and occurs occasionally in NG.

HABITAT: most larger water bodies.

N. ENG. RANGE: common on tableland lagoons and W, breeding success on lagoons depends on water level and degree of disturbance (White 1986).

**Australian Shelduck** *Tadorna tadornoides*

RANGE: endemic to SE and SW Aust.

HABITAT: fresh and brackish water.

N. ENG. RANGE: single record NE of Glen Innes, well outside normal range.

**Pacific Black Duck** *Anas superciliosa* (Fig.22)

RANGE: Aust., NG, NZ and the islands of the Pacific. HABITAT: permanent waters, creeks, farm dams and floodwater.

N. ENG. RANGE: Widespread, many breeding records. More numerous on tableland lagoons during droughts (Briggs 1977, White 1987).

**Grey Teal** *A. gibberifrons* (Fig.23)

RANGE: Aust., NG, NZ, Indonesia, Andaman Islands. HABITAT: Most wetlands. Nomadic, colonizing inland waters when they flood, then dispersing in all directions when they dry out.

N. ENG. RANGE: nearly as widespread as Black Duck, though less frequent on small water bodies. More numerous in autumn and during inland droughts (Briggs 1977, White 1987).

**Chestnut Teal** *A. castanea*

RANGE: SE and SW Aust., T, vagrant to NG.

HABITAT: saline coastal waters as well as inland.

N. ENG. RANGE: scarce, though regular, visitor to the larger water bodies.

**Australasian Shoveler** *A. rhynchotis* (Fig.24)

RANGE: NZ and SW and SE Aust., with records spread throughout Q.

HABITAT: lakes, permanent swamps.

N. ENG. RANGE: only in tableland lagoons. This accords with its preferred foraging behaviour of surface-filtering and upending to collect vegetation from the bottom. There are no breeding records though it could well breed on the larger lagoons, with dense emergent vegetation.

**Pink-eared Duck** *Malacorhynchus membranaceus*

RANGE: inland Aust. after good rains, coastal areas in droughts.

HABITAT: lakes, extensive swamps and floodwater.

N. ENG. RANGE: uncommon visitor, mostly to the tableland lagoons.

**Hardhead** *Aythya australis* (Fig.25)

RANGE: E and SW Aust., occasionally in NG, NZ and other Pacific islands.

HABITAT: permanent and deep waters, but highly mobile.

N. ENG. RANGE: widespread, where suitable water bodies occur. Single breeding record. Numbers tend to be higher in autumn (Briggs 1977).

**Maned Duck** *Chenonetta jubata* (Fig.26)

RANGE: most of Aust., except far N and deserts.

HABITAT: pasture near freshwater. Has almost certainly increased with clearing of native vegetation and provision of farm dams.



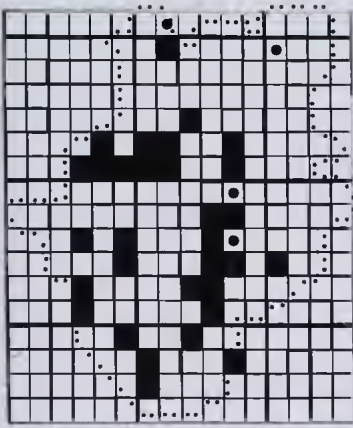


FIG. 21. Black Swan.

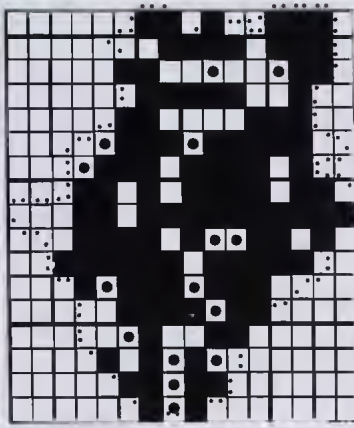


FIG. 22. Pacific Black Duck.

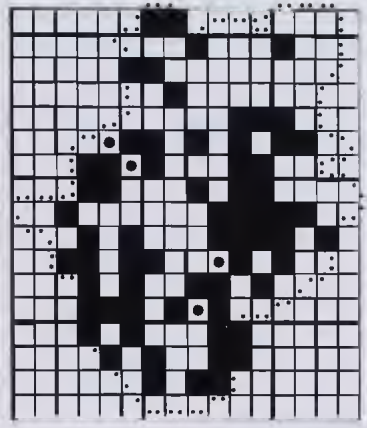


FIG. 23. Grey Teal.

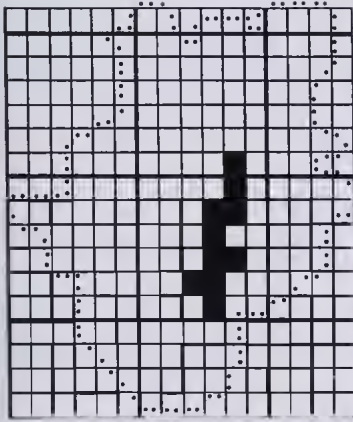


FIG. 24. Australasian Shoveler.

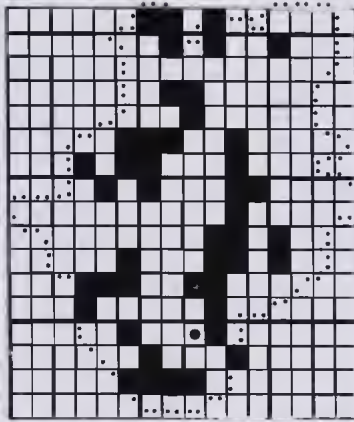


FIG. 25. Hardhead.

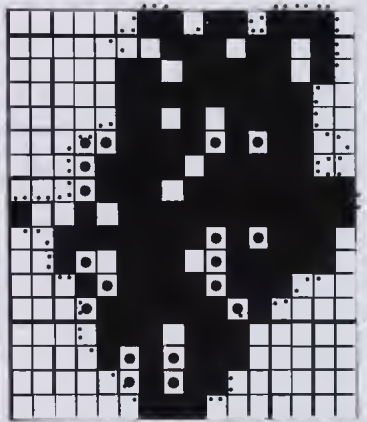


FIG. 26. Maned Duck.

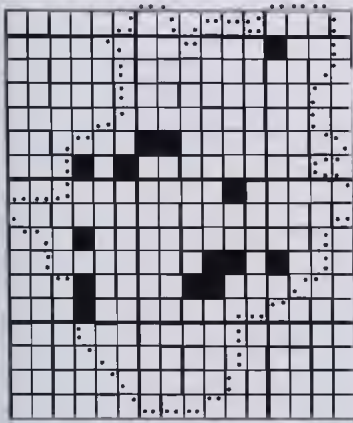


FIG. 27. Musk Duck.

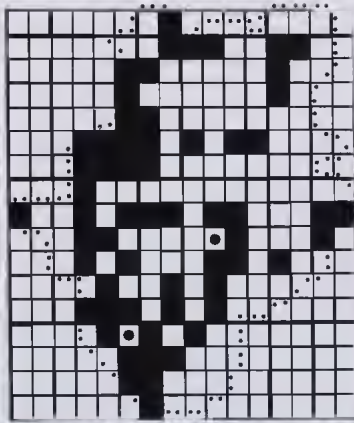


FIG. 28. Black-shouldered Kite.

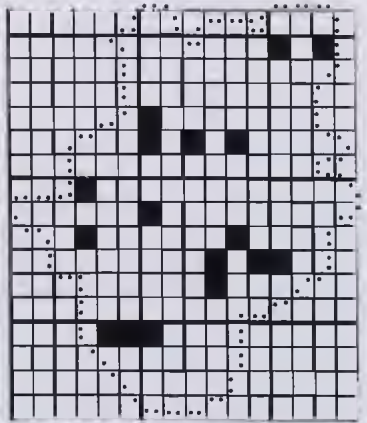


FIG. 29. Black Kite.

N. ENG. RANGE: throughout, being common on improved pasture around farm dams, with many breeding records.

**Blue-billed Duck** *Oxyura australis*

RANGE: SE and SW Aust.  
HABITAT: large, deep and permanent water bodies.  
N. ENG. RANGE: Dangar's Lagoon, where breeding has been recorded (most northerly in the RAOU atlas), and Llangothlin Lagoon.

**Musk Duck** *Biziura lobata* (Fig.27)

RANGE: SE and SW Aust.  
HABITAT: deep lakes and permanent swamps.  
N. ENG. RANGE: tableland lagoons and larger water bodies in the west. Subsequently recorded breeding at Dangar's Lagoon (Ford, pers. obs.)

**Osprey** *Pandion haliaetus*

RANGE: North America, Europe and Asia, most of the coastline of Aust., but scarce in V and T.  
HABITAT: mostly coastal in Aust., but lakes and rivers elsewhere.  
N. ENG. RANGE: single record, from Lake Keepit.

**Black-shouldered Kite** *Elanus notatus* (Fig.28)

RANGE: Aust., breeding mostly in SE and SW.  
HABITAT: open country, has expanded with clearance of forest and woodland for farming. Numbers fluctuate, migratory or nomadic.  
N. ENG. RANGE: widespread, and sometimes common on Northern Tablelands and W, but scarce in forested E and central N.

**Pacific Baza** *Aviceda subcristata*

RANGE: NG, N and E Aust., S to Sydney.  
HABITAT: forest.  
N. ENG. RANGE: 6 squares, in the densely forested E fringes. Sullivan (1931) recorded one E of Bingara and in 1986 it bred near Inverell (Ley 1990a).

**Black Kite** *Milvus migrans* (Fig.29)

RANGE: most of Old World. Widespread inland Aust., in some years more frequent near the coast.  
HABITAT: open country and woodland.  
N. ENG. RANGE: infrequent visitor, mostly on tablelands and W, most observations in 1979. It bred near Armidale in 1965 (Morris et al. 1981).

**Square-tailed Kite** *Lophoictinia isura*

RANGE: sparsely distributed through N, E and SW Aust.  
HABITAT: woodland and forests foraging at tree-tops.  
N. ENG. RANGE: records from only three squares, perhaps seen most often near Inverell (Baldwin 1975).

An earlier record from Mount Grattai (Mt Kaputar National Park, Cameron 1934). Recently seen Bendemeer, Kingstown and Gibraltar Range National Park (S. Debus, pers. comm.).

**Brahminy Kite** *Haliastur indus*

RANGE: N Aust. S to 32° S, and India, SE Asia, New Guinea and Pacific islands.  
HABITAT: coastal waters and occasionally inland rivers.  
N. ENG. RANGE: single record, from Gwydir River near Bingara. Baldwin (1975) recorded an immature at Copeton Dam in 1973.

**Whistling Kite** *H. sphenurus* (Fig.30)

RANGE: throughout Aust., except T.  
HABITAT: woodland and open forest, often near water.  
N. ENG. RANGE: widespread, though few records from the more forested areas, and it appears to have declined recently. Norton (1922) described it as extremely common, with hundreds feasting on rabbit carcasses near Walcha in 1919-1920. Cameron (1975) noted flocks of 50 to 100 near Glen Innes in the 1920s, but commented that it disappeared from the region during the 1960s. Baldwin (1975) found it common near Inverell, with 50 recorded at Copeton Dam. Possible reasons for the decrease are a decline in food, poisoning or competition with the Little Eagle. There would still seem to be plenty food for a carrion-eater, for instance from road-kills.

**Brown Goshawk** *Accipiter fasciatus* (Fig.31)

RANGE: throughout Aust., NG and islands of Indian and Pacific Ocean.  
HABITAT: forest and woodland.  
N. ENG. RANGE: widespread, with several breeding records.

**Collared Sparrowhawk** *A. cirrhocephalus* (Fig.32)

RANGE: most parts of Aust. and NG.  
HABITAT: chiefly eucalypt woodland and forest.  
N. ENG. RANGE: widespread, though less common than Brown Goshawk.

**Grey Goshawk** *A. novaehollandiae*

RANGE: N and E Aust., T, NG and adjacent islands.  
HABITAT: breeds in forest, but often in more open country outside breeding season.  
N. ENG. RANGE: 9 squares, mostly in the forested E.

**Red Goshawk** *Erythrotriorchis radiatus*

RANGE: rare endemic found from the Kimberley region around the N and E to extreme NE NSW. Possibly only a single pair now breeds in NSW (Debus, pers. comm.).

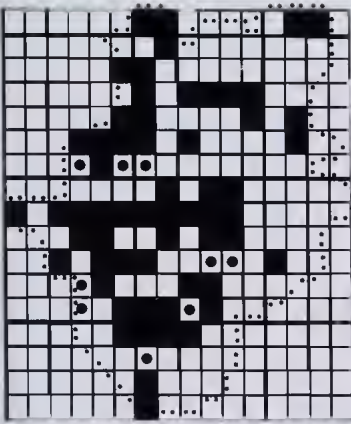


FIG. 30. Whistling Kite.

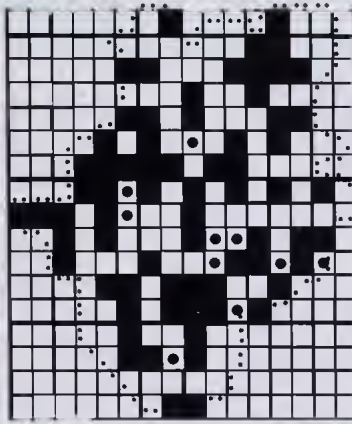


FIG. 31. Brown Goshawk.

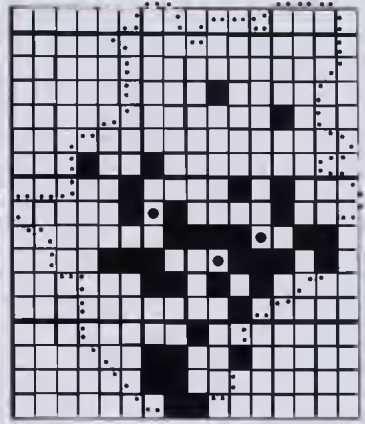


FIG. 32. Collared Sparrowhawk.

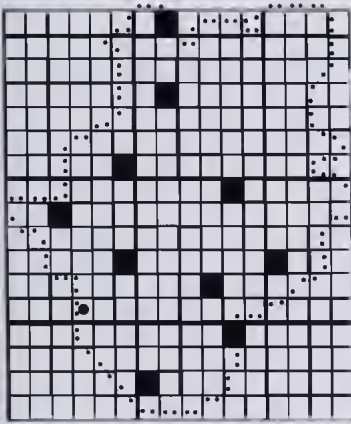


FIG. 33. White-bellied Sea-Eagle.

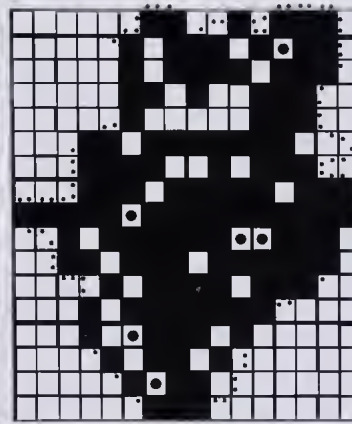


FIG. 34. Wedge-tailed Eagle.

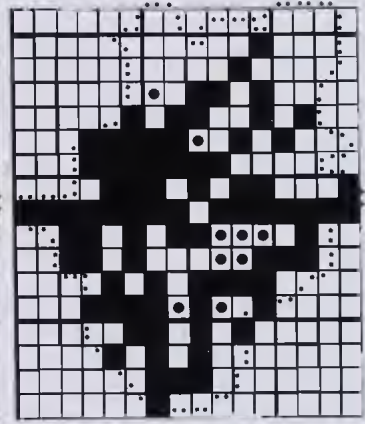


FIG. 35. Little Eagle.

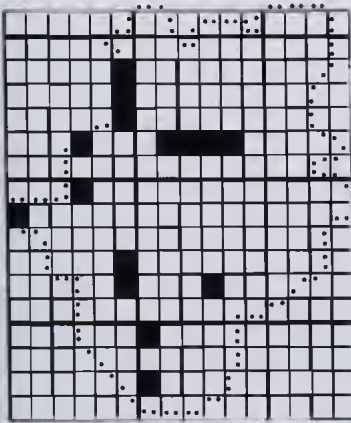


FIG. 36. Spotted Harrier.

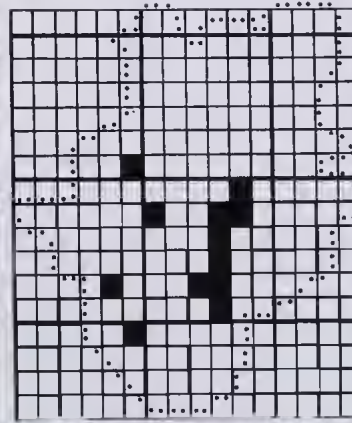


FIG. 37. Marsh Harrier.

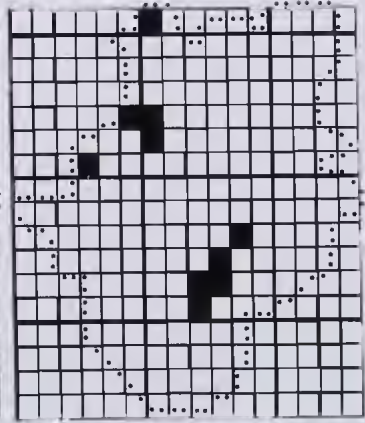


FIG. 38. Black Falcon.

**HABITAT:** tends to breed in riverine forest surrounded by open woodland or wetlands (Debus and Czechura 1988). Degradation of such habitats may have caused a decline in the species.

**N. ENG. RANGE:** only records during atlas period were from Gibraltar Range and Washpool National Parks. These parks contain substantial areas of wilderness and should be extensively explored for Red Goshawks. Earlier records from Ben Lomond and Tilbuster, N of Armidale (Debus 1982).

**White-bellied Sea-Eagle** *Haliaeetus leucogaster* (Fig. 33)

**RANGE:** India, SE Asia, NG, Aust.

**HABITAT:** coastal, major rivers and larger reservoirs.  
**N. ENG. RANGE:** scattered records on rivers and larger waters, a breeding record from Lake Keepit.

**Wedge-tailed Eagle** *Aquila audax* (Fig.34)

**RANGE:** throughout Aust., most abundant in open areas where sheep or rabbits are plentiful, also S PNG.  
**HABITAT:** most types of vegetation.

**N. ENG. RANGE:** all parts, paucity of records in the N central region may reflect under-recording rather than absence. Clearing of forests and intensification of grazing has probably favoured Wedge-tailed Eagles, although persecution occurs in the closely settled areas.

**Little Eagle** *Hieraaetus morphnoides* (Fig.35)

**RANGE:** Aust., NG.

**HABITAT:** woodland and open forest, but scarce in dense forest.

**N. ENG. RANGE:** most abundant large raptor, though fewer records from N and extreme E. It may have increased recently as Hays (1920) recorded the species as a new one to the Bundarra area in 1920, and it was not listed by Norton (1922) from Boree, near Walcha. Such an increase may be related to rabbits making up a large part of its diet (Debus 1984). The cluster of breeding records around Armidale reflect the work of Debus (1983, 1984).

**Spotted Harrier** *Circus assimilis* (Fig.36)

**RANGE:** Indonesia, Aust.

**HABITAT:** open country.

**N. ENG. RANGE:** patchy in W and cleared parts of the tablelands.

**Marsh Harrier** *C. aeruginosus* (Fig.37)

**RANGE:** most parts of Aust. and NZ.

**HABITAT:** swamps and wet grassland and crops, though in a broader range of habitats in T and NZ (Baker-Gabb 1986).

**N. ENG. RANGE:** in suitable habitat such as tableland lagoons.

**Black Falcon** *Falco subniger* (Fig.38)

**RANGE:** sparsely through inland Aust., scarce in W.  
**HABITAT:** open country, lightly timbered areas.  
**N. ENG. RANGE:** NW and tablelands, latter at least are vagrants.

**Peregrine Falcon** *F. peregrinus* (Fig.39)

**RANGE:** most of the world, but has declined in Europe and North America, as a result of poisoning by chlorinated hydrocarbons and persecution (Newton 1979). Although Peregrines in Aust. may carry moderate pesticide residues, the country still supports one of the largest and most stable populations of the species (Emison and Bren 1981, Pruett-Jones et al. 1981a,b, Olsen and Olsen 1988).

**HABITAT:** most areas, except heavy forest.

**N. ENG. RANGE:** quite common, especially in the gorges, where it breeds (S. Debus, pers. comm.) Only breeding records for atlas from the extreme W. Lack of records in the N requires further investigation.

**Australian Hobby** *F. longipennis* (Fig.40)

**RANGE:** Indonesia as well as most parts of Aust.

**HABITAT:** typically in open woodland, also in towns and cities.

**N. ENG. RANGE:** widespread, with most records coming from open country in W and tablelands.

**Brown Falcon** *F. berigora* (Fig.41)

**RANGE:** one of the most widespread birds in Aust.

**HABITAT:** in all habitats except for closed forests.

**N. ENG. RANGE:** throughout, though patchy in forested N and E.

**Australian Kestrel** *F. cenchroides* (Fig.42)

**RANGE:** throughout Aust., Indonesia, NG, rare in T.

**HABITAT:** open country.

**N. ENG. RANGE:** recorded in all parts.

**Australian Brush-turkey** *Alectura lathami* (Fig. 43)

**RANGE:** E Aust.

**HABITAT:** rainforest, but also thickets of Lantana and more open habitats inland. Birds spread inland when the prickly pear (*Opuntia*) outbreak was at its worst, but retreated again as prickly pears were controlled.

**N. ENG. RANGE:** closed forest in E. An isolated population near Bingara, which extends outside the region. The size and habitat requirements of this population would be worth investigating.

**Stubble Quail** *Coturnix novaezealandiae* (Fig.44)

**RANGE:** SE and SW Aust., sporadically elsewhere. It formerly occurred in T and NZ.

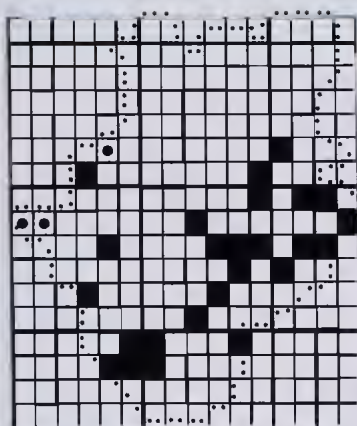


FIG. 39. Peregrine Falcon.

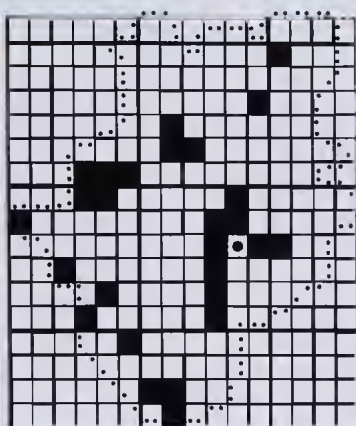


FIG. 40. Australian Hobby.

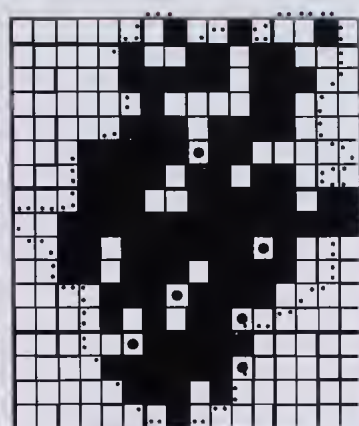


FIG. 41. Brown Falcon.

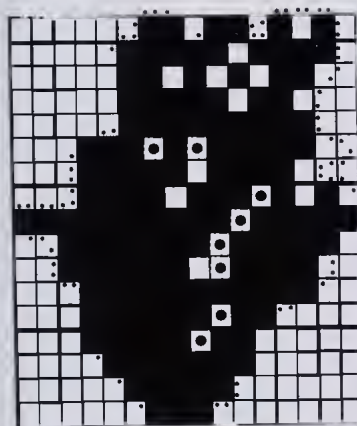


FIG. 42. Australian Kestrel.

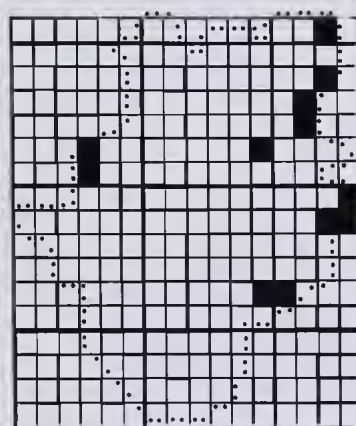


FIG. 43. Australian Brush-turkey.

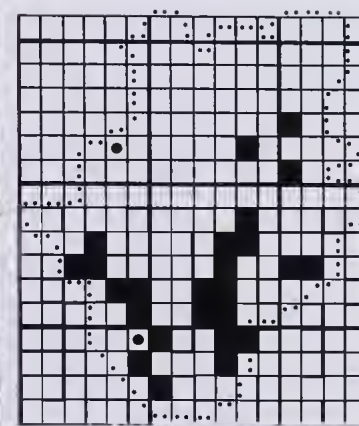


FIG. 44. Stubble Quail.

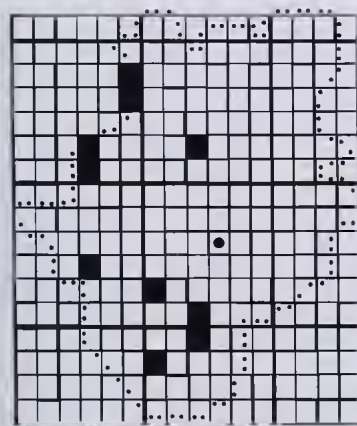


FIG. 45. Brown Quail.

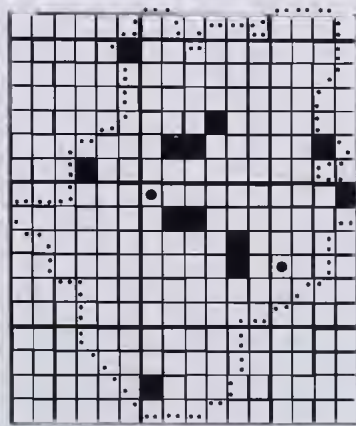


FIG. 46. Painted Button-quail.

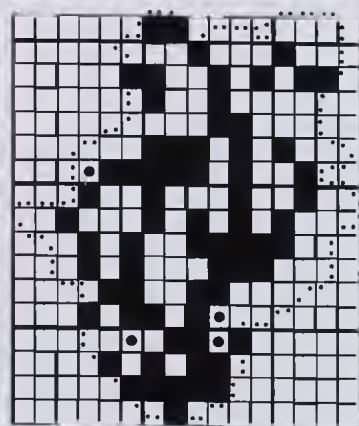


FIG. 47. Dusky Moorhen.

**HABITAT:** woodland and grassland, including crops.  
**N. ENG. RANGE:** most records from tablelands and SW, the areas with most extensive grassland. Numbers fluctuate unpredictably.

**Brown Quail** *C. australis* (Fig.45)

**RANGE:** N, E and SW Aust., T, Indonesia and NG.  
**HABITAT:** rank, moist grassland and low scrub.  
**N. ENG. RANGE:** several sites in central and NW New England. These do not necessarily reflect the distribution of favourable habitat and Brown Quail could well have been overlooked in other areas.

**Painted Button-quail** *Turnix varia* (Fig.46)

**RANGE:** E and S Aust. and New Caledonia.  
**HABITAT:** eucalypt forest and woodland, heath.  
**N. ENG. RANGE:** recorded over a wide area, but appears to be common nowhere. Clearing, grazing and fragmentation of habitat are detrimental to the species, but birds have not been recorded from large areas of apparently suitable habitat. As a ground-feeding bird it may be vulnerable to introduced predators.

**Little Button-quail** *T. velox*

**RANGE:** moves erratically throughout inland Aust.  
**HABITAT:** open habitats.  
**N. Eng. range:** three squares, near Tamworth and Manilla, in the SW, a single breeding record.

**Red-chested Button-quail** *T. pyrrhotorax*

**RANGE:** widespread, though scarce, inland E Aust.  
**HABITAT:** cryptic and easy to confuse with other button-quails; appears to fluctuate in numbers, so distribution, abundance and habitat hard to determine.  
**N. ENG. RANGE:** single breeding record, W of Inverell.

**Buff-banded Rail** *Rallus philippensis*

**RANGE:** coastal Aust., islands of Indian and Pacific Oceans, NG and Indonesia.  
**HABITAT:** dense, swampy vegetation, but also open habitats on islands.  
**N. ENG. RANGE:** only from the NW (near Inverell and Bingara), but fairly common on the N coast of NSW.

**Baillon's Crake** *Porzana pusilla*

**RANGE:** Europe, Africa, Asia, NG and Aust., principally in the SE.  
**HABITAT:** swamps and the edges of reedy lakes.  
**N. ENG. RANGE:** two records, both on the tablelands, undoubtedly an underestimate of range and abundance of this cryptic species.

**Australian Crake** *P. fluminea*

**RANGE:** mostly in SE and centre, scattered in WA.

**HABITAT:** typically in small pools, lagoons and swamps.

**N. ENG. RANGE:** two records, both from the tablelands. Like the last species, probably under-recorded.

**Dusky Moorhen** *Gallinula tenebrosa* (Fig.47)

**RANGE:** E half and SW of Aust., NG and Indonesia.  
**HABITAT:** fresh water surrounded by vegetation.  
**N. ENG. RANGE:** common and widespread, though patchily recorded from forested areas.

**Purple Swamphen** *Porphyrio porphyrio* (Fig.48)

**RANGE:** S Europe, Asia, NG, Aust., NZ and some Pacific islands.  
**HABITAT:** swamps or lakes surrounded by lush vegetation.  
**N. ENG. RANGE:** widespread in the lagoons and swamps of the tablelands, several records from other parts of New England.

**Eurasian Coot** *Fulica atra* (Fig.49)

**RANGE:** from N Europe through Asia to Aust., N Africa.  
**HABITAT:** large, shallow water bodies.  
**N. ENG. RANGE:** mostly tablelands and SW, where suitable water bodies occur.

**Brolga** *Grus rubicundus*

**RANGE:** N and inland E Aust. to W V and SE SA.  
**HABITAT:** swamps and grassy plains.  
**N. ENG. RANGE:** single record from extreme N, though Brolgas occur to the W and E.

**Bush Thick-knee** *Burhinus magnirostris*

**RANGE:** inland Aust. but has retreated from many closely settled or intensively grazed areas. Introduced predators have been blamed for this decline although it is still fairly common in some places where these predators are found.  
**HABITAT:** open scrub and woodland.  
**N. ENG. RANGE:** single record during the atlas period, from extreme N. However, the species was previously more widespread ("used to be extremely common about here, but since the coming of the fox they have become very rare"- Norton, 1922, from near Walcha; "once common, now rare, last heard in March 1958" from near Inverell, - Baldwin, 1975).

**Painted Snipe** *Rostratula benghalensis*

**RANGE:** Africa, India, China, SE Asia, Pacific islands and chiefly E inland Aust.  
**HABITAT:** shallow freshwater.  
**N. ENG. RANGE:** single record from W of Bundarra. Seen near Guyra in 1991 (Trémont, pers. comm.)

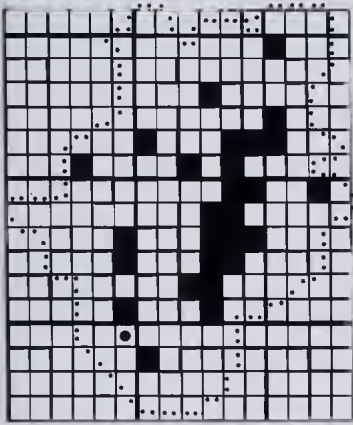


FIG. 48. Purple Swanphen.

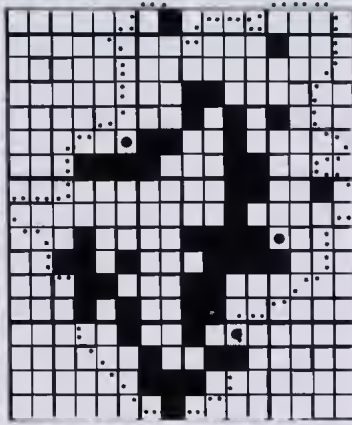


FIG. 49. Eurasian Coot.

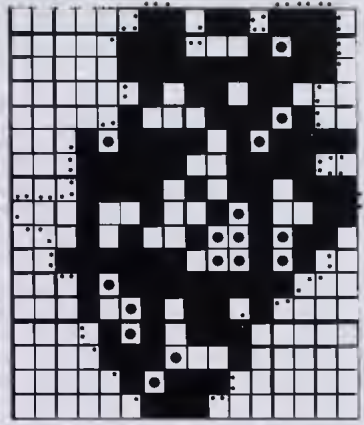


FIG. 50. Masked Lapwing.

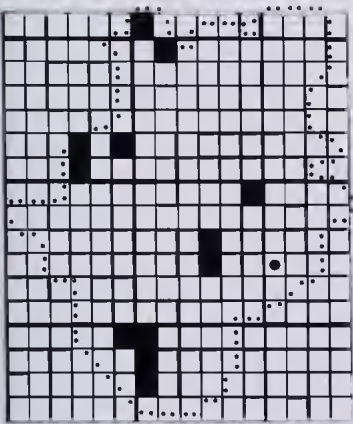


FIG. 51. Banded Lapwing

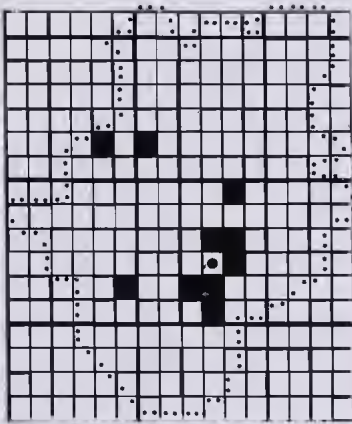


FIG. 52. Red-kneed Dotterel.

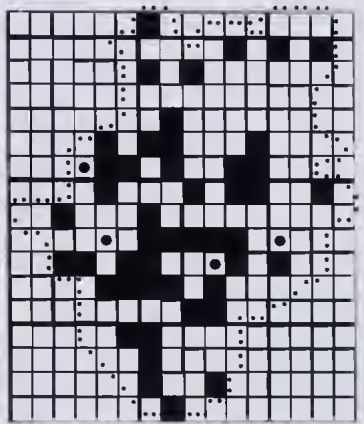


FIG. 53. Black-fronted Dotterel.

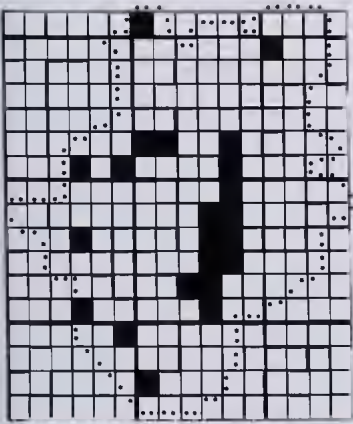


FIG. 54. Black-winged Stilt.

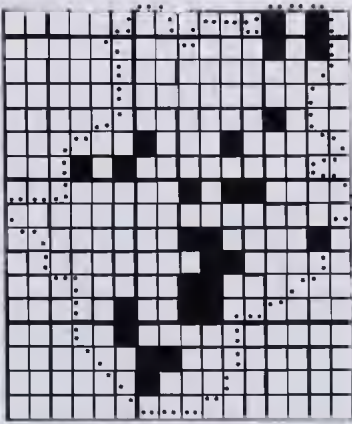


FIG. 55. Latham's Snipe.

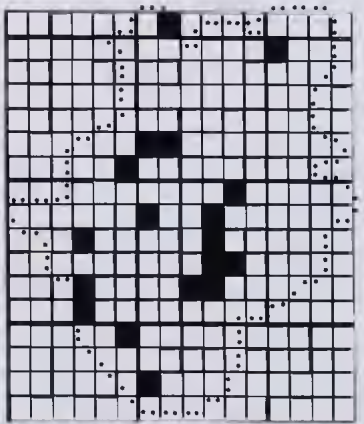


FIG. 56. Silver Gull.

**Masked Lapwing** *Vanellus miles* (Fig.50)

RANGE: E and N Aust., NZ, NG and Indonesia.  
 HABITAT: short grassland, usually near water.  
 N. ENG. RANGE: throughout, though scarce in heavily forested areas.

**Banded Lapwing** *V. tricolor* (Fig.51)

RANGE: throughout Aust. S of 20° S.  
 HABITAT: short grassland or bare areas.  
 N. ENG. RANGE: tablelands, e.g. Armidale airport, and several sites in W.

**Lesser Golden Plover** *Pluvialis dominica*

RANGE: breeds in N Asia and N America and winters around the W Pacific including Aust.  
 HABITAT: mudflats, saltmarsh, occasionally freshwater.  
 N. ENG. RANGE: single record near Armidale, also recorded from Armidale Sewerage Works in 1967 (Heron 1970).

**Red-kneed Dotterel** *Erythrogonys cinctus* (Fig.52)

RANGE: throughout most of Aust., except T, NG.  
 HABITAT: edges of shallow muddy pools.  
 N. ENG. RANGE: several records from tablelands, one of breeding, and three records from W.

**Red-capped Plover** *Charadrius ruficapillus*

RANGE: Aust., occasionally NZ.  
 HABITAT: sandy or shingly beaches, flooded inland saltlakes.  
 N. ENG. RANGE: single record, from near Uralla.

**Black-fronted Plover** *Ch. melanops* (Fig.53)

RANGE: throughout Aust.  
 HABITAT: edges of standing water, stony and sandy rivers and creeks.  
 N. ENG. RANGE: most parts, where suitable habitat exists.

**Black-winged Stilt** *Himantopus himantopus* (Fig.54)

RANGE: almost cosmopolitan, though absent from T and most arid parts of Aust.  
 HABITAT: swamps, lagoons and edges of lakes.  
 N. ENG. RANGE: tablelands and in W.

**Red-necked Avocet** *Recurvirostra novaehollandiae*

RANGE: breeds in inland Aust., retreating to coast in droughts.  
 HABITAT: flooded saltlakes, coastal salt pans.  
 N. ENG. RANGE: two records from tableland lagoons.

**Wood Sandpiper** *Tringa glareola*

RANGE: Palearctic, winters in small numbers in Aust.  
 HABITAT: nests in open coniferous forests, otherwise on edges of fresh water.  
 N. ENG. RANGE: recorded once in the atlas period, from near Armidale. Gosper (1973) saw it at Dangar's Lagoon in the 1960s.

**Greenshank** *T. nebularia*

RANGE: Palearctic, winter range to Aust.  
 HABITAT: breeds in temperate bogs and moorland, otherwise freshwater lagoons, swamps, estuaries.  
 N. ENG. RANGE: a few records from tableland lagoons (see also Gosper 1973).

**Marsh Sandpiper** *T. stagnatilis*

RANGE: breeds from Bulgaria to Mongolia and visits Aust. in small numbers.  
 HABITAT: inland waters and estuaries.  
 N. ENG. RANGE: regular visitor to the tableland lagoons (Heron 1970).

**Latham's Snipe** *Gallinago hardwickii* (Fig.55)

RANGE: breeds in Japan, winters in E and S Aust.  
 HABITAT: inland swamps.  
 N. ENG. RANGE: most common in upland parts, specially on grassy edges of lagoons.

**Bar-tailed Godwit** *Limosa lapponica*

HABITAT: breeds in E Siberia and Alaska and occurs around the coast of Aust. in the non-breeding season.  
 HABITAT: estuaries, beaches, rare inland.  
 N. ENG. RANGE: single record from the atlas period, from near Uralla. [Heron (1970) and Gosper (1973) recorded the Black-tailed Godwit (*L. limosa*), which was not noted in New England during the atlas, though it is more often found inland than the former species.]

**Sharp-tailed Sandpiper** *Calidris acuminata*

RANGE: breeds in arctic Siberia and is one of the most common Palearctic migrants to Aust.  
 HABITAT: tundra, coastal and inland waters.  
 N. ENG. RANGE: regular in small flocks on tableland lagoons and occasionally elsewhere.

**Silver Gull** *Larus novaehollandiae* (Fig.56)

RANGE: S Africa, NZ, New Caledonia and around most of the coast of Aust.  
 HABITAT: coastal, also inland in large numbers after heavy rain.  
 N. ENG. RANGE: numerous records, mostly of one or two stragglers on tableland lagoons or W.



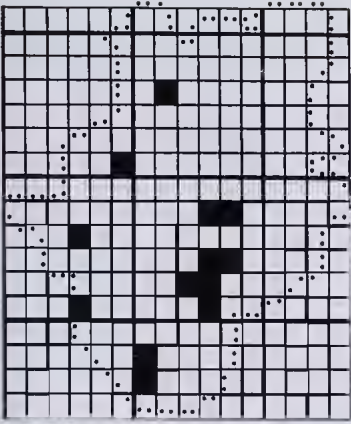


FIG. 57. Whiskered Tern.

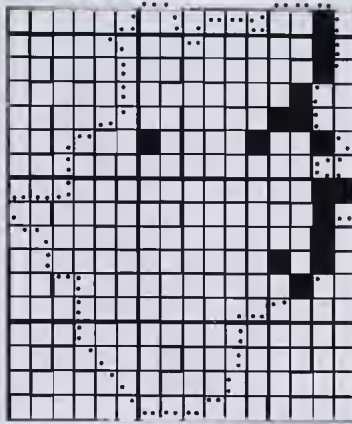


FIG. 58. Topknot Pigeon.

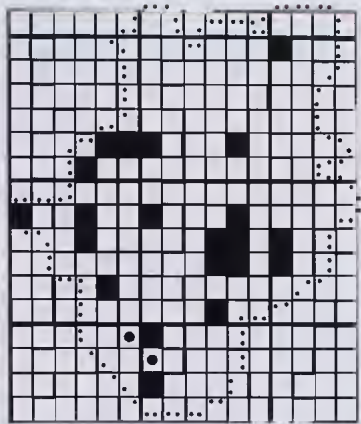


FIG. 59. Feral Pigeon.

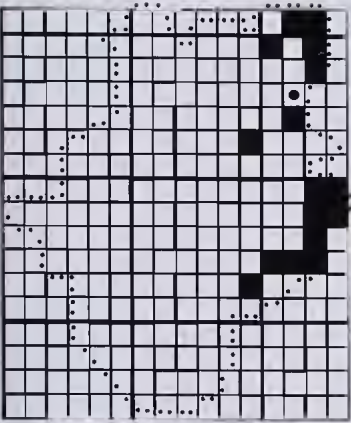


FIG. 60. Brown Cuckoo-dove.

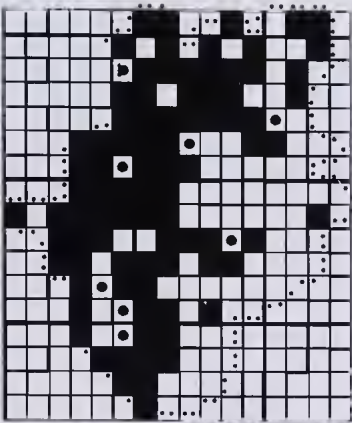


FIG. 61. Peaceful Dove.

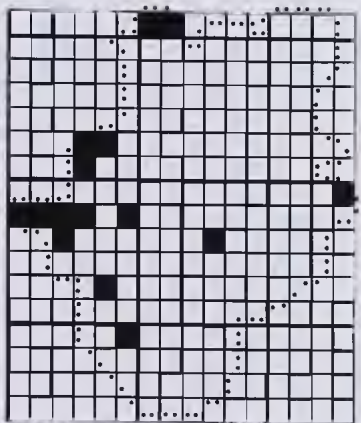


FIG. 62. Bar-shouldered Dove.

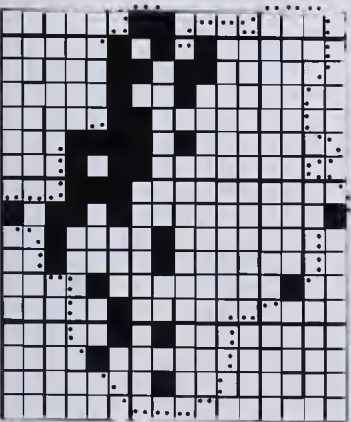


FIG. 63. Common Bronzewing.

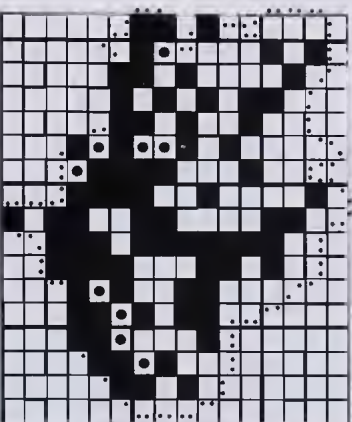


FIG. 64. Crested Pigeon.

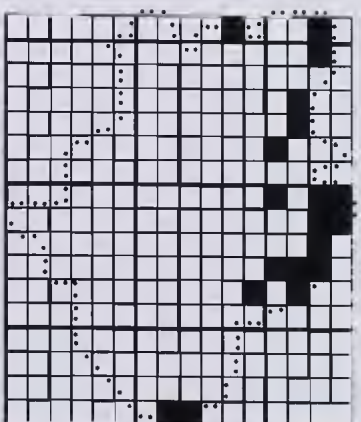


FIG. 65. Wonga Pigeon.

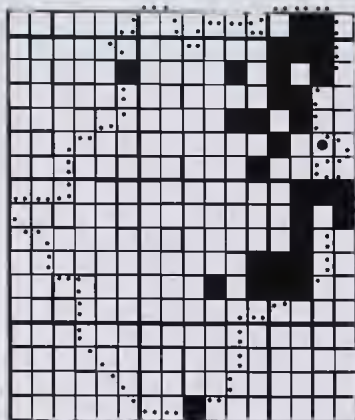


FIG. 66. Glossy Black-Cockatoo.

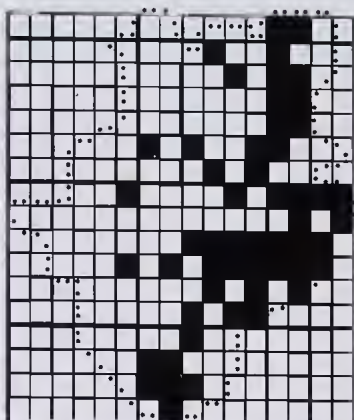


FIG. 67. Yellow-tailed Black-Cockatoo.

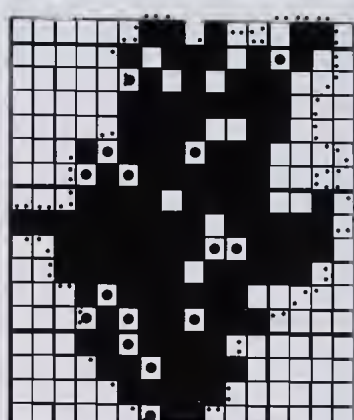


FIG. 68. Galah.

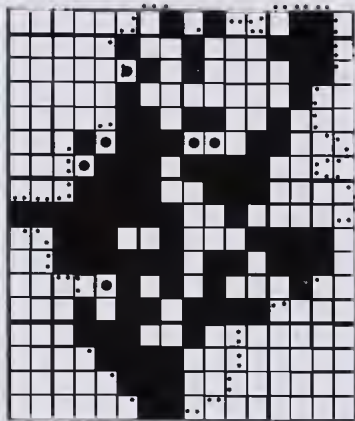


FIG. 69. Sulphur-crested Cockatoo.

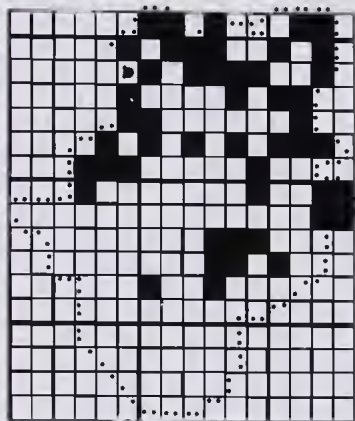


FIG. 70. Rainbow Lorikeet.

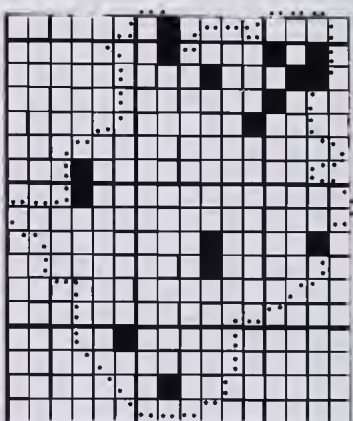


FIG. 71. Scaly-breasted Lorikeet.

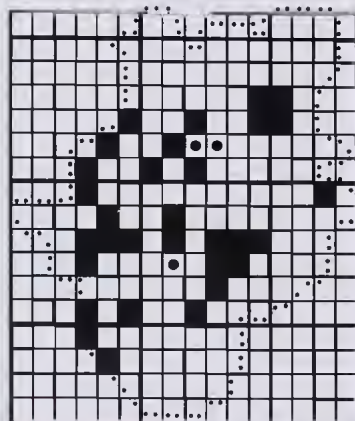


FIG. 72. Musk Lorikeet.

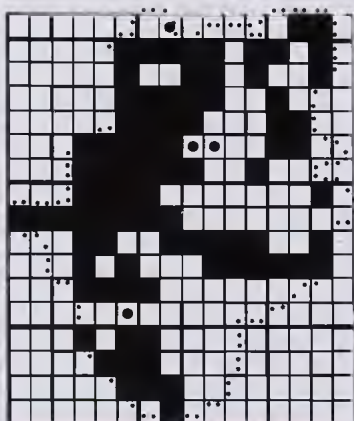


FIG. 73. Little Lorikeet.

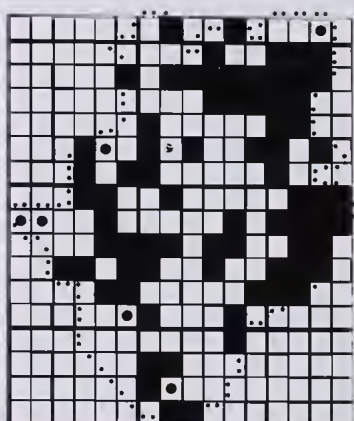


FIG. 74. Australian King Parrot.

**Whiskered Tern** *Chlidonias hybrida* (Fig.57)

RANGE: most of Aust., except T and deserts, also Eurasia and Africa.

HABITAT: freshwater swamps and lagoons.

N. ENG. RANGE: some tableland lagoons provide suitable breeding habitat, though no breeding records during the atlas. Several records from the W.

**Gull-billed Tern** *Gelochelidon nilotica*

RANGE: almost cosmopolitan, most regular along E coast of Aust. and, after heavy rain, parts of the inland.

HABITAT: coastal and inland swamps and lakes.

N. ENG. RANGE: single record, from near Armidale.

**Wompoo Fruit-dove** *Ptilinopus magnificus*

RANGE: NG and E Aust. S to NE NSW

HABITAT: rainforest.

N. ENG. RANGE: recorded once in the extreme NE

**Topknot Pigeon** *Lopholaimus antarcticus* (Fig.58)

RANGE: E Aust., from Cape York Peninsula to SE NSW.

HABITAT: rainforest and, less often, eucalypt forest or exotic fruit-trees.

N. ENG. RANGE: recorded in suitable habitat in the E third, with one outlying record near Inverell.

**White-headed Pigeon** *Columba leucomela*

RANGE: endemic to E Aust., from Cape York to SE NSW.

HABITAT: rainforest, but tolerates partly cleared land with exotic fruit trees.

N. ENG. RANGE: recorded from 5 squares in the NE corner.

**Feral Pigeon** *C. livia* (Fig.59)

RANGE: native to Europe, N Africa and parts of Asia, but introduced elsewhere including Aust., where now widespread.

HABITAT: seacliffs, towns, farmland.

N. ENG. RANGE: recorded chiefly in W and tablelands.

**Spotted Turtle-dove** *Streptopelia chinensis*

RANGE: native to S and E Asia, but introduced to Aust. and now in coastal towns or cities from Perth to Cairns.

HABITAT: towns, cultivated land.

N. ENG. RANGE: birds found near Tamworth could be first colonisers from Hunter Valley or escapees, recorded in Armidale after the atlas (Ford, pers. obs.).

**Brown Cuckoo-dove** *Macropygia amboinensis* (Fig. 60)

RANGE: E Aust. to NE V, NG and SE Asia.

HABITAT: rainforest and patches of exotic fruiting bushes along roadsides.

N. ENG. RANGE: E edge.

**Peaceful Dove** *Geopelia placida* (Fig.61)

RANGE: throughout Aust., except for SW, centre and T, also NG and SE Asia.

HABITAT: woodland.

N. ENG. RANGE: W and N, but absent from forested regions in the E and scarce on the tablelands.

**Diamond Dove** *G. cuneata*

RANGE: almost throughout inland Aust.

HABITAT: woodland and open country.

N. ENG. RANGE: only two records, near Tamworth and Ashford.

**Bar-shouldered Dove** *G. humeralis* (Fig.62)

RANGE: S NG and N and E Aust.

HABITAT: woodland and forest, particularly near water.

N. ENG. RANGE: W parts, also common to E of the region. Vagrant in the tablelands, being one of the few species whose distribution correlated with altitude.

**Emerald Dove** *Chalcophaps indica*

RANGE: SE Asia. NG, New Caledonia, Vanuatu and N and E Aust., S to SE NSW.

HABITAT: rainforest edges and disturbed land with undergrowth.

N. ENG. RANGE: three records, in gorges E of Armidale and in Washpool National Park.

**Common Bronzewing** *Phaps chalcoptera* (Fig.63)

RANGE: most parts of Aust.

HABITAT: most vegetation, except for deserts and dense forests.

N. ENG. RANGE: most common in the W. Clearing and habitat degradation may account for its scarcity on tablelands and dense habitat for its scarcity in E.

**Crested Pigeon** *Ocyphaps lophotes* (Fig.64)

RANGE: Aust., except for some deserts, coastal areas and T; expanded range with clearing.

HABITAT: open areas, farmland.

N. ENG. RANGE: most of region except forested E fringes and parts of tablelands.

**Squatter Pigeon** *Petrophassa scripta*

RANGE: inland E Q and extreme N NSW.

HABITAT: woodland near water.

N. ENG. RANGE: records from near Bonshaw and near Warialda represent the S extreme of distribution, although it originally occurred further S (e.g. near Inverell in 1963 and 1964 - Baldwin 1975, Ashford and Bingara - Morris et al. 1981).

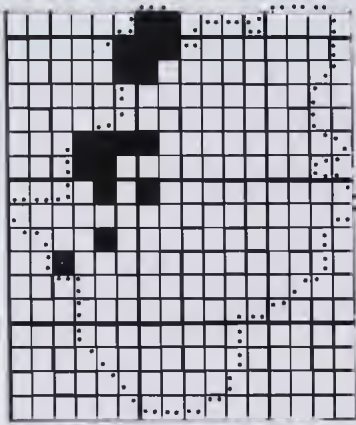


FIG. 75. Red-winged Parrot.

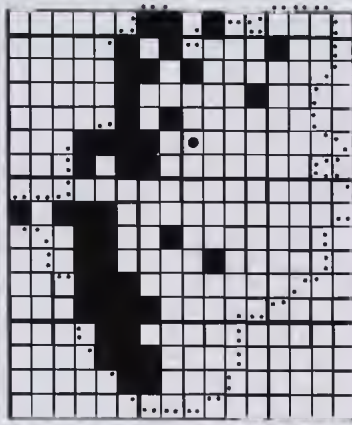


FIG. 76. Cockatiel.

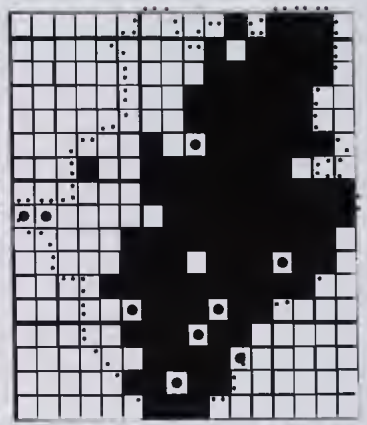


FIG. 77. Crimson Rosella.

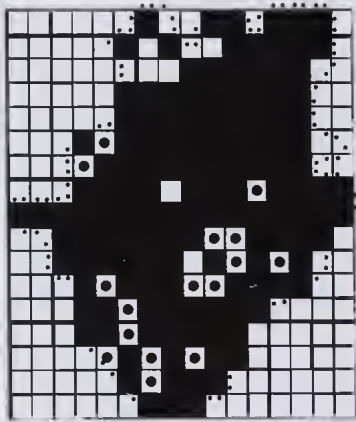


FIG. 78. Eastern Rosella

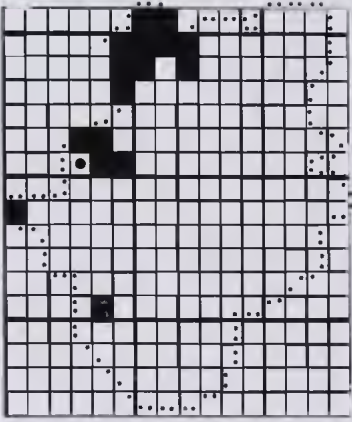


FIG. 79. Pale-headed Rosella.

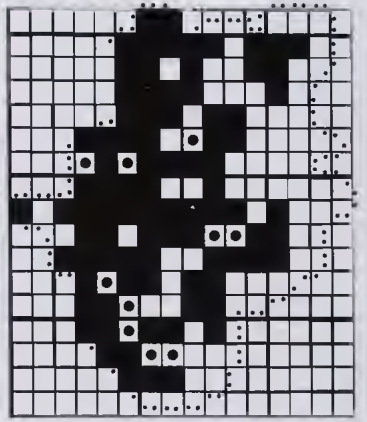


FIG. 80. Red-rumped Parrot.

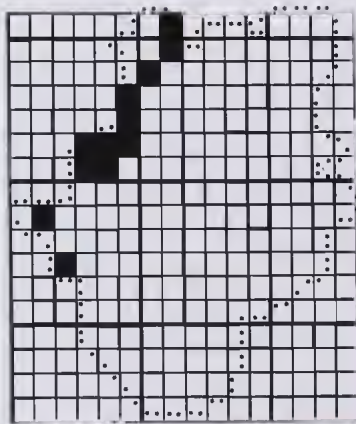


FIG. 81. Blue Bonnet.

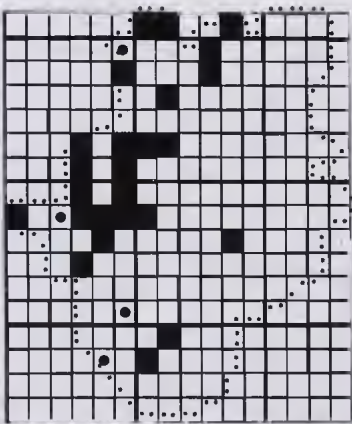


FIG. 82. Turquoise Parrot.

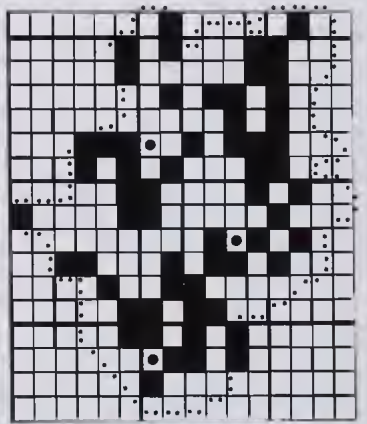


FIG. 83. Pallid Cuckoo.

**Wonga Pigeon** *Leucosarcia melanoleuca* (Fig.65)

RANGE: central Q to E V.  
 HABITAT: rainforest and eucalypt forest.  
 N. ENG. RANGE: E and extreme S.

**Glossy Black-Cockatoo** *Calyptorhynchus lathami* (Fig. 66)

RANGE: E Aust. from central Q to NE V, with an isolated population on Kangaroo Is.  
 HABITAT: woodland with *Casuarina*.  
 N. ENG. RANGE: E half, particularly on or near the gorges. There is a single record from near Ashford, and the species also occurs W of the region. [Baldwin (1975) recorded the Red-tailed Black-Cockatoo *C. magnificus* near Inverell in 1963. Unconfirmed records were made of it during the atlas.]

**Yellow-tailed Black-Cockatoo** *C. funereus* (Fig. 67)

RANGE: central Q around to S SA, T.  
 HABITAT: forest, heath and pine plantations.  
 N. ENG. RANGE: more widespread and abundant than the former species, absent only from parts of N and W.

**Galah** *Cacatua roseicapilla* (Fig.68)

RANGE: Aust., except in heavily forested areas; expanded since European settlement into areas cleared for agriculture.  
 HABITAT: woodland and farming areas.  
 N. ENG. RANGE: throughout, but not in forested E fringes.

**Little Corella** *C. sanguinea*

RANGE: widespread in inland Aust., except for extreme deserts, and S NG.  
 HABITAT: woodland, crops.  
 N. ENG. RANGE: recorded in two squares, near Manilla and Tamworth.

**Sulphur-crested Cockatoo** *C. galerita* (Fig.69)

RANGE: N and E Aust. and NG, with introduced populations in NZ and some Indonesian islands.  
 HABITAT: eucalypt woodland and forest, rainforest.  
 N. ENG. RANGE: recorded in most areas, though scarce in E and parts of tablelands. Birds inhabit rainforest on the E margin.

**Rainbow Lorikeet** *Trichoglossus haematodus* (Fig. 70)

RANGE: E Aust. from Cape York to Eyre Peninsula. Also NG and Indonesian and Pacific islands.  
 HABITAT: eucalypt forest and woodland, urban areas.

N. ENG. RANGE: mostly in N half and around Armidale.

**Scaly-breasted Lorikeet** *T. chlorolepidotus* (Fig. 71)

RANGE: Cape York to Melbourne.  
 HABITAT: eucalypt forest, often with Rainbow Lorikeets.  
 N. ENG. RANGE: scarcer than previous species, though recorded from many parts of region.

**Musk Lorikeet** *Glossopsitta concinna* (Fig.72)

RANGE: SE Q to Eyre Peninsula.  
 HABITAT: eucalypt woodland, mallee.  
 N. ENG. RANGE: mostly in central and W parts.

**Little Lorikeet** *G. pusilla* (Fig.73)

RANGE: S Cape York Peninsula to SE SA.  
 HABITAT: eucalypt forest and woodland.  
 N. ENG. RANGE: most widespread lorikeet, absent only from SE and parts of tablelands.

**Australian King-Parrot** *Alisterus scapularis* (Fig. 74)

RANGE: E Aust., from N Q to central V.  
 HABITAT: rainforest, eucalypt forest and woodland, occasionally crops.  
 N. ENG. RANGE: found in both E and W, but scarce on tablelands, possibly because native vegetation mostly cleared there.

**Red-winged Parrot** *Aprosmictus erythropterus* (Fig. 75)

RANGE: across N and E Aust., from the Kimberleys to central NSW, generally inland of the previous species.  
 HABITAT: woodland, especially near water, forests and mangroves in N.  
 N. ENG. RANGE: NW, range overlaps slightly with King-Parrot.

**Cockatiel** *Nymphicus hollandicus* (Fig.76)

RANGE: throughout inland Aust., tending to move S in spring and N in autumn.  
 HABITAT: scrub, woodland and agricultural crops.  
 N. ENG. RANGE: W half, with a few records further E. The Cockatiel was the subject of a detailed study on the NW slopes (Jones 1987).

**Budgerigar** *Melopsittacus undulatus*

RANGE: widespread in inland Aust., rarely reaching E coast.  
 HABITAT: semi-arid woodland.  
 N. ENG. RANGE: recorded in four squares in NW. Mills (1986) recorded Budgerigars in Guy Fawkes

National Park, N of Ebor, in 1985, well outside their normal range.

**Swift Parrot** *Lathamus discolor*

RANGE: breeds in T, spending winter between SE SA and N NSW.

HABITAT: eucalypt woodland and forest.

N. ENG. RANGE: single record near Bundarra is almost at the N limit of its winter range.

**Crimson Rosella** *Platycercus elegans*  
(Fig.77)

RANGE: the Crimson Rosella superspecies occurs from Kangaroo Is. to S Q. It shows a remarkable cline from crimson in most of its range, including Kangaroo Is. to orange near Adelaide, merging into yellow birds along the Murray-Darling system (Cain 1963). There is also an isolated population in N Q.

HABITAT: eucalypt forests and rainforests.

N. ENG. RANGE: throughout centre and E. An apparently isolated population around Mount Kaputar in the extreme W.

**Eastern Rosella** *P. eximius* (Fig.78)

RANGE: SE Aust. from SE Q to Adelaide.

HABITAT: eucalypt woodland, including partly cleared land.

N. ENG. RANGE: throughout region.

**Pale-headed Rosella** *P. adscitus* (Fig.79)

RANGE: NE Aust. from extreme N NSW to Cape York Peninsula. May interbreed with Eastern Rosella where ranges overlap.

HABITAT: open woodland.

N. ENG. RANGE: NW corner, hybrids common N of Inverell.

**Mallee Ringneck** *Barnardius barnardi*

RANGE: inland E Aust. from central Q to SE SA with an isolated population near Cloncurry, Q.

HABITAT: open eucalypt and acacia woodland, mallee.

N. ENG. RANGE: four squares in the extreme W.

**Red-rumped Parrot** *Psephotus haematonotus* (Fig. 80)

RANGE: SE Aust.

HABITAT: grassy woodland and agricultural areas.

N. ENG. RANGE: common, except in the forested east.

**Blue-bonnet** *Northiella haematogaster*  
(Fig.81)

RANGE: inland SE Aust., isolated population on Nul-larbor Plain.

HABITAT: semi-arid woodland.

N. ENG. RANGE: NW corner.

**Turquoise Parrot** *Neophema pulchella*  
(Fig.82)

RANGE: W of the Great Dividing Range from S Q to N V. Apparently more widespread at European settlement, then contracted its range and became very scarce early in the 20th century. It has now expanded and increased again.

HABITAT: grassy woodland.

N. ENG. RANGE: recorded from a wide area of W, with a few records from further E. The North West Slopes of NSW are a stronghold of the species, and it merits study to investigate its habitat preferences and the influence of clearing and habitat degradation on its populations.

**Oriental Cuckoo** *Cuculus saturatus*

RANGE: breeds in Asia and migrates to Indonesia in the non-breeding season and in small numbers to NG and N and E Aust.

HABITAT: forest.

N. ENG. RANGE: single record, near Walcha.

**Pallid Cuckoo** *C. pallidus* (Fig.83)

RANGE: throughout Aust., occasionally in NG and Timor.

HABITAT: woodland and open habitats.

N. ENG. RANGE: widespread, though patchy in more forested areas.

**Brush Cuckoo** *C. variolosus* (Fig.84)

RANGE: Kimberleys, N and E Aust. to S V. Other subspecies inhabit NG and SE Asia.

HABITAT: forest and woodland.

N. ENG. RANGE: mostly in E half.

**Fan-tailed Cuckoo** *C. pyrrhophanus* (Fig.85)

RANGE: from Cape York S to T and W to SW Aust. Also in NG and some Pacific islands.

HABITAT: forest, woodland and mallee.

N. ENG. RANGE: almost throughout region, though few records from NW and parts of the tablelands.

**Black-eared Cuckoo** *Chrysococcyx osculans*

RANGE: widely, but thinly, spread throughout inland Aust.

HABITAT: woodland and shrubland.

N. ENG. RANGE: 8 squares, mainly in W, with two breeding records.

**Horsfield's Bronze-Cuckoo** *Ch. basalis*  
(Fig.86)

RANGE: breeds throughout Aust., some birds winter to N.

HABITAT: woodland.

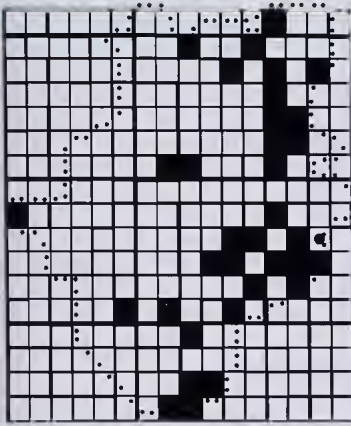


FIG 84. Brush Cuckoo.

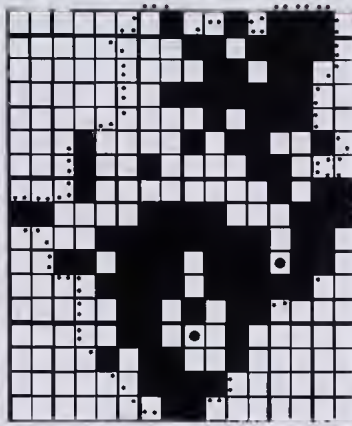


FIG. 85. Fan-tailed Cuckoo.

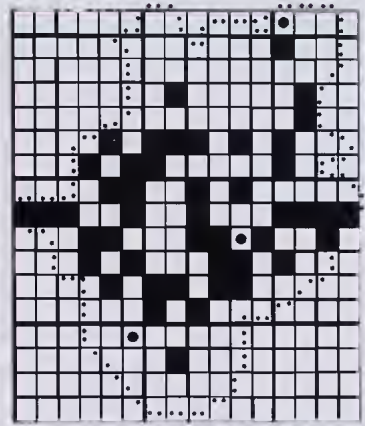


FIG. 86. Horsfield's Bronze-Cuckoo.

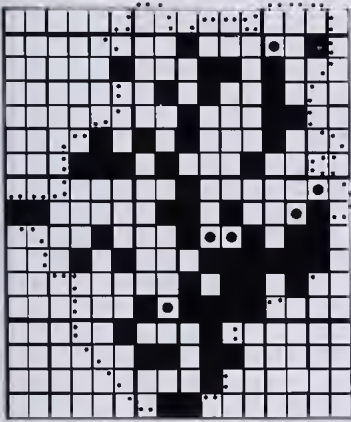


FIG. 87. Shining Bronze-Cuckoo.

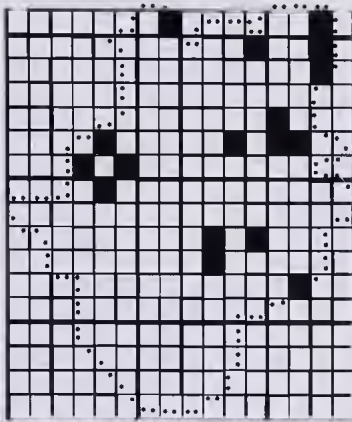


FIG 88. Common Koel.

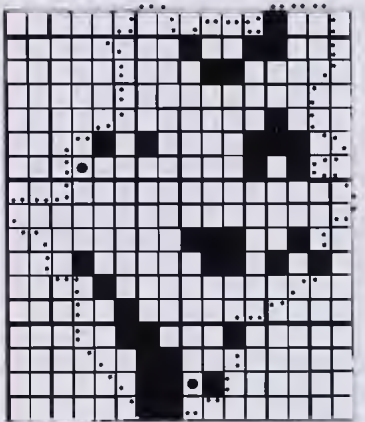


FIG. 89. Channel-billed Cuckoo.

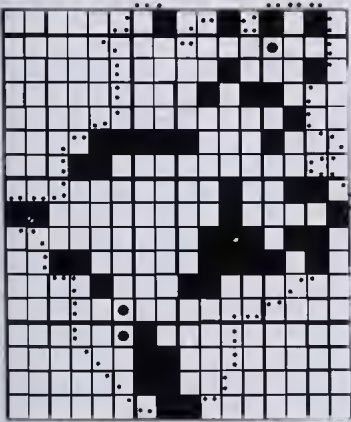


FIG. 90. Southern Boobook.

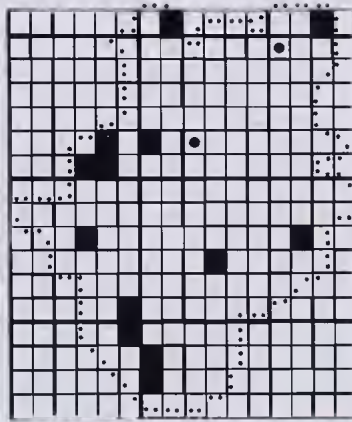


FIG. 91. Barn Owl.

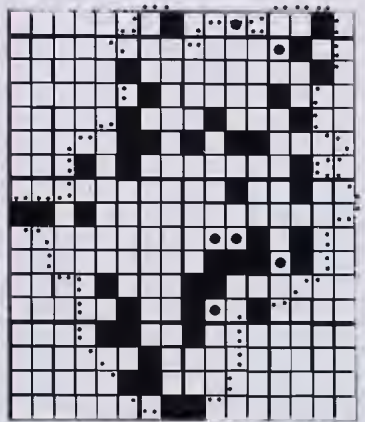


FIG. 92. Tawny Frogmouth.

N. ENG. RANGE: widespread, though few records from N and S.

**Shining Bronze-Cuckoo** *Ch. lucidus* (Fig.87)

RANGE: breeds in SE and SW Aust., migrating up the E coast to NG and Indonesia. Also breeds in NZ, the Philippines and other Pacific islands. NZ birds winter in the Solomon Islands, with some appearing in E Aust.

HABITAT: eucalypt forest and woodland.

N. ENG. RANGE: most parts, with more records than previous species in SE. The NZ subspecies has been recorded from the tablelands.

**Little Bronze-Cuckoo** *Ch. malayanus*

RANGE: the Little Bronze-Cuckoo and possibly conspecific Gould's Bronze-Cuckoo (*Ch. russatus*) occur in N Aust. from the Kimberleys to extreme NENSW. Also SE Asia and NG.

HABITAT: forest.

N. ENG. RANGE: single breeding record from near Tenterfield is most S in RAOU atlas.

**Common Koel** *Eudynamis scolopacea* (Fig.88)

RANGE: Asia, NG, the W Pacific islands, N and E Aust.

HABITAT: rainforest, eucalypt forest and woodland.  
N. ENG. RANGE: occurs continuously along the NSW coast and hinterland S to Sydney, with an isolated population on NW Slopes. Occasional records from the tablelands.

**Channel-billed Cuckoo** *Scythrops novaehollandiae* (Fig. 89)

RANGE: breeds in N and E Aust., and possibly NG, and winters in Indonesia and NG.

HABITAT: forest, especially where figs are abundant.  
N. ENG. RANGE: patchy distribution which is hard to interpret, but Channel-billed Cuckoos tend to be seen most often around Tamworth, where *Ficus* occurs on hillsides, and in the eastern gorges where other figs occur. They are highly mobile though, often being seen or heard elsewhere.

**Pheasant Coucal** *Centropus phasianinus*

RANGE: Timor, NG, N and E Aust.

HABITAT: rank grass in woodland or swamps.

N. ENG. RANGE: 2 records from extreme E, bordering coastal populations; records from Armidale, Ashford and Bingara are outside normal range.

**Powerful Owl** *Ninox strenua*

RANGE: SE Q to W V.

HABITAT: tall, moist forests.

N. ENG. RANGE: single record, E of Tenterfield.

Recorded in Gibraltar Range and London Bridge State Forest after atlas period (Debus, pers. comm.).

**Southern Boobook** *N. novaeseelandiae* (Fig.90)

RANGE: NZ, NG, parts of Indonesia, many islands in the W Pacific and most of Aust.

HABITAT: forests and woodland.

N. ENG. RANGE: most widespread owl.

**Barking Owl** *N. connivens*

RANGE: thinly spread in N, E and SW Aust. and NG.

HABITAT: eucalypt woodland.

N. ENG. RANGE: 5 widely scattered squares.

**Barn Owl** *Tyto alba* (Fig.91)

RANGE: cosmopolitan, Aust. except T.

HABITAT: all but desert and dense forest.

N. ENG. RANGE: widely scattered records, including two of breeding.

**Sooty Owl** *T. tenebricosa*

RANGE: perhaps Aust.'s rarest owl, with populations in Atherton region of N Q and from SE Q to central V, also NG.

HABITAT: rainforest and tall eucalypt forest.

N. ENG. RANGE: single record from near Tenterfield. Recorded subsequently from New England National Park on E fringes (P. Fleming, pers. comm.) and London Bridge State Forest (Debus, pers. comm.), and breeding recorded just SE of region.

**Tawny Frogmouth** *Podargus strigoides* (Fig.92)

RANGE: throughout Aust., NG.

HABITAT: eucalypt forest and all types of woodland.

N. ENG. RANGE: widespread and probably under-recorded.

**Australian Owlet-Nightjar** *Aegotheles cristatus* (Fig. 93)

RANGE: NG, most of Aust.

HABITAT: woodland and forest.

N. ENG. RANGE: patchy records probably underestimate its distribution.

**White-throated Nightjar** *Caprimulgus mystacalis*

RANGE: E Aust. from Cape York to central V, also NG, New Caledonia and Solomon Islands.

HABITAT: dry, open ridges in eucalypt forest and woodland.

N. ENG. RANGE: three records from N half.

**Spotted Nightjar** *C. guttatus*

RANGE: inland Aust.



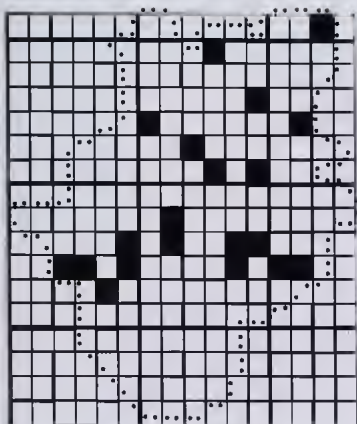


FIG. 93. Owllet Nightjar.



FIG. 94. White-throated Needletail.

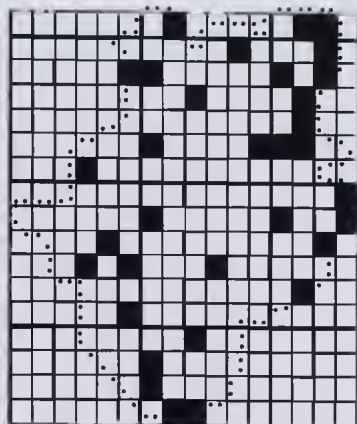


FIG. 95. Azure Kingfisher.

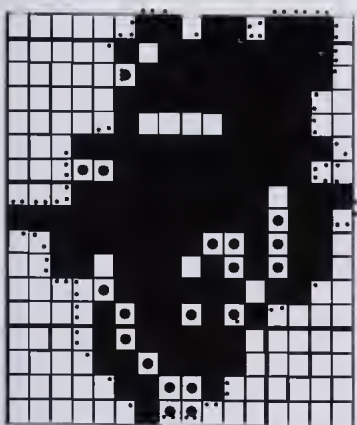


FIG. 96. Laughing Kookaburra.

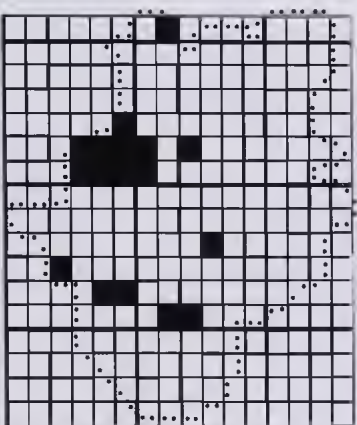


FIG. 97. Red-backed Kingfisher.

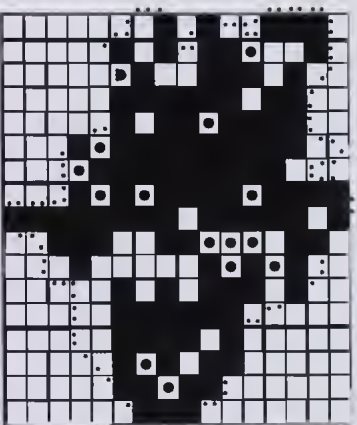


FIG. 98. Sacred Kingfisher.

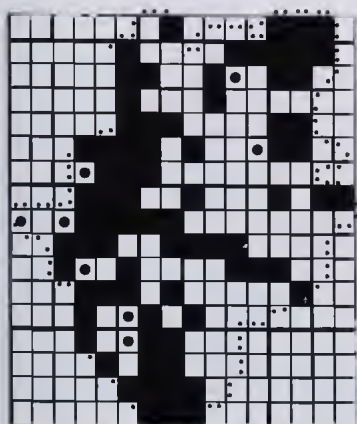


FIG. 99. Rainbow Bee-eater.

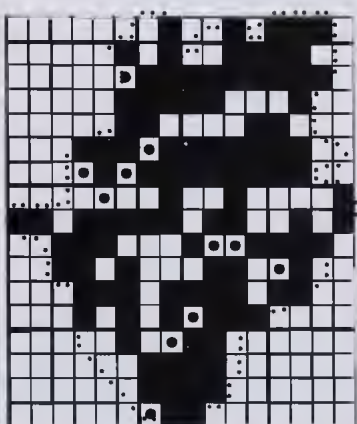


FIG. 100. Dollarbird.

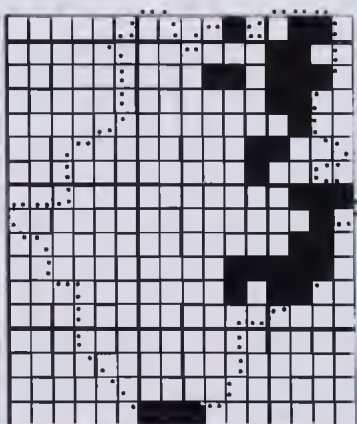


FIG. 101. Superb Lyrebird.

HABITAT: woodland and scrub.

N. ENG. RANGE: single record from near Barraba, most E in NSW.

**White-throated Needletail** *Hirundapus caudacutus* (Fig. 94)

RANGE: breeds in Asia, non-breeding season in E Aust.

HABITAT: aerial, over most habitats.

N. ENG. RANGE: widely reported, particularly in S and E.

**Fork-tailed Swift** *Apus pacificus*

RANGE: breeds in Asia and more widespread than previous species in Aust. in non-breeding season, though scarcer in E.

HABITAT: aerial, over most habitats.

N. ENG. RANGE: recorded from 7 scattered squares.

**Azure Kingfisher** *Ceyx azurea* (Fig.95)

RANGE: Indonesia, NG, E and N Aust.

HABITAT: streams and rivers.

N. ENG. RANGE: in E and W, but virtually absent from tablelands, possibly because streams are poorly vegetated and polluted by fertilisers.

**Laughing Kookaburra** *Dacelo novaeguineae* (Fig.96)

RANGE: E Aust., but despite scientific name, not NG. Introduced into SW Aust., T, Kangaroo Is and NZ.

HABITAT: eucalypt woodland and forest.

N. ENG. RANGE: recorded nearly everywhere, with many breeding records.

**Forest Kingfisher** *Halcyon macleayii*

RANGE: NE Aust., Top End and NG.

HABITAT: woodland and forest-edges, often near water.

N. ENG. RANGE: 5 squares on E fringes, with one breeding record E of Tenterfield. Baldwin (1975) noted it as an uncommon migrant near Inverell.

**Red-backed Kingfisher** *H. pyrrhopygia* (Fig.97)

RANGE: inland Aust., in places reaching the coast.

HABITAT: woodland.

N. ENG. RANGE: W half, irregular on the tablelands (Courtney 1971).

**Sacred Kingfisher** *H. sancta* (Fig.98)

RANGE: Indonesia, NG, NZ, Aust. except T, and numerous Pacific islands.

HABITAT: woodland.

N. ENG. RANGE: throughout, with many breeding records.

**Rainbow Bee-eater** *Merops ornatus* (Fig.99)

RANGE: breeds in most of Aust., except T and near S coast, and locally in NG. Winters in NG and Micronesia.

HABITAT: woodland and scrub, particularly where sandy.

N. ENG. RANGE: widespread, though scarce on tablelands and SE.

**Dollarbird** *Eurystomus orientalis* (Fig.100)

RANGE: breeds from India and China through to SE Aust. Australian birds move N in autumn.

HABITAT: woodland, roadsides and clearings in forests.

N. ENG. RANGE: widespread.

**Noisy Pitta** *Pitta versicolor*

RANGE: NG, E Aust. from Cape York to Sydney.

HABITAT: mostly rainforest.

N. ENG. RANGE: recorded E of Tenterfield and Gibraltar Range National Park.

**Superb Lyrebird** *Menura novaehollandiae* (Fig.101)

RANGE: SE Aust. from extreme SE Q to Melbourne.

HABITAT: rainforest and eucalypt forest.

N. ENG. RANGE: reported widely from E part and extreme S.

**Rufous Scrub-bird** *Atrichornis rufescens*

RANGE: very restricted distribution in SE Q and NE NSW.

HABITAT: rainforest and ecotone between rainforest and eucalypt forest (Ferrier 1985).

N. ENG. RANGE: only a few localities in New England and Gibraltar Range National Parks, on E margin.

**Singing Bushlark** *Mirafra javanica* (Fig.102)

RANGE: N and E Aust., Africa and S Asia.

HABITAT: open grassland and crops.

N. ENG. RANGE: mostly S and W, few records from tablelands.

**White-backed Swallow** *Cheramoeca leucosternum* (Fig. 103)

RANGE: central Aust., reaching coast in E and W.

HABITAT: open areas, nesting colonially in sandy banks.

N. ENG. RANGE: most frequent in N and W, though some records from elsewhere.

**Welcome Swallow** *Hirundo neoxena* (Fig.104)

RANGE: S of Tropic of Capricorn, and along the Q coast. Colonized NZ recently.

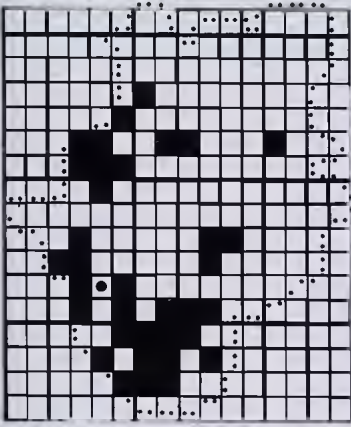


FIG. 102. Singing Bushlark.

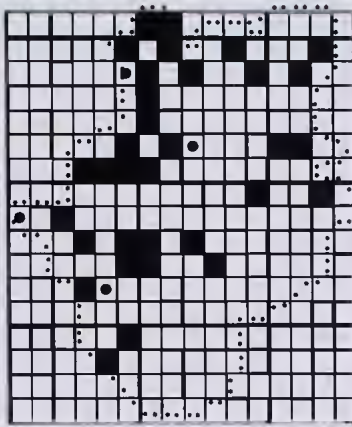


FIG. 103. White-backed Swallow.

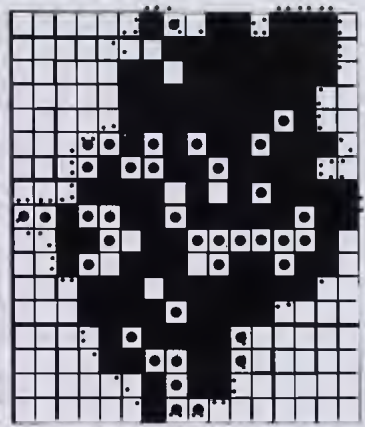


FIG. 104. Welcome Swallow.

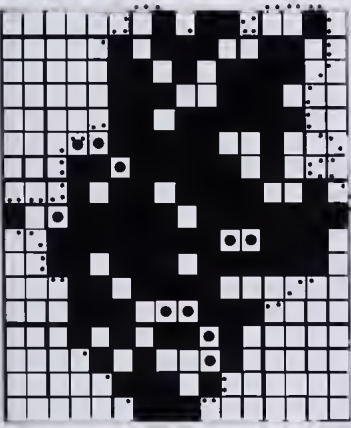


FIG. 105. Tree Martin.

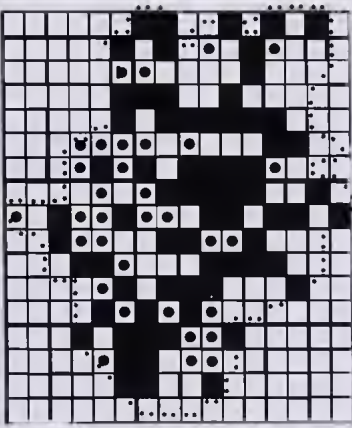


FIG. 106. Fairy Martin.

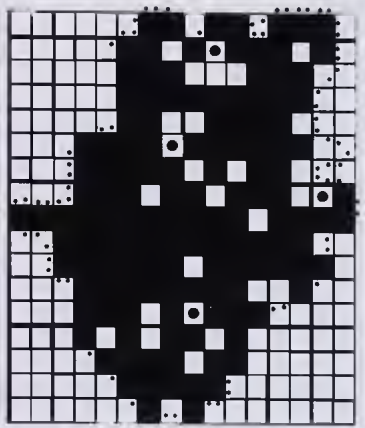


FIG. 107. Richard's Pipit.

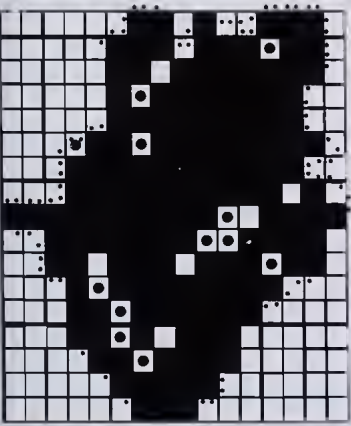


FIG. 108. Black-faced Cuckoo-shrike.

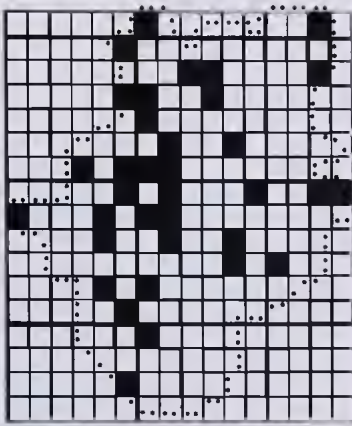


FIG. 109. White-bellied Cuckoo-shrike.

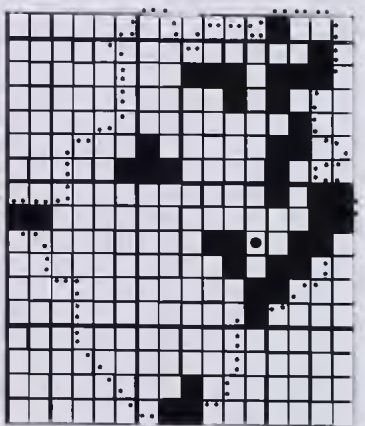


FIG. 110. Cicadabird.

HABITAT: open areas, often near human settlement.  
N. ENG. RANGE: everywhere in New England.

**Tree Martin** *Cecropis nigricans* (Fig.105)

RANGE: breeds S of Tropic in Aust., further N in non-breeding season, also NG, Indonesia and New Caledonia.

HABITAT: woodland and open forest.

N. ENG. RANGE: widespread, mostly summer visitor.

**Fairy Martin** *C. ariel* (Fig.106)

RANGE: throughout Aust., except deserts, far N and T.

HABITAT: more open country than Tree Martin, nests under bridges.

N. ENG. RANGE: most parts, though patchy in E, summer visitor.

**Richard's Pipit** *Anthus novaeseelandiae*  
(Fig.107)

RANGE: Aust., NZ, many parts of Europe, Asia and Africa.

HABITAT: grassland.

N. ENG. RANGE: widespread, wherever there is open grassland.

**Black-faced Cuckoo-shrike** *Coracina novaehollandiae* (Fig. 108)

RANGE: Aust., except deserts, India, SE Asia, NG.

HABITAT: scrub, woodland, open forest.

N. ENG. RANGE: present in all parts of New England.

**White-bellied Cuckoo-shrike** *C. papuensis*  
(Fig. 109)

RANGE: N and E Aust., NG.

HABITAT: woodlands and forests.

N. ENG. RANGE: patchily distributed, more common in W than E and tablelands.

**Cicadabird** *C. tenuirostris* (Fig.110)

RANGE: far N of NT and along E coast and adjacent ranges to Melbourne, NG and other Pacific islands.

HABITAT: rainforest and eucalypt forest.

N. ENG. RANGE: forests in the E half of New England, apparently outlying populations near Inverell and at Mount Kaputar.

**Ground Cuckoo-shrike** *C. maxima* (Fig.111)

RANGE: widespread through inland Aust.

HABITAT: woodland and scrub.

N. ENG. RANGE: SW, a few records from tablelands.

**White-winged Triller** *Lalage sueurii*  
(Fig.112)

RANGE: Indonesia, NG and Aust., except for T.

HABITAT: woodland and scrub, but not forest.

N. ENG. RANGE: widespread, except for the forested areas.

**Varied Triller** *L. leucomela*

RANGE: NG, N and E coasts of Aust. S to Port Macquarie.

HABITAT: forest and woodland.

N. ENG. RANGE: single record from NE corner.

**White's Thrush** *Zoothera dauma* (Fig.113)

RANGE: Since data were collected for the atlas, White's Thrush has been split into two species (Ford 1983). The Bassian Thrush, *Z. lunulata*, occurs on Kangaroo Island, the Mount Lofty Ranges, T and SE Aust. to the Q border, with an isolated population in the Atherton Tablelands of N Q. The Russet-tailed Thrush, *Z. heinei*, occurs from NE NSW to NE Q. More information is required on their distribution where they overlap, but *lunulata* seems to occur in the highlands and *heinei* in coastal areas. The super-species is widespread from E Europe through Asia to NG.

HABITAT: forest, more open country in autumn.

N. ENG. RANGE: mostly from E half. Probably most birds are *lunulata*, but birds captured at Dorrigo, just to the E of the region, had measurements that agreed with *heinei*.

**Blackbird** *Turdus merula*

RANGE: Europe and Asia, introduced to Aust. in the 1860s. Now spread through the temperate parts of SE Aust.

HABITAT: mostly parks and gardens, but also native woodland and forest.

N. ENG. RANGE: recorded from Armidale and Ural-la, where it seems established in small numbers. Current N limit of range.

**Rose Robin** *Petroica rosea* (Fig.114)

RANGE: breeds in SE Aust. to NE NSW. In autumn moves N.

HABITAT: forest, woodland after breeding.

N. ENG. RANGE: occurs mostly in E half though some records from elsewhere. The species breeds in tall forest on E fringes of region (Fleming 1980), becoming more widespread in autumn and winter.

**Flame Robin** *P. phoenicea* (Fig.115)

RANGE: breeds in SE Aust. between NE NSW and T.

HABITAT: woodland, often at high altitude, in winter more widespread in lower, more open country.

N. ENG. RANGE: throughout the SE half of region, typically breeding in grassy snow gum (*Eucalyptus pauciflora*) woodland (Fleming 1980). Many records from tablelands are non-breeding birds.

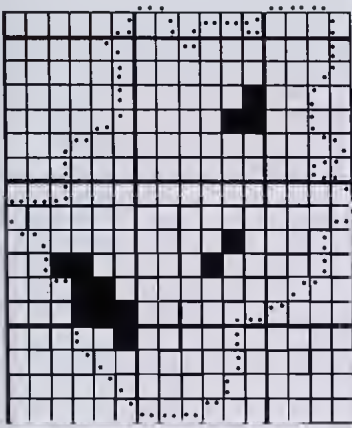


FIG. 111. Ground Cuckoo-shrike.

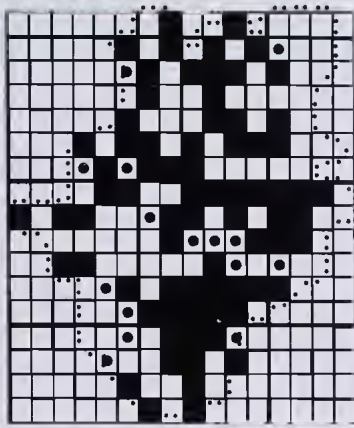


FIG. 112. White-winged Triller.

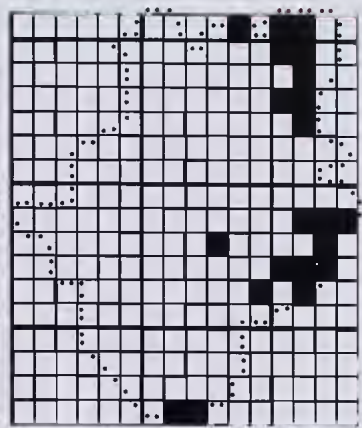


FIG. 113. White's Thrush.

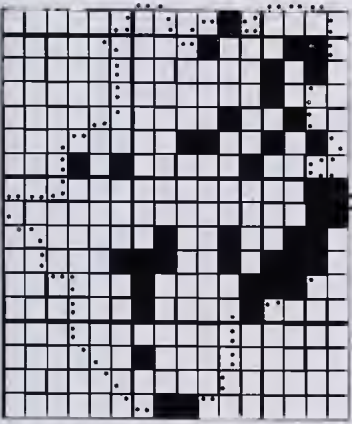


FIG. 114. Rose Robin.

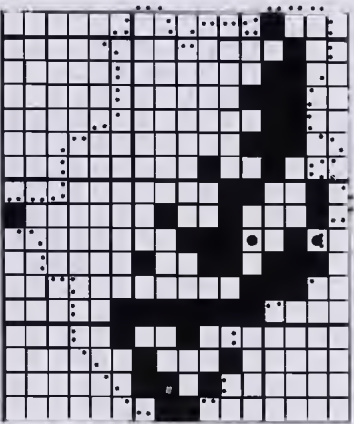


FIG. 115. Flame Robin.

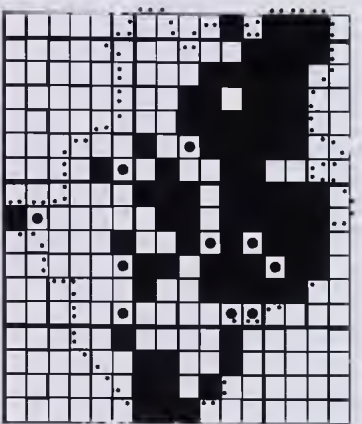


FIG. 116. Scarlet Robin.

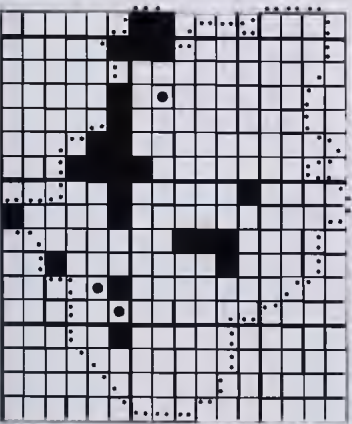


FIG. 117. Red-capped Robin.

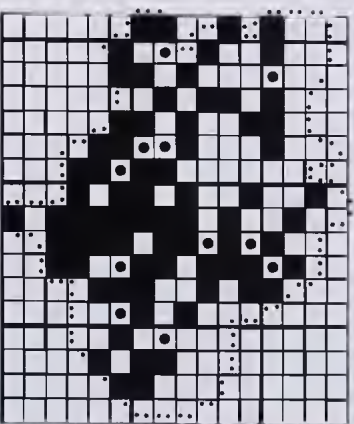


FIG. 118. Hooded Robin.

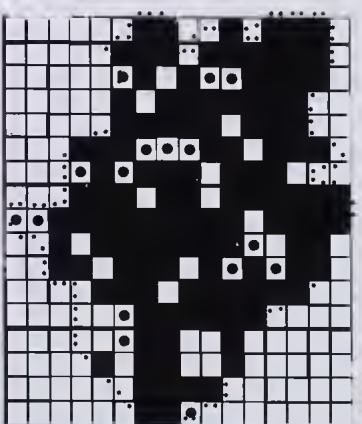


FIG. 119. Eastern Yellow Robin.

**Scarlet Robin** *P. multicolor* (Fig.116)

RANGE: breeds in SE Aust., including T, the Mount Lofty Ranges, Kangaroo Island and in SW Aust.  
 HABITAT: eucalypt forest, with patchy understorey.  
 N. ENG. RANGE: widespread, except in drier W and NW. An outlying population on Mount Kaputar.

**Red-capped Robin** *P. goodenovii* (Fig.117)

RANGE: inland Aust., N to about 20° S.  
 HABITAT: wide range of woodland and scrub.  
 N. ENG. RANGE: W half, range complements that of Scarlet Robin. Records from tablelands mostly during drought at end of atlas period.

**Hooded Robin** *Melanodryas cucullata* (Fig.118)

RANGE: throughout inland Aust.  
 HABITAT: woodland and scrub.  
 N. ENG. RANGE: widespread, except for forested E and SE fringes. Patchy on tablelands, perhaps because most suitable habitat has been cleared or degraded.

**Eastern Yellow Robin** *Eopsaltria australis* (Fig.119)

RANGE: E Aust. from the Atherton region of N Q to SE SA.  
 HABITAT: rainforest, eucalypt forest and woodland, mallee.  
 N. ENG. RANGE: throughout region, though scarce in heavily cleared areas.

**Jacky Winter** *Microeca leucophaea* (Fig.120)

RANGE: throughout Aust., except heavily forested areas, deserts and T.  
 HABITAT: woodland of all types, partly cleared forest.  
 N. ENG. RANGE: recorded in all parts of region.

**Pale-yellow Robin** *Tregellasia capito* (Fig.121)

RANGE: NE Q, SE Q to mid-N coast of NSW.  
 HABITAT: warm temperate, sub-tropical and tropical rainforest.  
 N. ENG. RANGE: E extremities.

**Crested Shrike-tit** *Falcunculus frontatus* (Fig.122)

RANGE: Atherton region of Q to the Mount Lofty Ranges of SA, distinct subspecies in Top End and SW Aust.  
 HABITAT: woodland, open forest.  
 N. ENG. RANGE: widespread, though patchy. Prefers eucalypts with peeling bark and appears susceptible to fragmentation and degradation of habitat.

**Olive Whistler** *Pachycephala olivacea*

RANGE: T and from SE SA to SE NSW, then patchily along the ranges to Q border.  
 HABITAT: rainforest in N, but wider range of forest further S.  
 N. ENG. RANGE: E escarpment from New England N. P. to Mount Hyland, in temperate rainforest.

**Golden Whistler** *P. pectoralis* (Fig.123)

RANGE: SW and E Aust. from Eyre Peninsula to NE Q, T. Also on numerous Pacific islands.  
 HABITAT: rainforest, eucalypt forest and woodland.  
 N. ENG. RANGE: throughout region, though patchy in W half. Moves to more open habitats in autumn.

**Rufous Whistler** *P. rufiventris* (Fig.124)

RANGE: Aust., except T and deserts.  
 HABITAT: wide range of woodland and scrub.  
 N. ENG. RANGE: throughout, though typically breeds in more open habitat than Golden Whistler.

**Grey Shrike-thrush** *Colluricincla harmonica* (Fig.125)

RANGE: throughout Aust., S NG.  
 HABITAT: forest, woodland and scrub.  
 N. ENG. RANGE: present in all parts.

**Little Shrike-thrush** *C. megarhyncha*

RANGE: NG, N and E Aust., S to NE NSW.  
 HABITAT: rainforest.  
 N. ENG. RANGE: single record, from Washpool National Park, in NE corner.

**Crested Bellbird** *Oreoica gutturalis*

RANGE: inland Aust., reaching S and W coasts.  
 HABITAT: woodland, mallee and dry scrub in inland Aust.  
 N. ENG. RANGE: several records from W, though scarce and patchily distributed. This represents E extreme of range.

**Black-faced Monarch** *Monarcha melanopsis* (Fig.126)

RANGE: E coast and adjacent ranges of Aust. Migratory, spending winter from central Q to NG.  
 HABITAT: rainforest and eucalypt forest.  
 N. ENG. RANGE: found in summer near E edge. Birds on tablelands probably on passage.

**Spectacled Monarch** *M. trivirgatus*

RANGE: breeds along E coast of Aust. to NE NSW, winters in NG.  
 HABITAT: rainforest.  
 N. ENG. RANGE: recorded from three squares on E extreme.

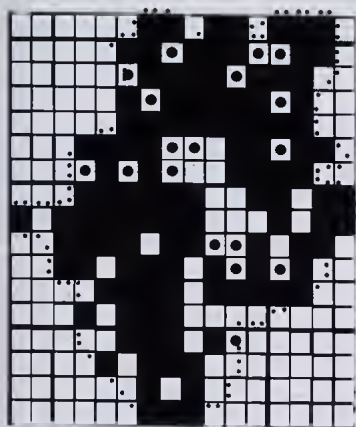


FIG. 120. Jacky Winter.

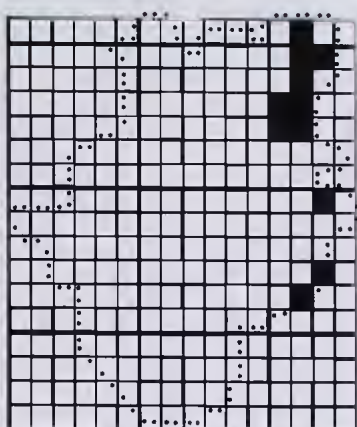


FIG. 121. Pale-yellow Robin.

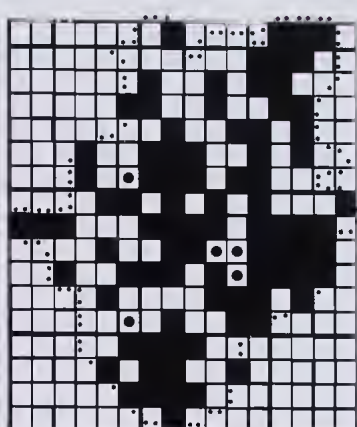


FIG. 122. Crested Strike-tit.

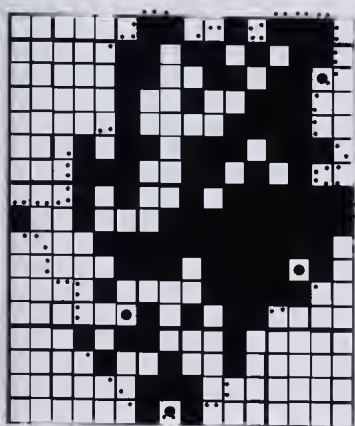


FIG. 123. Golden Whistler.

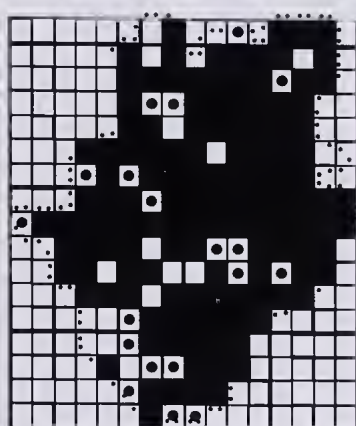


FIG. 124. Rufous Whistler.

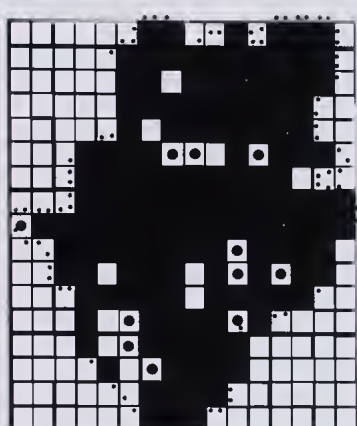


FIG. 125. Grey Strike-thrush.

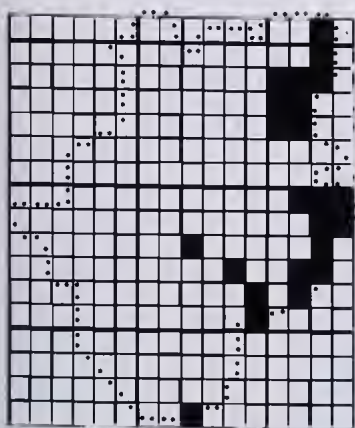


FIG. 126. Black-faced Monarch.

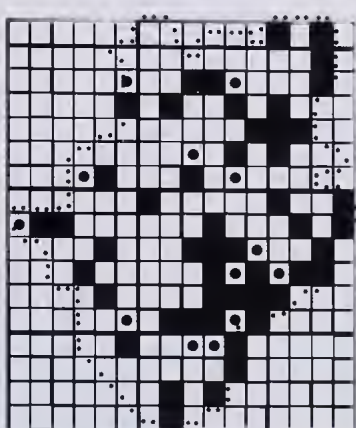


FIG. 127. Leaden Flycatcher.

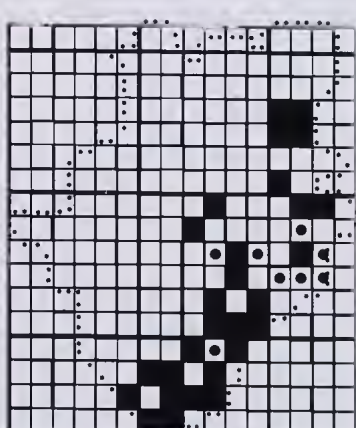


FIG. 128. Satin Flycatcher.

**Leaden Flycatcher** *Myiagra rubecula*  
(Fig.127)

RANGE: breeds in N and E Aust., and in NG and nearby islands. Winters in N Q and NG.

HABITAT: forest and woodland.

N. ENG. RANGE: widespread, though patchy, more common in E.

**Satin Flycatcher** *M. cyanoleuca* (Fig.128)

RANGE: breeds in SE Aust. and T. Migrates N in autumn to N Q and N.G.

HABITAT: eucalypt forest.

N. ENG. RANGE: occurs in SE half, more restricted than Leaden Flycatcher. Both species may breed syntopically, e.g. at Wollomombi.

**Restless Flycatcher** *M. inquieta* (Fig.129)

RANGE: throughout Aust. and S NG.

HABITAT: woodland, agricultural areas where few trees remain.

N. ENG. RANGE: widespread, though scarce in the denser forested areas. May co-occur with Leaden Flycatcher in grassy woodland.

**Rufous Fantail** *Rhipidura rufifrons*  
(Fig.130)

RANGE: N and E coasts of Aust. and adjacent ranges, NG and nearby islands. S birds migrate N in autumn.

HABITAT: mostly understorey of eucalypt forest (Cameron, 1986).

N. ENG. RANGE: E, migrants in Armidale in spring and autumn.

**Grey Fantail** *R. fuliginosa* (Fig.131)

RANGE: all parts of Aust.

HABITAT: forest, woodland and scrub.

N. ENG. RANGE: throughout, declining in forests in winter (Cameron 1985). Migrants numerous on tablelands in autumn and spring.

**Willie Wagtail** *R. leucophrys* (Fig.132)

RANGE: almost everywhere in Aust., except T.

HABITAT: woodland, farmland, prefers more open country than two previous species (Cameron 1985).

N. ENG. RANGE: throughout region.

**Logrunner** *Orthonyx temminckii*

RANGE: SE Q and E NSW S to Illawarra region.

HABITAT: subtropical and warm temperate rainforest, but also dense exotic undergrowth and small patches of rainforest (Howe *et al.* 1981).

N. ENG. RANGE: 6 squares on E edge.

**Eastern Whipbird** *Psophodes olivaceus*  
(Fig.133)

RANGE: E Aust. between Atherton region and Melbourne.

HABITAT: dense understorey in rainforest and wet sclerophyll forest.

N. ENG. RANGE: E and extreme S parts.

**Spotted Quail-thrush** *Cinlosoma punctatum*  
(Fig.134)

RANGE: SE Aust., between central Q and W V. Isolated populations in T and Mount Lofty Ranges.

HABITAT: eucalypt forest, typically on stony ridges.

N. ENG. RANGE: patchy in E half, with an isolated population around Mount Kaputar.

**Grey-crowned Babbler** *Pomatostomus temporalis* (Fig.135)

RANGE: N and E Aust., except deserts and highlands.

HABITAT: eucalypt and acacia woodland.

N. ENG. RANGE: W of Dividing Range. Also widespread in lowlands just NE of region.

**White-browed Babbler** *P. superciliosus*  
(Fig.136)

RANGE: S and central Aust., except near E coast.

HABITAT: eucalypt and acacia woodland and mallee, often in stony areas.

N. ENG. RANGE: mostly in rocky parts of NW Slopes. Absent from SW of region, tablelands and E of Dividing Range.

**Clamorous Reed-Warbler** *Acrocephalus stentoreus* (Fig.137)

RANGE: E Aust. and parts of coastal WA, as well as Africa, Asia and NG.

HABITAT: reed-beds in lagoons, larger farm dams and sluggish creeks.

N. ENG. RANGE: widespread, particularly on tablelands, but absent from forests. Birds were seen away from reed-beds in 1980-81 drought.

**Tawny Grassbird** *Megalurus timoriensis*

RANGE: Philippines, NG, N and E Aust., generally near coast.

HABITAT: wet heathland, swampy grassland or edges of lagoons.

N. ENG. RANGE: recorded from wet grassland near lagoons on tablelands. The status of this isolated population is unclear.

**Little Grassbird** *M. gramineus* (Fig.138)

RANGE: SW and SE Aust., some inland records, e. g. Lake Eyre drainage.

HABITAT: edges of swamps, lagoons, larger farm dams.



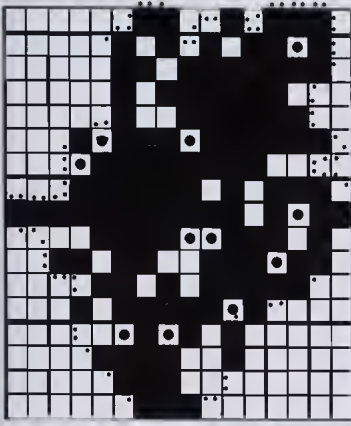


FIG. 129. Restless Flycatcher.

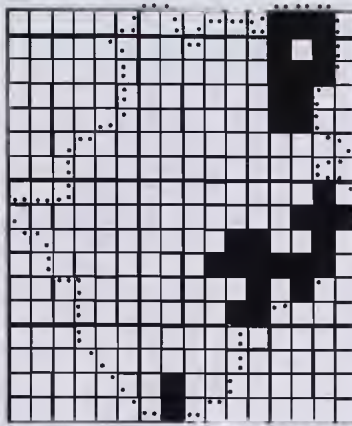


FIG. 130. Rufous Fantail.

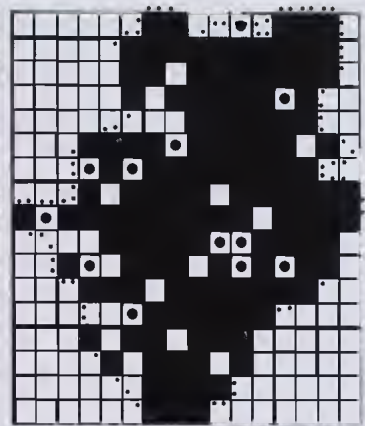


FIG. 131. Grey Fantail.

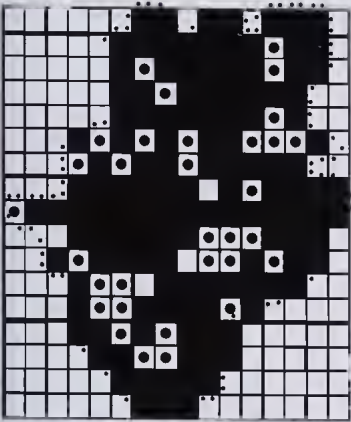


FIG. 132. Willie Wagtail.

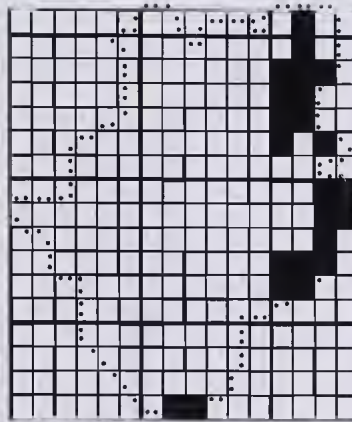


FIG. 133. Eastern Whipbird.

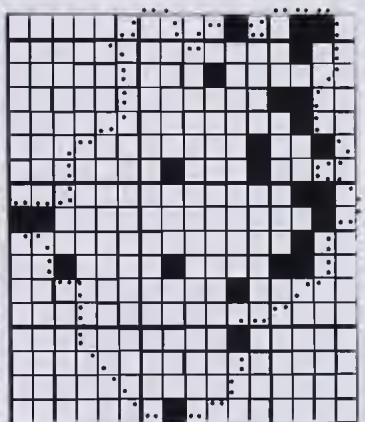


FIG. 134. Spotted Quail-thrush

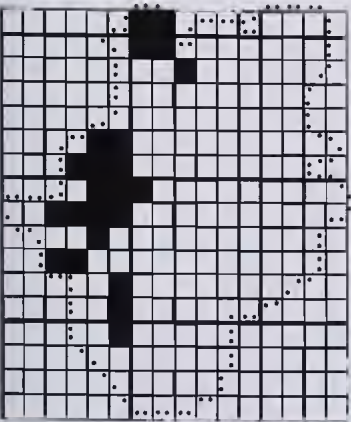


FIG. 135. Grey-crowned Babbler.

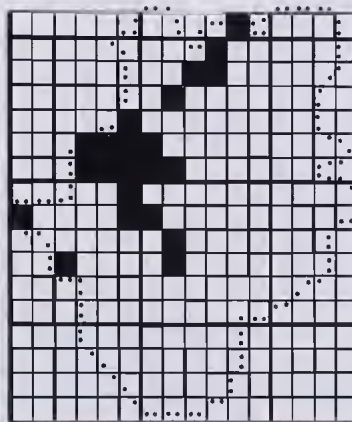


FIG. 136. White-browed Babbler.

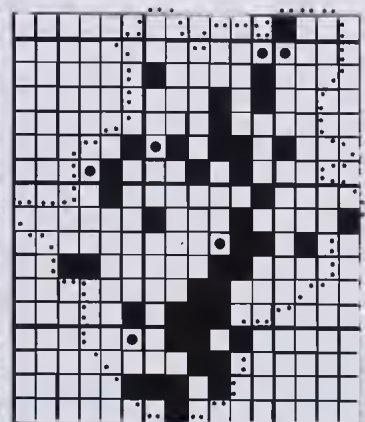


FIG. 137. Clamorous Reed-Warbler.

N. ENG. RANGE: widespread near wetlands on tablelands.

**Golden-headed Cisticola** *Cisticola exilis*

RANGE: N and E Aust. Also India, China, SE Asia and NG.

HABITAT: swamps and rank grassland.

N. ENG. RANGE: recorded from 9 widely scattered squares.

**Rufous Songlark** *Cinclorhamphus mathewsi* (Fig.139)

RANGE: throughout Aust., except forested areas and T. Migratory, leaving most S areas in late summer or early autumn.

HABITAT: open woodland, with long grass.

N. ENG. RANGE: widespread, except for E forested regions.

**Brown Songlark** *C. cruralis* (Fig.140)

RANGE: throughout inland Aust., reaching coast in drier areas, but absent from far N and T.

HABITAT: grassland, shrubland, open woodland and crops.

N. ENG. RANGE: cropping areas of W, and S parts of tablelands.

**Superb Fairy-wren** *Malurus cyaneus* (Fig.141)

RANGE: SE Aust. from central Q to Eyre Peninsula, and T.

HABITAT: forest, woodland and heath, with well-developed shrub layer.

N. ENG. RANGE: throughout, inhabiting blackberries in heavily cleared areas.

**Variiegated Fairy-wren** *M. lamberti* (Fig.142)

RANGE: widespread in Aust., except SW, extreme SE and T.

HABITAT: wide range of habitats, with dense understorey.

N. ENG. RANGE: parts of W, N and E fringes. The subspecies *lamberti* occurs in N and E and *assimilis* elsewhere. It tends to inhabit heathy vegetation on granite or other infertile rocks.

**Red-backed Fairy-wren** *M. melanocephalus*

RANGE: N and E Aust. S to NE NSW.

HABITAT: forest and woodland with a dense grassy understorey.

N. ENG. RANGE: only Washpool NP, in NE corner, recorded on Sara River in 1990 (Debus, pers. comm.).

**Southern Emu-wren** *Stipiturus malachurus*

RANGE: T, SW and SE Aust., N to SEQ.

HABITAT: heath and dense swampy areas.

N. ENG. RANGE: confined to Washpool and Gibraltar Range NPs in NE corner. This population is isolated from coastal ones.

**Large-billed Scrub-wren** *Sericornis magnirostris* (Fig.143)

RANGE: E Aust. from Atherton to Melbourne.

HABITAT: rainforest and wet sclerophyll forest.

N. ENG. RANGE: E edge of region.

**Yellow-throated Scrub-wren** *S. citreogularis* (Fig. 144)

RANGE: Atherton region and from SEQ to SE NSW.

HABITAT: rainforest and adjacent eucalypt forest.

N. ENG. RANGE: E and extreme S.

**White-browed Scrubwren** *S. frontalis* (Fig.145)

RANGE: several well-differentiated sub-species along coast and neighbouring ranges of Aust. from NE Q to Shark Bay, WA, and T.

HABITAT: forest, woodland, mallee and coastal heath.

N. ENG. RANGE: most of region, though patchy in W. Birds in NE corner resemble sub-species *laevigaster*, whereas those in SW are *frontalis*. There is clinal variation between the two forms (Ford 1985).

**Chestnut-rumped Hylacola** *S. pyrrhopygius* (Fig.146)

RANGE: SE Aust., SEQ to Mount Lofty Ranges.

HABITAT: heath and forest with a heathy understorey.

N. ENG. RANGE: series of isolated populations, most substantial ones being in Mount Kaputar area, Gibraltar Range National Park and Nandewar Ranges. Other populations could exist in rocky ranges elsewhere.

**Speckled Warbler** *S. sagittatus* (Fig.147)

RANGE: E Aust. from central Q to W V.

HABITAT: woodland with bare or stony ground.

N. ENG. RANGE: widespread, though patchy, avoiding forested and heavily cleared areas.

**Weebill** *Smicromis brevirostris* (Fig.148)

RANGE: widespread in Aust., not in T.

HABITAT: eucalypt woodland and mallee.

N. ENG. RANGE: common in N and W, but patchy E of Dividing Range.

**Brown Gerygone** *Gerygone mouki* (Fig.149)

RANGE: E Aust. between Atherton and E V.

HABITAT: rainforest and eucalypt forest with dense understorey.

N. ENG. RANGE: along E edge of New England.

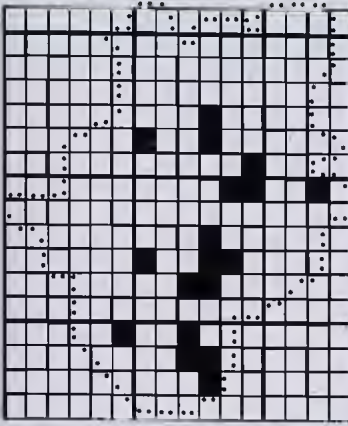


FIG. 138. Little Grassbird.

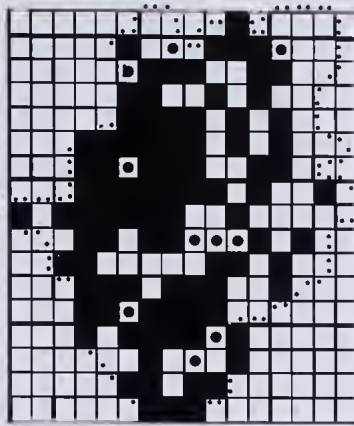


FIG. 139. Rufous Songlark.

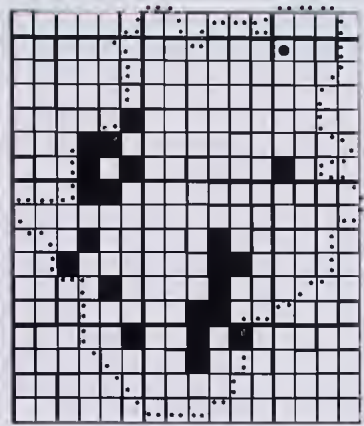


FIG. 140. Brown Songlark.

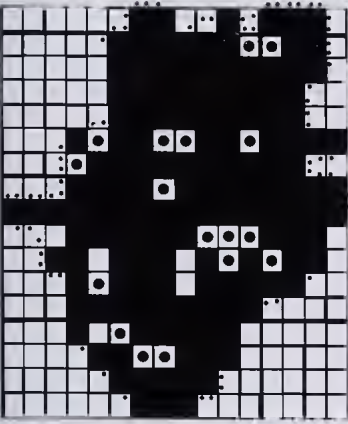


FIG. 141. Superb Fairy-wren.

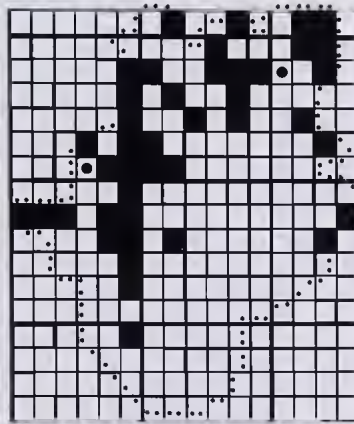


FIG. 142. Variegated Fairy-wren.

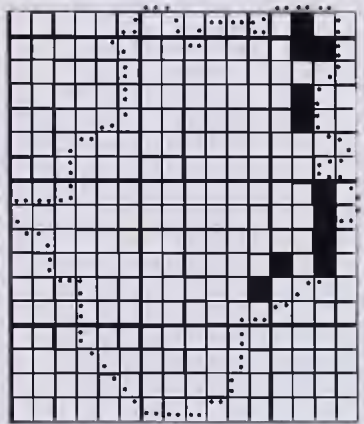


FIG. 143. Large-billed Scrub-wren.

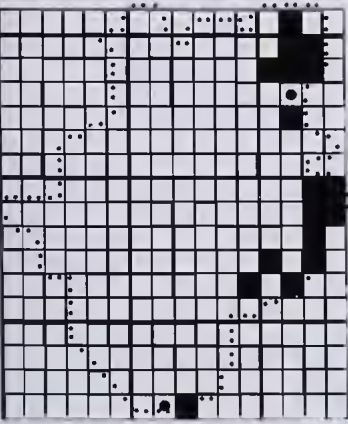


FIG. 144. Yellow-throated Scrub-wren.

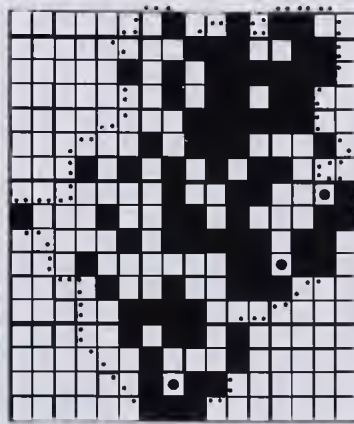


FIG. 145. White-browed Scrub-wren.

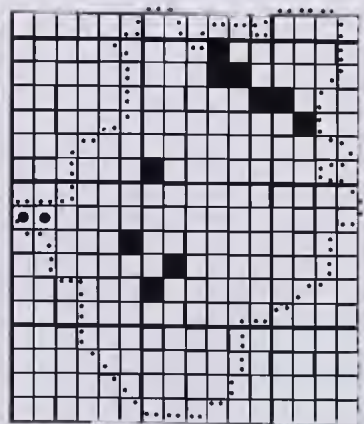


FIG. 146. Chestnut-rumped Hylacola.

**Western Gerygone** *G. fusca* (Fig.150)

RANGE: inland E Aust., central and SW Aust. Some inland and N movement in autumn.

HABITAT: woodland and mallee, also forest in SW.  
N. ENG. RANGE: W, with occasional individuals on tablelands.

**White-throated Gerygone** *G. olivacea* (Fig.151)

RANGE: N and E Aust., Mount Lofty Ranges. N-S migration.

HABITAT: eucalypt woodland and forest.  
N. ENG. RANGE: almost throughout region.

**Brown Thornbill** *Acanthiza pusilla* (Fig.152)

RANGE: SE Aust. from SEQ to Mount Lofty Ranges and Kangaroo Island.

HABITAT: rainforest, eucalypt forest and shrubs in eucalypt woodland.  
N. ENG. RANGE: widespread in E, rarely W of Dividing Range.

**Inland Thornbill** *A. apicalis* (Fig.153)

RANGE: inland Aust. S of 20° S, to coast in SW.

HABITAT: woodland and scrub.

N. ENG. RANGE: W, distribution almost mirroring that of its sibling species, the Brown Thornbill.

**Buff-rumped Thornbill** *A. reguloides* (Fig.154)

RANGE: E Aust., Atherton to Mount Lofty Ranges.

HABITAT: eucalypt woodland and forest.

N. ENG. RANGE: more widespread in E than W.

**Yellow-rumped Thornbill** *A. chrysorrhoa* (Fig.155)

RANGE: most of Aust. S of 20° S.

HABITAT: woodland and other open habitats, except deserts. Common in farmland, towns and pine-forests.

N. ENG. RANGE: throughout region.

**Yellow Thornbill** *A. nana* (Fig.156)

RANGE: E Aust.

HABITAT: woodland, especially with native pines (*Callitris*) or casuarinas.

N. ENG. RANGE: more common in W than E. In E, birds tend to be in dry casuarina woodland in gorges or along rivers.

**Striated Thornbill** *A. lineata* (Fig.157)

RANGE: coast and adjacent ranges of SE Aust.

HABITAT: eucalypt forest and woodland, sometimes rainforest.

N. ENG. RANGE: widespread in E, more patchy W of Dividing Range.

**Southern Whiteface** *Aphelocephala leucopsis* (Fig.158)

RANGE: throughout inland S Aust.

HABITAT: open woodland and acacia scrub.

N. ENG. RANGE: patchily distributed through NW Slopes and tablelands, being absent from areas of apparently suitable habitat.

**Varied Sittella** *Daphoenositta chrysoptera* (Fig.159)

RANGE: most of Aust., except for deserts and T. Five well differentiated subspecies, which hybridize where they overlap (Ford 1980, Short et al. 1983a).

HABITAT: woodland and forest.

N. ENG. RANGE: widespread, most birds belong to subspecies *chrysoptera*, except in NE where a few birds show characteristics of subspecies *leucocephala* (Short et al. 1983b).

**White-throated Treecreeper** *Climacteris leucophaea* (Fig.160)

RANGE: SE Aust., also near Eungella in central Q. No treecreepers occur in T or Kangaroo Island.

HABITAT: rainforest, eucalypt forest and woodland.

N. ENG. RANGE: throughout region.

**Red-browed Treecreeper** *C. erythrops* (Fig.161)

RANGE: SE Aust., mostly in ranges.

HABITAT: extensive eucalypt forests, preferring trees with ribbons of peeling bark (Noske 1985).

N. ENG. RANGE: E of or along Dividing Range.

**Brown Treecreeper** *C. picumnus* (Fig.162)

RANGE: throughout E Aust.

HABITAT: eucalypt woodland and mallee, including partly cleared areas.

N. ENG. RANGE: most parts, except for heavily forested areas.

**Red Wattlebird** *Anthochaera carunculata* (Fig.163)

RANGE: S Aust., from SE Q to SW Aust.

HABITAT: eucalypt woodland and forest, mallee and heath.

N. ENG. RANGE: common, except for W part. An apparently isolated population in Mount Kaputar region.

**Little Wattlebird** *A. chrysoptera*

RANGE: S Aust. and T, mostly near coast.

HABITAT: heathland, particularly with *Banksia*.

N. ENG. RANGE: NE corner, with single record from near Tamworth.

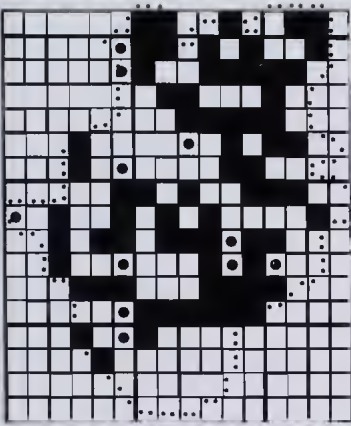


FIG. 147. Speckled Warbler.

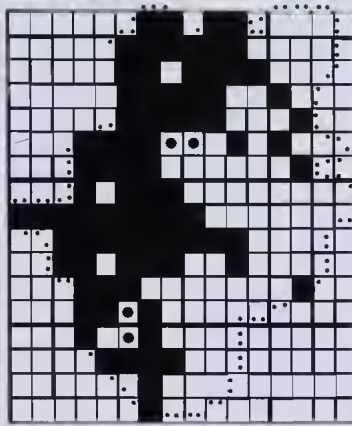


FIG. 148. Weebill.

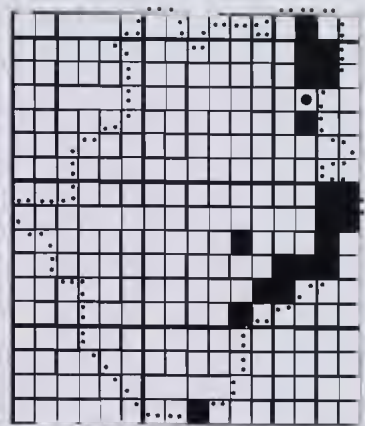


FIG. 149. Brown Gerygone.

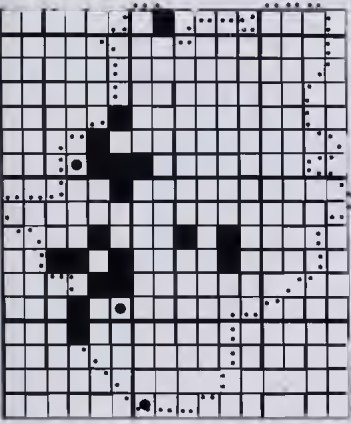


FIG. 150. Western Gerygone.

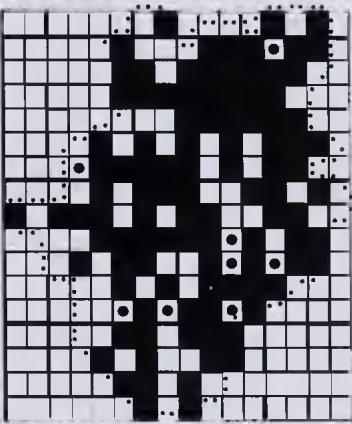


FIG. 151. White-throated Gerygone

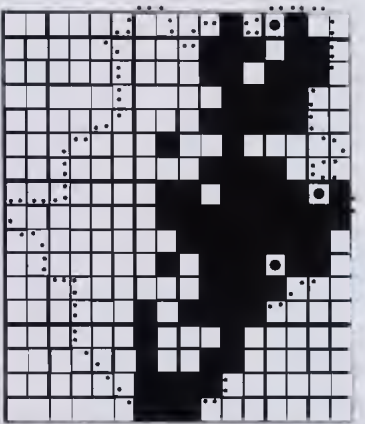


FIG. 152. Brown Thornbill.

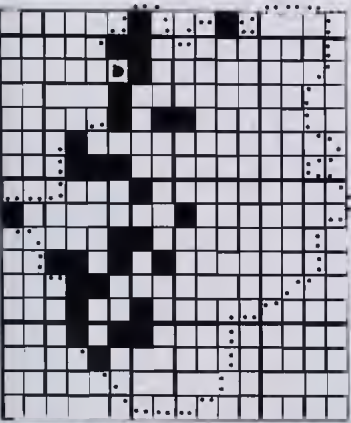


FIG. 153. Inland Thornbill.

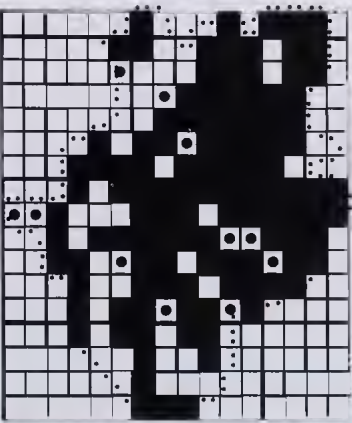


FIG. 154. Buff-rumped Thornbill.

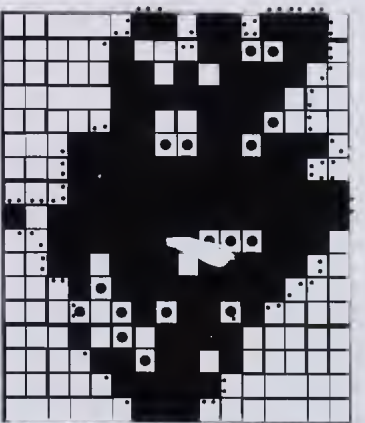


FIG. 155. Yellow-rumped Thornbill.

**Spiny-cheeked Honeyeater** *Acanthagenys rufogularis* (Fig.164)

RANGE: throughout inland Aust., reaching coast in S and W.

HABITAT: wide variety of woodland and scrub.

N. ENG. RANGE: W part, having a range that almost mirrors that of Red Wattlebird. Also a single record from near Ebor.

**Striped Honeyeater** *Plectorhyncha lanceolata* (Fig. 165)

RANGE: inland E Aust., reaching coast in a few places.

HABITAT: eucalypt, casuarina and paperbark woodland and mallee.

N. ENG. RANGE: W part, range very like that of Spiny-cheeked Honeyeater. Found in riverine casuarinas on W edge of tablelands.

**Noisy Friarbird** *Philemon corniculatus* (Fig.166)

RANGE: E Aust. from N Q to W V.

HABITAT: eucalypt forest and woodland.

N. ENG. RANGE: throughout region, leaves tablelands in winter.

**Little Friarbird** *Ph. citreogularis* (Fig.167)

RANGE: N and E Aust., mostly inland in S.

HABITAT: eucalypt woodland and farmland.

N. ENG. RANGE: W part, like Spiny-cheeked and Striped Honeyeaters. Scattered records elsewhere.

**Regent Honeyeater** *Xanthomyza phrygia*

RANGE: SE Aust. between Q border and SE SA. There has been a decline in abundance, especially in the S part of its range (Franklin et al., 1987). Now regarded as endangered (Brouwer and Garnett 1990). HABITAT: eucalypt forest and woodland, particularly flowering ironbarks.

N. ENG. RANGE: scattered records from NW slopes, breeding near Inverell. Since the atlas it has been seen near Armidale, Bundarra and at New England National Park (Ley, 1990b; Hines, pers. comm.; Ford, pers. obs.; McFarland pers. obs.). The W slopes of NSW may now be the stronghold of this species, and there is a need for more detailed information on its distribution and habitat requirements.

**Blue-faced Honeyeater** *Entomyzon cyanotis* (Fig.168)

RANGE: NE Aust.

HABITAT: eucalypt woodland, forest fringes and also farmland.

N. ENG. RANGE: several records in NE, but most common in W.

**Bell Miner** *Manorina melanophrys* (Fig.169)

RANGE: SE Aust. from S Q to Melbourne.

HABITAT: gullies in eucalypt forest, in ranges or foothills E or S of Great Dividing Range.

N. ENG. RANGE: E, with single record from NW corner, far outside expected range.

**Noisy Miner** *M. melanocephala* (Fig.170)

RANGE: E Aust., from Atherton to Mount Lofty Ranges.

HABITAT: eucalypt woodland, edge of eucalypt forest.

N. ENG. RANGE: throughout, associated with woodland suffering from dieback.

**Yellow-throated Miner** *M. flavigula* (Fig.171)

RANGE: inland Aust., extending to coast in WA.

HABITAT: woodland and scrub.

N. ENG. RANGE: NW, extensive overlap with Noisy Miner.

**Lewin's Honeyeater** *Meliphaga lewinii* (Fig.172)

RANGE: E Aust. from NE Q to Melbourne.

HABITAT: rainforest and wet sclerophyll forest.

N. ENG. RANGE: common in E, isolated population around Mount Kaputar (mostly outside New England).

**Yellow-faced Honeyeater** *Lichenostomus chrysops* (Fig.173)

RANGE: E Aust. from N Q to Mount Lofty Ranges. N-S migration.

HABITAT: eucalypt forest and woodland, sometimes mallee.

N. ENG. RANGE: widespread, scarce in W, but breeding around Mount Kaputar. Many birds pass through in autumn and spring (McFarland 1984).

**Singing Honeyeater** *L. virescens*

RANGE: throughout WA and inland E Aust.

HABITAT: mallee, acacia woodland, coastal heath, chenopod shrubland and mangroves.

N. ENG. RANGE: SW corner, though also recorded near Inverell (Baldwin 1975) and in Armidale (H. Bell, pers. comm.).

**White-eared Honeyeater** *L. leucotis* (Fig.174)

RANGE: E and SW Aust., SA.

HABITAT: eucalypt forest and woodland, mallee in W.

N. ENG. RANGE: widespread, though less common in W. Typically in scrubby forest on rocky hillsides.

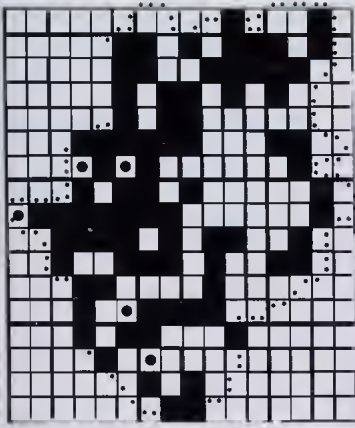


FIG. 156. Yellow Thornbill.

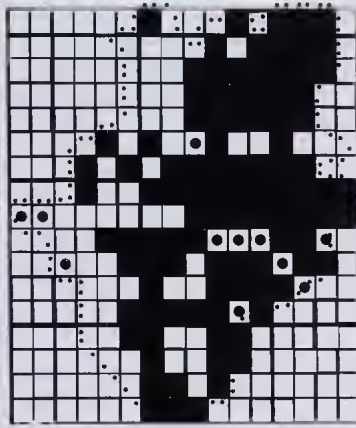


FIG. 157. Striated Thornbill.

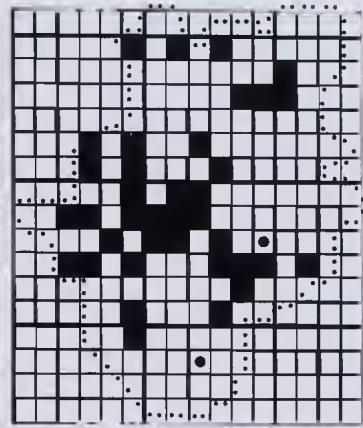


FIG. 158. Southern Whiteface.

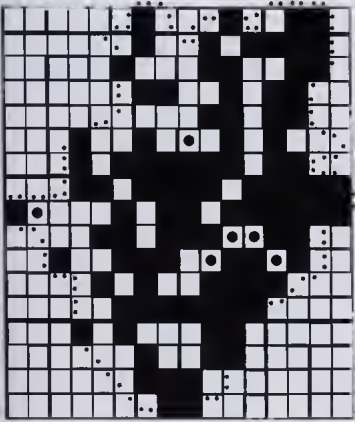


FIG. 159. Varied Sittella.

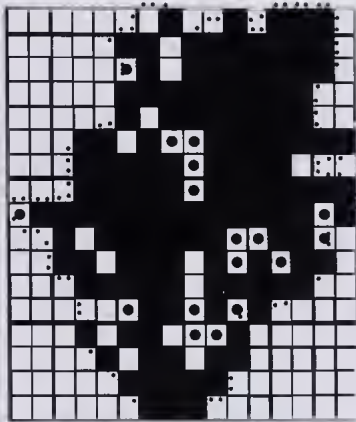


FIG. 160. White-throated Treecreeper.

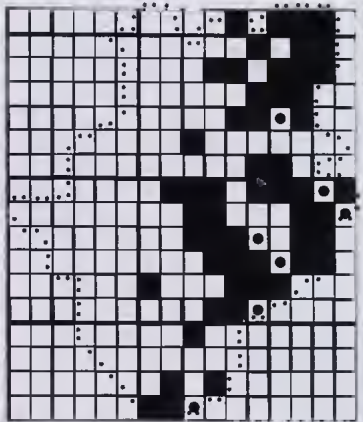


FIG. 161. Red-browed Treecreeper.

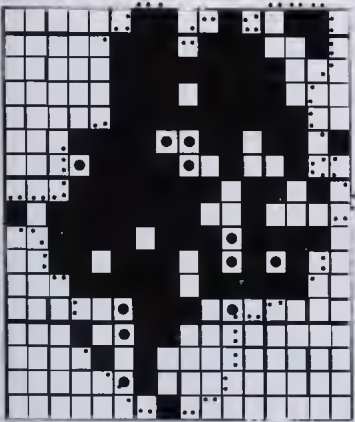


FIG. 162. Brown Treecreeper.

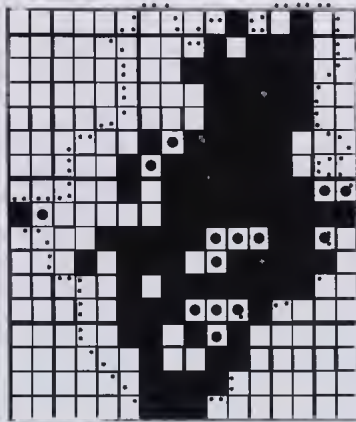


FIG. 163. Red Wattlebird.

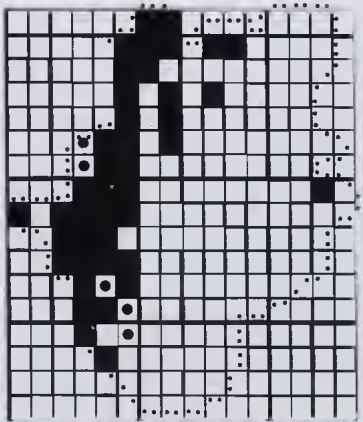


FIG. 164. Spiny-cheeked Honeyeater.

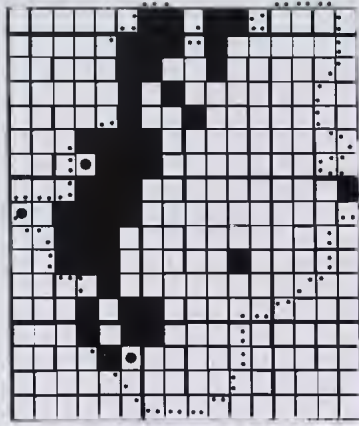


FIG. 165. Striped Honeyeater.

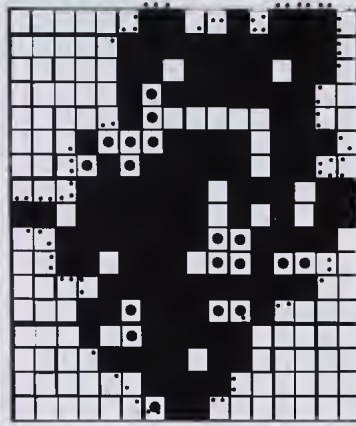


FIG. 166. Noisy Friarbird.

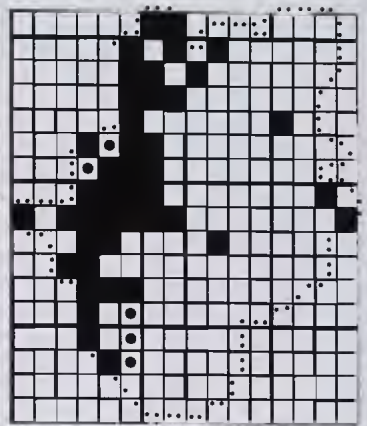


FIG. 167. Little Friarbird.

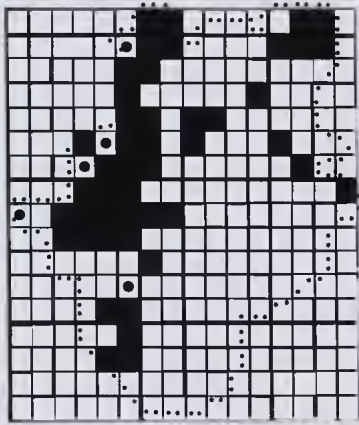


FIG. 168. Blue-faced Honeyeater.

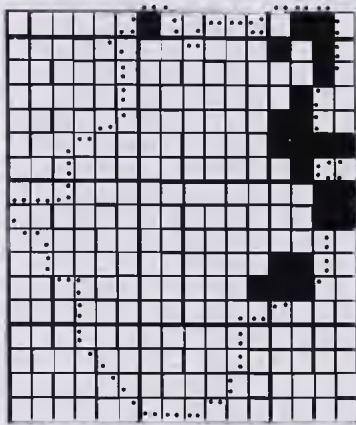


FIG. 169. Bell Miner.

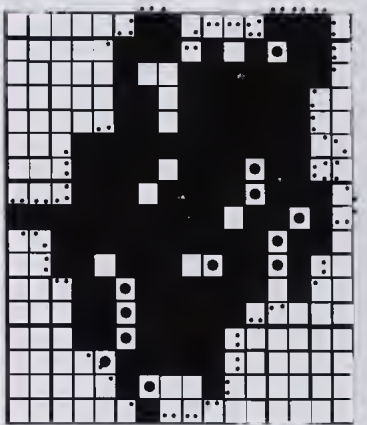


FIG. 170. Noisy Miner.

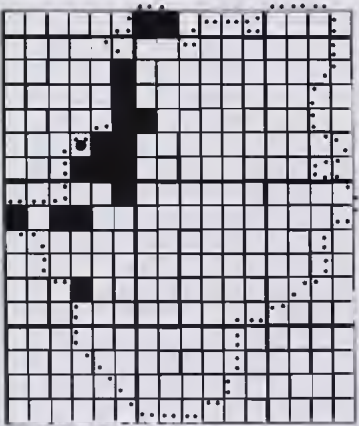


FIG. 171. Yellow-throated Miner.

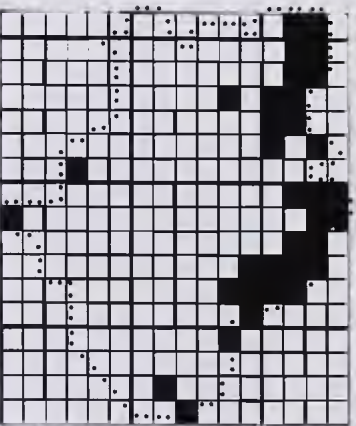


FIG. 172. Lewin's Honeyeater.

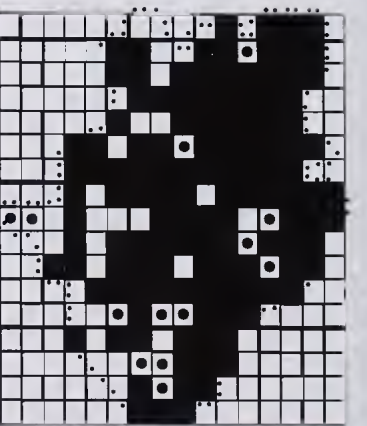


FIG. 173. Yellow-faced Honeyeater.



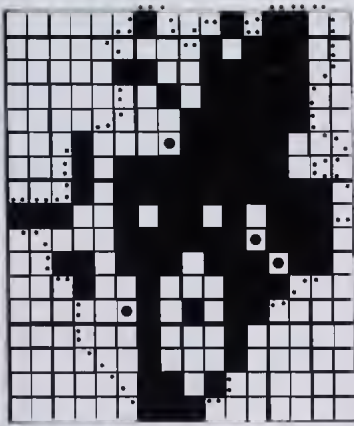


FIG. 174. White-eared Honeyeater.

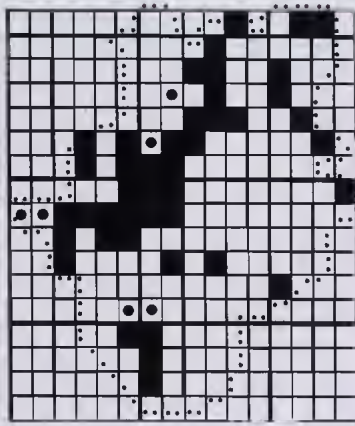


FIG. 175. Yellow-tufted Honeyeater.

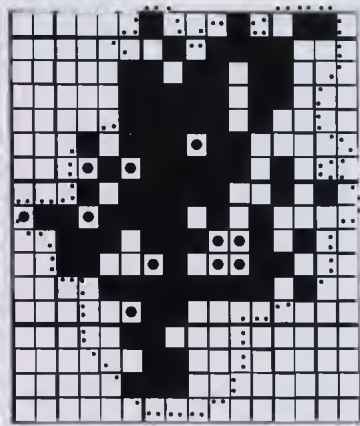


FIG. 176. Fuscous Honeyeater.

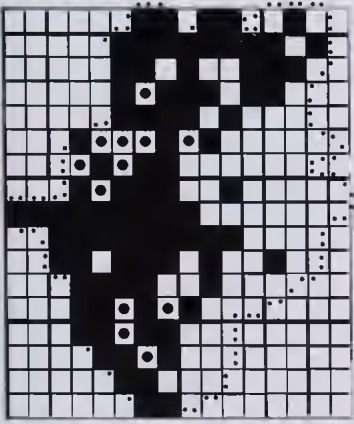


FIG. 177. White-plumed Honeyeater.

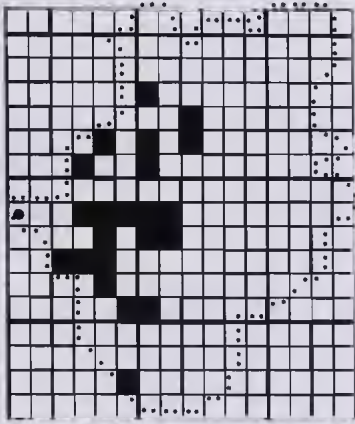


FIG. 178. Black-chinned Honeyeater.

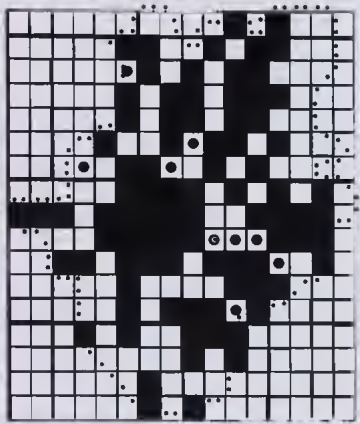


FIG. 179. Brown-headed Honeyeater.

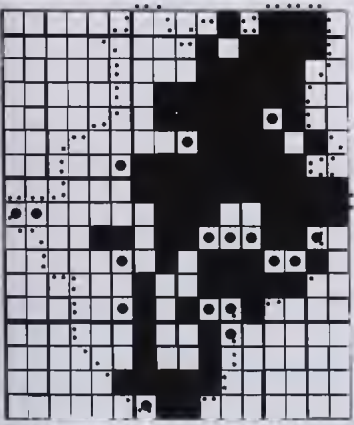


FIG. 180. White-naped Honeyeater

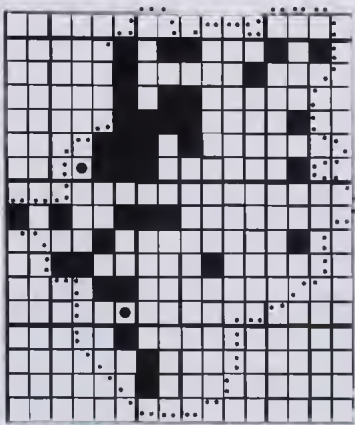


FIG. 181. Brown Honeyeater.

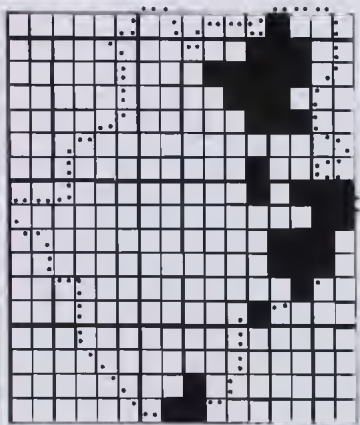


FIG. 182. New Holland Honeyeater.

**Yellow-tufted Honeyeater** *L. melanops*  
(Fig.175)

RANGE: SE Aust. from central Q to W V.  
HABITAT: eucalypt forest.  
N. ENG. RANGE: mostly W half, usually in colonies either on rocky hillsides with scrubby understorey or in moist gullies. Records E of Dividing Range are probably of wandering birds.

**Fuscous Honeyeater** *L. fuscus* (Fig.176)

RANGE: E Aust. between Cairns and W V.  
HABITAT: eucalypt woodland.  
N. ENG. RANGE: most parts, except for heavily forested areas. One of the most abundant birds in woodland on tablelands.

**White-plumed Honeyeater** *L. penicillatus*  
(Fig.177)

RANGE: widespread throughout inland E Aust. and in the central part of WA.  
HABITAT: eucalypt woodland and river red gums (*Eucalyptus camaldulensis*) along creeks.  
N. ENG. RANGE: mostly reported W of Dividing Range. Where it overlaps with Fuscous Honeyeater it is found in river oaks (*Casuarina cunninghamiana*) (Chan 1990).

**Black-chinned Honeyeater** *Meliphreptus gularis* (Fig.178)

RANGE: across N Aust. and inland SE Aust.  
HABITAT: eucalypt woodland.  
N. ENG. RANGE: subspecies *gularis* patchily distributed W of Dividing Range. Also occurs just to NE of region.

**Brown-headed Honeyeater** *M. brevirostris*  
(Fig.179)

RANGE: SE and SW Aust.  
HABITAT: eucalypt forest, woodland and mallee.  
N. ENG. RANGE: widespread, except forested areas.

**White-throated Honeyeater** *M. albogularis*

RANGE: N and E Aust. S to NE NSW.  
HABITAT: eucalypt and paperbark forest and woodland.  
N. ENG. RANGE: only in NE corner, but recorded Sara River in 1990.

**White-naped Honeyeater** *M. lunatus*  
(Fig.180)

RANGE: SW and SE Aust. and in uplands to NE Q. N-S migration.  
HABITAT: eucalypt forest and woodland.  
N. ENG. RANGE: widespread in centre and E, with isolated breeding population around Mount Kaputar.

There appears to be only slight overlap between White-naped and White-throated Honeyeaters.

**Brown Honeyeater** *Lichmera indistincta*  
(Fig.181)

RANGE: SW Aust. and N Aust. S to central NSW.  
HABITAT: mangrove, forest, woodland and heath.  
N. ENG. RANGE: mostly on W slopes, but a number of records from E fringes, which are continuous with coastal populations. Uncommon on tablelands.

**Painted Honeyeater** *Grantiella picta*

RANGE: scarce in inland E Aust., regular N-S migration.  
HABITAT: associated with mistletoes in eucalypt and acacia woodland.  
N. ENG. RANGE: 5 scattered squares in New England, with additional observations to SW of region.

**New Holland Honeyeater** *Phylidonyris novaehollandiae* (Fig.182)

RANGE: SW and SE Aust. and T.  
HABITAT: heath, dry sclerophyll forest and mallee.  
N. ENG. RANGE: E and extreme S parts of New England, in high forest with banksias (McFarland 1986).

**White-cheeked Honeyeater** *Ph. nigra*

RANGE: SW and E Aust. between NE Q and SE NSW.  
HABITAT: coastal heath and sclerophyll forest.  
N. ENG. RANGE: only from E fringes, an apparently sedentary population at New England National Park (McFarland 1984).

**Eastern Spinebill** *Acanthorhynchus tenuirostris* (Fig.183)

RANGE: E Aust. between NE Q and Kangaroo Island, T.  
HABITAT: forest, woodland and heath.  
N. ENG. RANGE: widespread through the central, S and E parts, with an apparently isolated population around Mount Kaputar. Most abundant bird in New England National Park in winter. Two birds captured there were originally banded near Nambucca Heads and Byron Bay.

**Scarlet Honeyeater** *Myzomela sanguinolenta*  
(Fig.184)

RANGE: E Aust. between NE Q and E V.  
HABITAT: eucalypt forest and woodland and paperbark woodland.  
N. ENG. RANGE: recorded widely, though rare in W and tablelands. Birds most often seen near Armidale in spring and autumn.

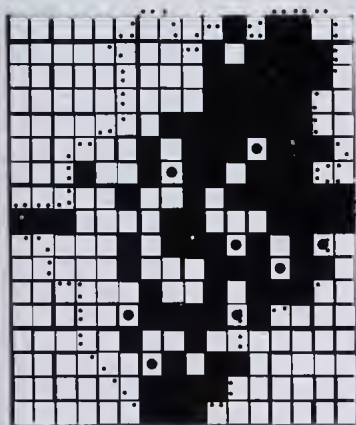


FIG. 183. Eastern Spinebill.

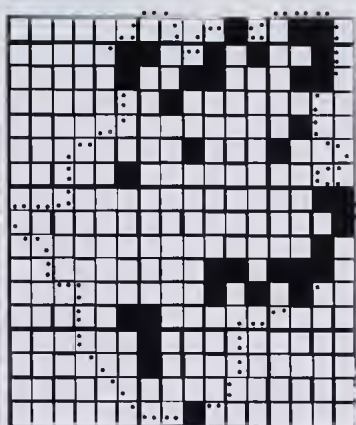


FIG. 184. Scarlet Honeyeater.

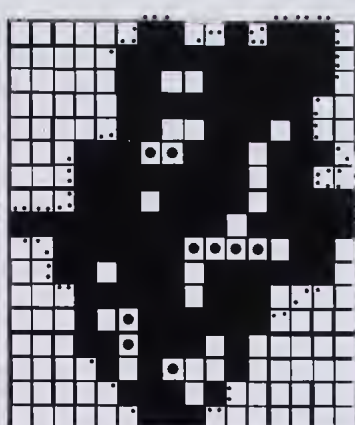


FIG. 185. Mistletoebird.

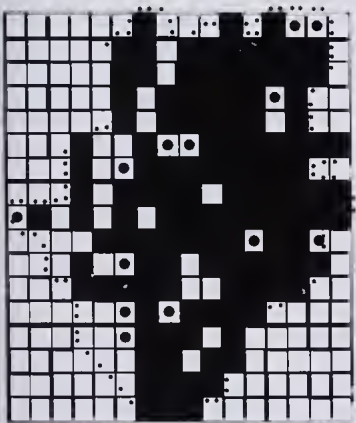


FIG. 186. Spotted Pardalote.

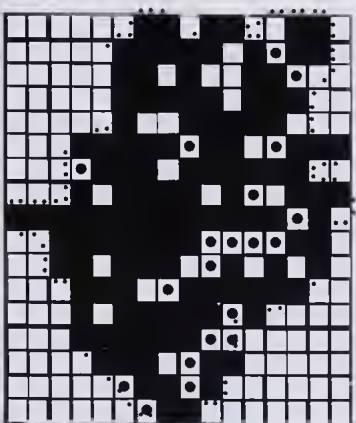


FIG. 187. Striated Pardalote.

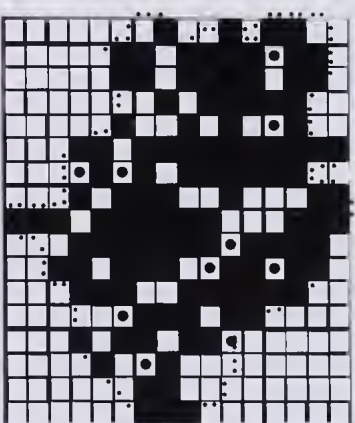


FIG. 188. Silveryeye.

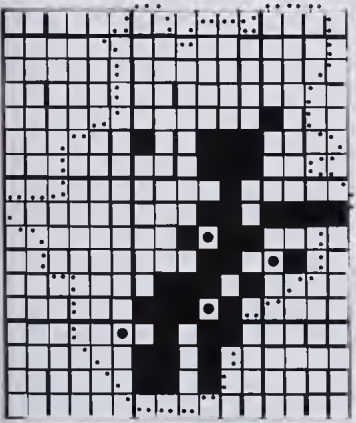


FIG. 189. European Goldfinch.

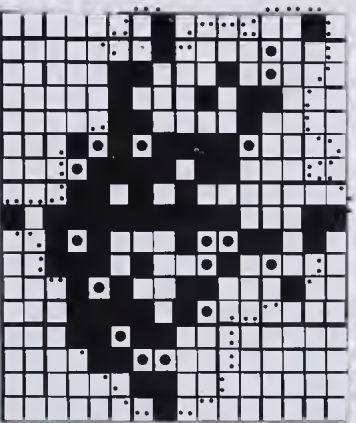


FIG. 190. House Sparrow.

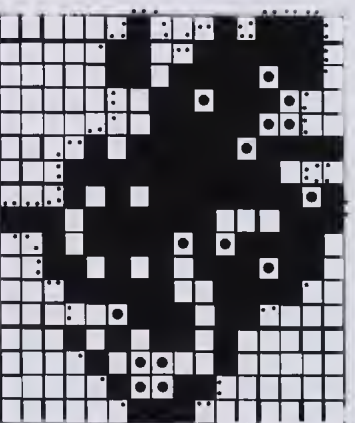


FIG. 191. Red-browed Firetail.

**Mistletoebird** *Dicaeum hirundinaceum*  
(Fig. 185)

RANGE: Aust., except deserts, T and other islands.  
HABITAT: mistletoes in forest, woodland and scrub.  
N. ENG. RANGE: recorded throughout.

**Spotted Pardalote** *Pardalotus punctatus*  
(Fig. 186)

RANGE: E and SW Aust. and T. Partly migratory.  
HABITAT: eucalypt forest and woodland.  
N. ENG. RANGE: most parts, though patchy in W.

**Striated Pardalote** *P. striatus* (Fig. 187)

RANGE: throughout Aust.  
HABITAT: eucalypt woodland and open forest.  
N. ENG. RANGE: throughout region. Mostly *ornatus*, though *substriatus* occurs in W and perhaps *melanocephalus* in NE.

**Silvereye** *Zosterops lateralis* (Fig. 188)

RANGE: E and S Aust. and T.  
HABITAT: forest, woodland, scrub, gardens.  
N. ENG. RANGE: throughout region. Dark-flanked Tasmanian race *lateralis* occurs in winter.

**European Goldfinch** *Carduelis carduelis*  
(Fig. 189)

RANGE: introduced to Aust. in 1850s, now through SE Aust. and T. Native to Eurasia and North Africa.  
HABITAT: farmland, gardens and other highly modified habitats.  
N. ENG. RANGE: present in tablelands and SE.

**House Sparrow** *Passer domesticus* (Fig. 190)

RANGE: introduced to Aust. in 1860s and now found almost throughout E half from Gulf of Carpentaria to Eyre Peninsula. Native range is Eurasia and North Africa, but introduced elsewhere.  
HABITAT: human habitation and modified habitats.  
N. ENG. RANGE: widespread, though absent from areas of native vegetation.

**Red-browed Firetail** *Emblema temporalis*  
(Fig. 191)

RANGE: E Aust., between Cape York and Kangaroo Island.  
HABITAT: eucalypt forest and woodland.  
N. ENG. RANGE: almost throughout region.

**Diamond Firetail** *E. guttata* (Fig. 192)

RANGE: E Aust. between central Q and Eyre Peninsula, generally inland.  
HABITAT: grassy woodland.  
N. ENG. RANGE: widespread, except for heavily forested E.

**Zebra Finch** *Poephila guttata* (Fig. 193)

RANGE: inland Aust., reaching coast in W.  
HABITAT: wide variety of woodland and scrub.  
N. ENG. RANGE: patchily distributed in W and centre, often in Hawthorn (*Cretaeagus*) scrub around Armidale (Kikkawa 1980).

**Double-barred Finch** *P. bichenovii* (Fig. 194)

RANGE: N and E Aust., S to NE V.  
HABITAT: woodland, forest and agricultural areas.  
N. ENG. RANGE: most areas, except SE and parts of tablelands.

**Plum-headed Finch** *Aidemosyne modesta*  
(Fig. 195)

RANGE: inland E Aust. between central Q and S NSW.  
HABITAT: eucalypt woodland, especially in dense vegetation along creeks.  
N. ENG. RANGE: patchily distributed in W and centre. Breeding record near Armidale is outside normal range.

**Chestnut-breasted Mannikin** *Lonchura castaneothorax*

RANGE: NG, N and E Aust. S to Sydney.  
HABITAT: swamps and farmland.  
N. ENG. RANGE: two records, near Tamworth and Ebor.

**Common Starling** *Sturnus vulgaris* (Fig. 196)

RANGE: introduced in 1850s, now found throughout SE Aust. between central Q and Nullarbor Plain. Occasionally beyond this region. Native range Europe and Asia, introduced N. America.  
HABITAT: farmland, will breed in neighbouring native vegetation.  
N. ENG. RANGE: Widespread and increasing, but patchy in E forests.

**Common Mynah** *Acridotheres tristis*

RANGE: introduced in 1860, now occurs between Melbourne and Brisbane. Native range is India and SE Asia.  
HABITAT: urban areas.  
N. ENG. RANGE: recorded S of Tamworth.

**Olive-backed Oriole** *Oriolus sagittatus*  
(Fig. 197)

RANGE: N and E Aust. S to W V. Also occurs in NG and adjacent islands.  
HABITAT: eucalypt forest and woodland.  
N. ENG. RANGE: widely, though patchily, distributed.

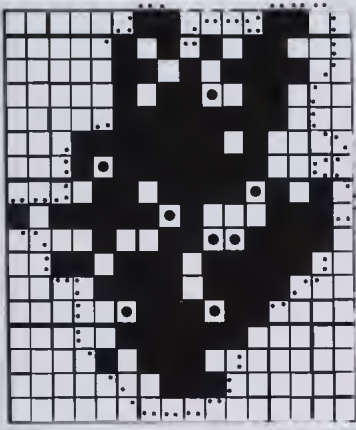


FIG. 192. Diamond Firetail.

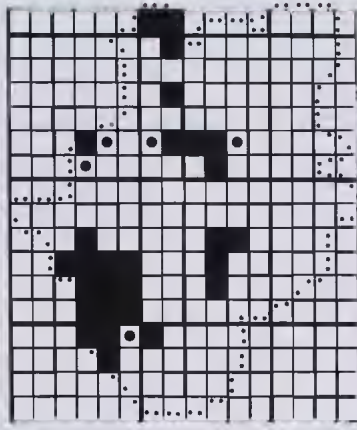


FIG. 193. Zebra Finch.

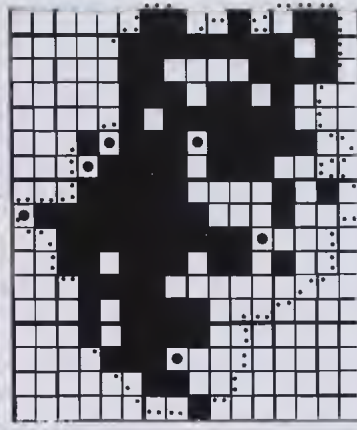


FIG. 194. Double-barred Finch.

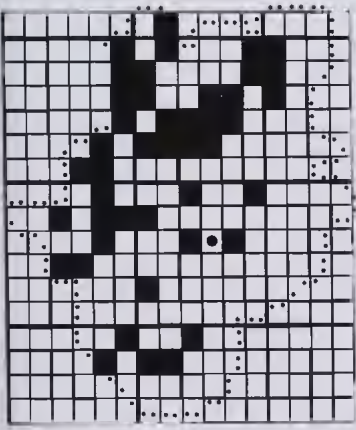


FIG. 195. Plum-headed Finch.

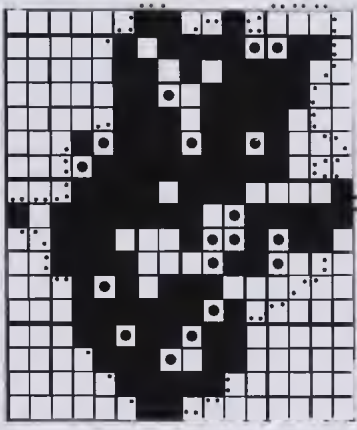


FIG. 196. Common Starling.

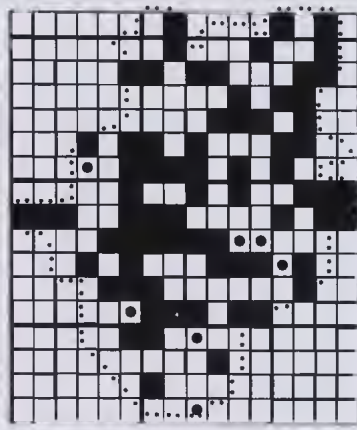


FIG. 197. Olive-backed Oriole.

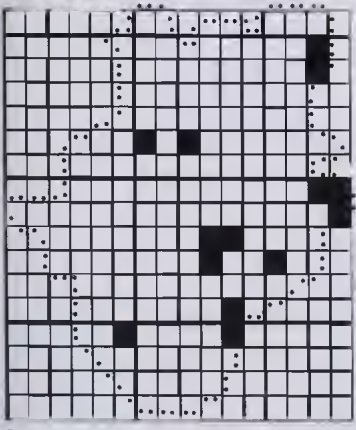


FIG. 198. Spangled Drongo.

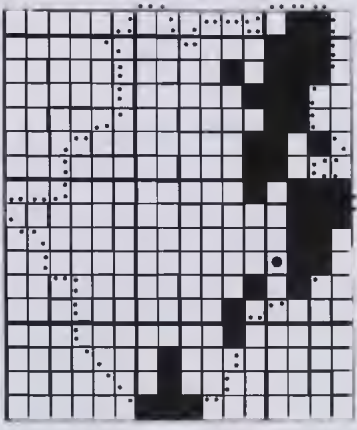


FIG. 199. Satin Bowerbird.

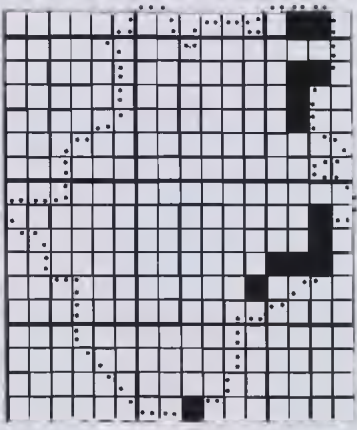


FIG. 200. Green Catbird.

**Figbird** *Sphecothebes viridis*

RANGE: N and E Aust. S to Sydney.

HABITAT: edges of rainforest and eucalypt forest, mostly near coast.

N. ENG. RANGE: three records, in NE corner.

**Spangled Drongo** *Dicrurus hottentottus*  
(Fig. 198)RANGE: N and E Aust. S to SE NSW; S Asia and NG.  
HABITAT: rainforest, mangroves, eucalypt forest and woodland.

N. ENG. RANGE: scattered records from E and centre. Probably only a passage migrant through tablelands.

**Satin Bowerbird** *Ptilonorhynchus violaceus*  
(Fig. 199)

RANGE: Atherton region, N Q and from SE Q to central V.

HABITAT: rainforest and eucalypt forest.

N. ENG. RANGE: E and extreme S.

**Regent Bowerbird** *Sericulus chrysocephalus*

RANGE: central Q to central NSW.

HABITAT: rainforest, also in other overgrown habitats.

N. ENG. RANGE: four squares on E fringes.

**Spotted Bowerbird.** *Chlamydera maculata*

RANGE: two well-defined subspecies, in inland W and central Aust., and in inland E Aust.

HABITAT: dense vegetation in eucalypt and acacia woodland, often near figs.

N. ENG. RANGE: confined to NW corner.

**Green Catbird** *Ailuroides crassirostris*  
(Fig. 200)

RANGE: SE Q and E NSW.

HABITAT: rainforest.

N. ENG. RANGE: E and extreme S.

**Paradise Riflebird** *Ptiloris paradiseus*

RANGE: SE Q and NE NSW.

HABITAT: rainforest.

N. ENG. RANGE: Washpool National Park and near Dorrego.

**White-winged Chough** *Corcorax melanorhamphos* (Fig. 201)

RANGE: E and S Aust., between central Q and Eyre Peninsula.

HABITAT: mallee, eucalypt woodland and grassy forest.

N. ENG. RANGE: most areas, though scarce on parts of tablelands, possibly due to extensive clearing.

**Apostlebird** *Struthidea cinerea* (Fig. 202)

RANGE: N and E Aust., mostly away from coast.

HABITAT: eucalypt and other semi-arid woodland, near water.

N. ENG. RANGE: W third of region.

**Australian Magpielark** *Grallina cyanoleuca*  
(Fig. 203)

RANGE: throughout Aust., except T and deserts.

HABITAT: farmland, open woodland and scrub.

N. ENG. RANGE: throughout region.

**White-breasted Woodswallow** *Artamus leucorhynchus*

RANGE: central, E inland and N Aust., between Shark Bay and Sydney. SE Asia, NG and many Pacific Islands.

HABITAT: eucalypt woodland and forest, mangroves and farmland, often near water.

N. ENG. RANGE: scattered records across N.

**Masked Woodswallow** *A. personatus*  
(Fig. 204)

RANGE: inland Aust., occasionally reaching coast.

HABITAT: woodland and scrub.

N. ENG. RANGE: scattered records, including two of breeding.

**White-browed Woodswallow** *A. superciliosus* (Fig. 205)

RANGE: inland E Aust., some records from inland WA. N-S migrant, sometimes erupting beyond its normal range and even reaching the coast.

HABITAT: woodland and scrub.

N. ENG. RANGE: widely reported from W and centre. Large numbers arrive on tablelands about every second year in early November, breed and depart in late December.

**Black-faced Woodswallow** *A. cinereus*

RANGE: inland Aust. and near coast in W.

HABITAT: open country, including farmland.

N. ENG. RANGE: W edge of region.

**Dusky Woodswallow** *A. cyanopterus*  
(Fig. 206)

RANGE: S Aust. to S Q.

HABITAT: eucalypt woodland and open forest.

N. ENG. RANGE: most of region, except for heavily forested areas. A summer visitor to tablelands.

**Little Woodswallow** *A. minor* (Fig. 207)

RANGE: widespread in N and central Aust. S to central NSW.

HABITAT: typically in rocky country.

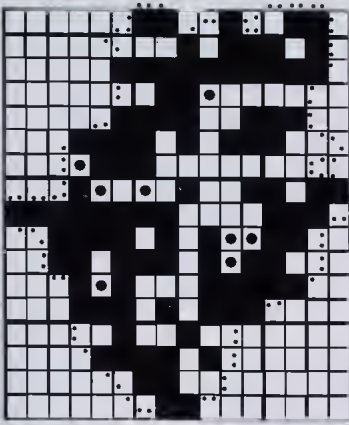


FIG. 201. White-winged Chough.

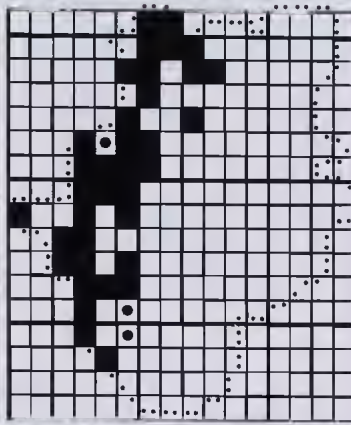


FIG. 202. Apostlebird.

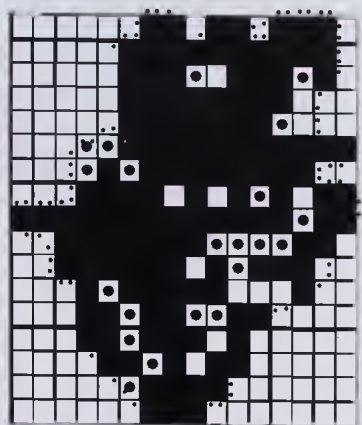


FIG. 203. Australian Magpie-lark.

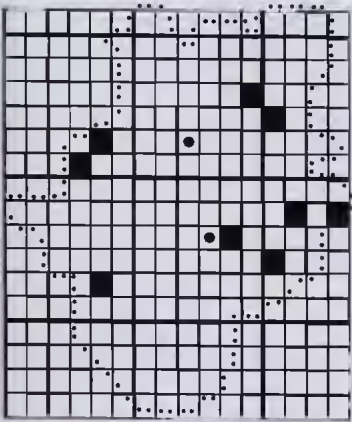


FIG. 204. Masked Woodswallow.

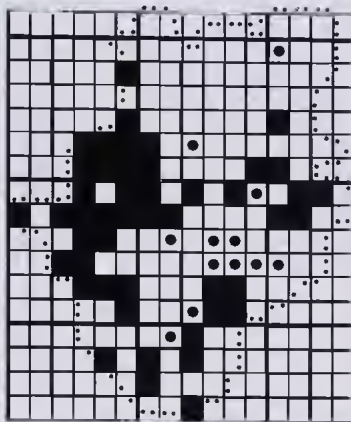


FIG. 205. White-browed Woodswallow.

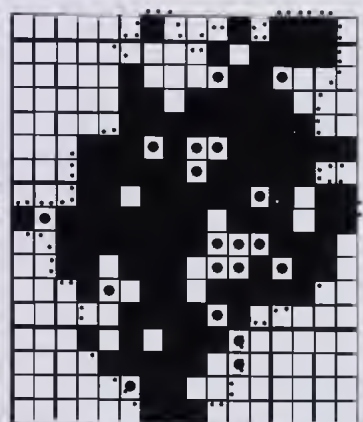


FIG. 206. Dusky Woodswallow.

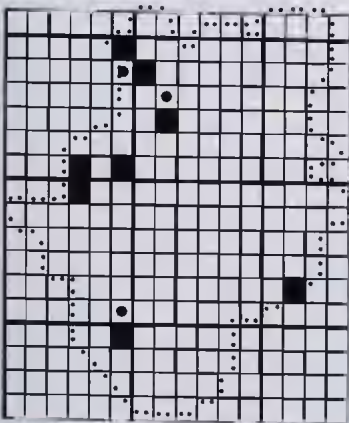


FIG. 207. Little Woodswallow.

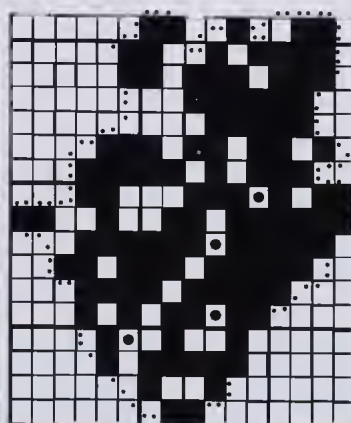


FIG. 208. Grey Butcherbird.

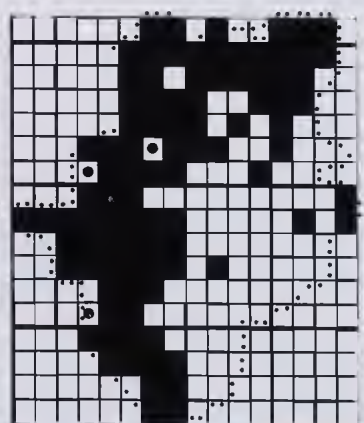


FIG. 209. Pied Butcherbird.

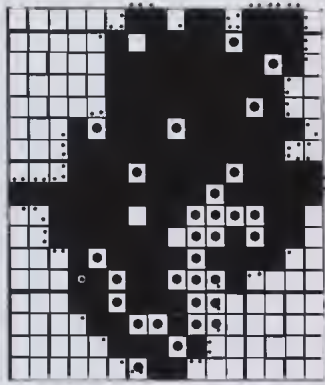


FIG. 210. Australian Magpie.

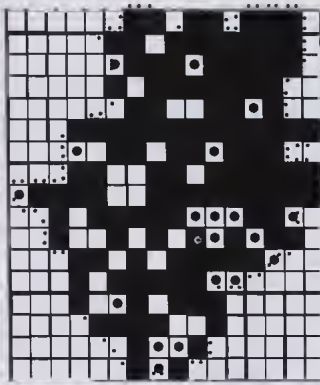


FIG. 211. Pied Currawong.

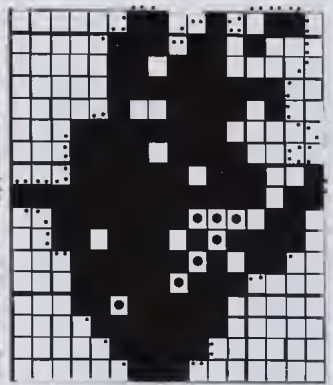


FIG. 212. Australian Raven.

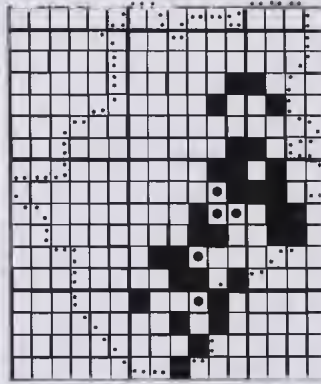


FIG. 213. Forest Raven.

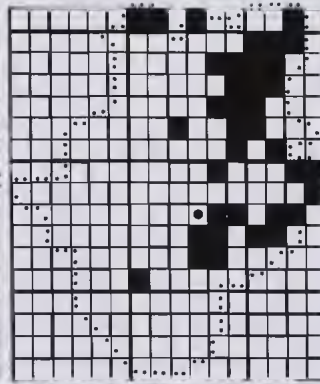


FIG. 214. Torresian Crow.

N. ENG. RANGE: breeding in NW and also near Tamworth.

**Grey Butcherbird** *Cracticus torquatus* (Fig.208)

RANGE: most of Aust., except N Q and deserts.  
HABITAT: woodland and open habitats.  
N. ENG. RANGE: throughout region.

**Pied Butcherbird** *C. nigrogularis* (Fig.209)

RANGE: throughout Aust., except SE.  
HABITAT: eucalypt and acacia woodland and mallee, can be common in farmland.  
N. ENG. RANGE: W and N, with a few records from centre and E. Also found along NE coast of NSW.

**Australian Magpie** *Gymnorhina tibicen* (Fig.210)

RANGE: Aust., except W T, extreme N and deserts. Also S NG and introduced to NZ. Three well-defined subspecies.  
HABITAT: woodland and open areas.  
N. ENG. RANGE: subspecies *tibicen* found

throughout region. Occasional white-backed birds seen.

**Pied Currawong** *Strepera graculina* (Fig.211)

RANGE: E Aust. between Cape York and W Vic.  
HABITAT: eucalypt woodland and forest.  
N. ENG. RANGE: throughout region, moving into forest to breed and into more open habitat and towns in autumn and winter.

**Australian Raven** *Corvus coronoides* (Fig.212)

RANGE: most parts of S and E Aust.  
HABITAT: open country and woodland.  
N. ENG. RANGE: most of region, though scarce in NE.

**Forest Raven** *C. tasmanicus* (Fig.213)

RANGE: T, S V and SA and NE NSW.  
HABITAT: mostly eucalypt forest.  
N. ENG. RANGE: E and S. This population (*boreus*) is continuous with that around Barrington Tops and Myall Lakes, but isolated by over 1,000 km from any other population.



**Torresian Crow** *C. orru* (Fig.214)

RANGE: N Aust., further S in E and W.  
 HABITAT: woodland and farmland.  
 N. ENG. RANGE: mostly in E and N.

## DISCUSSION

The New England region clearly has a diverse avifauna, with a total of 296 species recorded between 1978 and 1982, when the data for this atlas were collected. Whereas some species are non-breeding visitors, the majority of species are residents or breeding summer visitors. The main reason for the diversity of species is the variety of topography and vegetation found in the region. The latter ranges from rainforest, through a variety of eucalypt (open) forest and woodland to grassland. Woodland with *Casuarina* or native pine (*Callitris*), and heath, are other habitats that are represented. In addition, there are seasonal and ephemeral swamps, and more permanent water bodies, including lagoons and man-made reservoirs.

A further and related reason for the diversity of birds is that the region lies on or near the boundaries between several zoogeographical sub-regions. Kikkawa and Pearse (1969) classified data on the presence of bird species in 121 sites around Australia to delimit regions of similar avifaunas. Their classification, based on species of landbird, is shown in Figure 215, onto which the boundaries of the New England region are super-imposed. New England falls within the Kosciuskan faunal area. This is sub-divided between northern and southern components and one that falls in southeastern Queensland and northeastern New South Wales, all three of which occur in New England. In addition the Eyrean sub-region, with its arid-adapted species, is not far to the west of New England.

An examination of the distribution of individual species of landbird reveals that most fall into a small number of loose geographical categories (Table 1). Many species, e.g. Kestrel, Welcome Swallow and Willie Wagtail occur throughout the area and indeed most of these are widespread in Australia as a whole. Another group of species is found west of the Great Dividing Range, e.g. Cockatiel and Spiny-cheeked Honeyeater. Several of these only occur on the western fringes of New England. These are widespread in inland Australia, in arid and semi-arid habitats, being typical Eyrean species. Quite a number of species occur in the west and centre, being absent from the more densely

forested eastern parts. Examples are the Weebill and Red-rumped Parrot. A further group occurs in the centre and east, but is generally absent from the western third, such as Striated Thornbill and White-naped Honeyeater.

A few of the species with a western distribution in New England, e.g. Blue-faced Honeyeater and Pied Butcherbird, are also found in the coastal lowlands, although they are scarce in between, on the tablelands. This absence may be for climatic reasons or because the woodlands of the tablelands have been extensively cleared. A distinct group of wet forest species occurs on the eastern or northeastern fringes of the region, for example the White-headed Pigeon, Logrunner and Pale-yellow Robin. Very few species occur more commonly on the tablelands than they do to the east or west; possibly the two grassbirds fall into this category. A significant number of species do not show a clear geographical pattern, probably because they have more subtle habitat preferences than those species preferring wet or dry forest. In some cases this habitat preference is well known, as with the Southern Emu-wren and its association with heath. In other cases the distributions and habitat preferences of a species need further investigation.

There are several pairs of sibling species whose distributions meet and either do not overlap or do so only minimally in New England. These include the Scarlet and Red-capped Robin, and the Brown and Inland Thornbill, with

Throughout region	67
Western fringes	9
Northwest fringes	6
Southwest fringes	4
Western half	14
West and centre	22
Mostly centre	6
East and centre	8
Eastern half	14
Eastern fringes	24
Northeastern fringes	12
East and west but absent from centre	10
No clear pattern - specific habitat	8
No clear pattern	20
Vagrant	8

TABLE 1. Numbers of species of landbirds whose distribution falls into each geographical category.

Wandering Whistling Duck	<i>Dendrocygna arcuata</i>	Armidale
Little Bittern	<i>Ixobrychus minutus</i>	All regions of NSW
Black-breasted Buzzard	<i>Hamirostra melanosternon</i>	Copeton Dam
King Quail	<i>Coturnix chinensis</i>	West to Tenterfield
Spotless Crake	<i>Porzana tabuensis</i>	All regions of NSW
Common Sandpiper	<i>Tringa hypoleucos</i>	Keepit Dam
Pectoral Sandpiper	<i>Calidris melanotos</i>	Northern Tablelands
Curlew Sandpiper	<i>C. ferruginea</i>	All regions of NSW
Red-necked Phalarope	<i>Phalaropus lobatus</i>	Guyra
White-winged Tern	<i>Chlidonias leucoptera</i>	All regions of NSW
Superb Fruit-dove	<i>Ptilinopus superbus</i>	Wollomombi
Rose-crowned Fruit-dove	<i>Pt. regina</i>	Northern Tablelands
Gang Gang Cockatoo	<i>Callocephalon fimbriatum</i>	Ebor
Double-eyed Fig-Parrot	<i>Psittaculirostris diophthalma</i>	Northern Tablelands
Paradise Parrot	<i>Psephotus pulcherrimus</i>	North of Inverell
Masked Owl	<i>Tyto novaehollandiae</i>	All regions of NSW
Eastern Grass Owl	<i>T. longimembris</i>	Tenterfield
Albert's Lyrebird	<i>Menura alberti</i>	Northern Tablelands
White-fronted Chat	<i>Epthianura albifrons</i>	East to Bingara
Star Finch	<i>Neochmia ruficauda</i>	Namoi River, Inverell
Black-throated Finch	<i>Poephila cincta</i>	N Tablelands, NW Slopes

TABLE 2. Species not recorded in New England during the atlas, but recorded for the region by Morris et al. 1981. The site or region recorded is also noted.

the former being the species associated with wetter habitat. North-south replacements are less frequent, though the Eastern and Pale-headed Rosella overlap in the northwest of the region. Also, in some species, two or more distinct subspecies occur in New England, for instance in the Variegated Fairy-wren, Varied Sittella and Striated Pardalote.

A few species of bird were not recorded during the atlas but were recorded before this period. Those listed for the region by Morris et al. (1981), but not included in this atlas are shown in Table 2. Some of these were vagrants only. The Star Finch and the Black-throated Finch were recorded by Baldwin (1975) near Inverell in the 1960s and the latter species was seen near Tenterfield in 1963 (Hall, 1974). Morris et al. suggested that the former record was of escapees. The Paradise Parrot occurred in the northern parts of New England and now may be extinct throughout its range. The Fig-parrot, Albert's Lyrebird and the two fruit-doves would

have been present in the extreme northeastern corner of New England and the Rose-crowned Fruit-dove may still occur there occasionally. Other species were recorded during the atlas though their ranges have contracted since European settlement. The Bush Thick-knee has declined from being widespread to occur now only in the northern tip of the region. The Squatter Pigeon has probably also declined in the region, though its range may always have fluctuated greatly.

Several rare species were recorded during the atlas in New England. These include the Red Goshawk, Red-chested Button-quail, Painted Snipe, Wompoo Fruit-dove, Glossy Black-Cockatoo, Powerful Owl, Sooty Owl, Rufous Scrub-bird, Regent and Painted Honeyeaters. Only the Rufous Scrub-bird has received detailed study (Ferrier, 1985), though work is currently being carried out on the Red Goshawk, Wompoo Fruit-dove and the owls.

There are two main values in an atlas of this



FIG. 215. Zoogeographic regions of Australia, showing New England region overlapping with three sub-regions of the Kosciuskan region.

type. First, it raises numerous questions for future study, such as why do species show particular geographical distributions and why are all the species mentioned in the previous two paragraphs so rare, and are they declining and if so why? Secondly, it provides a data-base indicating the distribution of species in one period of five years. Future atlases on the avifauna or indeed on particular species and groups can tell us which species have shown a contraction or expansion of range. With large-scale changes imposed on all natural habitats by human activities and also predicted changes in climate it is likely that many species will indeed change their distribution in future decades. We are now in a much better position to detect and quantify these changes, and if necessary take action to attempt to prevent or reverse declines in the species concerned.

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#### LITERATURE CITED

- BAKER-GABB, D. 1986. Ecological release and behavioural and ecological flexibility in Marsh Harriers on islands. *Emu* 86: 71–81.

- BALDWIN, M. 1975. Birds of Inverell district, NSW. *Emu* 75: 113–120.
- BLAKERS, M., DAVIES, S. J. J. F., AND REILLY, P. N. 1984. 'The atlas of Australian birds'. (Melbourne University Press & RAOU: Melbourne).
- BRIGGS, S. 1977. Variation in waterbird numbers in four swamps on the Northern Tablelands of New South Wales. *Aust. Wildl. Res.* 4: 301–309.
- BROUWER, J. AND GARNETT, S. 1990. 'Threatened birds of Australia: an annotated list'. (RAOU and ANPWS: Melbourne).
- CAMERON, A. C. 1934. Report on a trip to Mount Grattai from Moree. *Emu* 33: 202–203.
- CAMERON, A. W. 1975. Changes in the wild life community of the Waterloo Valley between 1866 and 1975. 22–25. In Jarman, P. J. (ed.), 'Agriculture, forestry and wildlife: conflict or coexistence?' (UNE Press: Armidale).
- CAMERON, E. 1985. Habitat usage and foraging behaviour of three fantails (*Rhipidura*: Pachycephalidae). 177–191. In Keast, A., Recher, H., Ford, H. and Saunders, D. (eds), 'Birds of eucalypt forests and woodlands: ecology, conservation, management.' (Surrey Beatty: Sydney).
- CAIN, A. J. 1963. 'Animal species and their evolution.' (Hutchinson: London).
- CHAN, K. 1988. Habitat selection in sympatric breeding populations of the White-plumed Honeyeater *Lichenostomus penicillatus* and the Fuscous Honeyeater *L. fuscus*. B. Sc. Hons thesis, Dept. Zool., Univ. of New England, Armidale. (Unpubl.)
- COURTNEY, J. 1971. Breeding of the Red-rumped Kingfisher at Swan Vale, NSW. *Emu* 71: 174–175.
- DEBUS, S. 1982. Range and status of the Red Goshawk in New South Wales. *Aust. Birds* 16:41–45.
1983. Behaviour and vocalisations of nesting Little Eagles. *Aust. Bird Watcher* 10: 73–78.
1984. Biology of the Little Eagle on the Northern Tablelands of New South Wales. *Emu* 84: 87–92.
- DEBUS, S. J. S. AND CZECHURA, G. V. 1988. The Red Goshawk *Erythrotriorchis radiatus*: a review. *Aust. Bird Watcher* 12: 175–199.
- DISNEY, H. J. deS. 1979. Royal Australasian Ornithologists' Union Pilot Atlas Scheme. *Corella* 2: 97–163.
- EMISON, W. B. AND BREN W. M. 1981. Banding of Peregrine Falcon chicks in Victoria, Australia. *Emu* 80: 288–291.
- EMISON, W. B., BEARDSELL, C. M., NORMAN, F. I. AND LOYN, R. H. 1987. 'Atlas of Vic-

- torian birds.' (Dept. Conserv. For. Lands & RAOU: Melbourne).
- FERRIER, S. 1985. Habitat requirements of a rare species: the Rufous Scrub-bird. 241-248. In Keast, A., Recher, H., Ford, H., and Saunders, D. (eds), 'Birds of eucalypt forests and woodlands: ecology, conservation, management.' (Surrey Beatty: Sydney).
- FLEMING, P. 1980. The comparative ecology of four sympatric robins. Hons thesis, Dept. Zool., Univ. New England, Armidale. (unpubl.)
- FORD, J. 1980. Hybridization between contiguous sub-species of the Varied Sittella in Queensland. *Emu* 80: 1-12.
1983. Speciation in the Ground Thrush complex *Zoothera dauma* in Australia. *Emu* 83: 152-172.
1985. Secondary contact between sub-species of the White-browed Scrub-wren in eastern Australia. *Emu* 85: 92-96.
- FRANKLIN, D., MENKHORST, P. AND ROBINSON, J. 1987. Field surveys of the Regent Honeyeater *Xanthomyza phrygia* in Victoria. *Aust. Bird Watcher* 12: 91-95.
- GOSPER, D. G. 1973. Waterbirds on two tableland lagoons. *Aust. Bird Watcher* 5: 35-39.
- HALL, B. P. 1974. 'Birds of the Harold Hall Australian expeditions'. (British Museum, Natural History: London).
- HAYS, R. G. 1920. The Little Eagle. *Emu* 20: 33-34.
- HEATWOLE, H., AND SIMPSON, R. D. 1986. Faunal survey of New England. I. Introduction and general description of the area. *Mem. Qd Mus.* 22: 107-113.
- HERON, S. 1970. Birds of the sewerage works at Armidale, NSW. *Aust. Bird Watcher* 2: 269-272.
- HOWE, R. W., HOWE, T. D., AND FORD, H. A. 1981. Bird distributions on small rain forest remnants in New South Wales. *Aust. Wildl. Res.* 8: 637-651.
- JONES, D. 1987. Feeding ecology of the Cockatiel *Nymphicus hollandicus* in a grain-growing area. *Aust. Wildl. Res.* 14: 105-115.
- KIKKAWA, J. 1980. Seasonality of nesting by Zebra Finches at Armidale, NSW. *Emu* 80: 13-20.
- KIKKAWA, J. AND PEARSE, K. 1969. Geographical distribution of land birds in Australia - a numerical analysis. *Aust. J. Zool.* 17: 821-840.
- LEA, D. A. M., PIGRAM, J. J. AND GREENWOOD, L. 1977. 'An atlas of New England'. (University of New England: Armidale).
- LEY, A. J. 1990a. Two breeding records of the Pacific Baza in inland New South Wales. *Australian Bird Watcher* 13: 258-259.
- 1990b. Notes on the Regent Honeyeater *Xanthomyza phrygia*. *Australian Bird Watcher* 13: 171-173.
- McFARLAND, D. C. 1984. Seasonal changes in the avifauna of New England National Park. *Aust. Bird Watcher* 10: 255-263.
1986. Seasonal changes in the abundance and body condition of honeyeaters (Meliphagidae) in response to inflorescence and nectar availability in New England National Park, New South Wales. *Aust. J. Ecol.* 11: 331-340.
- MILLS, K. 1986. Birds observed in the Guy Fawkes River Valley, northern New South Wales. *Aust. Birds* 20: 44-48.
- MORRIS, A. K. 1979. The inland occurrence of Tropic-birds in New South Wales in March 1979. *Aust. Birds* 13: 51-54.
- MORRIS, A. K., MCGILL, A. R. AND HOLMES, G. 1981. 'Handlist of birds in New South Wales'. (NSW Field Ornithologists Club: Sydney).
- NEWTON, I. 1979. 'Population ecology of Raptors.' (Poyser: Calton, England).
- NORTON, S. P. W. 1922. Bird notes from Boree (New England Plateau). *Emu* 22: 39-44.
- NOSKE, R. A. 1985. Habitat use by three bark-foragers of eucalypt forests. 193-204. In Keast, A., Recher, H., Ford, H. and Saunders, D. (eds), 'Birds of eucalypt forests and woodlands: ecology, conservation, management.' (Surrey Beatty: Sydney).
- OLSEN, P. D. AND OLSEN, J. 1988. Breeding of the Peregrine Falcon *Falco peregrinus*: I. Weather, nest-spacing and territory occupancy. *Emu* 88: 195-201.
- PRUETT-JONES, S. G., WHITE, C. M. AND DEVINE, W. R. 1981a. Breeding of the Peregrine Falcon in Victoria, Australia. *Emu* 80: 253-269.
- 1981b. Eggshell thinning and organochlorine residues in eggs and prey of Peregrine Falcons from Victoria, Australia. *Emu* 80: 281-287.
- SHORT, L. L., SCHODDE, R. AND HORNE, J. F. M. 1983a. Five-way hybridization of Varied Sittellas *Daphoenositta chrysoptera* (Aves: Neositidae) in central Queensland. *Aust. J. Zool.* 31: 499-516.
- SHORT, L. L., SCHODDE, R., NOSKE, R. A. AND HORNE, J. F. M. 1983b. Hybridization of 'white-headed' and 'orange-winged' Varied Sittellas, *Daphoenositta chrysoptera leucocephala* and *D. c. chrysoptera* (Aves: Neositidae) in eastern Australia. *Aust. J. Zool.* 31: 517-531.
- SIMPSON, R. D. AND STANISIC, J. 1986. Faunal survey of New England. II. The distribution of

- Gastropod Molluscs. Mem. Qd. Mus. 22: 115-139.
- SOUTH AUSTRALIAN ORNITHOLOGICAL ASSOCIATION, 1977. 'A bird atlas of the Adelaide region'. (South Australian Ornithological Association: Adelaide).
- SULLIVAN, C. 1931. Notes from north-western New South Wales. Emu 31: 124-135.
- THOMAS, D. 1979. 'Tasmanian bird atlas.' Fauna of Tasmania Handbook No. 2, Univ. Tasmania.
- WHITE, J. M. 1986. Breeding of Black Swans on two New England lagoons. Corella 10: 17-20.
1987. The New England lagoons as drought refuges for waterbirds. Emu 87: 253-255.

## A PRELIMINARY NOTE ON THE INTESTINAL FLAGELLATES OF THE SOUTHERN AFRICAN ANURA

*Memoirs of the Queensland Museum* 30(3):432.  
1991.

This note follows the one previously published by Delvinquier & Jones (1988) (*Mem. Qd Mus.* 25(2): 333-334) on intestinal flagellates of Australian anurans.

Between 1988 and 1989, 409 adult specimens of 50 species of anurans and 13 tadpoles of two species of frogs, representing 9 families and from 26 localities in all four Provinces of South Africa and from Swaziland were checked for the presence of intestinal protozoans.

Specimens have been lodged with the Queensland Museum (QM). The anuran nomenclature follows Frost, D.R. (ed.) (1985). 'Amphibian Species Of The World. A Taxonomic and Geographical Reference.' (Allen Press, Inc. & The Association of Systematics Collections: Lawrence, Kansas, U.S.A.) and Frost, D.R., and Savage, J.M. (1987). *J. Herpetol. Ass. Africa* 33: 24.

Abbreviations are: N = number; Cc = *Chilomastix cauleryi* (QM GL 13025); Ga = *Giardia agilis* (QM GL 13028); Mb = *Monocercomonas batrachorum* (QM GL 13026, GL 13029); Se = *Spiroucleus elegans* (QMGL13027, GL13035, GL13036, GL13038); Tb = *Trichomitus batrachorum* (QMGL13030, GL13032, GL13037, GL13039); Ta = *Tritrichomonas augusta* (QM GL 13031, GL 13040).

HOSTS	N	Cc	Ga	Se	Mb	Ta	Tb
<b>ARTHROLEPTIDAE</b>							
<i>Arthroleptis wahlbergi</i>	1						

### BUFONIDAE

<i>Bufo angusticeps</i>	3						
<i>gariensis</i>	5				1	4	
<i>garmani</i>	20		14				11
<i>gutturalis</i>	33	1		18	6		9
<i>maculatus</i>	3			1			1
<i>rangeri</i>	9			1		2	5
<i>Capensibufo rosei</i>	5			2			
<i>Schismaderma carens</i>	16			6	3		12

### HELEOPHRYNIDAE

<i>Heleophryne natalensis</i>	2						
(tadpoles)	7		5				

### HEMISOTIDAE

<i>Hemisus guttatum</i>	1						
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### HYPEROLIIDAE

<i>Afrixalus aureus</i>	4			4			
<i>delicatus</i>	5			4			
<i>fornasinii</i>	6				1		1

HOSTS	N	Cc	Ga	Se	Mb	Ta	Tb
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<i>Hyperolius argus</i>	1						
<i>horstocki</i>	4						
<i>marmoratus</i>	42		1	14	1		
<i>pickersgilli</i>	3			1			2
<i>pusillus</i>	7			3			
<i>semidiscus</i>	6			3			
<i>tuberilinguis</i>	12			3			1
<i>Kassina maculata</i>	6			2			3
<i>senegalensis</i>	7			2			
<i>Leptopelis natalensis</i>	4			2		1	3
<i>mossambicus</i>	4			3			2
<i>Semnodactylus wealii</i>	6			6	1		3

### MICROHYLIDAE

<i>Breviceps adpersus</i>	1						1
<i>Phrynomerus bifasciatus</i>	5			3			3

### PIPIDAE

<i>Xenopus laevis</i>	17			13	1		3
(tadpoles)	6			3			
<i>muelleri</i>	1			1			

### RANIDAE

<i>Anhydrophryne rattrayi</i>	1						
<i>Arthroleptella lightfooti</i>	2						
<i>Cacosternum boettgeri</i>	18			8			4
<i>nanum</i>	2					1	1
<b>Phrynobatrachus</b>							
<i>mababiensis</i>	2			1			
<i>natalensis</i>	12			7			3
<i>Ptychadena anchitae</i>	3			1			
<i>mascareniensis</i>	3			1			
<i>mossambica</i>	2						
<i>oxyrhynchus</i>	10			1			1
<i>Pyxicephalus adpersus</i>	5						1
<i>Rana angolensis</i>	38		1	29	1		7
<i>fuscigula</i>	17			12			3
<b>Strongylopus fasciatus</b>	1						
<i>grayii</i>	3			2		1	2
<i>Tomopterna cryptotis</i>	19			8			6
<i>delalandii</i>	14					4	12
<i>krugerensis</i>	7			2		1	4
<i>natalensis</i>	6			1			1

### RHACOPHORIDAE

<i>Chiromantis xerampelina</i>	5						2
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B.L.J. Delvinquier and M.B. Markus and N.I. Passmore, Department of Zoology, University of the Witwatersrand, Johannesburg, 2050, South Africa; 25 February, 1991.

ADDITIONS TO THE INDO-AUSTRALIAN REPRESENTATIVES OF *ACARNUS*  
GRAY (PORIFERA: DEMOSPONGIAE: POECILOSCLERIDA), WITH DESCRIPTION  
OF A NEW SPECIES

FREERK HIEMSTRA AND JOHN N.A. HOOPER

Hiemstra, F. and Hooper, J.N.A. 1991 08 01: Additions to the Indo-Australian representatives of *Acarnus* Gray (Porifera: Demospongiae: Poecilosclerida), with description of a new species. *Memoirs of the Queensland Museum* 30(3): 431-442. Brisbane. ISSN 0079-8835.

The poorly known species *Acarnus tenuis* from southern Australian waters is redescribed and illustrated for the first time. A new species from Sumbawa in Indonesian waters is described, bringing the total number of species known for Indo-Australian waters to seven, and a key for Indo-Australian species is given. 14 species of *Acarnus* are now recognized worldwide, and a brief synopsis of the genus is given. Phylogenetic relationships of the genus proposed by Hooper (1987) are re-evaluated and five species-groups are proposed. □ *Porifera, Demospongiae, Acarnus, new species, Australia, Indonesia.*

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Recent collections undertaken by the *Snellius II* expedition in southern Indonesia discovered a thinly incrusting, previously undescribed species of *Acarnus*, bringing the total number of species known for the genus to 14. Given the close proximity of the type locality (Sumbawa) to the north coast of Australia, it is possible that this new species may also be a part of the tropical Australian sponge fauna, since other species of *Acarnus* known to occur in Australian waters, recorded by Hooper (1987), have also been found in southern Indonesia (ZMA collections, van Soest, personal communication; van Soest 1989). In addition, the *Snellius II* collections in Amsterdam also contain specimens of *A. souriei* (Lévi, 1952) from Indonesian waters, which extends its known distribution further eastwards from Palk Bay, India (Hooper, 1987, fig. 39).

Through the efforts of Miss Shirley Stone, type material of the poorly known *A. tenuis* Dendy from southern Australian waters was made available from the BMNH collections, and the species is re-described here. Although 'syntypes' of the species held in the NMV were examined during a comprehensive revision of the genus (Hooper, 1987), no trace of the species was found on any of the incrusting sponge substrates. *Acarnus tenuis* was subsequently treated as a *species inquirenda*, and its characters, as described by Dendy (1896), were declared circumspect until

the remaining BMNH microscope slides (reported by Ayling *et al.*, 1982) became available. In this paper *A. tenuis* is redescribed and illustrated for the first time. Its phylogenetic relationships with other members of the genus were merely speculated upon by Hooper (1987), but these are now re-evaluated. A key is also presented for identification of the seven Indo-Australian *Acarnus* species, and illustrations comparing these species are presented.

#### METHODS

Methods of collection, preservation and preparation of specimens for examination under light microscopy are described elsewhere (Hooper, 1986). Spicule measurements, based on 25 units, are presented as lower range–mean–upper range of lengths x widths. Preparation of material for scanning electron microscope examination is described by Buizer and van Soest (1977). The following abbreviations are used in the text: BMNH, British Museum (Natural History), London; MNHN, Muséum National d'Histoire Naturelle, Paris; NMV, Museum of Victoria, Melbourne; NTM, Northern Territory Museum, Darwin; ZMA, Zoological Museum Amsterdam.

## SYSTEMATICS

Order POECILOSCLERIDA Topsent  
 Family MYXILLIDAE Topsent  
*Acarnus* Gray, 1867

*Acarnus* Gray, 1867:544 [type species and full synonymy given by Hooper, 1987].

## DIAGNOSIS

Ectosomal spicules are tylotes; choanosomal spicules are smooth styles, with or without microspined bases, echinated by cladotylotes and sometimes by acanthostyles; microscleres are palmate isochelae and toxas, the latter usually including a category which is thick and evenly curved, with recurved points ('oxhorn' shaped).

## REMARKS

Species are easily recognizable as belonging to the order Poecilosclerida in having chelate microscleres, and as members of the genus *Acarnus* by their possession of cladotylotes. The recurved apical spines or clads of these spicules show some similarities with some Raspailiidae (e.g. *Ectyoplasia*, *Endectyon*) and tetractinal spicules of the Tetractinomorpha, but these are obviously analogous structures. Evidence for the origin of cladotylotes is conflicting. On the one hand (e.g. *A. primigenius* sp.nov.) the tetractinal modifications to cladotylotes in *Acarnus* appear to be highly derived forms of normal acanthostyle stock. This is illustrated by the series of spicules described in Figure 2a. This situation is thought to be similar to the origin and modification of acanthoplagiotrienes (monact, diact, triact, tetract and pentact forms) in the Raspailiidae genera *Cyamon* and *Trikentrion* (Hooper 1991b). Conversely, there is also a sequence demonstrated in *A. tenuis* (Fig. 1a,b) which suggests that larger, smooth-shaft forms of cladotylotes at least may be derived from ectosomal tylotes. In this regard *A. tenuis* is atypical of other species, and for reasons discussed further below, it may eventually be moved from *Acarnus* altogether.

Another character which appears to be characteristic for the genus *Acarnus* is the possession of thick toxas with greatly rounded central curvature and reflexed tips, resembling a pair of "oxhorns" (e.g. Fig. 2c). These sorts of spicules are shared by most, but not all species (absent in *A. tenuis* and apparently absent in *A. bicladotylotus*), but they are not unique to the genus, also occurring in some species of *Clathria*

of the Microcionidae (e.g. *C. (Axociella) cylindrica*, *C. (Clathria) inanchorata*; Hooper, in preparation).

The family placement of *Acarnus* is less easily decided. Van Soest (1984) transferred the genus from its traditional placement with the Microcionidae to the Myxillidae, based on the possession of ectosomal diactinal spicules (tylotes), which are apomorphic for the family. Hooper (1987:72) summarizes the arguments presented by various authors in favour of each system, and he chose to include the genus with the Myxillidae on the basis that the possession of ectosomal tylotes provides the only consistent character and clear differentiation between the two families (Hooper, in prep.). However, it is true that there are many characters shared between *Acarnus* and the Microcionidae, especially the geometry of microscleres. For the purposes of the present study the Microcionidae are considered to be an outlying sister-group of Myxillidae such as *Acarnus*. This argument is developed further below.

*Acarnus tenuis* Dendy, 1896  
 (Figs 1, 3a,b)

*Acarnus tenuis* Dendy, 1896:50–51. Hooper, 1987: 87–90, table 5.

## MATERIAL EXAMINED

LECTOTYPE: BMNH 1902.10.18.62 (RN974) (microscope slide): vicinity of Port Phillip Heads, Melbourne, Victoria, 38°20'S, 144°42'E; date and depth of collection unknown, J.B. Wilson, dredge [NMV G2456 now consists only of a specimen of the sponge *Plumohalichondria arenacea*, upon which *A. tenuis* incrustated, and from which the BMNH microscope slide preparation was made, but no trace of the incrusting sponge was found].

PARALECTOTYPE: BMNH 1902.10.18.375 (RN991) (microscope slide): same locality [NMV G2457 is a specimen of *Tedania digitata*, upon which *A. tenuis* incrustated, and from which the BMNH slide was made, but the incrusting species is no longer present].

PARALECTOTYPE: BMNH 1902.10.18.323 (RN1072): same locality [this BMNH specimen was not examined, nor is there any material with Dendy's RN number present in the NMV, supposedly incrustating on *Clathria typica*. Ayling *et al.* (1982) reported that the BMNH material consisted only of a microscope slide preparation, but this is unconfirmed, and it is still possible that the entire specimen is housed in the BMNH collection].



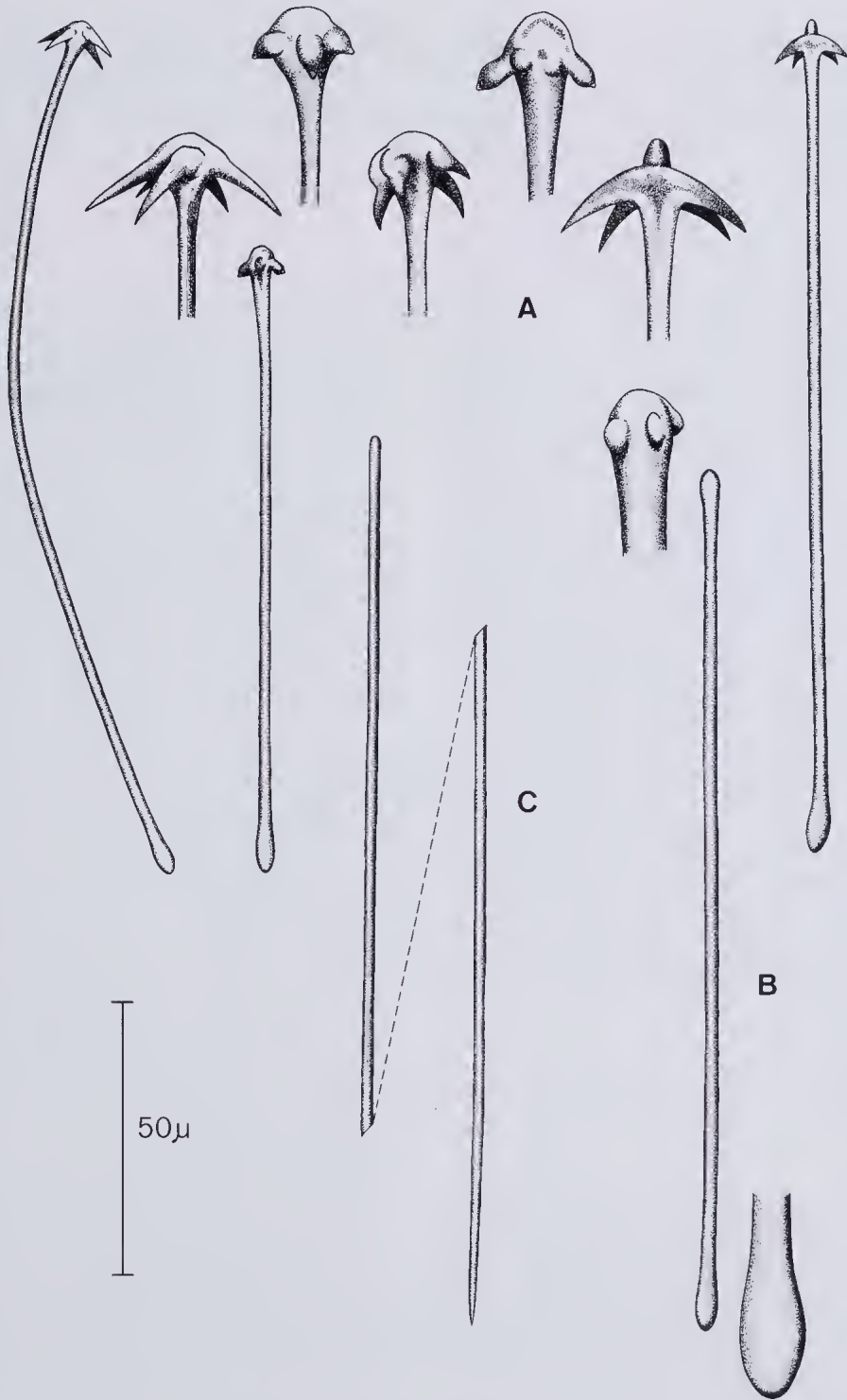


FIG. 1. *Acarnus tenuis*. A., cladotylotes, different growth stages and malformations. B., ectosomal tylote. C., choanosomal style.

## DESCRIPTION

The only extant material seen of this species consists of two microscope slide mounts of whole pieces. Nevertheless, they were enough to make the species recognizable, whereas Hooper (1987) had to rely on Dendy's (1896) brief and uninformative description. The specimens appear as pale yellowish blobs, flattened under the cover glass. They contain no visible spongin, and as a consequence, their skeleton is very lax, composed of loose bundles containing a mixture of cladotylotes orientated parallel to the surface and tylotes of equal size. The skeleton may be described as confusedly isotropic. The megascleres are of three types: tylotes (96–142–176 $\mu\text{m}$  x 2 $\mu\text{m}$ ) which are dominant and for the most part lying in bundles consisting of 15–20 spicules, together with cladotylotes of similar size (80–137–152 $\mu\text{m}$  x 2 $\mu\text{m}$ ), which seem to occur in all stages ranging from spicules resembling tylotes up to clear cladotylotes, and in this species at least they appear to be derived from tylotes. Cladotylotes are also abundant, generally lying in mixed bundles, although not all with the cladome in the same direction. Many cladotylotes are situated just under the surface of the sponge, piercing through it. Styles are not frequent (152–184–205 $\mu\text{m}$  x 2 $\mu\text{m}$ ). They do not occur in bundles, but are separately arranged in the skeleton. As noted by Dendy (1922), these spicules are stylote, strongylote, or sometimes subtylostylote, and in fact all these forms can be found in the preparations. Moreover, they seem to be modifications of one type, which is essentially a style. There are no microscleres. Numerous apparently unorganized spherical cells were also observed dispersed throughout the choanosome.

## DISTRIBUTION

Known only from the type locality of Port Phillip Heads, Victoria.

## REMARKS

Except for the possession of cladotylotes, this species would not have been assigned to the genus *Acaranus*, as it differs considerably from the other species in the genus. In fact Dendy (1922) suggested that a new genus might be created for *A. tenuis*. He considered that the key difference was the absence of chelate microscleres, but this is no longer considered of sufficient importance at the generic level (e.g. van Soest, 1984). However, other differences may vindicate his suggestion. For the time being

we propose to keep this species in the genus *Acaranus*, if for nothing else than convenience, and with affinities to the other species indicated by cladotylotes, but the species is readily differentiated from other members of the genus.

*Acaranus primigenius* sp. nov.  
(Figs 2, 3d,e,f, 4c)

## MATERIAL EXAMINED

HOLOTYPE: ZMA Por.7693: Bay of Sangara (Teluk Sengari). Sumbawa, Indonesia. 8°17'S, 118°15'E, 18m depth, 21 September 1984, coral reef, coll. H.A. ten Hove. *Snellius II* expedition, stn. 114/V/05.

## DESCRIPTION

The single specimen occurs as a thin hairy crust on the surface of a *Seriatopora* sp. (needle coral). In life it was bright orange, and in spirit it has a grey-purple colour.

The skeleton is composed of a basal plate of spongin with erect plumose spongin fibres arising in microcionid pattern, and fibres are cored with styles and echinated by acanthostyles and cladotylotes. Cladotylotes are of the same size as acanthostyles (54–62.5–67 $\mu\text{m}$  x 5 $\mu\text{m}$  at the base), and occur in all stages from true acanthostyles through all intermediate stages to true cladotylotes (Figs 2a, 3d,e). Apparently, the transformation from acanthostyles to cladotylotes starts with an increase in spine size at the tip of acanthostyles. The next step appears to be a progressive blunting of the pointed apex, resulting in a cladotylote. All cladotylotes, however, remain tapering from the base to the tip like regular acanthostyles, and these are as such readily distinguishable from other *Acaranus* cladotylotes which have a definitely tylote-like basal form. However, the tylote base (swelling) of the present species, from which the clads sprout, remains relatively small.

Styles are long (99–166–240 $\mu\text{m}$  x 4–5.5–6 $\mu\text{m}$ ), somewhat curved, and towards the tip they are slightly recurved. They possess a distinct base, which is heavily spined (Fig. 4c). Juvenile styles seem to be smooth and thin with a knob-like head. Acanthostyles are of a single size category only (60–66–68 $\mu\text{m}$  x 5 $\mu\text{m}$  at the base). The head is provided with spines curved in the direction of the tip, whereas the spines on the shaft are curved in the opposite direction. They appear to have the same function as the cladotylotes, since both are echinating. The ectosomal spicules consist of anisotylotes (137–156–184 $\mu\text{m}$  x 2.5 $\mu\text{m}$  in size),

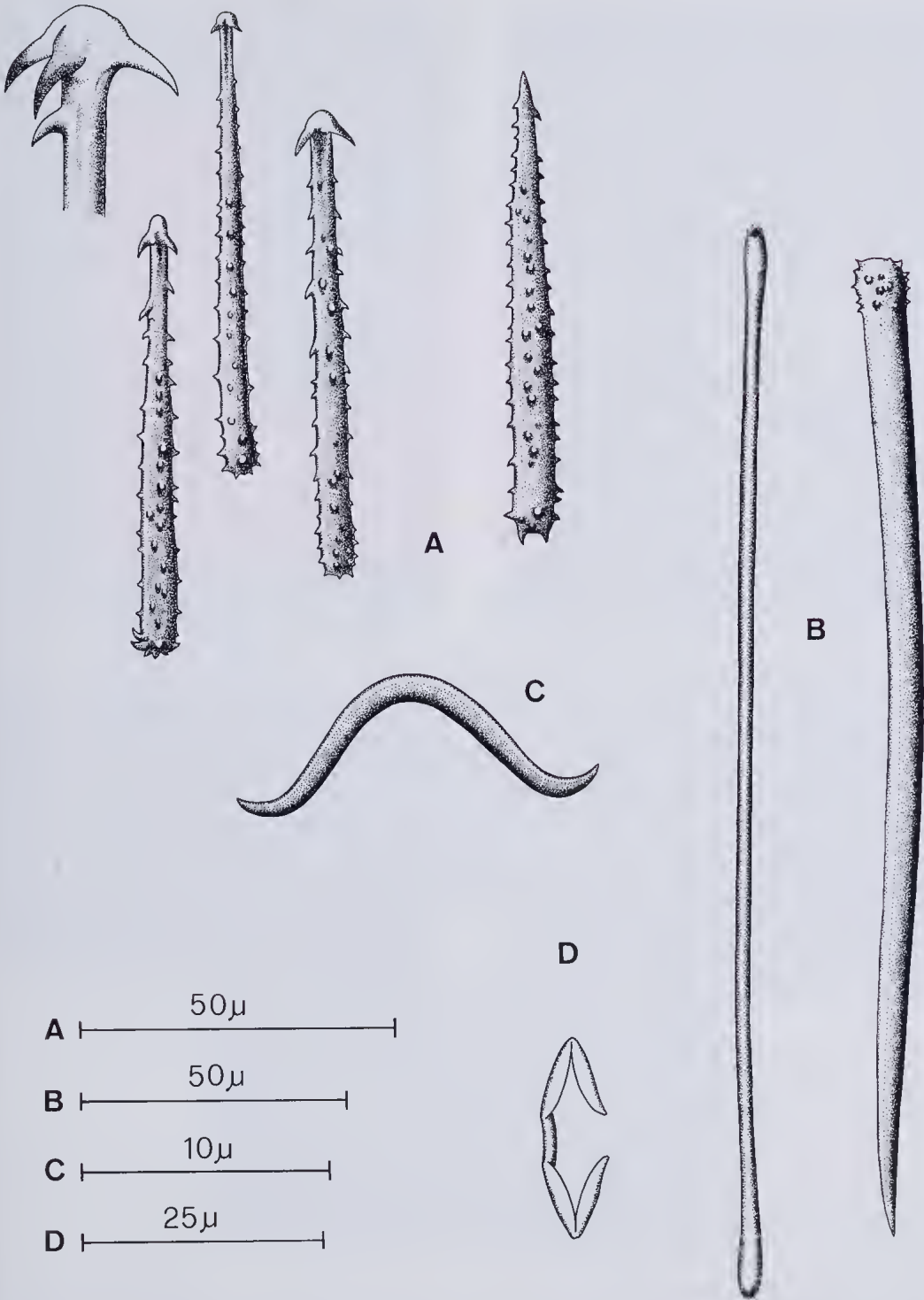


FIG. 2. *Acarnus primigenius*. A, cladotylotes and acanthostyle, different growth stages. B, tylote and style. C-D, toxas.



FIG. 3 A-C. *Acarnus tenuis*. A, cladotylotes protruding through the skin and the loose formation of round cells, not seen in other species of the genus. B, spicules of *A. tenuis* intermingled with those of its substrate *Tedania*; C, bundles of cladotylotes and tylotes. FIG. 3D-F, *Acarnus primigenius*. D-E, different growth stages of the basal clads. F, microspined base of the tylote spicule.

which appear smooth-based under the light microscope, but scanning electron microscopy (Fig. 3f) reveals microspines common to all *Acarnus* species (with the exception of *A. tenuis*).

Microscleres palmate isochelae (14-17.5-21.5 $\mu$ m), toxas of a single type, having characteristic "oxhorn"-like shape common to the genus (14-30-46 $\mu$ m x 1.5-3-4 $\mu$ m in size) (Fig. 2c).

#### DISTRIBUTION

Known only from the type locality of Sumbawa, southern Indonesia.

#### ETYMOLOGY

For the many plesiomorphic character states.

#### REMARKS

This new species is easily differentiated from

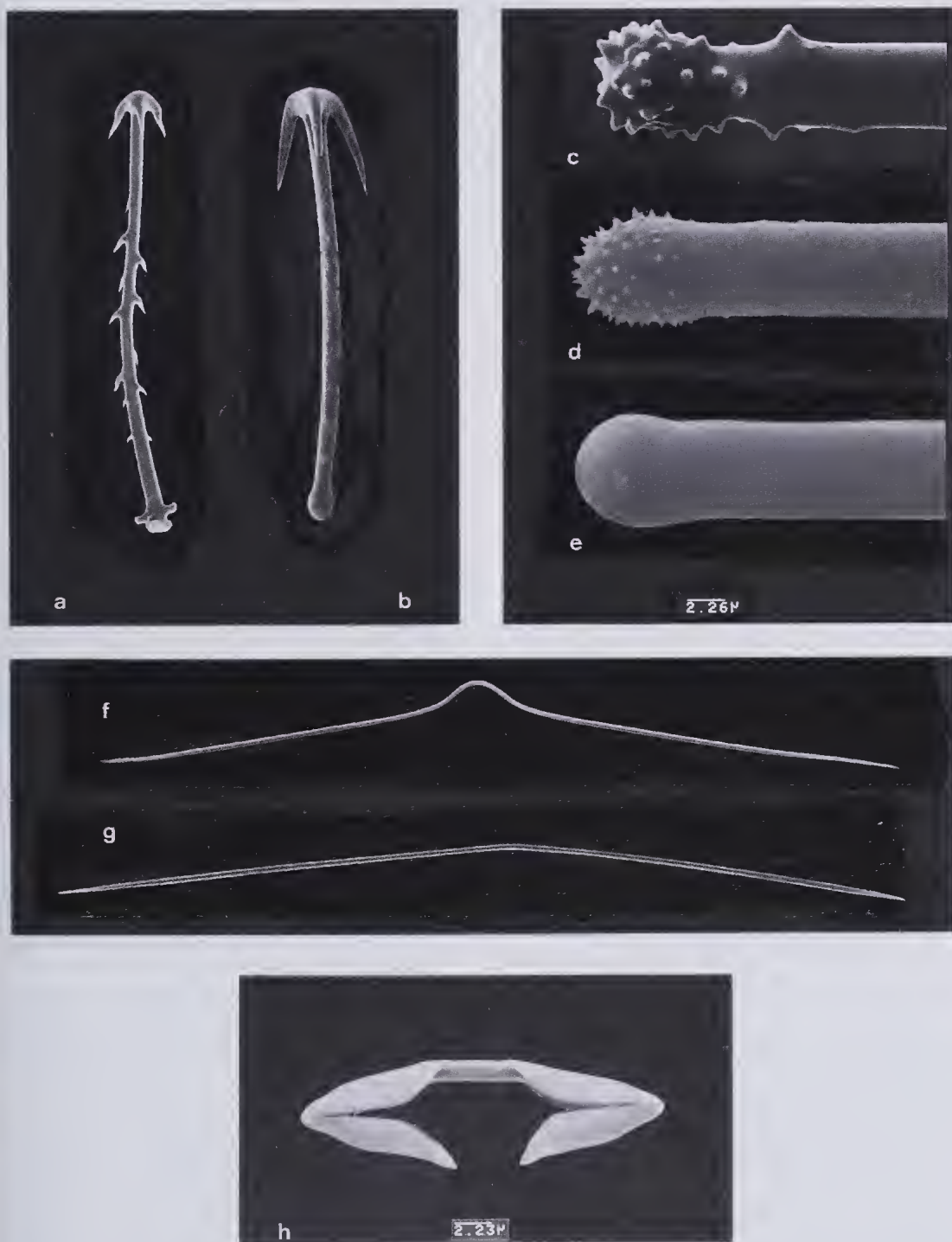


FIG. 4. Comparison between spicules of Indo-Australian *Acarnus* species. A,B, cladotylote varieties with microspined shaft and basal clads (A, *A. souriei*), and smooth shaft and swollen base (B, *A. ternatus*). C-E, variation in microspination of the bases of styles, A. *primigenius* (C), A. *tortilis* (D,E). F,G, longer toxas, showing the centrally curved (F, *A. innominatus*) and the slightly V-shaped types (G, *A. thielei*).

other *Acarinus* in having only small cladotylotes in combination with acanthostyles. *Acarinus topsenti* Dendy, 1922 also has only small cladotylotes but lacks acanthostyles. Skeletal structure also differs, being plumose in *A. primigenius* and isotropic/plumo-reticulate in *A. topsenti* (Hooper, 1987, fig.37). It is speculated that the plumose skeleton may represent an ontogenetic growth stage, occurring in more mature specimens, similar to the sequence found in *A. souriei* Lévi, 1952.

#### KEY TO THE INDO-AUSTRALIAN SPECIES OF *ACARINUS*

- 1a. No microscleres, spicule bundles consist of tylotes and cladotylotes only . . . *A. tenuis*.
- 1b. Microscleres present . . . . . 2.
- 2a. Acanthostyles present . . . . . 3.
- 2b. No acanthostyles present, larger cladotylotes usually with basal tylole swelling (Fig. 4b) . . . . . 4.
- 3a. Only small cladotylotes present (<100 µm) long . . . . . *A. primigenius*.
- 3b. Both small (<100 µm) and large cladotylotes present (>100µm), which have a cladome at their base (Fig. 4a) *A. souriei*.
- 4a. No small cladotylotes . . . . . *A. ternatus*.
- 4b. Both large and small cladotylotes . . . . . 5.
- 5a. With spined cladotylotes only . . . *A. tortilis*.
- 5b. With both smooth and spined cladotylotes 6.
- 6a. Thickly incrusting sponge, with long toxas bearing pronounced central curvature (Fig. 4f) . . . . . *A. innominatus*.
- 6b. Elaborate vasiform or flabellate growth form, coarse texture, long toxas slightly v-shaped (Fig. 4g) . . . . . *A. thielei*.

#### DISCUSSION

*Acarinus tenuis* Dendy, 1896 differs from all other *Acarinus* species in lacking microscleres, in having a lax skeleton, apparently without spongin fibres, and in lacking basal spination on

choanosomal styles. *Acarinus primigenius* differs from most species in having only small cladotylotes. The acanthostyles distinguish it from *A. topsenti* Dendy, 1922, together with the possession of a microcionid basal and dendroid choanosomal skeleton, an incrusting habit, larger tylotes, and heavy spines on the heads of styles (Fig. 4c). In having acanthostyles as well as cladotylotes echinating skeletal tracts, *A. primigenius* shows similarities with a group of species such as *A. souriei* (Lévi, 1952). These species were previously referred to *Acanthacarinus* Lévi, 1952, but Hooper (1987) supported their merger into a single genus on the basis that acanthostyles are primitive, and as such could not be used to define a genus.

*Acarinus souriei* and other members of the *souriei*-group (viz. *A. bicladotylotus* Hoshino, 1981, *A. radovani* (Boury-Esnault, 1973), and *A. tener* Tanita, 1963) differ from other species in having cladotylotes of two sizes, both of which have spined shafts, a dendritic skeletal architecture, in addition to the presence of echinating acanthostyles. Within the *souriei*-group, however, the differences are less clear. The Japanese species *A. tener* has larger cladotylotes (>80µm long) (whereas those of *A. souriei* are <80µm long). Similarly, *A. bicladotylotus* apparently has no large "oxhorn"-shaped toxas, but it is otherwise poorly differentiated from *A. souriei*. These differences require confirmation through re-examination of the original Japanese material (which unfortunately has now become virtually unobtainable for loan, following the untimely death of our colleague Takaharu Hoshino in 1988). Speculatively, however, it seems unlikely that the two species are distinct, since they are similar in most of their characteristics and they are only known to occur in restricted and adjacent localities in Japan. Conversely, *A. souriei* specimens reported from both sides of the Atlantic do seem to differ, and these may prove to be distinct species, in which case the species from the American shelf should be referred to *A. radovani* by priority.

The *tortilis*-group differs from the *souriei*-group in lacking acanthostyles, and from the *innominatus*-group in having only spined varieties of cladotylotes and both smooth and microspined bases on styles, which are also more-or-less straight. Other than *A. tortilis* Top-sent, 1892, other species included in the *tortilis*-group are *A. topsenti*, *A. toxatus* Boury-Esnault, 1973, and *A. polytylus* Pulitzer-Finali, 1983. *Acarinus topsenti* is easily differentiated from

other species in this group in having only small cladotylotes, whereas others have both small and large varieties of these spicules. The Brazilian *A. toxtatus* is distinguished in having its larger category of cladotylotes being very long and many-claded; the Mediterranean *A. polytylus* has polytylote examples of ectosomal and choanosomal spicules, but these may be merely malformations of normal ones found in *A. tortilis*, and the two species may prove to be conspecific.

The *innominatus*-group differs from other groups in having generally smooth shafts on the larger variety of cladotylotes, which also have a smooth basal tylote swelling. In addition, all members (viz. *A. erithacus* de Laubenfels, 1927, *A. innominatus* Gray, 1867, *A. thielei* Lévi, 1958, and *A. ternatus* Ridley, 1884) possess more-or-less abruptly curved styles which have smooth bases. *Acarnus ternatus* (which was not previously included with this group of species, but was placed in a group with *A. tenuis*; Hooper 1987) has only a single, larger size of cladotylotes, whereas the other species have two size categories of these spicules; *A. innominatus* has centrally curved long toxas (Fig. 4f) whereas both *A. thielei* and *A. erithacus* have their long toxas slightly v-shaped (Fig. 4g). The latter two species differ mainly in shape: *A. thielei* has a flabellate growth form, whereas *A. erithacus* is more massive.

#### PHYLOGENETIC REMARKS

The genus *Clathria* of the Microcionidae and the genus *Megaciella* of the Myxillidae are chosen as outgroups of *Acarnus*, representing both more-distantly and more-closely related taxa, and criteria for judging the apomorphic state of characters are listed below. This system essentially follows the findings of van Soest (1984) and Hooper (1987), but the conclusions of those authors are developed further in the following analysis.

Cladotylotes: small acanthostyle-like spined cladotylotes are plesiomorphic. Since the cladotylotes of *A. tenuis* seem to have a different origin, these are considered to be an apomorphy for this taxon, and it is speculated that its plesiomorphic state must have been the possession of a dermal layer of tylotes only. In *A. tenuis* all stages from tylotes to cladotylotes can be found, both of which have smooth shafts, and it seems unlikely that spicules with spined shafts have ever been present.

Acanthostyles: the possession of acanthostyles is considered to be plesiomorphic, since there is a tendency to lose acanthostyles (also throughout various groups of Poecilosclerida) and replace them with cladotylotes serving as echinating spicules.

Styles: the presence of microspines on the bases of the choanosomal styles is considered here to be plesiomorphic; apomorphy is the occurrence of smooth styles together with microspined ones, or completely replacing them.

Tylotes: the possession of a dermal layer of tylotes is the plesiomorphic state for the genus, since the character is shared by all myxillids. No apomorphic tendencies of this character were recorded for the genus.

Skeletal architecture: a reticulate or plumo-reticulate (dendroid) skeleton is considered to be plesiomorphic, and a plumose architecture is one of several possible derived conditions.

Microscleres: toxas do not seem to be of great importance in defining groups; in fact there seems to be random distribution in the loss of toxa categories (which was also found for the Microcionidae; Hooper, 1991a, and in preparation), whereas the most closely related advanced species seem to have kept all three categories of toxas. The loss of isochelae is probably a derived feature of the genus.

Based on this analysis of characters, the four species-groups proposed by Hooper (1987) are modified as follows:

GROUP I: *A. tenuis* - group has derived its cladotylotes from dermal tylotes, and is supposed to have lost the other spined spicules and microscleres. *Acarnus tenuis* is the only representative of this group.

GROUP II: *A. primigenius* - group has a dendritic skeletal architecture, one category only of toxas, and styles with distinctly spined bases: *Acarnus primigenius* is the only representative of this group.

GROUP III: *A. souriei* - group has retained the dendritic skeletal architecture, with echinating acanthostyles, and styles mainly with microspined bases. This group includes *A. souriei*, *A. radovani*, *A. tener* and *A. bicladotylotus*.

GROUP IV: *A. tortilis* - group has an isotropic skeleton, both microspined and smooth styles, but it has lost the acanthostyles. Representatives are *A. tortilis*, *A. topsenti*, *A. polytylus* and *A. toxtatus*.

GROUP V: *A. innominatus* - group also has a derived isotropic skeleton but has lost the

microspined styles, whereas larger cladotylotes show a strong tendency towards a smooth shaft and a smooth basal swelling. This group is represented by *A. innominatus*, *A. erithacus*, *A. thielei* and *A. ternatus*.

#### ACKNOWLEDGEMENTS

We are indebted to Dr Rob W.M. van Soest (University of Amsterdam) for his assistance, discussions, and for continually providing material from all corners of the ZMA collection. We are also grateful to Miss Shirley M. Stone (British Museum (Natural History)) and Prof. Claude Lévi (Muséum National d'Histoire Naturelle) for providing access to type material, and to Dr H.A. ten Hove (University of Amsterdam) for collecting the specimen of the new species, which made analysis of the genus so much easier.

#### LITERATURE CITED

- AYLING, A.L., STONE, S. AND SMITH, B.J. 1982. Catalogue of types of sponge species from Southern Australia described by Arthur Dendy. Rep. Nat. Mus. Vict. 1:87-109.
- BOURY-ESNAULT, N. 1973. Campagne de la "Calypso" au large des côtes Atlantiques de l'Amérique du sud (1961-1962). 1. 29. Spongiaires. Ann. Inst. Océan., Paris. 49(Suppl.):263-295.
- BUIZER, D.A.G. and SOEST, R.W.M. VAN 1977. *Mycale micracanthoxea* nov. spec. (Porifera, Poecilosclerida) from the Netherlands. Netherlands J. Sea Res. 11(3/4):297-304.
- DENDY, A. 1896. Catalogue of Non-Calcareous Sponges collected by J. Bracebridge Wilson, Esq., M.A., in the neighbourhood of Port Phillip Heads. Part 2. Proc. R. Soc. Vict. 2(8):14-51.
1922. Report on the Sigmatotetraxonida collected by H.M.S. "Sealark" in the Indian Ocean. Trans. Linn. Soc. London, Zool. In: Reports of the Percy Sladen Trust Expedition to the Indian Ocean in 1905, Volume 7. 18:1-164.
- GRAY, J.E. 1867. Notes on the arrangement of sponges, with description of some new genera. Proc. Zool. Soc. London 1867:492-558.
- HOOPER, J.N.A. 1986. Revision of the marine sponge genus *Axos* Gray (Demospongiae: Axinellida) from northwest Australia. The Beagle, Occ. Pap. N.T. Mus. Arts Sci. 3(1):167-189.
1987. New records of *Acarnus* Gray (Porifera: Demospongiae: Poecilosclerida) from Australia, with a synopsis of the genus. Mem. Qd Mus. 25:71-105.
- 1991a. Character stability, systematics and affinities between Microcionidae (Poecilosclerida) and Axinellida (Porifera: Demospongiae). Proc. 3rd Int. Conf Biol. Sponges, Woods Hole, USA. Smithson. Contrib. Zool. (in press).
- 1991b. Revision of the Family Raspailiidae (Porifera: Demospongiae), with description of Australian species. Invert. Tax. (in press).
- HOSHINO, T. 1981. Shallow-Water Demosponges of Western Japan, I, II. J. Sci. Hiroshima Univ. Ser. B., Div.1 (Zool.). 29(1):47-205, 29(2):207-289.
- LAUBENFELS, M.W. DE 1927. The Red Sponges of Monterey Peninsula, California. Ann. Mag. Nat. Hist. (9). 19:258-266.
- LÉVI, C. 1952. Spongiaires de la côte du Sénégal. Bull. Inst. français Afrique noire. 14:34-59.
1958. Résultats scientifiques des campagnes de la "Calypso". Fascicule III. V. Campagne 1951-1952 en Mer Rouge. 5. Spongiaires de Mer Rouge recueillis par la "Calypso" (1951-1952). Ann. Inst. Océan., Monaco. 34:3-46.
- PULITZER-FINALI, G. 1983. A collection of Mediterranean Demospongiae (Porifera) with, in appendix, a list of the Demospongiae hitherto recorded from the Mediterranean Sea. Ann. Mus. Civ. Storia Natur. Genova. 84:445-621.
- RIDLEY, S.O. 1884. Spongiida. In: Report on the Zoological Collections made in the Indo-Pacific Ocean during the Voyage of H.M.S. "Alert" 1881-2. British Museum (Natural History), London, 366-482, 582-630.
- SOEST, R.W.M. VAN 1984. Marine Sponges from Curaçao and other Caribbean Localities. Part III. Poecilosclerida. Stud. Fauna Curaçao other Carib. Is. (199):1-167.
1989. The Indonesian sponge fauna: a status report. Netherlands J. Sea Res. 23(2):225-232.
- TANITA, S. 1963. Report on the non-calcareous sponges in the Museum of the Biological Institute of the Tohoku University. Part II. Sci. Rep. Tohoku Univ., Ser. 4 (Biol.). 29(2):121-129.



## FIVE NEW SKINKS FROM QUEENSLAND RAINFORESTS

GLEN J. INGRAM

Ingram, G.J. 1990 08 01: Five new skinks from Queensland rainforests. *Memoirs of the Queensland Museum* 30(3): 443-453. Brisbane. ISSN 0079-8835.

Five skink species are erected in the *Lampropholis delicata* complex. *L. robertsi* sp.nov. inhabits montane rainforests on high peaks in northeastern Queensland and is sympatric with *L. coggeri* sp.nov. However, *L. coggeri* is widespread throughout montane and coastal rainforests in the northeast. *L. adonis* sp.nov. is known from two separate regions of rainforest in the mid-east and southeast of the State. In the south, it is sympatric with *L. couperi*. *L. colossus* sp.nov. is only known from the rainforests and Bunya Pine associations of the Bunya Mountains, southeastern Queensland. A key to the *Lampropholis delicata* complex is provided. □ *Scincidae, Lampropholis delicata complex, rainforests, Queensland.*

Glen J. Ingram, Queensland Museum, PO Box 300, South Brisbane, Queensland 4101, Australia; 28 February, 1991.

Ingram and Rawlinson (1981) erected three species in the *L. delicata* complex from eastern Australia. At the time, we were aware of several other new taxa but chose not to describe them because of the difficulty of characterising the species. These taxa differed little morphologically and most of the differences were in colour and pattern. Other workers have noticed the existence of undescribed taxa (Czechura and Miles, 1983; Czechura, 1986; Wilson and Knowles, 1988; Mather, 1990). In particular, Mather (1990) performed an electrophoretic and morphological comparison of the populations of *L. delicata* and concluded there were four distinct taxa in eastern Australia: three undescribed taxa and *L. delicata*. In this paper, while agreeing with Mather's taxa, I recognise two more undescribed species.

I distinguish the new taxa mainly by their different colour-patterns. In doing this, I am hypothesising that the colour-patterns are part of the Specific-Mate Recognition Systems (Lambert and Paterson, 1984) of the skinks. In this, I follow Paterson's (1985) Recognition Concept of Species in preference to the Biological Species Concept. *Lampropholis* species are alert, diurnal lizards that use visual cues in their behaviour and breeding displays (pers. obs.). Thus, it is not unreasonable to assume that they are capable of recognising patterns. Even so, the proposed species are testable hypotheses that can be refuted by showing that colour-pattern is not part of Specific-Mate Recognition Systems in these skinks.

With these new species, there are ten taxa in

the *L. delicata* complex. A key to them is given at the end of the paper. Abbreviations, measurements and morphological characters follow Ingram and Covacevich (1988), except for supraciliaries and supralabials, which are counted on the right side only. All specimens are housed in the Queensland Museum.

### SYSTEMATICS

#### *Lampropholis robertsi* sp.nov. (Figs 1-3)

*Lampropholis* sp. (3). Wilson and Knowles, 1988, p. 291. photo no. 504.

#### MATERIAL EXAMINED

HOLOTYPE J43911, Thornton Pk, via Daintree, NEQ (16°10'S, 145°23'E), collected by S. Wilson, J. Covacevich and G. Monteith on 24 September, 1984.

PARATYPES: Thornton Pk, via Daintree (J39856, 39857, 43912, 43964, 49648, 49659); Thornton Pk, boulder ranges (J43918); Thornton Pk, Summit (J43958); Pauls Luck, Carbine Tableland (J51948); Mt Lewis, via Mt Molloy (J47097, 48295); Mt Lewis, 25km along road (J51406); Bellenden Ker NP (J46193); Bellenden Ker Ra, Cable Tower 3 (J39855); Mt Bellenden Ker Summit (J39490, 39491); Mt Bellenden Ker, summit, nr TV Tower & Stn (J40033, 40036-9); Mt Fisher, Whiteing Rd, 7km SW Millaa Millaa (J41706-41708); Mt Fisher, 7km SW Millaa Millaa (J40609, 40610); Mt Fisher, via Millaa Millaa (J31194-31200); Mt Bartle Frere, E Face (J40041); Mt Bartle Frere (J47956, 47959); no data (J51405).

#### DIAGNOSIS

A large (maximum SV 49), robust (maximum

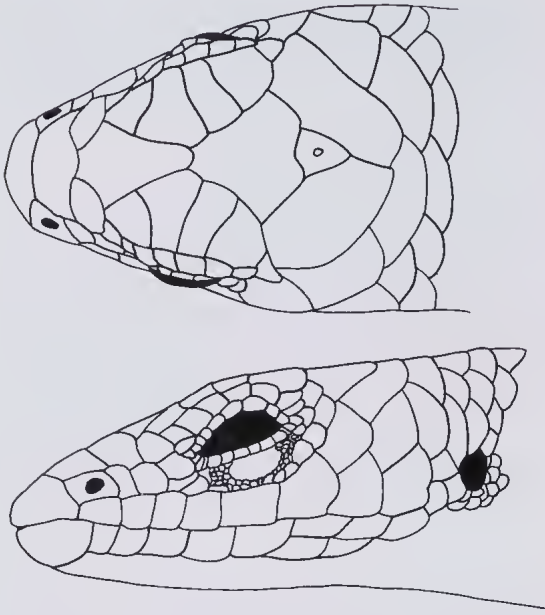


FIG. 1. *Lampropholis robertsi* (holotype J43911). Above: Dorsal view of head. Below: Lateral view of head.

HW 17) *Lampropholis* with fused frontoparietals, a free interparietal, seven supralabials, seven supraciliaries, short hindlimbs (HL<40) and with darker upper lateral surface colouration distinctly demarcated midlaterally from lighter lower lateral colouration. The demarcation can

be due to a sharp transition of dark to light pigments or be delineated by a pale brown to golden midlateral stripe or series of spots. Further distinguished from *L. colossus* and *L. delicata* by ventral colouration: grey with black-edged scales flecked with black; throat, chin, lower part of body and tail usually heavily black spotted; under the tail, the black markings often coalesce to outline a longitudinal series of white chevrons vs bright yellow to cream (*L. colossus*) or white (*L. delicata*) with or without black flecking on throat and tail, which can coalesce into lines.

#### DISTRIBUTION

Known only from rainforests of montane peaks from Thornton Peak south to Mt Bartle Frere, northeastern Queensland.

#### DESCRIPTION

SV: 21–49 (N=37), HW: 13–17 (N=30, mean 14.4), HL: 33–43 (N=25, mean 36.7), TL: 108–139 (N=7, mean 123.4).

Four supraoculars. Frontoparietals fused. Interparietal distinct. Supraciliaries 7, rarely 8 (N=26, mean 7.1). Supralabials 7 (N=27). Nuchals contacting parietals 2 (N=27). Midbody scale rows 25–30 (N=20, mean 27.8). Mid-dorsal scales smooth with 3–4 striations or weakly tricarinated. Number of scales from chin to vent 54–63 (N=22, mean 58.5). Lamellae under fourth toe 22–27 (N=24, mean 24.3).

Dorsal ground colour reddish brown to golden



FIG. 2. *Lampropholis robertsi* Mt Bartle Frere, above 1.5km (Bruce Cowell).

brown, sometimes with black longitudinal dashes. Upper lateral surface black to chocolate brown. Lower lateral surface light grey to brown with dark flecks and spots. Dorsolateral area golden to light brown tending to form an irregular stripe. Upper and lower lateral colouration sometimes separated by a golden to pale brown midlateral line, which can be broken into a series of spots. Ventrally, grey with black-edged scales flecked with black; throat, chin, lower part of body and tail usually heavily black spotted; under the tail, the black markings often coalesce to outline a longitudinal series of white chevrons.

## REMARKS

*L. robertsi* is sympatric with *L. coggeri*.

## ETYMOLOGY

For the Queensland naturalist Gregory Roberts.

***Lampropholis adonis* sp. nov.**  
(Figs 3–5)

*Lampropholis* sp. (5). Wilson and Knowles, 1988: 292, photo no. 506.

*Lampropholis delicata* Form B. Mather, 1990:570.

## MATERIAL EXAMINED

HOLOTYPE: J35097, 18km N of Dalrymple Heights, MEQ (21°04'S, 148°36'S), collected by G.J. Ingram on 2 December, 1978.

PARATYPES: Conway NP (J49750, 49563); Brandy Ck, Site 13 (J32754, 32793, 32795); Eungella NP, nr Vlasak property (J49591, 49597); Eungella NP (J46191, 49748, 49573, 49751); Thurgood Farm, 18km N Dalrymple Hts (J35104, 35122); Dalrymple Hts, 18km N (J35097); Crediton, Site 7 (J32644, 32652, 32701, 32706); Collaroy Holdings, Remnant Hut (J49746, 49753); Bulburin SF, Site 1a (J33604, 33607, 33609); Bulburin SF, adjoining Site 1a (J33701, 33717, 33718, 33720-33724); Bulburin, SF 67, via Lowmead (J23806-23808, 23805); Bulburin SF, 9km E Forestry Stn (J33736); Bulburin Barracks,

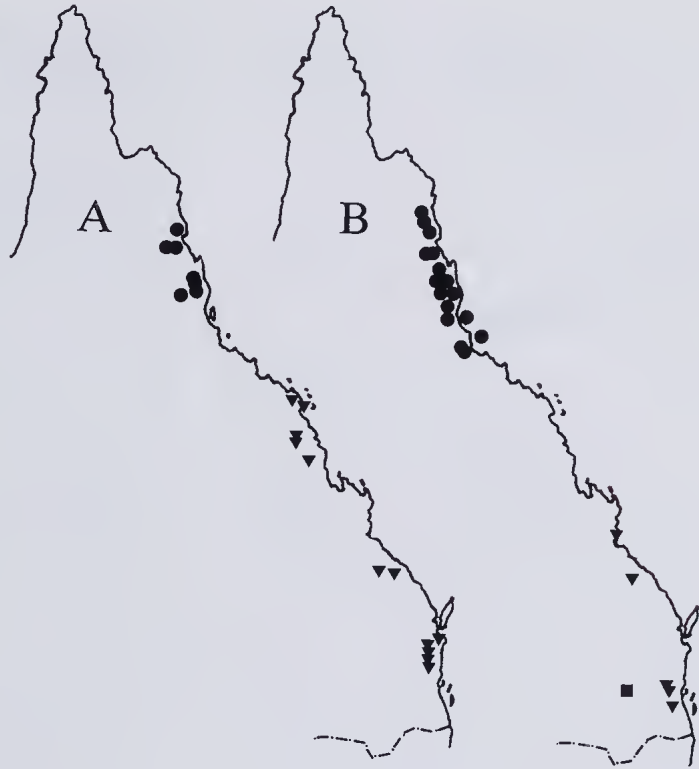


FIG. 3. A, Distribution of *Lampropholis robertsi* (●) and *L. adonis* (▼). B, Distribution of *L. colossus* (■), *L. coggeri* (●) *L. couperi* (△).

via Bullyan (J51319, 51323); Bulburin SF, top of ra (J27822, 27825, 27833); Bulburin SF, Granite Ck, nr Bruce Hwy Xing (J27820, 45297, 45298); Lowmead, 8-9.6km S (J23867); Dundowran, via Hervey Bay (J35198); Casy Ck, via Imbil (J27725); Cold Ck, via Imbil (J27732); Little Yabba Ck, via Kenilworth (J27721); Kondalilla NP (J49747).

OTHER MATERIAL: Brandy Ck, Site 13 (J32753, 32755-6, 32759, 32764, 32765, 32773, 32789, 32796); Cathu SF, Muirs Rd, nr western end of SF (J45825, 45826); Eungella (J28809); Thurgood Farm, 18km N Dalrymple Hts (J35101, 35123, 35124); Dalrymple Hts, 18km N (J35095, 35098, 35099); Finch Hatton NP, Site 9 (J34046); Finch Hatton NP, Site 9a (J34037, 34090); Eungella Schoolhouse (J46173); Crediton, Site 7 (J32636-32643, 32646, 32647, 32649-32651, 32698, 32699, 32700, 32702-32705, 32731, 32741, 32742); Crediton, Site 7a (J32670, 32672); Collaroy Holding, S of Sarina (J49592); Bulburin SF, Granite Ck, 13k SE Miriam Vale (J45775-45784); Lowmead, 3.2-4.8km N (J23825-6, 23828); Bulburin SF, adjoining Site 1a (J33699, 33710-33716, 33719, 33722, 33725); Bulburin SF, forestry camp (J33648, 33688); Bulburin SF, Site 1a (J33608, 33611, 33637, 33638, 33683); Bulburin SF (J33616-21); Bulburin SF, top of ra (J27823, 27824, 27826-27829, 27834); Bulburin SF, Granite Ck, via Many

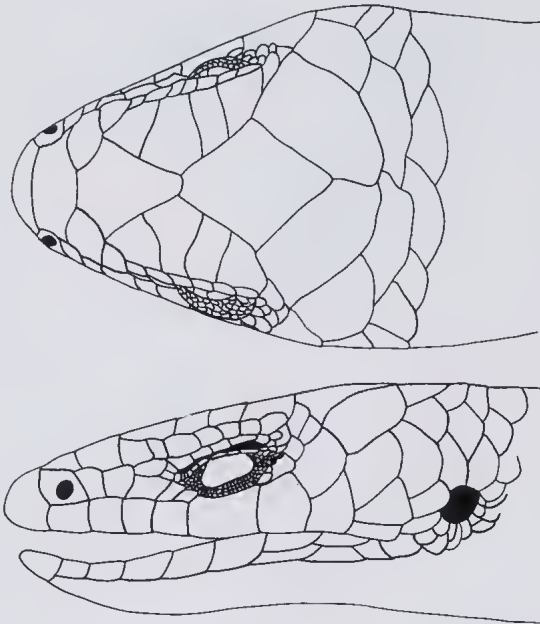


FIG. 4. *Lampropholis adonis* (holotype J35097). Above: Dorsal view of head. Below: Lateral view of head.

Peaks (J27817-27819); Brooyar Fire Tower, via Glastonbury (J28255); Cooloola, 1.6km E of L Cooloomera (J24496); Marys Ck, via Gympie (J27744); Cold Ck, via Imbil (J27731); Borumba Dam area, nr

Conondale Ra (J31867); Conondale Ra, Coonoon Gibber Ck (J36918); Kondalilla NP (J49572); Montville (J24499); Wootha, nr Maleny, ca.4km SW Town (J42425, 42428-42431).

#### DIAGNOSIS

A large (maximum SV 51), robust (maximum HW 18) *Lampropholis* with fused frontoparietals, a fused interparietal, seven supralabials, seven supraciliaries, short hindlimbs (HL<40) and with darker upper lateral surface colouration grading evenly into lighter lower lateral colouration. A midlateral light brown to white line or series of spots is never present.

#### DISTRIBUTION

Known from two separate regions. Mid-eastern Queensland: from near Proserpine south to the Collaroy, north of St Lawrence. Southeastern Queensland: from Bulburin State Forest south to the Blackall Range.

#### DESCRIPTION

SV: 17-51 (N=51). HW: 13-18 (N=1, mean 14.5). HL: 30-40 (N=45, mean 34.3). TL: 137-148 (N=3, mean 141.7).

Four supraoculars. Frontoparietals and interparietal fused to form one scale. Supraciliaries 7, very rarely 8 (N=48, mean 7.1). Supralabials 7, very rarely 8 (N=48, 7.0). Nuchals contacting parietals 2 (N=49). Midbody scale rows 25-33 (N=42, mean 28.4). Mid-dorsal scales smooth



FIG. 5. *Lampropholis adonis* Eungella National Park (David Knowles).

with 3–4 striations. Number of scales from chin to vent 50–61 (N=37, mean 54.5). Lamellae under fourth toe 19–24 (N=44, mean 21.8).

Colour pattern is very similar to that of *L. coggeri*. However, the juveniles are heavily spotted with white on the lateral surface. Also, the males of *L. adonis* have breeding colours of red on the sides of the body and tail, cherry-red reticulations on the underside of the tail, and blue on the throat, chin and labial scales.

#### REMARKS

Mather (1990) noted that there were two species of *Lampropholis* at Warro, the type locality of *Mococa delicata* de Vis (1888). He contended that de Vis's description was inadequate for allocating the name to either taxa and, because the holotype was lost, he selected a neotype. The new name-bearing specimen chosen by Mather is an example of a taxon that most people would know as *L. delicata* because it is common in gardens throughout eastern Australia. However, there is doubt that his assessment of de Vis's description was correct. De Vis wrote, 'interparietal incompletely separate....' The other taxon on Warro is *L. adonis*, which has the interparietal fused. More than likely, it was to this taxon de Vis referred because *L. delicata* has a separate interparietal. As well, *L. adonis* is common along riverine scrubs throughout Warro, while *L. delicata* is uncommon (pers. obs.).

Despite the doubt, however, Mather's decision is sensible. If he had selected an example of *L. adonis* as neotype, *Leiopisma hawaiiensis* Loveridge (1933), based on an introduced population in Hawaii (Baker, 1979), would have become the available name for the other taxon. This would have been nomenclaturally inconvenient because it is unknown from where in Australia the Hawaiian population originated and whether or not this polynesian population would continue to exist. With Mather's decision, *Leiopisma hawaiiensis* became a junior synonym of *Mococa delicata* and, for most purposes, nomenclaturally irrelevant.

Of interest is the similarity between *L. adonis* and *Carlia rhomboidalis*. *C. rhomboidalis* is a rainforest skink that has breeding colours of red sides and a blue throat and, coincidentally, a fused interparietal (see Ingram and Covaccvich, 1989). If *L. adonis* had four fingers instead of five, it would not be out of place in the genus *Carlia*. Further investigation is needed into the status of the two genera.

#### ETYMOLOGY

For Adonis, the beautiful youth beloved of the goddess Venus.

#### *Lampropholis colossus* sp.nov.

(Figs 3,6,7)

#### MATERIAL EXAMINED

HOLOTYPE: J49687, Bunya Mts National Park, SEQ (26°53'S 151°37'E), in rainforest near Tim Shea Falls, collected by K.R. McDonald on 26 January, 1974.

PARATYPES: Bunya Mts NP, 0.5km S TV Towers (J46095-46097); Bunya Mts NP, Survey Site 56 (J27549,27550); Bunya Mts NP (J30655-30657, 30659, 30660, 49689, 49692).

#### DIAGNOSIS

A very large (maximum SV 56), delicate (maximum HW 14) *Lampropholis* with fused frontoparietals, a free interparietal, seven supralabials, seven supraciliaries, short hindlimbs (HL<40) and with darker upper lateral surface colouration distinctly demarcated mid-laterally from lighter lower lateral colouration. The demarcation can be due to a sharp transition of dark to light pigments or be delineated by a white midlateral line or series of spots. Further distinguished from *L. delicata* by large size (maximum SV 56 vs 45) and ventral colouration (bright yellow to cream vs white). Further distinguished from *L. robertsi* by ventral colour pattern (see the diagnosis of that species).

#### DISTRIBUTION

Known only from the rainforests and Bunya Pine associations of the Bunya Mountains, southeastern Queensland.

#### DESCRIPTION

SV: 40–56 (N=13). HW: 11–14 (N=13, mean 12.4). HL: 28–37 (N=13, mean 33.4). TL: 150–189 (N=3, mean 172.8).

Four supraoculars. Frontoparietals fused. Interparietal distinct. Supraciliaries 7 (N = 13). Supralabials 7 (N=13). Nuchals contacting parietals 2 (N=13). Midbody scale rows 23–27 (N=13, mean 25.2). Mid-dorsal scales smooth with 3–4 striations. Number of scales from chin to vent 54–62 (N=13, mean 58.8). Lamellae under fourth toe 21–26 (N=13, mean 23.1).

Dorsal ground colour reddish to olive-brown with light to golden brown dorsolateral stripes and black laterodorsal stripes; the latter may be broken into a series of black dashes. Upper lateral surface dark brown to black and markedly

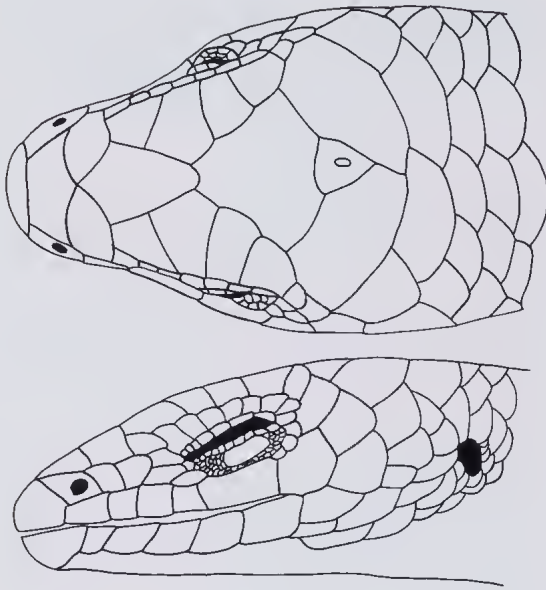


FIG. 6. *Lampropholis colossus* (paratype J30655). Above: Dorsal view of head. Below: Lateral view of head.

separated from the light brown to grey lower surface; sometimes the separation is marked by a strong, white, midlateral stripe, which can be broken into a series of spots. Ventrally bright yellow to cream; tail with black speckling that sometimes forms longitudinal, black, broken lines.

#### REMARKS

The specific status of *L. colossus* needs further

investigation. It is very similar to *L. delicata* and may just be an isolated, large form of that species. Moreover, there are several other unnamed, distinctly coloured populations of *L. delicata* throughout eastern Queensland that warrant similar investigations. Undoubtedly, the taxon *L. delicata* is still a complex of species.

#### ETYMOLOGY

Latin, *colossus*, a statue; refers to the skinks large size.

#### *Lampropholis coggeri* sp.nov. (Figs 3,8,9)

*Lampropholis* sp. (4). Wilson and Knowles, 1988: 291, photo no. 505.

*Lampropholis delicata* Form D. Mather, 1990:570.

#### MATERIAL EXAMINED

HOLOTYPE: J27133 Shiptons Flat, Cape York Peninsula, Qld (15°48'S 145°16'E), collected by G. Ingram and J. Covacevich on 18 November, 1975.

PARATYPES: Mt Hedley (J25243, 25244); Mt Hartley (J25251-25255, 25271); Twelve Mile Scrub, Gap Creek (J25299, 25300); Home Rule (J25139, 25201-25203, 25230, 25241, 25285, 25330); Shiptons Flat (J27130-27134); Mt Finnigan (J25217, 26301, 40536); Windsor Tableland (J40663); Daintree area (J29622); Mossman Gorge (J21408); Bakers Blue Mountain, 17km W of Mt Molloy, 900m (J39872); Mt Molloy (J27008-27011); Cableway Base Station, Bellenden Ker (J39858, 39864); Crater, Atherton Tableland (J12205); 20km N of Innisfail (J14092); 16km W of Innisfail (J18006); Walter Hill Ra, Charappa Ck drainage, Suttees Rd (J48170, 48172); Billy Ck Bridge SF 758, vicinity of bridge (J48210); Upper Boulder Creek via Tully, 650-900m (J42276, 42277, 42294); Paluma State Forest, 950m (J41733); Palm Island (J14009, 14022).



FIG. 7. *Lampropholis colossus* (holotype J49687) Bunya Mountains National Park (Gary Cranitch).

OTHER MATERIAL: Mt Finnigan NP (J25269, 40542); Gold Hill, China camp (J33170); Table Mt, 10km S Cape Tribulation (J41722); Thornton Pk, Summit (J43901); Thornton Pk, via Daintree (J43910); Windsor Tbl'd SF, survey peg TA213 (J48693); Windsor Tbl'd, 28km NNW Mt Carbine (J40658); Karnak - Devils Thumb, 8-12km NW Mossman (J51566); Bakers Blue Mt, 17km W Mt Molloy (J39871, 49582-1, 51567); Mossman Bluff (J49580); Lamb Ra, Emerald Ck (J41130); Lamb Ra, 19km SE Mareeba (J48557); Danbulla SF (J49739, 49740, 49743); Danbulla SF, Kauri Ck, Mt Haig Rd (J48277, 48278); Severin, Boar Pocket (J49614); Bellenden Ker NP, TV stn (J49593); Bellenden Ker Ra, Cableway Base Stn (J39865); Gadgarra SF (J49741); Upper Mulgrave R, below Gadgarra SF Tookeys Ck (J42308); Gadgarra SF, Upper Bull Ck (J48691); L Eacham (J47096, 48425, 49619, 49620, 49622); Russell R, cave site (J45916, 45918); Crater NP (J49576, 49613); near Herberton-Ravenshoe Crater Junction (J43632); Majors Mt, N side (J48139); Majors Mt, via Ravenshoe (J31112, 31113, 31133-31137); Charmilan Ck (J41361, 41362, 47628); Walter Hill Ra, Charappa Ck drainage, Suttees Rd (J48171); Forestry 'H' Rd, via Tully (J48244, 48245); Kirrama Ra, Bryce-Henry Logging Area (J51420); Kirrama Ra, Macks Logging Area (J51419, 51421, 51422); Kirrama Ra (J48310); Kirrama Ra, Alma Gap Logging Rd (J48317); Cardwell Ra, Upper Broadwater Ck, Valley (J48305); Hinchinbrook Is, Gayundah Ck (J44173, 44199); Wallaman Falls Rd (J48306).

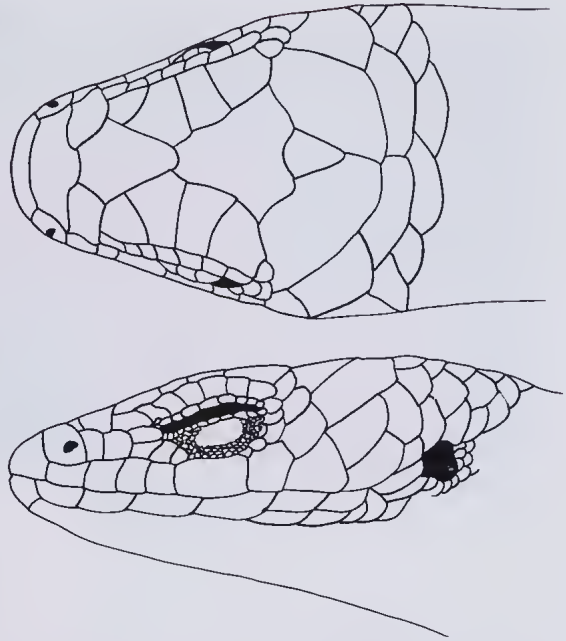


FIG. 8. *Lampropholis coggeri* (holotype J27133). Above: Dorsal view of head. Below: Lateral view of head.



FIG. 9. *Lampropholis coggeri* Thornton Peak (Steve Wilson).

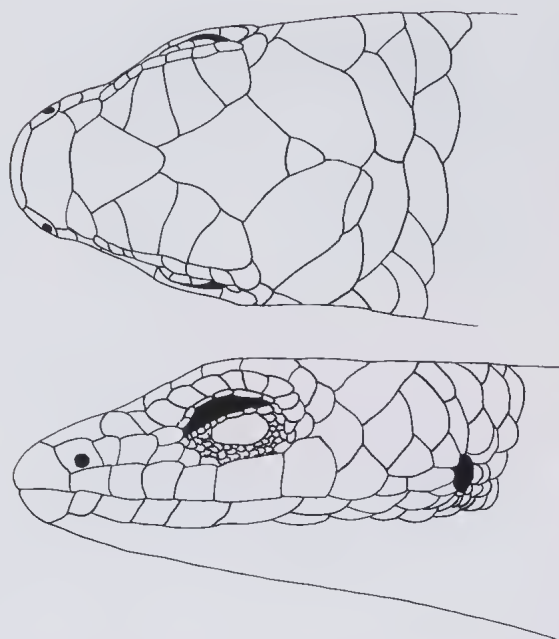


FIG. 10. *Lampropholis couperi* (holotype J49575). Above: Dorsal view of head. Below: Lateral view of head.

48307); Curacoa Is, Palm group (J49610, 49644); Elk Is (J49635, 49653, 49665); Bluewater Ra, N of Townsville (J46777).

#### DIAGNOSIS

A small (maximum SV 41), robust (maximum HW 18) *Lampropholis* with fused frontoparietals, a free interparietal, seven supralabials, seven supraciliaries, short hindlimbs (HL<40) and with darker upper lateral surface colouration grading evenly into lighter lower lateral colouration. A midlateral light brown to white line or series of spots is never present. Further distinguished from *L. couperi* by colour pattern: dorsal colour reddish to olive brown usually flecked with pale spots and black longitudinal dashes; the dashes can coalesce to form up to six dorsal lines; the outer two lines can delimit a paler brown dorsolateral stripe; lateral ground colour dark brown to reddish brown flecked with paler spots and, usually, black dashes vs dorsal colour uniform olive brown; upper lateral surface evenly black; dorsolateral area pale brown, edged strongly in black below.

#### DISTRIBUTION

Rainforests from near Cooktown south to Palm

Island and Bluewater Range near Townsville, NEQ.

#### DESCRIPTION

SV: 17–41 (N=40). HW: 14–18 (N=38, mean 15.4). HL: 30–39 (N=7, mean 33.8). TL: 140.6 (N=1).

Four supraoculars. Frontoparietals fused. Interparietal distinct. Supraciliaries 7, very rarely 6 or 8 (N=40, mean 7). Supralabials 7, very rarely 6 (N=40, mean 7). Nuchals contacting parietals 2, very rarely 3 (N=38, mean 2.0). Midbody scale rows 26–31 (N=38, mean 27.3). Mid-dorsal scales smooth with 3–4 striations. Number of scales from chin to vent 50–60 (N=38, mean 53.8). Lamellae under fourth toe 19–25 (N=37, mean 21.6).

Dorsal ground colour reddish to olive brown, usually flecked with pale spots and black dashes. The dashes tend to follow behind each other forming six longitudinal lines. The outer two can enclose a poorly defined, paler brown, dorsolateral stripe. Lateral ground colour dark brown to olive brown flecked with paler spots and, usually, black dashes; on lower lateral surface, ground colour is light brown: sides of tail tend to have black and light grey blotching on a brown background. Ventral ground colour light grey to creamy yellow, sparsely spotted with black; on the tail, the spotting is denser closer to the body, usually becoming concatenated to form black reticulations on a white background; sometimes the black markings are reddish brown on the edges.

#### REMARKS

*L. coggeri* is common in rainforest leaf-litter. It is sympatric with *L. robertsi* in parts of its range.

#### ETYMOLOGY

For Dr Harold Cogger, Australian Museum.

#### *Lampropholis couperi* sp. nov. (Figs 3,10,11)

*Lampropholis* form A. Czechura and Miles, 1983: 95.

*Lampropholis* sp. Czechura, 1986:63.

*Lampropholis* sp. (2). Wilson and Knowles, 1988: 291, photo no. 503.

*Lampropholis delicata* Form C. Mather, 1990:570.

#### MATERIAL EXAMINED

HOLOTYPE: J49575, Kondalilla NP, SEQ (26°41'S, 152°52'E), collected by D.G. Crossman and K.R. McDonald on 28 August, 1974.





FIG. 11. *Lampropholis couperi* Mt Nebo (Garry Cranitch)

PARATYPES: Kroombit Tops, Ubobo Rd, campsite, ca. 18 km W, on rd (J40153-7); Kroombit Tops (J42156); Kroombit Tops, Upper TA47, 45 km SSW Calliope (J43956); Bulburin SF, Site 1a (J33605); Little Yabba Ck, via Kenilworth (J27723); Jimna SF, Griffith Logging area (J49660); Jimna SF (J49669); Conondale Ra, E Side (J30293); Conondale (J30827); Wootha, nr Maleny, @ 4 km SW Town (J42426); Mt Nebo (J34162, J47950-1, J51663); Mt Glorious SF, Pine Shire, via Brisbane (J49752).

OTHER MATERIAL: Byfield, nr Rockhampton (J25741, 25745).

#### DIAGNOSIS

A large (maximum SV 49), delicate (maximum HW 16) *Lampropholis* with fused frontoparietals, a free interparietal, seven supralabials, seven supraciliaries, short hindlimbs (HL < 40) and with darker upper lateral surface colouration grading evenly into lighter lower lateral colouration. A midlateral light brown to white line or series of spots is never present. Further distinguished from *L. coggeri* by colour pattern (see the diagnosis of that species).

#### DISTRIBUTION

In rainforests from near Rockhampton, central eastern Queensland, south to Mt Glorious near Brisbane, southeastern Queensland.

#### DESCRIPTION

SV: 18–49 (N=21). HW: 11–16 (N=18, mean 13.6). HL: 27–38 (N=17, mean 32.8). TL: 112–141 (N=5, mean 124.2).

Four supraoculars. Frontoparietals fused. In-

terparietal distinct. Supraciliaries 7 (N=44). Supralabials 7 (N=20). Nuchals contacting parietals 2, very rarely 3 (N=20, mean 2.0). Midbody scale rows 26–30 (N=20, mean 27.2). Mid-dorsal scales smooth with 3–4 striations. Number of scales from chin to vent 52–62 (N=18, mean 55.5). Lamellae under fourth toe 20–24 (N=17, mean 22.4).

Dorsal colour uniform olive brown. Upper lateral area black, grading evenly into grayer lower lateral surface, which can have paler speckling. Dorsolateral colouration is paler brown, tending to form a bright stripe strongly edged below with black. On the tail, the lateral colouration breaks up into black speckling on a brown background. Ventrally, grey with black flecking that can be well-defined dots on the chin and throat; on the tail, the black markings are well-defined and tend to coalesce and form black reticulations.

#### REMARKS

The specific identity of the two specimens from Byfield, near Rockhampton, deserves further investigation. The locality is the only coastal lowland record of the species. I have tentatively allocated them to *L. couperi* but it is difficult to be sure because of their poor condition.

The identification of Wilson and Knowles (1988) photo number 503 as this species is also tentative. The skink looks like *L. couperi* but the sides are not black enough. The population, which is from Carnarvon Gorge, needs to be

collected and the identity of the species confirmed.

*L. couperi* is widely sympatric with *L. adonis* in southeastern Queensland.

#### ETYMOLOGY

For Patrick Couper, Queensland Museum.

#### KEY TO THE *L. DELICATA* COMPLEX

1. Usually 6 supralabials; 3 supraoculars.....  
.....*L. caligula*

Usually 7 supralabials; 4 supraoculars.....  
.....2

2. Usually 5 supraciliaries; midbody scale rows usually <23.....*L. amacula*

Usually 6 or 7 supraciliaries; midbody scale rows usually >23..... 3

3. Interparietal fused with frontoparietals to form one scale.....*L. adonis*

Interparietal free..... 4

4. Usually 6 supraciliaries; dark vertebral stripe present.....*L. guichenoti*

Usually 7 supraciliaries; dark vertebral stripe absent.....5

6. Hindlimbs long, usually >45% of SV; subdigital lamellae under fourth toe usually >27.....  
.....*L. mirabilis*

Hindlimbs not long, usually (<40% of SV; subdigital lamellae under fourth toe usually <27.....7

7. Darker upper lateral surface colouration grades evenly into lighter lower lateral colouration. A midlateral light brown to white line or series of spots is never present..... 8

Darker upper lateral surface colouration distinctly demarcated midlaterally from lighter lower lateral colouration. The demarcation can be due to a sharp transition of dark to light pigments or be delineated by a golden brown to white midlateral line or series of spots.....9

8. Dorsal colour uniform olive brown. Upper

lateral surface evenly black. Dorsolateral area pale brown, edged strongly in black below. Maximum SV 49mm..... *L. couperi*

Dorsal colour reddish to olive brown usually flecked with pale spots and black longitudinal dashes; the dashes can coalesce to form up to six dorsal lines. The outer two lines can delimit a paler brown dorsolateral stripe. Lateral ground colour dark brown to reddish brown flecked with paler spots and, usually, black dashes. Maximum SV 41mm.  
.....*L. coggeri*

9. Overall: brown, black and gold, robust skinks (HW 13-16% of SV). Ventrally, grey with black-edged scales flecked with black; throat, chin, lower part of body and tail usually heavily black spotted; under the tail, the black markings often coalesce to outline a longitudinal series of white chevrons.....  
.....*L. robertsi*

Overall: brown, black, grey and white, delicate skinks (HW 11-14% of SV). Ventrally, yellow to white with black flecking on throat and tail, which can coalesce into thin lines.....10

10. Ventrally yellow. Maximum SV 56mm. Rain-forest dwelling.....  
.....*L. colossus*

Ventrally white. Maximum SV 45mm. Open forest, woodland and heath dwelling.....  
.....*L. delicata*

#### ACKNOWLEDGEMENTS

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#### LITERATURE CITED

- BAKER, J.K. 1979. The rainbow skink, *Lampropholis delicata* in Hawaii. *Pacific Science* 33: 207-212.
- CZECURA, G.V. 1986. Distant exiles: Frogs and reptiles recorded from Kroombit Tops, south-eastern Queensland. *Qld. Nat.* 27: 61-67.
- CZECURA, G.V. AND MILES, J. 1983. Lizards. 80-99. In Davies, W. (ed.), 'Wildlife of the Brisbane area.' (Jacaranda Press: Brisbane).
- DE VIS, C.W. 1888. A contribution to the herpetology

- of Queensland. Proc. Linn. Soc. N.S.W. (2)2: 811-826
- INGRAM, G. AND COVACEVICH, J. 1988. Revision of the genus *Lygisaurus* de Vis (Reptilia, Scincidae) in Australia. Mem. Qd Mus. 25: 335-354.
1989. Revision of the genus *Carlia* (Reptilia, Scincidae) in Australia with comments on *Carlia bicarinata* of New Guinea. Mem. Qd Mus. 27: 443-490.
- INGRAM, G.J. AND RAWLINSON, P. 1981. Five new species of skinks (genus *Lampropholis*) from Queensland and New South Wales. Mem. Qd Mus. 20: 311-317.
- LAMBERT, D.M. AND PATERSON, H.E.H. 1984. On 'Bridging the gap between race and species'. The isolation concept and an alternative. Proc. Linn. Soc. N.S.W. 107: 501-514.
- LOVERIDGE, A. 1939. A new skink (*Leiopisma hawaiiensis*) from Honolulu. Proc. Biol. Soc. Wash. 53: 1-2.
- MATHER, P.B. 1990. Electrophoretic and morphological comparisons of *Lampropholis delicata* (Lacertilia: Scincidae) populations from eastern Australia, and a resolution of the taxonomic status of this species. Aust. J. Zool. 37: 561-574.
- PATERSON, H.E.H. 1985. The Recognition Concept of Species. 21-29. In Vrba, E.S. (ed.), 'Species and speciation. Transvaal Mus. Mon. 4.' (Transvaal Museum: Pretoria).
- WILSON, S.K. AND KNOWLES, D.G. 1988. 'Australia's reptiles: a photographic reference to the terrestrial reptiles of Australia.' (William Collins: Sydney).

## THE EARLIEST RECORD OF THE ?EXTINCT PLATYPUS FROG

*Memoirs of the Queensland Museum* 30(3):454, 1991.

The Platypus Frog (*Rheobatrachus silus*) was only recently described by Liem (1973). He discovered the frog in a stream in Kondalilla National Park, 3km SW of Montville in the Blackall Range, southeast Queensland, on 17 May 1972. Subsequently, it was also found in the Conondale Range (Czechura, 1975). The frog's discovery caused a sensation because of its aquatic-adapted morphology. As well, the subsequent publication of its bizarre parental care of carrying the tadpoles in the stomach (Corben, Ingram and Tyler, 1974) met with incredulity (Tyler, 1983).

Probably what is most amazing about the frog is that it had not been discovered earlier. It is very distinctive and, from Queensland Museum records, collectors were visiting the areas where it was found since the early part of this century. However, the frog *had* been collected before the date of Liem's find, but overlooked.

As part of the process of auditing the Queensland Museum's vertebrate collections in the preparation of an atlas, all specimens of Australian frogs where re-identified. During this endeavour, an old specimen of the Platypus Frog, *R. silus* was discovered. The specimen, registration number J12778, was a juvenile and measured: SV 20.0, TL 8.0, TL/SV 40.0, HW 6.2, HW/SV 31.0, HW/TL 77.5, ED 2.5, ED/HW 40.3, EN 1.4, IN 1.6, EN/IN 87.5 (measurements and abbreviations follow Ingram and Corben, 1990). According to growth data in Ingram (1983), the specimen is a first year frog.

Heber A. Longman (1880-1954), subsequently Director of the Queensland Museum (Turner, 1986), collected the specimen at Montville. There is no date of collection but Czechura (in press) said Longman was probably at Montville in May, 1915. Czechura was commenting on a series of specimens (J12772-12777, 12779, 12780) of the ?extinct Southern Dayfrog (*Taudactylus diurnus* Straughan and Lee, 1966) that were the earliest known specimens of that species, but also overlooked. These were collected at the same time by Longman along with the Platypus Frog specimen. As to the date of collection, the series J12772-12780 was probably collected at the same time as the reptiles J2315 and 2318 (*Cacophis krefftii* and *Gonocephalus spinipes* respectively). These have exactly the same data but were registered on 10 May, 1915. In the least, it can be said that the Montville specimens where taken before that date.

This earliest known record of the Platypus Frog is important because the species is thought to be extinct or in danger of being so (Ingram, 1990). Czechura and Ingram (1990) noted that the last record of a wild frog was on 8 December, 1979. Interestingly, in the museum's register near the entry for the old Platypus Frog specimen is a pencilled annotation that was subsequently erased. It asks if the specimen is a new species. Ironically, 57 years passed before the species was formally described and then we were to know the frog for only seven years before it would disappear.

The existence of the old Montville specimens of *R. silus* and *T. diurnus* illustrates the value of museum collections in the study of biodiversity. Museums are repositories of historical information about species (Manning, 1991) and often have the only data that are known. With endangered species,

the historical information is of great importance in making management decisions for conservation. It is a necessity for workers in biodiversity to examine museum collections in their research. Apparently, neither Liem (1973) nor Straughan and Lee (1966) did so and thus missed valuable data. As well, the species could have been discovered earlier by other workers and, by the present, we might have had enough information to save the frogs.

### Literature Cited

- CORBEN, C.J., INGRAM, G.J. AND TYLER, M.J. 1974. Gastric brooding: Unique form of parental care in an Australian frog. *Science* 186:946-947.
- CZECHURA, G.V. 1975. Notes on the frog fauna of Conondale Range, south east Queensland. *Herpetofauna* 7(2): 2-4.
- (in press). The Blackall-Conondale Ranges: frogs, reptiles and fauna conservation. In Werren, G.L. and Kershaw, A.P. (eds), 'The rainforest legacy.' Vol. 2. (Australian Government Publishing Service: Canberra).
- CZECHURA, G.V. AND INGRAM, G.J. 1990. *Taudactylus diurnus* and the case of the disappearing frogs. *Mem. Qd Mus.* 29: 361-365.
- INGRAM, G.J. 1983. Natural history. 16-35. In Tyler, M.J. (ed.), 'The Gastric Brooding Frog.' (Croom Helm: London).
1990. The mystery of the disappearing frog. *Wildlife Australia* 27(3): 6-7.
- INGRAM, G.J. AND CORBEN, C.J. 1990. *Litoria electrica*: a new treefrog from western Queensland. *Mem. Qd Mus.* 28:475-478.
- LIEM, D.S. 1973. A new genus of frog of the family Leptodactylidae from SE. Queensland, Australia. *Mem. Qd Mus.* 16:459-470.
- MANNING, R.B. 1991. The importance of taxonomy and museums in the 1990s. *Mem. Qd Mus.* 31:205-207.
- STRAUGHAN, I.R. AND LEE, A.K. 1966. A new genus and species of leptodactylid frog from Queensland. *Proc. R. Soc. Qd* 77: 63-66.
- TURNER, S. 1986. Heber Albert Longman. *Mem. Qd Mus.* 24:321-323
- TYLER, M.J. 1983. Introduction. 1-4. In Tyler, M.J. (ed.), 'The Gastric Brooding Frog.' (Croom Helm: London).

Glen Ingram, Queensland Museum, PO Box 300, South Brisbane, Queensland 4101, Australia; 24 June, 1991.

## LATE CAMBRIAN (POST-IDAMEAN) TRILOBITES FROM THE HIGGINS CREEK AREA, WESTERN TASMANIA

PETER A. JELL, NIGEL C. HUGHES AND ANTHONY V. BROWN

Jell, P.A., Hughes, N.C. and Brown, A.V. 1991 08 01: Late Cambrian (post-Idamean) trilobites from the Higgins Creek area, western Tasmania. *Memoirs of the Queensland Museum* 30(3): 455-485. Brisbane. ISSN 0079-8835.

Trilobites are described from nine localities on logging tracks between the Huskisson River and Burns Peak, NNE of Renison Bell, western Tasmania. The 18 taxa, 7 in open nomenclature, indicate an age in the pre-Payntonian Stage (Queensland scheme) or late Early to early Late Sunwaptan Stage (North American scheme). Seven new species are described as *Lotagnostus tullahensis*, *Rhaptagnostus mji*, *Cermatops thalasta*, *Asiocephalus latosuggrundus*, *Olenus apoxysomatus*, *Chekiangaspis concavus*, and *Wujiujiania distorta*. This fauna is important as it represents an off-shelf assemblage, possibly with some shelf inhabitants mixed in, that is contemporaneous with one of the carbonate shelf assemblages of western Queensland. □ *Late Cambrian, trilobites, Tasmania.*

Peter A. Jell and Nigel C. Hughes, Queensland Museum, PO Box 300, South Brisbane, Queensland 4101, Australia; Anthony V. Brown, Department of Resources and Energy, PO Box 56, Rosny Park, Tasmania 7018, Australia; 10 May, 1991.

Tasmanian Late Cambrian trilobites have been recorded (Jago, 1972, 1974, 1978, 1987; and references in Jago, 1979 and Banks, 1982) from several different parts of the State and from several different horizons. This paper presents a further discovery, in the Huskisson Group, in the Higgins Creek area between the Huskisson River and Burns Peak, 15 km NNE of Renison Bell, of a fauna of 18 trilobite taxa plus brachiopod and bradoriid elements; much of the fauna has not been previously described from Australia and has affinities with faunas from other parts of the world, in particular central China. The nearest occurrences of trilobites are those from the Huskisson River about 7 km NNE of Renison Bell (Jago, 1974) where the index fossil *Glyptagnostus reticulatus* indicates an early Idamean age.

A Late Cambrian fauna was described from the Climie Formation, Dundas Group (Jago, 1978) about 12 km south of Renison Bell. Jago (1978) favoured a post-Idamean age over the other possibility, latest Idamean. Jago's *Peltura* (?) sp. has a glabella with convex lateral margins and glabellar furrows that are almost straight in the two arms of the chevron and continuous across the axis; both are features of *Wujiujiania distorta* sp. nov. and we suggest that may be the more likely identity of Jago's specimen. His *Ceratopygidae*, gen. et sp. indet (Jago, 1978, pl.2, figs 16, 20) are indistinguishable from *Proceratopyge gordonensis* Jago, 1987, a close relative/descendant of which is found in our fauna.

His *Trilobita incertae sedis*, specimen 3 (Jago, 1978, pl.2, fig. 18) is assignable to *Cermatops thalasta* sp. nov. as it has the same structure of furrows on the pleural areas as described for that species below. Moreover, we concur with Jago that his cranidial fragment (Jago, 1978, pl.2, fig. 17) is conspecific with the pygidium but the possible assignment to *Briscoia* is revised. We suggest that both specimens belong to *C. thalasta*. *Lotagnostus* occurs in both faunas, with unavailability of features (through poor preservation) on Jago's (1978, pl.2, fig. 1) specimen preventing specific comparison. *Olenus* occurs in both faunas, albeit as entirely different species; some importance is attached to its generic range in Europe, but in China *O. sinensis* occurs with taxonomic relatives of some of our Higgins Creek fauna in horizons younger than those yielding the genus in Europe (Lu and Lin, 1989). Based on this series of observations we deduce that Jago's Climie Formation fauna and our Higgins Creek fauna were approximately contemporaneous. Jago (in Shergold et al., 1985) reassessed the age of his Climie Formation fauna on the basis of the discovery of *Hedinaspis* in a correlative horizon in the Professor Range; on that basis he considered it late Late Cambrian but tabulated it (Shergold et al., 1985, chart 7, col. 53) as medial Late Cambrian with which we agree. We are unaware of this record of *Hedinaspis* being illustrated and suggest that it should be carefully scrutinized to determine

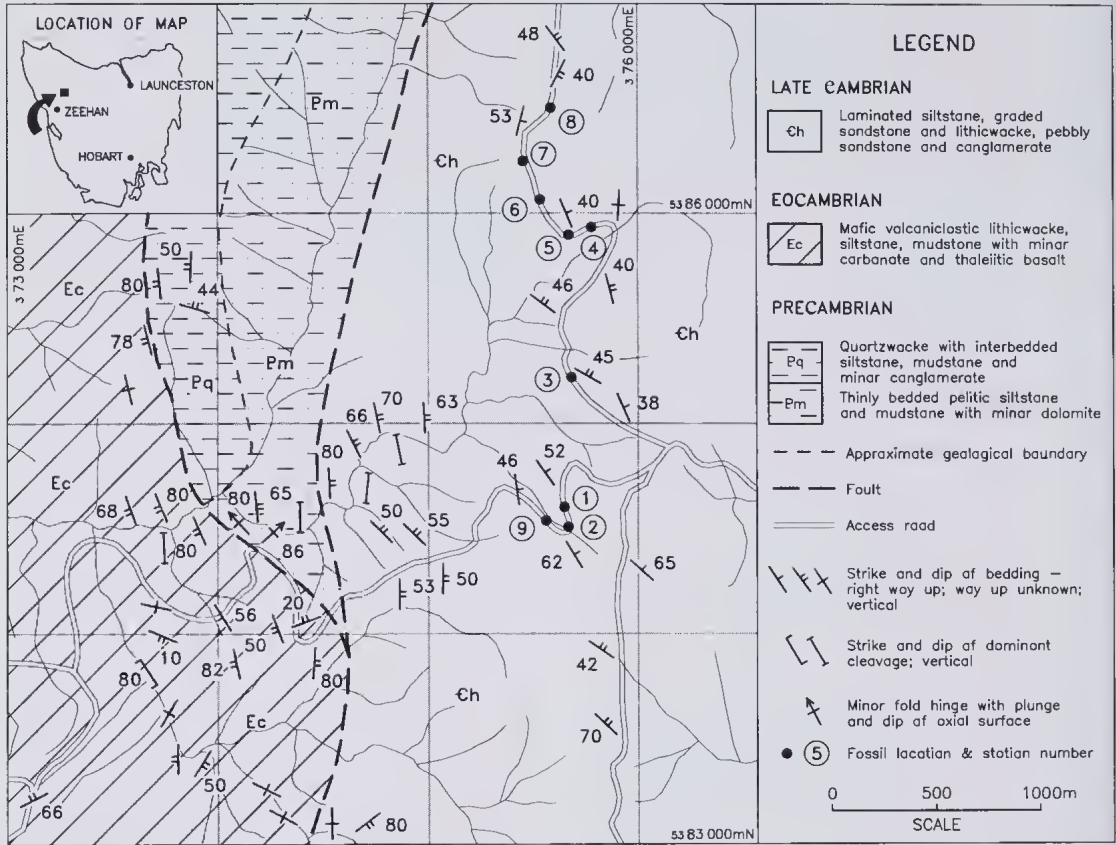


FIG. 1. Locality map for fossil localities mentioned in text. Area is situated between the Huskisson River and Burns Peak NNE of Renison Bell.

whether it may be the similar *Asiocephalus* or not. Similarly the record of *Hedinaspis* from western New South Wales (Webby et al., 1988) could represent *Asiocephalus*; distinctive features are unavailable on specimens illustrated.

The fauna from the Singing Creek Formation of the Denison Range, southwestern Tasmania (Jago, 1987) has in common with faunas described below *Micragnostus*, *Pseudagnostus*, *Aphelaspis*, *Proceratopyge*, but this does not indicate contemporaneity in itself. However, note that Jago (1987) compared his Leiostrigiacean gen. et sp. indet. to families that are normally post-Idamean in China and described a species of *Pseudoyuepingia*, that genus being post-Idamean in China and interpreted as such in western New South Wales (Webby et al., 1988). Moreover, Jago (in Shergold et al., 1985) attributed a post-Idamean to pre-Payntonian age to this fauna. Comparison of elements of this fauna with the one described below also suggest a

post-Idamean age with possible close proximity of the ages of both faunas. We accept Jago's (in Shergold et al., 1985) assessment of its age.

Geological setting and age of the Higgins Creek fauna indicate that it is buried in a turbidite sequence probably deposited on or at the base of the continental slope. Some of the taxa found in only one of the three faunas (Higgins Creek, Climie Formation, Denison Range) may have been shelf benthos, having been incorporated into the off shelf deposits by slump or flow at the shelf margin. Those taxa common to the faunas may have been off shelf benthos or inhabitants of the water column. We suggest that these three faunas were essentially contemporaneous, post-Idamean in age; discussion of this age is presented below.

LOCALITY AND GEOLOGICAL SETTING

During mapping for the Corinna 1:50,000

Geological Atlas Map Sheet (Turner et al. 1991), a small area containing a sequence of interbedded pebble to granule conglomerate, with dominantly siliceous clasts and matrix, graded sandstone and lithicwacke and siltstone was encountered along the poorly accessible southeastern margin of the map sheet in the Higgins Creek area (Fig.1). In March 1990, during a reconnaissance traverse into this area, nine localities with fossiliferous lithicwacke and siltstone were found in cuttings along a new road west from the Murchison Highway towards the Huskisson River; the area is about 15 km NNE of Renison Bell and 12 km NW of Tullah, both towns being on the Murchison Highway.

Lithologically, the sequence is dominated by interbedded siltstone and well bedded lithicwacke, with lenses and channel infillings of conglomerate. The conglomerate units are of both clast and matrix supported varieties. The open framework conglomerate units have dominantly chert clasts whereas the closed framework units are dominated by rounded quartzite clasts. The thicker sand grade beds and conglomerate units have scour bases and, in places, contain rip-up siltstone clasts in the basal section. Sand grade beds are usually graded and consistently give an east facing (easterly dip). Some sand grade beds contain intraformational soft sediment deformation and small cross-bedded channel infills. Siltstone beds are usually laminar but cross-bedded units are also present. Sedimentological features within this succession suggest a submarine fan environment of deposition.

The rock sequence is considered to belong to the upper part of the Huskisson Group and a correlate of the upper part of the Dundas Group (as described by Brown, 1986). Rock sequences lithologically similar to those containing the fossil sites occur to the north and south of the area. To the north, the succession contains mudstone, quartzite, greywacke, and tuffaceous greywacke-mudstone with conglomerate and crystalline tuff units (Collins et al., 1981).

To the south, exposures were available in two locations during the early to mid 1980s. The first of these were in roadside quarries made during the construction of the Lower Pieman Dam Road; however, these exposures have since been re-vegetated. The second location was in the Pieman River Gorge to the south of the road, but flooding the river to form Lake Pieman drowned these localities. Description of the sequences in these areas can be found in Green (1983) and Brown (1986).

The Higgins Creek sequence containing the fossils belongs to a belt of rocks formed during the latest Idamean, which is now thrust against Precambrian successions to the west and has Middle(?) Cambrian volcano-sedimentary successions thrust against it on the east. Due to discontinuous structures to the north and south of the Higgins Creek area and the unresolved structural complexity of the rocks to the east, it is not possible to give a structural relationship of this east facing sequence with the Middle(?) Cambrian volcano-sedimentary sequences.

The implication of structural complexity of the Higgins Creek area, the discontinuous structures both to the north and south of the Higgins Creek area, and the lack of knowledge as to the boundary relationship of this area with the sequences containing, the as yet undescribed, late Middle(?) Cambrian faunas within the volcanoclastic sequences to the east of Burns Peak (Corbett and McNeil, 1986; Corbett and Solomon, 1988: 101), and the tectonic significance of the new fauna, will be discussed within the forthcoming Explanatory Notes to the Corinna 1:50,000 Map Sheet (in prep.).

#### FAUNA AND AGE

We describe 18 trilobite taxa, with 7 of those in open nomenclature (Table 1). *Proceratopyge gordonensis* has been found in Australia in strata we consider approximately coeval with the collections described below but considered by Jago (1987) to be Idamean. *Pseudagnostus* sp. is compared with *P. idalis* Öpik, 1967, although that is a dubious comparison; *P. idalis* is restricted to the Idamean in the rest of Australia. Apart from its record in the Climie Formation (Jago, 1978) mentioned above, *Olenus* has been recorded in the Idamean of western Queensland (Öpik, 1963), and the *Olenus* Zones of Europe are correlated with the Australian Idamean. *Aphelaspis* is now widely known in Australia, but its greatest development is in North America; the *Aphelaspis* Zone of that continent is correlated with the early half of the Australian Idamean Stage. However, the range of this taxon is not certain and depends to large extent on better definition of this and related taxa currently assigned to separate but undifferentiated genera, as discussed in the systematics below. *Olentella* for example ranges into the post-Idamean. These taxa could be used to suggest correlation with the latest Idamean (Shergold et al., 1990).

However, the rest of the fauna is not obviously

TRILOBITES \ LOCALITIES	1	2	3	4	5	6	7	8	9
<i>Acmarrhachis?</i> sp.	X								
<i>Micragnostus</i> sp. cf. <i>M. intermedius</i> Palmer, 1968	X								
Pseudagnostids	X				X				
<i>Lotagnostus tullahensis</i> sp. nov.									X
<i>Pseudagnostus</i> sp.		X	X						
<i>Pseudagnostus (Sulcatagnostus)</i> sp.							X		
<i>Neoagnostus clavus</i> Shergold, 1972								X	
<i>Rhaptagnostus convergens</i> Palmer, 1955								X	
<i>Rhaptagnostus mji</i> sp. nov.									
<i>Proceratopyge</i> sp. cf. <i>P. gordonensis</i> Jago, 1987	X				X	X		X	X
<i>Cermatops thalasta</i> sp. nov.				X				X	X
<i>Asiocephalus latosuggrundus</i> sp. nov.	X	X							
<i>Olenus apoxysomatus</i> sp. nov.	X	X	X		X		X		
<i>Chekiangaspis concavus</i> sp. nov.					X				
<i>Wujiajiania distortus</i> sp. nov.		X	X				X		X
<i>Aphelaspis</i> sp.					X				X
Conocephalinidae indet.									X
<i>Aposolenopleura</i> sp.									X

TABLE 1. Distribution of fauna at the nine collecting localities marked on the locality map (Fig. 1).

in accord with this date. *Aposolenopleura* and the nearest specific comparison of *Lotagnostus tullahensis* are to be found in the *Hungaia magnifica* Faunule which was originally thought to be of late Trempealeau age (Rasetti, 1944); subsequently, Lochman and Wilson (1958) correlated it with the late Franconian (Sunwaptan) *Ptychaspis-Prosaukia* and *Saukia* Zones. Palmer (1968) accepted correlation with the late Franconian (late Early Sunwaptan) and erected *Asiocephalus* for trilobites from the same faunule. This genus is represented in our Higgins Creek fauna. In Kazakhstan, *Hedinaspis (Asiocephalus) sulcata* is the nominal species of a zone correlated with the *Trisulcatagnostus trisulcus* and *Eolotagnostus scrobicularis* Zones; Shergold et al. (1990) correlated these zones with the *Saukia* Zone (*Saukiella junia* Subzone) of North America even though *Saukiella* does not appear in the Kazakh sequence until two zones later in the *Harpidioides-Platypeltoides* Zone (Apollonov and Chugaeva, 1983); Shergold (pers. comm. June, 1991) would now correlate those Kazakh zones with older horizons in the rest of the world thus coming closer to the suggestion made here. We suggest

that horizon should be correlated with pre-*Saukiella* horizons in North America, i.e. with the late Early Sunwaptan (=late Franconian). *Cermatops* occurs in western Queensland in the post-Idamean *Wentsuia iota-Rhaptagnostus apsis* Zone (Shergold, 1980), and the Welsh species of Hughes and Rushton (1990) is from the contemporaneous *Parabolina spinulosa* Zone, two zones younger than the Idamean. The Chinese *Wujiajiania* and *Chekiangaspis* occur together in the *Lotagnostus punctatus* Zone of western Zhejiang; this zone is numbered 14 in the scheme of Lu and Lin (1989) with *Pseudagnostus idalis* occurring in the *Proceratopyge fenghuangensis* and *Erixanum* Zones (Zones 11 and 12 of Lu and Lin's scheme) those zones being correlated with the third and second last zones of the Australian Idamean, respectively (Lu and Lin, 1989, table 8). Therefore, if Lu and Lin's zone 13 (*Pseudoglyptagnostus clavatus-Sinoproceratopyge kiangshanensis* Zone) is equated with the last Idamean or an immediately post-Idamean Zone (J.H. Shergold (pers. comm. June, 1991) suggested equivalence with the *Irvingella* Zone) then the *Lotagnostus punctatus* Zone (14) is post-Idamean. In so far as the base of the *L.*



*punctatus* Zone of western Zhejiang is aligned with the base of the *Maladioidella* Zone of the North China Province and that Zone is shown by Shergold et al. (1990, fig.7) to be equivalent to the post-*Irvingella* Zone of Queensland, we correlate the *L. punctatus* Zone, with the late Early Sunwaptan (=late Franconian). Therefore, 6 members of the Higgins Creek fauna suggest correlation with this North American horizon.

*Neoagnostus clavus* is found in western Queensland in the penultimate and prepenultimate zones of the pre-Payntonian. Shergold et al. (1990) also correlated this horizon with the *Saukiella junia* Subzone of North America but that correlation was based on conodont work which has been revised providing a different picture (Nicoll and Shergold, 1991). Its contemporaneous horizons in the North American sequence may be near the Early/Late Sunwaptan boundary (Ludvigsen and Westrop, 1985). Similarly, *Rhaptagnostus convergens* is ascribed an age (Shergold, 1977) in the *Saukiella pyrene* Subzone of Nevada; that horizon, immediately on top of the *Ellipsocephaloides* Zone (Longacre, 1970, text-fig.5) indicates the Early to Late Sunwaptan boundary. These two species may therefore be added to those that suggest a Sunwaptan age for our fauna even if the suggestion is for a zone younger than suggested by the previous six species.

The Higgins Creek fauna, therefore, contains 8 species that suggest correlation with horizons just below or above the Early/Late Sunwaptan (=late Franconian) boundary (3 or 4 zones post-Idamean) and 4 that suggest latest Idamean but much less strongly. In discussions of *Wujia-jiania distorta* and *Asiocephalus latosuggrundus* we point out that they are probably ancestral to members of the respective genera found elsewhere in the world. Therefore, they may be interpreted as indicating a slightly older horizon in Tasmania. We initially considered that among the 9 localities, which could not be placed in stratigraphic sequence, some may have been late Idamean and others several zones post-Idamean. However, careful examination of the collections show the reported associations to be valid with some of the unexpected co-occurrences on one piece of rock.

We suggest that the age of the fauna may be post-Idamean within the Early Sunwaptan Stage, with which its constituents have been compared above; no zonal correlation may be substantiated with any other part of the world, not even with Queensland or other parts of Australia. As dis-

cussed above approximate contemporaneity with Jago's (1978, 1987) Climie and Singing Creek faunas is suggested as the only speculation at a more specific level. The lower fauna in the Watties Bore section (Webby et al., 1988) resembles the Tasmanian faunas in containing *Pseudoyuepingia*, *Proceratopyge*, *Pareuloma* (close to *Chekianaspis* as discussed by Webby et al. (1988, p.914)), and *Hedinaspis* sp. (may be *Asiocephalus* as discussed above); however, these similarities may be due to their occurring in the same off shelf environment where a number of genera are beginning to appear to have quite long ranges as well as to proximity of age, if any. The significance of the fauna is its further revealing the oceanic fauna of eastern Australia in the Late Cambrian and providing more information for correlation within Australia and the Asian region.

#### SYSTEMATIC PALAEOONTOLOGY

The fossils described herein are housed in the Geological Survey of Tasmania (prefix GST). Descriptive terminology follows Moore (1959), where possible, with the notation for glabella lobes and furrows following Henningsmoen (1957) (i.e. lobes termed L0, L1, L2, L3 etc. and furrows S0, S1, S2 etc from the occipital forward).

##### Class TRILOBITA

##### Order MIOMERA Jaekel, 1909

##### Superfamily AGNOSTOIDEA McCoy, 1849

##### Family AGNOSTIDAE McCoy, 1849

##### *Lotagnostus* Whitehouse, 1936

##### TYPE SPECIES

*Aagnostus trisectus* Salter, 1864 from the Late Cambrian of Britain and Sweden.

##### *Lotagnostus tullahensis* sp. nov.

(Fig. 3G-I)

##### ETYMOLOGY

Near the town of Tullah, western Tasmania.

##### MATERIAL

Holotype GST14375 and paratypes GST14373 and 14374 from Loc. 9.

##### DIAGNOSIS

Cephalon with well-impressed preglabella median furrow reaching border furrow,

scrobiculate cheek areas; anterior glabellar lobe large, subquadrate with slight anteromedial projection and rounded anterolaterally; S2 well-impressed, chevron-shaped over axis; glabellar node just behind S2; basal lobes large, triangular, extending well forward. Pygidium with wide, straight-sided axis finishing well forward of border furrow; first axial ring of two lateral lobes; second axial ring with high-rounded median node descending forward to articulating furrow and dividing first ring; cheek areas weakly scrobiculate; border flat but not wide, with pair of marginal spines posterior of widest point.

#### REMARKS

Generic assignment is made using the diagnosis of Ludvigsen et al. (1989) wherein the only point of possible disagreement could be the indication that the pygidial axis extends close to the posterior border furrow. In this Tasmanian species the axis does not appear to extend as far posteriorly (Fig. 3I) as in cogeners. Variation in this feature is evident in other species.

The Tasmanian cephalon is virtually indistinguishable from that of *L. americanus* (cf. Rasctti, 1944, pl. 36, fig. 1; Ludvigsen et al. 1989, pl. 1, fig. 25—upper right). Anterior glabellar shape and strongly divided posterior glabellar lobe are distinctive. However, the pygidium of that North American species has a wide border constricted acrolobes, axis reaching close to border furrow and differently shaped first and second pygidial axial rings and tubercle thereon. In this last feature, the furrow between the first and second pygidial axial rings is usually transverse and continuous in previously described species of the genus but in *L. americanus* as in our Tasmanian species (Ludvigsen et al. 1989, pl. 1, fig. 15; Rasctti, 1944, pl. 36, fig. 2) the tubercle interrupts that furrow, extending over the length of 2 segments. Nevertheless, shape of the lateral parts of the first ring and shape of the tubercle distinguish these 2 species. *Lotagnostus* sp. of Palmer (1968, pl. 12, figs 3, 4) has a pygidium almost identical with the Tasmanian (axial ring is longer, axis narrower, border narrower) but the associated cephalon is distinct (non-scrobiculate, wide border furrow, poorly divided posterior glabellar lobe, posteriorly placed glabellar node).

*Acmarrhachis* Resser, 1938

#### TYPE SPECIES

*Acmarrhachis typicalis* Resser, 1938, from the

Dresbachian of Alabama, by original designation.

*Acmarrhachis* ? sp.  
(Fig. 2A,B)

#### MATERIAL

GST14355 from Loc. 1

#### DISCUSSION

This specimen is too poorly preserved for taxonomic treatment but it is assigned to *Acmarrhachis* on the basis of glabellar shape with broadly rounded anterior and long anterior lobe, on lack of preglabellar median furrow and on shape of the pygidial axis which reaches to the posterior border furrow. This may be slim evidence but Shergold (1980) showed that the genus ranges higher into the Late Cambrian in Australia and the features outlined are sufficient for tentative assignment of this poor specimen.

*Micragnostus* Howell, 1935

#### TYPE SPECIES

*Agnostus clavus* Lake, 1906 from the Tremadocian of Wales, by original designation.

*Micragnostus* sp. cf. *M. intermedius*  
(Palmer, 1968)  
(Fig. 2G–I, K(right only))

#### MATERIAL

Three cranidia GST14359-14361 and one pygidium, GST14366 all from Loc. 1.

#### DISCUSSION

These cephalons are tiny and the pygidium is only a little larger. It is, therefore, difficult to compare them with material of the long-ranging *M. intermedius* (assigned to *Micragnostus* by Fortey (1980:21)) from Alaska (Palmer, 1968), Mexico (Robison and Pantoja-Alor, 1968) and Newfoundland (Ludvigsen et al., 1989). However, the pygidium is distinctive with its axis finishing well forward of the border furrow, and markedly narrow border for the genus or for agnostoids of this age. The latter feature in particular, is distinctive of *M. intermedius* among its contemporaries, but is shared with Tremadocian forms described by Fortey (1980, pl. 1). The cranidia are less distinctive but comparison with the smaller cranidia from Mexico (Robison and Pantoja-Alor, 1968, pl. 97, figs 4, 5) shows the anteriorly tapering glabella with well rounded

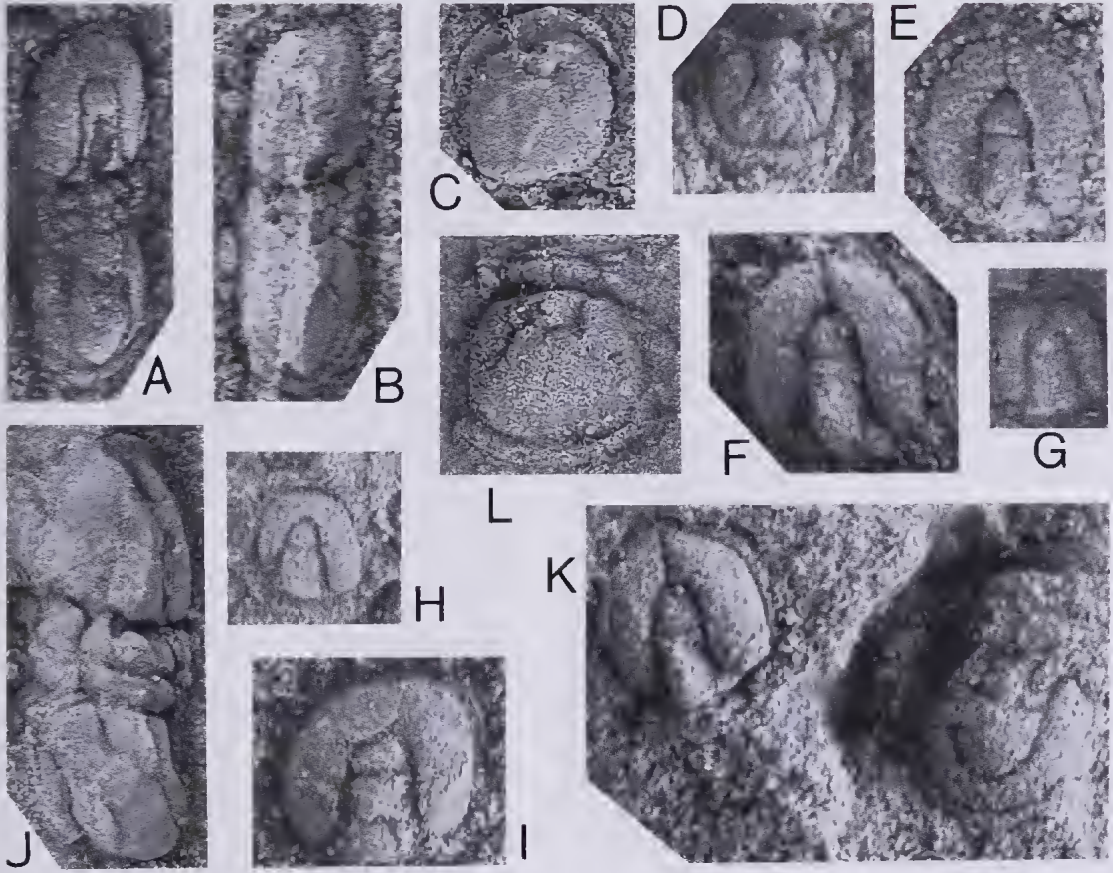


FIG. 2. All from Loc. 1 except L from Loc. 5. A, B, *Acmarrhachis?* sp. internal mould and latex cast, respectively, of complete specimen GST14355, x8. C, Effaced pseudagnostid GST14356, x7. D-F, K (left), *Rhaptagnostus mji* sp. nov. D, internal mould of small pygidium GST14357, x14. E, F, latex cast and internal mould of small cephalon GST14358, x14. K (left), internal mould of small cephalon GST14365, x14. G-I, K (right), *Micragnostus* sp. cf. *M. intermedius* (Palmer, 1968). G-I, internal moulds of small cephalons GST14359-14361, x15, x15, and x11, respectively. K (right), internal mould of pygidium GST14366, x14. J, Pseudagnostid indet. internal mould of complete deformed specimen GST14362, x6. L, Pseudagnostid indet. GST14363, x5.

anterior, narrow border, and short but distinct basal lobes to be shared by both sets of material. Identification with this American species is necessarily tentative because cranidia of comparable size to the larger American specimens are not available from Tasmania as yet and because the Tasmanian specimens are all internal moulds and therefore may prove to have different external morphology.

Family DIPLAGNOSTIDAE Whitehouse, 1936

Subfamily PSEUDAGNOSTINAE  
Whitehouse, 1936

*Neoagnostus* Kobayashi, 1955

#### TYPE SPECIES

*Neoagnostus aspidoides* Kobayashi, 1955  
from British Columbia, by original designation.

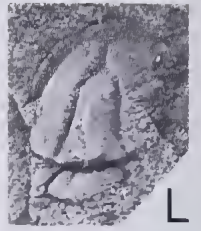
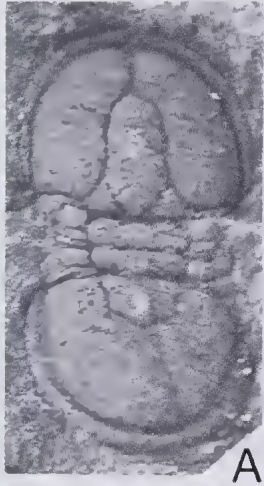
*Neoagnostus clavus* (Shergold, 1972)  
(Fig. 3M)

#### MATERIAL

GST14379, cephalon with first thoracic segment articulated from Loc. 8.

#### DISCUSSION

This cephalon resembles the western Queensland paratype figured by Shergold (1977, pl. 16, fig. 14), particularly in outline, glabellar lobes and node arrangement, and waisted glabel-

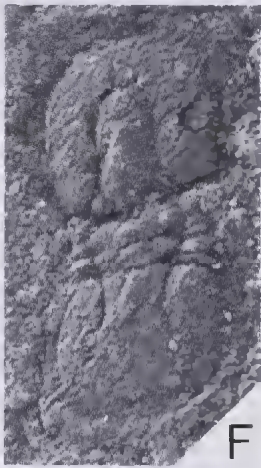


A

B

J

L



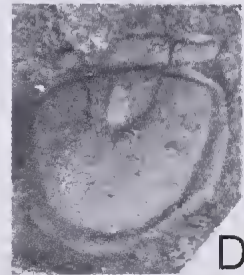
M

N

C

F

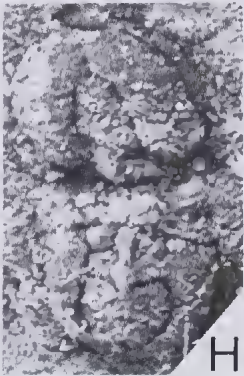
K



G

D

E



H

I

O

la. Only the preglabellar median furrow on the Tasmanian specimen could be used to distinguish it from the Queensland species but that is not sufficient in view of the other close similarities exhibited. This Tasmanian specimen has been tectonically compressed in the transverse direction so the glabella, border furrow (laterally) and basal lobes appear narrower than in the undistorted Queensland specimens but the specific identity is not in doubt, although a pygidium will be necessary to make certain identification.

### *Pseudagnostus* Jaekel, 1909

#### TYPE SPECIES

*Agnostus cyclopyge* Tullberg, 1880 from the Late Cambrian of Sweden.

### *Pseudagnostus* sp. (Figs 4,5)

#### MATERIAL

GST14381–14388 from Loc. 2, GST14390–14401 from Loc. 3.

#### DISCUSSION

Agnostids are common in collections from Localities 2 and 3 but they are invariably distorted to some degree and cannot be identified with confidence because the parietal structures of the glabella, which are so important to taxonomy in this group cannot be observed. It is not even certain how many species are represented (e.g. are Fig. 5J,I,L with blunter glabellar anterior and effaced accessory furrows conspecific with the rest of the material?). They are apparently spectaculate agnostids, with a well-impressed preglabellar median furrow, wide deliquiate border furrows, subquadrate pygidium, accessory furrows in most specimens, accessory furrows not reaching border furrow, marginal spines situated posteriorly level with or behind the rear of the acrolobe. These features are consistent with the morphology of *Pseudag-*

*nostus idalis* Öpik, 1967 but we are reluctant to suggest such an assignment on the available material. Further discussion of these specimens seems fruitless because the features of the glabella are uncertain.

### *Pseudagnostus* (*Sulcatagnostus*) sp. (Fig. 3J,K)

#### MATERIAL

GST14376, 14377 from Loc. 7.

#### DISCUSSION

The internal mould of a whole specimen is laterally compressed and damaged in some parts. Likewise the cranidium (Fig. 3K) is strongly distorted. Therefore, features of the subgenus are the scrobiculate cranidium, long straight-sided glabella with poorly impressed transverse furrow, well impressed preglabellar median furrow, small triangular basal lobes, truncated glabellar rear, elongate pygidial medial node, accessory furrows not meeting posteriorly, wide border furrow, and distinct marginal spines.

Features not fully in accord with *Ps.* (*Sulcatagnostus*) are the apparent lack (it is not clear if the border is entire at this point and the mid posterior spine might be an external feature anyway) of the third pygidial (mid posterior) spine and posterior position of marginal spines. *Ps.* (*Sulcatagnostus*) *rugosus* Ergaliev, 1980 also lacks the third pygidial marginal spine. As Shergold (1977) pointed out this form is closely allied to the *Ps. cyclopyge* Group of *Pseudagnostus* and Ergaliev's Kazakh species and this Tasmanian form could well belong to *Ps. idalis* if the mid posterior spine is considered subgenerically critical. However, the scrobiculate cranidium seems a distinctive feature of these 3 forms giving a basis for distinction.

### *Rhaptagnostus* Whitehouse, 1936

#### TYPE SPECIES

*Agnostus cyclopygeformis* Sun, 1924 from the

FIG. 3. A–F, *Rhaptagnostus mji* sp. nov. from Loc. 9. A,B, internal moulds of complete specimens (A is holotype) GST14367, 14368, x8 and x5, respectively. C, latex cast of complete specimen GST14369, x9. D,E, internal moulds of pygidia GST14370, 14371, x9. F, latex cast of small complete specimen GST14372, x12. G–I, *Lotagnostus tullahensis* sp. nov. from Loc. 9. G,H, latex casts of small complete specimens GST14373, 14374, x12. I, latex cast of larger articulated holotype GST14375, x10. J,K, *Pseudagnostus* (*Sulcatagnostus*) sp. from Loc. 7. J, internal mould of cranidium GST14376, x9. K, internal mould of articulated specimen GST14377, x9. L, *Pseudagnostus* indet. internal mould of cranidium and first thoracic segment from Loc. 7, GST14378, x5. M, *Neoagnostus clavus* Shergold internal mould of cephalon and first thoracic segment from Loc. 8, GST14379, x8. N,O, *Rhaptagnostus convergens* Palmer, latex cast and internal mould of articulated specimen from Loc. 8, GST14380, x7.

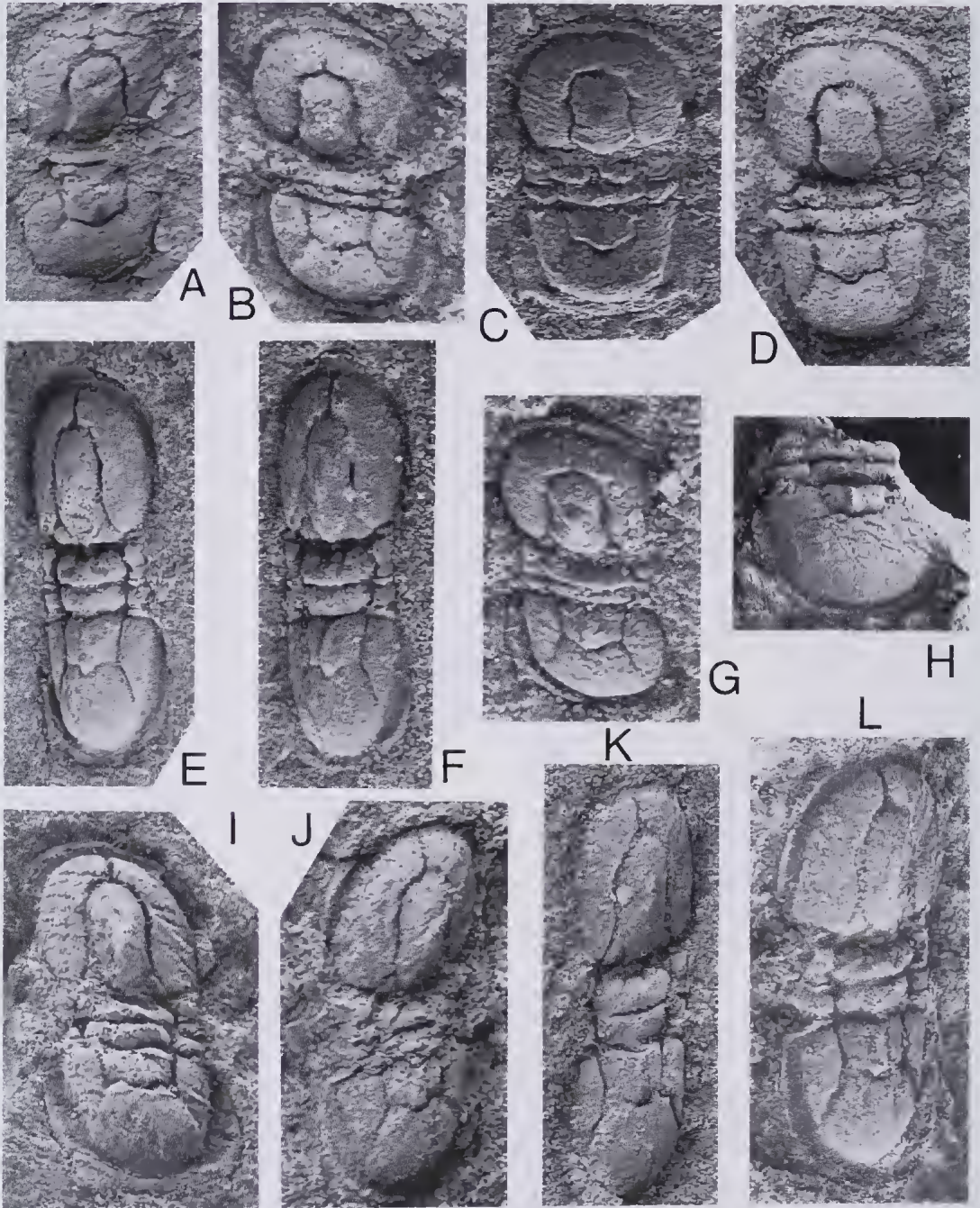


FIG. 4. *Pseudagnostus* sp. from Loc. 2. A, latex cast of articulated specimen GST14381, x8. B, G, internal mould and latex cast of articulated specimen GST14382, x10. C, D, latex cast and internal mould of articulated specimen GST14383, x10. E, F, internal mould and latex cast of articulated specimen GST14384, x10. H, internal mould of pygidium GST14385, x5. I, J, internal moulds of articulated specimens GST14386 and 14387, x6 and x8, respectively. K, L, latex cast and internal mould of articulated specimen GST14388, x6.

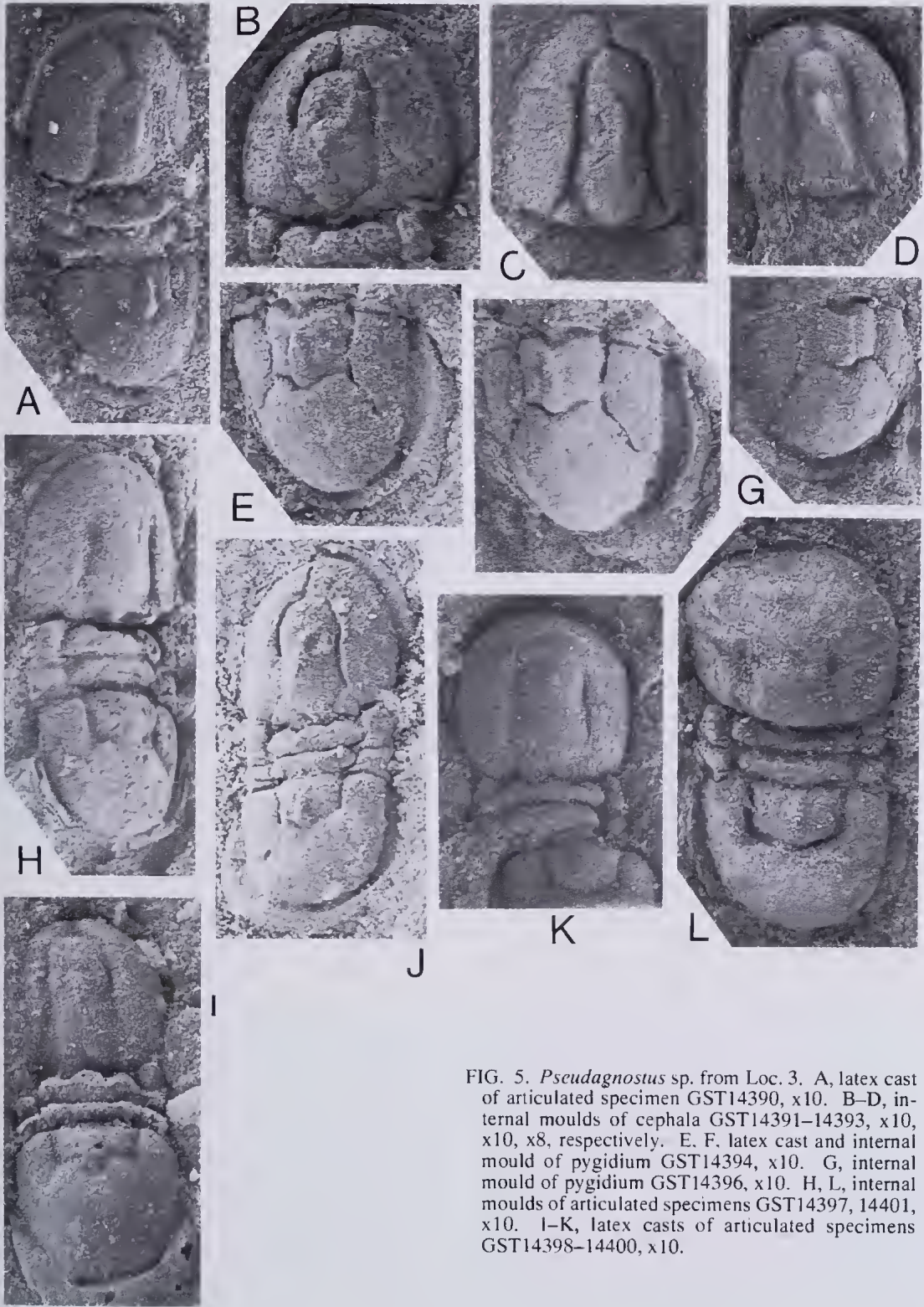


FIG. 5. *Pseudagnostus* sp. from Loc. 3. A, latex cast of articulated specimen GST14390, x10. B-D, internal moulds of cephalae GST14391-14393, x10, x8, respectively. E, F, latex cast and internal mould of pygidium GST14394, x10. G, internal mould of pygidium GST14396, x10. H, L, internal moulds of articulated specimens GST14397, 14401, x10. I-K, latex casts of articulated specimens GST14398-14400, x10.

Kaolishan Formation, Shandong by original designation.

**Rhaptagnostus mji** sp. nov.  
(Figs 2D–F, K(left), 3A–F)

ETYMOLOGY

For M.J. Clarke, Geological Survey of Tasmania, who facilitated completion of this paper.

MATERIAL

Holotype GST14367 (Fig.3A) from Loc. 9. Paratypes GST14357, 14358, 14365 from Loc. 1 and GST14368–14372 from Loc. 9.

DIAGNOSIS

Glabella relatively narrow, short, anteriorly rounded, with angular posterior, with short anterior lobe isolated by transverse transglabellar furrow, with small anterolateral lobes separated by the elongate glabellar node and bounded posteroaxially by almost straight furrows running to the glabellar node. Basal lobes short, triangular. Borders narrow throughout (proportionally wider in juvenile pygidia), with pair of posterior marginal spines decreasing in size to almost nothing in largest specimens. Preglabellar median furrow and axial furrow well-impressed. Accessory furrows not impressed on pygidium, but terminal pygidial node present. Pygidial axis not segmented, with long prominent node extending almost to the articulating furrow and giving axis pentagonal shape as it extends posteriorly slightly beyond the extend of the axial furrows.

GROWTH

Several small (cephala about 0.7–0.9mm and a pygidium 0.5mm long) from Loc. 1 and a complete specimen 3.7mm long (Fig.3F) are referred to this species based on comparison with the growth series recorded for the related *Pseudagnostus communis* by Palmer (1955). Changes with growth are 1, the posterior border of the pygidium becomes progressively shorter; 2, the pygidial marginal spines become less and less prominent and their position becomes more and more anterior relative to the posterior of the acrolobe; 3, the accessory furrows on the pygidium are incomplete on the small specimens but disappear altogether with growth; 4, the glabella is straight-sided in the small specimens but develops slight bulges around the anterolateral lobes with growth; the anterior lobe becomes proportionally shorter with growth

DISCUSSION

Generic assignment is based on the position of the glabellar node between the anterolateral lobes, the loss of accessory lobes in the pygidium and pygidial shape with tiny marginal spines well forward. There is distinct similarity with *Pseudagnostus communis*, particularly in the narrow border throughout, glabellar shape, and pygidial shape (Rasetti, 1961, pl.23, figs 15–17) with only a marginal difference in position of the glabellar node and remnant accessory furrows to separate them. The latter feature disappears with growth in the Tasmanian species but may still be a species discriminator. Separation from *R. leitchi* Webby et al., 1988 is difficult due to that species being sheared on the bedding plane. However, in the Tasmanian species the border is narrower and the anterior glabellar furrow is more transverse. It should be noted in passing that the 'raised, median axial bar' described by Webby et al. (1988:914), in the articulating furrow of the first thoracic segment is in fact the flange around the cephalothoracic aperture (Shergold et al., 1990, figs 3,4). *R. gunnari* Ludvigsen and Westrop in Ludvigsen et al., 1989 is a more effaced form with wider border furrows and pygidial border. *R. obsoletus* Lermontova, 1951 *R. bifax* Shergold, 1975 and *R. papilio* Shergold, 1972 are all effaced or semi-effaced.

**Rhaptagnostus convergens** (Palmer, 1955)  
(Fig. 3N,O)

MATERIAL

GST14380, a complete specimen from Loc. 8.

DISCUSSION

Tectonic deformation has shortened and distorted the axial furrow so that glabellar shape is difficult to determine with certainty. Nevertheless, it definitely has a broad subangular anterior and lateral bulges at the anterolateral lobes with the glabellar node between the posterior half of the anterolateral lobes. These features align it closely with *R. convergens* (Palmer, 1955) and adding the shape of the pygidium (which seems far less distorted than the cephalon), tiny marginal spines, narrow borders throughout, and pygidial axial expression including the posterior projection of the elongate node intruding on the ring furrow and the definition of the first ring furrow at the anterior of the median node there are many points of close similarity with *R. convergens*. As there are no distinguishing features evident on the Tasmanian specimen we are



forced to make this specific assignment but we understand that future collecting may necessitate revision of this identification if degree of impression of axial and preglabellar furrows becomes specifically important. In our opinion these features are not specifically important and may vary due to postdepositional history also. The impression as to their depth given by photographs may be misleading due to different lighting arrangements. For example the type cephalon as presented by Palmer (1955, pl.19, fig.14) was photographed with very low angle light as witnessed by the deep shadow on the right of the specimen; in that lighting the furrows seem extremely shallow, while in Shergold, 1977 (pl.16, fig.1) vertical lighting suggests deeper axial and preglabellar furrows. The only feature that appears different is the size of the basal lobes, but it is not clear on the Tasmanian specimen just how much of the posterior of the cephalon is curved down into the junction between it and the thorax. We suggest that the posterior of the glabellar and the basal lobes are not fully exposed in our specimen.

***Pseudagnostids* indet.**  
(Figs 2C,J,L, 3L)

**MATERIAL**

GST14356 and 14362 from Loc. 1, GST14363 from Loc. 5, and GST14378 from Loc. 7.

**DISCUSSION**

These unidentifiable specimens are recorded because 1, GST14356 is the only effaced agnostoid among these collections and since effaced forms seem to dominate in contemporary platform carbonates of western Queensland (Shergold, 1972, 1975, 1980) it may prove significant that one specimen be recorded; 2, GST14362 is a whole specimen apparently with the accessory furrows of the pygidium fully enclosing the deuterolobe which is laterally bulbous towards the posterior; this feature is unknown in other agnostoids described herein; 3, GST14363 is the only agnostid in the collection from Locality 5 and although it could be assigned to the species from Loc. 2 this identification is not certain on this specimen alone; and 4, GST14378 is the only pseudagnostid from Loc. 7 and could also belong to the same taxon as occurs at Loc. 3 but requires better material for assignment. None of these specimens is well enough preserved to be described taxonomically but their occurrence needs to be recorded.

Order POLYMERIA Jaekel, 1909  
Suborder ASAPHINA Salter, 1864  
Family CERATOPYGIDAE Linnarsson, 1869  
Subfamily PROCERATOPYGINAE  
Wallerius, 1895

**Proceratopyge** Wallerius, 1895

**TYPE SPECIES**

*Proceratopyge conifrons* Wallerius, 1895.

**Proceratopyge** sp. cf. *P. gordonensis* Jago,  
1987  
(Fig. 6)

*Proceratopyge gordonensis* Jago, 1987:222, pl. 26,  
figs 1-10; pl. 27, figs 1-8.

**MATERIAL**

Holotype UTGD88350a. Other material of this study GST14403, 14406, 14407 from Loc. 1, GST14408 from Loc 5, GST14404 from Loc. 7, GST14405 from Loc. 8, and GST14402 from Loc 9.

**DISCUSSION**

Jago (1987) described and discussed this species in considerable detail. Our specimens are tectonically deformed with considerable shortening (Fig.6B) in some and elongation (Fig.6D) in others. After accounting for this deformation the only distinction that could be drawn may be in the greater divergence of the anterior limbs of the facial suture, longer preglabellar length and more rounded glabellar anterior (in elongate specimens) in our material. These features are not sufficient for specific separation but at this stage the assignment is considered tentative until an objective assessment of all the species of *Proceratopyge* is carried out. The internal mould of a complete specimen (Fig. 6A) shows the median suture and numerous terrace lines on the doublure, which features were not evident on Jago's illustrations.

Subfamily IWAYASPIDINAE Kobayashi,  
1962

**Cermatops** Shergold, 1980

**TYPE SPECIES**

*Cermatops vieta* Shergold (1980, p.87, pl.34,  
figs 3-11).

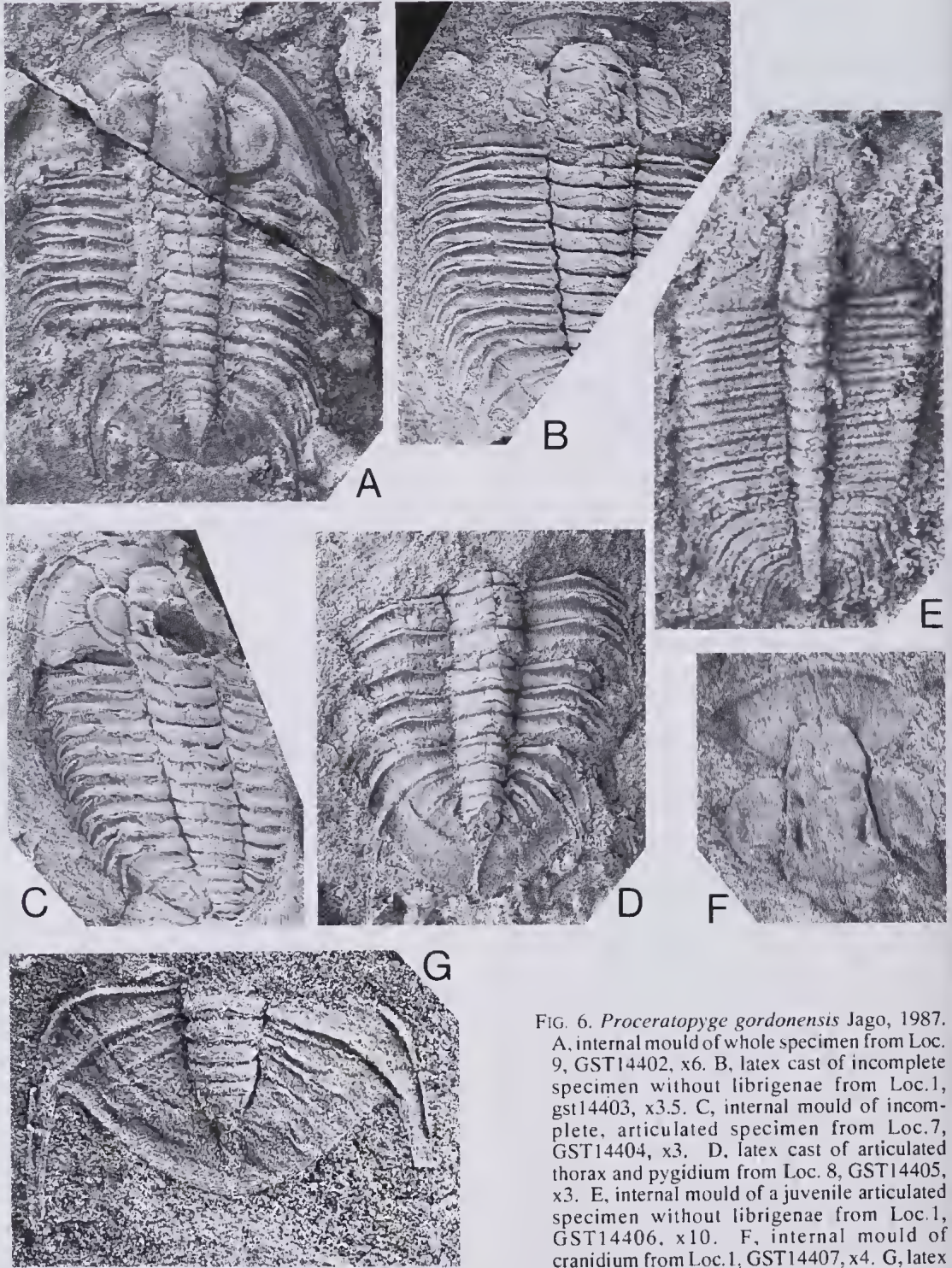


FIG. 6. *Proceratopyge gordonensis* Jago, 1987. A, internal mould of whole specimen from Loc. 9, GST14402, x6. B, latex cast of incomplete specimen without librigenae from Loc.1, gst14403, x3.5. C, internal mould of incomplete, articulated specimen from Loc.7, GST14404, x3. D, latex cast of articulated thorax and pygidium from Loc. 8, GST14405, x3. E, internal mould of a juvenile articulated specimen without librigenae from Loc.1, GST14406, x10. F, internal mould of cranium from Loc.1, GST14407, x4. G, latex cast of pygidium from Loc. 5, GST14408, x5.

*Cermatops thalasta* sp. nov.  
(Fig. 7)

ETYMOLOGY

Greek *thalao*, bruise, crush.

MATERIAL

Holotype GST14412 from Loc. 4. Paratypes GST14413–14416, 14418 from Loc. 4, GST 14417 from Loc. 8 and GST14409–14411 from Loc. 9.

DIAGNOSIS

Glabella tapering forward; anterior margin evenly curved except for a slight medial projection and suggestion of narrow plectrum; frontal area long and concave; anterior limbs of facial suture diverging strongly forward; librigena with doublure more than half width, with median suture in doublure, and with short stout genal spine. Thorax of 10 segments. Pygidium with rounded anterolateral corners; propleural band extremely short and truncated laterally at or just beyond paradoublural line; doublural width c. 0.3 of pygidial width.

DESCRIPTION

Large (2 cm cranial length, 2.5 cm pygidial length), smooth species of low convexity, with distinct furrows. Glabella tapering forward to rounded anterior, with crescentic almost exsagittal S1 (typically ceratopygid) and more anterior furrows unavailable. Occipital furrow shallow medially, with short deeper crescentic depressions laterally but isolated from axial furrow. Frontal area 0.25 cephalic length, concave; border not distinctly separated but a short marginal piece upturned, with small medial projection in margin and weak medial ridge running back to glabella. Palpebral lobe 1/2 cephalic length, flat, projecting strongly, and well rounded laterally. Posterolateral limb long, wide, with shallow border furrow near posterior margin. Facial suture with anterior section diverging forward at c. 45°–60° to exsagittal line, widest point close to margin, in middle section running in a broadly rounded curve (convex adaxially), interrupted only by the prominent palpebral lobe, leaving a narrow fixed cheek in the middle 1/3 of glabella.

Librigena with paradoublural line about halfway between eye and margin in transverse line through centre of eye; eye socle low; lateral margin weakly upturned but border not defined; genal spine stout, c. 1/2 length of cheek; doublure wide; sagittal medial suture anteriorly.

Thorax of 10 segments (Fig. 7J) smaller specimen with 9 segments (Fig. 7K) interpreted as last meraspid. Pleural furrows well-impressed, running from anterior at axial furrow to midlength and deepening in articulating line, then shallowing on free pleura; pleural tips with retral curve, becoming more so on more posterior segments.

Pygidium semicircular except for well-rounded anterolateral corners; axis of 6 rings plus terminus, reaching just above border furrow, barely tapering, with rounded posterior indistinctly extended posteriorly in lower decreasing ridge. Pleural areas with well-impressed pleural and interpleural furrows proximally; propleural band extremely short and fading out at paradoublural line so that only ridge of the postpleural band extends out towards the margin. Border furrow broad, indistinct as concave trough. Doublure wide, 1/2 pleural width, with close spaced comarginal terrace lines.

REMARKS

This species is known from a few fragmentary specimens, severely distorted by tectonism but the available features are enough to identify a new species. Generic assignment is based to large extent on the pygidium where comparison with *C. vieta* is extremely close. Only the greater taper of the axis and fewer axial rings distinguish that Queensland species. In the cephalon, the Tasmanian glabella is more rounded anteriorly, the course of the facial suture is different, the anterior margin has a slight forward projection, glabellar furrows are better impressed and the free cheek has a wider doublure and less prominent border furrow.

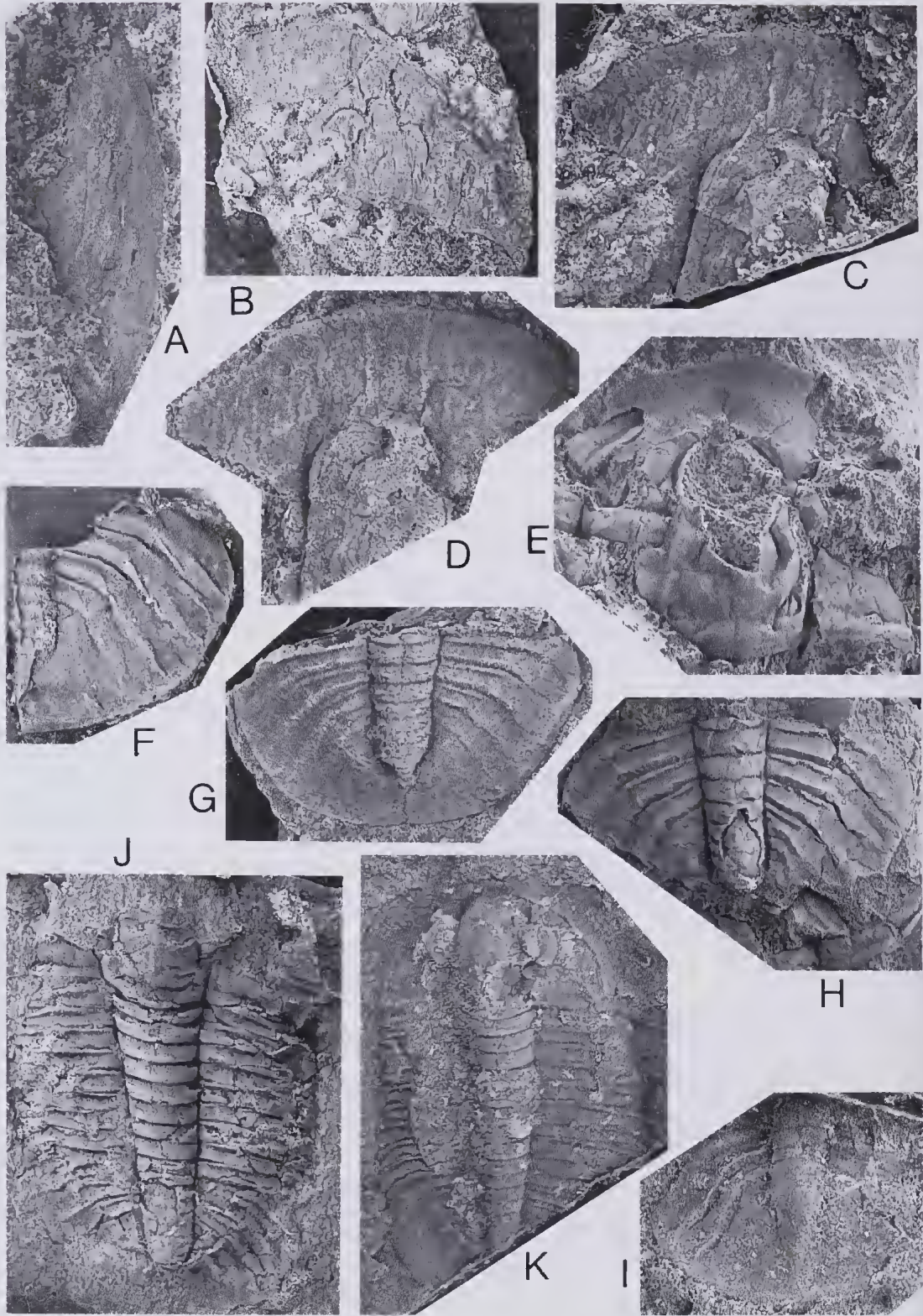
*C. discoidalis* (Salter, 1866) (Hughes & Rushton, 1990) is distinguished from the new species by the squared glabellar anterior (although a rounded anterior is possible (e.g. Hughes & Rushton, 1990, pl. 1, fig. 9) through tectonic distortion), larger palpebral lobes, short genal spine, and excavated posterior pygidial margin.

The two articulated thoraxes (Fig. 7J, K) with this type of pygidium, and with a ceratopygid cephalon, are assigned to this species on the pygidia but they do serve to confirm association of head and tail suggested by Shergold (1980) and Hughes & Rushton (1990) for this genus.

*Asiocephalus* Palmer, 1968

TYPE SPECIES

*Asiocephalus indigator* Palmer, 1968 from



Franeonian strata in the Hillard Peak area of east central Alaska.

#### REMARKS

Although Apollonov and Chugaeva (1983) considered *Asiocephalus* a subgenus of *Hedinaspis* Troedsson, 1951 we consider them generically separate, in light of new information from the Tasmanian species and in particular because of the larger pygidium with 5 or more axial rings.

Discovery of this species, which also occurs in Kazakhstan in older strata than other *Asiocephalus* or *Hedinaspis* indicates a possible intermediate between the Iwayspidinae (e.g. *Cermatops*) and the *Hedinaspis* group, particularly in development of thoracic and pleural features. This lineage involves increasing numbers of thoracic segments and decreasing number of pygidial segments as well as specialization of thoracic segments. All of the changes are possible through *A. latosuggrundus*.

#### *Asiocephalus latosuggrundus* sp. nov. (Fig. 8)

*Hedinaspis (Asiocephalus) sulcata* Lisogar; Apollonov & Chugaeva, 1983:83, pl.10, figs 2,3.

#### ETYMOLOGY

Latin *latus*, broad and *suggrunda* eaves; referring to the wide pygidial doublure.

#### MATERIAL

Holotype GST14419 from Loc. 1. Paratype GST14420 from Loc. 2.

#### DIAGNOSIS

Cephalic doublure narrow laterally, expanded anteromedially to be as long as frontal area; distinct eye ridges oblique posteriorly away from axis, running to small kidney-shaped palpebral lobes. Cephalic surface (except glabella) caecate. Thorax of 13 segments; each segment with short propleural band and long postpleural band; pleural tips curved posteriorly, more so posteriorly. Pygidium semicircular; axis of 6

rings plus terminus; pleural bands as on thoracic segments; doublure wide (nearly 0.25 pygidial width at widest), with prominent eomarginal terrae lines.

#### DESCRIPTION

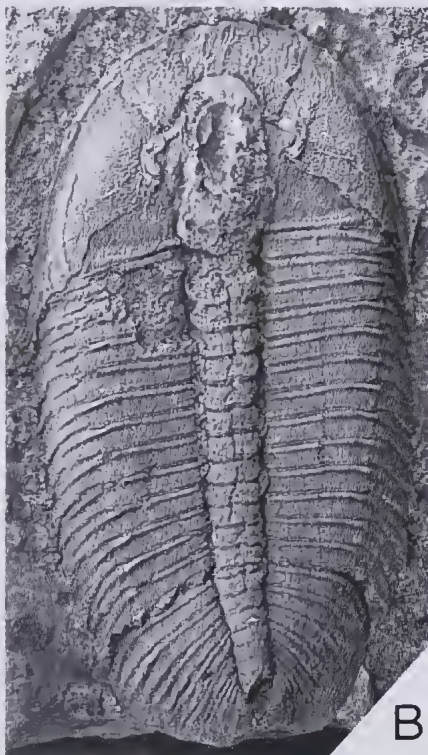
Subisopygous, gently convex. Cephalon semicircular, with prominent fine caecal network except on glabella: major caecum running posterolaterally from eye on librigena has distinct angle in it about halfway across genal field. Glabella subparallel sided, with rounded anterior; S1 crescent shaped, S2 almost continuous over axis but separated by high area bearing the preoccipital node; S0 with deep lateral depression isolated from the axial furrow. Frontal area long, gently concave, with faintest suggestion of a plectrum; border short, upturned, poorly defined. Palpebral lobe short, at level of S2 and S3, kidney-shaped, elevated, defined by well-impressed palpebral furrow, connected to glabella via distinct eye ridge sloping forward to axial furrow. Facial suture diverging forward in pre-ocular part, curving gently adaxially towards margin; in central portion running in a wide curve, except where interrupted by palpebral lobe, leaving narrow fixigena; postocular part running in sigmoidal curve to posterior margin anterior to a long wide posterolateral limb. Posterior border short, gently raised, uniform. Librigena with low eye socle, wide convex genal field and narrow border defined by shallow but distinct border furrow; genal spine c. 0.4 of cheek length to genal angle. Internal mould showing doublure on cephalon covered with prominent eomarginal terrae lines; anteriorly doublure expands in length to be as long as frontal area medially, indicating a median suture and presumably conterminant hypostome. Although the hypostome is preserved beneath the glabella it is dislodged posteriorly away from the glabellar anterior and the only comment possible is its length of 60% of cranial length.

Thorax of 13 segments; articulating halfring extremely short providing virtually no angle for enrollment. Pleurae with extremely short propleural band and extremely long gently rising

FIG. 7. *Cermatops thalastus* sp. nov. A–D from Loc. 9; E–I, K from Loc. 4; J from Loc. 8. A, internal mould of librigena, GST14409, x5. B, latex cast of large librigena with a thoracic segment preserved beneath and pressed through the exoskeleton GST14410, x2. C, D, latex cast and internal mould of anterior cranial fragment GST14411, x2.5. E, internal mould of damaged cranidium GST14412, x2. F, latex cast of pygidial fragment GST14413, x3. G, internal mould of pygidium GST14414, x3. H, internal mould of damaged pygidium GST14415, x2. I, latex cast of juvenile pygidium GST14416, x6. J, latex cast of incomplete articulated specimen GST14417, x4. K, latex cast of incomplete articulated specimen GST14418, x3.



A



B



C

FIG. 8. *Asioccephalus latusuggrundus* sp. nov. A,B, latex cast and internal mould of articulated specimen from Loc. 1, GST14419, x3. C, internal mould of articulated specimen without librigenae from Loc. 2, GST14420, x3.

postpleural band. A second transverse furrow runs along the posterior margin to the articulating line: pleural furrow deepest in articulating line close to anterior margin, then curving posteriorly on free pleura to posterior half of pleura and finishing at spinose retral termination; articulating facet not developed as anterior part of free pleura is raised and bears 4-6 fine but distinct ridges parallel to the anterior margin. Exsagittal terrace lines on doublure of free pleurae.

Pygidium semicircular, with axis of 6 rings plus terminus and low postaxial ridge running into posterior border furrow. Pleural area of 6-7 segments each with pleural, interpleural and posterior marginal furrows extending to paradoublural line then petering out distally before reaching margin. Anterolateral corner rounded, with small downsloping articulating facet. Border furrow wide and shallow; border narrow, poorly defined. Doublure wide, bearing prominent comarginal terrace lines.

#### REMARKS

The two articulated specimens are distorted in opposite directions so making it difficult to be certain of original dimensions.

Generic assignment is based on the large multi-segmented pygidium, along with cephalic features of the *Hedinaspis* Troedsson, 1951–*Asiocephalus* group. This is essentially the differential diagnosis given by Palmer (1968:83). The Alaskan type species is distinguished by its shorter wider frontal area, transverse eye ridges, well-impressed occipital furrow, more prominent preoccipital node and narrower pygidial doublure. *A. sulcata* Lisogor, 1970 is difficult to interpret because, two cranidia assigned there (Apollonov & Chugaeva, 1983, pl.10, figs 2,3) are identical with the Tasmanian species and are distinct from the cranidium of similar size figured earlier by Lisogor (1977, pl.30, fig.22) which represents *sulcata* as originally proposed (Lisogor, 1970). Therefore, we remove those two cranidia to our new species. The attitude of the eye ridges is distinctive in available material. Although adult pygidia associated with the known heads are not available we anticipate that they will have 6 or more axial rings and a wide doublure.

#### Family OLENIDAE Burmeister, 1843

#### *Olenus* Dalman, 1827

##### TYPE SPECIES

*Entomostracites gibbosus* Wahlenberg, 1821.

#### *Olenus apoxysomatus* sp. nov. (Fig. 9)

##### ETYMOLOGY

Greek *apoxys*, tapering; *somatos*, body; referring to strongly tapering thoracic pleurae (less spine) posteriorly through thorax.

##### MATERIAL

Holotype GST14427 from Loc. 1. Paratypes GST14421, 14423, 14425, 14428, from Loc. 1, and GST14422, 14424, 14426, 14429–14431 from Loc. 7.

##### DIAGNOSIS

Moderately sized palpebral lobe; genal spine continuous with lateral margin; inner spine angle right angled. Thoracic of 20 segments, with axial spines, with long pleural spines becoming gradually longer to about segment 12 corresponding to a narrowing of the pleurae. Pygidium extremely small, transverse.

##### DESCRIPTION

Largest available cranidium with basal glabellar width of 4 mm. Exoskeleton flat, except for raised convex axis and tall axial spines standing above it. Entire surface smooth.

Cranidium about as wide across palpebral lobes as long, gently convex but with anterior of glabella descending steeply. Glabella parallel sided to extremely gently tapering with bluntly rounded anterior. S1 deep, chevron shaped, not continuous across axis, at slightly lower angle to axial furrow than S2 which is more transverse, as wide as S1; S3 narrower, still more transverse, not reaching axial furrow. L0 of uniform length, with short geniculate median spine. Preglabellar field short (c. 20% of basal glabellar width); anterior border flat to gently convex near margin, strongly upturned, slightly elongate medially. Palpebral lobes of moderate length (c. 40% of basal glabellar width), elevated, kidney-shaped, convex, defined by shallow palpebral furrow situated only half glabellar width from glabella; eye ridge distinct, transverse, running laterally from axial furrow at level of S3. Preocular facial suture exsagittal, straight to gently convex laterally, curving adaxially near border to traverse border at extremely low angle and cross the margin near the midline; postocular suture running posterolaterally at c. 45% in slight curve to define a large triangular posterolateral limb. Posterior border furrow deep and short; posterior border short, convex, with sinuous curve to posterior in articulating line (i.e. exsagittally behind the eye), then gentle curve forward distally.

Librigenae yoked, with low eye socle, wide genal field bearing well-developed caecal network; border furrow well-impressed just inside the inner edge of doublure; border narrow, flat to gently convex near margin, upturned; doublure with distinct terrace lines, elongate anteromedially over a glabellar width; genal spine slightly advanced, almost maintaining curve of margin, just directed a little laterally, 1.5 times length of rest of librigena, with border furrow extending a little way down dorsal surface of spine; angle between genal spine and posterior border 90–100°; facial suture reaching posterior margin a considerable distance from the genal spine.

Thorax of 20 segments; each axial ring with prominent geniculate median spine. Pleurae narrow, each about as wide as axis, becoming markedly narrower to posterior; pleural spine long, longer than pleura of same segment, becoming progressively longer back to about seg-

ment 12, then progressively shorter to posterior, emanating from propleural band; well-impressed pleural furrow near anterior of segment throughout, running onto base of the spine laterally. Articulating facet short, wide.

Pygidium tiny, transverse, with indistinctly segmented axis reaching posterior margin, no segmentation on pleurae, no border defined.

#### REMARKS

This species is most simply distinguished by the strong taper of the thorax of 20 segments. Perhaps most similar is *O. attenuatus* (Boeck) (Westergård, 1922, pl.4, figs 15-19, pl.5, figs 1-9) which has 15 or 16 thoracic segments, spinose pleural tips and almost identical cephalon but that species has a relatively large pygidium. *O. wahlenbergi* Westergård, 1922 is similarly distinguished.

Librigenae are interpreted as being yoked (Fig.9G) although one specimen (Fig.9E,F) suggests a median furrow. This is not the case though, because the fracture is to the right of the elongate part of the doublure indicating that it is not symmetrical.

#### *Chekiangaspis* Lu in Chien, 1961

#### TYPE SPECIES

*Chekiangaspis chekiangensis* Lu in Chien, 1961 from the Late Cambrian, Sandu Shale, Yangiawen, Guizhou.

#### REMARKS

Lu (in Chien, 1961) likened this genus to *Olenus* Dalman and *Leptoplastus* Angelin so it is difficult to understand why it was referred to the Agrauidae unless because of his comparison with *Acrocephalina*. However, that genus was originally and subsequently placed in the Solenopleuridae. We agree with the comparison with the olenid genera mentioned and also with *Parabolina*. It differs from these genera principally in containing forms with diverging preocular facial sutures curving strongly across border area (Lu & Lin, 1989). Distinctive features of *Chekiangaspis* are found in various

olenid species of Scandinavia, such as the long occipital spine in *Parabolina mobergi* Westergård, 1922, *P. megalops* Moberg & Moller, 1898 (Westergård, 1944); the advanced genal spine of most species of *Leptoplastus*; the excavated anterior margin as in *L. norvegicus* Holtedahl, 1910 or *L. ovatus* Angelin (Westergård, 1922, pl.8, fig.18); the triangular pygidium of many *Leptoplastus*; and the 12 thoracic segments of most of these olenid genera. However, no other olenid has the combination of features exhibited by *Chekiangaspis*. Assignment of the Tasmanian species extends its distribution considerably and although this species cannot be considered truly typical because it lacks the furrows running forward from anterolateral corners of glabella its correspondence in all other features makes this slight extension of the generic concept necessary.

#### *Chekiangaspis concavus* sp. nov.

(Fig. 10)

#### ETYMOLOGY

Latin *concavus*, arched concave; referring to anterior margin.

#### MATERIAL

Holotype GST14432; paratypes GST14433-14437 all from Loc. 5.

#### DIAGNOSIS

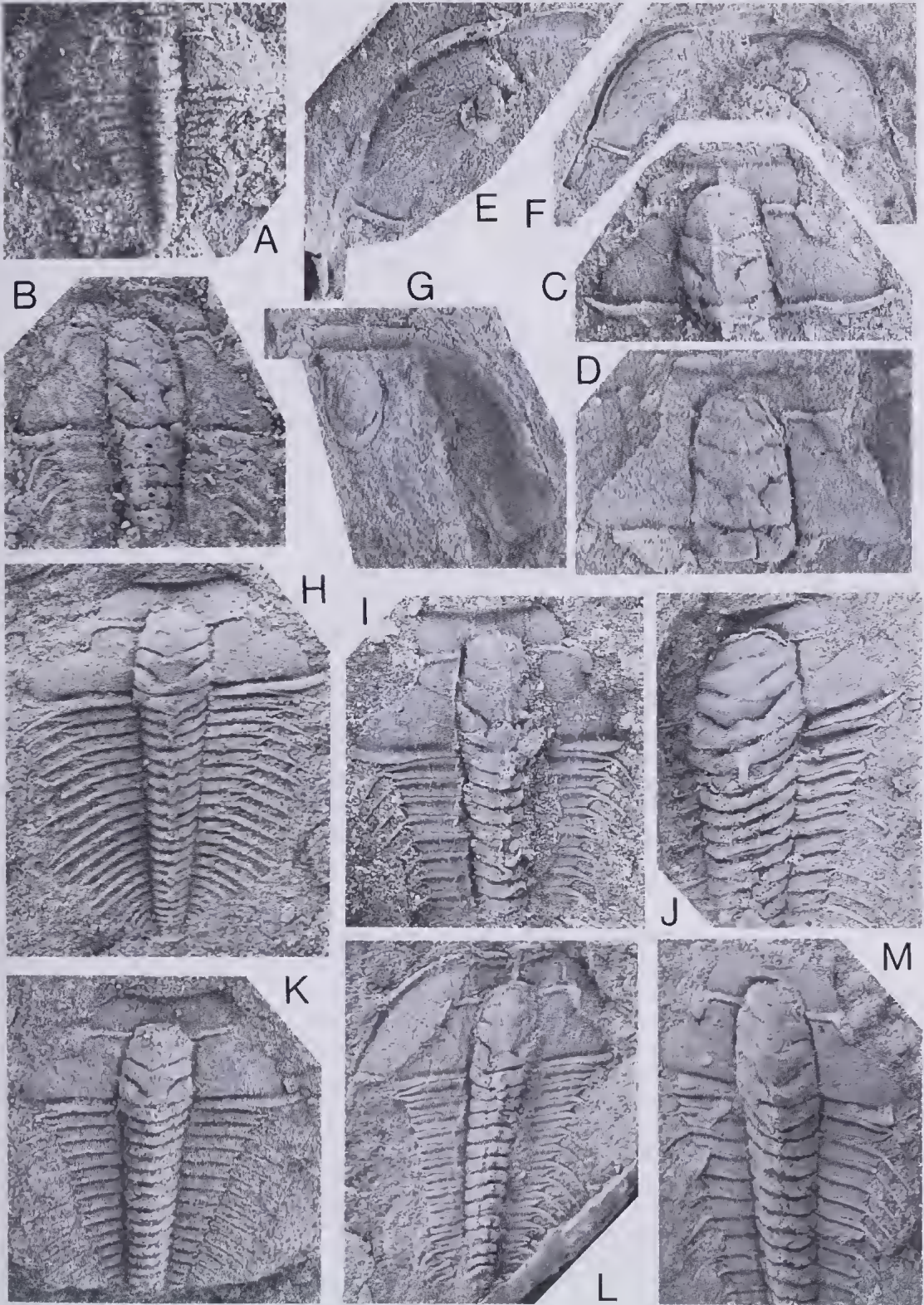
Pair of broad shallow depressions rather than distinct furrow running forward from anterolateral corners of glabella to anterior margin. Anterior margin of cephalon strongly concave, posterolateral limb wide and short. Short palpebral lobe opposite S2. Thorax of 12 segments, each with median tubercle and 8th segment bearing long subhorizontal spine extending well beyond posterior of pygidium; pleural tips truncated, nonspinose. Pygidium subtriangular, transverse, with 3 axial rings plus terminus that reaches close to posterior margin.

#### DESCRIPTION

Moderately sized, wide, strongly convex in

FIG. 9. *Olenus apoxysomatus* sp. nov. A, C, E, F, H, I, K from Loc. 1; B, D, G, J, L, M from Loc. 7. A, internal mould of articulated juvenile specimen GST14421, x10. B-D, latex casts of series of small cranidium of increasing size GST14422, 14423, 14424, x7, x6, x6, respectively. E, F, latex cast and internal mould of librigenae GST14425, x6 and x5, respectively. G, internal mould of hypostome and rostral plate and external mould of librigena GST14426, x8. H, K, latex cast and internal mould of articulated holotype without librigenae GST14427, x9. I, J, L, M, latex casts of articulated specimens GST14428-14431, x5, x5, x7, x4, respectively.





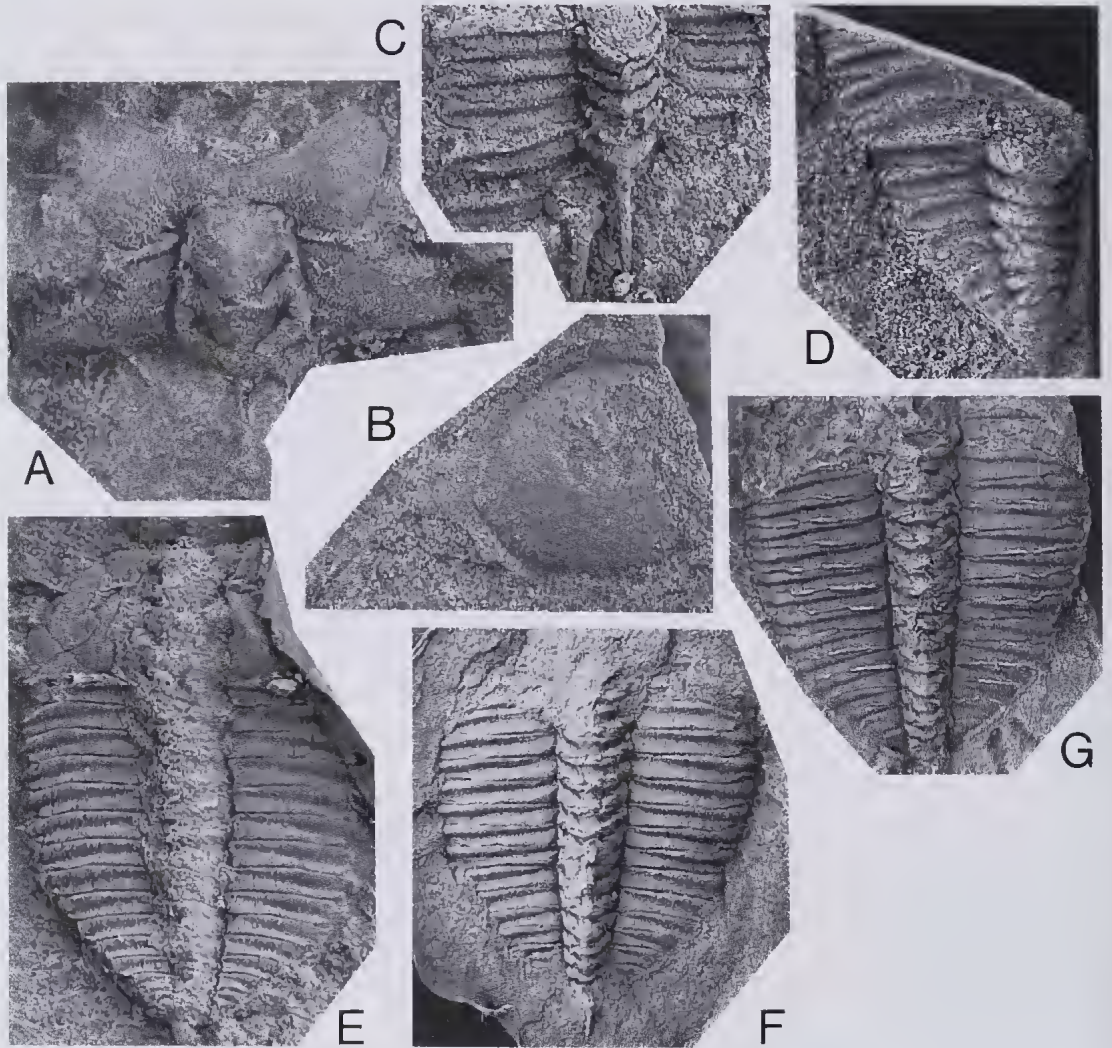


FIG. 10. *Chekiangaspis concavus* sp. nov. from Loc. 5. A, damaged internal mould of holotype cranium GST14432, x5. B, internal mould of damaged librigena GST14433, x5. C, latex cast of thoracic fragment GST14434, x6. D, internal cast of damaged pygidium and thoracic rear GST14435, x6. E, latex cast of damaged articulated specimen GST14436, x4. F, G, latex cast and internal mould of articulated thorax and pygidium GST14437, x3.

anterior profile; axis with near vertical median spine stands above gently convex pleural areas. Cranium wider across eyes than long. Glabella occupying large part of cranium, straight to gently convex sides tapering gently forward to truncated anterior, with subangular corners; 3 pairs of lateral furrow, all discontinuous across axis and S3 barely more than a pit isolated from axial furrow. S0 well-impressed, longer and

deeper laterally; occipital ring with long median spine more than half glabellar length. Frontal area 16-20% of cephalic length, with flat anteriorly descending preglabellar field leading to border furrow; border strongly upturned, longest medially; anterior margin concave, markedly so in one specimen (Fig. 10A). Palpebral lobe short, raised, oblique, opposite S2 on glabella; eye line distinct, leaving axial furrow

forward of S3, running obliquely back to palpebral lobe; interocular cheeks 1/3 basal glabellar width. Preocular parts of facial suture diverging forward, convex laterally, curving adaxially anteriorly in broad arc; postocular section of facial suture concave just behind eye then running laterally at low angle to transverse and swinging sharply to margin distally to isolate large, wide posterolateral limb. Posterior border furrow well-impressed, shallowing distally; posterior border short, transverse to articulating line behind eye then curving sinuously back and forward in broad curve to facial suture. Surface of frontal area and fixed cheek with caecal network. Librigena wide, with advanced stout genal spine tapering strongly and extending laterally to disturb curve of margin.

Thorax of 12 segments, of uniform width to about 8th segment then tapering back; axial rings with short halfring but long articulating furrow, with short vertical median spine on each of first 7 segments, large geniculate spine on 8th extending back well beyond rear of pygidium and prominent tubercle on succeeding segments. Pleurae wide, with only 12th pleura equal to width of axis, anterior and posterior margins parallel throughout but extremity of segments 1-8 swung forward. Pleural furrow sharply impressed, running diagonally across pleura. Articulating facet wide and short. Pleural tips truncated, together forming smooth lateral margin.

Pygidium transverse to elongate triangular, with 3 axial segments and terminus reaching posterior margin; pleural areas poorly segmented; border indistinct; doublure narrow.

#### REMARKS

This species is distinguished from *C. chekianensis* by its lack of distinct furrows forward from the glabella, more divergent preocular facial sutures and wider posterolateral limbs. The few specimens available make complete understanding uncertain but sufficient to make generic assignment and identify a new species.

### *Wujiajania* Lu & Lin, 1980

#### TYPE SPECIES

*Wujiajania expansa* Lu & Lin, 1980 from the Siyangshan Formation, late Changshanian - early Fengshanian, in western Zhejiang.

#### REMARKS

This genus was distinguished from *Wester-*

*gaardites* Troedsson, 1937 by its 16 rather than 19 thoracic segments, its narrower axis, and lack of marginal pygidial spines (Lu & Lin, 1989). The Tasmanian species fits with *Wujiajania* on these features except for the number of thoracic segments which is closer to *Wujiajania* than *Westergaardites*. In all respects, the Tasmanian *W. distorta* sp. nov. may be considered ancestral to *W. expansa* Lu & Lin, 1980 which in turn may be considered ancestral to *Westergaardites*. An ancestor for *W. distorta* is probably to be found within *Parabolina* where 12 thoracic segments is standard. This lineage may, therefore, be seen as being accompanied by an increase in number of thoracic segments. Cephalic features of the Tasmanian species are indistinguishable from those of *W. expansa* and so the diagnosis of *Wujiajania* is amended to include a range in the number of thoracic segments.

### *Wujiajania distorta* sp. nov.

(Figs 11, 12)

#### ETYMOLOGY

Latin *distorta*, misshapen, deformed; referring to the ubiquitous tectonic deformation.

#### MATERIAL

Holotype GST14442 from Loc. 9. Paratypes GST14440 from Loc. 2, GST14438, 14441, 14443, 14456 from Loc. 3, and GST14439, 14444-14455, 14457-14459 from Loc. 9.

#### DIAGNOSIS

Glabella wide, with convex lateral margins and broadly rounded anterior. Thorax of 13 segments. Pygidium transverse; axis of 3 rings plus terminus extending to gently excavated posterior margin.

#### DESCRIPTION

Exoskeleton gently convex in anterior view, up to 23 mm long in available sample, with smooth surface. Cranidium occupied mainly by large glabella. Glabella slightly wider than long; lateral margins convex (almost parallel-sided in some smaller specimens but this may be due to tectonic distortion), greatest width adjacent to lateral end of S2, with broadly rounded to truncated anterior at border furrow; S0 well-impressed, transverse or curving forward laterally, S1 and S2 slit-like, chevron-shaped, continuous across axis, S3 slit-like, parallel to S2 but isolated from axial furrow and extremely shallow across axis; L0 longer laterally than medially,

with prominent median tubercle. Anterior border uniformly short, upturned; anterior border furrow well-impressed. Prominent eye ridge running a short distance posterolaterally into short upturned curved palpebral lobe well-defined by palpebral furrow that extends axially behind eye line. Fixigena narrow anteriorly, widening behind palpebral lobe into triangular posterolateral limb. Facial suture diverging forward in short preocular section; postocular section running almost in a straight line posterolaterally at c.45° to exsagittal to posterior margin; posterior border angularly convex, with wide posterior facet beyond lateral articulating point which is less than the axial width away from axial furrow. Librigenae yoked by short doublure, with well-developed caecal network, low eye socle; border subrounded in section, with distinct comarginal terrace lines laterally; genal spine continuing lateral margin in exsagittal line, longer than cheek itself, with prominent longitudinal terrace lines dorsally and ventrally; narrow lateral and anterior doublure bearing terrace lines; facial suture meeting posterior margin well inside genal angle. Hypostome olenid, conterminent.

Thorax of 13 segments; axis extremely wide anteriorly, tapering strongly to posterior, with median spine on each segment situated near the anterior of ring and curving backwards as it rises; articulating halfring large, occupying half segmented length. Pleura with articulating line 1/3 pleural width from axial furrow; propleural band extremely short at axial furrow, longer at lateral articulating point then of uniform length behind long wide steeply sloping articulating facet, with posteriorly curving pleural spine; pleural furrow deeply impressed in articulating line in mid-length of segment, running to lateral margin just behind pleural spine; postpleural band long at axial furrow tapering strongly to articulating line then of uniform length to tip.

Pygidium transverse; axis of 3 rings plus terminus reaching posterior margin medially at small distinct excavation in margin; pleural and interpleural furrows impressed; border furrow poorly defined, not depressed, poorly defining narrow border; doublure of moderate width, nar-

rowing posteromedially, bearing distinct comarginal terrace lines; margin without spines.

#### REMARKS

This species is most simply distinguished from Chinese (Lu & Lin, 1989; Chien, 1961, Lin & Zhang in Zhu *et al.* 1979) by the number of thoracic segments. In the absence of articulated specimens, cranidia may be extremely difficult to separate if preserved in different matrix or if distorted after deposition. Only greater lateral inflation of the glabella and S4 in Chinese forms give a distinction but even these are not entirely reliable. Nevertheless, the number of thoracic segments, which is consistent through the 15 articulated Tasmanian individuals and through the available Chinese material is sufficient to distinguish species.

Family PTEROCEPHALIIDAE Kobayashi,  
1935

*Aphelaspis* Resser, 1935

#### TYPE SPECIES

*Aphelaspis walcotti* Resser, 1938.

#### DISCUSSION

Palmer (1960, 1962, 1965), Henderson (1976); Shergold (1982), Jell in Powell *et al.* (1982) and Jago (1987) have commented on this genus.

*Aphelaspis* sp.  
(Fig. 13A-E)

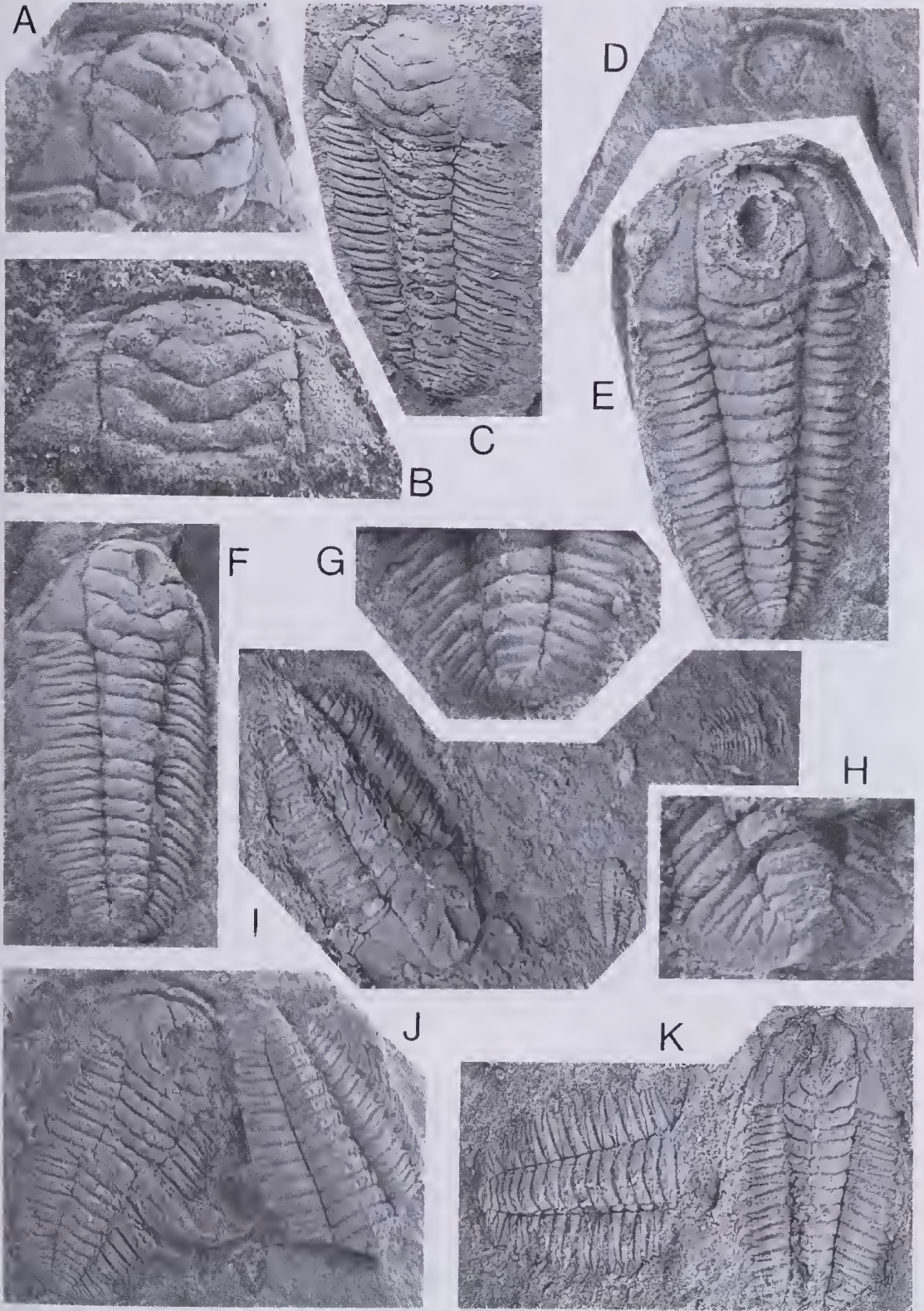
#### MATERIAL

GST14461, 14463 from Loc. 5, GST14461, 14462 from Loc. 9.

#### DESCRIPTION

Glabella with straight anteriorly converging sides, truncated anteriorly, angular anterolateral corners, without furrows. Preglabellar field convex, 15% of cranidial length. Anterior border, long, 19% of cranidial length, flat, tapering laterally. Palpebral lobes arcuate, long (30% of cephalic length), with their midlength opposite

FIG. 11. *Wujiajiania distortus* sp. nov. A, D, F from Loc. 3, B, E, G-K from Loc. 9. C from Loc. 2. A, B, internal moulds of cranidia GST14438 and 14439, x8. C, latex cast of articulated specimen GST14440, x3. D, latex cast of hypostome and ventral surface of rostral plate and genal spines GST14441, x10. E, internal mould of articulated holotype GST14442, x8. F, internal mould of articulated specimen GST14443, x6. G, internal mould of pygidium GST14444, x10. H, latex cast of pygidium GST14445, x10. I, latex cast of three articulated specimens of different sizes GST14446-14448, x3. J, internal mould of two articulated specimens GST14449 and 14450, x2.5. K, internal mould of two articulated specimens GST14451 and 14452, x2.



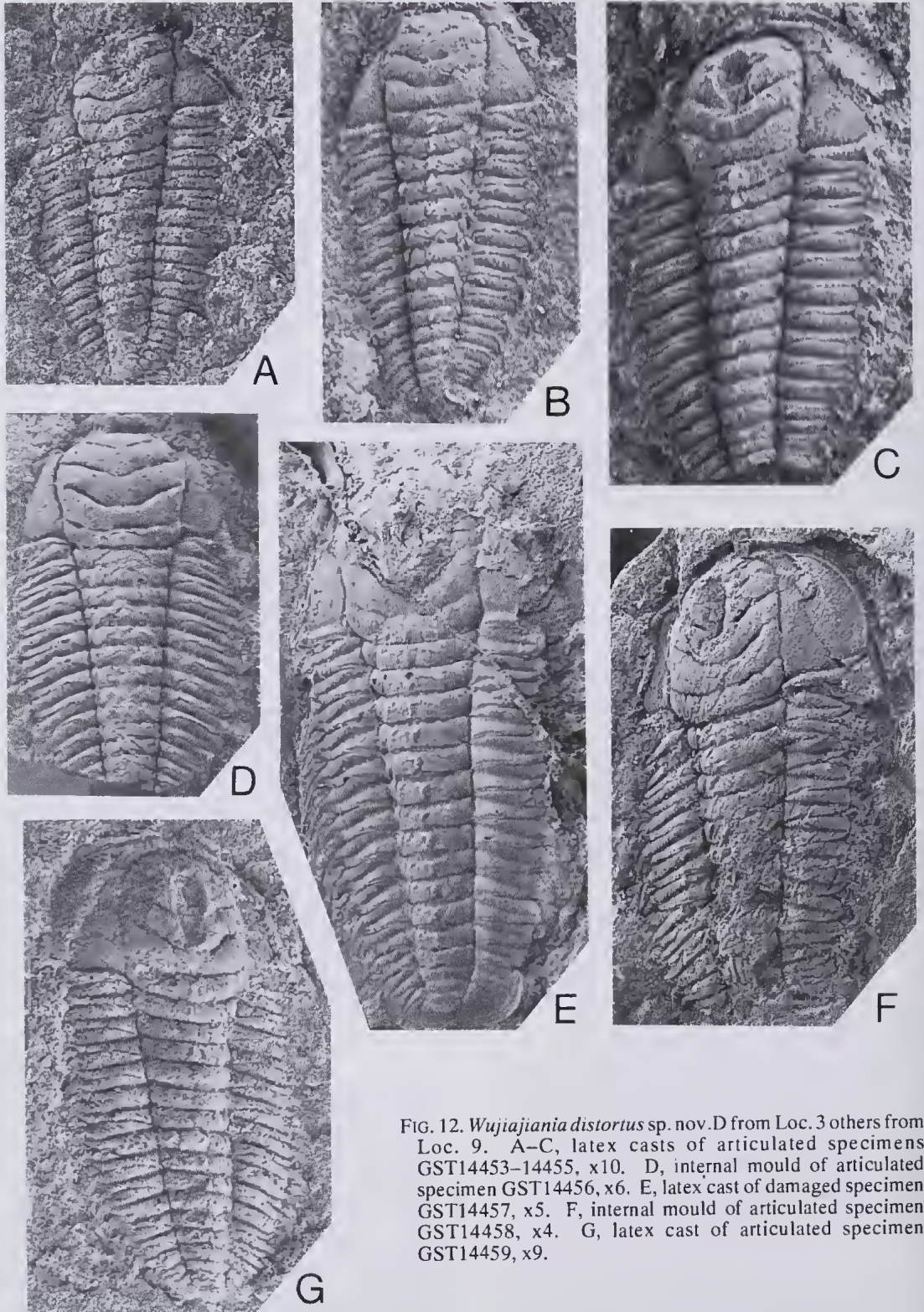


FIG. 12. *Wujajiania distortus* sp. nov. D from Loc. 3 others from Loc. 9. A–C, latex casts of articulated specimens GST14453–14455, x10. D, internal mould of articulated specimen GST14456, x6. E, latex cast of damaged specimen GST14457, x5. F, internal mould of articulated specimen GST14458, x4. G, latex cast of articulated specimen GST14459, x9.

midlength of glabella, flattened on top but raised above interocular cheek. Facial suture with preocular part diverging strongly forward to midlength of border where it turns in a sharp angle to run at extremely low angle to margin; postocular part parallel to posterior margin for most of its course.

Librigena with distinct eye socle, wide genal field, moderately wide convex doublure, strong genal spine curving adaxially.

Pygidium small, transverse, highly convex; axis of 3 rings plus terminus that reaches excavated posterior margin. Three inflated pleural bands descending to margin almost vertically; doublure convex, narrow, almost vertical. In posterior profile margin strongly upswept over sagittal line.

#### REMARKS

This rare species is not fully exhibited in available material but the unfurrowed, straight sided, tapering, truncated glabella, position and size of palpebral lobes and the anterior border are sufficient to allow generic assignment.

*Aphelaspis* has been identified in Australia as two named species *P. australis* Henderson, 1976 and *A. cantori* Jago, 1987. Jell (in Powell *et al.*, 1982) compared western NSW material to *A. australis* and Shergold (1982) referred 2 cranidia as well as shedding doubt on Opik's (1963) assignment of two cranidia to *Aphelaspis*. Each of these Australian taxa may be separated from the form described here by the long, flat, tapering anterior border of our specimens. It may be allied with North American species such as *A. haquei* Hall & Whitfield, 1877 (Palmer, 1965) but although that species could not be separated except on the pygidium, our available material is too poor to make specific assignment.

This taxon is similar to *Olentella* Ivshin, 1955 but at present no clear diagnoses exist to distinguish the two genera. *Olentella* occurs in Kazakhstan, northern Siberia and Antarctica (Shergold *et al.*, 1976) in late Idamean and post-Idamean strata. The long flat anterior border, relatively longer palpebral lobes and course of the facial suture forward of the eye are the features we use to apply the generic name. Unless satisfactory discrimination can be achieved between *Aphelaspis*, *Olentella* and several other similar genera there may be no point in maintaining the separate names now being employed without clear diagnosis of any of them. In our opinion the best comparisons are made with species currently assigned to *Aphelaspis* al-

though it is acknowledged that no species of that genus has a pygidium quite like the one attributed here. No species of *Olentella* has been attributed such a pygidium either but pygidia attributed to each of these genera are remarkably similar (cf. Palmer, 1965, pl.9, fig.21 and Shergold and Cooper, 1985, fig.6L).

Family CONOKEPHALINIDAE Hupé, 1953

#### Conocephalinidae indet. (Fig. 13G–J)

#### MATERIAL

GST14465–14469 from Loc. 9.

#### DESCRIPTION

Large cranidium (Fig. 13H). Glabella pyriform, anteriorly truncated at border furrow but with rounded anterolateral corners; S1 running a short distance from axial furrow before bifurcating into barely visible transverse anterior branch and deep posterior branch apparently reaching occipital furrow at high angle to transverse; S2 narrower, well-impressed, curving slightly backwards adaxially. Anterior border convex, elongate posteriorly in medial section. Palpebral lobe long (2/3 glabella) and narrow, convex, arcuate, situated close to glabella; palpebral furrow deep and broad; interocular cheek narrow, inflated. Preocular facial suture diverging forward from anterior of palpebral lobe just lateral to axial furrow, curving adaxially across anterior border and almost parallel to margin for considerable distance.

Smaller cranidia (Fig. 13G,I,J). These two cranidia have more rectangular glabellae, glabellar furrows less distinct, anterior border not medially elongate, long geniculate occipital spine, and short wide posterolateral limb.

In the large cranidium a piece of exoskeleton probably a thoracic segment lies beneath the anterior of the glabella and has been pressed through the cranidium during compaction.

#### REMARKS

These cranidia are assigned to one taxon on the basis of the palpebral lobe and long truncated glabella but their assignment is by no means certain with the few internal moulds available. It is taken into consideration that internal moulds show a different morphology from external surface and the concept of this taxon could be different when its exterior is known. Therefore,

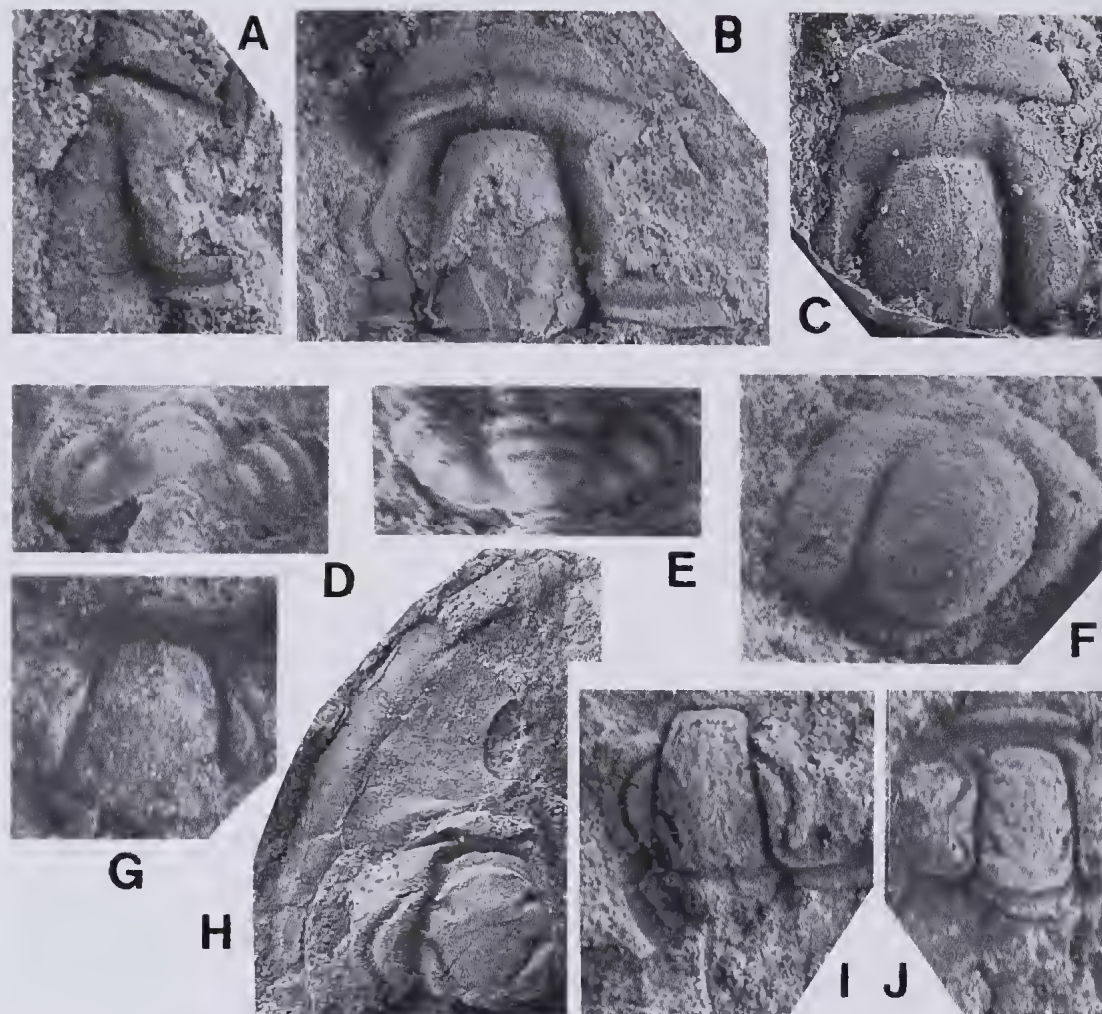


FIG. 13. A–E, *Aphelaspis* sp. A, C from Loc. 9, B, D, E from Loc. 5. A–C, latex casts of cranial fragments GST14460–14462, x6, x7 and x4, respectively. D, E, posterior and dorsal views of internal mould of pygidium GST14463, x10. F, *Aposolenopleura* sp. latex cast of distorted cranidium from Loc. 9, GST14464, x20. G–J, Conocephalinidae indet. all from Loc. 9. G, I, J, internal moulds of small cranial fragments GST14465, 14468, 14469, x10. H, internal mould of larger cranidium and ventral surface of librigena GST14466, 14467, x3.

only features considered unlikely to be significantly different are used in this discussion.

Assignment is made to the Conocephalinidae on the basis of the pyriform glabella and palpebral structure. They may be compared to *Lobocephalina pyriceps* Öpik, 1967 from the early Late Cambrian of western Queensland but differ principally in the long occipital spine. Öpik (1967:247) considered this family and the Saukiidae as having common ancestry.

The laterally bulging glabella of this taxon (not apparent in juvenile specimens (Fig. 13I) but

beginning to appear in others (Fig. 13J)) is evident in many Dikelocephaloidea and Remopleuroidea (Fortey & Chatterton, 1988 as well as Idahoiidae (Ludvigsen & Westrop, 1983, pl. 7, fig. 7 among others). If the librigena (Fig. 13H) with long forward extension of doublure is correctly assigned, a median furrow is a distinct possibility raising the question of whether or not one or more of the groups assigned to the Asaphida by Fortey (1990) may have had a separate origin via the Conocephalinidae. This suggestion would accommodate glabellar shape,



palpebral structure in the transition to Remopleuroidea better than the suggested route via the Auritamidae Öpik, 1967 (Fortey & Chatterton, 1988) but the spinose pygidia of *Auritama* may have been more easily transformed into a kainellid pygidium. Certainly the long flat border, palpebral lobes well away from axis and more rounded straight sided glabella of *Auritama* speak against its possible ancestral position relative to Remopleuroidea and Dikelocephaloidea. In passing there seems no good reason to separate the Ryssometopoidea of Öpik (1967) from the Conocephalinidae except perhaps in terms of rostral structure but this remains unclear for both groups.

The shape and depth of S1 suggest similarity with *Lorettina* Shergold, 1972 but preglabellar structure, glabellar shape and palpebral structure argue against a relationship.

#### Family Unassigned

#### *Aposolenopleura* Raymond, 1937

##### TYPE SPECIES

*Aposolenopleura dunbari* Raymond, 1937 from the Gorge Formation at Highgate Falls, Vermont.

##### DISCUSSION

The Chinese *Onchonotina* Lu, 1964 is here considered synonymous with *Aposolenopleura*, in particular because of the course of the facial suture across the anterior border being so oblique as to leave, on the cranidium, a border that is sharply pointed at each end and is little wider than the glabella.

#### *Aposolenopleura* sp. (Fig. 13F)

##### MATERIAL

One incomplete external mould of a cephalon, GST14464 from Loc. 9.

##### DESCRIPTION

Highly convex cranidium with deep axial furrow; glabella anteriorly rounded, reaching border furrow; S1 shallow, oblique; S2, S3 etc not impressed; S0 well-impressed, transverse. Anterior border tapering laterally to be absent from cranidium before reaching facial suture; border furrow shallow, concave forward. Fixigena c.1/2 glabellar width. Palpebral lobe and other features unknown.

##### REMARKS

The features of the anterior border furrow and border suggest *Aposolenopleura* but in the absence of better material it is not possible to make comparison with the North American species (Rasctti, 1944). Although several small Chinese genera have similar anterior borders (e.g. some *Solenoparia*, *Solenopleura*, *Trachoparia* and others (Lu et al., 1965)) none have it disappearing from the cranidium as in *Aposolenopleura*.

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#### LITERATURE CITED

- APOLLONOV, M.K. AND CHUGAEVA, M.N. 1983. Some trilobites from the Cambrian-Ordovician boundary, Batyrbaisai Valley, Maly Karatau. 66-90. In Apollonov, M.K., Bandedetov, S.M., and Ivshin, N.K. (eds), 'The Lower Palaeozoic stratigraphy and palaeontology of Kazakhstan'. (Akad. Nauk. Kazakh. SSR: Alma-Ata).
- BANKS, M.R. 1982. 'Cambrian fossils and fossil localities in Tasmania'. (Univ. Tasmania: Hobart) 48p.
- BROWN, A.V. 1986. Geology of the Dundas - Mt Lindsay - Mt Youngbuck region. Bull. geol. Surv. Tasm. 62: 1-221.
- CHIEN, YIYUAN 1961. Cambrian trilobites from Sandu and Duyun, southern Kweichow. Acta palaeont. sin. 9: 91-129.
- COLLINS, P.L.F., GULLINE, A.B. AND WILLIAMS, E. 1981. Mackintosh, Tasmania. Tasm. Dept. Mines Geol. Atlas, 1 mile Series, Explan. Rept. Sheet 44 (8014N).
- CORBETT K.D. AND McNEIL, A.W. 1986. Geology of the Rosebery-Mt Block area. Tasm. Dept. Mines Mt Read Volcanic Project 1:25,000 geol. map.
- CORBETT, K.D. AND SOLOMON, M. 1989. Cambrian Mt. Read Volcanics and associated mineral deposits. Spec. Publ. Geol. Soc. Aust. 15: 84-153.
- ERGALIEV, G. Kh. 1980. 'Trilobites of the Middle and Upper Cambrian of the Maly Karatau'.

- (Akad. Nauk Kazakh. SSR: Alma-Ata). 211p. [In Russian.]
- FORTEY, R.A. 1980. The Ordovician trilobites of Spitsbergen III. Remaining trilobites of the Vallahfonna Formation. Norsk Polarinst. Oslo, Skrift. 171: 1-163.
1990. Ontogeny, hypostome attachment and trilobite classification. *Palaeontology* 33: 529-576.
- FORTEY, R.A. AND CHATTERTON, B.D.E. 1988. Classification of the trilobite suborder Asaphina. *Palaeontology* 31: 165-222.
- GREEN, G.R. 1983. The geological setting and formation of the Rosebery volcanic-hosted massive sulphide ore body, Tasmania. PhD Thesis, Dept. of Geology, Univ. of Tasmania. (Unpubl.).
- HENDERSON, R.A. 1976. Upper Cambrian (Idamean) trilobites from western Queensland, Australia. *Palaeontology* 19: 325-364.
- HENNINGSMOEN, G. 1957. The trilobite family Olenidae. Skrifter utgitt av det Norske Videnskaps-Akademi i Oslo. 1. Matematik-naturvidenskapelig Klasse for 1957, 1: 1-303.
- HUGHES, N.C. AND RUSHTON, A.W.A. 1990. Computer-aided restoration of a Late Cambrian ceratopygid trilobite from Wales, and its phylogenetic implications. *Palaeontology* 33: 429-445.
- JAGO, J.B. 1972. The youngest recorded Cambrian trilobites. *Search* 3: 173,174.
1974. *Glyptagnostus reticulatus* from the Huskisson River, Tasmania. *Pap. Proc. R. Soc. Tasm.* 107: 117-127.
1978. Late Cambrian fossils from the Climie Formation, western Tasmania. *Pap. Proc. R. Soc. Tasm.* 112: 137-153.
1979. Tasmanian Cambrian biostratigraphy - a preliminary report. *J. geol. Soc. Aust.* 26: 223-230.
- JAGO, J.B. 1987. Idamean (Late Cambrian) trilobites from the Denison Range, south-west Tasmania. *Palaeontology* 30: 207-231.
- LERMONTOVA, E.V. 1951. 'Upper Cambrian trilobites and brachiopods from Boshche-Kulya'. *Vses. nauchno-issled. geol. Inst. (VSEGEI)* 49p.
- LISOGOR, K.A. 1970. New species of trilobites from the Upper Cambrian of Maly Karatau. *Geologiya, Alma-Ata* 6: 13-20.
1977. Biostratigraphy of Upper Cambrian and Tremadoc trilobites of the Maly Karatau (southern Kazakhstan). *Trudy Inst. Geol. Geofiz. Akad. Nauk. USSR, Sib. Otd.* 313: 197-265.
- LOCHMAN, C. AND WILSON, J.L. 1958. Cambrian biostratigraphy in North America. *J. Paleont.* 32: 312-350.
- LONGACRE, S.A. 1970. Trilobites of the Upper Cambrian Ptychaspid Biome, Wilberns Formation, central Texas. *Paleont. Soc. Mem.* 4: 1-70.
- LUDVIGSEN, R. AND WESTROP, S.R. 1983. Franconian trilobites of New York State. *New York State Museum Memoir* 23: 1-82.
1985. Three new Upper Cambrian stages for North America. *Geology* 13: 139-143.
- LUDVIGSEN, R., WESTROP, S.R. AND KINDLE, C.H. 1989. Sunwaptan (Upper Cambrian) trilobites of the Cow Head Group, western Newfoundland, Canada. *Palaeontogr. can.* 6: 1-175.
- LU, YANHAO, CHANG, W.T., CHU CHAOLING, CHIEN YIYUAN, AND HSIANG LEEWEN 1965. 'Chinese fossils of all groups. Trilobita' (Science Press: Peking), 2 vols, 766p.
- LU, YANHAO AND LIN, HUANGLING, 1980. Cambro-Ordovician boundary in western Zhejiang and the trilobites contained therein. *Acta palaeont. sin.* 9: 118-134.
1989. The Cambrian trilobites of western Zhejiang. *Palaeontologia sinica, n.s. B,* 25, 178: 1-287.
- MOORE, R.C. (ed.) 1959. 'Treatise on invertebrate paleontology, Part O, Arthropoda 1.' (University of Kansas Press: Lawrence) 560p.
- NICOLL, R.S. AND SHERGOLD, J.H. 1991. Revised Late Cambrian (pre-Payntonian-Datsonian) conodont biostratigraphy at Black Mountain, Georgina Basin, western Queensland, Australia. *BMR J. Geol. Geophys.* 12: 93-118.
- ÖPIK, A.A. 1963. Early Upper Cambrian fossils from Queensland. *Bull. Bur. Miner. Resour. Geol. Geophys. Aust.* 64: 1-133.
1967. The Mindyallan fauna of northwestern Queensland. *Bull. Bur. Miner. Resour. Geol. Geophys. Aust.* 74: 404p. 67pls.
- PALMER, A.R. 1955. Upper Cambrian agnostidae of the Eureka district, Nevada. *J. Paleont.* 29: 86-101.
1960. Trilobites from the Upper Cambrian Dunderberg Shale in the Eureka district, Nevada. *Prof. Pap. U.S. Geol. Surv.* 334C: 53-109.
1962. *Glyptagnostus* and associated trilobites in the United States. *Prof. Pap. U.S. Geol. Surv.* 374F: 1-49.
1965. Trilobites of the Late Cambrian Pterocephaliid Biome in the Great Basin, United States. *Prof. Pap. U.S. Geol. Surv.* 493: 1-105.
1968. Cambrian trilobites of east-central Alaska. *Prof. Pap. U.S. Geol. Surv.* 559B: 1-115.

- POWELL, C.McA., NEEF, G., CRANE, D., JELL, P.A. AND PERCIVAL, I.G. 1982. Significance of Late Cambrian (Idamean) fossils in the Cupala Creek Formation, northwestern New South Wales. *Proc. Linn. Soc. N.S.W.* 106: 127-150.
- RASETTI, F. 1944. Upper Cambrian trilobites from the Lévis Conglomerate. *J. Paleont.* 18: 229-258.
1961. Dresbachian and Franconian trilobites of the Conococheague and Frederick Limestones of the central Appalachians. *J. Paleont.* 35: 104-124.
- ROBISON, R.A. AND PANTOJA-ALOR, J. 1968. Tremadocian trilobites from the Nchixtlan Region, Oaxaca, Mexico. *J. Paleont.* 42: 767-800.
- SHERGOLD, J.H. 1972. Late Upper Cambrian trilobites from the Gola Beds, western Queensland. *Bull. Bur. Miner. Resour. Geol. Geophys. Aust.* 112: 1-127.
1975. Late Cambrian and Early Ordovician trilobites from the Burke River Structural Belt, western Queensland, Australia. *Bull. Bur. Miner. Resour. Geol. Geophys. Aust.* 153: 1-251, 58pls.
1977. Classification of the trilobite *Pseudagnostus*. *Palaeontology* 20: 69-100.
1980. Late Cambrian trilobites from the Chatsworth Limestone, western Queensland. *Bull. Bur. Miner. Resour. Geol. Geophys. Aust.* 186: 1-111.
1982. Idamean (Late Cambrian) trilobites, Burke River Structural Belt, western Queensland. *Bull. Bur. Miner. Resour. Geol. Geophys. Aust.* 187: 1-69.
- SHERGOLD, J.H. AND COOPER, R.A. 1985. Late Cambrian trilobites from the Mariner Group, northern Victoria Land, Antarctica. *BMR J. Geol. Geophys.* 9: 91-106.
- SHERGOLD, J.H., COOPER, R.A., MACKINNON, D.I. AND YOCHELSON, E.L. 1976. Late Cambrian Brachiopoda, Mollusca and Trilobita from northern Victoria Land, Antarctica. *Palaeontology* 19: 247-291.
- SHERGOLD, J.H., JAGO, J.B., COOPER, R.A. AND LAURIE, J. 1985. The Cambrian System in Australia, Antarctica and New Zealand. *IUGS Publs* 19: 1-85.
- SHERGOLD, J.H., LAURIE, J.R. AND SUN XIAOWEN, 1990. Classification and review of the trilobite order Agnostida Salter, 1864: an Australian perspective. *Rept. Bur. Miner. Resour. Geol. Geophys. Aust.* 296: 1-93.
- TROEDSSON, G.T. 1937. On the Cambro-Ordovician faunas of western Quruq tagh, eastern T'ien-shan. *Palaeontologia Sinica n.s. B, no. 2*, 106: 1-74.
1951. *Hedinaspis*, new name for *Hedinia* Troedsson, non Navas. *Geol. fören. Stockholm Förh.* 73(4): 695.
- TURNER, N.J., BROWN, A.V., MCCLENGHAN, M.P. AND SOETRISNO, Is. 1991. Corinna. Geological Atlas 1:50,000 series. Sheet 43 (7914N). Div. Mines and Min. Resour., Tasmania.
- WEBBY, B.D., WANG, QIZHENG AND MILLS, K.J. 1988. Upper Cambrian and basal Ordovician trilobites from western New South Wales. *Palaeontology* 31: 905-938.
- WESTERGÅRD, A.H. 1922. Sveriges Olenidskiffer. *Sver. geol. Unders. Afh. Ca18*: 1-188.
1944. Borrningar genom skånes Alunskiffer 1941-1942. *Sveriges Geol. Unders. Avh. och Upps. ser. C, Arsbok* 38(1): 1-45.
- ZHU, ZHAOLING, LING HUANLING, AND CHANG ZHIHENG 1979. Trilobites. 81-116. In 'Atlas of the palaeontology of Qinghai.' (Geological Publishing House: Beijing).



# NEW DISTRIBUTION RECORDS FOR *ANTECHINUS GODMANI* (THOMAS), A RESTRICTED RAINFOREST ENDEMIC

K.R. MCDONALD

McDonald, K.R. 1991 08 01: New distribution records for *Antechinus godmani* (Thomas), a restricted rainforest endemic. *Memoirs of the Queensland Museum* 30(3): 487-491. Brisbane. ISSN 0079-8835.

*Antechinus godmani*, a restricted rainforest endemic of the wet tropics of Queensland, is recorded from locations up to 55km south of the previously known range. The 36 specimens collected in the Kirrama and Cardwell Ranges are no larger in size than those from other localities. *Antechinus godmani*, distribution, biology.

K.R. McDonald, Queensland National Parks and Wildlife Service, Pallarenda, Townsville, Queensland 4810; 12 May, 1991.

The Atherton *Antechinus* (*A. godmani*) was used to define the focal point for the Atherton Subregion, as determined by non-volant mammals, in the wet tropics region of Queensland (Winter et al., 1984). Its distribution had a north-south dimension of c. 60km (Van Dyck, 1982; Laurance, 1990). Its documented northern and southern limits had no obvious habitat or topographical restrictions and Winter et al. (1984), suggested the known range was probably an artefact of inadequate searching techniques. *A. godmani* is an upland species with an altitudinal minimum of 600m (Laurance, 1990); its distribution should be restricted by major low altitude features such as the Herbert River.

This paper reports a southern range extension and suggests probable geomorphic limits to the range of the Atherton *Antechinus*.

## METHODS

During fauna surveys of the southern Wet Tropics Biogeographic Region, several sites were searched for terrestrial vertebrates. The work was done to fill in known gaps between collection sites. Surveys were carried out in June and July, 1989, and January, 1990.

Elliot type A traps were baited with PAL dog food (beef) mixed with bran to absorb excess moisture or rolled oats and peanut paste, the latter to specifically target *Melomys cervinipes*. Break-back rat-traps were baited with salami. Traps were placed 7-10m apart along old logging roads, partly grown-over with vegetation, beside recently used logging roads and along paths cut through the rainforest understorey. Traps were set beside logs, trees or in the open. Specimens are deposited in the Queensland

Museum and the Queensland National Parks and Wildlife Service, Townsville. Measurements follow Van Dyck (1982).

## TRAPPING RESULTS AND NEW RECORDS

Thirty-six *A. godmani* were captured at ten sites in the Cardwell and Kirrama Ranges at altitudes of 760-1000m (Table 1). Locations have a geology of undifferentiated Permo-Carboniferous granite or rhyolites of the Glen Gordon Volcanics supporting vegetation types of simple notophyll and complex mesophyll vine forests on gentle (<5°) slopes (Table 1). The mesophyll vine forests were mainly on slopes of <1°. All areas except two had been logged, the most recent being 1986/87 when logging ceased. Rainfall would be similar to Koombooloomba c.50km to the north, which, at 720m, has median annual rainfall of 2760mm. Other small ground mammals captured in adjacent traps were *Antechinus stuartii*, *Rattus fuscipes/leucopus* and in the same trapline, *Melomys cervinipes*.

The 31 trap locations where *A. godmani* was captured were in the following positions: 11 base of tree; 10 near logs; 7 in the open; 1 near a stump; 1 in thick fern area; 1 near a tree and log. Released *A. godmani* ran into holes at the bases of trees, hollows in trees, logs or log piles. Large epiphytes were not a feature of the forest.

Other sites, trapped without success, were areas of lower altitude but of the same geology and vegetation; of a similar vegetation, geology, and altitude, but with rain at the time of trapping; or areas which had the same vegetation and geology but had a windswept easterly aspect. Additional trapping sites within the northern

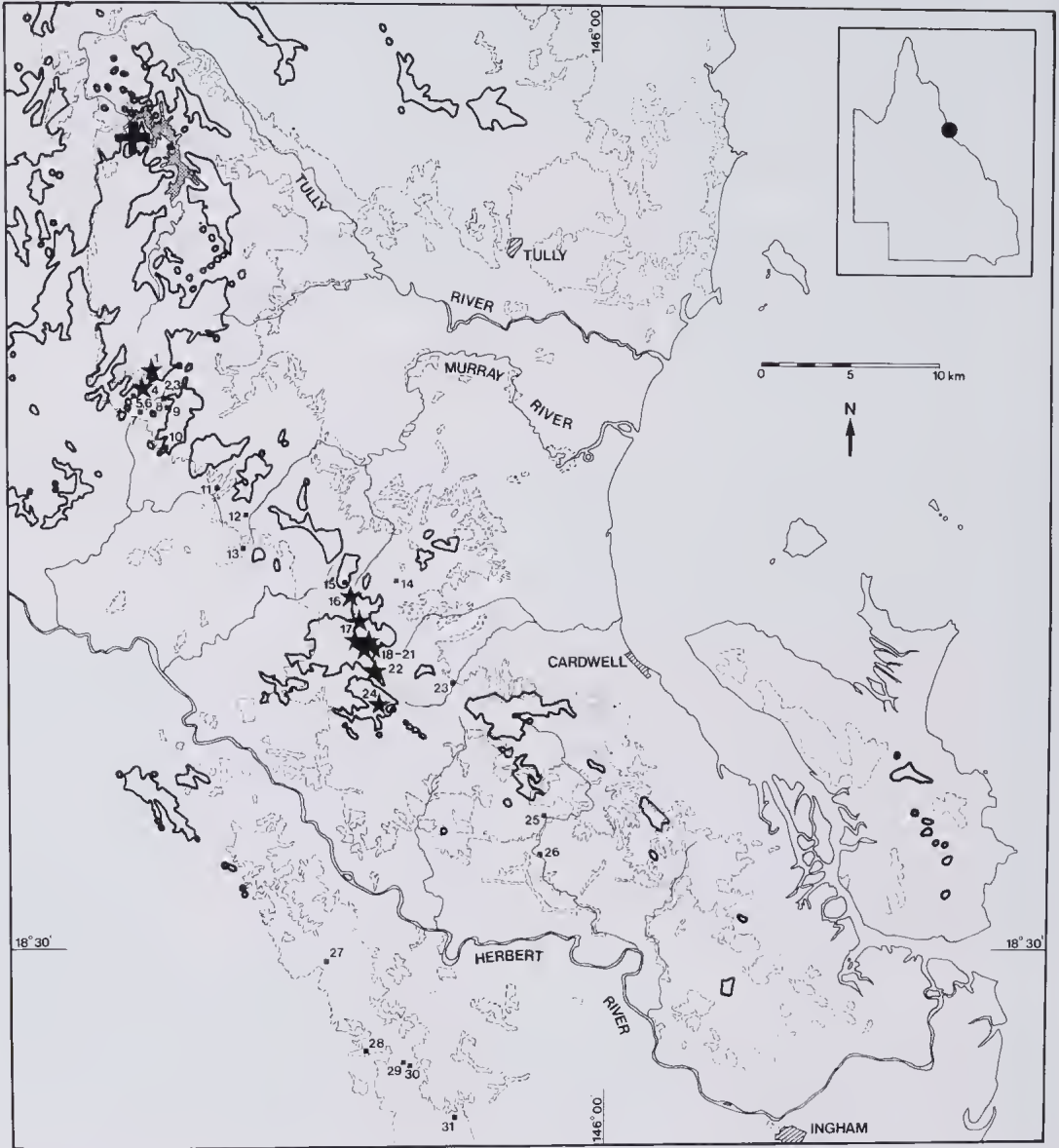


FIG 1. *Antechinus godmani* collection sites (stars) and other sites (squares) where trapping was carried out on the Kirrama and Cardwell Range and the Seaview Range. The 800m contour (solid lines) and rainforest (dashed line) are shown. The most southern previously recorded location near Koombooloomba Dam is shown as a +. Numbers refer to sites in Table 1.

granite areas of Bryce-Henry and Macks Logging Areas where *A. godmani* was collected in July were trapped without success (Table 1). Locations on the Seaview Range in the Mt Fox/Wallaman Falls area, south of the Herbert Valley were trapped in late February, 1990.

This survey extends the range of *A. godmani*

c.55km from the previous southern limit which was Koombooloomba Dam (Van Dyck, 1982; Laurance, 1990). Preferred habitat appears to be rainforests at high altitudes on the Atherton Tableland and the Kirrama and Cardwell Range in the Atherton Uplands block of Winter et al. (1984). A skull now in the Queensland Museum

Site	Latitude ±5"	Longitude ±5"	Altitude (m)	Geology <sup>1</sup>	Vegetation <sup>2</sup>	A.g.	A.s.	A.f.	R.spp	Umys	Mel	Year Logged
1	18°01'50"	145°36'50"	980-1000	UG	8/9	x	x		x		x	Unlogged
2	18°02'12"	145°36'43"	880-900	"	8		x		x		x	1987
3	18°02'27"	145°36'47"	880-900	"	8							1986/87
4	18°02'55"	145°36'20"	760-780	"	8	x	x		x		x	1986/87
8	11°03'07"	145°36'18"	760-780	"	8		x		x			1986/87
6	18°03'58"	145°36'00"	760-780	"	8		x		x		x	1986/87
7	18°03'58"	145°36'44"	660-680	"	8		x		x		x	1965/69
8	18°04'37"	145°37'37"	720-740	"	8				x		x	1965/69
9	18°04'57"	145°37'24"	740-760	"	8		x		x		x	1965/69
10	18°05'42"	145°37'52"	780-800	"	8							1960/64
11	18°06'18"	145°38'27"	640-660	"	2a				x		x	1960/64
12	18°09'14"	145°41'22"	620-640	"	2a				x	x	x	1970/74
13	18°10'25"	145°41'58"	640-660	"	x				x	x		1980/84
17	18°12'12"	145°49'26"	580-600	"	2a		x		x			unlogged
15	18°12'20"	145°46'50"	820-880	"	9				x			1980/84
16	18°13'05"	145°47'25"	800-820	"	2a	1			x			1976
17	18°14'10"	145°47'45"	880-900	GG	8	x	x		1		x	1960/62
18	18°15'17"	145°47'58"	840-860	"	8	x	x		x		x	1958/62
19	18°15'18"	145°47'55"	880-890	"	8	x			x		x	1958/62
20	18°15'13"	145°48'05"	880-900	"	8	x	x		x		x	1958/62
21	18°15'20"	145°48'20"	880-900	"	8	1	x		x			1958/62
22	18°16'50"	145°48'35"	800-820	"	8	x			x			1957
23	18°16'58"	145°52'35"	80-120	UG	1a			x	x			unlogged
24	18°17'55"	145°48'50"	800-820	"	2a	x	x		1			unlogged
25	18°23'42"	145°56'56"	80-100	"	2a				x		x	unlogged
26	18°25'15"	145°56'37"	40-60	AL	1a				x	x	x	pre 1954
27	18°31'25"	145°45'50"	560-580	"	8				x			1970/74
28	18°35'03"	145°47'13"	540-560	"	2a			x	x			unlogged
29	18°36'15"	145°49'20"	580-600	GG	8				x		x	1970/74
30	18°36'25"	145°49'45"	620-640	"	8				x			1970/74
31	18°39'30"	145°52'17"	600-620	"	8				x			1965/69

<sup>1</sup>. de Keyser et al. (1965), Richards (1980).

<sup>2</sup>. Tracey and Webb (1975), Tracey (1982). Numbers are those used by Tracey and Webb (1975).

UG = Undifferentiated granites. GG = Glen Gordon Volcanics. AL = Alluvium.

Ag = *Antechinus godmani*. As = *Antechinus stuartii*. Af = *Antechinus flavipes*. R.spp = *Rattus* spp. Umys = *Uromys caudimaculatus*. Mel = *Melomys cervinipes*.

TABLE 1. Location, altitude, geology, vegetation and year logged for small rainforest mammals collected on the Kirrama and Cardwell Range in 1989 and the Seaview Range in 1990. All sites are within State Forests except for 24, 25, and 28 which are in National Parks.

(JM6687) is an *A. godmani* collected from State Forest 185 near Tinaroo Dam in September, 1969. One specimen has been collected from Mt Bellenden Ker (J.W. Winter, pers. comm.). In light of these records, it seems reasonable to expect that, *A. godmani* would be on the Lamb Range on the northern end of the uplands. The species is more widely distributed than original-

ly thought (Van Dyck, 1982; Laurance, 1990). *A. godmani* should be rated 'rare' according to the criteria in Thomas and McDonald (1989). It should not be rated endangered or vulnerable as there is no known threat to its habitat. The species is confined to pockets of upland, rainforest habitat and appears not to have a con-

	Sex	Mean	SD	Range	N
HB	♀	122.33	5.3	112-130	12
	♂	136.88	7.84	120-150	17
TL	♀	97.83	5.49	88-106	12
	♂	115.94	8.03	100-127	17
Ear	♀	19.5	0.82	18-21	12
	♂	20.82	1.74	19-25	17
Pes (s.u.)	♀	19.92	1.36	18-22	12
	♂	21.76	1.35	19-24	17
Weight	♀	57.9		53-73	8
	♂	90.0		81-101	5

TABLE 2. Measurements (in mm) of head-body (HB), tail (TL), ear, pes and weight (gm) of *A. godmani* from the Kirrama/Cardwell Range.

tinuous distribution throughout the Atherton Upland block.

*A. godmani* has been collected at 600m on the Atherton Tablelands (Laurance, 1990) and 1500m on Mt Bellenden Ker (J.W. Winter, pers. comm.). The species is found at 760-1000m on the Kirrama Range (Table 1). Geology of the areas in the collection localities of *A. godmani* range through Permo-Carboniferous rhyolites and granites and Pleistocene basalts. The species does not appear to favour any geological type.

The animal has been trapped in simple and complex notophyll vine forest, mesophyll vine forest and simple microphyll vine-fern forest (Table 1; Van Dyck, 1982; J.W. Winter, pers. comm.). The species occurs in all the dominant rainforest types in the Atherton Upland block as defined by Tracey and Webb (1975).

*A. godmani* does not appear to be eliminated by selection logging. Locations in which the animals were found on the Kirrama Range were logged 2-30 years prior to the trapping programme (Table 1). The species has been found in Yamanie and Bellenden Ker National Parks. All other areas have been in State Forest. All locations are within the Wet Tropics World Heritage Area.

#### MEASUREMENTS (Table 2)

Eight females with developing or well developed pouches (HB 117-127mm) had weights from 53-73gm, mean 57.9gm. A female with six pouch young weighed 56gm.

#### REPRODUCTIVE CONDITION

Of four females caught in June 1989 only one

showed pouch development. In July, all eight females caught, had developing (four) or well-developed pouches with one caught on 14 July having six young (crown rump length 6.1mm). All males, except for one, were caught in June.

An internal examination of three females with well-developed pouches showed embryos in the uterus. Females had unequal embryos developing in each uterine horn and totals greater than the number of teats (Table 3).

#### ACKNOWLEDGEMENTS

Dr Ross Hynes supervised the fauna survey. Jeanette Covacevich and Dr J.W. Winter read the manuscript and gave helpful advice. Stephen

Specimen No	Uterine horn		Pouch condition
	L	R	
N36711	3	7	well-developed
N36714	5	2	well-developed
N36661	5	2	well-developed

TABLE 3. Embryo number in each uterine horn for three female *A. godmani* in July 1989.

Van Dyck assisted in identification with initial specimens and discussed his knowledge on field collection of *A. godmani*. Les Hawkes and staff of the Queensland Forestry Service and officers of the Queensland National Parks and Wildlife Service at Cardwell assisted in the field. Dr J. Miller gave advice on the embryology and Russell Cumming drew the map. This assistance is gratefully acknowledged.

#### LITERATURE CITED

- DE KEYSER, F., FARDON, R.S.H. AND CUTTLER, L.G. 1965. Ingham Queensland 1:250,000 Geological Series Sheet SE/55. Explan. Notes, Bur. Miner. Resour. Geol. Geophys. Aust.
- LAURANCE, W.F. 1990. Distributional records for two 'relict' dasyurid marsupials (Marsupialia: Dasyuridae) in north Queensland rainforest. Aust. Mammalogy. 13: 215-218.
- RICHARDS, D.N.G. 1980. Palaeozoic granitoids of northeastern Australia. In Henderson, R.A. and Stephenson, P.J. (eds), 'The geology and geophysics of northeastern Australia'. (Geol. Soc. Aust. Qld Div.:Brisbane).
- THOMAS, M.B. AND MCDONALD, W.J.F. 1989. 'Rare and threatened plants of Queensland.' 2nd ed. (Qld Dept Primary Ind.:Brisbane).



- TRACEY, J.G. 1982. 'The vegetation of the humid tropical region of north Queensland'. (CSIRO: Melbourne).
- TRACEY, J.G. AND WEBB, L.J. 1975. 'Vegetation of the humid tropical region of North Queensland. (15 maps at 1:100000 scale plus key.)' (CSIRO Aust. Long Pocket Labs: Indooroopilly).
- VAN DYCK, S. 1982. Status and relationships of the Atherton Antechinus, *Antechinus godmani* (Marsupialia:Dasyuridae). Aust. Mammalogy 5: 195-210.
- WINTER, J.W., BELL, F.C., PAHL, L.I. AND ATHERTON, R.G. 1984. The specific habitats of selected northeastern Australian rainforest mammals. (Unpublished Report to the World Wildlife Fund - Australia:Sydney).

## NEMATOTAENIID CESTODES FROM AUSTRALIAN AMPHIBIANS

*Memoirs of the Queensland Museum* 30(3): 492, 1991.

Hickman (1960) examined Tasmanian frogs for adult cestodes of the cyclophyllidean Nematotaeniidae Lühe, 1910. He described *Nematotaenia hylae* Hickman, 1960 (from *Litoria ewingii* and *Ranidella signifera*), *Cylindrotaenia crinia* (Hickman, 1960) Jones, 1987 (from *R. tasmaniensis*), and *Cylindrotaenia minor* (Hickman, 1960) Jones, 1987 (from *R. tasmaniensis* and *R. signifera*). These cestodes have been recognized (Jones, 1987) as distinct species.

We examined 924 adult anurans from mainland Australia for intestinal parasites (Delvinquier and Jones, 1988). As well, we examined voucher specimens of *Assa darlingtoni*, *Philoria loveridgei* and *Ranidella parinsignifera*, from the Queensland Museum. Here we list the nematotaeniid cestodes (Table 1) from all these frogs and from a specimen of *Ranidella riparia* (Coll. Dr. Mahoney, Australian Helminthological Collection, South Australian Museum; AHC 17750), and two specimens of *Bufo marinus*. (Coll. Dr. R. Speare). Cestodes collected by us have been deposited in the Queensland Museum (QM GL 4886-4888).

Host	N	Cm	Nh	S	I	Loc.
<b>Myobatrachidae</b>						
<i>Assa darlingtoni</i>	13	2		5	1	A
<i>Philoria loveridgei</i>	4	1		1	1	A
<i>Limnodynastes ornatus</i>	10		2	5	2	B,C
<i>Ranidella parinsignifera</i>	20		7	5	2	D
<i>R. signifera</i>	40		2	2	1	E
<i>R. riparia</i>	na		1	na	na	F
<i>Uperoleia rugosa</i>	5		1	5	1	G
<b>Hylidae</b>						
<i>Cyclorana novaehollandiae</i>	6		2	2	1	H
<i>Litoria fallax</i>	72		8	14	1	1
<i>L. inermis</i>	26		8	2	1	J
<i>L. latopalmata</i>	20		1	9	1	H
<i>L. pallida</i>	21		5	4	1	K
<i>L. peronii</i>	26		1	5	1	1
<b>Bufo</b>						
<i>Bufo marinus</i>	>767*		2	many	1	L

TABLE 1. Anuran hosts of nematotaeniid cestodes from the Australian mainland. Abbreviations are : N=number of hosts examined; S=number of localities from which host was collected; I=number of localities in which host infected; Cm=*Cylindrotaenia minor*; Nh = *Nematotaenia hylae*. Localities: A=Lamington National Park, Qld; B=Road Atherton-Herberton, Qld; C=Seven Emu Lagoon, Qld; D=Brisbane, Qld; E=Rous, N.S.W.; F=Yudnamutana, Gammon Ranges, S.A.; G=Ban Ban, Qld; H=Road Eidsvold-Gayndah, Qld; I=Mt Nebo, Qld; J=Road Mossman-Mareeba, Qld; K=Westmoreland Station, Qld; L=10 km north of Mundubbera, Qld. na= data not available; \*- pooled data of authors and Dr R. Speare.

*Nematotaenia hylae* is the most common nematotaeniid of Australian anurans (Table 1) occurring in water-breeding frogs and toads, which, with the exception of *Cyclorana novaehollandiae* and *Bufo marinus*, have a snout-to-vent length of 50mm or less. Finding *N. hylae* in cane toads is interesting because we have examined over 260 specimens of *Bufo marinus* for nematotaeniid cestodes without finding any adult cestodes. In his study, Dr R. Speare (pers. comm.) examined over 500 cane toads and found only two infected specimens. *Nematotaenia hylae* occurs in amphibians in Tasmania. South Australia and the eastern mainland states, whereas the cane toad is restricted to Queensland, New South Wales and the Northern Territory. Members of *Nematotaenia* have not been recorded from South America, where *B. marinus* originated (Jones, 1987). Therefore, it is unlikely that *N. hylae* was introduced into Australia with *B. marinus* but rather that the native parasite has adopted the cane toad as a new host.

Life-cycles of *Cylindrotaenia* from Africa and South America (Joyeux, 1924; Stumpf, 1982) suggest that *Cylindrotaenia* has a one-host aquatic cycle, (i.e. adult or juvenile frogs become infected by eating cestode eggs in water). No other information is available for nematotaeniid life cycles. The host range of *Cylindrotaenia* in Australia however, allows us to postulate on the life cycles of these parasites.

*Cylindrotaenia minor* was found in two species of myobatrachid frogs (Table 1) which occur in isolated mountain forests in southern Queensland and northern New South Wales (Cogger, 1985). One species, *Assa darlingtoni*, rears its young in small pouches on the flanks of the rear legs of adult males (Cogger, 1985). The other, *Philoria loveridgei* lays its eggs in moist tunnels on the forest floor (Cogger, 1985). Neither frog breeds in water. Thus, it is likely that the life cycle of this tapeworm is completed on land. Two other species of *Cylindrotaenia* are known from the Australian mainland (Jones, 1987); both infect lizards which do not utilize bodies of water for breeding or drinking. In the light of these observations nematotaeniid life-cycles (Joyeux, 1924; Stumpf, 1982) need to be further studied.

### References

- COGGER, H.G. 1983. Reptiles and amphibians of Australia. (A.H. and A.W. Reed: Sydney) 660p.
- DELVINQUIER, B.L.J. AND JONES, M.K. 1988. A preliminary note on the intestinal flagellates of the Australian Anura. Mem. Qd. Mus. 25: 333-334.
- HICKMAN, J.L. 1960. Cestodes of some Tasmanian Anura. Ann. Mag. Nat. Hist. Series 13, 3: 1-23.
- JONES, M.K. 1987. A taxonomic revision of the Nematotaeniidae Lühe, 1910 (Cestoda, Cyclophyllidae). Syst. Parasitol. 10: 165-245.
- JOYEUX, C.E. 1924. Recherches sur le cycle évolutif des *Cylindrotaenia*. Ann. Parasit. Hum. Comp. 2: 74-81.
- STUMPF, I.V.K. 1982. Ciclo evolutiva da *Cylindrotaenia americana* Jewell, 1916 (Cyclophyllidae: Nematotaeniidae) em *Bufo ictericus*. Acta. Biol. Paranaense 10/11: 41-52.

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# THE RESHARPENING OF BEVEL-EDGED TOOLS FROM COASTAL SOUTHEAST QUEENSLAND

IAN J. MCNIVEN

McNiven, I.J. 1991 08 01: The resharpening of bevel-edged tools from coastal southeast Queensland. *Memoirs of the Queensland Museum* 30(3): 493-504. Brisbane. ISSN 0079-8835.

Bevel-edged tools are a distinctive Aboriginal stone tool type from coastal southeast Queensland. To date, most research on these tools has focused on their morphology and use, particularly in relation to the processing of the plant food staple bungwall fern. This paper investigates the dynamic use-life of these tools through an investigation of working edge maintenance and resharpening at two sites recently excavated at the mouth of the Maroochy River. □ *Bevel-edged tools, aboriginal tools, SE Queensland, coastal.*

*Ian J. McNiven, Department of Archaeology La Trobe University Bundoora Victoria 3083, Australia; 24 November, 1989.*

The study of stone artefacts is a fundamental concern of prehistoric archaeology, reflecting the bias of the archaeological record towards these least destructible elements of past cultural systems. Traditionally under the culture history paradigm, research on stone artefacts focused upon the elucidation of temporal and spatial dimensions of static morpho-functional types. Over the last two decades however, increasing attention has been directed towards technological aspects of artefact manufacture, resulting in the recognition of stone artefacts as dynamic elements of cultural systems. At the heart of this paradigmatic redirection has been studies documenting changes in artefact morphology resulting from rejuvenation of worn or broken tools (Frison, 1968; Wheat, 1975; Cahen, Keeley and van Noten, 1979; van Noten, Cahen and Keeley, 1980; Dibble, 1984, 1987; Driskell, 1986; Hiscock, 1988a; Flenniken and Raymond, 1986).

Australian archaeologists have long recognised the effects of resharpening upon stone artefact morphology, particularly in the case of the gradual reduction of tula adzes into exhausted tula slugs (Howchin, 1934; Mulvaney, 1975; McCarthy, 1976; Sheridan, 1979). The tula adze reduction model however, is largely derived from ethnographic observations of hafted tula adze resharpening (Horne and Aiston, 1924; Tindale, 1965; Gould, Koster and Sontz, 1971). Few studies have demonstrated directly from the archaeological record that prehistoric tulas were reduced to exhausted tula slugs by gradual resharpening of blunted work-

ing edges (Gould, 1977; Hiscock, 1988b; Hiscock and Veth, 1991).

The only Australian study specifically aimed at demonstrating tool resharpening from the archaeological record is Kamminga's (1974) analysis of 'unifacial pebble choppers' from the Seelands site in northeastern New South Wales (McBryde, 1974). It was found that the extensive use-wear on many of these tools was similar to truncated segments of use-wear found on a number of small flakes also recovered from the site. As a result, Kamminga concluded that since:

'...the flakes are found in association with the unifacial pebble choppers at Seelands, and since the morphology and distribution of the wear along the edges is the same on both artefact types, it is almost certain that the polished rejuvenation flakes are the retouch debitage from the unifacial pebble choppers' (1974, p. 371).

Although Kamminga's (1974) report was only preliminary, it does provide an analytical framework for investigation of stone tool resharpening. Of particular significance is the identification of similar use-wear patterns on both tools and resharpening flakes. My paper attempts to elaborate Kamminga's approach through an examination of bevel-edged tool resharpening from coastal southeast Queensland.

## PREVIOUS RESEARCH ON BEVEL-EDGED TOOLS

Jackson (1939) described stone artefacts he surface collected from shell middens on the Sunshine Coast, southeast Queensland (Fig. 1).

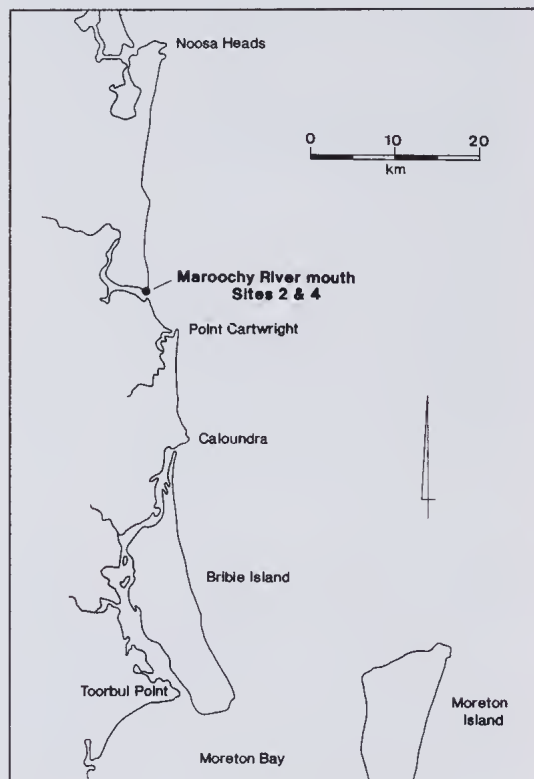


FIG. 1. Map of study area.

Amongst these artefacts were implements he associated with the processing of starch-rich rhizomes of 'bungwall' fern (*Blechnum indicum*). Classing these artefacts *bungwall choppers*, Jackson described them as being 'quartzite or some other suitable rock, flaked away on one margin after the style of a chisel, and possessing secondary chipping along its edge' (Jackson, 1939, p. 292). Jackson's functional inference appears to have been based upon early European observations of fern root processing by coastal Aboriginal people in the region, the morpho-functional potential of the implements and the identification of edge 'rounding' on some 'cutting edge(s)' (Jackson, 1939, p. 290-293).

In the 1970's Kamminga (1981) examined eleven artefacts from various locations in coastal southeast Queensland within the category of 'bungwall choppers' and identified a separate tool type called *bevelled pounders*. This new category was based on use-wear patterns, and was restricted to implements exhibiting intentionally ground flat bevels on their edges, some 3-13mm in width (Kamminga, 1981, p. 34). The

remaining 'chopper' implements were identified as *worimi* (McCarthy, 1941, p. 24; 1976, p. 25; McCarthy, Bramell and Noone, 1946, p. 22) or more generally *east coast chopping tools* (Kamminga, 1978, p. 270-273), a separate class of implement exhibiting edge 'rounding' as opposed to edge bevelling. Using both ethnohistorical observations (e.g. Bancroft, 1894; Petrie, 1980) and the results of his own use-wear analyses, Kamminga (1981) associated bevelled pounders with the processing of bungwall fern root. In contrast, the wear on the choppers was consistent with 'woodworking activities' (Kamminga, 1981, p.34).

A subsequent morphological and selective use-wear analysis of 24 bevelled pounders from the Toorbul Point area adjacent to Bribie Island was undertaken by Gillieson and Hall (1982). Once again, the tools were associated with the processing of bungwall fern. Other results relevant to this study were, first, bevels tend to be quite narrow, with the majority (72%) less than 3mm in width. Second, bevelling can result from use-wear rather than purposeful grinding. Third, use-wear patterns indicate that the use of these tools also included chopping and scraping activities, not just pounding. As a result, the functional categorization of these implements as bevelled pounders was questioned. Although the term bevelled pounder has continued to be used in recent years (McNiven, 1985; Nolan, 1986; Hall and Hiscock, 1988; Hall, Higgins and Fullagar, 1989), this study will employ the more functionally neutral label of *bevel-edged tool*.

#### BEVEL RESHARPENING

The chopping and scraping procedure employed by Gillieson and Hall (1982) in their experimental use-wear study was based upon descriptions by Bancroft (1894) and Petrie (1980) of bungwall processing by Moreton Bay Aboriginal people during the 19th century. For example, Bancroft (1894, p. 25) suggested 'The bungwall stone is not unlike a stone tomahawk, the sharp edge being used to bruise the rhizome against a slab of bloodwood', while Petrie (1980, p. 92) stated that the fern was 'scraped and cut up finely with sharp stones on a log' (see Fig. 2). Gillieson and Hall (1982, p. 59) found that removal of starchy material from the central part of the rhizome was 'facilitated' by the use of 'sharp-edged' implements, a finding consistent with the narrow bevels found on most archaeological specimens of bevel-edged tools.

Hall, Higgins and Fullagar (1989, p. 150) sug-



FIG. 2. Photo of Aboriginal man processing bungwall fern on Bribie Island circa 1890 (Queensland Museum Neg.# LH285/20a).

gested that as the relative efficacy of bevel-edged tools to process plant foods gradually decreased with progressive bevel widening from continued use, a series of resharpening flakes may have been removed to rejuvenate the bevelled working edge. This suggestion appears to derive from the observation of flaking along some bevelled margins, which in some cases has removed large sections of the actual bevel (cf. Crooks, 1982, p. 86). To date however, no attempt has been made to demonstrate whether bevel flaking actually represents bevel rejuvenation (i.e. resharpening) and/or some other form of artefact modification.

### MAROOCHY RIVER MOUTH SITES

Maroochy River mouth Sites 2 and 4 exhibit a range of shell and stone artefact remains, including bevel-edged tools, dating to the last 500 years (McNiven, 1989) (Fig. 1). They are located on low sand ridges (1–2m a.s.l.) in an area of

seasonally inundated sedgeland swamps and tidal mangrove forests. Vegetation on the sites includes mixed eucalypt forest and casuarina woodlands.

The bevel-edged tools analysed in this paper were from a series of surface excavations totalling some 184 m<sup>2</sup> in area (see McNiven, 1989 for details). During preliminary analysis of all stone artefacts from both sites however, I noticed that many small flakes exhibited remnants of bevelled edges similar to the resharpening flakes described by Kamminga (1974) for the Seelands site. As a result, I decided that the sample of bevel-edged artefacts from Sites 2 and 4 would provide an excellent opportunity for the investigation of bevel-edged tool resharpening.

### BEVEL-EDGED STONE ARTEFACTS

Stone artefacts were classified as bevel-edged artefacts if they possessed one or more bevelled edges. A bevelled edge was defined as any edge with a flat facet exhibiting use-wear. Use-wear was identified by the presence of abrasive smoothing and/or impact cracking on the bevelled surface and edge rounding along the margins of the bevel. This definition allowed differentiation from edges modified by rounding (e.g. east coast chopping tools) and/or percussion flaking (Kamminga, 1981, p.17). All bevelled edges were examined using a Wild stereoscopic microscope with a zoom lens (12–60x magnification).

The 107 bevel-edged artefacts recovered from Sites 2 and 4, were broadly classified as 42 flakes, 35 cores, 21 broken flakes (missing initiation platform) and flaked pieces and 9 manuports after Hiscock's (1984, p. 129) stone artefact fracture typology. For the purposes of this paper however, analysis was restricted to cores and flakes (n=77, 72%). Both these artefact types allowed more direct and precise inferences to be made concerning the manufacture and reduction of bevel-edged tools. In contrast, technological insights into the production of broken flakes and flaked pieces were limited by a lack of diagnostic flaking traits, while manuports, by definition, exhibit no evidence of flaking.

### CORES

The 35 bevelled cores are represented by at least eight stone types with the majority (n=23, 66%) manufactured from arkose (feldspathic sandstone) and silcrete (Table 1). Artefact weights range from 33.4g to 1112.0g with a mean of 347.1g (Table 1). The majority (n=32) of cores exhibit areas of cortex, most of which

TABLE 1: Bevel-edged artefact raw materials

Raw material	Cores		Cores		Flakes		Flakes	
	n	%	wt.(g)	%	n	%	wt.(g)	%
Arkose	12	34.3	4092.0	33.6	29	69.0	1080.2	75.8
Sandstone	2	5.7	571.7	4.7	0	0.0	0.0	0.0
Silcrete	11	31.4	2760.0	22.7	7	16.7	314.3	22.0
Quartz	2	5.7	1250.5	10.3	1	2.4	2.8	0.2
Quartzite	1	2.9	207.4	1.7	0	0.0	0.0	0.0
Trachyte	1	2.9	595.7	4.9	0	0.0	0.0	0.0
Rhyolite	1	2.9	343.9	2.8	0	0.0	0.0	0.0
Igneous*	5	14.3	2349.3	19.3	5	11.9	28.7	2.0
Totals:	35	100	12170.5	100	42	100	1426.0	100

\* = unidentified igneous rock

indicate the exploitation of river cobbles (n=31) (e.g. Fig. 3a).

The length of a bevel was defined by the max-

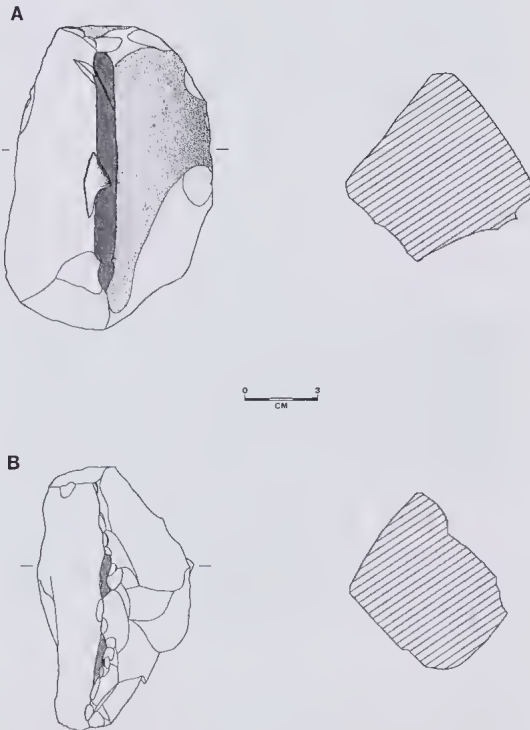


FIG. 3. Bevel-edged tools from Maroochy River mouth Site 4: A, bevelled core (SQ25); B, bevelled flake (SQ13) (bevels denoted by grey shading).

imum extent of continuous or discontinuous bevelling along a single edge. The mean length of a bevelled edge is 32mm with a range of 6-110mm. In contrast, maximum bevel widths have a much more restricted range of 1-18mm with a mean of 5mm (Table 2). The number of bevels on cores ranges from 1-5 with a mean of 2.6.

Most bevelled edges (n=59, 64%) exhibit some form of flaking modification. In some cases, flaking was initiated from the working edge using the bevelled surface as a striking platform. This activity resulted in the removal of a *marginal* section of bevel producing a localized reduction in bevel width (Figs 3a, 4a). In other cases, flaking was initiated immediately to the side of the bevelled edge using one of the lateral faces as a striking platform. The result was the removal of an entire *segment* of bevel thus producing a discontinuity in the bevelled edge (Fig. 4b, see also Fig. 3b).

#### FLAKES

The 42 bevel-edged flakes were classified into the broad categories of either bevelled flakes (n=5) or bevel flakes (n=37). *Bevelled flakes* exhibit bevelling along the edge of the ventral or inside surface, indicating that the bevel was created after the flake was created (Fig. 3b). In contrast, *bevel flakes* exhibit bevels located on the dorsal or outside surface and/or platform with no encroachment onto the ventral surface. In all cases where bevels intersect the margin of the flake, the bevel has been truncated by the

TABLE 2: Bevel-edged artefact bevel characteristics

	Bevelled cores	Bevelled flakes	Type A	Bevel flakes Type B	Type C
Number of artefacts	35	5	21	11	5
Number of bevels	92	10	24	11	5
Bevel length (mm)					
minimum	6	7	4	3	7
maximum	110	37		25	15 32
mean	32.2	25.8	15.1	8.1	—
Bevel width (mm)					
minimum	1	1	2	1	2
maximum	18	7	6	3	6
mean	5.2	3.6	4.0	1.9	—

NB. means calculated only for sample sizes of 10 or more

ventral surface, indicating that the bevel was created prior to flake detachment.

Bevel flakes were further subdivided into three types (Table 2). Type A bevel flakes ( $n=21$ ) exhibit a single truncated segment of a bevelled edge located along the dorsal edge of the platform (Fig. 5) and were produced by the process of segment bevel flaking (Fig. 4b). Three of these flakes also exhibit small segments of a bevelled edge located on the distal half of the dorsal surface (Fig. 5d). Type B bevel flakes ( $n=11$ ) have a platform consisting of the marginal section of a bevelled edge with the actual edge of the bevel forming the dorsal edge of the platform (Fig. 6). They were produced as a result of marginal bevel flaking (Fig. 4a). Type C bevel flakes ( $n=5$ ) exhibit either a truncated segment or a marginal section of a bevelled edge running along a dorsal ridge oriented sub-parallel to the lateral margins of the flake (Fig. 7).

Bevel-edged flakes are made from at least four stone types with the majority represented by arkose and silcrete ( $n=36$ , 86%) (Table 1). Flake weights range from 0.1g to 595.6g with a mean of 34.0g.

#### TESTING THE RESHARPENING HYPOTHESIS

The patterning of bevelling on bevelled cores and bevelled flakes demonstrates that these ar-

tefacts were used as *tools*. That is, the artefacts were actually used to perform some activity that created a bevelled edge. In contrast, the truncation of most bevelled edges on bevel flakes by dorsal negative flake scars and/or by the ventral surface indicates that the bevels on these artefacts was created prior to detachment from a bevel-edged tool (i.e. bevelled core or bevelled flake).

Most bevel flakes exhibit bevels located either along the dorsal edge of the platform (Type A) or on the actual platform itself (Type B) ( $n=32$ , 86%). These flakes would have resulted in localized, relative increases in working edge sharpness, raising the question as to whether such edge resharpening was the reason for the removal of these bevel flakes.

#### INTENTIONAL FLAKING OR USE-WEAR?

Implicit in the concept of resharpening is the notion of a conscious and deliberately planned course of action. Therefore, all identified resharpening flakes must be demonstrated to be the result of intentional removal by knappers.

The problem of intentional flaking is not as simple as it may appear. Numerous bevel-edged tools have a series of cracks running through the surface of the bevel sub-parallel to the bevel margin. These cracks result from multiple im-

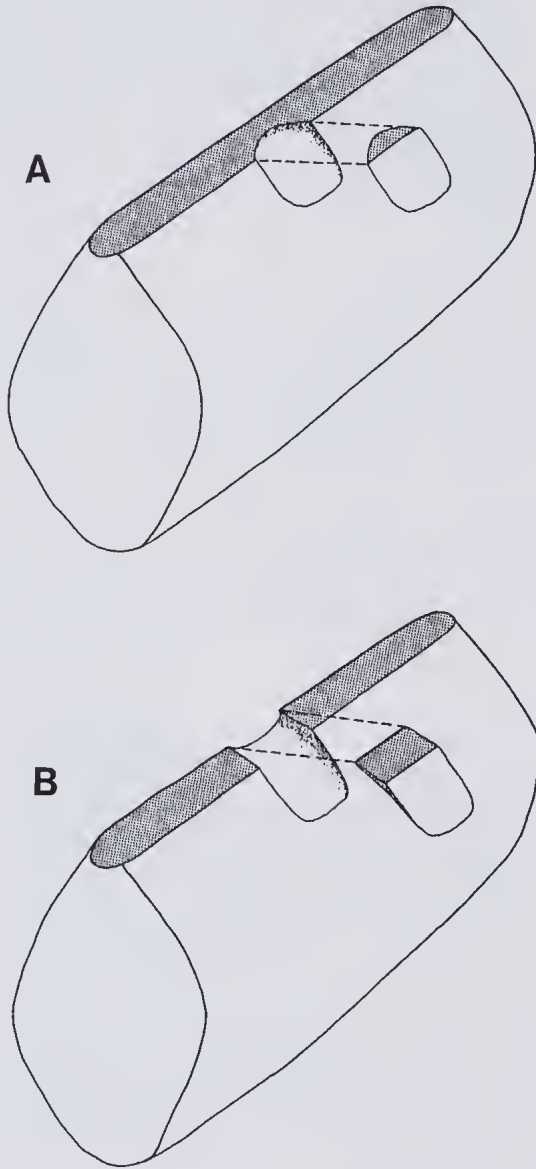


FIG. 4. Bevel flaking types: A, marginal bevel flaking; B, segment bevel flaking.

pacts of the bevelled edge against a relatively hard surface during use. In other cases, these cracks have continued through the artefact and intersected the lateral face of the bevelled edge forming a fracture and a partially detached flake (Fig. 8). It is apparent that if force had continued to be applied to these partly detached flakes, most would have been dislodged removing a marginal section of bevel on the flake platform.

The morphology of these partially detached flakes is identical to Type B bevel flakes documented above. Such an observation provides support for the hypothesis that Type B bevel flakes are in fact a use-wear phenomenon and not the result of intentional knapping (cf. "impact flakes" - Hayden, 1979, p. 65).

It can be expected that if Type B bevel flakes are a use-wear phenomenon, then their relative abundance at the sites should reflect the relative scratch hardness and toughness of differing

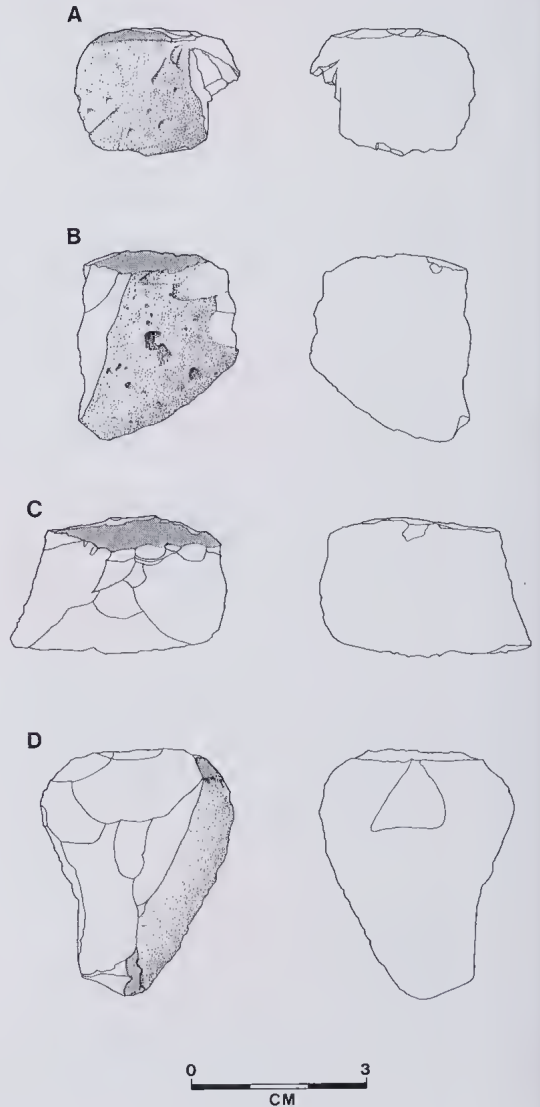


FIG. 5. Type A bevel flakes: A, Site 4/1/18; B, Site 4/1/25; C, Site 4/1/15; D, Site 4/1/8 (bevels denoted by dark shading).



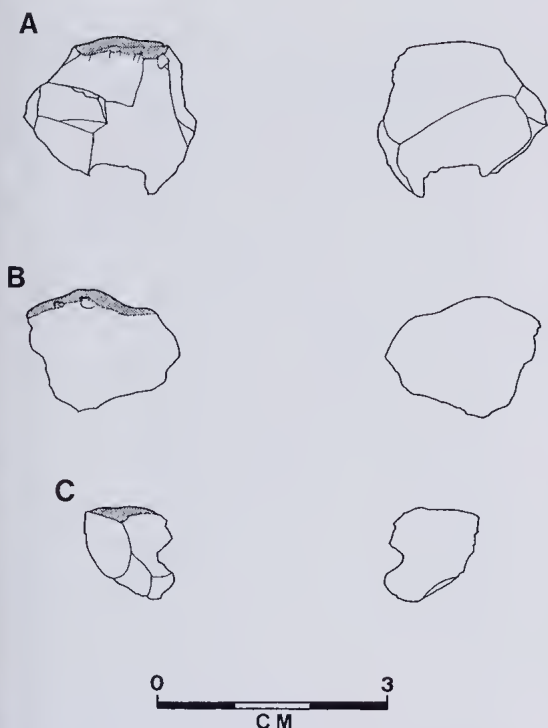


FIG. 6. Type B bevel flakes: A, Site 4/1/25; B, Site 4/1/7; C, Site 4/1/11 (bevels denoted by dark shading).

stone types from which bevel-edged tools are manufactured. As noted above, the majority of bevel-edged tools at these sites are manufactured from arkose and silcrete. Silcrete is the hardest (Mohs 8.5) and toughest (8.2 on the Modified Los Angeles Abrasion Test) stone generally used by Aboriginal people in Australia, making it the most resistant to use-wear abrasion and fracturing (Kamminga, 1982, p. 27-29). In contrast, arkose, which largely comprises feldspar grains (Prinz, Harlow and Peters, 1978), is some 30% softer (Mohs 6) (Hurlbut, 1959) than silcrete and much less tough (pers. obs.). As a result, the working edges of arkose bevel-edged tools would be less resistant to use-wear damage, and the archaeological record should exhibit a positive bias towards arkose Type B bevel flakes.

Fig. 9 shows that there is such a major bias. It should be noted however, that this finding does not negate the hypothesis that Type B bevel flakes are the result of bevel resharpening. For example, given that the working edges of arkose bevel-edged tools are more likely to wear faster than those on silcrete tools, it would be expected that arkose tools would require relatively greater

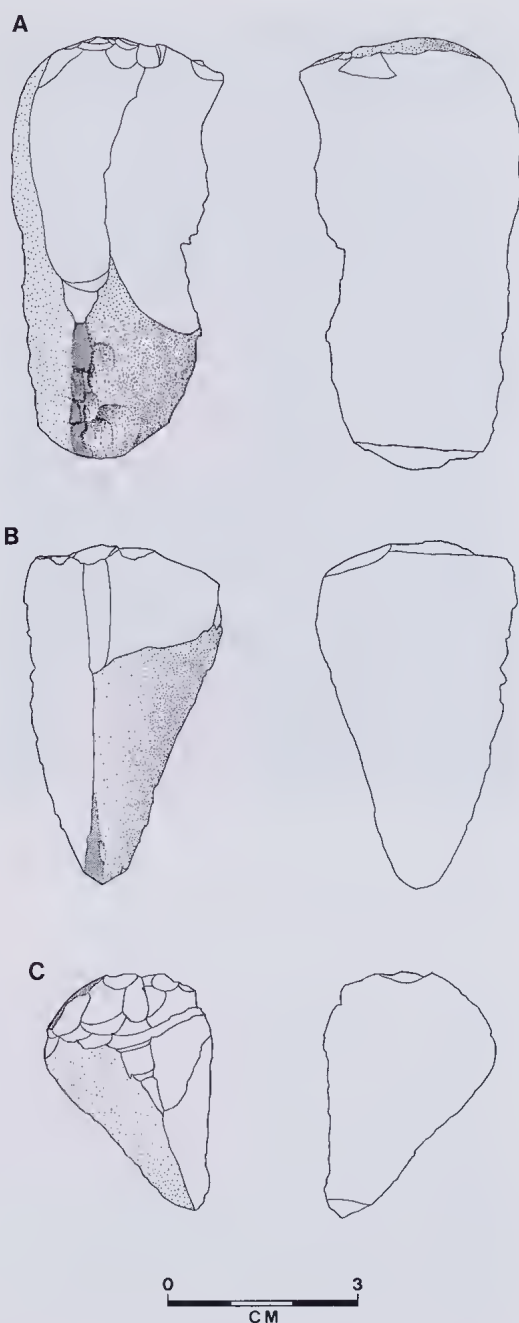


FIG. 7. Type C bevel flakes: A, Site 2/12; B, Site 4/1/15; C, Site 4/1/18 (bevels denoted by grey shading).

edge rejuvenation. However, when this data is combined with the crack and fracture data documented above, the overall evidence is more supportive of a use-wear origin for Type B bevel flakes.



FIG. 8. Photo of cracks along margins of bevel on a bevel-edged tool (Site 4/2/2) (x8).

The hypothesis that Type B bevel flakes are a use-wear phenomenon may also be complicated by differences in the use of silcrete and arkose bevel-edged tools. Examples include differential use of hardwood anvils, and differing tool functions, duration of tool use and amount of use prior to transportation and subsequent discard at sites. Despite these potential complications, the simplest explanation for the existence of Type B bevel flakes is impact of bevel-edged tools against a hard surface during use. This inference is consistent with ethnohistorical references documenting the use of 'bungwall stones' against a slab of hardwood (Fig. 2).

#### EDGE RESHARPENING OR EDGE RESHAPING?

The location of platforms away from the bevelled working edge on Type A and Type C bevel flakes suggests that these artefacts were a product of intentional knapping. Regarding bevel resharpening however, it is clear that the

removal of Type A bevel flakes, in contrast to Type C bevel flakes, would have resulted in both a predictable and efficacious localized resharpening of the bevelled working edge.

It can be predicted that if flakes were systematically removed from more intensely use-worn (i.e. wider) bevels to resharpen the working edge, then the following two test implications would be expected. First, a high ratio of bevel "resharpening" flakes to bevel-edged tools on sites, and, second, bevels found on resharpening flakes should represent the larger end of the bevel width range found on bevel-edged tools.

The small ratio of Type A bevel flakes ( $n=21$ ) to bevel-edged tools ( $n=40$ ) recovered from Sites 2 and 4 contrasts with the expectations of the first resharpening test implication. The evidence shows that on average, less than one bevel "resharpening" flake exists for each bevel-edge tool discarded at both sites. When it is also considered that bevel-edged tools discarded on a site probably only represents a small proportion of the bevel-edged tools used at a site, it is clear that systematic resharpening of bevel-edged tools was not taking place at Sites 2 and 4. Similarly, it is doubtful that only an occasional resharpening flake was removed from a bevel-edge tool as such an isolated event would have little overall effect upon edge sharpness.

Following the second resharpening test implication, a comparison was made of bevel

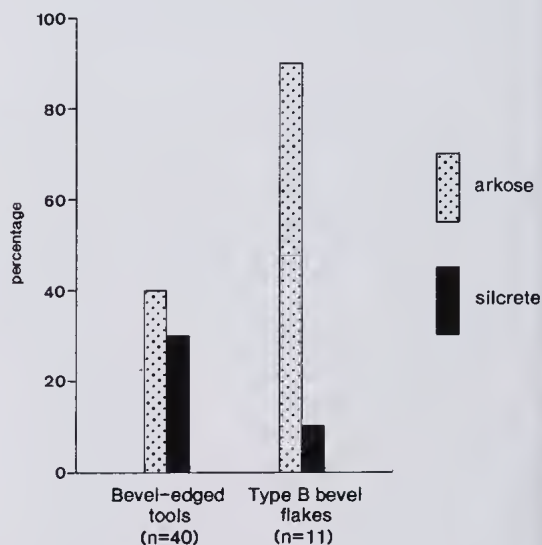


FIG. 9. Relative proportion of arkose and silcrete bevel-edged tools and Type B bevel flakes at Maroochy River mouth Sites 2 and 4.

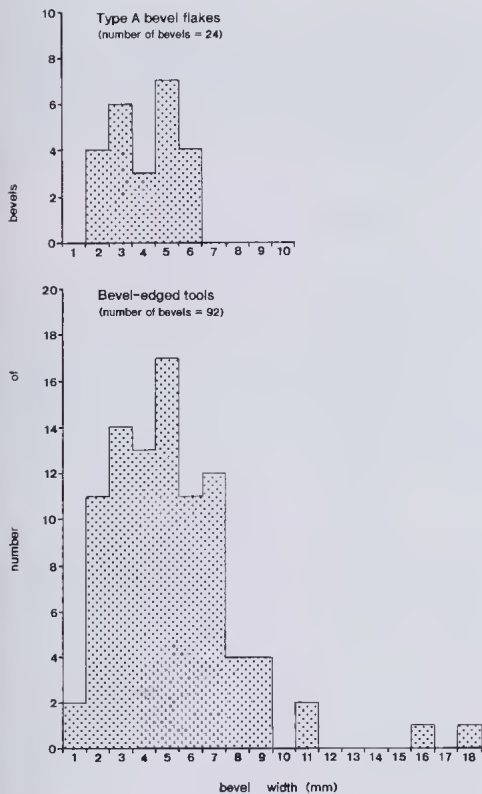


FIG 10. Distribution of bevel widths located on Type A bevel flakes and bevel-edged tools from Maroochy River mouth Sites 2 and 4.

widths on both Type A bevel flakes and bevel-edged tools. The width of bevels on Type A bevel flakes is remarkably representative of the lower half of the bevel width range recorded on bevel-edged tools (Fig. 10). No apparent bias was observed for the removal of wider bevels from bevel-edged tools. In fact the smaller mean bevel width on Type A bevel flakes (4mm) compared to bevel-edged tools (5mm) supports the view that a bias existed towards the removal of flakes from narrower bevelled edges. Clearly, the hypothesis that bevel resharpening was taking place at Sites 2 and 4 is unsustainable.

The apparent targeting of narrower bevelled edges for flaking strongly supports the view that such modification was specifically related to a reshaping not resharpening of the working edge. Whether this reshaping was related to an actual change in tool function and/or the result of a localized rejuvenation of a damaged section of bevel is not known (Cahen, Keeley and van Noten, 1979, p. 666). Future resolution of this

problem will centre upon a comparative use-wear study of variously sized bevels on both bevel flakes and bevel-edged tools, and the refitting of bevel flakes onto bevel-edged tools.

In contrast to Type A and Type B bevel flakes, the most parsimonious explanation for Type C bevel flakes is that they represent reduction of bevel-edged tools unrelated to the modification of the bevelled working edge they exhibit. In such a situation, it would be expected that a number of flakes would inadvertently exhibit remnants of old bevels along dorsal ridges sub-parallel to flake margins. Whether such reduction was actually aimed at increasing the general functional efficacy of the tool to perform similar and/or differing tasks is unknown.

#### REGIONAL VARIATIONS IN BEVEL RESHARPENING

The lack of supporting evidence for resharpening of bevel-edged tools at Maroochy River mouth Sites 2 and 4 does not negate the possibility that bevel resharpening occurred at other sites in the region. In this regard, future investigations of bevel-edged tool resharpening should consider regional variations in bevel-edged tool use and the effects of raw material proximity upon the nature of edge bevelling and edge maintenance.

For example, many archaeologists argue that regional variations in the form and modification of stone tools is a product of the nature of associated settlement-subsistence activities (Binford and Binford, 1966; Binford, 1973; 1977; 1979; Lourandos, 1977; McBryde, 1977; Ebert, 1979; Schrire, 1982; Torrence, 1983; Jones, 1985; Shott, 1986). Therefore, it is possible that bevel resharpening was only associated with certain types of activities, and that such activities were not carried out at Sites 2 and 4. Similarly, bevel resharpening may only occur after a prolonged period of tool use, at the end of a particular blunting stage in the use-life of a bevel-edged tool. If Maroochy River mouth Sites 2 and 4 were visited immediately after a resharpening stage, then little evidence of bevel resharpening would be expected (cf. Keeley, 1982, p. 807). In both situations, evidence for resharpening may be present at other sites in the region which form the remainder of the annual settlement-subsistence system.

The second potentially important issue concerning regional variations in bevel-edged tool resharpening is the effects of raw material

proximity. Such influences may manifest themselves in two key areas. First, a corollary of the proposition that the physical properties of raw materials may influence the nature of bevel reshaping, is that any factor that influences the selection of raw materials for bevel-edged tools will also influence the potential nature of bevel reshaping. Of the numerous factors that influence peoples decisions concerning the selection of stone artefact raw materials, one of the most important is relative physical access to a stone source (Hayden, 1977; O'Connell, 1977; Byrne, 1980; Dibble, 1985; Hiscock, 1986; 1988a; McNiven in press). Consequently, bevel-edged tools located on sites in close proximity to a certain stone source would be expected to be manufactured mostly from this stone type. If this stone type was not very resistant to bevel use-wear damage, then a greater proportion of bevel reshaping flakes may be expected to occur on these sites.

The second potential effect of raw material proximity upon regional variations in bevel reshaping is relative costs of edge maintenance. For example, a negative relationship often exists between the relative amount of tool retouching on sites and the proximity of those sites to replacement stone. That is, as sites are located further away from a stone source, people are more inclined to rejuvenate (i.e. resharpen) the edges of tools made from that raw material as opposed to discarding the artefact (Schiffer, 1975; Hayden, 1977; Byrne, 1980; Bamforth, 1986; Hiscock, 1988a). It should be noted however, that the opposite effect may also take place. People may decide to increase the reshaping threshold in situations where the cost of accessing replacement stone is energetically and/or socially higher than the cost of decreasing efficiency in tool function (Hiscock, 1988a, p. 113). Once again, both propositions can be tested by examining regional variations in the maintenance of bevelled edges on sites.

### CONCLUSION

This paper has attempted to create an analytical framework for the investigation of bevel-edged tool reshaping in coastal southeast Queensland. It is hoped that this framework will not only aid future research in this area, but also stimulate researchers to explore other potential variables that may effect stone tool maintenance. Clearly, our ability to explore the dynamic use-life of stone artefacts within past cultural sys-

tems is limited by poorly developed theoretical models, and even more constrained by a lack of methodological tools operationalizing these models. In this regard, future study of the nature of bevel-edged tool reshaping may provide new insights into these important areas.

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### REFERENCES

- BAMFORTH, D.B. 1986. Technological efficiency and tool curation. *American Antiquity* 51(1):38-50.
- BANCROFT, T.L. 1894. Note on Bungwall (*Blechnum serrulatum* Rich.), an Aboriginal food. *Proc. Linn. Soc. N.S.W.* 19:25-26.
- BINFORD, L.R. 1973. Interassemblage variability - the Mousterian and the 'functional' argument. 227-254. In C. Renfrew (ed.) 'The explanation of culture change'. (Duckworth: Surrey).
1977. Forty-seven trips: a case study in the archaeological formation processes. 24-36. In R.S.V. Wright (ed.) 'Stone tools as cultural markers: change, evolution and complexity'. (Australian Institute of Aboriginal Studies: Canberra).
1979. Organization and formation processes: looking at curated technologies. *J. Anthropological Res.* 35(3):255-273.
- BINFORD, L.R. AND BINFORD, S.R. 1966. A preliminary analysis of functional variability in the Mousterian of Levallois facies. *American Anthropologist* 68(20):238-295.
- BYRNE, D. 1980. Dynamics of dispersion: the place of silcrete in archaeological assemblages from the lower Murchison, Western Australia. *Archaeology and Physical Anthropology in Oceania* 15:110-119.
- CAHEN, D., L.H. KEELEY AND F.L. VAN NOTEN 1979. Stone tools, toolkits, and human behaviour in prehistory. *Current Anthropology* 20(4):661-683.
- CROOKS, J. 1982. Report of three excavations at Pumicestone Passage, Moreton Bay, southeast Queensland. Unpublished B.A. (hons) thesis, University of Queensland.

- DIBBLE, H.L. 1984. Interpreting typological variation of Middle Paleolithic scrapers: function, style, or sequence of reduction? *J. Field Archaeol.* 11:431-436.
1985. Raw-material variation in Levallois flake manufacture. *Current Anthropology* 26(3):391-393.
1987. The interpretation of Middle Paleolithic scraper morphology. *American Antiquity* 52(1):109-117.
- DRISKELL, B.N. 1986. The chipped stone tool production/use cycle. *BAR International Series* 305.
- EBERT, J.I. 1979. An ethnoarchaeological approach to reassessing the meaning of variability in stone tool assemblages. 59-74. In C. Kramer (ed.) 'Ethno-archaeology: implications of ethnography for archaeology'. (Columbia University Press: New York).
- FLENNIKEN, J.J. AND RAYMOND, A.W. 1986. Morphological projectile point typology: replication experimentation and technological analysis. *American Antiquity* 51(3):603-614.
- FRISON, G.C. 1968. A functional analysis of certain chipped stone tools. *American Antiquity* 33(2):149-155.
- GILLIESON, D.S. AND HALL, J. 1982. Bevelling bungwall bashers: a use-wear study from southeast Queensland. *Australian Archaeology* 14:43-61.
- GOULD, R.A. 1977. Puntutjarpa Rockshelter and the Australian Desert Culture. *Anthrop. Paps Amer. Mus. Nat. Hist.* 54(1).
- GOULD, R.A., KOSTER, D.A. AND SONTZ, A.H.L. 1971. The lithic assemblage of the Western Desert Aborigines of Australia. *American Antiquity* 36(2):149-169.
- HALL, J., HIGGINS, S. AND FULLAGAR, R. 1989. Plant residues on stone tools. 136-160. In W. Beck, Clarke, A. and Head, L. (eds.) 'Plants and Australian archaeology'. *Tempus Volume 1*.
- HALL, J. AND HISCOCK, P. 1988. The Moreton Region Archaeological Project (MRAP) - Stage II: an outline of objectives and methods. *Qd Archaeol. Res.* 5:4-24.
- HAYDEN, B. 1977. Stone tool functions in the Western Desert. 178-188. In R.S.V. Wright (ed.) 'Stone tools as cultural markers: change, evolution and complexity'. (Australian Institute of Aboriginal Studies: Canberra).
1979. Palaeolithic reflections: lithic technology and ethnographic excavation among Australian Aborigines. (Australian Institute of Aboriginal Studies: Canberra).
- HISCOCK, P. 1984. Preliminary report on the stone artefacts from Colless Creek Cave, northwest Queensland. *Qd Archaeol. Res.* 1:120-151.
1986. Raw material rationing as an explanation of assemblage differences: a case study from Lawn Hill, northwest Queensland. 179-190. In G. K. Ward (ed.) 'Archaeology at Anzaas Canberra: a collection of papers presented to Section 25A, of the Congress of the Australian and New Zealand Association for the Advancement of Science, in May 1984'. (Canberra Archaeological Society: Canberra).
- 1988a. Prehistoric settlement patterns and artefact manufacture at Lawn Hill, North-west Queensland. Unpublished Ph.D. thesis, University of Queensland.
- 1988b. A cache of tulas from the Boulia district, western Queensland. *Archaeology in Oceania* 23(2): 60-70.
- HISCOCK, P. AND VETH, P. 1991. Change in the Australian Desert Culture: a re-analysis of tulas from Puntutjarpa Rockshelter. *World Archaeology* 22(3): 332-345.
- HORNE, G.A. AND AISTON, G. 1924. 'Savage life in central Australia'. (MacMillan: London).
- HOWCHIN, W. 1934. Stone implements of the Adelaide tribe of Aborigines now extinct. Adelaide.
- HURLBUT, C.S. 1959. 'Dana's manual of mineralogy'. (John Wiley and Sons: New York).
- JACKSON, G.K. 1939. Aboriginal middens of the Point Cartwright district. *Mem. Qd Mus.* 2:289-295.
- JELINEK, A.J. 1976. Form, function and style in lithic analysis. 19-33. In C.B. Cleland (ed.) 'Cultural change and continuity'. (Academic Press: New York).
- JONES, R. (ed.) 1985. Archaeological research in Kakadu National park. ANPWS Publ. 13. (ANU: Canberra).
- KAMMINGA, J. 1974. Appendix 2 (7) Report on the edge wear on stone tools from the Clarence River sites. 371-372. In I. McBryde 'Aboriginal prehistory in New England'. (Univ. Sydney Press: Sydney).
1978. Journey into the microcosms: a functional analysis of certain classes of prehistoric Australian stone tools. Unpublished Ph.D thesis, University of Sydney.
1981. The bevelled pounder: an Aboriginal stone tool type from Southeast Queensland. *Proc. R. Soc. Qd* 92:31-35.
1982. Over the edge: functional analysis of Australian stone tools. *Univ. Qd Anthropol. Mus. Occas. Paps Anthropol.* 12.
- KEELEY, L.H. 1982. Hafting and retooling: effects

- on the archaeological record. *American Antiquity* 47(4):798-809.
- LOURANDOS, H. 1977. Stone tools, settlement, adaptation: a Tasmanian example. 219-224. In R.S.V. Wright (ed.) 'Stone tools as cultural markers: change, evolution and complexity'. (Australian Institute of Aboriginal Studies:Canberra).
- MCBRYDE, I. 1974. 'Aboriginal prehistory in New England'. (Univ. Sydney Press:Sydney).
1977. Determinants of assemblage variation in New England prehistory. 225-250. In R.S.V. Wright (ed.) 'Stone tools as cultural markers: change, evolution and complexity'. (Australian Institute of Aboriginal Studies:Canberra).
- MCCARTHY, F. D. 1941. Two pebble industry sites of Hoabinhien 1 type on the north coast of New South Wales. *Rec. Aust. Mus.* 21(1):21-26.
1976. Australian Aboriginal stone implements. (Australian Museum Trust: Sydney).
- MCCARTHY, F.D., BRAMELL, E. AND NOONE, H.V.V. 1946. The stone implements of Australia. *Mem. Aust. Mus.* 9.
- MCNIVEN, I. 1985. An archaeological survey of the Cooloola region, S.E. Queensland. *Qld Archaeol. Res.* 2:4-37.
1989. Aboriginal shell middens at the mouth of the Maroochy River, Southeast Queensland. *Qd Archaeol. Res.* 6:28-52.
- in press. The effects of raw material proximity upon stone artefact assemblages along the Cooloola coastline, S.E. Queensland. In I. Davidson, Godwin, L. and Sutton, S. (ed.) 'Technological analysis and Australian archaeology'. BAR International Series.
- MULVANEY, D.J. 1975. 'The prehistory of Australia'. (Pelican: Melbourne).
- NOLAN, A. 1986. Sandstone Point: temporal and spatial patterns of Aboriginal site use at a midden complex, southeast Queensland. Unpublished B.A. (hons) thesis, University of Queensland.
- O'CONNELL, J.F. 1977. Aspects of variation in central Australian lithic assemblages. 269-281. In R.S.V. Wright (ed.) 'Stone tools as cultural markers: change, evolution and complexity'. (Australian Institute of Aboriginal Studies:Canberra).
- PETRIE, C.C. 1980. 'Tom Petrie's reminiscences of early Queensland'. (Angas and Robertson:Brisbane).
- PRINZ, M., HARLOW, G. AND PETERS, J. 1978. 'Simon and Schuster's guide to rocks and minerals'. (Fireside:New York).
- SCHIFFER, M.B. 1975. Classifications of chipped-stone tools. In M.B. Schiffer and House, J.H. (eds) 'The Cache River archeological project: an experiment in contract archeology'. *Arkansas Archaeological Survey, Res. Ser.* 8.
- SCHRIRE, C. 1982. The Alligator rivers: prehistory and ecology in western Arnhem Land. *Terra Australis* 7. (ANU Press: Canberra).
- SHERIDAN, G. 1979. Tulas and triodia: a multidisciplinary investigation of the mechanics and antecedents of the Koondi Tuhla and their implications for prehistory. Unpublished B.A. (hons) thesis, Australian National University.
- SHOTT, M. 1986. Technological organization and settlement mobility: an ethnographic examination. *J. Anthropol. Res.* 42:15-51.
- TINDALE, N.B. 1965. Stone implement making among the Nakako, Ngadadjara and Pitjandjara of the Great Western Desert. *Rec. S. Aust. Mus.* 15:131-164.
- TORRENCE, R. 1983. Time budgeting and hunter-gatherer technology. 11-22. In G. Bailey (ed.) 'Hunter-gatherer economy in prehistory'. (Cambridge University Press: Cambridge).
- VAN NOTEN, F., CAHEN, D. AND KEELEY, L. 1980. A Paleolithic campsite in Belgium. *Scientific American* 242(4):44-51.
- WHEAT, J.B. 1975. Artefact life histories: cultural templates, typology, evidence and inference. 7-15. In J.S. Raymond, Loveseth, B., Arnold, C. and Reardon, G. (eds). 'Primitive art and technology'. *Archaeol. Ass., Dept. Archaeol., Univ. Calgary.*

## FISHES OF THE BULLOO-BANCANNIA DRAINAGE DIVISION

S. HAMAR MIDGLEY, MARY MIDGLEY AND STUART J. ROWLAND

Midgley, S.H., Midgley, M. and Rowland, S.J. 1991 08 01: Fishes of the Bulloo-Bancannia Drainage Division. *Memoirs of the Queensland Museum* 30(3): 505-508. Brisbane. ISSN 0079-8835.

Fish were sampled from the Bulloo River in the Bulloo-Bancannia drainage division during 1986 and 1989. Seven indigenous species, in six families, were recorded: *Nematalosa erebi*, *Neosilurus* sp., *Hypseleotris* sp., *Melanotaenia splendida tatei*, *Macquaria ambigua*, *Leiopotherapon unicolor* and *Bidyanus welchi*. Museum records added *Mogurnda adspersa* and the exotic *Gambusia affinis*. The depauperate fish fauna is probably due to the small size and ephemeral nature of the division. No species is endemic to the Bulloo Division, but five other species which occur in both adjacent drainage divisions, Lake Eyre and Murray-Darling, were not recorded; there has been no mixing of fishes between the divisions in recent times.

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More than 70% of Australia is arid or semi-arid (Barker and Greenslade 1982) so there is a paucity of permanent freshwater fish habitats in the internal drainage divisions (Fig. 1).

Although the fishes of the Western Plateau, Lake Eyre and Murray-Darling divisions have been recorded (Lake 1971, 1978; Glover and Sim 1978; Glover 1979, 1982; McDowall 1980; Merrick and Schmida 1984) little is known of the fish fauna of the Bulloo-Bancannia division which lies between the Lake Eyre and Murray-Darling divisions. Lake (1971) presumed that *Nematalosa erebi*, *Ambassis castelnaui*, *Macquaria ambigua*, and *Leiopotherapon unicolor* were found in the Bulloo division, and more recent reviews by Lake (1978), Llewellyn and Pollard (1980) and Merrick and Schmida (1984) added *Neosilurus argenteus*, *Neosilurus* sp. 2, *Bidyanus welchi* and *Scortum barcoo*.

An extensive survey of the freshwater fishes of inland Queensland and the Northern Territory has been conducted by S.H.M. and M.M. This paper reports the fishes sampled from the Bulloo-Bancannia division in 1986 and 1989. Limnology of the Bulloo River is briefly described.

### MATERIALS AND METHODS

This elongated drainage division (Fig. 1) has an area of c. 100,000 km<sup>2</sup> and is comprised of two internal basins (Anon, 1967). The Bulloo River drains the northern part of the division after occasional periods of general runoff and

ends in shallow ephemeral marshlands near the Queensland border. The river is normally a chain of widely separated waterholes, many of which are ephemeral. In the southern part of the division indefinite drainage enters several depressions; this area is the Bulloo Overflow. Evaporation rates far exceed rainfall; runoff occurs only after occasional periods of heavy rain, resulting in extensive shallow flooding.

### SAMPLING

Fish were sampled during day and night using dip nets, gill nets (75 and 112 mm mesh) seine nets (5 and 12 mm), and hook and line. The relative abundance of each species was categorised as abundant, common or rare. The sampling effort was similar in both years. Sub-samples of each species were preserved in 10% formalin. Water quality variables were measured using a secchi disc, thermometer, appropriate meters and Hach titration equipment.

#### 1986

Fish were sampled during September from a permanent hole (3 km x 40 m) in the Bulloo River, c. 50 km WSW of Thargomindah, 28°10'S, 143°22'E (Fig. 1). The river had only recently stopped flowing after rains (100-150 mm) in May, June and July.

#### 1989

Fish were sampled during September from the

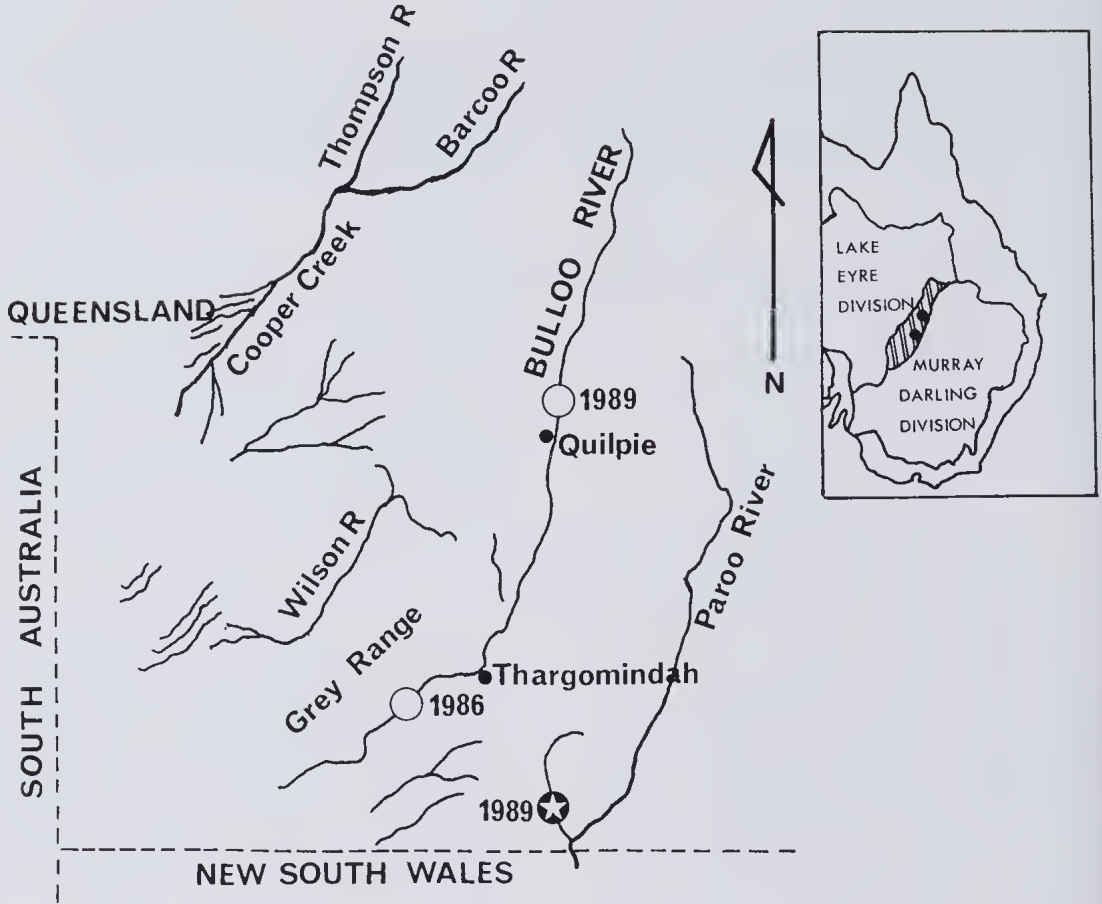


FIG. 1. Sampling sites in the Bulloo River (○); and the Boorara Creek (⊙). Inset showing internal drainage divisions of Australia.

permanent "Como Hole" (1.5 km x 30 m) in the Bulloo River, approximately 25 km N of Quilpie, 26°23'S, 144°18'E (Fig. 1). The river had flooded during May, 1989, but when sampled was a series of widely separated waterholes.

#### MUSEUM RECORDS

Queensland Museum (QM): *Neosilurus* sp. (QMI20400), *Melanotaenia splendida* (QMI20398), *Macquaria ambigua* (QMI14182, QMI20399, QMI20406, QMI20412), *Morgurnda adspersa* (QMI8002; a single specimen from the Bulloo River in 1955).

Australian Museum (AM): *Nematalosa erebi* (AMI16006-001, AMI18928-001, AMI19059-003), *Neosilurus* sp. (AMI19058-002, AMI19059-002, AMI21690-002, AMI27071-001), *Gambusia affinis* (AMI19059-001; from the Bulloo River Overflow, near Clifton Bore,

in 1976), *Melanotaenia* sp. (AMI 18928-002), *Macquaria ambigua* (AMI16006-002, AMI21690-001, AMI21694-001), *Leiopotherapon unicolor* (AMI18927-001, AMI18928-003, AMI19058-001, AMI19059-004).

South Australian Museum (SAM): *Melanotaenia* sp., *Hephaestus* sp. (probably *Bidyanus* sp.).

#### RESULTS AND DISCUSSION

Seven indigenous species, in six families and seven genera were recorded (Table 1).

There is uncertainty about the taxonomic status of some fishes in inland Australia, particularly the neosilurids and the eleotrids (Lake, 1978; Hoese et al., 1980; Merrick and Schmida, 1984) and major taxonomic reviews are underway (R. McKay, pers. comm.). Although



Family	Species Name	Common Name	Relative Abundance*		Remarks <sup>1</sup>
			1986	1989	
Clupeidae	<i>Nematalosa erebi</i>	bony bream	A	A	occurs in WP, LE, BB
Plotosidae	<i>Neosilurus</i> sp.	catfish	R	—	
Eleotridae	<i>Hypseleotris</i> sp.	gudgeon	R	C	1st record in BB
Melanotaenidae	<i>Melanotaenia splendida tatei</i>	desert rainbow fish	R	R	1st record in BB endemic to WP, LE, BB
Percichthyidae	<i>Macquaria ambigua</i>	golden perch	R	C	
Teraponidae	<i>Leiopotherapon unicolor</i>	spangled perch	C	—	occurs in WP, LE, BB
	<i>Bidyanus welchi</i>	Welch's grunter	—	R	

\* A - abundant, C - common, R - rare.

1WP = Western Plateau; LE = Lake Eyre; BB = Bulloo-Bancannia Drainage Divisions.

TABLE 1. Fishes sampled from the Bulloo River

Llewellyn and Pollard (1980) recorded *Neosilurus argenteus* from two bore tanks east of Milparinka in the catchment of the Bulloo system, this catfish is unlikely to be *N. argenteus* (R. McKay pers. comm.). In the current study, *M. splendida tatei* was identified using the description of Allen and Cross (1982). There are no previously published records of melanotaenids from the Bulloo-Bancannia, but one specimen of *Melanotaenia* sp. was sampled from the Bulloo River Overflow in 1975 (AMI 18928-002) and *Melanotaenia splendida* was sampled from the Bulloo River in 1983 (QMI 20398). Substantial genetic differentiation between *M. ambigua* in the Barcoo River (possibly a new species), the Murray-Darling and the Dawson-Fitzroy river systems (Musyl and Keenan unpubl. data) demonstrates the need for research into taxonomy and biogeography of inland Australian fishes. No species is endemic to the Bulloo-Bancannia drainage.

*A. castelnaui*, and *S. barcoo*, have been reported in the Bulloo-Bancannia division (Lake, 1971, 1978; Merrick and Schmida, 1984), but were not sampled during the current study and are not listed in museum records. This may be due to misidentification, inaccurate verbal reports, their absence from this division, their relatively low abundance and/or the limited sampling. Many Australian native fishes have patchy, irregular distributions, and it is likely that fishes in the Bulloo River and other internal drainage divisions undergo very large fluctuations in abundance in response to irregular flooding and long periods of drought that are characteristic of arid, inland Australia. Only *N.*

*erebi* was abundant in both 1986 and 1989, and *Neosilurus* sp., *L. unicolor* and *B. welchi* were each sampled in only one year (Table 1.)

The fish fauna of the Bulloo-Bancannia division is depauperate compared to that of the two adjacent divisions. Glover (1982) listed 26 indigenous species from 12 families in the Lake Eyre division, and there are approximately 24 native species from 12 families in the Murray-Darling river system (McDowall 1980). In contrast, however, Glover (1982) recorded only seven indigenous species from six families in the vast, arid Western Plateau division. The low species diversity and abundance in the Bulloo-Bancannia and Western Plateau divisions are probably due to the ephemeral nature of both divisions and the relatively small size of the Bulloo-Bancannia.

Although Lake (1971) and Llewellyn and Pollard (1980) stated that water from the Bulloo system reaches the Murray-Darling in times of major flooding, the Bulloo-Bancannia is considered to be a separate drainage division (Anon 1967), and waters from the Bulloo cannot reach tributaries of the Murray-Darling river system even during extensive floods (K. Smith, G. Beaton pers. comm.). At least four indigenous species, *Retropinna semoni*, *Craterocephalus eyresii*, *Craterocephalus stercusmuscarum*, and *Ambassis castelnaui*, and the exotic, *Carassius auratus*, that have been recorded in both the Lake Eyre and Murray-Darling divisions (Glover, 1982; Merrick and Schmida, 1984) have not been recorded from the Bulloo, suggesting that there has been no mixing of fishes between the divisions in recent times. This is

Water quality variable	Sampling Site	
	Thargomindah Sept. 1986	"Como Hole" Sept. 1989
turbidity-secchi disc (m)	0.03	0.05
pH	6.6	7.4
total dissolved solids (ppm)	45	50
alkalinity (ppm)	51	51
Ca hardness (ppm)	17	34
Mg hardness	34	17
total hardness (ppm)	51	51
temperature (°C) at surface	18	19
1m	17.5	17
2m	16.5	14
4m	-	13
dissolved oxygen (ppm) at surface	7.8	7.8
1m	7.8	7.8
2m	6.5	6.2
4m	-	5.5

TABLE 2. Limnology of the Bulloo River

supported by the relatively large numbers of *Bidyanus bidyanus*, *R. semoni* and the exotic *Cyprinus carpio* in Boorara Creek [a tributary of the Murray-Darling system close to the Bulloo division (Fig. 1)] in September, 1989 (Midgley and Midgley, unpubl. data).

The high turbidity of the Bulloo River is characteristic of the surface waters of the internal drainage divisions. The water quality variables were at levels considered suitable for freshwater fishes.

#### ACKNOWLEDGEMENTS

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#### LITERATURE CITED

- ALLEN, G.R., and CROSS, N.J., 1982. "Rainbow-fishes of Australia and Papua New Guinea". (Angus and Robertson: Sydney), 141p.
- ANON. 1967. Surface water resources. In "Atlas of Australian Resources" Second series. (Department of National Development: Canberra).
- BARKER, W.R. AND GREENSLADE, P.J.M., (eds) 1982. "Evolution of the flora and fauna of arid Australia". (Peacock: Frewville), 392p.
- GLOVER, C.J.M. 1979. Studies on central Australian fishes: further observations and records. *S. Aust. Nat.* 53: 58-62
1982. Adaptations of fishes in arid Australia. 241-246. In Barker, W.R. and Greenslade, P.J. M. eds.
- GLOVER, C.J.M. AND SIM, T.C. 1978. Studies on central Australian fishes: a progress report. *S. Aust. Nat.* 52: 35-44.
- HOESE, D.F., LARSON, H.K. AND LLEWELLYN, L.C. 1980. Gudgeons. 169-185. In "Freshwater fishes of south-eastern Australia". (Reed: Sydney).
- LAKE, J.S. 1971. "Freshwater fishes and rivers of Australia". (Nelson: Sydney), 61p.
1978. "Australian freshwater fishes. An illustrated field guide." (Nelson: Melbourne), 161p.
- LLEWELLYN, L.C. AND POLLARD, D.A. 1980. Eeltailed catfishes. 91-93. In "Freshwater fishes of south-eastern Australia". (Reed: Sydney).
- MCDOWALL, R.M., (ed.) 1980. "Freshwater fishes of south-eastern Australia." (Reed: Sydney), 208p.
- MERRICK, J.R. AND SCHMIDA, G.E., 1984. "Australian freshwater fishes. Biology and management." (J.R. Merrick: North Ryde), 409p.

# A COLLECTION OF LARGE CORE TOOLS FROM LOWLAND PAPUA, WESTERN PROVINCE, PAPUA NEW GUINEA

MONICA MINNEGAL

Minnegal, M. 1991 08 01: A collection of large core tools from lowland Papua, Western Province, Papua New Guinea. *Memoirs of the Queensland Museum* 30(3): 509-515. Brisbane. ISSN 0079-8835.

Ten large core tools found at or near Gwaimasi village are described. The four waisted blades in the collection were generally somewhat shorter than the unwaisted tools, but no other attributes consistently distinguished these categories. Local people identified all these tools, irrespective of shape, as nut-opening hammers but this interpretation is doubtful.

□ *Core tools, waisted blades, ethnoarchaeology, Papua New Guinea.*

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In 1987 six large axe-like core tools, some waisted, were dug up at Gwaimasi (5°54'S, 142°6'E; 100m ASL), a Papua New Guinean village on the west bank of the Strickland River just south of the Blucher Range foothills. Another four of these implements were found within a few kilometres of the village (Fig. 1). Similar artefacts have previously been recovered in mainland Papua New Guinea from archaeological sites in the Highlands (Bulmer, 1964, 1977; White *et al.*, 1970), from lowlands just north of the central ranges (Gorecki, *pers. comm.*) and from Huon Peninsula on the north coast (Groube *et al.*, 1986). A few have been found as isolates elsewhere (Swadling, 1983), but none have previously been reported from lowland Papua.

This paper provides a description of the Gwaimasi blades. It discusses the context of the finds, their character, and possible interpretations.

## CONTEXT

Gwaimasi is the Kubo name of a waterfall where a small stream drops down to join the Strickland River. In February 1986 a longhouse was built near the top of the fall, on an old levee bank. Over the next 18 months several smaller family houses were built nearby, to form the village that became known as Gwaimasi (or Komagato). The site had been gardened some 15–20 years earlier.

Six large blades made of flaked cobbles were found as ground was cleared within the village. Clearing entailed removal of all topsoil together with associated weeds, shrubs, tree trunks and roots. Soil throughout the 200m<sup>2</sup> area was turned

to a depth of 15–50 cm, and occasionally more. (This was not traditional practice but a response to government demands. It would not have occurred at this site before.) Stones larger than a few centimetres were tossed into heaps; some were to be used later as heat retainers in ovens. Four blades were discovered in these piles. The other two were recognized as they were dug up.

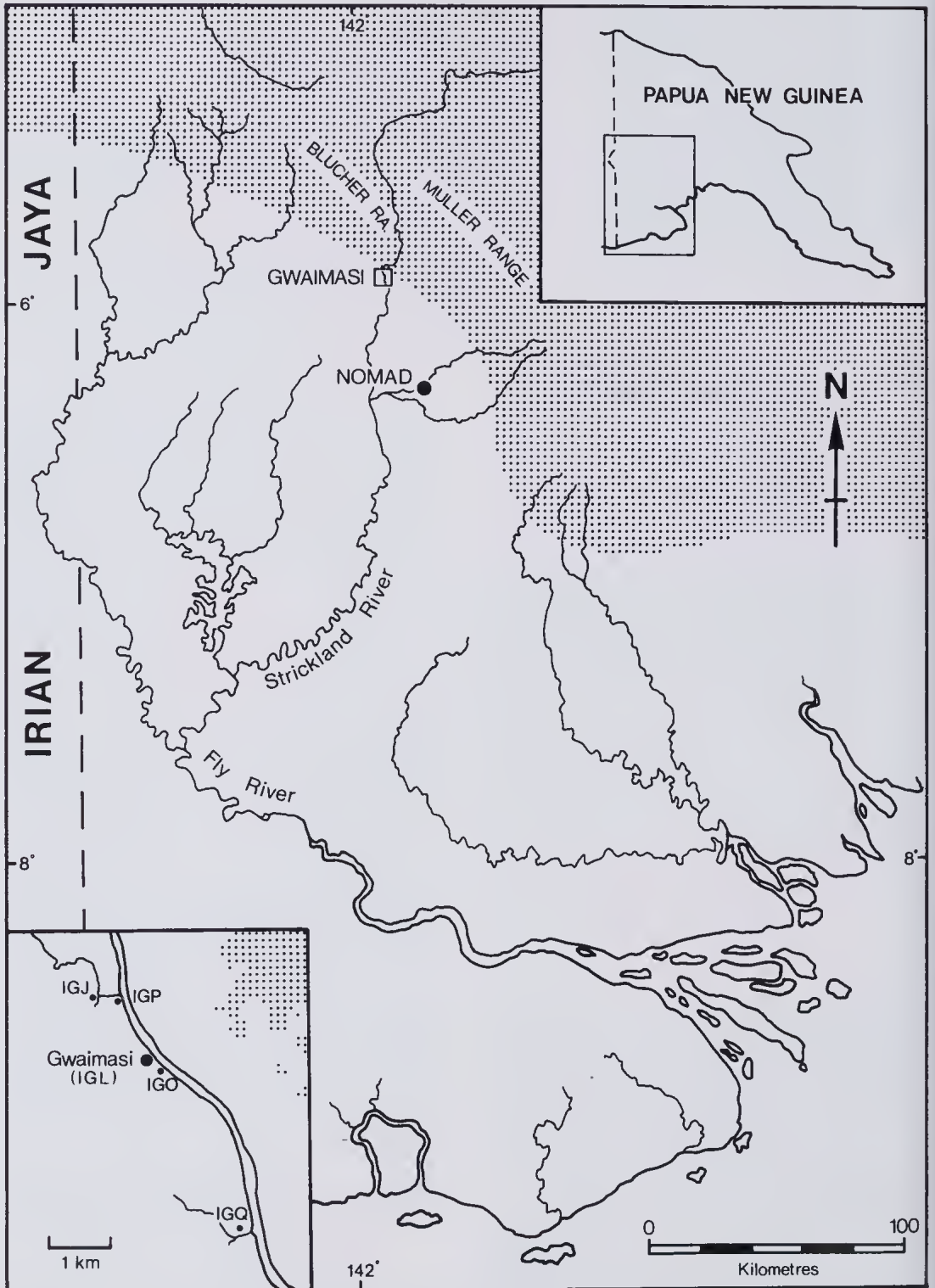
The top of the levee bank, where the village was built, was covered with several metres of coarse yellow-grey silt. Below this lay what appeared to be a cobble bed packed with clay, and then conglomerate rock. The blades were all found in the silt layer, which contained no obvious charcoal or bone that might be used to date the deposit. Apart from the blades themselves the only undoubted artifacts recovered from this layer were a few small chert flakes. No ground or polished artifacts were dug up, though these had been used at least in the recent past (some people still owned specimens).

Another four blades were found up to 4 km from Gwaimasi (Fig. 1). One was at a recently abandoned garden house (IGJ), where it had reportedly been used to open nuts. Another was on a table at an abandoned mining exploration camp (IGP). The third had been placed on a stump in a newly felled garden (IGO), while the last was brought back by a woman who found it while tending pandanus at an old garden site (IGQ).

All ten artefacts are registered in the Papua New Guinea National Museum.

## DESCRIPTION OF BLADES

The Gwaimasi blades were all made from flat,



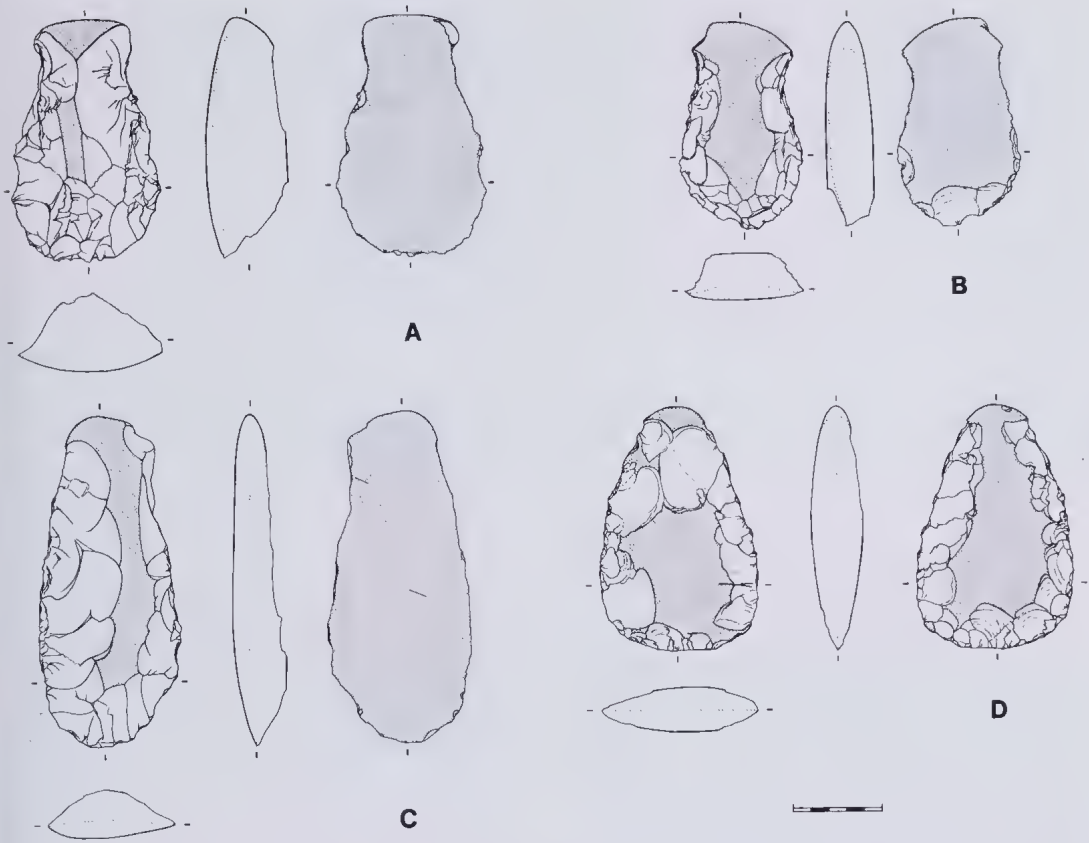


FIG. 2: Four examples of core tools from Gwaimasi. (A = 87.89.7.IGL.5; B = 87.89.4.IGL.2; C = 87.89.1.IGJ.1; D = 87.89.3.IGL.1) Scale is in centimetres.

waterworn cobbles of indurated siltstone or mudstone; such cobbles would have been available as a minor component of conglomerate outcrops in the foothills just north of the village, and in streams draining those hills (Francis, 1989). They have been flaked along three sides, on one or both faces, but generally retain much of the original cortical surface. None shows any sign of grinding (Fig. 2; Table 1). Flaked surfaces on all but one of the blades have a well developed yellowish-brown weathering patina.

Eight of the blades were primarily unifacially flaked, with few flakes, if any, removed from the other face. All have a definite unflaked butt end and a convex edge at the distal end. They tend to have a plano-convex/subtriangular cross-section, with one face much more curved than the other, and an asymmetrical profile, with edges

crenate- or s-shaped when seen end on. Four of these eight blades are distinctly 'waisted', with a pronounced indentation flaked on each side near the butt end (Fig. 2a,b). Another three are roughly similar to these in shape but lack the obvious waist; they have, at most, some narrowing towards the butt (Fig. 2c). The last of the unifacially-flaked blades is somewhat different in shape; it is the narrowest in the collection, despite being the third longest. This blade (87.89.6.IGL.4) was the only one found with flaked surfaces unpatinated, suggesting that it was manufactured more recently than the others or, perhaps, less exposed to weathering.

Two blades were definitely bifacially flaked; they had flakes removed from both faces along all or most of three sides (Fig. 2d). Both fall within the range of sizes for the unifacially-

FIG. 1: Location of Gwaimasi and sites where core tools described were found. Shaded area is land above approximately 200 m.

TABLE 1: Dimensions of the Gwaimasi core tools.

PNG				
National Museum Catalogue No.	Length mm	Breadth mm	Thickness mm	Weight gm
Unifacially flaked waisted				
87.89.7.IGL.5	136.3	83.5	46.0	568
87.89.12.IGO.2	113.2	57.9	36.0	290
87.89.4.IGL.2	117.1	68.0	25.5	295
87.89.5.IGL.3	109.5	70.6	30.0	255
unwaisted				
87.89.1.IGJ.1	183	79.2	27.8	496
87.89.15.IGL.7	159	82.5	40.0	576
87.89.11.IGP.1	139.5	73.7	29.7	361
87.89.6.IGL.4	145.8	57.4	34.8	297
Bifacially flaked				
87.89.3.IGL.1	136.8	86.8	30.7	512
87.89.13.IGQ.1	120.8	73.0	30.0	367

flaked blades, and like those blades their butt ends are unflaked (though one may have been broken). They differ from the unifacially-flaked blades, however, in that their distal ends are less convex and they are lenticular in cross-section. One is very symmetrical in profile. The other, made of coarser stone and more roughly flaked, is less so. In both, edges are straight when seen end on. Neither of these blades is waisted.

Several of the blades have had small chips removed from the cortical face along edges. This chipping, possibly attributable to use damage, is concentrated at distal ends. Two blades have also had several large flakes removed from their cortical face at the distal ends (Fig. 2b). This may reflect attempts to rejuvenate worn blades; these are two of the three shortest blades in the collection.

Most attention in the literature on artifacts of this sort has focussed on waisted examples. Apart from the waisting itself, however, the only attribute that distinguishes waisted from unwaisted blades in this collection is length; the

four waisted blades are also four of the five shortest blades found (Table 1; P.05). No consistent differences appear in either breadth or thickness. Given that the two 'rejuvenated' blades mentioned above were both waisted, it may be that waisting somehow permitted continued use of blades that had been shortened beyond some critical point.

Detailed measurements for the four waisted blades from Gwaimasi (Table 2; dimensions concerned are indicated in Fig.3), compared with waisted blades from other sites in Papua New Guinea (Table 3), suggests some basic patterns. The Gwaimasi waisted blades are, on average, slightly shorter and 10–20mm narrower than those from two highland sites, Kosipe and Yuku, but fall well within the general range of variation. They are, however, 58mm shorter, and 63mm narrower on average than the rather older blades from Huon Peninsula; in fact, the Gwaimasi blades fall completely outside the range of breadths for the Huon blades. Relative to length and breadth the Gwaimasi blades are surprisingly thick. Average thickness is 11mm and 9mm greater than that of blades from Kosipe and Yuku respectively, and only 7mm less than that of the Huon blades. Finally, waists tended to be positioned nearer the butt on Gwaimasi blades than on those from the other sites. The actual positions fall within the range of those from Kosipe, but show only slight overlap with the range of positions on Huon and Yuku tools.

## INTERPRETATION

The Gwaimasi blades appear to have been deliberately manufactured; they were not just cores that have been occasionally and opportunistically used for other tasks. Some of their morphological features, in particular the shapes of cross-sections and edges, may have been accidental consequences of the original shape of the cobbles and of whether flakes were removed from one or both faces. Other attributes, how-

PNG							
National Museum Catalogue No.	L	L <sub>2</sub>	L <sub>3</sub>	B	B <sub>2</sub>	B <sub>3</sub>	
87.89.7.IGL.5	136	29	82	84	48	54	
87.89.12.IGO.2	113	24	75	58	41	51	
87.89.4.IGL.2	117	30	61	68	49	57	
87.89.5.IGL.3	110	38	57	71	38	47	

TABLE 2: Dimensions of four waisted blades from Gwaimasi (mm).

TABLE 3: Average dimensions of waisted blades from four New Guinea sites.

Site (n)	Length (mm)		Breadth (mm)		Thickness (mm)		Position of waist	
	$\bar{L}$	s (range)	$\bar{B}$	s (range)	$\bar{T}$	s (range)	$\frac{L_2}{L}$	s (range)
Huon* (39)	177	24.9 (110-221)	130.3	19.4 (101-167)	41.5	9.4 (26-65)	0.42	0.05 (0.34-0.50)
Kosipe* (7)	126.6	32.1 (83-179)	93.6	30.6 (51-136)	23.1	9.6 (10-34)	0.33	0.11 (0.19-0.52)
Yuku* (10)	127	41.7 (74-215)	81.3	22.0 (57-128)	25.4	12.0 (15-48)	0.40	0.06 (0.32-0.49)
Gwaimasi (4)	119	11.9 (110-136)	70.0	10.5 (58-84)	34.4	8.9 (26-46)	0.26	0.07 (0.21-0.35)

\* Data from Muke (1984).

ever, such as unflaked butt ends and the presence of waisting just below the butt, are more difficult to explain if the blades were simply a source of flakes. In addition, people living in the Gwaimasi area had ready access to much better stone in the form of chert cobbles from the same conglomerate outcrops that provided the stone for the blades; flakes of this chert were present

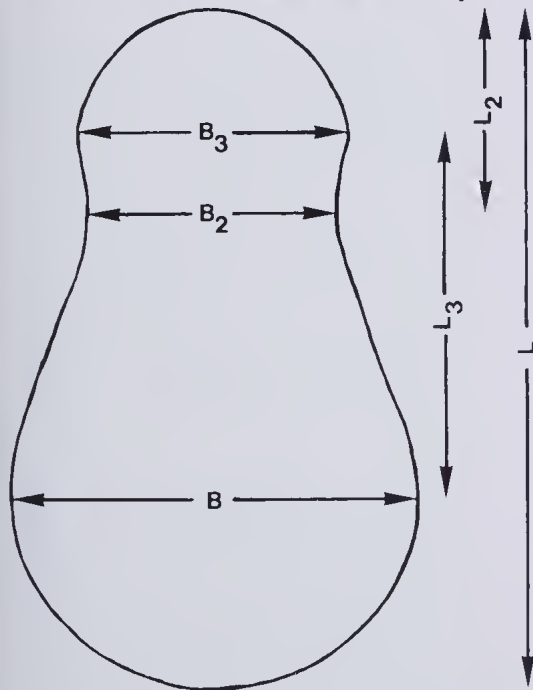


FIG. 3: Key to measurements of waisted blades.

in the levee bank soils where most of the blades were found. But for what were these implements used?

The 25 people who lived at Gwaimasi in 1986-87 were Kubo speakers. This was the western extreme of Kubo land; virtually all other Kubo lived east of the Strickland. Use of stone tools was still part of Kubo life at this time. Chert flakes were used daily to work wood, bone and fibre. Carefully shaped chert cores formed the heads of sago pounders. Stone anvils and hammers were stored at the base of many nut trees, ready for use. Steel axes and bushknives were being used to fell trees and for coarse woodwork but several men, late teens and older, could recall ground stone axes being used for these purposes. (Nomad, the nearest government patrol post at 4 days walk away, was not established till the early 1960's, with regular patrols not reaching people in the Gwaimasi area till 1969.) Ground stone adzes had been used until even more recently for making canoes.

People at Gwaimasi identified the blades immediately as *hoi* (chopping implements). When pressed, they elaborated as *yu hoi* (stone axes) or *kogwai hoi* (ancestor's axes). After some months - a delay imposed not by reluctance to talk but by lack of a common language - several men gave more information. Though questioned separately their stories were remarkably similar. All the blades, irrespective of shape, were classed together as a particular kind of *hoi* - *hagagobi hoi* - used, they said, only for opening *haga* nuts (*Canarium* sp.). They were not hafted; the blade was simply held in the hand and swung

as a hammer, with the side of the blade taking the impact. The men were adamant that the blades were not held as choppers, that the distal ends were not the utilized edges, and that the blades were not used for felling trees.

There are several reasons for doubting the above interpretation. First, most of the blades were simply too short to be used in the manner described without serious risk to knuckles. Stone hammers used by Gwaimasi residents to open nuts tended to be about 200mm in length. They were referred to as *dobae* and not *hoi*, were usually unmodified, had an oval cross-section and no obvious edge. Although one of the Gwaimasi blades (the longest in the collection; 87.89.1.IGJ.1) may well have been used in the previous twelve months to open *Canarium* nuts this observation is more likely to account for the proffered explanation rather than to substantiate it; the occurrence of patination on this blade implies that it had not been recently manufactured for the purpose. Secondly, the inner shell of *Canarium* nuts is very hard, and some use damage could be expected on hammers used to open them. Such damage was certainly evident on a hammer that was seen being used to open *kose* nuts (another *Canarium* sp.). The few signs of possible use damage seen on the collected blades tended to be concentrated at the distal edges, not the sides. Finally, when the first blade was found in the village one of the older men demonstrated to some youths how it would have been hafted - as an adze, not an axe. Later, the same man was one of the most adamant that such blades were not used with a haft.

It seems likely that the interpretation Gwaimasi people gave of these core tools was not based on knowledge of original manufacture and use. Rather, their account was based on the recent casual use some people had made of one blade. As such it deserves to be considered a possibility, but not accepted unquestioningly. Definitive functional interpretations will require analysis of wear and damage patterns on the blades themselves.

## DISCUSSION

Large axe-like core tools, many of them waisted, have now been recovered from scattered sites in the highlands, lowlands and islands of Papua New Guinea. The few dated sites indicate that these implements were first used at least 40,000 BP (Huon; Groube *et al.*, 1986) and continued in use to at least 6,000 BP (Yuku; Bulmer,

1977). Flaked blades began to be finished by grinding during their final period of use at some sites, and their eventual disappearance from assemblages may be related to introduction of fine-quality polished axe-adzes from highland quarries (Bulmer, 1964, 1977).

Muke (1984) has argued that the size and weight of waisted blades has declined through time in Papua New Guinea. This would imply that the Gwaimasi blades are relatively young, and fit into the latter end of this sequence.

The addition of grinding techniques to the stoneworking repertoire was probably of major significance in Papua New Guinea. Bulmer (1977:58) suggested that edge-ground blades were more efficient than their flaked counterparts for many tasks. In particular, while flaked axes may have been adequate for small-scale clearing of trees (e.g. by ring-barking) associated with management of forest edge resources edge-ground blades may have been essential for substantial clearance of forests for gardens. If this interpretation is correct then at the time the Gwaimasi blades were being used the surrounding area may not have been being gardened; no ground implements were found in association with the flaked blades.

This does not necessarily mean that the people who used those blades were not gardeners. PNG farmers still regularly make special camps to exploit forest resources, such as pandanus nuts or sago, that are only available in areas above or below the altitude range of their gardens. Kosipe, a highlands site with a stone assemblage dominated by large flaked blades, has been interpreted as a seasonal camp for exploitation of pandanus nuts. Perhaps Gwaimasi, too, was a seasonal camp to which people, based in foothills and mountains to the north, descended to procure certain otherwise unobtainable forest resources. One such resource may have been sago, which grows wild in the extensive swamps behind Gwaimasi but does not naturally occur in the hills.

Given the limited amount of archaeological work done in interior lowland Papua New Guinea it is difficult to assess the merits of this suggestion. Interestingly, however, the only site in the northern lowlands where large numbers of flaked blades have been found (Yerem; Gorecki *pers. comm.*) occupies a situation almost identical to that of Gwaimasi - on the banks of a river just where it emerges from mountains to flow through sago swamps.



## ACKNOWLEDGEMENTS

Pamela Swadling, of the Papua New Guinea National Museum, organized identification of the raw materials used for the Gwaimasi blades, and encouraged publication of this description. Peter Dwyer, of the Zoology Department, University of Queensland, organized the field trip.

## LITERATURE CITED

- BULMER, S. 1964. Prehistoric stone implements from the New Guinea highlands. *Oceania* 34(2): 246-268.
1977. Waisted blades and axes. 40-50. In Wright, R.V.S.(ed.). 'Stone tools as cultural markers'. (Australian Institute of Aboriginal Studies: Canberra).
- FRANCIS, G. 1989. 'Petrography of the Gwaimasi flaked blades'. (Unpublished Technical Note, Geological Survey, Department of Minerals and Energy, Papua New Guinea).
- GROUBE, L., CHAPPELL, J., MUKE, J. AND PRICE, D. 1986. A 40,000 year-old human occupation site at Huon Peninsula, Papua New Guinea. *Nature* 324: 453-455.
- MUKE, J.D. 1984. 'The Huon discoveries: a preliminary report on the stone artefacts and a comparative analysis of the distribution of waisted tools in Greater New Guinea'. Unpublished B.Lit. thesis, ANU, Canberra.
- SWADLING, P. 1983. 'How long have people been in the Ok Tedi impact region?' Papua New Guinea National Museum Record 8.
- WHITE, J.P., CROOK, K.W.A. AND BUXTON, B.P. 1970. Kosipe: a late Pleistocene site in the Papuan highlands. *Proc. Prehistoric Soc. n.s.* 36: 142-170.



THE INDO-PACIFIC PILUMNIDAE VII. NOTES ON *HETEROPILUMNUS*  
*SASEKUMARI* (SERÈNE, 1971) AND *CRYPTOLUTEA* WARD, 1936 (CRUSTACEA:  
DECAPODA: BRACHYURA)

PETER K.L. NG AND PETER J.F. DAVIE

Ng, P.K.L. and Davie, P.J.F. 1991 08 01: The Indo-Pacific Pilumnidae VII. Notes on *Heteropilumnus sasekumari* (Serène, 1971) and *Cryptolutea* Ward, 1936 (Crustacea: Decapoda: Brachyura). *Memoirs of the Queensland Museum* 30(3): 517–524. Brisbane. ISSN 0079-8835.

A redescription of the poorly known pilumnid crab *Heteropilumnus sasekumari* (Serène, 1971) is provided, including the first known males of the species. *H. sasekumari* is only the second rhizopine species known to occur predominantly in mangroves, with a wide range from Peninsular Malaysia to Borneo and northern Australia. *Cryptolutea lindamanensis* is redescribed and the genus rediagnosed. A primary diagnostic character is the denticulated plate produced from the coxa of each ambulatory leg. *Serratocoxa* Ng, is considered a junior synonym of *Cryptolutea* Ward. *Cryptolutea* now contains *C. lindamanensis* Ward, *C. sagamiensis* (Sakai), *C. granulosa* (MacGilchrist), and *C. teschi* (Serène). □ Crustacea, Brachyura, Pilumnidae, mangrove-dwelling, Indo-West Pacific.

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The Indo-West Pacific pilumnid subfamily Rhizopinae Stimpson, 1858, is comprised of small, usually mud-dwelling crabs, that are often cryptic. Their taxonomy has been under extensive review in recent years (Ng, 1987) but some problems remain to be resolved. In particular *Cryptolutea* Ward, 1936, has been poorly known. It was included in the Rhizopinae for the first time by Ng (1987) but he was unable to adequately diagnose it, and expressed some doubts as to its validity.

*Heteropilumnus sasekumari* was originally described on the basis of a single female from the mangroves of western Peninsular Malaysia under *Rhizopa* Stimpson, 1858, by Serène (1971). Ng (1985) queried the placement of this species in *Rhizopa* and refigured the species. He also added a new record (a female) from Labuan, northern Borneo. Davie (1985) then recorded the species as *Rhizopa sasekumari* in his checklist of mangrove crabs from northern Australia. He incorrectly recorded the species from Singapore. Ng (1987) subsequently transferred the species to *Heteropilumnus* De Man, 1895, restricting *Rhizopa* to *R. gracillipes* Stimpson, 1858.

Males of *Heteropilumnus sasekumari* have not previously been collected. In view of the importance of the male gonoduct positions, form of the male first pleopod, and structure of the male abdomen in xanthoid and pilumnid taxonomy,

opportunity is taken here to describe the first known males of *Heteropilumnus sasekumari* from Australia. This species is also unusual with regard to its ecology – all specimens have been recorded from mangroves and appear to prefer this habitat. This would make it only the second mangal rhizopine species known (see Ng, 1990).

G1 and G2 indicate the male first and second pleopods, respectively. All measurements are of the carapace width and length, respectively. Specimens are deposited in the Queensland Museum (QM) and Zoological Reference Collection (ZRC), Department of Zoology, National University of Singapore.

***Heteropilumnus sasekumari* (Serène, 1971)**  
(Figs 1, 2)

?*Rhizopa sasekumari* Serène, 1971: 915-16, Pl. 5A.  
*Rhizopa sasekumari*: Guinot, 1971: 1078; Ng, 1985: 631, Fig. 2; Davie, 1985: 261, 262.  
*Heteropilumnus sasekumari*: Ng, 1987: 73, 79, 96.

**MATERIAL EXAMINED**

HOLOTYPE: ZRC 1969.12.2.7, ♂, littoral zone, Port Swettenham, western Peninsular Malaysia, A. Sasekumar, 28 Oct. 1968.

OTHER MATERIAL: ZRC 1965.11.23.49–50, 2 ♀♀, Prai, Province Wellesley, western Peninsular Malaysia, Dec. 1938 (det. R. Serène, 1962). ZRC

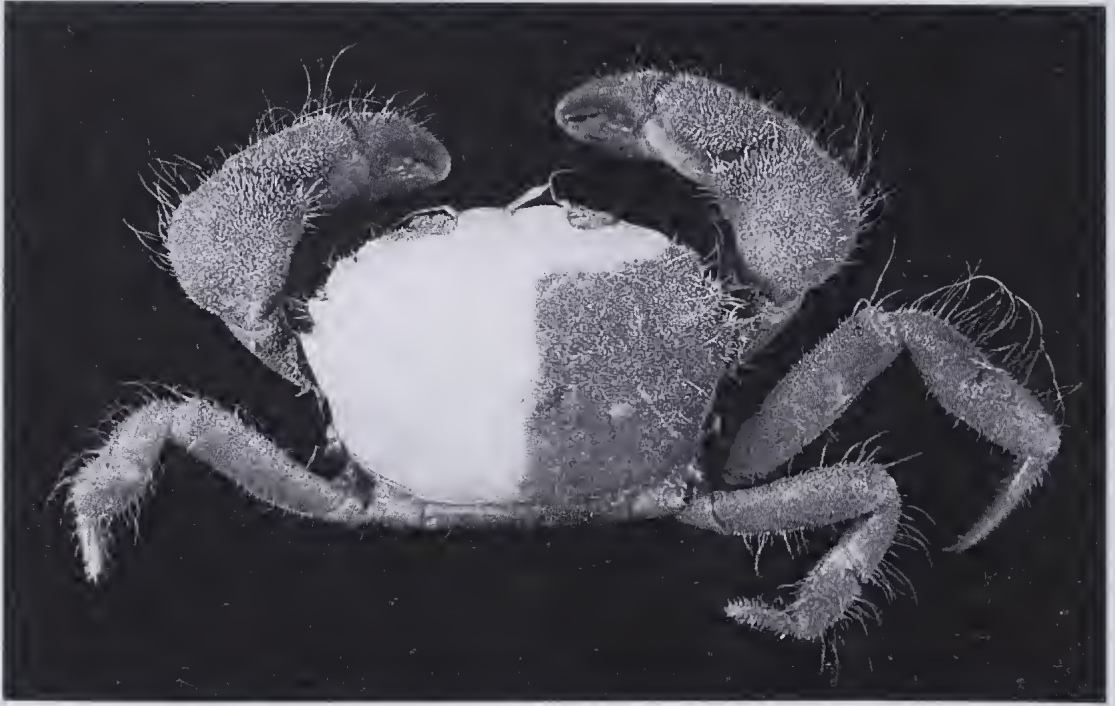


FIG. 1. *Heteropilumnus sasekumari* (Serène, 1971). Male, 18.0 x 13.5 mm, Queensland (QM W4596).

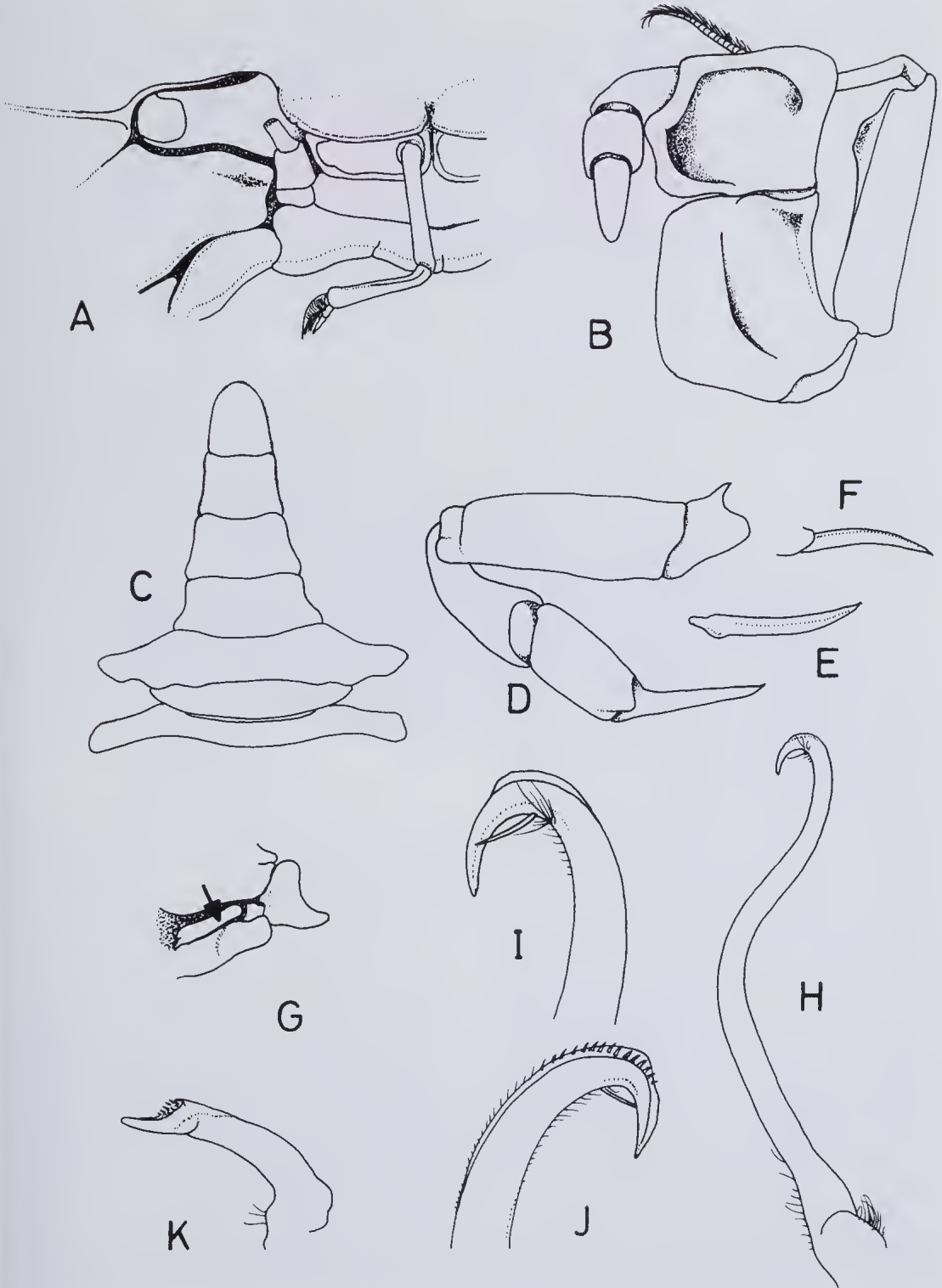
1965.11.23.51, ♀, mangrove, Labuan, Sabah, Borneo, 1938 (det. R. Serène, 6 Dec. 1969). QM W4596, ♂, (18.0 x 13.5 mm), Trinity Inlet, C. 2.5 km from mouth of Redbank Creek, Cairns, Queensland, R. Timmins, 13 Dec. 1974. QM W3852, ♂, Calliope River, SE Queensland, Australia, 4 Aug. 1978. QM W7887, ♀, Susan River, Hervey Bay, SE Queensland, Australian Littoral Society, 24 Dec. 1971.

#### DESCRIPTION

Carapace quadrilateral, distinctly broader than long. Dorsal surface densely pubescent, with numerous scattered long hairs; pubescence does not completely obscure indentation on anterolateral margin. Frontal margin deflexed, divided into two gently convex lobes by shallow cleft, external angle not obvious. Orbital margins smooth, outer edges of supra- and infraorbital margins separated by deep, very narrow incision. Eyes well developed, filling orbital space, cor-

nea distinct, pigmentation present. Basal antennal segment movable, filling most of wide orbital hiatus (Fig. 2A). Antennular fossae wide, occupying most of space below frontal margin, separated by very narrow gap. External orbital angle well defined, broadly truncate, outer margin gently sinuous, inner margin very short, separated from first epibranchial tooth by deep but narrow notch; first epibranchial tooth broadly triangular, inner margin half length of outer, outer margin gently sinuous, separated from second epibranchial tooth by triangular notch, second epibranchial tooth triangular, curved obliquely forwards, inner margin concave, outer distinctly convex, tip rounded, separated from third epibranchial tooth by deep V-shaped notch, third epibranchial tooth triangular, directed obliquely outwards, tip sharp. Posterolateral margins almost straight, distinctly converging towards gently convex posterior carapace margin. Posterior margin of epistome sinuous, distinctly

FIG. 2. *Heteropilumnus sasekumari* (Serène, 1971). Male, 18.0 x 13.5 mm, Queensland (QM W4596). A, frontal view. B, left third maxilliped (denuded). C, abdomen. D, left fourth ambulatory leg (denuded). E, dactylus of left fourth ambulatory leg, lateral view. F, dactylus of left fourth ambulatory leg, dorsal view showing curvature. G, left male gonopore and penis (arrow). H, left G1. I, J, distal part of G1. K, left G2.



cut into four lobes, incisions deep, distinct. Endostomial ridges not apparent.

Third maxillipeds occupying entire buccal cavity, merus quadrate, depressed medially, margins cristate, outer distal margin distinctly produced; ischium wider proximally than distally, with deep median sulcus, inner margin with row of short stiff hairs, outer margin distinctly concave; exopod long, reaching external angle of merus, distal one third of inner edge with truncated lobe, setose flagellum long, extending beyond width of merus (Fig. 2B).

Chelipeds stout, usually right slightly larger. Outer surfaces covered with dense pubescence and scattered long stiff setae. Distal posterior margin of merus with sharp tooth. Inner angle of carpus with large low, blunt tooth. Median parts of larger chela naked, smooth; pubescent areas with numerous small granules; inner surface rugose. Fingers darkened almost to hooked tip which is beige-coloured; cutting edges with 5–6 large blunt teeth and several denticles; fingers each with one low longitudinal ridge on outer surface; dorsal proximal part of dactylus with numerous small granules, pubescence, and scattered long setae (Ng, 1985: Fig. 2C, D).

Ambulatory legs setose as on carapace, second leg longest, meri, carpi and propodi unarmed, surfaces smooth when denuded, without spines or tubercles. First to fourth dactyli long, gently recurved, fifth dactylus, when placed horizontally, curves gently upwards (Fig. 2D–E).

Male abdomen with seven segments, all freely articulating (Fig. 2C). First male abdominal segment reaching base of coxa of last pair of ambulatory legs, second less wide, third hexagonal, fourth to sixth progressively less trapezoidal, seventh triangular, lateral margins convex, tip rounded.

Gonopores coxal, penis reaching G1 via relatively broad, exposed groove formed by sternites 7 and 8 (Fig. 2G). G1 very slender, strongly sinuous, distal part hooked downwards, tip very slender, tapering to sharp point (Fig. 2H–J). G2 very short, sigmoid, distal part dilated, inner surface depressed into cup-like structure, tip distinctly produced, cup-like depression with numerous short spines (Fig. 2K).

#### DISTRIBUTION

Western Peninsular Malaysia; Labuan, Sabah, Borneo; tropical and sub-tropical eastern Queensland, Australia.

#### REMARKS

The transfer and retention of *sasekumari* in *Heteropilumnus* remains provisional. Ng (1987) noted that *Heteropilumnus* is in urgent need of revision; the characters used to characterise the genus being inadequate (Ng and Tan, 1988). The carapace provides the only reliable generic features the shape (almost rectangular), and the pattern of setae on the dorsal surface (a short pubescence on the posterior parts of the carapace, with much longer setae on the anterolateral, supra-orbital, frontal regions and frontal margins). Several species in *Pilumnus* (*s. lato*), *Cryptocoeloma*, *Viaderiana* and *Typhlocarcinus* also appear to be very closely related (Ng, 1987, 1989).

In the ZRC are two more females (not reported by Ng, 1985) of *H. sasekumari* (ZRC 1965.11.23.49–50) from Prai, in Province Wellesley, northwestern Peninsular Malaysia, near the island of Penang. They had been identified by Serène before 1971, but he did not include this material in his original description. This record thus extends the species' range further north.

*Heteropilumnus sasekumari* is one of only two pilumnids known to occur predominantly (if not wholly) in littoral mangrove areas. Other than its habitat, almost nothing else is known about its biology and habits. The other known mangrove pilumnid is the rhizopine, *Luteocarcinus sordidus* Ng, 1990, from western Peninsular Malaysia.

#### *Cryptolutea* Ward, 1936

*Cryptolutea* Ward, 1936: 1 (type species *Cryptolutea lindemanensis* Ward, 1936, by monotypy).

*Cryptolutea*: Guinot, 1969: 247; Ng, 1987: 87, 99.

*Serratocoxa* Ng, 1987: 101 (type species *Lophoplax teschi* Serène, 1971, by original designation).

#### REMARKS

This poorly known monotypic genus contained *C. lindemanensis* Ward, 1936, known only from the holotype from Lindeman Island off central Queensland. Ng (1987: 99) placed it in the Rhizopinae and expressed doubt on its validity, suggesting that *C. lindemanensis* may be a synonym of *Ceratoplax luteus*. Elsewhere in that paper (p. 101) he recognised a group of species, *Lophoplax teschi* Serène, 1971, *Ceratoplax sagamiensis* Sakai, 1935, and *C. granulosa* MacGilchrist, 1905, as being congeneric and erected *Serratocoxa*, to receive them. This had earlier been suggested by Serène



FIG. 3. *Cryptolutea lindemanensis* Ward, 1936. Male holotype (QMW744).

and Lohavanijaya (1973) who were first to recognise on '... the posterior border of the ambulatory legs of a denticulated wing-like plate covering the ischium' on all three species.

On examination of the holotype of *C. lindemanensis* it was found that this species was both clearly distinct from *Ceratoplax luteus* and also exhibited the remarkable wing-like plate on the coxa of the walking legs. It is without doubt congeneric with the other species included by Ng (1987) in *Serratocoxa* and therefore *Serratocoxa* Ng must become a junior synonym of *Cryptolutea* Ward. A diagnosis is given here which is only slightly modified from that given by Ng (1987) for *Serratocoxa*.

*Cryptolutea* now contains *C. lindemanensis*

Ward, 1936; *C. sagamiensis* (Sakai, 1935); *C. granulosa* (MacGilchrist, 1905), and *C. teschi* (Serène, 1971).

#### DIAGNOSIS

Carapace distinctly quadrate, the anterolateral margin arcuate, almost entire, or with blunt lobes more or less distinct. Anterolateral angle of merus of third maxilliped produced. Coxa of ambulatory legs with denticulated plate which partially covers the ischium. First male abdominal segment broader than third, reaching, or almost reaching base of last pair of ambulatory legs; male genital openings coxal, with penis exposed and lying in a groove between sternites 7 and 8. G1 slender, sinuous; G2 short, sinuous.

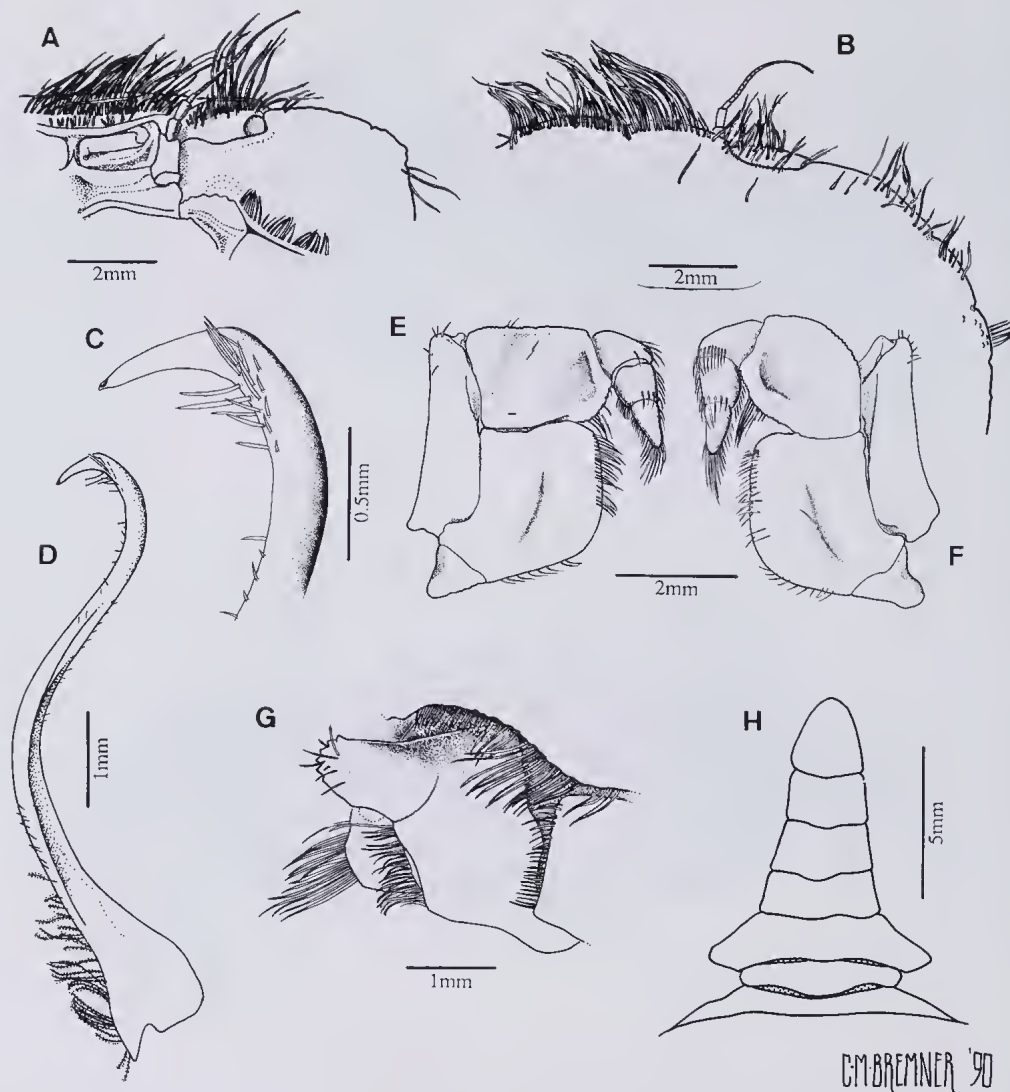


FIG. 4. *Cryptolutea lindemanensis* Ward, 1936. Male holotype (QM W744). A, frontal view. B, frontal and anterolateral margin. C, tip of left G1. D, left G1. E, right third maxilliped. F, deformed left third maxilliped. G, denticulated plate on the coxa of fourth ambulatory leg. H, abdomen.

***Cryptolutea lindemanensis* Ward, 1936**  
(Figs 3, 4)

*Cryptolutea lindemanensis* Ward, 1936: 1-2, pl.1, figs 1-3; Ng, 1987: 79, 99.

**MATERIAL EXAMINED**

**HOLOTYPE:** QMW744, 1♂ (15.8 x 12.4 mm) Lindeman Is., Whitsunday Passage, ME. Queensland, M. Ward.

**DESCRIPTION**

Carapace quadrilateral, 1.27 times broader than long. Dorsal surface glabrous, but edged by a fringe of moderately long, soft setae, particularly prominent across frontal lobes and onto ocular peduncles. Regional definition not obvious except for transverse gastro-cardiac groove, and associated short concave longitudinal grooves. Frontal margin deflexed, slightly concave viewed from front, laterally rounded without antennal notches; frontal region with shallow, median, longitudinal groove so



that front appears slightly bilobed from above. Supra-orbital border minutely granular, laterally rounded to form first epibranchial lobe. Intra-orbital margin smooth; laterally rounded, without notches or incisions; blunt lobe at inner edge, reaching level of distal end of basal antennal segment. Ocular peduncles fill the orbital space; not freely movable; corneas relatively small, not visible from above; distinct but not darkly pigmented in holotype. Basal antennal segment movable, inner distal margin just reaching front. Antennular fossae wide, occupying most of space below frontal margin, separated by narrow septum. Anterolateral margin granular, evenly arched, divided into 3 confluent broad lobes separated by two small but distinct notches; first lobe longer than second, third lobe not clearly separated from posterolateral margin. Posterolateral margins slightly convergent. Posterior margin, very broad, only slightly less than maximum carapace width; costate; slightly and evenly convex. Posterior margin of epistome, triangular medially with distinct median incision; medio-lateral incisions vestigial; lateral margins, straight, oblique. Endostomial ridges present, confined to lower half of efferent branchial canal.

Third maxillipeds occupying most of buccal cavity. Merus quadrangular, c. 1.4 times broader than long; outer distal margin produced (Fig. 4E) (left third maxilliped of the holotype (Fig. 4F) has an apparently aberrant merus). Ischium with lateral margins sub-parallel except near base where width increases; c. 1.8 times longer than width medially; inner margin slightly convex, granular over distal third, becoming smooth proximally, armed with a row of stiff setae originating behind margin. Exopod reaching external angle of the merus.

Ambulatory legs fringed with long setae; third pair longest; unarmed except for serrated coxal plate (Fig. 4G), which is produced to lie over proximal part of ischium. Dactyli relatively long, subequal in length to propodi; armed with long slender terminal claw; bearing 5 thick rows of long setae, one along dorsal mid-line, and two pairs spaced evenly on anterior and posterior surfaces. Dactyli of first three pairs gently recurved; dactyli of fifth pair curved slightly upwards.

Chelipeds stout, left slightly larger. Merus armed on posterior margin with blunt, granulated, sub-distal tooth. Carpus with inner angle granulate, bearing a broad fringe of long setae, otherwise naked. Chela naked except for broad

band of long setae on superior surface which extends onto dactylus for about its proximal third. Dactylus with longitudinal groove running most of its length. Both fingers darkened for approximately distal four-fifths, fingers pointed; crossing at tips; evenly serrated. Fixed finger with longitudinal groove for most of its length; with a few short setae in the groove. Outer face of chela naked; smooth except for two or three rows of low scattered tubercles near the inferior margin; and a few granules proximally.

Male abdomen with seven free segments. First segment broader than third, almost but not quite reaching to base of coxa of last pair of legs. Second segment much narrower than first or third. Fourth to sixth segments tapering. Telson rounded triangular, slightly longer than broad at base, longer than preceding segments.

Gonopores coxal; penis lies exposed in groove between sternites 7 and 8. G1 very slender, sinuous; distal part weakly recurved, tip very slender, tapering to a sharp point; a series of stout setae present sub-proximally (Fig. 4C). G2 very short, sigmoid, tip very long and slender, armed with single long, fine seta terminally.

#### DISTRIBUTION

Only known from the type specimen from Lindeman Is., mid-eastern Queensland.

#### REMARKS

The merus of the left third maxilliped of the holotype may be considered aberrant. Unlike the right merus, that on the left has the outer distal margin rounded and not produced at all. The inner proximal margin is also more obliquely receding than that on the right (Fig. 4F). Both these differences give the merus a more ovoid shape and the third maxilliped a much less quadrate appearance (Fig. 4E, F). The left maxilliped agrees with the right in all other aspects. It is probable that the shape of the left merus is a result of previous damage and aberrant regrowth. The form of the outer distal margin of the third maxilliped merus has been used extensively in rhizopine taxonomy (Ng, 1987), and the present observations of asymmetrical third maxilliped meri in *C. lindemaniensis* indicates that it may sometimes be less reliable than previously believed; especially when only single specimens are known.

#### ACKNOWLEDGEMENTS

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#### LITERATURE CITED

- DAVIE, P.J.F. 1985. The Biogeography of littoral crabs (Crustacea: Decapoda; Brachyura) associated with tidal wetlands in tropical and subtropical Australia. In K. N. Bardsley, J.D.S. Davie and C.D. Woodroffe (eds), 'Coasts and tidal wetlands of the Australian monsoon region,' A. N. U. North Aus. Res. Unit, Darwin, Mangrove Mon. 1: 259-275.
- GUINOT, D. 1969. Recherches préliminaires sur les groupements naturels chez les Crustacés Decapodés Brachyours. VII. Les Goneplacidae. Bull. Mus. Natn. d'Hist. Nat. Paris (2)41(1): 241-265.
1971. Recherches préliminaires sur les groupements naturels chez les Crustacés Decapodés Brachyours. VIII. Synthèse et bibliographie. Bull. Mus. Natn. d'Hist. Nat. Paris (2)42(5): 1063-1090.
- NG, P.K.L. 1985. On a new species of pilumnid crab, *Rhizopa yangae* sp. nov. from Singapore, with notes on the genus *Rhizopa* Stimpson, 1858 (Decapoda: Brachyura: Pilumnidae). J. nat. Hist. 19: 627-633.
1987. The Indo-Pacific Pilumnidae II. A Revision of the genus *Rhizopa* Stimpson, 1858 and the status of the Rhizopinae Stimpson, 1858 (Crustacea: Decapoda: Brachyura). Indo-Malayan Zoology 4(1): 69-111, Pl. 1.
1989. The Indo-Pacific Pilumnidae IV. On *Cryptocoeloma haswelli* Rathbun, 1923 (Crustacea Decapoda, Brachyura). Crustaceana 56: 47-57.
1990. Indo-Pacific Pilumnidae VI. *Luteocarcinus sordidus* new genus and species, from mangrove swamps in Peninsular Malaysia (Crustacea: Decapoda: Brachyura: Rhizopinae). Proc. Biol. Soc. Wash. 103: 95-99.
- NG, P.K.L. AND TAN, L.W.H. 1988. The identities of *Heteropilumnus subinteger* (Lanchester, 1900) and *Heteropilumnus hirsutior* (Lanchester, 1900) stat. nov., with description of a new species, *Heteropilumnus holthuisi* sp. nov. (Crustacea, Decapoda, Brachyura, Pilumnidae). Crustaceana 54: 13-24.
- SERÈNE, R. 1971. Observations préliminaires sur des Brachyours nouveaux ou Mal Connus du Sud-est Asiatique (Crustacea Decapoda). Bull. Mus. Natn. d'Hist. Nat. Paris (2)42(5): 903-918.
- SERÈNE, R. AND LOHAVANIJAYA, P. 1973. The Brachyura (Crustacea: Decapoda) collected by the Naga Expedition, including a review of the Homolidae. In 'Scientific results of marine investigations of the South China Sea and the gulf of Thailand 1959-1961'. Naga Report 4(4): 1-187.
- WARD, M. 1936. Crustacea Brachyura from the coasts of Queensland. Mem. Qd Mus. 11: 1-13.

## INTERTIDAL AND SHALLOW WATER HYDROIDS FROM FIJI. II. PLUMULARIIDAE AND AGLAOPHENIIDAE

J.S. RYLAND AND M.J. GIBBONS

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Nineteen species of Hydroida Plumulariidae and Aglaopheniidae were obtained from intertidal reefs and shallow waters in Fiji. The generic name *Monotheca* Nutting is used for species of *Plumularia* (s. lat.) having a single hydrotheca per hydrocladium, for example, *M. obliqua* (Saunders in Johnston); and *Lytocarpia* Kirchenpauer and *Macrorhynchia* Kirchenpauer are preferred to their better known junior synonyms, respectively *Thecocarpus* Nutting and *Lytocarpus* Allman. *Lytocarpia bathyalis* sp.nov., *L. nicpenni* sp.nov. and *L. vitiensis* sp.nov. are erected. All species are illustrated with line drawings made using a camera lucida, and substantial variability is figured for *Gymnangium eximum* (Allman) and *Lytocarpia phyteuma* (Kirchenpauer). □Hydroida, taxonomy, Pacific, Fiji, coral reefs, intertidal, shallow water.

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This paper constitutes the second and final part of our account of hydroids collected by the first author in Fiji during 1978-80, and deals with the Plumulariidae (in the broad sense). All the non-plumulariid hydroids were described by Gibbons and Ryland (1989) whose account should be consulted for a general introduction and for details of the stations.

### SYSTEMATICS

#### Family PLUMULARIIDAE

##### *Antennella* Allman, 1877

##### *A. secundaria* (Gmelin, 1791) (Fig. 1)

*Sertularia secundaria* Gmelin, 1791: 3854  
*Antennella secundaria* (Gmelin, 1791): Millard, 1975:  
332; Vervoort and Vasseur, 1977: 64

#### DESCRIPTION

Colony typically comprising erect, unbranched stems without hydrocladia (but see Variations), reaching 10 mm. Stem consisting of basal athecate and distal hydrotheca-bearing regions. The former of variable length, with one or more transverse nodes proximally; only its distalmost internode bearing mesial

nematothecae; terminated by a hinge joint. Stem thecate distally, with alternate thecate and athecate internodes separated by almost transverse and very oblique nodes respectively. Atecate internodes of variable length, usually longer than thecate internodes; one or two nematothecae; without internodal septa. Thecate internodes with four nematothecae: one medio-inferior, not reaching base of hydrotheca, a pair of laterals which rarely overlap the thecal margin, and one small medio-superior nematotheca in axil immediately behind free adcauline wall of hydrotheca; internodal septa absent.

Hydrothecae cup-shaped, adnate for one-half to two-thirds vertical height, with sides more or less straight and parallel, flaring to margin; or abcauline wall convex in lower region before expanding to margin above; variably thickened. Margin smooth and oblique, at 45-55° to axis. Basal hydrothecae broader and more squat than those distally.

Medio-inferior nematotheca two-chambered but of variable length and mobility; distal chamber scoop-like, adcauline wall much lower than abcauline. Lateral nematothecae pedicellate, arising near top of adnate region of hydrotheca; infundibulariform, the distal chamber broad and shallow, with rim sloping gently mesiad from outer edge. Medio-superior nematotheca of variable size: minute and one-chambered or larger

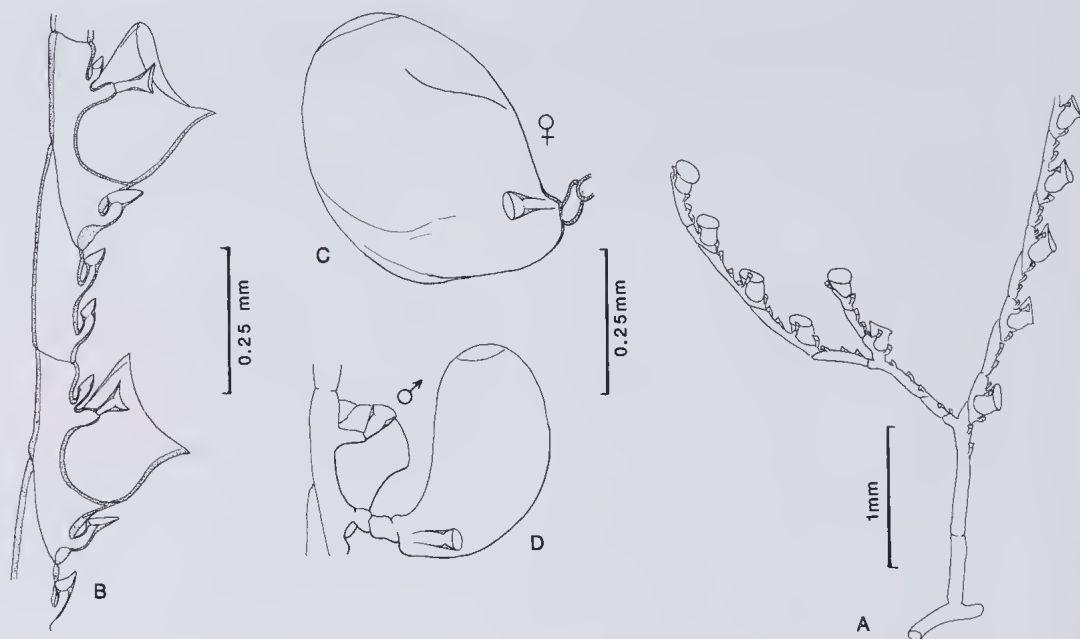


FIG. 1. *Antennella secundaria*. A, part of colony. B, hydrothecae and nematothecae. C, female gonotheca. D, male gonotheca. A,C,D, QMGL10291, Joske's Reef. B, QMGL10292, Great Astrolabe Reef.

and two-chambered, distal chamber with almost non-existent adcauline wall.

Colony hermaphrodite. Gonothecae borne immediately below hydrothecae, often male and female from below same hydrotheca. Both with pedicel of two segments, curved and pear-shaped, tapering proximad and rounded distally, with operculate aperture; bearing 2-3 two-chambered nematothecae basally. Male gonotheca smaller and less truncated distally.

#### VARIATIONS AND REMARKS

Unbranched colonies are common everywhere around Fiji. However, branched forms, which tend to resemble *Monastaechas quadridens* (McCrary, 1857) in colony structure and helicoid sympodial branching, are also present. In these, an apophysis is present on the posterior surface of the basal athecate internode, immediately below the terminal hinge-joint. This in turn gives rise to another athecate internode of variable length, with a variable number of nematothecae, terminal hinge-joint and posterior apophysis, etc. Each branch, therefore, arises from an apophysis on the posterior surface of the previous one. Colonies with more than four such branches rare; occasional colonies have two hydrocladial apophyses arising at the same level

on the posterior or postero-lateral surface of the basal internode. While *A. secundaria* and *M. quadridens* are very similar, Millard (1975) has pointed out they can be differentiated by examining the main colony axis. If this is formed by the first hydrocladium then the specimen is *A. secundaria*: if it is formed by the bases of successive hydrocladia then *M. quadridens*. Vervoort and Vasseur (1977) have given very good descriptions of the two forms.

#### MEASUREMENTS ( $\mu\text{m}$ )

Measurements for unbranched and branched colonies respectively. Hydrocladium: thecate internode 105-240, 130-170; athecate internode 300-420, 280-410. Hydrotheca: abcauline length 160-190, 140-180; adnate adcauline length 105-145, 135-140; free adcauline length 70-115, 110-125; marginal diameter 165-225, 160-200. Gonotheca (seen only on unbranched colonies; presumed  $\delta$  and  $\eta$  respectively): vertical height 324-432, 396-450; opercular diameter 72-90, 144-162; maximum width 191-210, 252-238.

#### OCCURRENCE IN FIJI

Common and widespread, usually under coral boulders, once on *Thyrosocyphus fruticosus*;

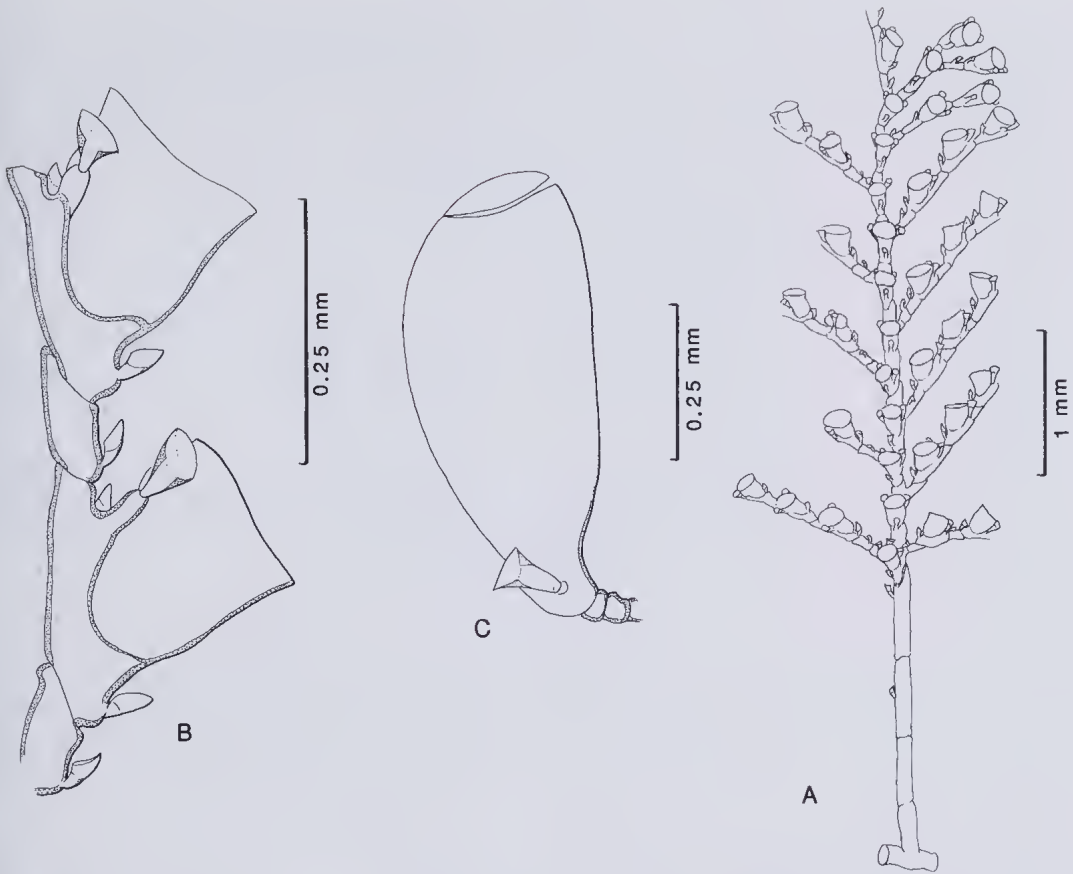


FIG. 2. *Halopterus buskii*. A, part of colony. B, part of hydrocladium. C, gonotheca. QMGL10293, Suva Barrier Reef.

sometimes supporting *Hebella parasitica* (Suva barrier reef). Ndeumba, 20 Aug 78 (BM 1984.5.17.38); with gonothecae 24 Jun 78 and 18 Sep 78 (QM GL10291; BM 1984.5.17.39). Also collected at Tanaea, Tarawa atoll, Kiribati, 11 Feb 79.

#### WORLD DISTRIBUTION

Cosmopolitan. Type locality: Mediterranean.

*Halopterus* Allman, 1877

*Halopterus buskii* (Bale, 1884)  
(Fig. 2)

*Plumularia buskii* Bale, 1884: 125

*Plumularia buskii*: Billard, 1913: 21

*Heterotheca buskii* (Bale): Hirohito, 1974: 30

*Halopterus buskii* (Bale, 1884): Vervoort and Vasseur, 1977: 72

#### DESCRIPTION

Colony with erect stems arising from a hydro-rhiza, reaching 9 mm; consisting of basal athecate and distal thecate, hydrocladia-bearing parts, the two separated by a hinge-joint. Proximal part may be subdivided by transverse nodes; uppermost internode bearing anterior nematothecac in two longitudinal series. Distal part divided by oblique hinge-like nodes into thecate internodes, each with one hydrotheca and up to six nematothecae: one medio-inferior, one or two pairs lateral, and up to three medio-superior, in two longitudinal series (either alternate or opposite each other). One or two pairs of subopposite hydrocladia arising on short apophyses from sides of first one or two cauline hydrothecae; thereafter, arrangement alternate, one hydrocladium per internode. An athecate internode may occur immediately above a hydrotheca, in which case bearing one or more

of the superior nematothecae from internode below.

Hydrocladia, bearing hydrothecae on upper surface, consisting first of a short athecate internode without nematothecae and septa, terminated by slightly oblique node; thereafter athecate and thecate internodes alternate, their terminal nodes respectively oblique and almost transverse. Thecate internodes 1.5–2 times length of athecate internodes, without septa; with four nematothecae: one medio-inferior, one pair lateral, and one medio-superior, small, in the axil immediately behind free adcauline wall of hydrotheca. Atecate internodes without septa, with one nematotheca.

Hydrothecac cup shaped, taller than wide, adnate for one-third to one-half of vertical height, with walls almost straight, flaring slightly to margin; adcauline edge of margin approximately one-half way up distal athecate internode; without intrathecal septum. Margin oblique, 45–55° to axis.

Medio-inferior nematothecae rarely reaching base of hydrotheca: two-chambered and immovable, distal chamber short and scoop-like, without adcauline wall, proximal chamber not sharply demarcated from internode. Lateral nematothecae on finger-like pedicel, reaching more or less to thecal margin, two-chambered and movable, narrowly obconical with distal chamber shallow, broad and often quite deeply emarginated on mesial side. Medio-superior nematotheca small but distinctly two-chambered; distal chamber without adcauline wall.

Gonothecae on stem, immediately below hydrothecae; on pedicel of two segments; elongate and pear-shaped, curving upwards; with two two-chambered nematothecae near base. Aperture circular, broad and operculate.

#### MEASUREMENTS ( $\mu\text{m}$ )

Measurements made on BM1988.11.10.6–7 and QM GL10293 respectively. Stem: internode length 360–380, 265–325. Hydrocladium: thecate internode 190–240, 175–230; athecate internode 130–140, 100–150. Hydrotheca: abcauline length 175–210, 150–180; adnate adcauline length 140–160, 140–160; free adcauline length 100–130, 100–120; marginal diameter 160–180, 160–185. Gonotheca (presumed ♂ and ♀ respectively): opercular diameter 45–54, 162–234; vertical height 450–612, 558–738; maximum width 216–234, 252–360.

#### VARIATIONS

A second pair of lateral nematothecae may be present per cauline hydrotheca, mesial to and much smaller than normal pair. Likewise on the hydrocladium, two medio-superior nematothecae are often present behind the free adcauline wall of the hydrotheca.

#### REMARKS

See Remarks under *H. polymorpha*.

#### OCCURRENCE IN FIJI

Suva barrier reef, 7 Jul 78 (QMGL10293; BM 1984.5.17.40); Joske's reef, on coral rock, with gonothecae, 18 Sep 78.

#### WORLD DISTRIBUTION

Eastern Indian Ocean and western Pacific, north to Japan (Sagami Bay, Honshu), south to Great Barrier Reef.

#### *Halopteris diaphana* (Heller, 1868)

(Fig. 3)

*Anisocalyx diaphana* Heller, 1868: 42

*Plumularia diaphana* (Heller): Fraser, 1944: 342

*Antennella diaphana diaphana* (Heller, 1868): van

Gemerden-Hoogveen, 1965: 49

*Halopteris diaphana diaphana* (Heller, 1868): Ver-voort, 1968: 58

#### DESCRIPTION

Colony comprising erect stems arising from creeping hydrorhiza; stems reaching 21 mm; athecate basally, thecate and pinnate distally; the two regions separated by a very oblique hinge-type node. Basal internodes of variable length, with up to five transverse, slightly annulated nodes; uppermost internode bearing a number of irregularly arranged nematothecae. Distal part divided by oblique nodes into thecate internodes, each with one hydrotheca near base and up to five nematothecae: one medio-inferior, one pair lateral, and one or two medio-superior. First pair or two pairs of hydrocladia subopposite, arising from short apophyses at sides of first one or two hydrothecae; thereafter, strictly alternating, one per internode. Extra short, athecate internodes may occur sporadically, these having a basal transverse node and single nematotheca.

Hydrocladia with hydrothecac on upper surface; consisting, first, of a very short athecate internode, without nematothecae or septa, terminated by an oblique node; thereafter, athecate and thecate internodes alternate, terminated respectively by oblique and transverse nodes.

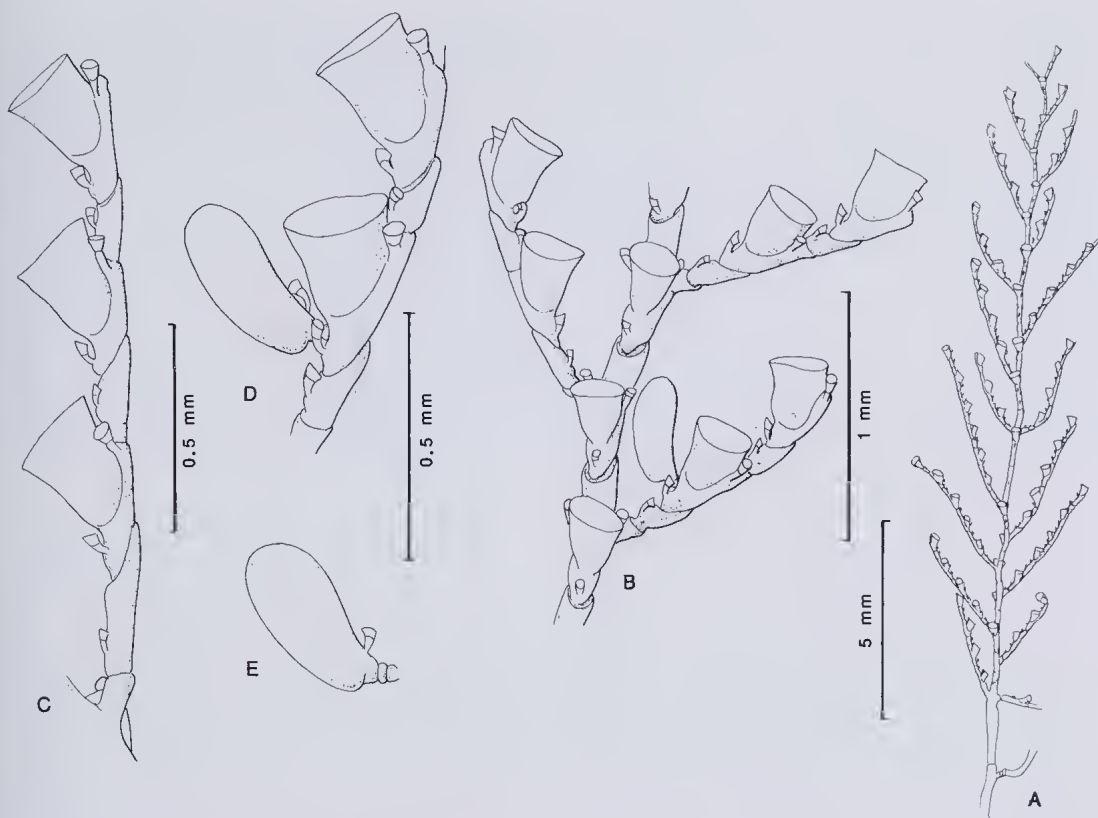


FIG. 3. *Halopterus diaphana*. A, part of colony. B, part of stem and hydrocladia. C, hydrocladium in profile. D, gonotheca from B. E, gonotheca. A, QMGL10294, Mba. B-D, QMGL10295, Joske's Reef.

Athecate internodes typically longer than thecate, without septa but each with a proximal nematotheca. Thecate internodes with three nematothecae: one medio-inferior, one pair lateral; also without septa.

Hydrothecae cup-shaped, taller than wide, adnate for one-half to two-thirds of vertical height, with walls more or less straight, flaring slightly to margin, without intrathecal septum. Margin oblique, at 45–50° to axis.

Medio-inferior nematotheca never reaching base of hydrotheca; immovable, two-chambered; distal chamber short and scoop-like, without adcauline wall. Lateral nematothecae shortly pedicellate, rarely reaching or overtopping thecal margin; movable and two-chambered; distal chamber obconical, the mesial side slightly lower than outer.

Gonothecae (in our material probably immature male) on hydrocladia, each immediately below a hydrotheca; shortly cylindrical; on pedicel of two segments; curving upward, taper-

ing proximad and truncated or, more normally, rounded distally. Aperture small and operculate; one two-chambered nematotheca near the base.

#### MEASUREMENTS ( $\mu\text{m}$ )

Stem: internode length 430–700. Hydrocladia: thecate internode length 160–225; athecate internode length 170–325. Hydrothecae: abcauline length 200–225; adnate adcauline length 180–210; free adcauline length 75–115; marginal diameter 190–210. Gonothecae (? immature male): length 324–346; maximum width 144–162.

#### VARIATIONS

Branched colonies rare; branches of same structure as main stem, athecate proximally, with hydrothecae and hydrocladia distally, arising from short apophyses on basal part of stem. In some colonies, especially the fertile material from Joske's Reef, athecate internodes of

hydrocladia are not longer than thecate internodes.

#### REMARKS

This species appears variable in internode length, and arrangement and structure of nematothecae. Caribbean material has been described by van Gernerden-Hoogveen (1965) and Vervoort (1968). Most of our specimens agree with those of van Gernerden-Hoogveen in having long athecate internodes on the hydrocladia. However, they lack the superior nematotheca in the axil immediately behind the free adcauline wall of the hydrotheca, and the lateral nematothecae do not have such scoop-like distal chambers; in these respects our material resembles that described by Vervoort (1968) from Puerto-Colombia, except that he recognized a nematotheca in the axil of the hydrocladium, absent from our specimens. Other of our material, from Joske's Reef, has short athecate internodes and agrees very well with Vervoort's (1968) description, apart from the absence of a nematotheca in the hydrocladial axil. No axillary nematotheca was indicated by Nutting (1900) in West Indian material (as *Plumularia alternata* Nutting, 1900) though one was later described by Fraser (1944). When identifying this as *H. diaphana*, we have taken account of the great variability (we have been comparing Pacific and Atlantic material) apparently exhibited by this species: the regular thecate cauline internodes have been useful to separate this species from *H. constricta* Totton, 1930, with which it might otherwise be confused.

#### OCCURRENCE IN FIJI

Yarawa reef, off Mba, under boulder, 8 Jul 78 (QM GL10294; BM 1984.5.17.41); reproductive, Joske's Reef, 18 Sep 78 (QM GL10295).

#### WORLD DISTRIBUTION

Widely distributed in tropical and warm temperate waters.

#### *Halopteris polymorpha* (Billard, 1913) (Fig. 4)

*Plumularia polymorpha* Billard, 1913: 24

*Halopteris polymorpha* (Billard, 1913): Millard, 1975: 354

#### DESCRIPTION

Colony comprising erect stems arising from a creeping hydrorhiza; stem reaching 12.5 mm;

consisting of basal athecate and distal thecate, hydrocladia-bearing parts: the two separated by an oblique joint. Basal part variable in length, entire or subdivided proximally by one or more transverse nodes; the uppermost internode bearing anterior nematothecae in two longitudinal series. Distal part divided by oblique nodes into thecate internodes, each with a hydrotheca basally and up to eight nematothecae: one medio-inferior, one pair lateral and up to five medio-superior, in two longitudinal series. One or two pairs of opposite hydrocladia arising from short apophyses at sides of the first one or two hydrothecae; thereafter hydrocladia alternate, one per internode. Cauline internodes may incorporate a distal transverse node, forming an athecate internode bearing most of the superior nematothecae.

Hydrocladia consisting first of a short athecate internode lacking nematothecae and internodal septa, terminated by a more or less transverse node; thereafter, athecate and thecate internodes alternate, ended respectively by oblique and transverse nodes. Athecate internodes much the longer, without septa but with up to three mesial nematothecae. Thecate internodes also without internodal septa and generally with three nematothecae: one medio-inferior, not reaching base of hydrotheca, and a lateral pair, more or less reaching (but not overtopping) the thecal margin.

Hydrothecae cup-shaped, squat and shallow, adnate for between one-half to two-thirds of vertical height; with walls more or less straight, widening gradually to margin; not flared. Without intrathecal septum. Margin at 45–50° to axis.

Medio-inferior nematotheca two-chambered: proximal chamber long and probably immovable, distal one short and scoop-like, without an adcauline wall. Lateral nematothecae on short, finger-like pedicel: two-chambered and movable, obconical, with distal chamber shallow, broad, and only slightly emarginate on mesial side.

Gonothecae (probably female) on stem, each immediately below a hydrotheca: pyriform-ovoid, on pedicel of one segment, curving upwards, tapering proximad and rounded distally; with two two-chambered nematothecae near base. Aperture circular and operculate.

#### VARIATIONS

The hydrocladial hydrothecae may have a minute one-chambered medio-superior



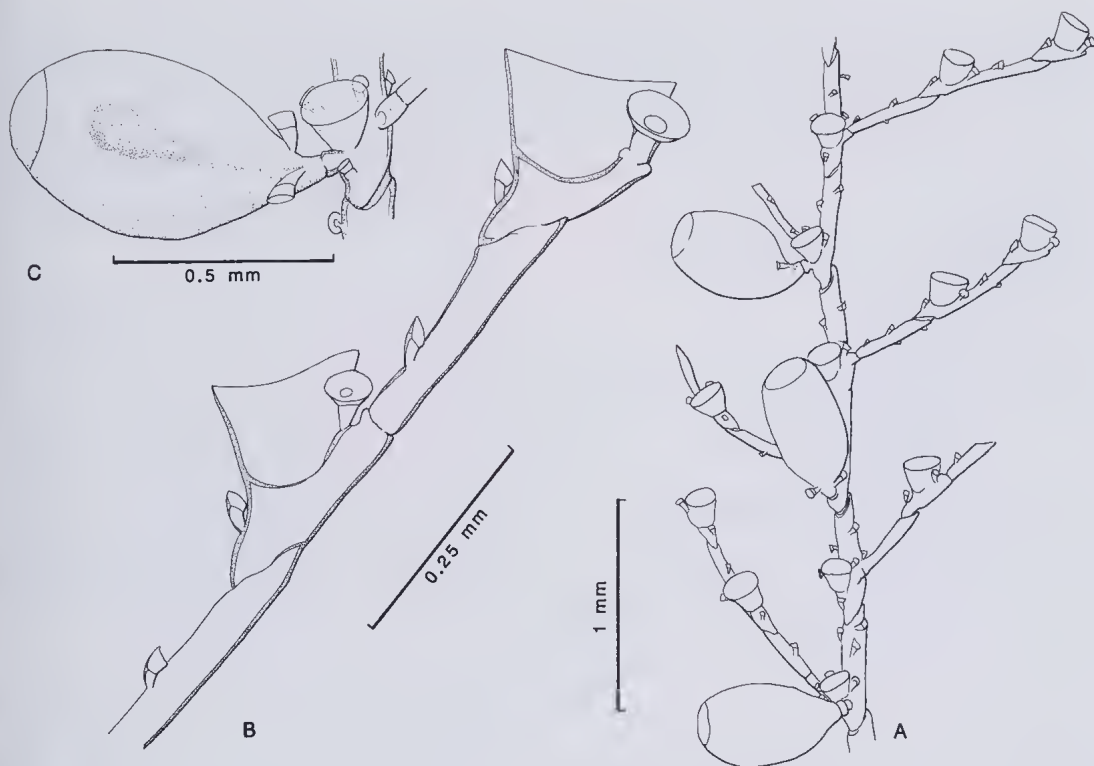


FIG. 4. *Halopteris polymorpha*. A, part of stem with hydrocladia. B, hydrothecae and nematothecae. C, gonotheca. QMGL10296, Suva Barrier Reef.

nematotheca located immediately behind the free adcauline wall.

#### MEASUREMENTS ( $\mu\text{m}$ )

Measurements are from QM GL10296 and Siboga Sta. 80 (Billard, 1913) respectively. Stem: internode length 475–570, -. Hydrocladia: thecate internode 140–200, 340–380; atehcate internode 230–280, 380–470. Hydrotheca: abcauline length 110–140, 135–160; adnate adcauline length 135–150, -; free adcauline length 75–90, -; marginal diameter 175–220, 200–215. Gonotheca (probably female): length -, 594–720; maximum diameter -, 342–414; opercular diameter -, 216–234.

#### REMARKS

Both *H. buskii* (Billard, 1913; Vervoort and Vasseur, 1977) and *H. polymorpha* (Billard, 1913; Millard, 1975) are extremely variable in terms of internode length, shape and size of hydrothecae, and number, arrangement and structure of nematothecae. Moreover, they resemble each other very closely. Our specimens

of *H. buskii* have shorter internodes than previously described and do not have the abcauline "marginal tooth" depicted by Vervoort and Vasseur. In terms of nematothecal arrangement they resemble those described by Billard (1913) and Hirohito (1974) in often having two pairs of lateral nematothecae; their structure, however, differs from Billard's description in that the distal chamber is not goblet-like and deeply emarginate, yet it is not deep and even rimmed as shown by Vervoort and Vasseur (1977, fig. 30C). Ours are broad and shallow but show definite, though gradual, mesial emargination. In identifying our material as *H. polymorpha* we have been influenced by Billard's description of specimens from Siboga Sta. 80 (1913, fig. 14A) in terms of cup shape and relative internode lengths and by the fact that gonothecae have a one-segment pedicel, while those of *H. buskii* have two segments. The lateral nematothecae, used by Billard to separate the two species, are too variable to provide a good diagnostic character. No record of a two-chambered medio-su-

perior nematotheca, axillary to a hydrotheca, has yet been made for *H. polymorpha*; they are always minute and single chambered (cf. *H. buskii*). It seems to us that these two nominal species require comprehensive investigation.

#### OCCURRENCE IN FIJI

Among sponge, forereef slope, Suva barrier reef, 0–20 m, with gonothecae, 19 Feb 80 (QM GL10296).

#### WORLD DISTRIBUTION

Red Sea, Africa, Seychelles, Indonesia (Borneo Bank, Rotti), New Caledonia.

### *Plumularia* Lamarck, 1816

#### *Plumularia habereri* Stechow, 1909 (Fig. 5)

*Plumularia Habereri* Stechow, 1909: 77

*Plumularia habereri* Stechow (1909): Billard, 1913: 42

*Plumularia habereri* Stechow, 1909: van Gemerden-Hoogveen, 1965: 60

#### DESCRIPTION

Colony comprising erect stems arising from a mass of hydrorhizal fibres; stems thick, polysiphonic; reaching 82 mm; branching alternate and in one plane distally, though irregular and in many planes basally (branches arising from both peripheral and axial tubes of stem). Branches polysiphonic to a variable degree basally but monosiphonic distally. Axial tubes of stem and branches divided by slightly oblique nodes into internodes of irregular length, each with a variable number of alternate hydrocladial apophyses and nematothecae. Apophyses borne laterally, each typically with two latero-axillary nematothecae and one small mamelon on upper surface; occasionally also a superior nematotheca. In the polysiphonic region of stem and branches, irregularly scattered nematothecae occur on peripheral tubes.

Hydrocladia typically divided into regular thecate internodes by slightly oblique nodes; hydrothecae on upper surface. No basal athecate internode. Distal region of thecate internodes occasionally (especially distally) cut off by partial or complete nodes into one or more short athecate internodes; these without nematothecae but with an internal, peg-like thickening of the perisarc, on the hydrothecal side, which may develop into a septum. Thecate internodes with three nematothecae: one medio-inferior on a

prominent swelling, not reaching base of hydrotheca, and two lateral on indistinct projections, overtopping the thecal margin. Typically without internodal septa but with up to five perisarcal pegs on the hydrothecal side capable of so developing: two pegs basally (one below and one above papilla of medio-inferior nematotheca), one distally, and one or two in between.

Hydrothecae adnate for more or less entire vertical height, tubular, widening a little to margin; abcauline wall more or less parallel to hydrocladial axis, the margin orthogonal to it. Intrathecal septum absent.

Nematothecae all two-chambered, movable; distal chamber nearly as deep as proximal one, funnel-shaped and slightly emarginate on mesial or adcauline side: not scoop-like.

Gonothecae not observed; described as bag-shaped, smooth, tapering proximally and rounded distally; borne at base of hydrocladium (Stechow, 1909).

#### MEASUREMENTS ( $\mu\text{m}$ )

Stem: internode length 380–1240. Hydrocladium: internode length 270–360. Hydrotheca: marginal diameter 70–85; abcauline height 155–195; adnate adcauline wall 140–165; free adcauline wall 10–25.

#### VARIATIONS

The hydrothecae at the base of hydrocladia are usually shorter and wider than those distally. The athecate internodes occurring sporadically along the hydrocladium rarely bear a nematotheca.

#### REMARKS

This species has been redescribed in many varieties by Billard (1913) and van Gemerden-Hoogveen (1965). Our material does not agree with the latter's description of that from the Caribbean in that it lacks the short adcauline intrathecal septum at the base of the lateral nematothecae and, moreover, the adcauline cup margin is not developed into upwardly pointing cusps. Of the forms designated by Billard, f. *subarmata* and f. *mediolineata* can be eliminated on account of their excessive development of internodal septa, the broad internodes, and ovoid hydrothecae; the latter form also has an abcauline intrathecal peg; f. *mucronata* has too few internodal septa, and the lateral nematothecae are in distinct cup-like embayments; however, the medio-inferior nematotheca is supported on a prominent basal swelling. The differences between f. *attenuata* and f. *elongata* are less clear

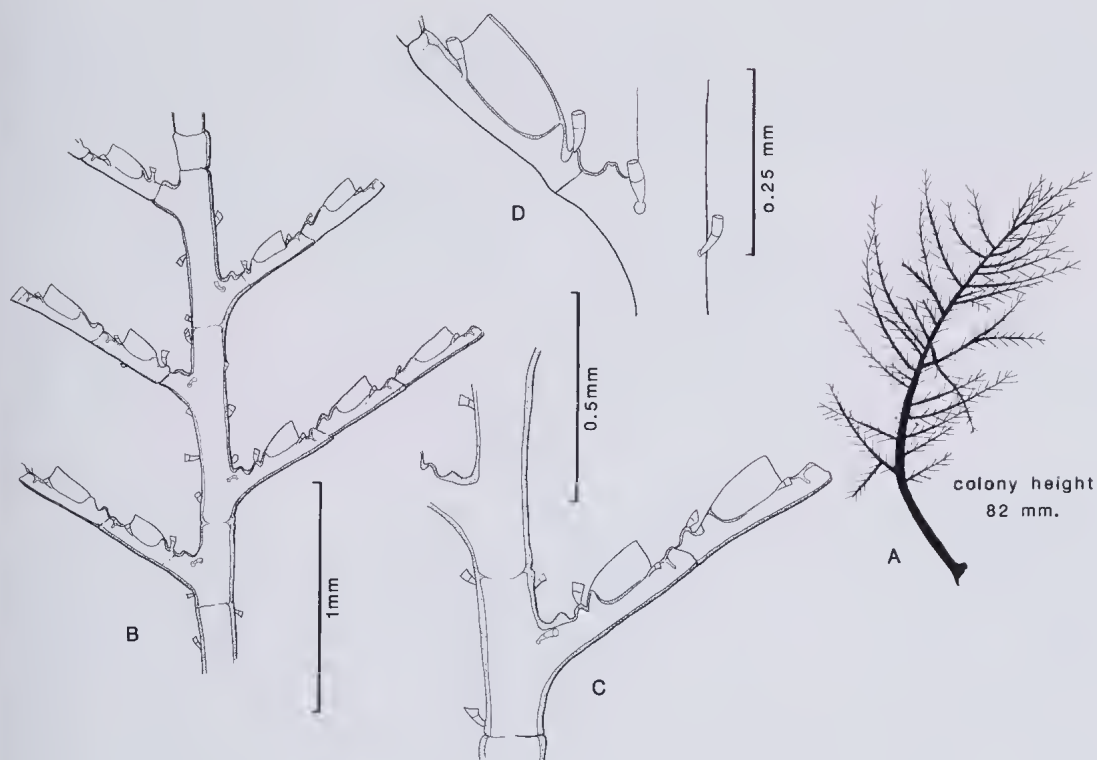


FIG. 5. *Plumularia habereri*. A, colony. B, part of stem with hydrocladia. C, part of B, enlarged. D, hydrotheca and nematothecae, further enlarged. QMGL10297, Great Astrolabe Reef.

and, though both are illustrated as having numerous internodal septa, a note was made of their absence in younger colonies. In our material the hydrothecae do not narrow distad and the margin is not angled as in *f. elongata*. *F. attenuata* was described as being much shorter and perhaps therefore younger than our material, but it still showed internodal septa. Differences shown by our material are insufficient to warrant a new form, so we assign it to *f. attenuata*.

#### OCCURRENCE IN FIJI

Herald Pass, Great Astrolabe reef, 27 m, 24 Jun 78 (QM GL10297; BM 1984.5.17.42).

#### WORLD DISTRIBUTION

Japan (Sagami Bay), Indonesia, Caribbean (Curaçao).

***Plumularia pennycuikae* Millard and Bouillon, 1973**  
(Fig. 6)

*Plumularia* sp. Pennycuik, 1959: 183

*Plumularia pennycuikae* Millard and Bouillon, 1973: 85

*Plumularia pennycuikae* Millard and Bouillon, 1973: Millard, 1975: 398

#### DESCRIPTION

Colony comprising erect stems arising from stolonate hydrorhiza; stems monosiphonic, reaching 8.5 mm, unbranched but bearing alternate hydrocladia in one plane; basal part without hydrocladia or nematothecae, very short and subdivided proximally by one or more transverse nodes, without nematothecae. Thereafter, stem divided by transverse nodes into regular internodes, each bearing one long hydrocladial apophysis distally and up to four nematothecae: two axillary (one anterior, one posterior), one inferior and one inferior-opposite; a small mamelon present on the upper surface of the apophysis. Internodal septa absent.

Hydrocladia, bearing hydrothecae on upper surface, consisting first of a short basal athecate internode, lacking nematothecae but with proximal and distal internodal septa, terminated by a very oblique hinge-like joint. Thereafter,

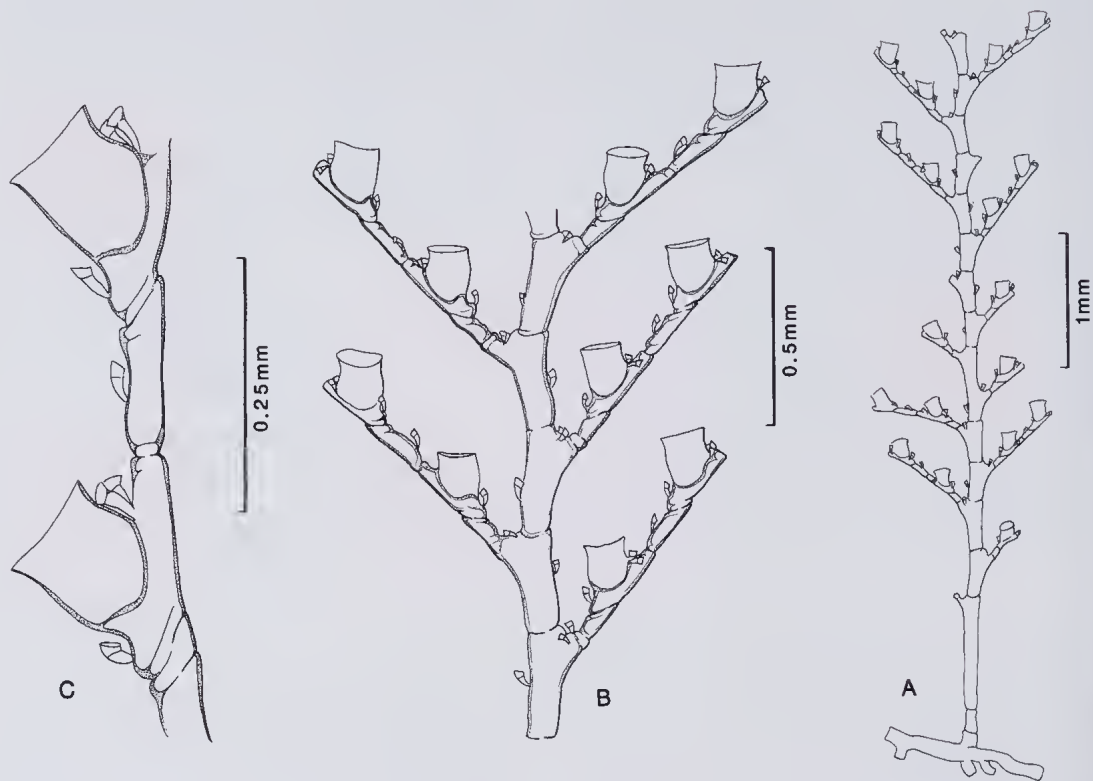


FIG. 6. *Plumularia pennycuikae*. A, part of colony. B, part of stem and hydrocladia. C, part of hydrocladium in profile. QMGL10298, Ngaloa.

thecate and athecate internodes alternate, terminated respectively by transverse and oblique nodes. Atecate internodes shorter and with one nematotheca at mid-length; usually with proximal and distal internodal septa, though these may be represented by internal peg-like thickenings of the perisarc of the upper wall. Thecate internodes with three nematothecae: one medio-inferior, reaching about to the base of hydrotheca, and one pair lateral, not overtopping thecal margin; septa present or not.

Hydrothecae cup-shaped, adnate for approximately one-half vertical height; abcauline wall straight and free; adcauline wall concave, flared to margin; intrathecal septum absent. Margin at  $45\text{--}60^\circ$  to hydrocladial axis.

All nematothecae two-chambered and movable. Medio-inferior and cauline nematothecae each with long proximal chamber and short, scoop-like distal one. Lateral nematothecae not

on finger-like process; with shallow, broad distal chamber, slightly lower on mesial side.

Gonothecae not observed but female ovoid to spherical and bearing one egg, borne on hydrocladial apophyses of stem (Millard, 1975); male unknown.

#### MEASUREMENTS ( $\mu\text{m}$ )

Stem: internode length 225–275. Hydrocladia: thecate internode 165–180; athecate internode 125–175. Hydrothecae: abcauline length 115–125; adnate adcauline length 90–116; free adcauline length 60–85; marginal diameter 115–120.

#### VARIATIONS

Some specimens have been observed to have the first one or two basal internodes with opposite hydrocladia.

## OCCURRENCE IN FIJI

Ngaloa, on coral rock, 15 Jun 79 (QM GL10298).

## WORLD DISTRIBUTION

Southern Africa, Seychelles, Great Barrier Reef (various localities).

***Plumularia strictocarpa* Pictet, 1893**  
(Fig. 7)

*Plumularia strictocarpa* Pictet, 1893: 55

*Plumularia strictocarpa* Pictet (1893): Billard, 1913: 34

*Plumularia strictocarpa* Pictet, 1893: Millard, 1975: 402

## DESCRIPTION

Colony consisting of erect stems arising from stolonate hydrorhiza. Stems monosiphonic, reaching 14 mm, unbranched but bearing alternate hydrocladia; basal part short, without hydrocladia or nematothecae. Thereafter, divided by oblique nodes into regular internodes, each bearing a short, antero-lateral hydrocladial apophysis distally, and up to three nematothecae: one axillary, one or two inferior-oppo- site; a small mamelon on the upper surface of the apophysis. Internodal septa absent.

Hydrocladia, bearing hydrothecae on upper surface, consisting of a short basal athecate internode, without nematothecae but with one septum, terminated by a very oblique joint. Thereafter, thecate and athecate internodes alternate, terminated respectively by transverse and oblique nodes. Relative lengths of these internodes variable. Atecate internodes with one nematotheca and proximal and distal septa. Thecate internodes with three nematothecae, one medio-inferior, never reaching base of hydrotheca, and one pair lateral, usually overtopping thecal margin. Two or three internodal septa present; proximal, distal, and occasionally a third at base of lateral nematothecae.

Hydrothecae adnate for entire vertical height, cup-shaped, neither flared nor narrowed to margin, abcauline wall more or less straight. Margin at 50–70° to hydrocladial axis. Intrathecal septum absent.

All nematothecae two-chambered and movable. Medio-inferior and cauline nematothecae with long proximal chamber and shorter distal one, with latter lower on adcauline side but not scoop-like. Lateral nematothecae on finger-like

process, with shallow, broad, even rimmed, distal chamber.

Gonothecae borne below hydrocladial apophyses near colony base, distinctly annulated, barrel-shaped, often curved, narrowing slightly distad; aperture on a short collar.

## MEASUREMENTS (µm)

Stem: internode length 320–390. Hydrocladia: thecate internode 240–280; athecate internode 85–170. Hydrothecae: abcauline length 80–95; adnate adcauline length 75–90; marginal diameter 95–100. Gonotheca: length 684–882; opercular diameter 234–342.

## REMARKS

In the absence of gonothecae, this species would be impossible to distinguish from *P. setacea* (Linnaeus, 1758) and *P. warreni* Stechow, 1919. Since much of the material found on Fiji was in non-reproductive condition, and distributions of the three species overlap, it would be meaningless to discuss variability. However, since *P. setacea* and *P. warreni* are likely to occur around Fiji we mention the differences relating to gonothecae. In contrast to *P. strictocarpa*, the gonothecae of both the other species are dimorphic. In *P. setacea* from the British Isles (the material upon which the species is based was collected by Ellis (1755) in S.E. England) male gonangia occur below the female gonangia on the same stem but in smaller numbers (Cornelius and Ryland, 1990). Whether through variability over a wide geographical range or perhaps because another species has become involved, the *P. setacea* described by Millard (1975) from South Africa is gonochoric. *P. warreni* is also gonochoric. The planulae of *P. setacea* develop within the gonothecae, while those of *P. warreni* complete their development in external marsupia. The male gonotheca of *P. setacea* is slender, smooth, with a small aperture; that of *P. warreni* is often slightly curved, smooth or with a vaguely irregular outline: these may not provide reliable separation. The female gonotheca of *P. setacea* is compressed, smooth, with a large aperture supported on a tubular neck, which may be curved slightly to one side. That of *P. warreni* is elongate, ovoid, with a smooth or slightly irregular outline, without a neck. In *P. warreni* var. *pambanensis* Gravelly, 1927, from the Great Barrier Reef (Pennycuik, 1959; JSR, pers. obs. at Heron I.) both male and female gonothecae are cylindrical and the planulae develop in external marsupia.

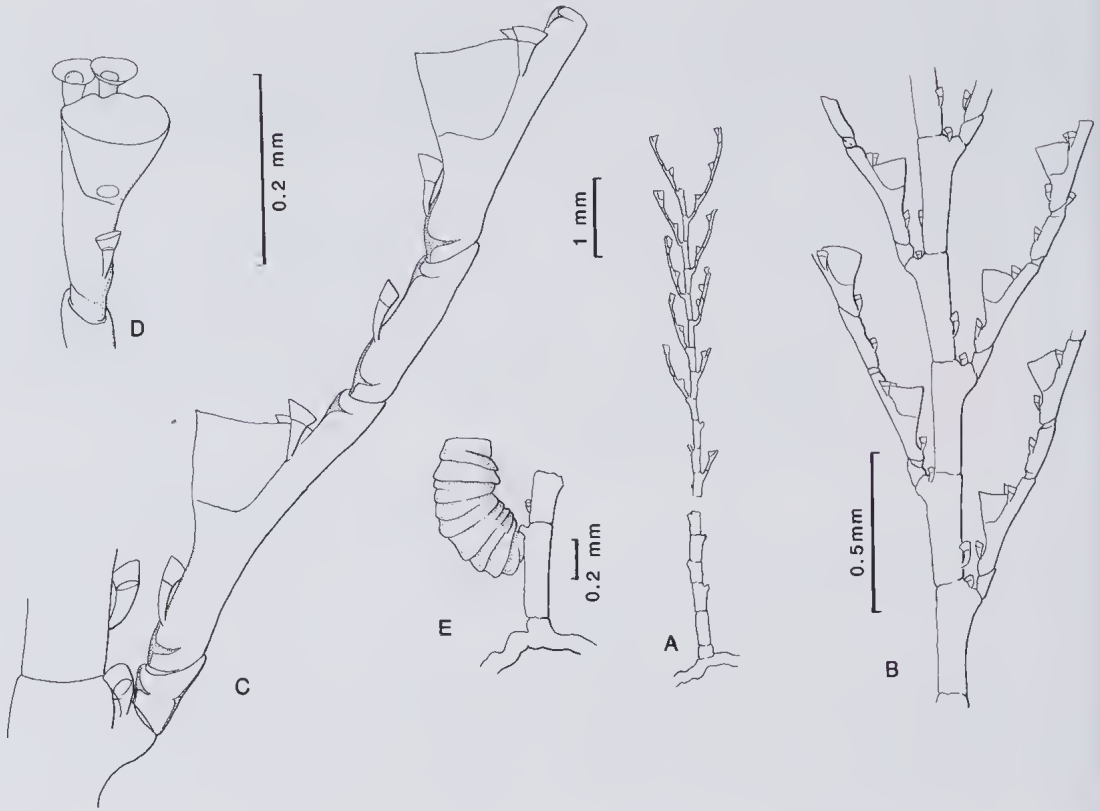


FIG. 7. *Plumularia strictocarpa*. A, part of colony. B, part of stem and hydrocladia. C, basal portion of hydrocladium in profile. D, hydrotheca and nematotheca. E, gonotheca. QMGL10299, Great Astrolabe Reef.

#### OCCURRENCE IN FIJI

On coral rock, windward Great Astrolabe Reef, with gonothecae, 24 Jun 78 (QMGL 10299). A non-fertile *Plumularia* from Joske's reef, 18 Sep 78, and other collections from the Great Astrolabe, cannot with certainty be assigned to this species.

#### WORLD DISTRIBUTION

Warm water cosmopolitan.

#### *Plumularia strobilophora* Billard, 1913 (Fig. 8)

*Plumularia strobilophora* Billard, 1913: 35

*Plumularia strobilophora* Billard, 1913: Vervoort and Vasseur, 1977: 79

#### DESCRIPTION

Colony consisting of erect stems arising from stolonate hydrorhiza. Stems monosiphonic, reaching 10 mm, unbranched but bearing alter-

nate hydrocladia; basal part as remainder, with hydrocladia and nematothecae. Stem divided by transverse or slightly oblique nodes into regular internodes, each bearing a short, distal hydrocladial apophysis without mamelon but with up to four nematothecae: one inferior-opposite (to the apophysis), two latero-axillary, and one on the upper surface of the apophysis. Internodal septa absent.

Hydrocladia with hydrothecae on upper surface, consisting of a short basal athecate internode, without nematothecae but with proximal and distal internodal septa (all the hydrocladial internodes similar). Thereafter, thecate and athecate internodes alternate, terminated respectively by transverse and oblique nodes. Athecate internodes longer than thecate, and bearing midway one or two nematothecae. Thecate internodes with three nematothecae: one medio-inferior, not reaching to base of hydrotheca, and one pair lateral, at base of free adcauline wall, overtopping thecal margin.

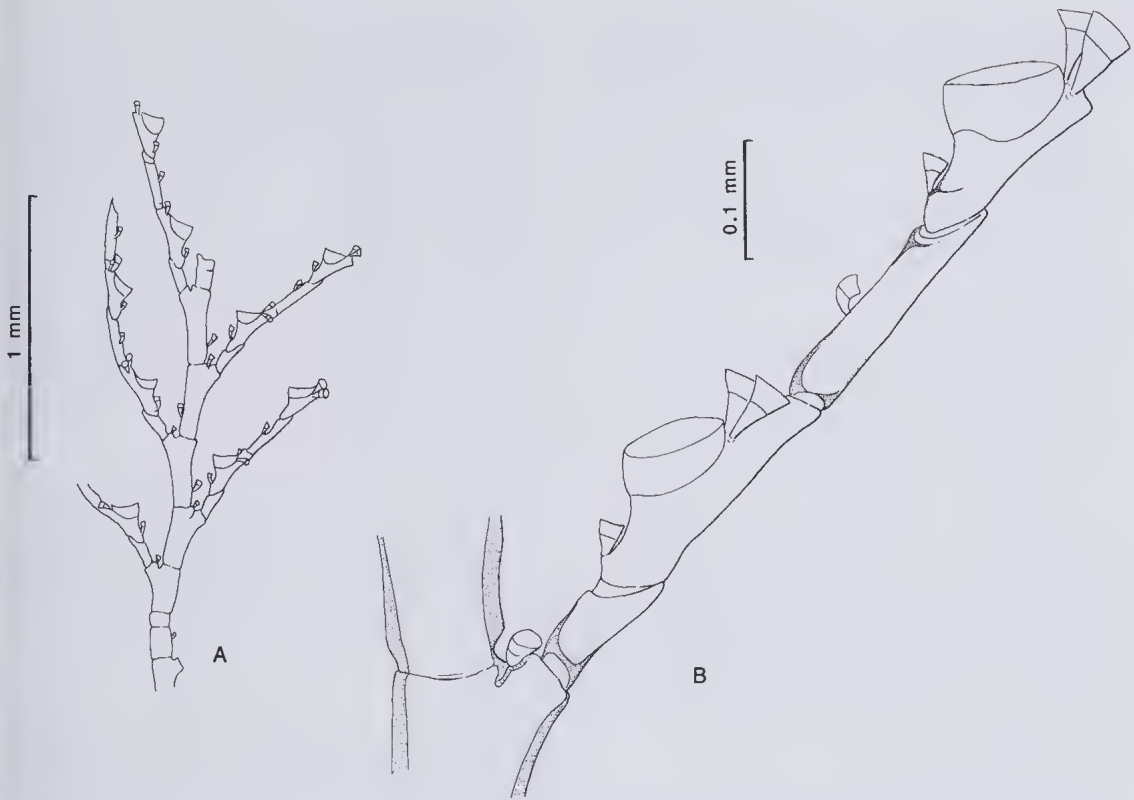


FIG. 8. *Plumularia strobilophora*. A, part of stem with hydrocladia. B, basal portion of hydrocladium in profile. QMGL10300, Great Astrolabe Reef.

Hydrothecae shallow; marginal diameter one and one-half to two times abcauline depth; nearly completely adnate, with very short free adcauline wall and straight abcauline wall. Margin oblique, at  $55\text{--}60^\circ$  to hydrocladial axis. Intrathecal septum absent.

All nematothecae two-chambered and movable. Medio-inferior and cauline nematothecae with long proximal and shorter distal chambers, the latter slightly lower on adcauline margin but not scoop-like. Lateral nematothecae obconical, rim of distal chamber more or less even.

Gonothecae not observed; but inserted in the axil of hydrocladia, conical with a truncated distal end (Billard, 1913).

#### MEASUREMENTS ( $\mu\text{m}$ )

Stem: internode length 220–285. Hydrocladia: thecate internode 160–190; athecate internode 220–230. Hydrothecae: abcauline length 25–50; adnate adcauline length 90–100; free adcauline length 15–20; marginal diameter 90–100.

#### VARIATIONS

Hydrocladia and stem frequently with renovated nodes; these producing short athecate internodes which tend to occur singly on hydrocladia but in succession on the stem: they may or may not have a nematotheca. The number of nematothecae in the hydrocladial axil is variable, apparently because of damage: their former presence is commonly indicated by a small pore in the perisarc. Internodal septa likewise of variable occurrence; if not observed then replaced by internal perisarcal thickenings of the abcauline wall.

#### REMARKS

Our material differs somewhat from previous descriptions. The athecate are longer than the thecate internodes, agreeing with Vervoort and Vasseur (1977) but not with Billard (1913); however, as in other species, internode length is very variable. The lack of an observable mamelon on the upper surface of the apophysis accords with Billard, as does the non-conical structure of the

medio-inferior and cauline nematothecae. The hydrothecae, however, tend to be much broader than previously noted, at least eliminating possible confusion with *P. setacea* (Linnaeus, 1758).

#### OCCURRENCE IN FIJI

On coral boulder, windward Great Astrolabe reef, 24 Jun 78 (QMGL10300).

#### WORLD DISTRIBUTION

Gulf of Suez, Malay Archipelago, French Polynesia; also Trinidad (Vannucci, 1951).

#### *Monotheca* Nutting, 1900

##### *M. obliqua* (Saunders in Johnston, 1847) (Fig. 9)

*Minute Sertularia*: Lister 1834: 372, pl. 8, fig. 5  
*Laomedea obliqua* Saunders: Johnston, 1847: 106  
*Plumularia obliqua* Saunders: Hincks, 1868: 304  
*Plumularia obliqua* (Johnston, 1847): Millard, 1975: 396  
*Monotheca obliqua* (Saunders in Johnston): Cornelius and Ryland, 1990: 152

#### DESCRIPTION

Colony consisting of delicate stems arising from a thicker stolonate hydrorhiza. Stems monosiphonic, reaching 3 mm; unbranched but bearing alternate hydrocladia in one plane; divided by transverse or slightly oblique nodes into regular internodes, each bearing a short hydrocladial apophysis and containing at least three internodal septa or peg-like perisarcular thickenings: one proximal, one in the apophysis, and a variable number distal. Upper surface of apophysis bearing a small mamelon and axillary and inferior-opposite nematothecae.

Hydrocladia consisting of short basal athecate and longer, terminal thecate internodes; former usually less than half length of the latter, with proximal and distal septa; without nematothecae. Thecate internode with hydrotheca on its upper surface, narrowing beside base of hydrotheca, then expanding and terminating below thecal margin; three nematothecae: one medio-inferior, reaching the base of hydrotheca, and one pair lateral, overtopping thecal margin. Two very distinct internodal septa: at base and at start of distal expansion.

Hydrotheca cup-shaped, almost completely adnate, with smooth, convex abcauline wall, expanding slightly to margin; eversion variable but

especially over end of internode; without intrathecal septum.

Nematothecae all two-chambered and movable: medio-inferior and cauline nematothecae with distal chamber slightly less deep than proximal one; lower on adcauline side but not scoop-like. Lateral nematothecae with deep, narrow distal chamber that is distinctly lower on mesial side.

Only female gonothecae observed. Borne at colony base, slightly annulated, large, ovoid, tapering proximad and truncated distally; aperture broad, with distinct cap or operculum. Male gonotheca described as tapering at both ends, with aperture terminal, small (Gili i Sardà, 1982; Cornelius and Ryland, 1990).

#### MEASUREMENTS ( $\mu\text{m}$ )

Stem: internode length 230–280. Hydrocladia: thecate internode 135–160; athecate internode 25–40. Hydrothecae: abcauline length 130–170; marginal diameter 100–130. Gonotheca (female): length 830–1005; width 640–800.

#### REMARKS

The female gonotheca does not correspond well with that illustrated by Hincks (1868, Fig. 36, p.305), but agrees with Lister's (1834) original engraving. Also likely to occur around Fiji, having been reported from both New Zealand and Japan, are *Plumularia pulchella* Bale, 1882, and *P. spinulosa* Bale, 1882, which, having a single hydrotheca per hydrocladium, are also referable to *Monotheca* Nutting, used by Cornelius and Ryland (1990). The first species has a concave abcauline thecal wall and two nematothecae in the hydrocladial axil; the second has a distinct adcauline intrathecal septum and the hydrocladium ends in a spine.

#### OCCURRENCE IN FIJI

On red algae, Ndeumba, LWST, 8 Jul 78 (BM 1984.5.17.44); with female gonothecae, 9 Sep 79 (QM GL10301).

#### WORLD DISTRIBUTION

Cosmopolitan.

#### Family AGLAOPHENIIDAE

Millard (1975) maintained Aglaopheniinae as a subfamily of Plumulariidae; others (e.g., Rees and Vervoort, 1987) have done likewise. Other authors (e.g., Bouillon, 1985; Cornelius and Ryland, 1989), whom we have followed, have preferred to confer family status.



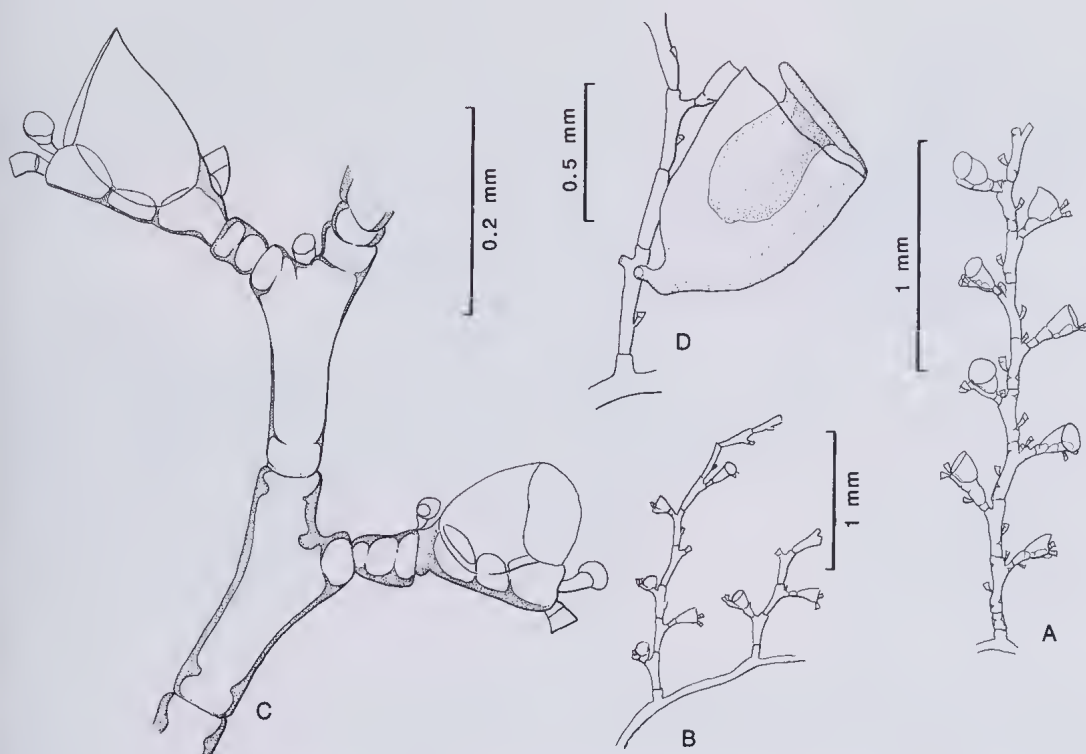


FIG. 9. *Monothecha obliqua*. A, B, parts of colonies. C, stem internodes and hydrocladia. D, female gonotheca. QMGL10301, Ndeumba.

### *Gymnangium* Hincks, 1874

#### *G. eximium* (Allman, 1874) (Figs 10–12)

*Taxella eximia* Allman, 1874: 179

*Halicornaria bipinnata* Allman, 1876: 279

*Gymnangium eximium* (Allman, 1874): Stechow, 1923: 236; Vervoort and Vasseur, 1977: 81; Rees and Vervoort, 1987: 156

#### DESCRIPTION

Colony erect. Stems reaching 110 mm or only 20 mm, depending on growth form (see Variations); lightly polysiphonic; bearing subopposite branches in one plane, these redivided to a secondary or tertiary level. Final branches polysiphonic basally; axial tubes of branches arising from the peripheral tubes of stem (or lower order branch). Axial tube of stem and branches bearing alternate hydrocladia and divided by slightly oblique, indistinct nodes which slope alternately left and right (imparting a vaguely geniculate appearance for the younger parts of the colony).

Basal internodes of stem and branches without

hydrocladia but with regularly-placed median nematothecae. These typically conical, with terminal aperture, facing distad along branch axis. Thereafter all internodes with a midlateral hydrocladial apophysis and two nematothecae: antero-inferior and antero-superior; a minute mamelon on the apophysis. Cauline nematothecae broadly based, widening distally; gutter-like or open with a large aperture on the inner surface; or bifurcated, with tubular or scroll-like processes ending in two terminal apertures at  $180^\circ$  to each other. Antero-inferior nematotheca on the hydrocladial apophysis, directed along hydrocladial axis; antero-superior nematotheca median but with aperture directed away from hydrocladium.

Hydrocladia divided by slightly oblique nodes into regular, straightish internodes, with anterior hydrotheca and two internodal septa: one opposite adcauline intrathecal septum and one at base of lateral nematothecae.

Hydrothecae sigmoid in profile, deep, widening only slightly to margin; abcauline wall variable, but convex in lower adnate region and concave above. A short adcauline intrathecal

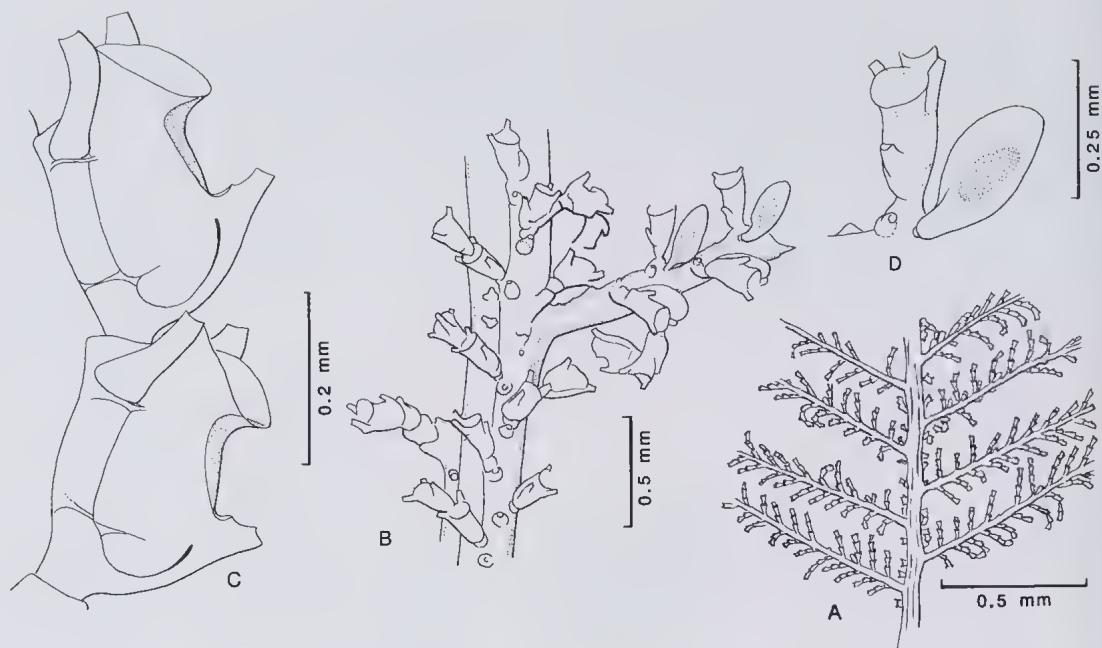


FIG. 10. *Gymnangium eximium*, first form. A, part of colony. B, part of stem and basal portion of hydrocladium. C, hydrothecae and nematothecae. D, gonotheca. QMGL10302, Great Astrolabe Reef.

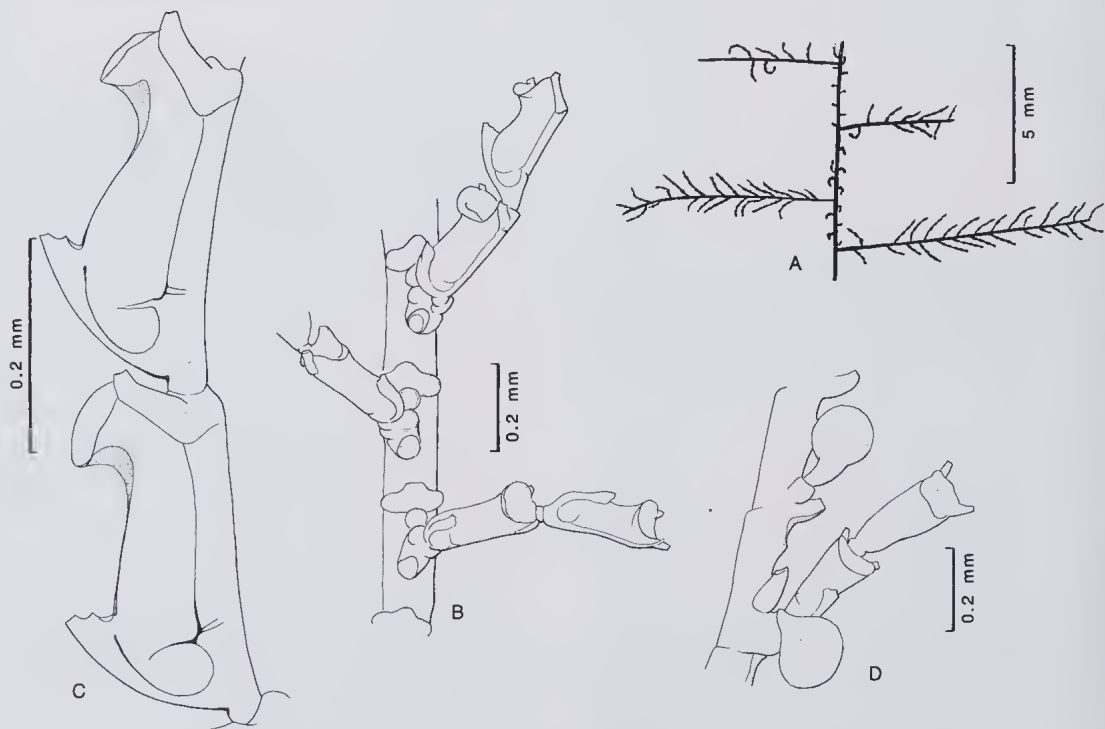


FIG. 11. *Gymnangium eximium*, second form. A, part of colony. B, part of stem and bases of hydrocladia. C, hydrothecae and nematothecae. D, gonotheca. A-C, QMGL10307, Ndeumba; D, QMGL10306, Ndeumba.

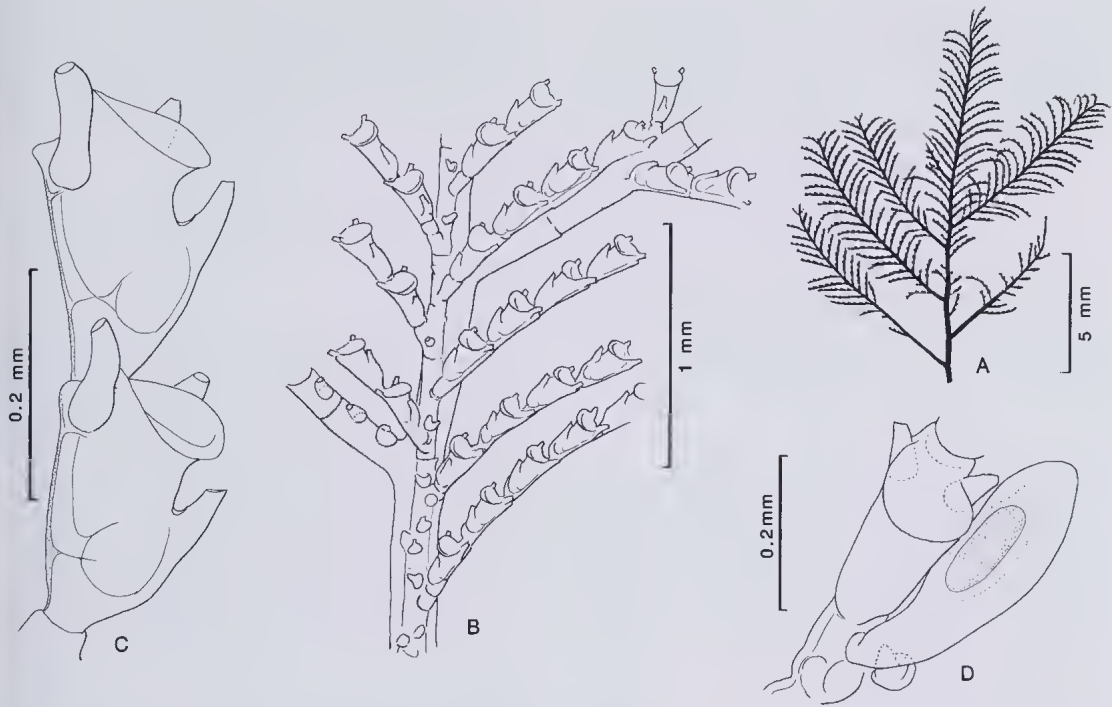


FIG. 12. *Gymnangium eximium*, third form. A, part of stem and hydrocladia. B, part of stem and basal portions of three hydrocladia. C, hydrothecae and nematothecae. D, gonothecae (? immature). A-C, QMGL10304, Great Astrolabe Reef. D, QMGL10305, Yanutha.

septum above the hydropore, perisarcular thickening below margin distinct. Margin facing away from internode at approximately  $70^\circ$ ; smooth or with low-lying, broadly triangular teeth. With three nematothecae: one medio-inferior and two lateral. Medio-inferior nematotheca tubular, adnate to abcauline thecal wall for one-third to one-half of cup height, then free and divergent; with three apertures: terminal, on upper surface at beginning of free part, and opening into hydrotheca near top of adnate part. Lateral nematothecae tubular, with terminal and mesial apertures; overtopping thecal margin, directed antero-distad.

Gonothecae forming double row on anterior surface of branches, one per hydrocladial apophysis; flattened and lens shaped with distinct pedicel.

#### VARIATIONS

Nodes are usually indistinct on the stem and branch base. Adcauline hydrothecal septa developed to a variable degree, indistinct. Colonies show tendency to reverse the orientation of the stem several times throughout length.

This species occurred in three different colony morphs. The first (Fig. 10), which corresponds most to the type from Ceylon, described by Allman (1874, 1876) as 'attaining a height of upwards of a foot', reaches 110 mm in our material, and has branches of about even length. Its hydrocladia are of two types: those on the stem bear four or fewer (mean three) hydrothecae, those on the branches bear more than four but fewer than seven.

Our second and rarest morph (Fig. 11) differs from the others not only in colony form but also in hydrothecal shape and nematothecal structure. Branches are of the same length throughout, long, widely spaced and orthogonal to the stem. Stem hydrocladia bear never more than three (mean two) hydrothecae, branch hydrocladia typically three or four; the nodes slope posterad (as opposed to anterad). Hydrothecae are similar in basic shape but taller, thinner and less sigmoid: medio-inferior nematothecae short and at  $90^\circ$  to the hydrotheca. Antero-superior cauline nematothecae distinct; broad, flat, adherent to axial tube, trifurcate; branches extending across width of axial tube, each with an aperture. Two

of the apertures opposite, conspicuous and directed laterad on rounded extensions; the third small, directed distad.

The third and commonest morph in our collections (Fig. 12), has flat, round, leaf-like colonies, up to about 20 mm in height and bright yellow when living; the middle branches are the longest, with hydrocladia bearing as many as 20 hydrothecae or more. Vervoort and Vasseur (1977) obtained this form.

The first and second forms were encountered together on the Great Astrolabe Reef. Despite the differences, which all involve features known to be variable, we believe that all three forms may be referred to the same species.

#### MEASUREMENTS ( $\mu\text{m}$ )

Measurements refer to 1st (QM GL10302-3), 2nd (GL10305), and 3rd (GL10306-7) morphs respectively. Stem: internode length 160-250, 250-320, 150-230. Hydrocladium: internode length 175-210, 250-270, 165-220.

Hydrotheca: vertical height, 210-215, 230-250, 200-215; marginal diameter 95-115, 150-180, 90-100; adnate adcauline wall 70-100, 110-123, 70-90; free adcauline wall 55-90, 110-123, 50-70. Medio-inferior nematotheca: length 45-60, 35-50, 50-650. Lateral nematotheca: length 100-120, 90-110, 90-105.

#### REMARKS

Although *Gymnangium gracilicaule* (Jäderholm, 1903) bears a superficial resemblance to this species and has a similar distribution (Millard, 1975), the abcauline intrathecal septum in *G. eximium* is distinctive.

#### OCCURRENCE IN FIJI

Found at LWST and below, in gulleys, in windward situations. First and second forms: Herald Pass, leeward Great Astrolabe Reef, 28 m, 24 Jun 78; north of Yanutha reef, Mbengga leeward barrier reef, 4-8 m, 7 Oct 79 (BM 1984.5.17.49-50, 56; QMGL10302-5). Third form: Suva barrier forereef off Nasease, 0-20 m, 19 Feb 80; Ndeumba, LWST, many occasions; Ngaloa, 15 Jun 79; windward Great Astrolabe Reef, 24 Jun 78, 11 Jul 80 (BM1984.5.17.47-48, 51; QMGL10306-8). With gonothecae 24 Jun 78, 8 Jul 78, 20 Aug 78, 7 Oct 79, 12 Jul 80. Some colonies from the Great Astrolabe bore *Antennella secundaria* and *Hebella parasitica*.

#### WORLD DISTRIBUTION

Red Sea, tropical Indian Ocean (Wasini,

Amirante I. (Jarvis, 1922)), Ceylon (Allman, 1876) and French Polynesia.

#### *Gymnangium hians* (Busk, 1852) (Fig. 13)

*Plumularia hians* Busk, 1852: 396

*Halicornaria hians* (Busk): Billard, 1913: 68

*Gymnangium hians* (Busk, 1852): Millard, 1975: 444

#### DESCRIPTION

Colony with erect stems rising from a creeping hydrorhiza. Stem monosiphonic but thick and tough; reaching 150 mm; unbranched; divided by slightly oblique nodes, which slope alternately left and right, into internodes of variable length. Each internode with two or three, alternate, fronto-lateral hydrocladial apophyses, the hydrocladia disposed in a shallow, abfrontally directed V. Basal part of colony without hydrocladial apophyses but with a variable number of low-lying mesial nematothecae. Three nematothecae associated with each apophysis: antero-inferior, antero-superior, and postero-axillary; mamelon absent. Antero-inferior nematotheca small, narrowing distally, not on the apophysis, directed along hydrocladial axis; antero-superior nematotheca widening distally and directed along stem axis; postero-axillary nematotheca weakly bifurcate, projecting away from stem or hydrocladium but with mesial aperture directed along stem axis.

Hydrocladia bearing hydrothecae frontally, divided by slightly oblique, often indistinct, nodes into thecate internodes. Internodes more or less straight, of variable length; without internal septa.

Hydrothecae sac-shaped, rounded, widening to margin. Abcauline septum one-half to two-thirds distance up abcauline wall; exceeding half thecal width, straight at first, curled over at the end. Abcauline wall convex throughout. Hypopore protected by several small spines. Margin at 30-45° to internode, with six lateral cusps. Adcauline and middle pairs prominent, abcauline pair low and rounded, all directed slightly laterally.

Three nematothecae to each hydrotheca: the medio-inferior adnate for entire length of abcauline hydrothecal wall, then free and divergent, curving upward, with concave adthecal surface, pointed at end, upper surface open, no internal opening. Lateral nematothecae saccular, broad-based, narrowing little; gutter-like, with terminal aperture directed dorso-posterad.

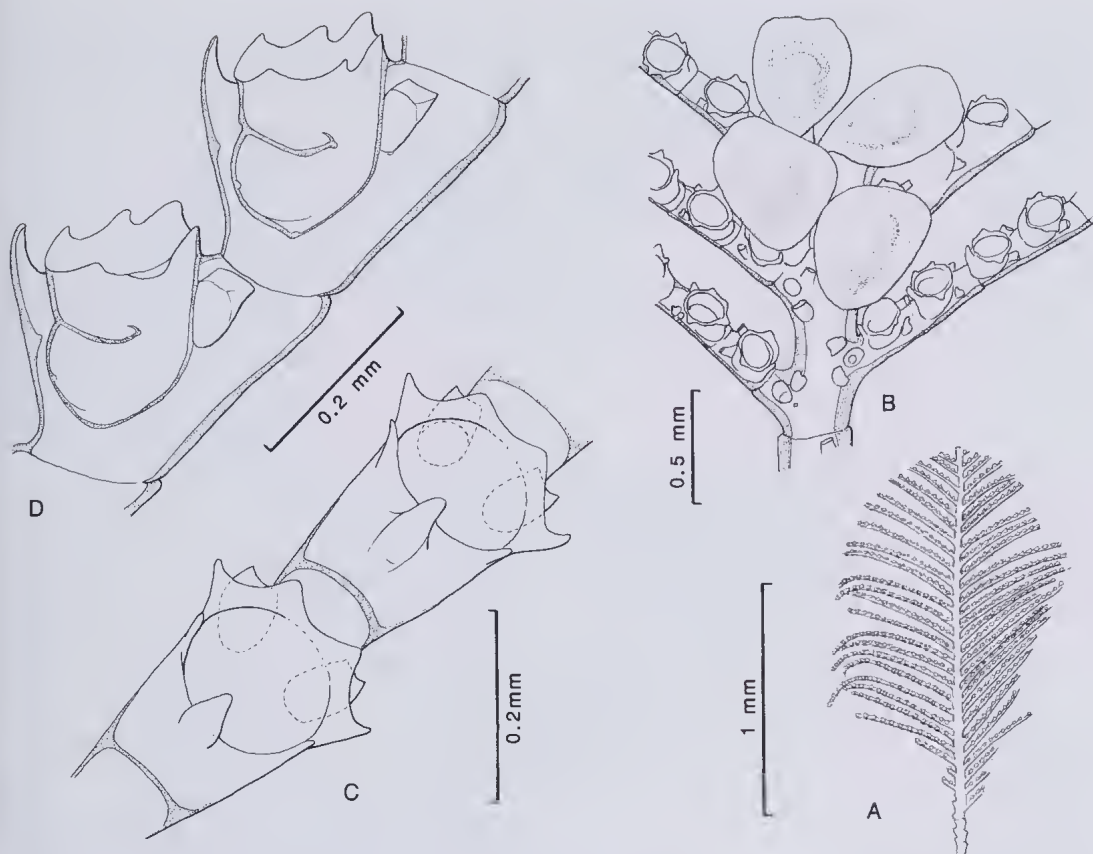


FIG. 13. *Gymnangium hians*. A, part of colony. B, part of stem with gonothecae and bases of hydrocladia. C, D, hydrothecae and nematothecae. QMGL10309, Great Astrolabe Reef.

Cauline nematothecae saccular, variably shaped, broad-based, gutter-like, narrowing little, aperture on inner surface.

Gonothecae in distal half of colony; one per hydrocladial apophysis, forming a double series on the anterior stem surface; smooth, ovoid, truncated distally.

#### MEASUREMENTS ( $\mu\text{m}$ )

Stem: internode length 450–800. Hydrocladium: internode length 50–270. Hydrotheca: vertical height 225–245; marginal diameter 150–180; adnate adcauline wall 210–220; free adcauline wall 30–50. Nematheca: length of lateral nematotheca 60–80; length of medio-inferior nematotheca 40–60.

#### VARIATIONS

In tall colonies all hydrocladia are typically of equal length; if shorter, then leaf-shaped (Fig. 13A), with the mid-region hydrocladia the

longest. Cauline nematothecae are very variable in form, often distinctly bifurcate, with two distal perisarcal extensions; never tubular. Lateral nematothecae only rarely overtopping the hydrothecal margin.

#### REMARKS

Resembles *G. haswelli* (Bale, 1884, as *Halicornaria*) in shape and size, except that Bale's illustrated specimen has a medio-inferior nematotheca which is not gutter-like but tubular, with two apertures: terminal, and on the upper surface at the beginning of the free part. It also resembles *G. speciosa* (Allman, 1877, as *Halicornaria*) in hydro- and gonothecal form; but that species has opposite hydrocladia in the plane of the stem.

#### OCCURRENCE IN FIJI

Not recorded from any Viti Levu reefs but abundant and conspicuous in the channels at the

windward edge of the Great Astrolabe Reef; with gonothecae 24 Jun 78 (QMGL10309; BM 1984.5.17.52-3), 12 Jul 80 (BM1984.5.17.54); colonies often supporting *Clytia hemisphaerica*, *Hebella dyssymetra*, *Sertularella diaphana delicata*, and *Antennella secundaria*. Also from north tip of Yanutha reef, Mbengga leeward barrier reef, 4-8 m, 7 Oct 79 (BM1984.5.17.55).

#### WORLD DISTRIBUTION

Tropical and subtropical Indo-Pacific: Red Sea, Africa, East Indies, Torres Strait, Japan, Hawaii, Kermadec Islands; also Caribbean.

#### *Lytocarpia* Kirchenpauer, 1872

*Lytocarpia* Kirchenpauer (1872) has precedence over the more familiar *Thecocarpus* Nutting (1900) and in this respect (though with some misgivings on account of the similarity to *Lytocarpus*) we follow Rees and Vervoort (1987).

#### *Lytocarpia bathyalis* sp. nov. (Fig. 14)

#### HOLOTYPE

QMGL10310-1; BM1988.11.10.5. Found entangled in a prawn trap.

#### TYPE LOCALITY

Off Suva barrier reef, about 450 m depth. 1978.

#### DESCRIPTION

Colony tall and delicate, 130 mm, little branched, arising from a tangle of hydrorhizal fibres. Stem polysiphonic, branches lightly polysiphonic basally and monosiphonic distally. Stem and branches bearing long, regularly alternate hydrocladia arising from axial tube; axial tubes of branches arising from the peripheral tubes of stem; divided by indistinct oblique nodes into regular internodes. Each internode with a mid-lateral apophysis, and antero-inferior and antero-axillary nematothecae; a small mamelon on the apophysis. Cauline nematothecae broadly based and either bifurcate or conical; if the latter, then with one terminal aperture which is often confluent and scroll-like with a second, smaller one, at inner base. Antero-inferior nematotheca orientated along the stem axis (not on hydrocladial apophysis), distinctly bifurcate, the apertures directed laterad. Antero-axillary nematotheca conical, aperture directed laterad.

Hydrocladia divided into regular thecate inter-

nodes by indistinct transverse nodes; internodes more or less straight, without septa; the hydrotheca in the upper half of the anterior surface.

Hydrothecae deep, triangular; adcauline wall straight, abcauline wall diverging progressively from base to margin; narrowing below septum. Adcauline intrathecal septum above the hypopore, sigmoidal, of variable length; if complete then inserting two-fifths to one-half way up abcauline wall. Margin directed from internode at 70-80°; with seven marginal cusps. Abcauline cusp more or less fused to the medio-inferior nematotheca, incurved and pointed. Lateral cusps low and rounded, the middle one pointed slightly and sweeping posterad; all upward directed.

Medio-inferior nematotheca adnate to abcauline wall for entire hydrothecal height, then free for a short distance, curving over hydrotheca; bifurcate, scroll-like or slightly tubular to two terminal apertures, with a third at the base of the free part, opening immediately behind the abcauline marginal cusps. Lateral nematothecae tubular, narrowing distad, with two apertures, terminal and mesial; these sometimes confluent and scroll-like, directed antero-distad, overtopping thecal margin.

Corbulae numerous, borne on the stem, parallel to and in the plane of the hydrocladia; open, with pedicel of one hydrotheca-bearing segment followed by up to 40 segments carrying alternate paired ribs. Each rib with proximal hydrotheca (with two lateral but no medio-inferior nematothecae) above the blade base and a single nematotheca below; true perisarc crest absent. Blade narrow, the edges bearing subopposite nematothecae. These long and tubular with terminal and basal apertures inclined along rib axis. Rib indistinctly segmented, typically with one or two nematothecae. Rib internodes with a small mamelon and two opposed, conical nematothecae directed laterad. Gonothecae cordate, somewhat compressed.

#### MEASUREMENTS ( $\mu\text{m}$ )

Internode length: 750-820. Hydrotheca: abcauline length 400-420; adcauline height 430-480; marginal diameter 230-250. Nematotheca length: medio-inferior 80-95; lateral 175-190.

#### OCCURRENCE IN FIJI

Off Suva barrier reef, about 450 m, with corbulae. 1978 (QMGL10310, 10311).

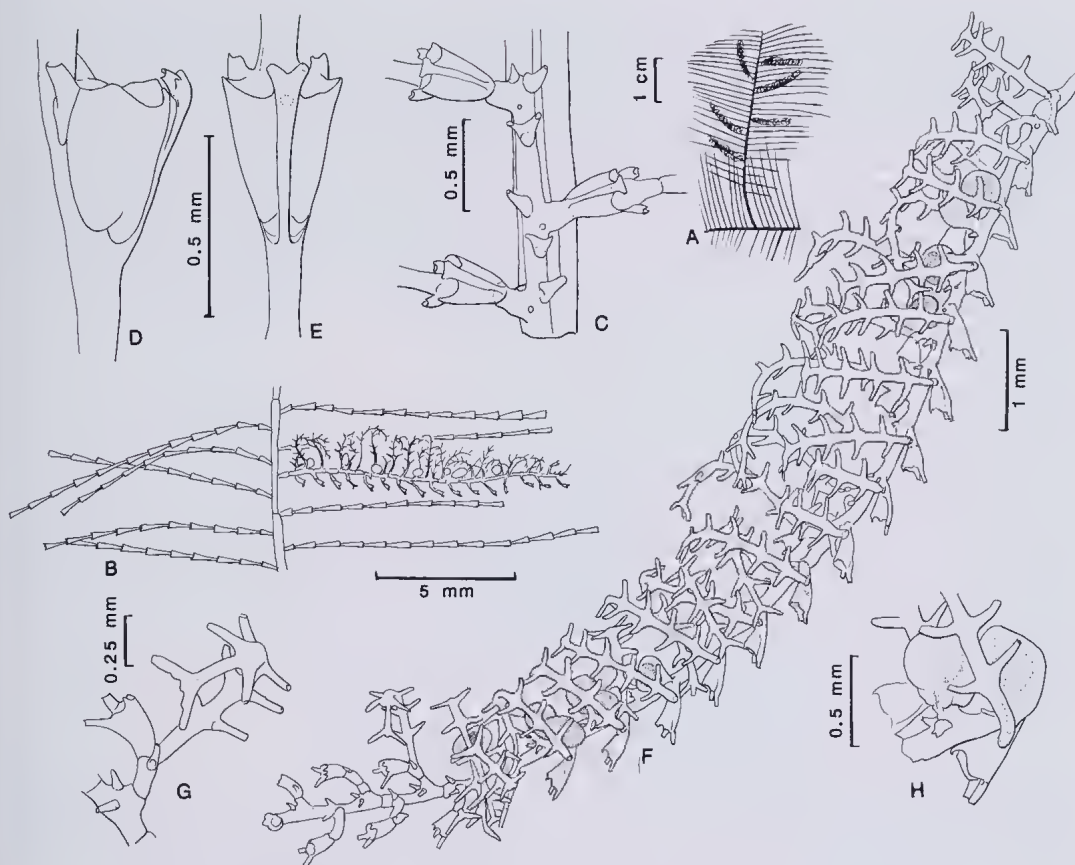


FIG. 14. *Lytocarpia bathyalis* sp. nov. All drawings are of the holotype (slides QMGL10310-1). A, part of main stem and a principal branch. B, part of a branch with hydrocladia and corbula. C, part of branch with bases of three hydrocladia. D, E, hydrotheca and nematotheca. F, phylactocarp. G, bract. H, gonotheca.

***Lytocarpia brevirostris* (Busk, 1852)**  
(Fig. 15)

*Plumularia brevirostris* Busk, 1852: 397

*Thecocarpus brevirostris* (Busk): Billard, 1913: 89

*Thecocarpus brevirostris* (Busk, 1852): Millard,  
1975: 454

**DESCRIPTION**

Colony erect. Stems reaching 20 mm, lightly polysiphonic; unbranched or with subopposite branches, usually in one plane, redivided as stem to a secondary or tertiary level. Axial tubes of branches arising from the peripheral tubes of the stem and lower order branches; final branches lightly polysiphonic basally. Stem and branches with alternate hydrocladia from axial tube; this divided by slightly oblique, indistinct nodes, sloping alternately left and right, imparting a slightly geniculate appearance to the younger

parts of the colony. Basal part of stem and branches without hydrocladia; latter with internodes bearing a single nematotheca. Thereafter, all internodes with a mid-lateral hydrocladial apophysis and two nematothecae: antero-inferior and antero-superior; a mamelon on the apophysis. Cauline nematothecae broadly based, widening distally; gutter-like or open with large aperture on inner surface. Sometimes bifurcating distally, with terminal apertures at 180° to each other; then tubular or scroll-like for a variable distance below the apertures. Antero-inferior nematotheca directed along hydrocladial axis; antero-superior nematotheca mesial, directed along internodal axis.

Hydrocladia divided by indistinct oblique nodes into regular thecate internodes. Internodes slightly convex, with a bulge distally; generally

without internodal septa; hydrothecae on anterior surface.

Hydrothecae sigmoid in profile, deep, widening to margin. Abcauline wall convex and thickened in lower region, where adnate to nematotheca; then sharply reflexed. Adcauline intrathecal septum above hydropore, of variable length. Margin facing away from internode at 35–50°, with seven cusps.

Abcauline tooth tall and pointed, may approximate the end of medio-inferior nematotheca owing to curvature of upper abcauline wall; three pairs of pointed and outwardly directed lateral cusps, middle pair broad, triangular. Medio-inferior nematotheca tubular, adnate to abcauline thecal wall for two-fifths to one-half cup height, then free and divergent, curving upward and away from hydrocladial axis; with three apertures: terminal, on upper surface at beginning of free part (these two usually confluent), and opening to hydrotheca near top of adnate part. Lateral nematothecae tubular and narrowing distally, gutter-like; with antero-mesial aperture; overtopping thecal margin, directed postero-laterad.

Corbulae stubby; length 1.5–2.5 times width, much shorter than hydrocladia. Corbula closed, with pedicel of one hydrothecal segment, followed by up to 10 segments carrying alternate paired ribs. Each rib raised proximally as a perisarcral crest supporting a single hydrotheca (with two lateral, but no medio-inferior, nematothecae), then continued as a broad blade with gutter-like nematothecae along outer edge and scattered irregularly on the distal upper surface; inferior edge fused to the superior edge of the preceding rib. Superior edge often with a leaflike outgrowth bearing one nematotheca between hydrotheca and blade. Corbula terminated by up to three complete hydrothecae. Gonothecae delicate, scarcely visible inside the pod-like corbula.

#### MEASUREMENTS ( $\mu\text{m}$ )

Internode length: 270–320. Hydrotheca: free abcauline length 45–80; adnate abcauline length 110–125; adcauline height 220–240; marginal diameter 70–110. Nematotheca length: medio-inferior 70–110; lateral 65–80.

#### VARIATIONS

Colony leaf-like, with a tendency to reverse stem face several times. Subopposite branches may be in slightly different planes from main stem, angled postero-laterad. Hydrocladial inter-

nodes may have a small incomplete septum opposite the adcauline intrathecal septum.

#### OCCURRENCE IN FIJI

Yarawa reef, Mba, under boulders, 8 Nov 78 (BM1984.5.17.65); Tailevu Point, on coral rock, 16 Sep 78, 14 Jul 79 (QMGL10314); Thangilai reef, 28 Apr 79 (QMGL10312–3; BM 1984.5.17.66); Ndeumba 18 Mar 79; Great Astrolabe Reef, with *Hebella dyssymetra*, 23 Jun 78 (BM1984.5.17.67), 12 Jul 80.

#### WORLD DISTRIBUTION

Tropical Indo-west Pacific.

#### *Lytocarpia nicpenni* sp. nov. (Figs 16, 17)

#### HOLOTYPE

QMGL10315; BM1984.5.17.68. Collected by Dr. N. Penn.

#### PARATYPES

QMGL10316, BM1984.5.17.69 and 70.

#### TYPE LOCALITY

Makuluva Pass (Sta.33), 15–20m, 2 May 1980.

#### DESCRIPTION

Colony a well-branched fan, reaching 90 mm. Stem bearing largely alternate branches in one plane, these once or twice redivided in same manner. Stem and primary branches typically lightly polysiphonic basally, monosiphonic distally. Stem and branches with alternate hydrocladia from axial tube. Axial tubes of branches arising from peripheral tubes of the stem; divided by slightly oblique, indistinct nodes into regular internodes. Branch basal internodes without hydrocladial apophyses but with regularly arranged mesial nematothecae, one per internode; thereafter, all internodes bearing a hydrocladial apophysis laterally and two nematothecae, antero-inferior and antero-superior; a large mamelon present on the apophysis. Cauline nematothecae bifurcate to a variable degree; tubular or scroll-like to two terminal apertures, open on inner surface. Antero-inferior nematotheca directed more or less distad along stem axis, with apertures lateral, opposite each other. Antero-superior nematotheca partly on the apophysis and directed more or less distad along stem axis.

Hydrocladia bearing hydrothecae on anterior surface, divided into thecate internodes by indis-



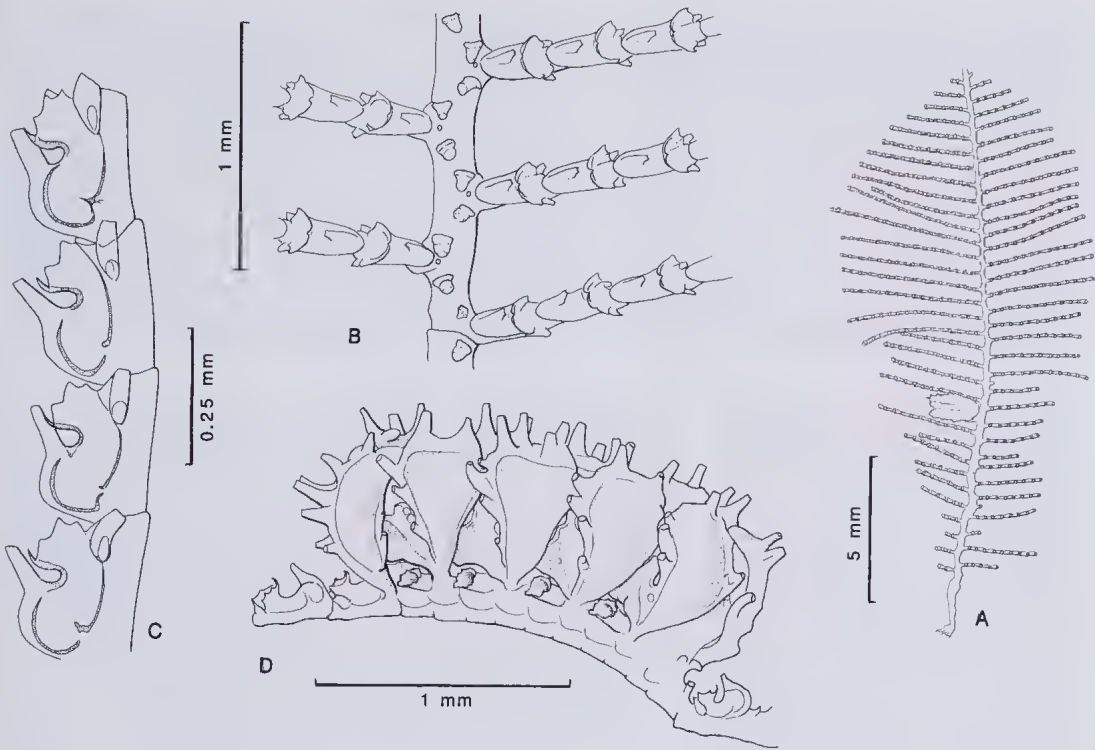


FIG. 15. *Lytocarpia brevirostris*. A, part of colony. B, part of stem and bases of hydrocladia. C, part of hydrocladium in profile. D, corbula. A,B, QMGL10312. C, QMGL10313, Thangilai Reef. D, QMGL10314, Tailevu Point.

tinct transverse nodes; internodes more or less straight, without internodal septa.

Hydrothecae sac-shaped, rarely widening to margin. Abcauline wall thickened and convex where adnate to nematotheca; concave above. Adcauline septum above hydropore of variable length, usually long and sinuous, inserting below the free part of medio-inferior nematotheca. Margin at  $55\text{--}70^\circ$  to internode, with nine marginal cusps. Abcauline cusp tall and pointed; remainder progressively rounded and low lying, upward directed, separated by rounded bays.

Medio-inferior nematotheca tubular, adnate to abcauline thecal wall for one-half to two-thirds cup height, then free; with two apertures, terminal, and on upper surface at beginning of free part (the two sometimes confluent); no opening to hydrotheca. Lateral nematothecae tubular and bifurcate, with mesial and two terminal apertures; one part directed anterad and overtopping thecal margin, the other extending posterad across the width of the internode; the latter sometimes absent.

Corbulae numerous on stem and branches, in

same plane as and paralleling the ordinary hydrocladia; open, with pedicel of one hydrothecate segment followed by up to 36 segments carrying alternate paired ribs. Each rib with a small mamelon and two associated nematothecae, one in axil and directed along the corbular axis, the other opposite the rib and directed away from it. Ribs without perisarc crest, with a single nematotheca in angle of blade base and a hydrotheca beyond it; this with a pair of undivided lateral nematothecae but no medio-inferior nematotheca. Blades narrow, bearing subopposite nematothecae on edges (though the first blade unpaired); not contiguous with adjacent ribs (hence open). These nematothecae long and tubular, increasing in length along the blade, oblique to the rib edge and with terminal and basal apertures. Rib indistinctly segmented, typically with one or two pairs of nematothecae per segment. Gonotheca lens-shaped.

#### MEASUREMENTS ( $\mu\text{m}$ )

Internode length 250–280. Hydrotheca: free abcauline length 75–110; adnate abcauline

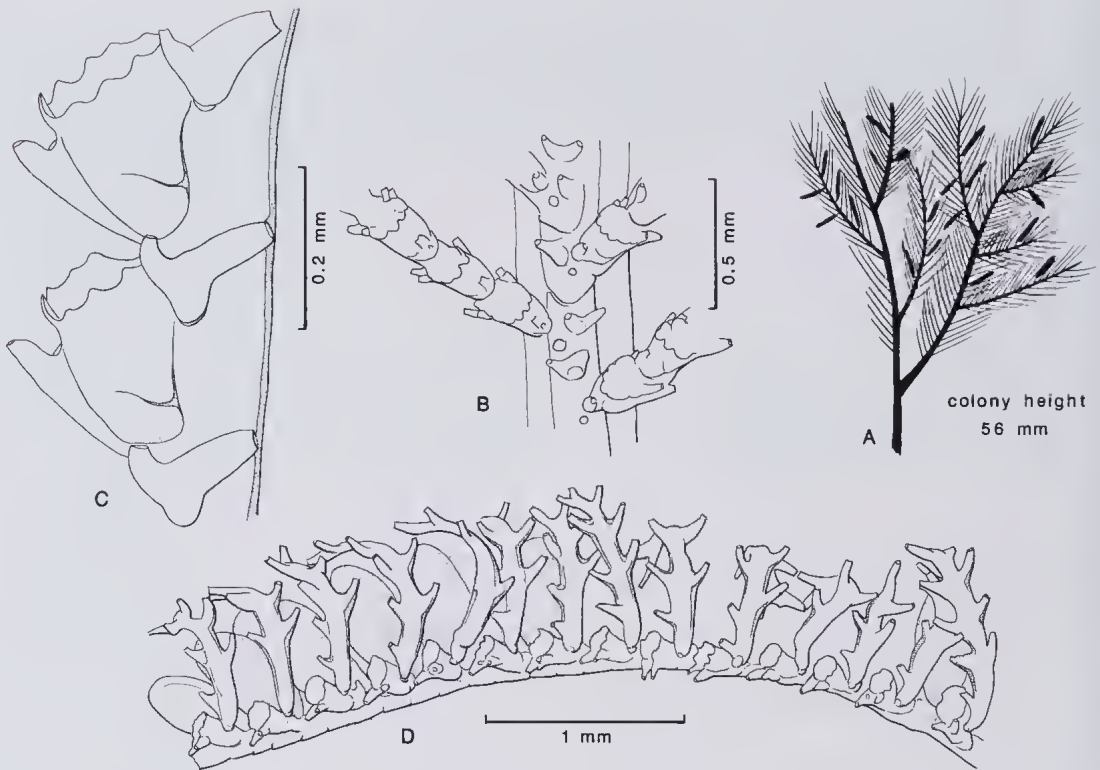


FIG. 16. *Lytocarpia nicpenni* sp.n. All drawings are of the holotype (QMGL10315). A, part of colony. B, part of stem and bases of three hydrocladia. C, hydrothecae and nematothecae in profile. D, corbula.

length 160–185; adcauline length 230–260; marginal diameter 140–170. Nematotheca length: medio-inferior 60–85; lateral (anterior part) 120–150; lateral (posterior part) 95–120.

#### VARIATIONS

Nodes at branch and colony base very indistinct. Free abcauline wall of hydrotheca showing a variable degree of concavity and height: if short then very concave with abcauline marginal tooth close to medio-inferior nematotheca, if long then straight and roughly parallel with the internode. Antero-superior cauline nematotheca may not be bifurcated but conical, with terminal aperture directed laterad from hydrocladium; on hydrocladia, lateral thecal nematothecae often lacking the posterior element, the pair on any hydrotheca even differing in this respect. Hydrothecae rarely develop along corbula ribs. A second corbula sometimes arises from the rib of an existing, undamaged one.

#### OCCURRENCE IN FIJI

No intertidal records. Makuluva Pass, 15–20

m, 2 May 80 (holotype); Suva barrier reef, 0–20 m, 19 Feb 81 (BM1984.5.17.69); north tip of Yanutha reef, Mbengga, 15–20 m, 7 Oct 79 (paratype, QMGL10316) and Pratt Reef, Mbengga, 4 m, 3 Nov 79 (BM 1984.5.17.70); all with corbulae.

#### *Lytocarpia phyteuma* (Kirchenpauer, 1876) (Figs 18,19)

*Aglaophenia phyteuma* Kirchenpauer, 1876: 23

*Thecocarpus phyteuma* (Kirchenpauer, 1876): Millard and Bouillon, 1973: 95; Vervoort and Vasseur, 1977: 86

#### DESCRIPTION

Stems arising from creeping hydrorhiza, monosiphonic; reaching 60 mm; divided by slightly oblique nodes into regular internodes. Basal internodes of colony without hydrocladia but with irregularly arranged distal nematothecae. Thereafter, each internode with a single lateral hydrocladial apophysis and three nematothecae: antero-inferior, antero-superior, and

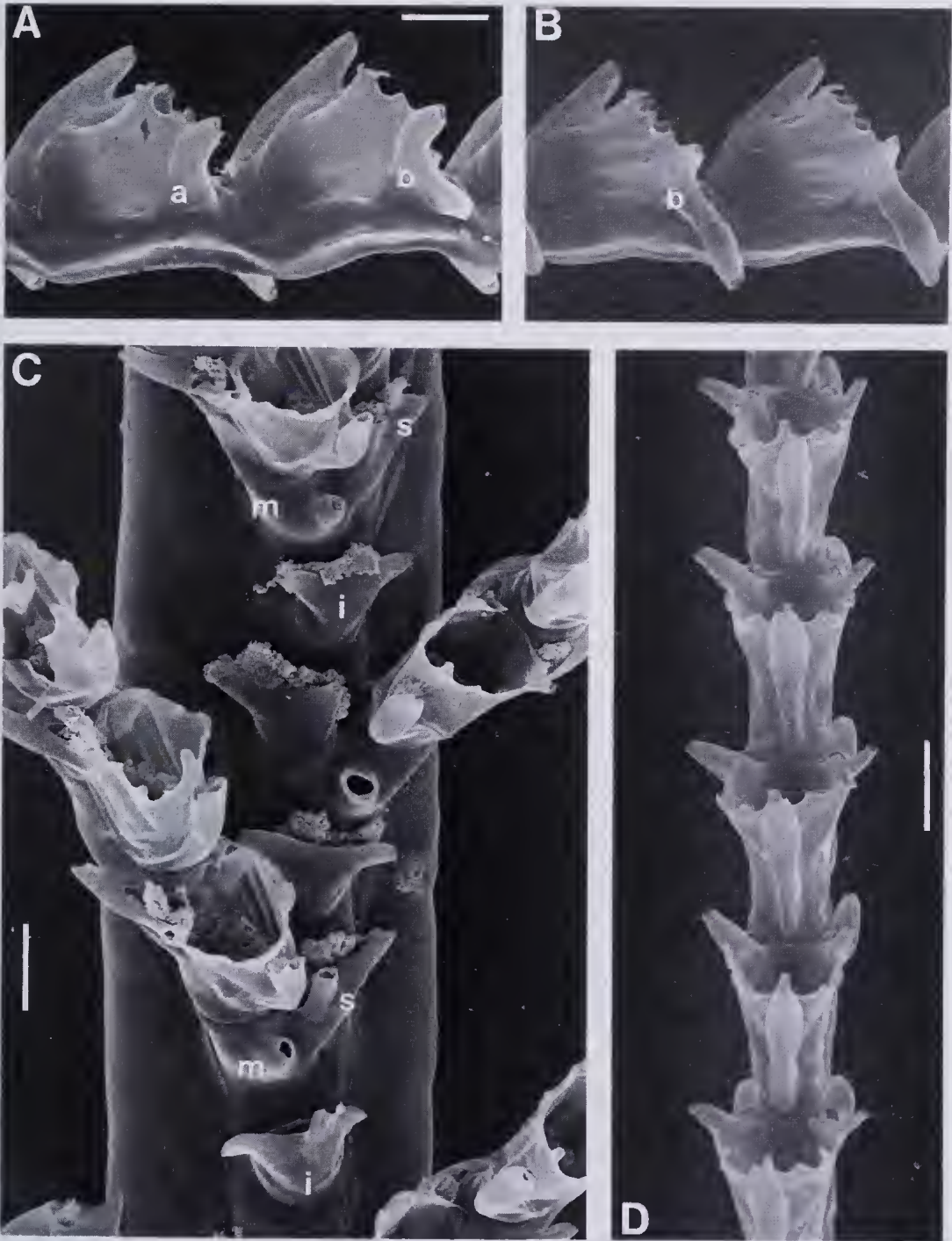


FIG. 17. Scanning electron micrographs of *Lytocarpia nicpenni* sp. nov. A, B, lateral views of hydrothecae. The lateral nematothecae are either bifurcate (b) or represented by only the anterior fork (a). C, part of stem. Between the hydrocladia are an inferior nematotheca (i), a mammelon (m), and a superior nematotheca (s). D, anterior view of hydrothecae. Some lateral nematothecae have both anterior (a) and posterior (p) apertures. Scale bar = 100  $\mu$ m. SEMs by Dr M. Fordy.

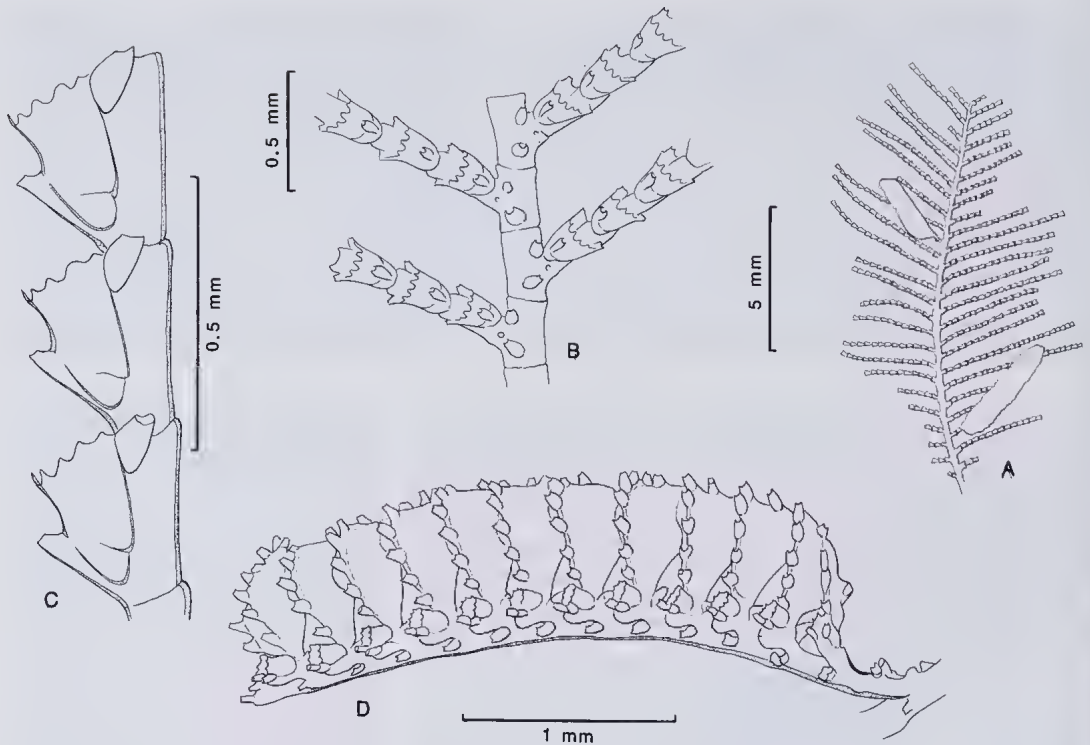


FIG. 18. *Lytocarpia phyteuma*. A, part of colony. B, part of stem and bases of hydrocladia. C, hydrothecae and nematothecae. D, corbula. A, QMGL10319. B,D, QMGL10318, Great Astrolabe Reef. C, QMGL10317, Nukulevu.

postero-axillary; a small mamelon on the apophysis. Cauline nematothecae very variable, all broadly based and with gutter-like aperture on inner surface. Antero-inferior nematotheca median, below apophysis, directed along hydrocladial axis, saccular, wider proximally or distally. Antero-axillary nematotheca narrowing distally, directed along internode axis. Postero-axillary nematotheca sometimes weakly bifurcate, projecting away from internode, with mesial aperture directed along the internode axis.

Hydrocladia alternate, bearing hydrothecae anteriorly, divided by slightly oblique, indistinct nodes into thecate internodes; these more or less straight, without septa.

Hydrothecae variable, sac-shaped, delicate, widening to margin. Abcauline wall thickened, convex in lower adnate region and concave above. Adcauline septum above hydropore of variable length. Margin at 60–80° to internode, with nine marginal cusps. Abcauline, median cusp tall and pointed, remainder progressively more rounded and low lying; directed upward,

separated by rounded bays. With three nematothecae, one medio-inferior and two lateral. Medio-inferior nematotheca tubular, adnate to abcauline thecal wall for one-half to four-fifths cup height, then free, divergent, and gutter-like; also opening to hydrotheca near top of adnate part. Lateral nematothecae likewise tubular and gutter-like, with antero-mesial aperture; overlapping thecal margin, directed posterad.

Corbulae long, about two-thirds length of hydrocladia; closed, with a pedicel of one hydrotheca-bearing segment followed by 20–36 segments bearing alternate paired ribs. Each rib proximally bearing a tall perisarc crest supporting a single hydrotheca (with lateral but no medio-inferior nematothecae); continuing as a broad blade bearing a series of gutter-like nematothecae along the outer/superior edge and having the inner/inferior edge fused to the inner face of the preceding rib. Ribs of the basal pair bear nematothecae on their inferior and superior edges; inferior edge often developed as a leaflike

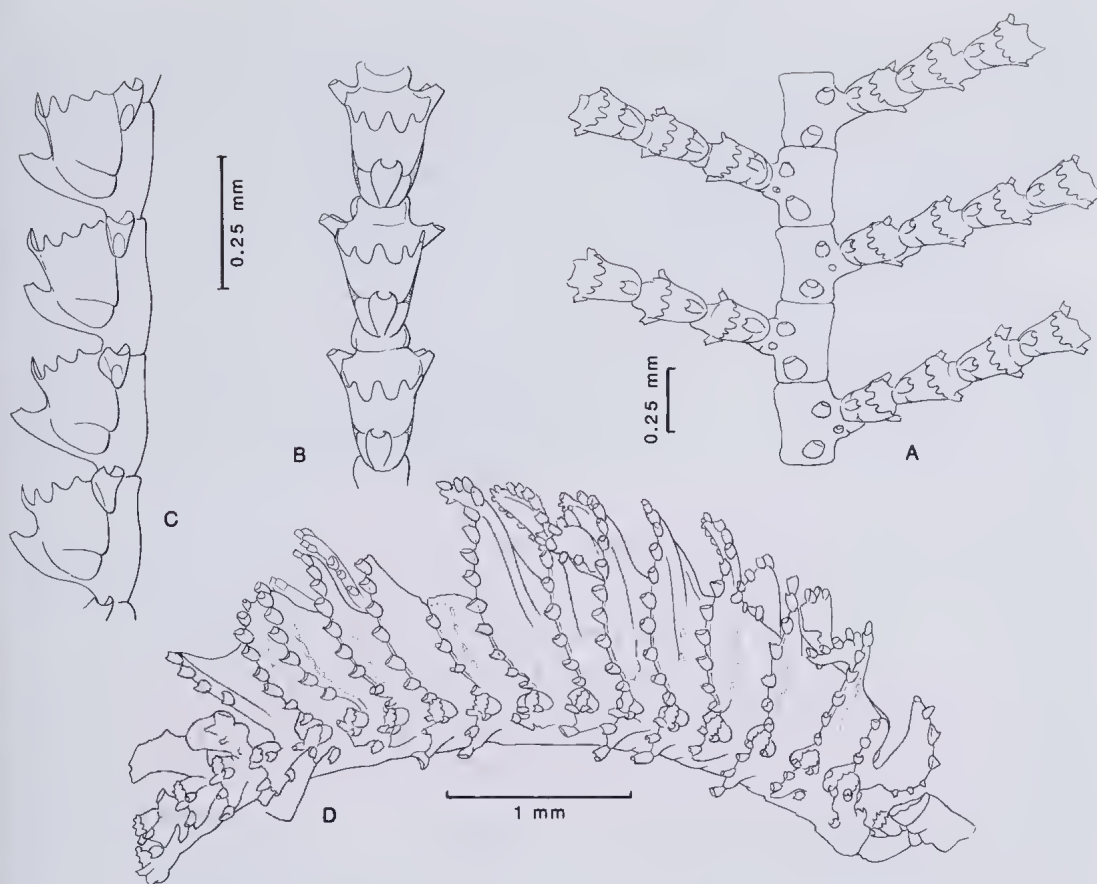


FIG. 19. *Lytocarpia phyteuma* continued. A, part of stem and bases of hydrocladia. B, C, part of hydrocladium. D, corbula. A-C, QMGL10320. B, QMGL10321, Ndeumba.

outgrowth. Nematothecal apertures facing distad along the rib edge.

#### MEASUREMENTS ( $\mu\text{m}$ )

Internode length: 220–300. Hydrotheca: free abcauline length 70–120; adnate abcauline length 115–155; adcauline height 220–240; marginal diameter 110–140. Nematotheca length: medio-inferior 50–65; lateral 95–140.

#### VARIATIONS

Colony leaf-like in appearance, with hydrocladia either close together or more distant. Sometimes the antero-posterior orientation of the stem is reversed several times. Free abcauline thecal wall of variable length; long, straightish and parallel to internode, or short and concave, the abcauline cusp close to the medio-inferior nematotheca. The greater the concavity, the more acute the marginal angle. Hydrothecal sep-

tum may be complete, below the thecal opening of the medio-inferior nematotheca, or present only as a short extension of the adcauline peg at this level. In the corbula, the basal perisarcal crest of each rib may extend beyond its hydrotheca and bear one terminal and up to three disto-medial nematothecae.

#### OCCURRENCE IN FIJI

Nukulevu, on ascidian, 0.5–2 m, 27 May 79 (QMGL10317; BM 1984.5.17.63); Suva barrier reef, near harbour entrance, 0–13 m, 3 Jun 80 (BM 1984.5.17.64); Ndeumba, gulleys at LWST, 18 Mar 79 (QMGL10320–1; BM 1984.5.17.61); windward Great Astrolabe Reef, 24 Jun 78 (QMGL10318; BM1984.5.17.60), 11 Jul 80 (QMGL10319; BM1984.5.17.62), some with *Hebella dyssymetra*; Frigate Pass, Mbengga leeward barrier reef, 3–8 m, with *H.*

*dyssymetra*; 2 Nov 79. Corbulae present February, March, May, June, July, August.

#### WORLD DISTRIBUTION

Tropical Indo-west Pacific: Seychelles, Indonesia, Great Barrier Reef, Tonga, Tuvalu, and French Polynesia.

### *Lytocarpia vitiensis* sp. nov. (Figs 20,21)

#### HOLOTYPE

QMGL10322-4; BM1984.5.17.71. Collected by Dr. N. Penn.

#### PARATYPE

BM1984.5.17.72

#### TYPE LOCALITY

Suva Harbour entrance, 12 m (Sta. 25), 21 Nov 79.

#### DESCRIPTION

Colony a well-branched fan, reaching 60 mm, bearing irregularly alternate branches in one plane, these redivided as stem. Stem polysiphonic, branches typically lightly polysiphonic basally and monosiphonic distally. Stem and branches bearing alternate hydrocladia from axial tube. Axial tubes of branches generally arising from the peripheral tubes of the stem; divided by indistinct oblique nodes into regular internodes. Branch basal internodes without hydrocladial apophysis but each with a single mesial nematotheca; thereafter, all internodes with an antero-lateral apophysis and two or three anterior nematothecae: one or two inferior, one superior; and a large mamelon on apophysis. Nematothecae of variable shape and size: broad based and widening distad, gutter-like with aperture on inner surface; usually bifurcate, tubular or scroll-like for a variable length to the terminal apertures; these at 90–180° to each other. Lower antero-inferior nematothecae large, strongly bifurcate, apertures directed laterad, extending whole width of axial tube; orientated distad along stem axis. Upper antero-inferior nematotheca directed along the stem axis, distinctly bifurcate. Antero-superior nematotheca weakly bifurcate, directed distad along stem axis.

Hydrocladia divided into regular thecate internodes by indistinct oblique nodes; internodes more or less straight, without internodal septa; hydrothecae on anterior surface.

Hydrothecae sac-shaped, delicate, not widen-

ing to margin. Abcauline wall long and slightly convex in lower adnate region: short and more or less straight above, slightly thickened. Usually without intrathecal septum. Margin at angle of 50–60° to internode axis, with nine cusps. Abcauline cusp tall and pointed but cusps progressively rounded and low lying posteriorly; directed upward; separated by rounded bays.

Medio-inferior nematotheca tubular, adnate to abcauline hydrothecal wall for one-half to two-thirds cup height, then free, rather straight, with concave upper surface; with three apertures: terminal, on upper surface at beginning of free part (these two usually confluent), and opening into hydrotheca near top of adnate part. Lateral nematothecae tubular and tapering distad, directed postero-distad, and overtopping the thecal margin; with terminal and antero-mesial apertures.

Corbulae numerous, borne on and in the plane of the branches, parallel with the ordinary hydrocladia; open, with pedicel of one hydrothecate segment followed by up to 36 segments carrying alternate paired ribs. Each rib with a small mamelon and two associated nematothecae, one in the axil and directed along the corbular axis, the other opposite the rib and directed away from it. Blade size decreasing distad. Each rib with a single nematotheca in angle of blade base and a hydrotheca beyond it; this with two lateral but no medio-inferior nematothecae; no perisarc crest. Blades narrow, the edges bearing subopposite nematothecae; these long and tubular, oblique to the rib axis, with terminal and basal apertures; their length increasing distad. Rib indistinctly segmented, typically with one or two pairs of nematothecae per segment. Gonothecae lens-shaped.

#### MEASUREMENTS (µm)

Internode length 230–260. Hydrotheca: free abcauline length 75–95; adnate abcauline length 150–180; adcauline height 220–250; marginal diameter 140–160. Nematotheca length: medio-inferior 65–80; lateral 150–170.

#### VARIATIONS

Shape of hydrothecal abcauline wall variable, more or less straight throughout and parallel to internode, or distinctly concave below and convex above; adnate region always longer than free part. Some specimens show a weak adcauline intrathecal septum above the hypopore. Lateral marginal cusps of similar size, or the second pair

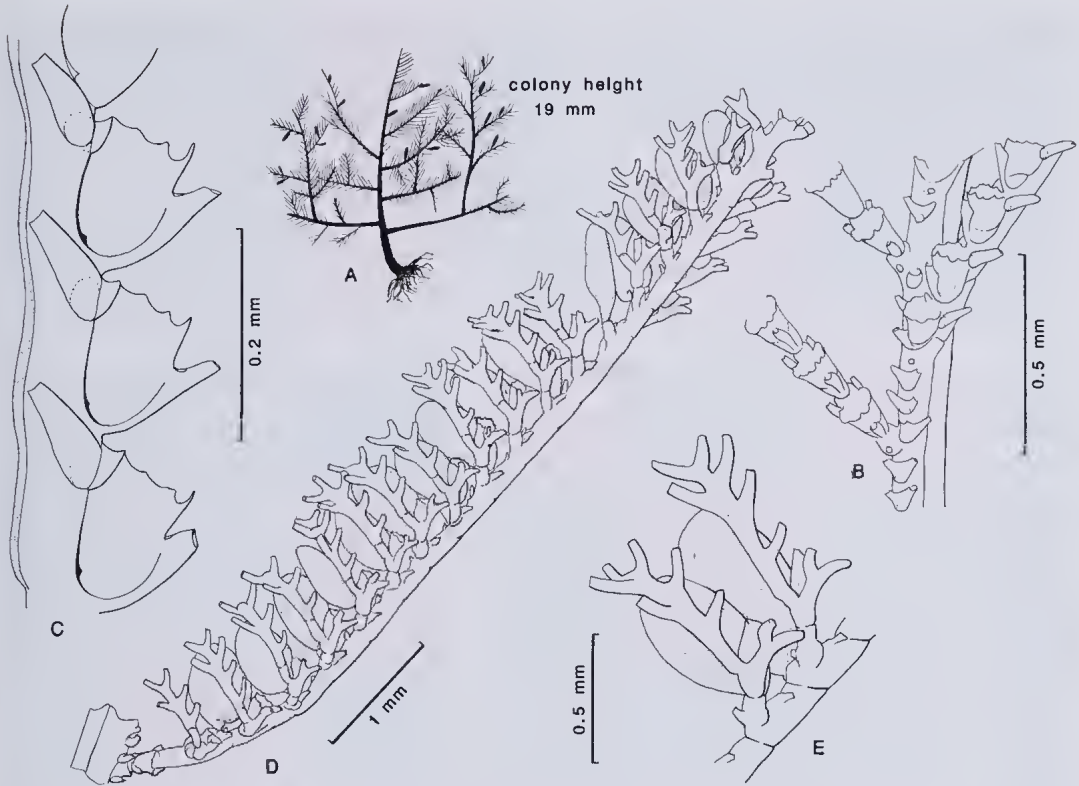


FIG. 20. *Lytocarpia vitiensis* sp. nov. All drawings are of the holotype (slides QMGL10323–4). A, colony. B, part of branch and bases of hydrocladia. C, hydrothecae and nematothecae. D, corbula. E, gonothecae.

from the adcauline side taller. The lower inferior cauline nematothecae are often absent and all cauline nematothecae are variably (or even not) bifurcated.

#### REMARKS

This species closely resembles *Lytocarpia nicpenni*, both in terms of general colony form and corbula structure, although the colonial fans of the present species seem a little smaller and less dense. The hydrothecae differ mainly in having non-bifurcated lateral nematothecae. However, in the previous species also, hydrothecae at the hydrocladial base frequently bear non-bifurcated lateral nematothecae; but while the single element in *L. nicpenni* is directed anterad, it is directed posterad in *L. vitiensis*. The hydrothecae in *L. nicpenni* have a well developed intrathecal septum, those of *vitiensis* usually do not. The present species also differs from *L. nicpenni* in sometimes having a third nematotheca associated with the hydrocladial apophysis and in the medio-inferior nematotheca opening to the hydrotheca.

#### OCCURRENCE IN FIJI

Suva harbour entrance, about 12 m, with corbulae, 21 Nov 79 (holotype, QMGL10322–4; BM 1984.5.17.71). Frigate Pass, Mbengga leeward barrier reef, 3–8 m, 3 Nov 79 (BM 1984.5.17.72).

#### *Macrorhynchia* Kirchenpauer, 1872

*Macrorhynchia* Kirchenpauer (1872) is the valid name for the genus more familiarly known as *Lytocarpus* Allman, 1883, see Rees and Vervoort (1987).

#### *Macrorhynchia philippina* (Kirchenpauer, 1872) (Fig. 22)

*Aglaophenia* (*Macrorhynchia*) *Philippina* Kirchenpauer, 1872: 29

*Lytocarpus philippinus* (Kirchenpauer): Billard, 1913: 78

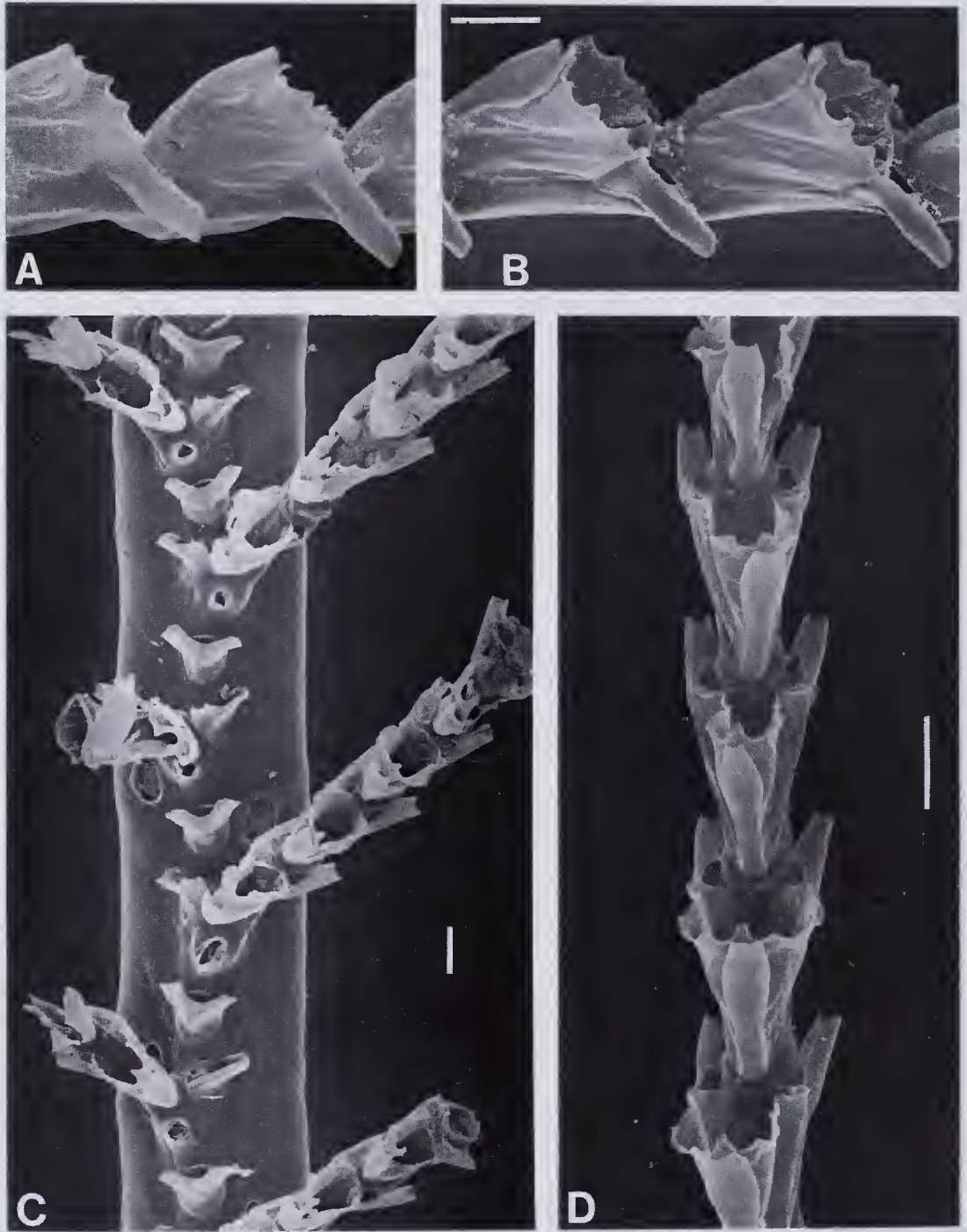


FIG. 21. Scanning electron micrographs of *Lytocarpia vitiensis* sp. nov. A,B, lateral view of hydrothecae. The lateral nematothecae have only a posterior aperture. C, part of stem. Between the hydrocladia are either one or (at the top) two inferior nematothecae (i), a mammelon (m), and a superior nematotheca (s). D, anterior view of hydrothecae. Scale bar = 100  $\mu$ m. SEMs by Dr M. Fordy.



*Lytocarpus philippinus* (Kirchenpauer, 1872): Millard, 1975: 449

*Macrorhynchia philippina* (Kirchenpauer, 1872): Rees and Vervoort, 1987: 177

#### DESCRIPTION

Colony reaching 160 mm. Stems bearing irregularly alternate branches in same plane, these redivided to a fifth order. Stem and main branches polysiphonic, final branches typically lightly polysiphonic basally and monosiphonic distally; all bearing alternate hydrocladia from axial tube. Axial tubes of branches arising from peripheral tubes of stem or major branches; divided by oblique nodes into regular internodes. Basal branch internode long, without hydrocladial apophyses but with regularly arranged mesial nematotheca; terminated by a very oblique articulated joint. Thereafter, all internodes with one antero-lateral apophysis and two nematothecae, antero-inferior and antero-axillary; a small mamelon on apophysis. Cauline nematothecae broad-based, conical, with a terminal aperture and a second, smaller one, at inner base, never confluent. Antero-inferior nematotheca on hydrocladial apophysis and directed along its axis; the antero-axillary nematotheca directed disto-laterad. Cauline nematothecae at branch bases typically bifurcate.

Hydrocladia divided into regular thecate internodes by indistinct transverse nodes; internodes more or less straight, with two internodal septa, opposite the small adcauline intrathecal peg and at the base of lateral nematothecae; bearing hydrothecae on anterior surface.

Hydrothecae sigmoid in profile, widening to margin. Abcauline wall convex in adnate region, concave above. Perisarcal thickening below margin distinct, but variably developed; a small intrathecal peg on adcauline wall above the hydropore. Margin facing away from internode at 30–50°, with three cusps. Abcauline cusp very small and resembling a spine; two laterals low-lying with broadly triangular lobes. Medio-inferior nematotheca tubular, adnate to abcauline hydrothecal wall for approximately one-half the cup height; then free, divergent, sometimes upward pointing; with three apertures: terminal, on upper surface at beginning of the free part, and opening to hydrotheca near top of adnate part. Lateral nematothecae tubular, with terminal and mesial apertures; overtopping thecal margin, directed laterad and antero-distad.

Phylactocarps not observed (but described by Millard, 1975).

#### MEASUREMENTS (µm)

Internode length: 260–300. Hydrotheca: free abcauline length 45–60; adnate abcauline length 120–140; adcauline height 220–250; marginal diameter 100–115. Nematotheca length: medio-inferior 60–80; lateral 100–135.

#### VARIATIONS

Colony typically spindly, loosely spiralling, characteristically having a dark brown stem and white hydrocladia. Some specimens with very long, clubbed tendrils arising from the end of hydrocladia. Upper abcauline wall of hydrotheca variably concave, hence angle between the internode and the thecal margin also variable.

#### OCCURRENCE IN FIJI

Common along the fore-reef at Ndeumba, 0–2 m, many collections but never with phylactocarps (QMGL10326–10328; BM1984.5.17.58,59).

#### WORLD DISTRIBUTION

Pantropical.

#### *Macrorhynchia phoenicea* (Busk, 1852) (Fig. 23)

*Plumularia phoenicea* Busk, 1852: 398

*Aglaophenia phoenicea* Busk: Bale, 1884: 159

*Lytocarpus phoeniceus* (Busk): Billard, 1913: 74

*Macrorhynchia phoenicea* (Busk): Mammen, 1967: 313

*Lytocarpus phoeniceus* (Busk, 1852): Millard, 1975: 451

#### DESCRIPTION

Colony erect; stem polysiphonic, reaching 30 mm; bearing irregularly alternate branches in one plane, these never redivided, lightly fascicled basally. Axial tubes of branches generally arising from peripheral tubes of stem; divided by slightly oblique nodes into regular internodes. Hydrocladia arising from axial tube. Basal internodes of stem and branches without hydrocladial apophyses but with one medial nematotheca per internode; all distal internodes with one apophysis on antero-lateral surface, and antero-inferior and antero-axillary nematothecae; a small mamelon on the apophysis. Cauline nematothecae conical, variably sized, with terminal and smaller mesial apertures; the latter orientated along stem axis. Antero-superior

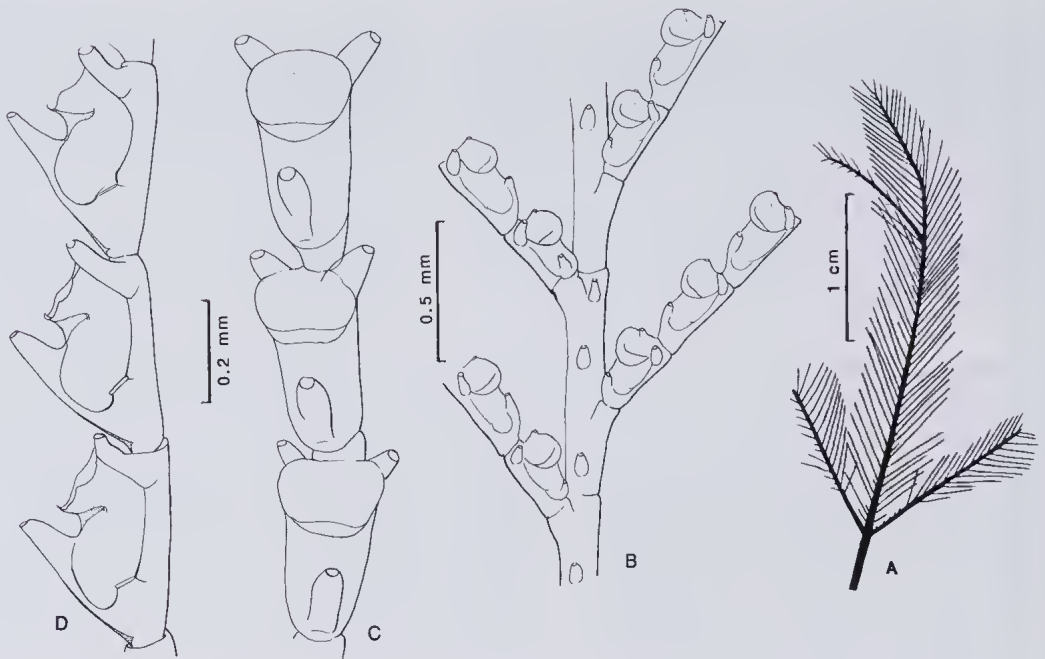


FIG. 22. *Macrorhyncha philippina*. A, part of colony. B, part of stem and bases of hydrocladia. C, D, hydrothecae and nematothecae. A, QMGL10328, off Magnetic Island, Queensland. B, QMGL10327, Ndeumba. C, QMGL10325 Lizard Island, Queensland. D, QMGL10326, Ndeumba.

nematotheca with aperture directed laterad; antero-inferior nematotheca directed distad or along hydrocladial axis.

Hydrocladia divided into regular thecate internodes by oblique nodes; internodes more or less straight, with three septa: one opposite adcauline interthecal septum, one at base of lateral nematothecae, and a faint one in between these; hydrothecae on anterior surface.

Hydrothecae sac-shaped, widening to margin; abcauline septum below margin long, extending for more than half the thecal width, at first straight but distinctly curled over at the end. Abcauline wall thickened, long, parallel to medio-inferior nematotheca for nearly entire lower adnate region, then very short and concave above; with a small peg just above the hydropore. Margin broad, facing away from internode at 30–40°; with nine marginal cusps. Abcauline cusp very small and pointed, laterals more or less equal in height, directed out and up.

Medio-inferior nematotheca tubular, adnate to abcauline thecal wall for majority of thecal length, then free and divergent, extending well beyond thecal margin, directed out and distad. Apertures terminal and on upper surface at beginning of free part, without internal opening

to hydrotheca. Lateral nematothecae tubular, long, directed latero-distad and slightly posterad; with two apertures, terminal and mesial.

Phylactocarps comprising a narrow blade with proximal hydrotheca replace every third hydrocladium. Blade divided by slightly oblique nodes into regular 'internodes' bearing two or three long, tubular nematothecae with terminal and basal apertures. 'Internodes' typically with opposite nematothecae on lateral edges, though alternate 'internodes' to the distal end of the blade bear a third, much longer nematotheca on the outer surface. Phylactocarp curled around gonotheca which is lens shaped but not strongly flattened.

#### MEASUREMENTS ( $\mu\text{m}$ )

Internode length: 240–260. Hydrotheca: free abcauline length 20–30; adnate abcauline length 100–115; adcauline height 180–230; marginal diameter 120–160. Nematotheca length: medio-inferior 110–140; lateral 65–75.

#### VARIATIONS

The second pair of lateral cusps on the hydrothecal margin may be pointed and back-

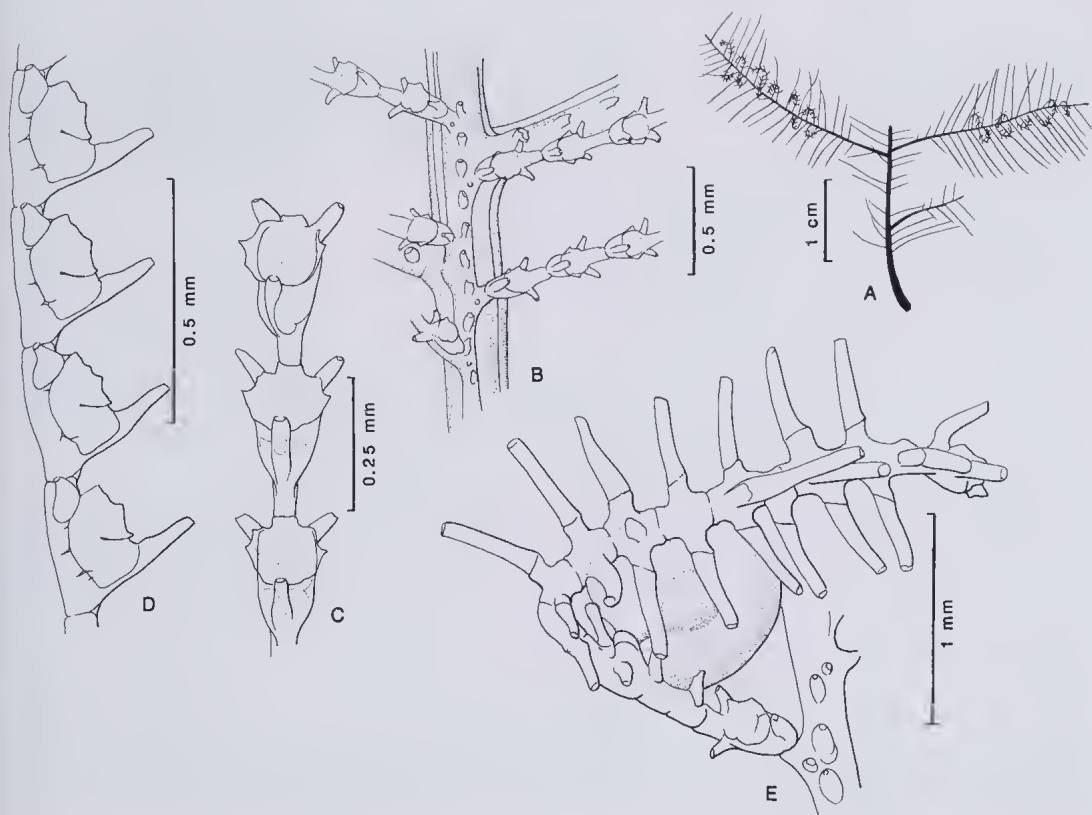


FIG. 23. *Macrorhynchia phoenicea*. A, part of colony. B, part of stem with bases of hydrocladia. C, parts of hydrocladia in profile. D, part of hydrocladium in plan view. E, phylactocarp. QMGL10329, Suva Barrier Reef.

ward sweeping. Those cauline nematothecae on the base of the stem and branches can be saccular, widening distad, and gutter-like.

#### REMARKS

The hydrothecal shape resembles that illustrated by Bale (1884: from Port Molle) though the long medio-inferior nematotheca is more akin to the variety from Port Darwin. This is a very variable species in terms of hydrothecal shape, length of medio-inferior nematotheca, and orientation of lateral nematothecae. Contrary to the description of Millard (1975), the gonotheca is borne on the second blade segment while the first bears a single nematotheca on its inner surface.

#### OCCURRENCE IN FIJI

Suva barrier forereef, opposite Nasese, 4–20 m, with phylactocarps, 19 Feb 80 (QM GL10329; BM1984.5.17.57).

#### WORLD DISTRIBUTION

Tropical Indo-Pacific.

*Aglaophenia* Lamouroux, 1812

*Aglaophenia postdentata* Billard, 1913  
(Fig. 24)

*Aglaophenia postdentata* Billard, 1913: 100

*Aglaophenia postdentata* Billard, 1913: Millard and Bouillon, 1973: 90

#### DESCRIPTION

Colony with small erect stems arising from creeping hydrorhiza, reaching 8.5 mm. Stems unbranched, unthickened, monosiphonic; bearing alternate, pinnately arranged hydrocladia; divided by slightly oblique nodes into internodes which bear one or two antero-lateral hydrocladial apophyses. Three nematothecae associated with each apophysis: antero-inferior, antero-axillary, and postero-axillary; a small

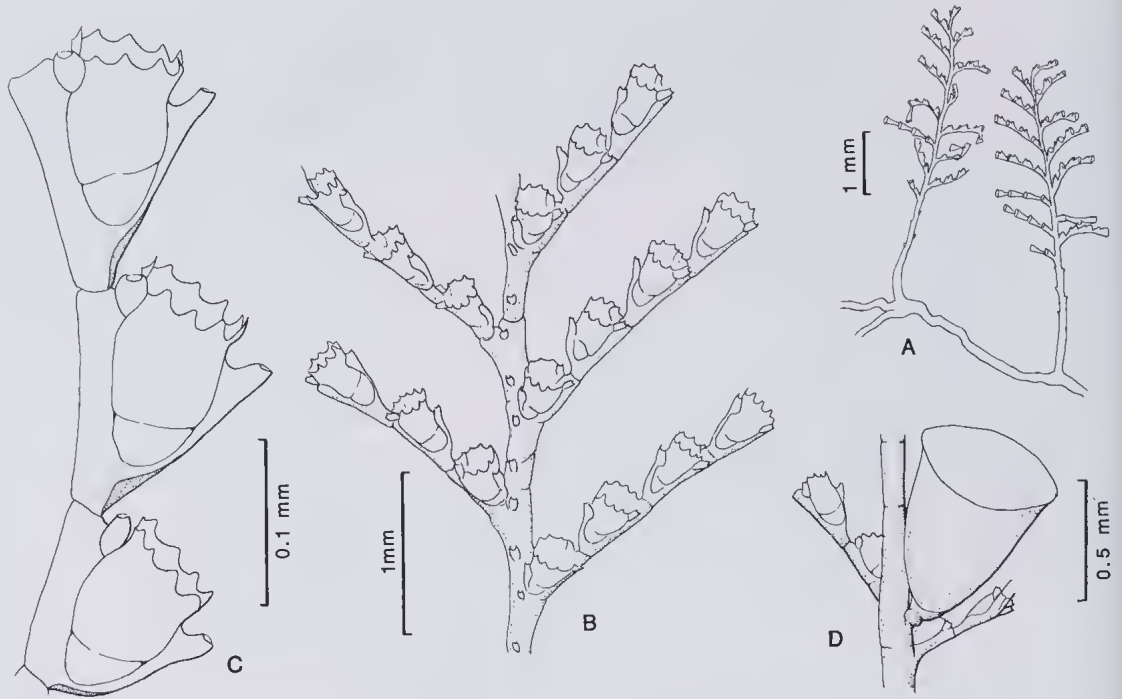


FIG. 24. *Aglaophenia postdentata*. A, part of colony. B, part of stem and bases of hydrocladia. C, hydrothecae with nematothecae in profile. D, associated *Hebella parasitica*. QMGL10330, Great Astrolabe Reef. B–D, QMGL10331, Thangilai.

mamelon on each apophysis. Proximal part of stem without hydrocladia, of variable length, and with one or two distal internodes articulating with each other and the stem above by means of very oblique, hinge-like nodes. Each of these internodes with one mesial nematotheca. Cauline nematothecae broadly based, conical and gutter-like, with aperture on the inner surface. Inferior nematotheca directed out and along stem axis; both axillary nematothecae directed laterad.

Hydrocladia divided into regular, more or less straight, internodes without internodal septa; hydrothecae on the anterior surface.

Hydrothecae sac-shaped, delicate, widening little to margin. Abcauline wall convex in adnate region, slightly concave above. Adcauline septum above hydropore, of variable length, usually long and bowed up in the middle; often complete. Margin rarely facing away from internode, though this dependent on the degree of concavity of the free portion of abcauline wall; 10 marginal cusps. The ab- and adcauline cusps most prominent; the laterals also pointed, more or less of equal size, directed upward, separated by triangular bays.

Medio-inferior nematotheca gutter-like, adnate to abcauline thecal wall for more than one-half cup height, then free and divergent. No internal opening to the hydrotheca at top of adnate region. Lateral nematothecae entirely on thecal wall, saccular and gutter-like, with antero-mesial aperture; not overtopping thecal margin, directed posterad.

Corbulae not observed (see Vervoort, 1941 or Millard and Bouillon, 1973 for descriptions).

#### MEASUREMENTS ( $\mu\text{m}$ )

Internode length: 250–270. Hydrotheca: free abcauline length 45–95; adnate abcauline length 125–150; adcauline height 180–250; marginal diameter 120–140. Nematotheca length: medio-inferior 35–50; lateral 45–55.

#### VARIATIONS

Colony thin, with unfascicled stems; may have opposite hydrocladia at stem base. Cauline nodes, sloping alternately left and right, may impart a slightly geniculate appearance to younger parts of the colony. Internodal septum may be present. Free abcauline wall of theca variably concave and may be more or less paral-

lel to hydrocladium. Adcauline marginal cusp variably developed, usually obvious but rarely as prominent as indicated in published descriptions. Some specimens have all the cusps tall and thin, imparting a very different appearance to the hydrothecae.

## REMARKS

The similarities between this species and juvenile colonies of *A. pluma* (Linnaeus, 1758) have been discussed by previous authors. Although the posterior marginal cusp is not distinctly demarcated from the laterals in our material, its size and shape provide sufficient evidence to allow recognition of the species.

## OCCURRENCE IN FIJI

Great Astrolabe Reef, 12 Jul 80 (QM GL10330). Thangilai reef, 28 Apr 79 (QM GL10331); Suva barrier reef, 29 Mar 79 and, with *Hebella parasitica*, 27 Apr 79; Joske's reef, 18 Sep 78 (BM1984.5.17.46); Ndeumba, with *H. parasitica*, 18 Mar 79.

## WORLD DISTRIBUTION

Seychelles, Celebes, Moluccas.

## LITERATURE CITED

- ALLMAN, G.J. 1874. On the diagnosis of new genera and species of hydroids. *Nature*, London 11: 179.
1876. Diagnoses of new genera and species of Hydroida. *Journal of the Linnean Society (Zoology)* 12: 251-284.
1877. Report on the Hydroida, collected during the exploration of the Gulf Stream by L.-F. de Pourtalès. *Memoirs of the Museum of comparative Zoology at Harvard College* 5: 1-66.
1883. Report on the Hydroida dredged by H.M.S. Challenger during the years 1873-1876. Part I. Plumularidae. *Scientific Results of the Challenger Expedition. Zoology* 7(20): 1-54.
- BALE, W.M. 1882. On the Hydroida of south-eastern Australia, with descriptions of supposed new species and notes on the genus *Aglaophenia*. *Journal of the Microscopical Society of Victoria*, 2: 15-48.
1884. Catalogue of the Australian hydroid zoophytes. Sydney: Australian Museum.
- BILLARD, A. 1913. Les Hydroïdes de l'expédition du Siboga. I. Plumularidae. *Siboga Expedition* 7a: 1-115.
- BOUILLON, J. 1985. Essai de classification des Hydropolyps-Hydroméduses (Hydrozoa-Cnidaria). *Indo-Malayan Zoology* 1: 29-243.
- BUSK, G. 1852. An account of the Polyzoa, and Sertularian zoophytes, collected in the voyage of the Rattlesnake, on the coasts of Australia and the Louisiade Archipelago, etc. In: MacGillivray, J. *Narrative of the voyage of H.M.S. Rattlesnake, Vol. 1, Appendix I: 343-402*. London.
- CORNELIUS, P.F.S. AND RYLAND, J.S. 1990. Hydrozoa. 107-158. In P.J. Hayward and J.S. Ryland (eds), 'Marine fauna of the British Isles and north-west Europe'. (The Clarendon Press:Oxford).
- ELLIS, J. 1755. 'An essay towards a natural history of the corallines'. London.
- FRASER, C.McL. 1944. 'Hydroids of the Atlantic coast of North America'. (University of Toronto Press: Toronto).
- GIBBONS, M.J. AND RYLAND, J.S. 1989. Intertidal and shallow water hydroids from Fiji. 1. Athecata to Sertulariidae. *Mem. Qd Mus.* 27: 377-432.
- GILI I SARDA, J-M. 1982. Fauna de cnidaris de les Illes Medes. *Treballs de la Institucio Catalana d'Historia Natural.* 10: 1-175.
- GMELIN, J.F. 1791. *Caroli a Linné ... Systema Naturae...* ed. 13. *Vermes.* 1(6): 3021-3910. *Lipsiae*, 3 vols (1788-1793).
- GRAVELY, F.H. 1927. The littoral fauna of Krusadai Island in the Gulf of Manaar, Hydrozoa. *Bulletin of the Madras Government Museum (Nat. Hist.)* 1: 7-20.
- HELLER, C. 1868. Die Zoophyten und Echinodermen des Adriatischen Meeres. *Verhandlungen der Zoologisch-botanischen Gesellschaft in Wien* 18: 1-88.
- HINCKS, T. 1868. 'A history of the British hydroid zoophytes'. 2 vols. (Van Voorst: London).
1874. On deep-water Hydroida from Iceland. *Annals and Magazine of Natural History, Ser. 4*, 13: 146-153.
- HIROHITO, Emperor of Japan, 1974. Some hydrozoans of the Bonin Islands. (Imperial Household: Tokyo).
- JÄDERHOLM, E. 1903. *Aussereuropäische Hydroïden im schwedischen Reichsmuseum.* *Arkiv for Zoologi* 1: 259-312.
- JOHNSTON, G. 1847. 'A history of British zoophytes', 2nd ed., 2 vols. (Van Voorst: London).
- KIRCHENPAUER, G.H. 1872. Ueber die Hydroïdenfamilie Plumularidae, einsele Gruppen derselben und ihre Fruchtbehälter: I. *Aglaophenia* Lx. *Abhandlungen aus dem Gebiet der Naturwissenschaften, Hamburg* 5: 1-52.
1876. Ueber die Hydroïdenfamilie Plumularidae,

- einselne Gruppen derselben und ihre Fruchtbehälter (II. *Plumularia* und *Nemertesia*). Abhandlungen aus dem Gebiet der Naturwissenschaften, herausgegeben vom Naturwissenschaftlichen Verein in Hamburg 6: 1-59.
- LAMARCK, J.P.B.A. de 1816. Histoire naturelle des animaux sans vertèbres. Ed. 1,1. (Bailliere: Paris).
- LAMOUREUX, J.V.F. 1812. Extrait d'un mémoire sur la classification des Polypiers coralligènes non entièrement pierreux. Nouveau Bulletin des Sciences par la Société Philomatique de Paris 3: 181-188.
- LINNAEUS, C. 1758. Systema naturae... Ed. 10. Holmiae: Laurentii Salvii.
- LISTER, J.J. 1834. Some observations on the structure and functions of tubular and cellular Polypi, and of Ascidiæ. Phil. Trans. R. Soc. 125: 365-388.
- MAMMEN, T.A. 1967. On a collection of hydroids from South India. III. Family Plumulariidae. J. Mar. Biol. Assoc. India 7: 291;324.
- MCCRADY, J. 1857. Gymnophthalmata of Charleston Harbor. Proceedings of the Elliott Society of Natural History of Charleston, South Carolina, I (cover date 1859): 103-221; (pagination of reprint: 1-119).
- MILLARD, N.A.H. 1975. Monograph of the Hydroida of Southern Africa. Annals of the South African Museum 68: 1-513.
- MILLARD, N.A.H. and BOUILLON, J. 1973. Hydroids from the Seychelles (Coelenterata). Annales du Musée royal de l'Afrique centrale. Sciences: Zoologiques 206: 1-106.
- NUTTING, C.C. 1900. American hydroids. Part I. The Plumularidae. Special Bull. US Natl Mus. 4(1): 1-285.
- PENNYCUK, P.R. 1959. Faunistic records from Queensland. Part V. Marine and brackish water hydroids. Papers Dept. Zool., Univ. Qd 1: 141-210.
- PICTET, C. 1893. Etude sur les Hydraires de la Baie d'Amboine. Revue suisse de Zoologie, 1: 1-64.
- REES, W.J. and VERVOORT, W. 1987. Hydroids from the John Murray Expedition to the Indian Ocean, with revisory notes on *Hydrodendron*, *Abietinella*, *Cryptolaria* and *Zygophylax* (Cnidaria: Hydrozoa). Zoologische Verhandlungen, Leiden, 237: 1-209.
- STECHOW, E. 1909. Beiträge zur Naturgeschichte Ostasiens: Hydroid-polypen der japanischen Ostküste. Abhandlungen der Bayerischen Akademie der Wissenschaften, Suppl. Bd. 1(6): 1-111.
1919. Zur Kenntnis der Hydroidenfauna des Mittelmeeres, Amerikas und andere Gebiete, nebst Angaben über einige Kirchenpauersche Typen von Plumulariden. Zoologische Jahrbücher (Systematik Abteilung) 42: 1-172.
1923. Zur Kenntnis der Hydroidenfauna des Mittelmeeres, Amerikas und andere Gebiete, 2. Teil. Zoologische Jahrbücher (Systematik Abteilung) 47: 29-270.
- TOTTON, A.K. 1930. Coelenterata. Part V. Hydroida. Natural History Report of the British Antarctic Terra Nova Expedition, 5: 131-252.
- VAN GEMERDEN-HOOGVEEN, G.C.H. 1965. Hydroids of the Caribbean: Sertulariidae, Plumulariidae and Aglaopheniidae. Studies on the fauna of Curaçao, 22: 1-87.
- VANNUCCI, M. 1951. Hydrozoa e Scyphozoa existente no Instituto Paulista de Oceanografia. Bolim do Instituto Oceanografico, S. Paulo, 2(1): 69-100.
- VERVOORT, W. 1941. Biological results of the Snelius Expedition. XI. The Hydroida of the Snelius Expedition (Milleporidae and Stylasteridae excluded). Temminckia, 6: 186-240.
1968. Report on a collection of Hydroida from the Caribbean region, including an annotated checklist of Caribbean hydroids. Zoologische Verhandlungen, Leiden, 92: 1-124.
- VERVOORT, W. and VASSEUR, P. 1977. Hydroids from French Polynesia with notes on distribution and ecology. Zoologische Verhandlungen, Leiden, 159: 1-98.

# TAXONOMIC REVIEW OF THE *VARANUS PRASINUS* GROUP WITH DESCRIPTIONS OF TWO NEW SPECIES

ROBERT GEORGE SPRACKLAND

Sprackland, R.G. 1991 08 01: Taxonomic review of the *Varanus prasinus* group with descriptions of two new species. *Memoirs of the Queensland Museum* 30(3): 561-576. Brisbane. ISSN 0079-8835.

Examination of seven character systems, including skull morphology, scalation, external morphology, colour pattern, ecology, karyotype, and behaviour, provide the data for taxonomic rearrangement. The subspecies *Varanus prasinus kordensis* is placed in junior synonymy with *V. prasinus*, while the subspecies *V. p. bogerti* and *V. p. beccarii* are elevated to specific status. In addition, two new extralimital species are described, *V. teriae*, sp. nov., from Australia's Cape York Peninsula, and *V. telenesetes* sp. nov., from Rossell Island, Papua New Guinea. A model for tree monitor origin and dispersal is presented. The group is probably derived from *Varanus indicus* stock, having primarily invaded New Guinea and extended later into northeastern Australia. □ *Varanus, taxonomy, zoogeography, cladistics.*

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Tree monitors are a closely allied group of medium sized lizards that range across the lowlands of New Guinea (Boulenger, 1885; De Rooij, 1915; Mertens, 1942c, 1950, 1959; Allison, 1982) and northeastern Australia (Cogger, 1975; Czechura, 1980). They are characterized by elongated body and limbs, and a fully prehensile tail (Greene, 1986), that is at least 1.75 times snout-vent length. Most widespread of these lizards is the striking emerald, or green, tree monitor, *Varanus prasinus*. The adaptations for arboreality represent highly derived characters within the Varanidae (Greene, 1986).

Mertens (1942a, c) assigned *V. prasinus* to the subgenus *Odatria* primarily on the basis of its round tail, but acknowledged that *V. prasinus* was unlike other odatrians. Mertens (1941, 1942a,c, 1950) placed four subspecies under *V. prasinus*: *prasinus*, *kordensis*, *beccarii*, and *bogerti*. My examination of a number of varanid species, including several *Odatria* and *V. prasinus*, suggests that the *prasinus*-group is distinct enough in habits, ecology, and morphology to warrant separation from *Odatria*.

This paper reviews the tree monitors, and concludes that 1, two subspecies previously assigned to *V. prasinus* be elevated to specific status, 2, the subspecies *kordensis*, representing normal variation within *prasinus*, be placed in junior synonymy with *prasinus*, 3, Australian and Rossell Island lizards represent new species,

and 4, the *prasinus* group is directly descended from *Varanus indicus*-related varanids and not from *Odatria*.

## MATERIALS AND METHODS

Forty six specimens of the *V. prasinus*-group were examined for skull morphology, scalation, external morphology, colour-pattern, ecology, and behaviour. Live specimens of *V. prasinus* and *V. beccarii* were examined in zoos and private collections.

Fifty-seven derived traits were tabulated for 23 varanid species to determine relationships of the *prasinus*-group to the Varanidae in general (Appendices 1 and 2). A character was assigned ancestral (0) status if it was common in related, non-varanid outgroups (heloderms, lanthanotids, anguids) (Pregill et al., 1986). Thus, a round nostril condition, common to most lacertilians, is rated as ancestral, while a slit nostril is considered derived. McDowell and Bogert (1954) pointed out that in varanids, the elongation of the snout is a secondary (=derived) condition that preceded the forward placement of the nostrils. Consequently, an ancestral varanid is expected to have an elongated snout with a posterior nostril (0) (i.e. *V. griseus*). In non-varanid outgroups, the adpressed limbs do not meet, so this was taken as the ancestral condition. Other traits were assessed similarly.

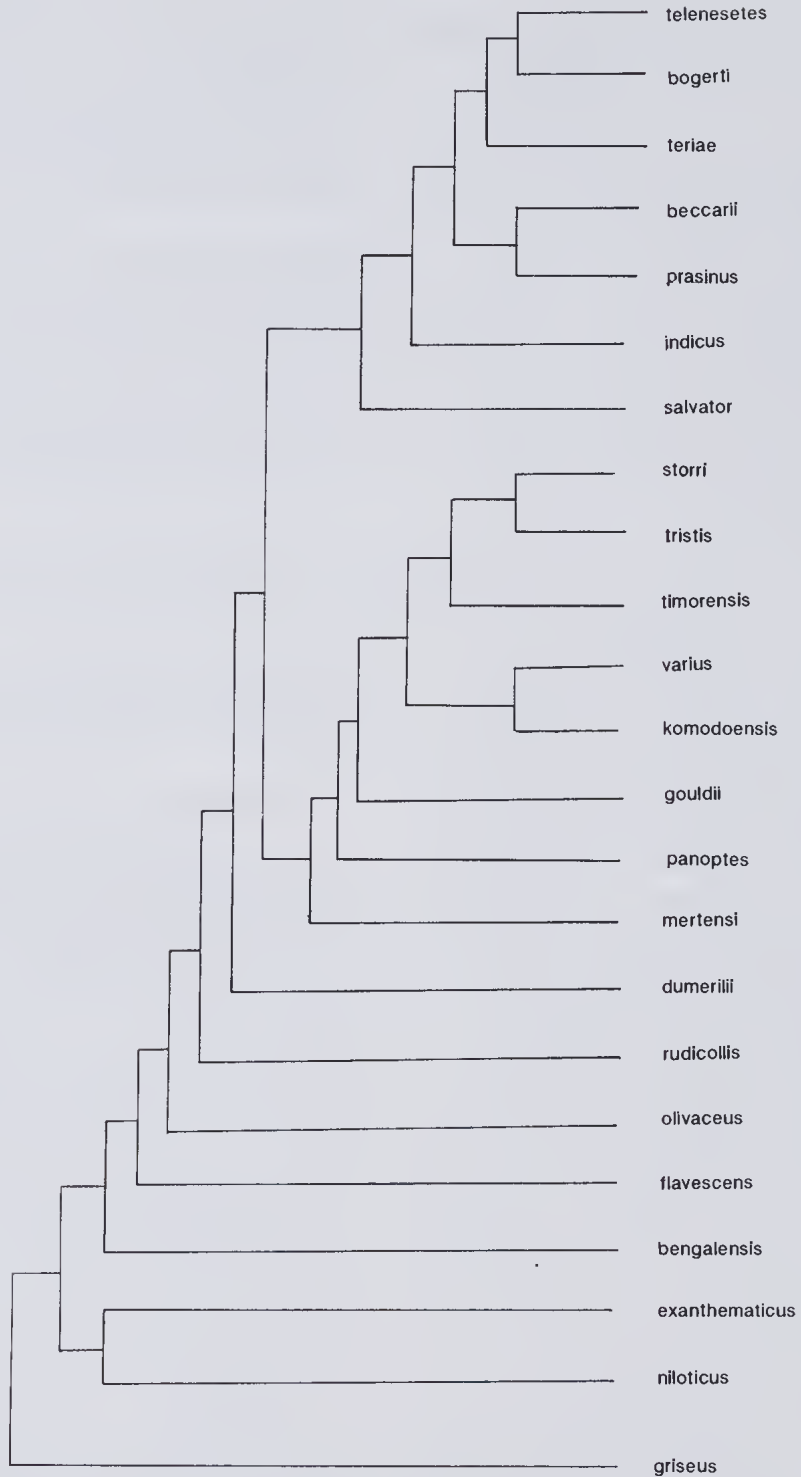


FIG. 1. PAUP produced cladogram for 23 varanids. Note that the geographic range for each taxon extends further east as one moves up the cladogram. Also note the implied relationship of the prasinoids (top 5 taxa) to both *V. indicus* and *V. salvator*. Character states and characters used given in Appendices 1 and 2.



Karyotype data were derived from Holmes et al. (1975), King and King (1975) and Auffenberg (1981, 1988). Hemipenial data are from Branch (1982) and Bohme (1988). Some information on cranial morphology was taken from Mertens (1942b). Other data were taken from specimens at the institutions listed below. The cladogram (Fig. 1) was constructed from the Phylogenetic Analysis Using Parsimony program (PAUP).

Specimens examined were from the American Museum of Natural History (AMNH), British Museum (Natural History) (BMNH), Field Museum of Natural History (FMNH), Florida State Museum (FSM), Queensland Museum (QM), United States National Museum of Natural History (USNM), University of Kansas Museum of Natural History (KU), California Academy of Sciences (CAS), Museum of Comparative Zoology (MCZ), Museum of Vertebrate Zoology (MVZ), University of Texas at Arlington (UTACV), San Jose State University Vertebrate Museum (SJSU), and the author's collection (RGS).

A brief description of certain character states employed (Appendix 1) is warranted:

4. The area surrounding the nostril is either raised, forming a distinct mound along the line of the canthus rostralis (1), or else the region is undifferentiated from the canthus.

8. The tongue is short (0) if it extends no greater than the distance from the snout tip to the posterior border of the eye.

10. The snout is considered broad at the tip (0) if there is minor constriction anterior to the eyes, that is, if the dorsal aspects of the canthus rostralis are nearly parallel.

12. A blunt snout (0) is taken to mean the line of the mouth is nearly parallel to the line of the canthus.

21. Cranial surface is a character of overall texture. A rough (0) surface has deep sutures between individual scales.

22. A rounded canthus is an indistinct morphological line (0); a distinct canthus is an acute line formed at the junction of the dorsal and lateral aspects of the region between the eye and the snout tip (1).

23. If the snout is triangular (1) in section, the lower borders of the maxillary bones are further apart than their upper borders.

28. Neck length is moderate (0) if it is less than or equal to the distance from snout tip to posterior border of the eye.

53. Reserved for unpublished data.

## RESULTS

In the Australia–New Guinea region, two major lines diverged: 1, the primarily Australian

monitors, characterized by small, pebbled cranial scales, comparatively short tails, and terrestrial habits, and 2, the Indo–New Guinean monitors that retain large, polygonal cranial scales, relatively long tails and arboreal/semi-aquatic habits. In the first group have been placed two subgenera (Mertens, 1942c). *Varanus* includes *varius*, *komodoensis*, *gouldii*, *panoptes* and *mertensi* (and probably *rosenbergi*, which was unavailable for this study), all species >1m in TL. The other subgenus is *Odatria*, typically <1m TL, with round, keeled tails. Except for *Varanus (Odatria) timorensis*, the subgenus is endemic to Australia.

*Varanus indicus* was removed from Mertens' subgenus *Varanus* and assigned to the subgenus *Euprepiosaurus* (Bohme, 1988), to which *V. karlschmidti* may be added (pers. obs.). Bohme also placed *V. prasinus* in *Euprepiosaurus* while leaving *V. salvator* unassigned. Though this study has employed less than half the described varanid taxa, preliminary results seem to indicate that subgeneric distinction in *Varanus* may be an unwarranted artifact. Mertens (1942a, c) assigned the tree monitors to the subgenus *Odatria*, containing 'small species, under 1m long, with rather short snout (except in *prasinus*, where it is decidedly long), and moderately high head, the nostril round or oval, almost always nearer the tip of the snout than the eye and... the tail is not laterally compressed...; supraoculars not much differentiated, except in the *prasinus* group; ...most with mesoprosopic, except *prasinus*, which has hypsirosopic...maxilla; nasals paired (except for *prasinus*)' (Mertens, 1942c, p. 240). A mesoprosopic snout would be square in section; a hypsirosopic snout would be triangular in section, with a broad base and narrow dorsal aspect.

McDowell and Bogert (1954) also noted that the maxillary structure, which produces facial robustness in most odatrians, is nearly flat in *V. prasinus*. Mertens distinguished *prasinus* from other odatrians by four characters; snout length, maxillary configuration, supraocular structure, and condition of the nasal bones.

An examination of odatrian monitors and the *prasinus*-group reveals other morphological distinctions. Cranial lepidosis in *Odatria* is small, pebbled in texture, and nearly uniform in size over the frontal-parietal region. In *V. prasinus* and its allies, these individual scales are larger, flat, polygonal, glossy, and smooth (though the depth of suture lines between individual scales gives an overall rugose texture in some taxa).

The supraoculars are transversely enlarged, and quite distinct from the frontal-parietal scales. The labial scales in *odatrians* are small and indistinct; in *prasinus*, they are larger, and well defined. Mertens (1942c, p.291) noted these features, and concluded that '*prasinus* seems unrelated to any recent monitors, being similar to no other species.'

This study disputes Mertens' assertion, and suggests the *prasinus*-group are closely allied to *V. indicus*, and, less closely, to *V. salvator*. In contrast to *Odatria*, the southeast Asian varanids tend to be larger, with compressed, slightly keeled tails. The limbs are longer, slender, and terminate in elongated digits. Their habitats tend to be mesic or semi-aquatic. In morphology, they resemble *prasinus* in having similar cranial scalation, including flat, polygonal, glossy scales, and enlarged supraoculars. They also agree in having fused nasal bones, long snout, medial nostrils (in *indicus*) and flat maxillary region.

Comparing data from Bohme (1988) and 56 presence/absence characters, this study confirms the affinities between the *V. prasinus*-group (*prasinus*, *beccarii*, *bogerti*, *teriae* and *telenesetes*) and *V. indicus* (Fig. 1).

However, this study cannot assign the tree monitors to an existing subgenus. Though similarities with *V. indicus* are numerous, at least six differences are equally distinct. Erection of a subgenus for tree monitors would form a paraphyletic assemblage, leaving *indicus*, *salvator*, and, probably, *karlschmidti* and *salvadorii* as the artificial sister group.

Because the cladogram (Fig. 1) is based on a limited number of taxa and characters, it cannot represent a final picture of varanid phylogeny. Both the characters employed and the purpose of using PAUP were to help ascertain the relationships of the tree monitors to each other and, in a general sense, to other varanids. That five good tree monitor lineages exist is a warranted conclusion; that subgeneric criteria can, or should be established, is not. Consequently, I recommend against subgeneric assignments for *Varanus* on the grounds that 1, different studies tend to ally species differently, 2, most designated subgenera are monotypic, thus of no real value (e.g., they either represent valid genera or they tell us nothing of systematic importance), and 3, the frequent shifting of subgeneric content in the literature presents a confusing and, at this stage at least, pointless exercise.

## SYSTEMATICS

### *Varanus prasinus* Group

I suggest that the presently recognised subspecies be elevated to full specific status based on morphological distinctness and distribution. I follow Wiley (1981), seeing sympatry and hybridization as irrelevant to determining functional evolutionary entities. The absence of observable hybrids can be used to support specific designations, although admittedly this is an artificial criterion as hybrids are often phenotypically indistinct. Allopatry of these taxa has resulted in distinguishable characters and lineages, even among the patternless melanistic forms. Though many biologists resist descriptions based largely on colour and pattern, such obvious traits are important and have already been used to erect new species (Myers and Daly, 1976; Storr, 1980). The variation of hue and pattern in *V. prasinus* once used to separate two subspecies is widespread throughout the lizard's range, and represents dynamic variation within the taxon. Enough characters can be examined to show no distinction between *prasinus* and *kordensis*.

#### DIAGNOSIS

Medium sized (to 1m total length), with (1) thin body, neck, limbs, digits and tail, (2) tail round in section, (3) tail fully prehensile, (4) nostril round or slightly oval, (5) nostril positioned midway between snout tip and orbit, (6) nasals fused, (7) premaxillary teeth 9, maxillary 10, dentary 11, (8) supraoculars transversely dilated, (9) preocular streak absent, (10) canthus rounded, (11) cranial scales large, polygonal, glossy, (12) maxillary region flat, not swollen, (13) snout triangular in sectional aspect, (14) preanal pores absent, and (15) tongue pink.

Characters 1, 2, 3, 4, 5, 9, 10, 13, and 14 are synapomorphic to tree monitors. Characters 2, 3, 5, 7, 9, 10 and 14 separate them from *V. komodoensis*, *gouldii*, *varius* and *salvator*. Characters 3, 5, 6, 7, 8, 9, 10, 11 and 12 separate them from *Odatria*. Though closely allied to *Euprepiosaurus* (Bohme, 1988), including *V. indicus* (Bohme, 1988) characters 1, 2, 3, 7, 9, and 15 distinguish tree monitors from the latter. They share character 15 with *V. karlschmidti* and subspecies presently assigned to *V. indicus* (e.g., *V. i. spinulosus* and *V. i. kalabeck*; Sprackland, in prep).



FIG. 2. *Varanus prasinus*, showing the banded (upper right and lower; author's collection) and rosette (upper left; Oklahoma City Zoo) dorsal patterns.

	<i>telenesetes</i>	<i>teriae</i>	<i>prasinus</i>	<i>bogerti</i>	<i>beccarii</i>
#ventrals	92	84-91	71-90	87-90	70-79
#midbody	100	90-93	80-112	95-99	81-86
#richtals	40	40	32-42	44-48	32-37
Nuchals	sl. keel	sl. keel	smooth/sl. keel	tubercular	keeled
Cranials	smooth	sl. rugose	smooth	rugose	sl. rugose
Gulars	flat	conical	flat	flat	flat
Palms	pale	black	black	black	black
Ventor	mottled	green	green	black	black
Dorsum	green	black	green	black	black
Pattern	yes	yes	yes	no	no
Ventrals	smooth	smooth	sl. keel	smooth	sl. keel

TABLE 1. Comparison of morphological features in tree monitors.

## COMMENTS

Tree monitors are derived from the *V. salvator-indicus* lineage as evidenced primarily by cranial lepidosis and skull morphology. They are distinct in colour, habits, ecology and morphology warranting specific status (Fig 1). The green colour, prehensile tail and arboreal habit suggest this easternmost radiation is highly derived. Apparent lack of vagility in distribution of tree monitors, compared to the *indicus* or *salvator* groups, is assumed to reflect recency of evolution, though the group is moving from mainland New Guinea to islands and adjacent Australia.

***Varanus prasinus* (Schlegel, 1839)**

(Figs 2,3)

*Monitor viridis* Gray, 1831:26.*Monitor prasinus* Schlegel, 1839:78, tab.22, fig.5.*Hydrosaurus prasinus* Schlegel; Gray, 1845:13.  
(Lizards Brit. Mus.)*Varanus prasinus* Schlegel; Bleeker, 1856:278.(Reis  
Minahassa 1).*Monitor kordensis* Meyer, 1874:131.*Odatria prasina* (Schlegel); Günther, 1877:413.  
(Ann. Mag. Nat. Hist.19).*Varanus kordensis* (Meyer); Boulenger 1885:322.  
(part)*Varanus kordensis* (Meyer); De Rooij, 1915:152.  
(part)*Varanus prasinus prasinus* Schlegel; Mertens,  
1942c:292.*Varanus prasinus kordensis* (Meyer); Mertens,  
1942c:295.

## MATERIAL EXAMINED

UTACV6736, 6744, 6816; FMNH14102,

14103; AMNH99610, 59051, 101071, 92335, 92337, 59053, 99611, 92371, 92663, 105877, 105878; MCZ149745, 149746, 141304, 140843, 126800, 126801, 137514, 4435, 137529, 137530, 10119, 126798; USNM195775 (3 sp); CAS135589, 126909, 20900, 126922; RGS100, 101; MVZ74904, 74905; plus 7 living animals.

## DIAGNOSIS

Green, with black chevrons dorsally, unpatterned below. Nuchals round or oval, smooth or with slight keel.

Distinct from *beccarii*, *teriae* and *bogerti* on the basis of colour and smoother nuchals. It differs from *telenesetes* in having black, not pale, palmar surfaces, and in having an unpatterned ventral coloration. (Table 1).

## DESCRIPTION

Snout long, depressed at tip. Canthus rostralis indistinct, swollen around nostrils. Nostrils round, median between orbit and snout tip. Upper labials flat, smooth and distinct, 22-23 in number. Cephalic scales large, polygonal, smooth or with minute pits. Sutures between cephalic scales shallow, giving a predominantly smooth texture. Supraoculars 3-7, transversely elongated. Scales from rictus to rictus 32-42. Nuchal scales are round or oval, anterior scales larger and smoother than posterior (though they occasionally shrink and become keeled from preservation). Posterior nuchals with single, posterior apical pit.

Dorsal scales slightly oval, becoming oval along sides, structure as posterior nuchals. Mid-body scales in 80-112 rows. Ventral scales in

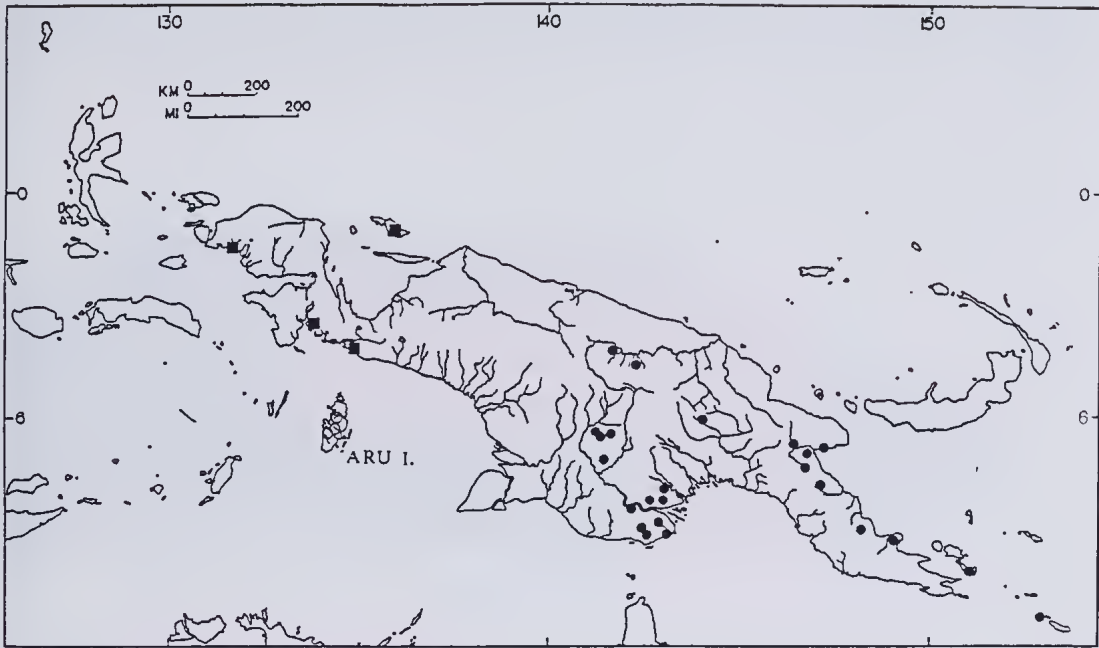


FIG. 3. Range map for *Varanus prasinus* (circles are localities examined by author; squares are localities from the literature) and *V. beccarii* (open circles) Aru Islands. Both taxa occur in lowland forests up to 500m.

71–90 rows, very feebly keeled, of *salvator*-type structure (Fig. 10).

Adult SVL 125–290 mm ( $\bar{x}$ =226.4). TL 463–874mm ( $\bar{x}$ =653.7).

Scales green, ranging from dark jade to lime; labials often marked with black spots. Epidermis between scales velvet black, forming 6–8 crossbands in some individuals (Fig. 2 upper right and lower); these bands sometimes lacking; the green scales forming close-knit, indistinct concentric rings (Fig. 2 upper left); the latter, once assigned to the subspecies *kordensis* is found throughout the range of *prasinus*, and from the same sites as the banded morph; temporal streak absent; ventrally uniform green in color; throat yellowish, sometimes with greyish crossbands.

#### DISTRIBUTION

New Guinea mainland, in lowland forests below 1,500 feet; absent from the mountains (Fig. 3).

#### REMARKS

*Monitor viridis* was described by Gray (1831)

based on a yellowish specimen without locality data. Schlegel (1839) examined a specimen from Fort de Bus on the western coast of New Guinea (=Irian Jaya) and renamed the species *Monitor prasinus*. Schlegel included a colour illustration of the lizard in the accompanying atlas. Because Gray's type was lost and the identity of *M. viridis* unconfirmed, *prasinus* took priority.

Meyer (1874) described *Monitor kordensis* from Wiak (=Kordo) Island, western New Guinea, based on its smaller dorsal scales, and a spotted, rather than banded, dorsum. DeRooij (1915) noted that the tail of *kordensis* was at least 2.33 times SVL, while it was under 1.75 times SVL in *prasinus*. Mertens (1941, 1942c) recognised these characters as distinguishing *kordensis* from *prasinus*, but concluded that they were conspecific. Mertens (1941) placed *kordensis* as a subspecies of *prasinus*, and maintained that position in a family review of varanids. His decision was based on only two animals and one skull of *kordensis* (Mertens, 1942c:295). Most characteristic of the differences between the taxa have been the keeled nature of the nuchals in *kordensis*. In living specimens of these lizards,



FIG. 4. Holotype of *Varanus telenesetes* sp. nov., QMJ1190, dorsal view of head.

the nuchals are smooth anteriorly, becoming oblong and keeled posteriorly. In specimens of *prasinus* (sensu Mertens, 1942c), preservation often causes a shrinking of these scales, making all nuchals appear oval and keeled. This character has not proved to be a reliable discriminant for either live or preserved tree monitors.

Boulenger (1885) noted that the body scales of *kordensis* are elongated, but observation also shows that the lateral body scales of *prasinus* are generally ovoid. Boulenger's description of *kordensis* is based on two specimens, one from Kordo (type locality), the other from 'New Guinea, South of Huon Gulf.' The latter is also described as 'entirely black.' I examined the latter specimen (BMNH76.7.6.2), and it proved to be *V. bogerti*. As a note of importance, Boulenger (1885) described *prasinus* as having caudal scales 'not keeled' and 'keeled' in the same paragraph, probably reflecting the variable effect of preservation on scutellation.

DeRooij (1915) described *kordensis* similarly to Boulenger, adding that the tail is 2.33 times SVL (vs 1.75 times SVL in *prasinus*). In measuring 40 lizards for this feature, no clear pattern

was found in tail length/SVL ratio, either clinally from east to west, or by population within any given area. DeRooij also described *kordensis* as being either black or olive with dark crossbands. In listing the habitat, she indicated that the only specimens she examined personally were from the Aru Islands, which are now assigned to *V. beccarii*. The remaining localities given include much of New Guinea, and include, most likely, descriptions of *V. bogerti* and *V. prasinus* taken from other workers.

The most visible distinction between lizards dubbed *kordensis* and *prasinus* is colour pattern, which is what Meyer (1874) used as the principle justification for naming the new species. In the former, dorsal bands of green are formed from large ocelli, giving the dorsum a spotted appearance unless the lizard is distended with air. *V. prasinus* is banded with green, ocelli being distinguishable only in juveniles or along the spine. *V. kordensis* tends to be darker green (jade) than *prasinus* (lime). However, the geographical distribution of these patterns is random, showing no cline or population centres. The variation in colour and pattern may reflect

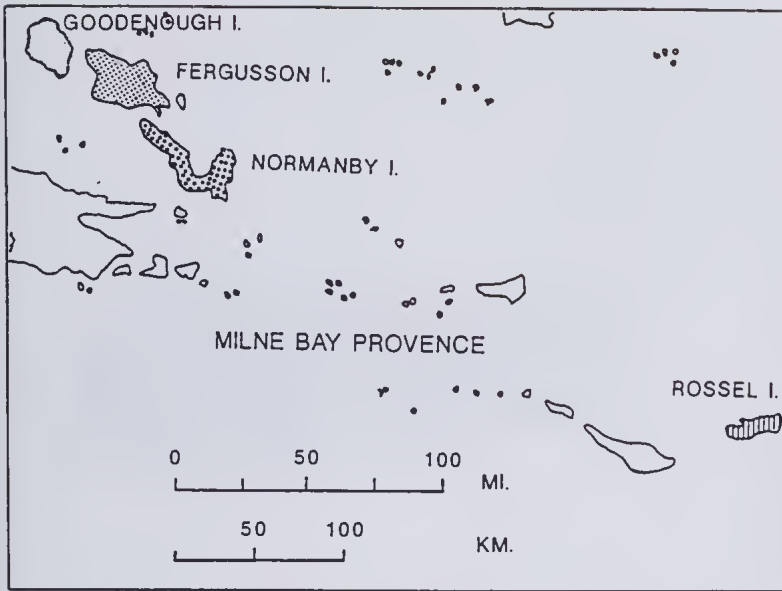


FIG. 5. Range map for *Varanus bogerti* (stippling) and *V. telenesetes* (lined).

allelic differences of a simple dominant/recessive pattern, but verification will require direct observation of known hybrids, suggesting the need for a longterm, captive breeding program. Given that the only difference separating these taxa is minor color variation, retention of *kordensis* as a subspecific entity is unwarranted.

***Varanus telenesetes* sp. nov.**  
(Figs 4,5)

1980 *Varanus prasinus* Czechura, p.103.

**MATERIAL EXAMINED**

**HOLOTYPE:** QMJ1190, Rousell (Rosset) Island, Milne Bay Province, Papua New Guinea.

**DIAGNOSIS**

Similar to *V. prasinus* from which it differs in having light, not black, palmar surfaces, smooth ventral scales, and a mottled ventral pattern. (Table 1).

**DESCRIPTION**

SVL 217 mm. TL 425 mm. Nuchal scales round, feebly keeled (possibly from preservation), equal in size to dorsals. Snout depressed, broad at tip. Nostril round, midway between orbit and snout tip. Upper labials 22, solid in color. Supraoculars enlarged, 7 in number. Scales across rictus 36. Tongue light in colour, probably yellowish in life. Cranial scales large,

flat and smooth. Gular scales small, round, flat. Midbody scales in 100 rows. Ventrals in 92 rows, smooth. Palmar surfaces with conical pads, pale in colour. Claws short, compressed. Caudals feebly keeled. Adpressed limbs meet and overlap.

In colour, similar to *V. prasinus*, being green above, with indistinct dark chevrons, apices pointed posteriorly. Ventrally mottled cream and dark brown. Throat banded.

**REMARKS**

Mertens (1959) examined a varanid from Rosset Island which he assigned to *V. prasinus bogerti*, but the Queensland Museum specimen bears no resemblance to *bogerti*. Aside from the distinct colouration, the snout of *telenesetes* is broader and blunter than that of *bogerti*; *telenesetes* is further distinct from *bogerti* in having smooth cranial scales, fewer scales across the rictus (36 vs 44–48), feebly keeled (vs tubercular) nuchals, and feebly keeled (vs strongly keeled) dorsal scales.

Czechura (1980) discussed two monitors allied to *V. prasinus* but did not fit existing subspecific descriptions. They represent three specimens from Queensland (*V. teriae*), and a single specimen from Rosset Island, Papua New Guinea (*V. telenesetes*). *V. telenesetes* appears to represent a relict population that arrived on Rosset Island when there was a land link to mainland New Guinea, suggested by the zoned distribution of the tree monitors, and the lack of vagility demonstrated in their dispersal.

**ETYMOLOGY**

Greek *tele-*, far and *nesetes*, island dweller; refers to occurrence at the easternmost point of New Guinea, 330 km from the nearest tree monitor population.

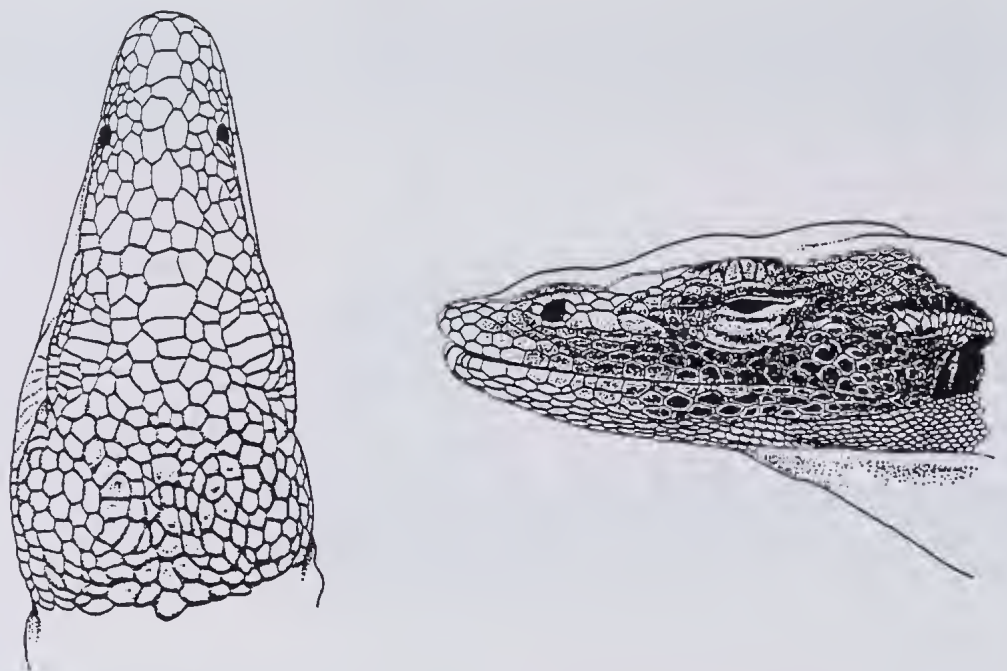


FIG. 6. *Varanus teriae* sp. nov., from the holotype. Drawn by Jeff Boundy from photograph by author.

*Varanus teriae* sp. nov.  
(Figs 6,7; Table 2)

PARATYPES: QMJ35450, 35451; same locality data as holotype.

*Varanus prasinus prasinus*, Czechura, 1980 :103.

MATERIAL EXAMINED

HOLOTYPE: QMJ31566 from Buthen Buthen, Nesbit River, Cape York Peninsula, Queensland. Collected August 1978, by Gregory Czechura.

	QMJ31566 (H)	QMJ35450 (P)	QMJ35451 (P)
SVL	254	252	225
Tail	513	500	450
Snout-Orbit	21	22	19
Ventr Scale Rows	84	86	91
Midbody Scale Rows	93	90	90
Scales Across Rictus	36	36	36
Sex	M	M	F

TABLE 2. Measurements of the type series of *Varanus teriae* sp. nov.

DIAGNOSIS

A predominantly melanistic lizard, with light bluish-green snout tip, yellow dorsal spots forming thin, paired chevrons and caudal rings, a pronounced temporal streak, and a pale yellowish ventor, readily distinguished by colour and pattern from all other tree monitors. It is further distinguishable by the conical, not flat, gular scales, a more anterior nostril, and by a more robust appearance, especially the postocular region (Table 1).

DESCRIPTION

SVL 225–254mm. TL 450–513mm. Snout not depressed at tip. Nostril oval, slightly nearer tip of snout than eye. Six or seven transversely dilated supraoculars. Upper labials 21–23, uniformly coloured. Gular scales conical, pointed. Anterior nuchals round, smooth; anterior nuchals ovoid, slightly keeled, subequal with dorsals. Midbody scales in 90–93 rows. Ventrals in 84–91 rows, smooth. Adpressed limbs meet and overlap. Tail at least 1.75 times SVL, round in section, distinctly keeled.

In colour, *V. teriae* is black above, with a





FIG. 7. Range map for *Varanus teriae* sp. nov. near Coen, Cape York Peninsula.

bluish-green upper snout, from tip to interorbital area. The body has small, yellow dots that form indistinct, paired chevrons that become caudal bands. A pale cream or yellow temporal streak extends from the posterior rim of the orbit 3–5 mm past the upper point of the ear, and is bordered above by a darker stripe. Ventral colouration is a pale lime green, including the ventral aspects of the limbs. The palmar surfaces are black, and covered with conical scales.



FIG. 8. *Varanus bogerti*, from Mertens (1950).

#### REMARKS

Colour, pattern, and the conical gulars separate *V. teriae* from other tree monitors. From *beccarii* it is further distinguished by its slightly keeled (vs strongly keeled) nuchals, smooth ventrals, higher ventral scale count (84–91 vs 70–79), and higher midbody scale count (90–93 vs 81–86). From *bogerti* it is distinguished by a higher snout (tip depressed in *bogerti*), shallower suture lines between cranial scales (giving *teriae* a smoother cranial texture) and slightly keeled nuchals (vs strongly keeled).

#### ETYMOLOGY

For my wife, Teri.

*Varanus bogerti* Mertens, 1950 comb. nov.

(Figs 5,8)

*Varanus prasinus bogerti* Mertens, 1950:3.

*Varanus kordensis* (Meyer); Boulenger, 1885:322.  
(part)

*Varanus kordensis* (Meyer); Boulenger, 1895:16.

*Varanus kordensis* (Meyer); DeRooy, 1915:152.  
(part)

#### MATERIAL EXAMINED

HOLOTYPE: AMNH41639, PARATYPES AMNH 41638, Fergusson Island, Milne Bay Province, Papua New Guinea; AMNH76722, Waikaiana, Normanby Island, Milne Bay Province, Papua New Guinea; BMNH76.7.6.2, South of Huon Gulf (Papua New Guinea); BMNH89.7.1.8, St Aignan, Louisiades, Milne Bay Province, Papua New Guinea.

#### DIAGNOSIS

A melanistic monitor lacking all trace of pattern. Tubercular, sharply keeled nuchals, rugose cranials and colour are distinctive. (Table 1).

#### DESCRIPTION

As given by Mertens (1950), except that nostril position in *bogerti* is not appreciably posterior to that of *beccarii*.

#### REMARKS

*V. bogerti* and *prasinus* come closer to sympatry than any other two members of the tree monitor group. *V. bogerti* is known from Fergusson and Normanby Islands, while *prasinus* is recorded for Goodenough (Burt and Burt, 1932; Mertens, 1950), all in the same archipelago.

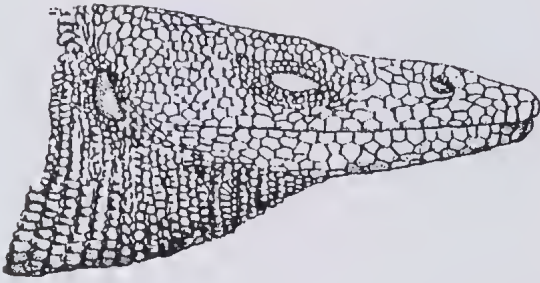


FIG. 9. *Varanus beccarii*, from type description of Doria (1874).

*Varanus beccarii* (Doria, 1874) comb. nov.

(Figs 3,9)

*Monitor beccarii* Doria, 1874:331.

*Varanus kordensis* (Meyer); Boulenger, 1885:322.  
(part)

*Varanus kordensis* (Meyer); DeRoos, 1915:152.  
(part)

*Varanus prasinus beccarii* Mertens, 1941:272.

#### MATERIAL EXAMINED

MCZ7489 (2 specimens), Aru Islands; BMNH1910.4.26.25-26, 'B.O.V. Expedition' Dutch New Guinea; BMNH1905.11.29.4, Fak Fak, Dutch New Guinea; one uncatalogued skull, plus 4 live specimens.

#### DIAGNOSIS

Melanistic, with triangular keeled nuchal scales. Differs from *bogerti* in having lower scale counts and smoother cranial lepidosis. It differs from *prasinus*, *telenesetes* and *teriae* in

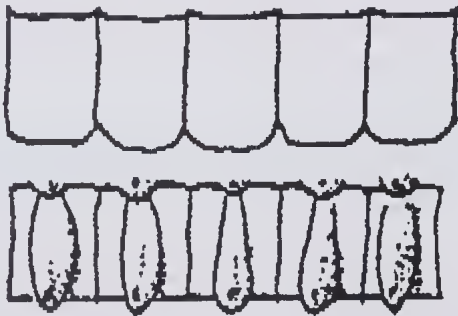


FIG. 10. Ventral scales of *Varanus salvator* (upper) and *V. varius* (lower), showing the two distinct morphologies of these scales in varanids.

colour, pattern, and hull-shaped nuchal scales. (Table 1).

#### DESCRIPTION

The largest of the tree monitors, to 340mm SVL; snout long, depressed at tip, considerably narrowed anterior to nostrils. Canthus somewhat distinct, giving the snout a higher appearance than in other tree monitors. Nostrils round, median between snout tip and anterior edge of orbit. Upper labials flat, smooth and distinct, 22-23 in number. Cranials large, polygonal and smooth, with minute pits. Sutures between cranials deep, giving a predominantly rough texture (less so than in *V. bogerti*). Supraoculars 3-7, transversely elongated. Scales from rictus to rictus 32-37. Nuchal scales are hull-shaped, keeled.

Dorsal scales elongate, moderately keeled, especially along the flanks. Midbody scales in 81-86 rows. Ventrals in 70-79 rows, slightly keeled, of *V. salvator*-like structure (Fig.10).

Adult SVL 150-340mm, TL 503-945mm.

Scales uniformly black, with no trace of pattern. Ventral surfaces also black, sometimes grayish near axilla and groin. The snout tip may be white in young specimens, from the rostral back three or four scales; in older specimens, this may become dark brown (preserved specimens). The head scales, especially the upper cranials and temporal scales, are glossy in texture.

#### REMARKS

The melanistic *Monitor beccarii* was described in 1874 (Doria, 1874) from Wokan, Aru Islands, south of western New Guinea. This species was distinguished on the basis of its black colouring and strongly keeled nuchal scales. The overall similarity in scale counts and morphology caused Boulenger (1885) to include it in his account of *V. kordensis*; similarly, DeRoos (1915) failed to separate *beccarii* from *kordensis* in her account. Mertens (1941) noted the affinities, including enlarged supraoculars, elongated limbs and body, tail round in section, overlapping ventral and midbody scale counts, and geographic proximity and assigned *beccarii* as a subspecies of *prasinus*.

#### DISCUSSION

A model for the *V. prasinus* group evolution can be presented. In tree monitors there is an elongation and narrowing of the snout beyond that seen in *V. indicus* and *V. salvator*. Limbs and

digits of tree monitors are longer and thinner than in *salvator*, though they resemble *salvator*. Three of the five tree monitor taxa are melanistic, (cf. the arboreal *V. rudicollis*, which in the adult stage is almost completely black). Insular melanism is seen in *salvator* from the Nicobar and Andaman Islands (Draniyagala, 1944, 1961), but is rare in *Odatria* (*V. acanthurus insulanicus* [Worrell, 1963]; and *V. tristis*, which has a black head and body, and virtually indistinct rosette dorsal pattern [Cogger, 1975]) and the *gouldii* group (*V. rosenbergi* is characteristically dark, but retains a distinct pattern). Pattern in the *salvator*-related taxa involves small clusters of light scales that form indistinct circles and random spots, while in both the *V. gouldii* and *Odatria* groups, these patterns become well defined rings and flower-shaped spots. The green tree monitor falls into the former category. Even individuals with a spotted pattern more closely resemble the *salvator* or *indicus* pattern than they do either of the Australian groups.

Tail length in tree monitors exceeds 200% of SVL; in odatrians and *V. gouldii*, the tail tends to be shorter than 110% of SVL (exceptions are the odatrians *V. glebopalma*, *V. kingorum* and *V. pilbarensis*).

Nuchal lepidosis in *V. beccarii* and *V. bogerti* is similar to that of *V. rudicollis*, consisting of highly keeled, triangular scales that are distinct both in size and texture to surrounding scales. In the tree monitors, the scales are comparatively smaller than in *rudicollis*.

Ecologically, tree monitors are arboreal inhabitants of humid forests (Cogger, 1975; Czechura, 1980). This is similar to the *salvator* and *indicus* groups, but quite different from the terrestrial *gouldii* and *Odatria* groups, which tend to be found in xeric habitats (Cogger, 1975; Storr, 1980).

The evolution of tree monitors from *V. salvator* stock leading to the closely allied *V. indicus* stock would be a more parsimonious explanation of their evolutionary origin than the secondary dispersal from odatrians presented by Mertens (1942). The *V. indicus* group is unusual in that, along with *V. olivaceus*, it is the only non-prasinid with green pigmentation, though this is often so dark as to appear black. The colouration of *indicus* is quite similar to that of *teriae*.

In addition to the features described above, *Odatria* is characterised by round tails, with distinctly keeled to spinose lepidosis. The limbs

tend to be short and stout, as are the digits. Ecologically, they inhabit xeric or marginally mesic areas (Mertens, 1942a,b; Worrell, 1963; Cogger, 1975; Storr, 1980). All these features suggest *Odatria* is derived from *gouldii*-group ancestors, not the other way around, as suggested by others (Mertens, 1942; Storr, 1964; King and King, 1975; Auffenberg, 1988). Consequently, for reasons of morphology, ecology, and distribution, prasinoids must be removed from *Odatria*.

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#### LITERATURE CITED

- ALLISON, A. 1982. Distribution and ecology of New Guinea lizards. *Monographie Biologicae* 42: 803-813.
- AUFFENBERG, W. 1988. 'Gray's monitor lizard'. (Univ. Florida Press: Miami). 419p.
- BOHME, W. 1988. Zur genitalmorphologie der sauria: funktionelle und stammesgeschichtliche aspekte. *Bonner Zool. Monogr.* 27: 1-176.
- BOULENGER, G. 1885. 'Catalogue of the lizards in the British Museum (Natural History), Vol. 2'. (British Museum (Nat. Hist.): London). 497p.
1895. On a collection of reptiles and batrachians from Ferguson Island, D'Entrecasteaux Group, British New Guinea. *Ann. Mag. Nat. Hist.* (6), 16:28-32.

- BRANCH, W.R. 1982. Hemipeneal morphology of platynotan lizards. *J. Herp.* 16: 16-38.
- BROWN, J.H. AND GIBSON, A.C. 1983 'Biogeography'. (Mosby:St. Louis). 643p.
- BURT, C. AND BURT, M. 1932. Herpetological results of the Whitney South Sea expedition. VI. Pacific island amphibian and reptiles in the collection of the American Museum of Natural History. *Bull. Amer. Mus. nat. Hist.* 63: 461-595.
- COGGER, H. 1975. 'Reptiles and amphibians of Australia'. 1st ed.(Reed:Sydney). 584p.
- CZECHURA, G. 1980. The emerald monitor, *Varanus prasinus* (Schlegel): an addition to the Australian mainland herpetofauna. *Mem. Qd Mus.* 20: 103-109.
- DERANIYAGALA, P. 1944. Four new races of the kabaragoya lizard, *Varanus salvator*. *Spolia Zeylonica* 24: 59-62.
1961. The water monitor of the Andaman islands - a distinct subspecies. *Spolia Zeylonica* 61: 78-85.
- DeROOIJ, N. 1915. 'The reptiles of the Indo-Australian archipelago. I. Lacertilia, Chelonia, Emydosauria'. (E.J. Brill:Leiden). 384p.
- DORIA, G. 1874. Enumerazione dei rettili raccolti dal Dott. G. Beccari in Amboina alle Isole Aru ed alle Isole Kei durante gli anni. *Ann. Mus. Civ. Stor. Nat. Giacomo Doria* 6: 325-357.
- GRAY, J.E. 1831. A synopsis of species of the class Reptilia. 1-110. In Griffith, E. 'The Animal Kingdom arranged in conformity with its organization by Baron Cuvier, vol. 9'. (Whittaker, Treacher & Co:London). 481+110p.
- GREENE, H. 1986. Diet and arboreality in the emerald monitor, *Varanus prasinus*, with comments on the study of adaptations. *Feldiana:Zool.* 31:1-12.
- HOLMES, R., KING, M. AND KING, D. 1975. Phenetic relationships among varanid lizards based upon comparative electrophoretic data and karyotypic analyses. *Biochem. System. Ecol.* 3: 257-262.
- KING, M. AND KING, D. 1975. Chromosomal evolution in the lizard genus *Varanus* (Reptilia). *Austr. J. Biol. Sci.* 1975: 89-108.
- LOSOS, J.B. AND GREENE, H.W. 1989. Ecological and evolutionary implications of diet in monitor lizards. *Biol. J. Linn. Soc.* 35: 379-407.
- MCDOWELL, S. AND BOGERT, C. 1954. The systematic position of *Lanthanotus* and the affinities of the anguinomorph lizards. *Bull. Amer. Mus. Nat. Hist.* 105: 1-142.
- MERTENS, R. 1941. Zwei neue Warane des australischen faunengebietes. *Senckenbergiana* 23: 266-272.
- 1942a. Die familie der Warane (Varanidae). Erster teil: allgemeines. *Abh. Senck. Naturf. Ges.* 462: 1-116.
- 1942b. Die familie der Warane (Varanidae). Zweiter teil: der schadel. *Abh. Senck. Naturf. Ges.* 465: 117-234.
- 1942c. Die familie der Warane (Varanidae). Dritter teil: taxonomie. *Abh. Senck. Naturf. Ges.* 466: 235-365.
1950. Notes on some Indo-Australian monitors (Sauria: Varanidae). *Amer. Mus. Novitates* 1456:1-7.
1959. Liste der Warane Asiens und der Indo-Australischen Inselwelt mit systematischen bemerkungen. *Senck. Biol.* 40: 221-240.
- MEYER, A.B. 1874. Eine Mitteilung von Hrn. Dr. Adolf Bernhard Meyer über die von ihm auf Neu-Guinea den Inseln Jobi, Mysore und Mafoor im Jahr 1873 gesammelten Amphibien. *Mber. K. Preuss. Akad. Wiss. Berl.* 1874: 128-140.
- MYERS, C. AND DALY, J. 1976. Preliminary evaluation of skin toxins and vocalizations in taxonomic and evolutionary studies of poison-dart frogs (Dendrobatidae). *Bull. Amer. Mus. Nat. Hist.* 157: 175-262.
- PREGILL, G., GAUTHIER, J. AND GREENE, H. 1986. The evolution of helodermatid squamates with description of a new taxon and an overview of Varanoidea. *Trans. San Diego Soc. Nat. Hist.* 21: 167-202.
- SCHLEGEL, H. 1839. 'Abbildungen neuer oder unvollständig bekannter Amphibien, nach der Natur der dem Leben entworfen'. (Arnz:Düsseldorf). 141p.
- STORR, G. 1964. Some aspects of the geography of Australian reptiles. *Senck. Biol.* 45: 577-589.
1980. The monitor lizards (genus *Varanus* Merrem, 1820) of Western Australia. *Rec. West. Aust. Mus.* 8: 237-293.
- WILEY, E. 1981. 'Phylogenetics, the theory and practice of phylogenetic systematics'. (John Wiley: New York). 439p.
- WORRELL, E. 1963. 'Reptiles of Australia'. (Angus & Robertson: Sydney). 207p.

APPENDIX 1. Character states for cladistic analysis of *Varanus*.

1. Nostril round (0) or slit-like (1).
2. Nostril posterior (0), median (1) or anterior (2) in position.
3. Nostril lateral (0) or dorsal (1).
4. Nostril region not swollen (0) or swollen (1) in appearance.
5. Nostril without (0) or with (1) a valve.
6. Nasal bones fused (0) or separate (1).
7. Closed mouth forms distinct seam (0) or is tight and seamless (1).
8. Tongue short (0) or long (1).
9. Tongue dark (0) or light (1) in color.
10. Snout broad (0) or narrow (1) at tip.
11. Snout depressed (0) or high (1).
12. Snout blunt (0) or acute (1) in adults.
13. Gular scales flat (0) or conical (1).
14. Eyelids with normal (0) or slightly fringed (1) scales.
15. Preocular streak present (0) or absent (1).
16. Postocular streak present (0) or absent (1).
17. Supratemporal arch thin (0) broad (1) or absent (2).
18. Supraocular scales subequal, small (0) or dilated, larger than interorbital scales (1).
19. Cranial scales flat, non-reflective (0) or glossy (1).
20. Cranial scales large, polygonal (0) or small, pebbled (1).
21. Cranial surface rough (0) or smooth (1).
22. Canthus rostralis rounded (0) or distinct (1).
23. Snout boxlike (0) or triangular (1) in section.
24. Nuchal scales subequal to dorsals (0) or larger than dorsals (1).
25. Nuchal scales rounded (0), keeled (1) or very keeled (2).
26. Nuchal area banded (0) or unbanded (1).
27. Nuchal scales smaller or equal to occipital scales (0) or larger than occipital scales (1).
28. Neck length moderate (0) or elongate (1).
29. Dorsal scales uniform, subequal (0) or heterogenous (1).
30. Dorsals small (0) or large (1).
31. Dorsum patterned (0) or unpatterned (1).
32. Digits with enlarged terminal scale (0) or not (1).
33. Claws conical (0) or compressed (1).
34. Ventral scales smooth (0) or keeled (1).
35. Ventral scales rectangular (0) or oblong (1).
36. Adpressed limbs meet (0) or do not meet (1).
37. Preanal pores absent (0) or present (1).
38. Ventral caudal scales larger or equal to dorsal caudals (0) or smaller than dorsal caudals (1).
39. Caudal scales irregular (0) or form bands of annuli (1).
40. Tail slightly (0) or fully (1) prehensile.
41. Caudal scales glossy, slightly keeled (0) or strongly keeled (1).
42. Tail length greater than (0), equal to (1) or less than (2) snout-vent length.
43. Tail round (0), approximately half round (1) or compressed (2) in section.
44. Tail lacking dorsal keel (0), or having double dorsal keel (1).
45. Tail banded (0) or unbanded (1).
46. Tail completely [100%] banded (0) or less than completely banded (1).
47. Parietal bone slightly (0) or greatly (1) constricted medially.
48. Gular fold absent (0) or present (1).
49. Ear exposed (0) or concealed (1).
50. Nasal bones dorsally with table-like surface (0) or knife-like (1).
51. Karyotype group A (0), B (1), C (2), D (3), E (4), or F (5) [data from Holmes, King & King, 1985].
52. Hemipenal group A (0), B (1), C (2), D (3), E (4), F (5), G (6) or H (7) [data from Bohme, 1986].
53. Reserved.
54. Size range 0.1-0.5 M (0), 0.6-0.9 M (1), 1-1.5 M (2), over 1.5 M (3).
55. Ventrally mottled (0) or solid (1) in color.
56. Ecology primarily fossorial/terrestrial (0), arboreal (1) or aquatic (2).
57. Palmar surfaces lacking (0) or possessing conical processes (1).
58. Palmar surfaces pale (0) or black (1).

## APPENDIX 2. Distribution of characters in 23 varanid taxa. Unavailable data are entered by a '9'.

Taxon	Character state
<i>GRISEUS</i>	100100100000010000010100000000000000000000001110142920000
<i>BENGALEN</i>	1000000100100000000001000000000010001000002100010121930000
<i>EXANTHEM</i>	1000000100100010000001010010110010110000011101010150931000
<i>SALVATOR</i>	0200000101010000011001000011000011001000002100010024930200
<i>DUMERILI</i>	1100100111010010101001010001110011001000002100010011921200
<i>RUDICOLL</i>	1000000101110010010001012011000011100000002101110121920101
<i>PRASINUS</i>	0101000101010010011010100001000011000011000010010013911111
<i>BECCARII</i>	0101000101010010011000101101001011000011000010010013911111
<i>TELENESE</i>	0101000101010010011010100001000010000011000010010013910110
<i>TERIAE</i>	0101000101011010011000101001000010000011000000010013911111
<i>VARIUS</i>	0200000110010000000101000011000111100000002100110016931000
<i>INDICUS</i>	010100010101001101100010011100011000000002100010013920100
<i>GOULDII</i>	0101001111010100000101000101000010000100001101010006921000
<i>STORRI</i>	0200011000010100000101000100000110010010110010010037901000
<i>BOGERTI</i>	0101000101010000011000102101001010000011000010010013911111
<i>TIMOR</i>	0200010110010000000100000101000010000010000000010037911000
<i>KOMODO</i>	0200000110000011000100000100001011001000001110110116931000
<i>NILOTIC</i>	1100000100100000000101000001000010001000002100110150930000
<i>OLIVAC</i>	1101000110100010000100000001000010000000002100110029930100
<i>TRISTIS</i>	0200010110000000000000000001000010000010000000010037901000
<i>FLAVES</i>	1100000110100010000001000000000010101000001100110121920000
<i>PANOPTES</i>	0101001111110100000101000101000010000100002100010006920200
<i>MERTENSI</i>	0210001190000010001010000101000010000000002100010006921201

NEW SPECIES AND NEW RECORDS OF *TESSERODON* HOPE (COLEOPTERA: SCARABAEIDAE) FROM NORTHERN AUSTRALIA

R.I. STOREY

Storey, R.I. 1991 08 01: New species and new records of *Tesserodon* Hope (Coleoptera: Scarabaeidae) from northern Australia. *Memoirs of the Queensland Museum* 30(3): 577-588. Brisbane. ISSN 0079-8835.

Five new species of *Tesserodon* Hope (Scarabaeini: Canthonina) are described: *erratum*, *feehani*, *henryi*, *hilleri* and *simplicipunctatum*. Identity of *T. gestroi* Lansberge is discussed and the species redescribed. New records and taxonomic notes are given for *T. gestroi*, *T. intricatum* Lea, *T. granulatum* Matthews, *T. novaehollandiae* (Fabricius), *T. variolosum* Macleay, *T. pilicrepus* Matthews and *T. tenebroides* Matthews. A key to the Australian species is provided and species relationships briefly discussed.

R.I. Storey, Department of Primary Industries, P.O. Box 1054, Mareeba, Queensland 4880; 5 May 1990.

Matthews (1974) revised Australian genera and species of Scarabaeini, including *Tesserodon* Hope in which he recognized eight valid species. *Tesserodon* also occurs in New Guinea where five species were attributed to the genus by Paulian (1985). This paper describes five additional Australian species, four on the basis of new material not seen by Matthews and one following examination of the holotype of *T. gestroi* Lansberge. The Australian species are keyed, new records and notes on intraspecific variation are given for most of the previously described species, and species relationships within the genus are briefly discussed.

ABBREVIATIONS

The following abbreviations for collections are used:

ANIC—Australian National Insect Collection, CSIRO, Canberra, A.C.T.

ANIC (MMUS)—Australian National Insect Collection, CSIRO (on permanent loan from the Macleay Museum, University of Sydney), Canberra, A.C.T.

BMNH—British Museum (Natural History), London, U.K.

HAHC—H.F. Howden Collection, Ottawa, Canada

MCSN—Museo Civico de Storia Naturale "Giacomo Doria", Genoa, Italy

OXUM—Hope Entomological Collections, Oxford, U.K.

PGAC—P.G. Allsopp Collection, Bundaberg, Qld

QMBA—Queensland Museum, Brisbane, Qld

QPIM—Entomology Branch, Department of Primary Industries, Mareeba, Qld

SAMA—South Australian Museum, Adelaide, S.A.

UQBA—Department of Entomology, University of Queensland, Brisbane, Qld

WAMP—Western Australian Museum, Perth, W.A.

In locality records CYP stands for Cape York Peninsula.

*Tesserodon* Hope, 1837

*Tesserodon* Hope, 1837, p.55.

TYPE SPECIES

*Scarabaeus novaehollandiae* Fabricius, 1775, by monotypy.

KEY TO THE AUSTRALIAN SPECIES OF *TESSERODON*

(Modified from Matthews (1974))

1 Punctures on elytral intervals accompanied by chevron or horseshoeshaped cicatrices or complete annuli .....2

Elytral punctures simple ..... 5

2(1) Eyes smaller, separated by 11–13 eye widths. Clypeal edge strongly notched at clypeogenal suture. Elytral intervals 2–6 subcostate. Hindwing reduced, flightless species. Total length 5.8–8.3 mm. ....*feehani* sp.nov.

Eyes larger, separated by 5–8 eye widths. Clypeal edge at most feebly notched at clypeogenal suture. Elytral intervals flatter, only interval 6 sometimes subcostate. Fully winged species .....3

3(2) Elytral intervals dull, with dense microsculp-

- ture. Aedeagus as in Fig.2. Total length 5.3–7.0 mm. .... *variolosum* Macleay
- Elytral intervals shiny, at least in centre portion.....4
- 4(3) Cicatrices around elytral punctures small, leaving about half of width of interval smooth, never closed into annuli; intervals often tectate, at least laterally. Eyes larger, separated by 5–6 eye widths. Aedeagus as in Fig.1. Total length 5.6–8.9 mm ..... *erratum* sp.nov.
- Cicatrices around elytral punctures large, leaving about 1/3 width of interval smooth, closed into annuli or almost so; intervals nearly flat, only the 6th more or less tectate. Eyes smaller, separated by 6–8 eye widths. Aedeagus as in Fig.3. Total length 5.1–7.2mm..... *intricatum* Lea (part)
- 5(1) Dorsal part of eyes small, not reaching halfway to clypeogenal suture, separated by about 20 eye widths. Male with small projection on hind trochanter, hind femur without a projection at base of posterior edge ..... 6
- Dorsal part of eyes larger, reaching halfway or more to clypeogenal suture, separated by 5–16 eye widths. Male without small projection on hind trochanter, usually with a projection at base of posterior edge of hind femur .....7
- 6(5) Edge of head nearly entire at clypeogenal sutures. Elytral epipleura transversely corrugated posteriorly. Total length 4.2–6.3mm. .... *tenebroides* Matthews
- Edge of head distinctly notched before clypeogenal sutures. Elytral epipleura not corrugated. Total length 4.8–5.4 mm..... *pilicrepus* Matthews
- 7(5) Shape suboval, elytra shortened. Hindwing reduced, flightless species. Eyes narrower, separated by 13–16 eye widths ..... 8
- Shape more elongate, elytra not shortened. Fully winged species. Eyes wider, separated by 5–12 eye widths ..... 9
- 8(7) Larger species, total length 7.1–8.6 mm. Punctuation on head and pronotum denser, tending to be arranged in transverse rows. .... *henryi* sp. nov.
- Smaller species, total length 4.2–5.0 mm. Punctuation of head and pronotum less dense, not arranged in transverse rows. .... *hilleri* sp. nov.
- 9(7) Clypeus with large granule behind base of each seta. Setae slender and strongly recurved. Total length 4.9–8.2mm. .... *granulatum* Matthews
- Clypeus without granules. Setae stout, erect .....10
- 10(9) Genal edges sharply angled, straight before and behind the angle. Total length 7.0–8.0mm..... *angulatum* Westwood
- Genal edges with a rounded angle, not prominent, usually feebly curved.....11
- 11(10) Elytral intervals flat, dull with dense microsculpture. Total length 5.1–7.5mm. .... *gestroi* Lansberge
- Elytral intervals subconvex, nitid at least in centre ..... 12
- 12(11) Dorsal parts of eyes narrow, separated by 6–8 eye widths. Discal pronotal punctures linear. Total length 5.2–7.1mm. .... *intricatum* Lea(part)
- Dorsal parts of eyes wider, separated by 5–6 eye widths. Discal pronotal punctures simple or elongate-annular ..... 13
- 13(12) Larger species, total length 7.3–7.9mm. Space between clypeal teeth V-shaped. Pronotal punctures in centre of disc simple, without annular rings..... *simplicipuntatum* sp. nov.
- Smaller species, total length 3.8–6.1 mm. Space between clypeal teeth usually U-shaped. All pronotal punctures with annular rings. .... *novaehollandiae* (Fabricius)

**Tesserodon feehani** sp. nov.  
(Figs 7,9,10)

ETYMOLOGY

For the collector John Feehan, CSIRO, Canberra.

MATERIAL EXAMINED

Holotype ANIC 105 ♂ 15.16°S 144°59'E, 14 km W by N of Hopevale Mission, NE Qld, 7–10.v.1981, J. Feehan. Paratypes (14): QLD: same data as holotype, (9♂♂, 2♀♀). 15.24°S 145.03°E, Hazelmere Stn, 24



km WNW of Cooktown, 8.v.1981, J. Feehan, (3 ♀ ♀). (Paratypes in ANIC, QMBA, QPIM).

## DESCRIPTION

Oval, convex. Total length 5.8–8.3 mm., maximum width 4.1–5.3 mm.

*Male*. Head. Median teeth small, apices rounded, broadly V-shaped between, a little expanded past shallow lateral excisions, rest of margins straight to clypeogenal sutures which are strongly notched, genal angles obtusely rounded. Dorsal parts of eyes small, oval, extending about halfway to clypeogenal sutures, separated by 11–13 eye widths. Punctures numerous, coarse, deep, reniform, each with a short, erect seta.

Pronotum. Punctures coarse, deep, dense, guttiform, tending to form longitudinal lines. Each puncture with a fine, erect seta at basal point, surface nitid between.

Elytra. Broad, widest about 1/3 of distance from base, then evenly rounded to apex. Striae geminate, crenulate. Intervals 2–6 subcostate on basal 2/3, nitid in centre, fine microsculpture along margins, rows of punctures along lateral margins, each puncture with an annular cicatrice and a short, erect seta in centre.

Hind wings. Greatly reduced to about 1/2 length of elytra.

Legs. Protibial spur short, truncate, broader at apex than at base. Hind femur with a strong, rounded tubercle at base of posterior edge. Tooth at apex of hind tibia strong, recurved.

Ventral surface. Meso- and metasterna with numerous, deep punctures, annulate to horse-shoe-shaped on lateral lobes of metasternum, each with a short, erect seta. Punctures on pygidium with complete annuli and short, erect setae, surface nitid between.

Aedeagus. Parameres asymmetrical (Fig. 7).

*Female*. Clypeal teeth and lateral excisions stronger. Protibial spur narrow, pointed, hind femur without basal tubercle and hind tibia without apical tooth. Otherwise like male.

## COMMENTS

This flightless species is close to *henryi* sp. nov. but the hind wings are not as reduced and the elytra are different. The ocellate punctures on the elytral intervals are similar to those of *erratum* sp. nov. but the almost costate condition of the intervals in *feehani* separates them. *T. feehani* has been taken in cow dung and trapped with human excrement during both day and night. Most specimens were taken in closed forest.

*Tesserodon variolosum* Macleay, 1888  
(Fig. 2)

*Tesserodon variolosum* Macleay, 1888, p.897; Matthews, 1974, p. 88.

## MATERIAL EXAMINED

Holotype ♀, King's Sound, W.A., ANIC (MMUS). Other material: NT: Larrimah, 4.xii.1978, R.I. Storey, (2 ♀ ♀); Berry Springs Rd, via Darwin, 27-30.xi.1978, R.I. Storey, (1 ♂, 1 ♀); Wildman R, Arnhem Hwy, 30.xi.1978, R.I. Storey, (6 ♂ ♂, 4 ♀ ♀); 12.06°S 133.04°E, Cooper Ck, 19 km E by S of Mt Borradaile, 31.v.1973, E.G. Matthews, (1 ♀). WA: 18.10°S 125.35°E, Fitzroy Crossing, 17.iii.1984, K. and E. Carnaby, (1 ♂). (Specimens in ANIC, HAHC, PGAC, QMBA, QPIM, SAMA, UQBA).

## COMMENTS

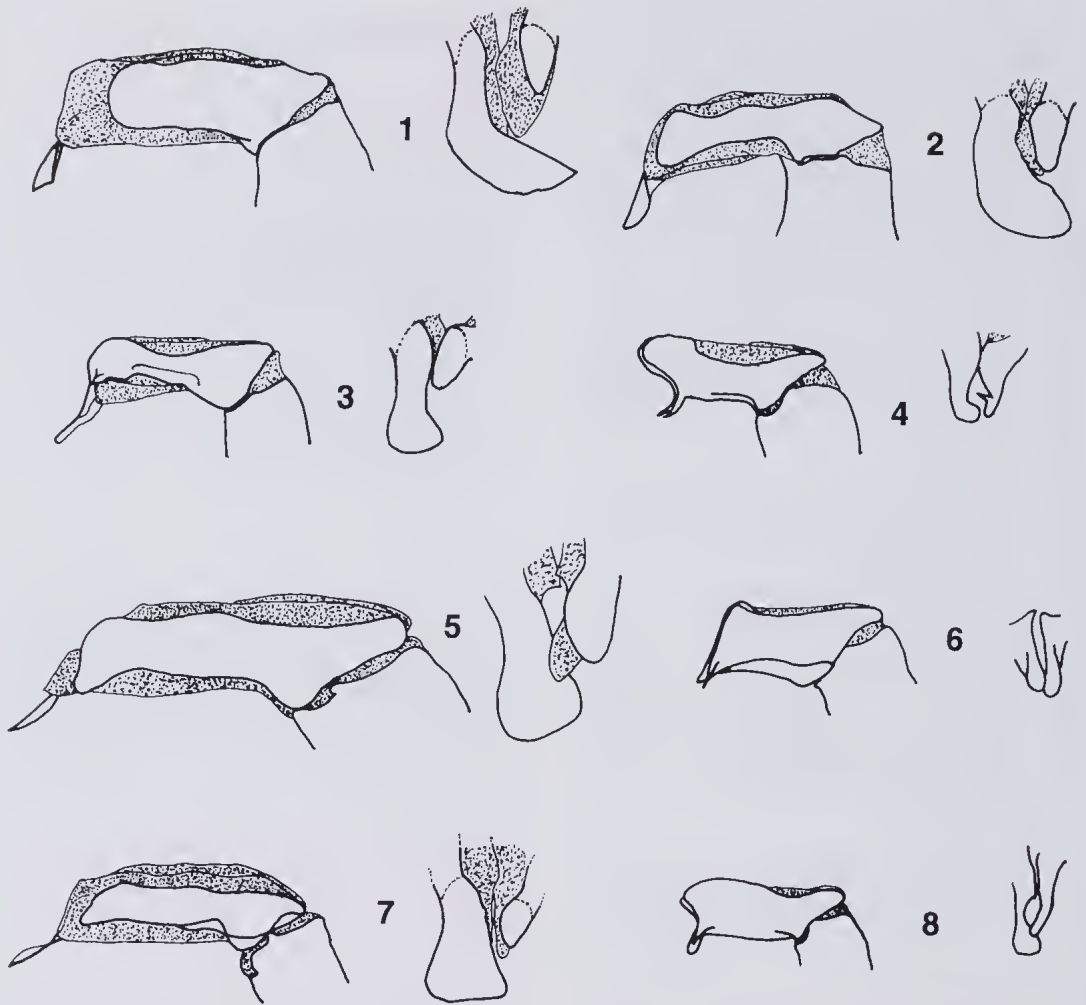
*T. variolosum* has a wide distribution from Groote Eylandt in the Gulf of Carpentaria to the east Kimberleys in Western Australia. It is close to *erratum* sp. nov.; both species were taken at the Wildman River. *T. variolosum* is usually smaller than *erratum* with the elytral intervals duller and flatter, especially apically. Both species have the elytral interval punctures at least partially cicatricate (a character not noted by Matthews (1974) for *variolosum*). Eyes are smaller in *variolosum*, separated by 7–10 eye widths. The Fitzroy Crossing specimen has the pronotal punctures sparser, annular and not formed into grooves. However, positive identification depends on examination of the male genitalia (Fig. 2). Specimens were taken at light and trapped with human excrement baits.

*Tesserodon erratum* sp. nov.  
(Figs 1,13,14)

*Tesserodon gestroi* Lansberge: Matthews, 1974, p.82.

## MATERIAL EXAMINED

Holotype QMBA T.11590 ♂ Wildman R, Arnhem Hwy, N.T., 30.xi.1978, R.I. Storey. Paratypes (42) NT: same data as holotype, (3 ♂ ♂, 8 ♀ ♀); 6 km E of Humpty Doo, 9.ii-4.iii.1987, R.I. Storey, (4 ♂ ♂, 19 ♀ ♀); Humpty Doo, 28-29.xi.1974, R.I. Storey, (1 ♀); 24–43 km S of Darwin, 29.i.1968, E. Matthews, (2 ♂ ♂ 3 ♀ ♀); 24 km S of Darwin, 21.i.1968, E.M., (1 ♂); Lee Point, Darwin, 28.i.1968, E. Matthews, (2 ♀). Paratypes in ANIC, HAHC, PGAC, QMBA, QPIM, SAMA, UQBA.



FIGS 1–8. *Tesserodon* spp., parameres, lateral and apical views: 1, *T. erratum* sp. nov. 2, *T. variolosum* Macleay. 3, *T. intricatum* Lea. 4, *T. gestroi* Lansberge. 5, *T. henryi* sp. nov. 6, *T. granulatatum* Matthews. 7, *T. feehani* sp. nov. 8, *T. hilleri* sp. nov.

#### DESCRIPTION

Suboval, somewhat flattened. Total length 5.6–8.9 mm., maximum width 3.7–5.9 mm.

*Male.* Head. Median teeth small, apices rounded, rounded V-shaped between, only feebly excised outside median teeth, rest of margins feebly curved to the slightly notched clypeogenal sutures, genal angles rounded. Dorsal parts of eyes large, extending about  $\frac{2}{3}$  of way to clypeogenal sutures, separated by 5–6 eye widths. Surface densely and coarsely punctate with large reniform punctures accompanied by tubercular aspiration on clypeus, with short, erect setae.

Pronotum. Surface densely punctate with

large, deep punctures which are elongate and crepidulate or guttiform on disc, laterally tending to form longitudinal grooves, becoming compound then strongly horseshoe-shaped towards edges, with very short, stout setae, surface between nitid.

Elytra. Broad, widest about  $\frac{1}{3}$  of way from base, then roundly tapering to apex. Striae punctate, geminate, crenulate. Intervals slightly convex, becoming somewhat tectate laterally, surface nitid in centre, fine microsculpture laterally, with a row of punctures along each lateral margin, each preceded by a horseshoe-shaped cicatrix and bearing a short, erect seta.

Hind wings. Fully developed.

Legs. Protibial spur short, widened at apex which is about 1 1/2 times width at base. Hind femur with a round tubercle at base of posterior edge. Tooth at apex of hind tibia short, blunt.

Ventral surface. Mesosternum deeply punctate with large reniform or annular punctures, metasternum similarly punctate, weakly so on median lobe becoming stronger, larger and more cicatricose on lateral lobes, all punctures with short setae. Pygidium with large reniform or horseshoe-shaped punctures.

Aedeagus. Parameres asymmetrical (Fig. 1).

*Female*. Protibial spur narrow, pointed, hind femur without basal tubercle and hind tibia without apical tooth. Otherwise like male.

#### COMMENTS

Matthews (1974) misidentified this species as *T. gestroi* Lansberge for the reasons mentioned under that species. The above description is basically that given by Matthews (1974) for *gestroi*. It is still known only from the Darwin area, as far east as the Wildman River crossing on the Arnhem Highway. Specimens were trapped with human excrement baits.

#### *Tesserodon intricatum* Lea, 1923 (Fig. 3)

*Tesserodon intricatum* Lea, 1923, p.357; Matthews, 1974, p. 83.

#### MATERIAL EXAMINED

Holotype ♂ Grootte Eylandt, N.T., N.B. Tindale, SAMA. Other material: NT: 32 km W of Katherine, 8.ii.1968, E. Matthews, (1♂); Elcho Is, 26.iii.1976, M.E. Farr, (1♂); same locality, 29.iv.1976, K. and E. Carnaby, (1♂); 6km E of Humpty Doo, 9.ii-4.iii.1987, R.I. Storey, (1♀); 9 km W of Jabiru, 29-30.xi.1978, R.I. Storey, (2♀); 12.06°S 133.04°E, Cooper Ck, 19 km E by S of Mt Borradaile, 31.v.1973, E.G. Matthews, (1♂); same locality, 5.vi.1973, M.S. Upton, (1♀); 12.20°S 133.19°E, Nabarlek Dam, 15 km S by W of Nimbuwah Rock, 2.vi.1973, E.G. Matthews, (2♀); 12.23°S 132.56°E, 7 km NW by N of Cahills Crossing, East Alligator R, 27.v.1973, E.G. Matthews, (2♂♂); 12.46°S 132.39°E, 12 km NNW of Mt Cahill, 20.v.1973, E.G. Matthews, (2♂♂, 1♀); 12.48°S 132.42°E, Nourlangie Ck, 8 km N of Mt Cahill, 21.v.1973, E.G. Matthews, (2♂♂, 2♀♀); 12.49°S 132.51°E, 15 km E by N of Mt Cahill, 29.x.1972, E. Britton, (2♂♂, 3♀♀); 12.47°S 132.51°E, Baroalba Ck Springs, 19 km NE by E of Mt Cahill, 28.x.1972, E. Britton, (2♀♀); 12.50°S 132.51°E, 15 km E by N of Mt Cahill, 29.x.1972, E.

Britton, (4♂♂, 1♀); 12.52♂S 132.47°E, Nourlangie Ck, 8 km E of Mt Cahill, 22.v.1973, E.G. Matthews, (1♂). WA: Kununurra, 9-13.xii.1975, R.I. Storey, (4♂♂). (Specimens in ANIC, QPIM, SAMA).

#### COMMENTS

The above specimens exhibit considerable variation and it is with some hesitation that I include them all under *intricatum*. Future study may indicate that more than one species is represented. Nine specimens are close if not identical to the holotype, including the possession of annular rings around the punctures on the elytral intervals. Another 15 are identical to these in all characters (including aedeagus (Fig.3)) except that the elytral punctures are not at all annular. Others also lack the annular rings but vary in structure of the edge of the clypeus (teeth more or less developed), density and shape of the pronotal punctures and even shape of the tubercle on the male hind femur which is very strong in some and almost absent in the remainder. All forms were taken in the Mt Cahill area. Specimens were collected at light and trapped with human excrement.

#### *Tesserodon tenebroides* Matthews, 1974

*Tesserodon tenebroides* Matthews, 1974, p.84.

#### MATERIAL EXAMINED

Holotype ♂, Barrow Is, W.A., 26.v.1964, W.H. Butler, WAMP. Other material: WA: Blow Holes Rd, 30-50 km N of Carnarvon, 20-21.vii.1978, H. and A. Howden, (6♂♂, 6♀♀); same locality, 3.ix.1978, K. and E. Carnaby, (1♂, 4♀); W side of Northwest Cape, N of Cape Range Park, 27-28.vii.1978, H. and A. Howden, (1♂); 26 km S of Exmouth, 26.vii.1978, H. and A. Howden, (2♂♂). Specimens in ANIC, HAHC, QPIM, UQBA.

#### *Tesserodon pilicrepus* Matthews, 1974

*Tesserodon pilicrepus* Matthews, 1974, p.84.

#### MATERIAL EXAMINED

Holotype ♂, Peron Peninsula near Nanga (Taillefer Isthmus), W.A., 4.viii.1972, E.G. Matthews and H.F. Howden, SAMA. Other material: WA: Burma Road Reserve, 30 km E of Walkaway, 16.ix.1986, R.P. McMillan, (1♀); 52 km E of Kalbarri, 7-8.viii.1978, H. and A. Howden, (1♂). Specimens in HAHC, WAMP.

***Tesserodon henryi* sp. nov.**  
(Figs 5, 11, 12)

ETYMOLOGY

For its first collector Prof. Henry F. Howden of Ottawa, Canada.

MATERIAL EXAMINED

Holotype QMBA T.11588, ♂, Hann Tableland, 13 km WNW of Mareeba, NE Qld, 17.i-17.ii.1989, Storey and Dickinson, MDPI Intercept Trap Site No. 31. Paratypes (33): QLD: same data as holotype, (2♂♂, 7♀♀); same data, 13.x.-9.xii.1988, (1♀); same data, 7.xii.1988-17.i.1989, (1♂, 2♀♀); same data, 17.ii.-20.iii.1989, (1♀); 12 km W of Herberton, 11-15.ii.1979, R.I. Storey, (1♂, 4♀♀); Watsonville, 22-27.iii.1980, R.I. Storey, (8♂♂, 3♀♀); 27-32 km W of Atherton, 10.ii.1975, H. and A. Howden, (2♂♂, 2♀♀). Paratypes in ANIC, HAHC, PGAC, QMBA, QPIM, SAMA, UQBA.

DESCRIPTION

Oval, convex. Total length 7.1-8.6 mm., maximum width 4.9-6.0 mm.

**MALE.** Head. Median teeth small, apices rounded, broadly V-shaped between, lateral excisions feeble, rest of margins slightly rounded to clypeogenal sutures which are feebly notched, genal angles obtusely rounded. Dorsal parts of eyes small, suboval, extending almost halfway to clypeogenal sutures, separated by 14-16 eye widths. Punctures dense, coarse, reniform, somewhat transversely aligned, each with a short, erect, pointed seta.

Pronotum. Punctures coarse, dense, guttiform, tending to form longitudinal lines, each puncture with a short, erect, pointed seta at basal point, surface nitid between, a row of horseshoe-shaped punctures along basal margin.

Elytra. Broad, shortened, widest just before base, evenly rounded to apex. Striae geminate, slightly crenulate. Intervals flat to feebly convex, surface dull with dense microsculpture, rows of punctures along lateral margins of each with short, erect, blunt setae which are angled towards centre of each interval.

Hind wings. Greatly reduced to about 1/3 length of elytra.

Legs. Protibial spur short, truncate, broader at apex than at base. Hind femur with a feeble,

rounded tubercle at base of posterior edge. Tooth at apex of hind tibia strong, recurved.

Ventral surface. Meso- and metasterna with numerous punctures, annulate to horseshoe-shaped, each with a short, erect seta. Pygidium with large annulate punctures with short, erect setae, surface between nitid.

Aedeagus. Parameres asymmetrical (Fig. 5).

**FEMALE.** Protibial spur narrow, pointed, hind femur without basal tubercle and hind tibia without apical tooth. Otherwise like male.

COMMENTS

Although it has the reduced eyes and shortened elytra of the similarly flightless *tenebroides* and *pilicrepus*, *henryi* does not seem to be closely related to them. It lacks the projection on the hind trochanter, and has the small tubercle on the posterior edge of the hind femur found in most species of the genus. *T. henryi* has been taken in only two areas adjacent to the western edge of the Atherton Tableland. The habitat is tall eucalypt forest on coarse granite soil where it was trapped with human excrement baits and taken in intercept/pitfall traps.

***Tesserodon hilleri* sp. nov.**  
(Figs 8, 15, 16)

ETYMOLOGY

For Tony Hiller of Mt Glorious, the collector of most of the known specimens.

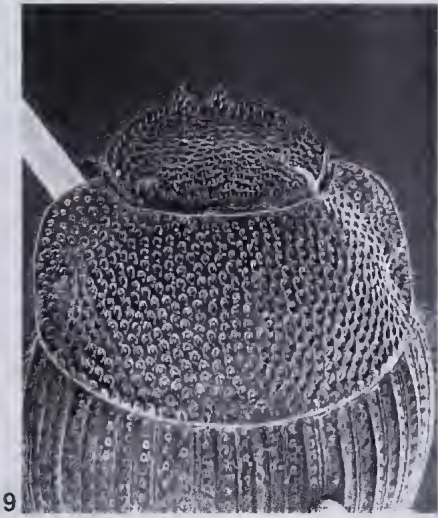
MATERIAL EXAMINED

Holotype QMBA T.11589, ♂, 90 km SE of Charters Towers, NE Qld, 19.iii.1984, A. Hiller, found feeding inside body of dead *Haploscapanes barbarossa* (Fabricius) [Coleoptera:Scarabaeidae]. Paratypes (5): QLD: same data as holotype, collected inside dead *Macropanesthia rhinoceros* Saussure [Blattodea:Blaberidae], (2♂♂, 2♀♀); 100 km E of Hughenden, 26-30.iii.1976, R.I. Storey, (1♂). Paratypes in ANIC, QMBA, QPIM.

DESCRIPTION

Oval, moderately convex. Total length 4.2-5.0 mm., maximum width 2.9-3.0 mm.

**Male.** Head. Median teeth small, apices rounded, broadly U-shaped between, a little expanded past V-shaped lateral excisions, rest of margin almost straight to clypeogenal sutures



9



10



11



12



13



14

which are feebly notched, genal angles obtusely rounded. Dorsal parts of eyes small, extending about halfway to clypeogenal sutures, separated by 13–15 eye widths. Punctures moderately dense, coarse, reniform, each with a short, erect seta, surface between subnitid with fine microsculpture.

Pronotum. Punctures moderate, coarse, those on anterior 2/3 elongate, linear, the posterior 1/3 and along lateral margins circular except those along basal margin which are horseshoe-shaped, each puncture with a short, erect seta at posterior end, surface between subnitid with very fine microsculpture.

Elytra. Broad, shortened, widest about 1/3 distance from base, then evenly rounded to apex. Striae geminate, crenulate. Intervals flat to feebly convex, surface with fine microsculpture, stronger towards sides, each interval with a row of widely spaced punctures along lateral margins, each puncture bearing a short, erect seta.

Hind wings. Greatly reduced to about 1/3 length of elytra.

Legs. Protibial spur truncate, inner apical angle produced. Hind femur with a feeble, rounded tubercle at base of posterior edge. Tooth at apex of hind tibia strong, recurved.

Ventral surface. Annulate punctures on mesosternum and lateral lobes of metasternum, central portion of metasternum with simple punctures, all bearing short, erect setae. Pygidium with a few coarse, setate punctures, surface nitid to finely microsculptured between.

Aedeagus. Parameres asymmetrical (Fig. 8).

*Female*. Median teeth and lateral excisions of clypeus stronger. Protibial spur narrow, pointed, hind femur without basal tubercle and hind tibia without apical tooth. Otherwise like male.

#### COMMENTS

*T. hilleri* is another flightless species from Queensland which like *fehani* and *henryi*. but unlike the Western Australian *pilicrepus* and *tenebroides* has the hind wings reduced to a vestige rather than completely absent. It is closely related to *novaehollandiae* (Fabricius), their aedeagi being almost indistinguishable. Specimens have been collected from the bodies of large decaying insects and also trapped with human excrement.

*Tesserodon granulatum* Matthews, 1974  
(Fig. 6)

*Tesserodon granulatum* Matthews, 1974, p.85.

#### MATERIAL EXAMINED

Holotype ANIC ♂, Ayers Rock, N.T., 16.ii.1967, M.S. Upton. Other material: WA: 21.20°S 127.00°E, 160km SW of Balgo, iii.1975, S. Fritsch, (1♂, 1♀); 2–6 km SE of Broome, 14–18.xii.1975. R.I. Storey, (1♂, 4♀); 18.49°S 123.17°E, 163 km SE of Broome, 3.viii.1976, I.F.B. Common, (1♀); Talawara Stn, i.1971, A. Douglas, (3♂♂, 4♀♀); 21.21°S 125.59°E, Well 43, Canning Stock Route, 14.xii.1972, N.S.E. Iv, (1♂); 28.21°S 124.54°E, 90 km W of Neale Junction, 20.ix.1982, B. Hanich and T.F. Houston, (1♂); 28.21°S 122.37°E, 37 km NE of Laverton, 10–12.ix.1982, B. Hanich and T.F. Houston, (1♀); 21.44°S 123.40°E, Lake Auld, 11–17.vi.1986, L. Charlton, (1♀). Specimens in ANIC, PGAC, QPIM, UQBA, WAMP.

#### COMMENTS

The male was unknown to Matthews (1974), but is now known to have typical secondary sexual characters of truncate protibial spur and recurved inner apical tooth on the hind tibia. Both the hind trochanter and the posterior margin of the hind femur lack a projection. The aedeagus is illustrated in Fig.6. Specimens were taken at light and trapped with decaying fish and human excrement.

*Tesserodon angulatum* Westwood, 1841

*Tesserodon angulatum* Westwood, 1841, p.66.

#### HOLOTYPE

♂, New Holland, Swan River?, OXUM448. (not seen)

#### MATERIAL EXAMINED

None.

*Tesserodon gestroi* Lansberge, 1885  
(Figs 4,17,18)

*Tesserodon gestroi* Lansberge, 1885, p. 375.

#### MATERIAL EXAMINED

Holotype ♂ Somerset, Cape York, i.1875, L.M. d'Alberty, MCSN. Other material: QLD: 11.40°S 142.50°E, Captain Billy Ck, CYP, ABR5 Areas 4,5, and 6, 9–13.vii.1975, G.B. Monteith, (19♂♂, 25♀♀); Dividing Range, 15 km W of Captain Billy Ck, CYP, 4–9.vii.1975, G.B. Monteith, (1♀); Lake Boronto (=Wincheura), Newcastle Bay, CYP, 21–26.ix.1974, G.B. Monteith, (6♂♂, 3♀♀); same data, 30.i.–4.ii.1975, (9♂♂, 3♀♀). Specimens in ANIC, QMBA, QPIM, SAMA, UQBA.

## DESCRIPTION

Elongate-oval, subconvex. Total length 5.1–7.5 mm., maximum width 3.4–4.5 mm.

*Male*. Head. Median teeth short, wider at base than length, V-shaped between, lateral excisions very weak, then rest of margins straight to clypeogenal sutures which are feebly notched, genal angles subquadrate, rounded. Dorsal parts of eyes large, extending about 3/4 of distance to clypeogenal sutures, separated by about 5 eye widths; canthus very short. Punctures moderate, coarse, round to reniform each with a short, thick, blunt, erect seta, surface between subnitid with very fine microsculpture.

Pronotum. Punctures dense, coarse, fairly constant in size and round shape over entire surface, each with a short, thick, blunt, erect seta at posterior end, surface between subnitid with very fine microsculpture.

Elytra. Elongate, widest at about basal 1/3, sides subparallel for basal 1/2, then rounded to apex. Striae punctate, geminate, crenulate. Intervals flat, rows of close punctures along lateral margins of each, with short, blunt, erect setae, surface between dull with dense microsculpture.

Hind wings. Fully developed.

Legs. Protibial spur truncate, inner apical angle produced. Hind femur with a strong, rounded tubercle at base of posterior edge. Tooth at apex of hind tibia strong, recurved.

Ventral surface. Meso- and metasterna with moderate, annulate punctures over entire surfaces, tending towards horseshoe-shaped on lateral lobes of metasternum, each with a fine, recurved seta centrally. Pygidium with moderate, dense, annulate punctures, each with a short, fine, erect seta, surface between nitid.

Aedeagus. Parameres asymmetrical, as in Fig. 4.

*Female*. Median teeth of clypeus stronger. Protibial spur narrow, pointed, hind femur without basal tubercle and hind tibia without apical tooth. Otherwise like male.

## COMMENTS

*T. gestroi* was based on a single specimen collected by L.M. d'Albertis. Matthews (1974) was not able to examine the holotype and as no further specimens potentially belonging to this species were available from or near the type locality, he attributed *gestroi* to a large species taken in the north of the Northern Territory. Subsequently, Dr G.B. Monteith, Queensland Museum took a long series of specimens near the type locality and identified them as *gestroi*. My examination of the holotype of *gestroi* con-

firmed Matthews' error and allowed redescription of *gestroi*. Matthews' Northern Territory species was described above as *T. erratum*. *T. gestroi* is close to *novaehollandiae* (Fabricius), and has a similar aedeagus.

Queensland Museum records indicate that *gestroi* occurs almost entirely in rainforest, with only a few trapped in *Callitris intratropica* R. T. Baker and H.G. Smith forest adjacent to rainforest. The soil is sandy and most were trapped with human excrement baits. Available records also indicate that it is nocturnal.

*Tesserodon simplicipunctatum* sp.nov.  
(Figs 19,20)

## ETYMOLOGY

Latin *simplex*, unmixed, simplicity and *punctum*, small hole; referring to pronotal punctures.

## MATERIAL EXAMINED

Holotype: QMBA T.11591, ♀, 10 km E Heathlands Airstrip, CYP, NE Qld, 8.vii.1975, G.B. Monteith. Paratype (1): NT: 12.17°S 133.13°E, 18 km E by N of Oenpelli, 1.vi.1973, Matthews and Upton, (1♀). Paratype in ANIC.

## DESCRIPTION

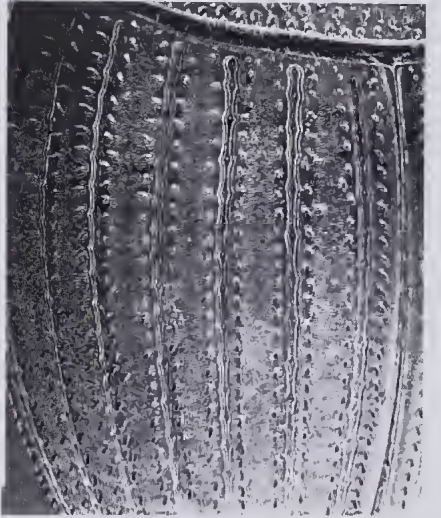
Elongate-oval, subconvex. Total length 7.3–7.9 mm., maximum width 4.5–5.1 mm.

*Female*. Head. Median teeth short, about as wide as long, V-shaped between, flanked by shallow lateral excisions, rest of margins then straight to clypeogenal sutures which are feebly notched, genal angles obtusely rounded. Dorsal parts of eyes large, suboval, extending about 2/3 of way to clypeogenal sutures, separated by 5-6 eye widths. Punctures moderate, simple, those on back of occiput with incomplete, indistinct cicatrices, each with a short, erect seta, surface nitid between.

Pronotum. Punctures moderate, simple, evenly distributed over entire surface, those towards sides with incomplete, indistinct cicatrices, each with a short, erect seta, surface nitid between.

Elytra. Broad, widest just before base, subparallel for about 3/4 of the elytral length then rounded to apex. Striae geminate, slightly crenulate. Intervals feebly convex, surface nitid, rows of simple punctures along lateral margins of each interval, each puncture with a short, erect, pointed seta, most angled in towards centre of interval.

Hind wings. Fully developed.





Legs. Protibial spur narrow, pointed, hind femur without basal tubercle and hind tibia without inner apical tooth.

Ventral surface. Mesosternum with dense, annulate punctures, metasternum with simple punctures on anterior portion, annulate on posterior tending towards horseshoe-shaped on lateral lobes, each with a short, thin seta. Pygidium with numerous simple punctures, each with a short seta, surface nitid between.

*Male.* Unknown

#### COMMENTS

This large species, known only from two females, is apparently close to *novaehollandiae*. The simple pronotal punctures, especially in the centre of the disc should separate *simplicipunctatum* from all other Australian species. The Queensland specimen was trapped with human excrement bait set in heath vegetation including *Asteromyrtus lysicephala* (F. Muell. and Bailey) Craven and *Grevillea pieridifolia* Knight on sandy soil (QMBA records).

#### *Tesserodon novaehollandiae* (Fabricius, 1775)

*Scarabaeus novaehollandiae* Fabricius, 1775, p.29, no. 113.

*Tesserodon novaehollandiae*: Hope, 1837, p.55; Matthews, 1974, p. 87.

#### HOLOTYPE

New Holland (probably Endeavour River, Qld, June-August 1770, J. Banks), BMNH (Banks).(not seen)

#### MATERIAL EXAMINED

QLD: 11.40°S 142.45°E, Dividing Range, 15 km W of Captain Billy Ck, CYP, ABRS sltes 1 and 3, 5-12.ii.1976, G.B. Monteith, (3♂♂ 3♀♀); same locality, 4-9.vii.1975, G.B. Monteith and D.L. Hancock, (2♀♀); same locality, 9-13.vii.1975, G.B. Monteith, (1♂); Lake Boronto (=Wincheura), Newcastle Bay, CYP, 30.i.-4.ii.1975, G.B. Monteith, (1♂, 1♀); 6 km N of McDonnell R, CYP, 13-14.vii.1975, G.B. Monteith, (9♂♂, 2♀♀); Telegraph X'ing, Dulhenty R, CYP, 2-4.vii.1975, G.B. Monteith, (1♀); Moreton Telegraph Stn, CYP, 30.vi.1975, G.B. Monteith, (4♂♂, 2♀♀); Weipa, 5-8.ii.1975, G.B. Monteith, (2♂♂, 1♀); Evans

Landing, Weipa, 3-5.ii.1976, G.B. Monteith, (1♀); Hibberd Point, Weipa, 3-5.ii.1976, G.B. Monteith, (1♀); Iron Range, CYP, 30.vi.-4.vii.1977, G.B. Monteith, (2♀♀); Archer X'ing, 70 km N of Coen, CYP, 17-18.vii.1975, G.B. Monteith, (1♂); 18 km W of Port Stewart, 25-28.vi.1976, G.B. and S.R. Monteith, (2♂♂, 12♀♀); Cape Flattery Heath, 45 km N of Cooktown, 13-14.vii.1976, G.B. and S.R. Monteith, (6♂♂, 5♀♀); same locality, 20.x.1981, R.I. Storey and I.J. Titmarsh, (1♂); 10 km N of Hopevale, 9.vii.1976, G.B. and S.R. Monteith, (1♂); 15.10°S 145.07°E, 3.5 km SW by S of Mt Baird, 3-5.v.1981, A. Calder, (1♂); same data, 1.D. Nauman, (1♀); 15.16°S 144.59°E, 14 km W by N of Hopevale Mission, 7-10.v.1981, J. Feehan, (1♀); 15.17°S 145.13°E, 1 km N of Rounded Hill, 5-6.x.1980, T. Weir, (1♂, 1♀); Wrotham Park, via Chillagoe, 26.xi.1977, R.I. Storey, (1♂); Maitland Downs, via Mt Carbine, 13-16.i.1978, R.I. Storey, (4♂♂, 14♀♀); 11 km WSW of Petford, 3-4.iv.1988, R.I. Storey, (2♂♂); Norman R via Normanton, 19.xi.1978, R.I. Storey, (2♂♂); Walker Ck, 40 km SE of Karumba, 28.v.1972, G.B. and S.R. Monteith, (1♀); 36 km W of Georgetown, 31.iii.1976, R.I. Storey, (2♂♂); 27 km W of Forsayth, 24.xii.1977, R.I. Storey, (3♂♂, 3♀♀); same data, 20-21.xi.1976, (1♂); 18.12°S 142.52°E, Gilbert R, 72 km W by N of Georgetown, 30.xi.1981, J. Balderson, (1♀); 12 km W of Herberton, 11-15.ii.1979, R.I. Storey, (2♀♀); 27-32 km W of Atherton, 15.ii.1975, H. and A. Howden, (1♀); 23 km E of Mareeba, 29.i.1989, R.I. Storey, (3♀♀); same locality, 11.ii.1989, H. and A. Howden, (1♀); Tolga, 6.i.1986, J.D. Brown, (1♂); same data, 23.i.1986, (1♂); 2-3 km up Mt Spec Rd, 7.v.1974, R.I. Storey, (1♀); Keppel Sands, 37 km E of Rockhampton, 6.iii.1975, H. and A. Howden, (1♂).NT: Larimah, 4.xii.1976, R.I. Storey, (2♂♂, 1♀); 14.31°S 132.22°E, Tindal, 1-20.xii.1967, W.J.M. Vestjens, (1♂); 12.28°S 131.03°E, Howard Springs, 24 km S of Darwin, 10.xi.1972, E. Britton, (1♂); 12.17°S 133.13°E, 18 km E by N of Oenpelli, 1.vi.1973, Matthews and Upton, (1♀); 11.09°S 132.09°E, Black Point, Coburg Pen, 15-23.ii.1977, T.A. Weir, (1♂, 1♀); 11.01°S 136.45°E, Rimbija Is, Wessel Is, 21.i.-3.ii.1977, Farrow and Downs, (1♂); same locality, 3-14.ii.1977, T.A. Weir, (1♂, 1♀). WA: Kununurra, 9-13.xii.1975, R.I. Storey,

(1♂, 1♀); 6 km E Kununurra, 12–13.xii.1975, R.I. Storey, (3♂♂, 1♀); Fitzroy River (on Hwy 1), 13.iv.1984, K. and E. Carnaby, (1♀); 14.48°S 129.49°E, 3 km NW by N of Mining Camp, Mitchell Flat, 15.v.1983, D. Rentz and J. Balderson, (1♂). Specimens in ANIC, HAHC, PGAC, QMBA, QPIM, SAMA, UQBA, WAMP.

#### COMMENTS

This widespread species is found throughout tropical Australia from the north of Western Australia across to the tip of Cape York Peninsula and as far south as Rockhampton in Queensland, often together with other species (*feehani*, *variolosum*, *intricatum*, *henryi* and *gestroi*). *T. novaehollandiae* is variable, although this variation does not seem (from the sample examined) to be geographical. The shape of the edge of the clypeus of the male varies considerably: the clypeal teeth can be short or long and the space between them varies from a broad U- to perfect V-shaped; the lateral excisions range from almost nonexistent to a prominent U- or V-shape. The eyes vary in width and in size of the gap with the canthus at the back of the head. There is some variation in the punctuation of the pronotum and elytral intervals, the punctures being at least twice as dense in some as in others. The protibial spur of the male also varies in shape, from long and truncate to shorter and wide, almost bifurcate, at the tip. However, judging from the shape of the aedeagus, only one species is involved. Specimens were taken at night in traps baited with human excrement and carrion and at light. One specimen was collected in a standing mushroom. Available records are from a variety of open forest types, on hard and sandy soils.

#### DISCUSSION

Although Australian species of *Tesserodon* are similar in general appearance, groupings, based on shape of the aedeagus, are recognised:

A – *pilicrepus*, *tenebroides*

B – *erratum*, *variolosum*

C – *intricatum*, *henryi*, *feehani*

D – *novaehollandiae*, *gestroi*, *granulatum*, *hil-leri*

The male of *simplicipunctatum* is unknown and *angulatum* from southwest Western Australia was not encountered in the study.

I suggest that group A is the most primitive through to group D being the most advanced. It is of interest that flightless species are known in groups A, C, and D. Thus it seems likely that wing reduction has arisen more than once, probably at least 3 times in the genus. Three of the new species from Queensland are flightless and have restricted distributions in relatively uninhabited areas. It is therefore probable that new species of the genus will be discovered through further collecting in northern areas.

#### ACKNOWLEDGEMENTS

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#### LITERATURE CITED

- FABRICIUS, J.C. 1775. *Systema Entomologiae*. (Flensburg and Leipzig).
- HOPE, F.W. 1837. *The Coleopterist's Manual*, containing the lamellicorn insects of Linnaeus and Fabricius. Vol.1. (Bohn: London).
- LANSBERGE, J.W. van 1885. Descriptions d'espèces nouvelles de Coléoptères appartenant au Musée Civique de Genes. *Ann. Mus. civ. stor. nat. Giacomo Doria* 22: 375–400.
- LEA, A.M. 1923. Australian dung beetles of the Subfamily Copridae. *Rec. S. Aust. Mus.* 2: 353–396.
- MACLEAY, W. 1888. The insects of King's Sound and its vicinity. II. The lamellicornes. *Proc. Linn. Soc. N.S.W.* 3: 897–904.
- MATTHEWS, E.G. 1974. A revision of the scarabaeine dung beetles of Australia. II. Tribe Scarabaeini. *Aust. J. Zool. (Suppl. Ser.)* 24: 1–211.
- PAULAN, R. 1985. Les Coléoptères Scarabaeidae Canthonines de Nouvelle-Guinée. *Annls. Soc. ent. Fr., n.s.* 21(2): 219–238.
- WESTWOOD, J.O. 1841. Descriptions of the Australian species of lamellicorn beetles, belonging to the family of the sacred beetles. *Proc. R. ent. Soc. Lond.* 1841: 66–67.

## BARK PAINTING BY ANGUS NAMPONAN OF AURUKUN

PETER SUTTON

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The significance of a bark painting by Angus Namponan of Aurukun is discussed in terms of style and significance, with a commentary on the relationship of the figures in the painting to the cultural beliefs of the Aboriginal peoples of the area. Transcripts of interview between the author and artist are included for the first hand responses concerning the painting and the story it tells.

*Peter Sutton, P.O. Box 638, North Adelaide, South Australia 5006; 14 May, 1991.*

A bark painting in the collection of the Queensland Museum (Reg.No. QE10170) (Fig. 2), was collected by Roger Hardley, of the Queensland Museum, in June 1976 and the artist was recorded as Angus Namponan (Fig. 1) of Aurukun, Cape York Peninsula.

Bark paintings are a medium introduced to Cape York Peninsula through the influence of the arts and crafts industry, and very few have been produced there or found their way into public collections. Most of those made at Aurukun in recent years have been painted by people originally from Mornington Island, where bark painting is more common. Later in this paper I discuss relationships between this painting by Namponan and other bark painting forms found elsewhere, chiefly in the Top End of the Northern Territory.

On 2 November 1990 I interviewed Angus Namponan, accompanied by Ray Wolmby, and made two field tapes (Appendix).

The painting is made up of three panels (A,B,C) which have been sketched schematically (Fig. 2). Various motifs within the panels are numbered (Fig. 2) and these are the numbers referred to below.

### PANEL A

#### SPEARING MILKFISH BY NIGHT

This is an image drawn from an important myth and related ceremonial performance which is part of the Winchenem ceremonial group's spiritual heritage. Three men (2) are spearing Milkfish (or Bonefish, known as Walkaln in Wik-Mungkan and Eeth in Wik-Elken). One has a multi-prong spear hooked up to his throwing stick, and the other two hold paddles. The outrigger canoe is shown in plan view, while the

figures in it are shown three-quarters frontally in perspective.

That they are fish-spearing at night is indicated by the man in the outrigger canoe (3) holding aloft a torch made from rolled and bound tea tree bark (1). The season is also suggested, as Wolmby points out in the taped interview, as the time when these fish are speared in this way is August to October (he gives both months). The Milkfish themselves are indicated by the typically streamlined fish forms with dark side patterning (4). In ceremonial performances by the Winchenem group, carved representations of these fish have often been used, as in the University of Queensland Anthropology Museum example illustrated in Bartlett (1989:66 (A158)), and Morphy (1981: 58, 129 (N217)). The film, *Dances of Aurukun* (AIAS 1962) also exemplifies the use of these Milkfish (Bonefish) carvings in Winchenem performance. In those carvings the side marking is a long narrow stripe, while in Namponan's painting it is a large panel covering most of the side of the fish.

The artist is not a member of the clan whose estate includes the location of the mythic events shown here, nor is he a member of this ceremonial group. His own estate is just inland from Cape Keerweer and his ceremonial group is Apelech, on which more is said below. Panels, B and C, depict mythic events at sites which belong to Apelech clans, although neither site is specifically part of Namponan's own clan country. It is worth mentioning here, that the relative political ease with which senior people in this region may relate or even perform Dreaming dramas said to 'belong' to others is distinctive. It is common practice for people to narrate myths for places over which they make no primary claims of a territorial or religious nature, so long as they are within the normal spectrum

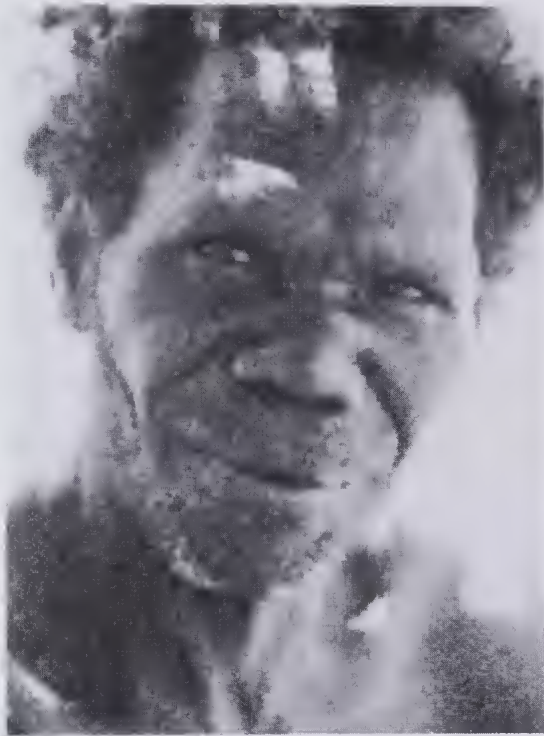


FIG. 1. Angus Namponan.

of social and territorial contact of the individual actor. This is typically accompanied by statements assigning primary rights in this knowledge to the owning groups.

The site referred to in this case is given by Namponan as Wuben (#2425), after Wolmby, by way of assistance, suggests it might be referred to as Mukiy. Mukiy is the focal site (#2387) of the estate on the Small Archer River (maps have 'Tompaten Creek') which belongs to the Pam-began/Kawangka clan. As the story place is in this estate the use of its cover-name is a reasonable way of making broad reference to the country. However, detailed field mapping with members of the relevant clan has established that the location of the totemic increase centre or 'story place' for this species is on the high bank of the Small Archer River some way upstream from the more accessible site of Wuben. At this point a freshwater spring drains into the river at low tide. This place is called Walkaln-aw (#2422), literally 'Milkfish Totemic Centre' (Further details of this site and the others referred to here are contained in Sutton et al. (1990). This is at present a restricted document.).

A version of the myth associated with this

image may be found in McConnel (1957:39-41), where she referred to the species as bony bream. She also mentioned that the key actor in the story had a younger and an older brother, which may account for the threesome depicted in Namponan's painting.

The three men (2) performing Winchenem ceremony at the bottom of panel A are the same three men (2) as depicted in the canoe. They are holding ceremonial poles characteristic of certain performance styles in the Wik-speaking area. They wear cockades of white cockatoo feathers. It is worthy of comment that they, like all the other human figures in the painting, have no ceremonial body paint, although a faint red outline around their bodies may suggest the usual covering of red ochre. Typical Winchenem body paint would in this case have been horizontal stripes about the legs and possibly also the torso.

The large half-circles (5) which form part of the borders between the panels are defined by Namponan and Wolmby as 'Winchenem dots', which are characteristically larger than those of Apelech. Namponan also refers to them as 'from on top'. This is because the clans associated with Winchenem mostly have estates in the dry sclerophyll uplands east of the coastal floodplains where the other major ceremonial groups south of the Archer have their lands (i.e., going north to south between the Archer and Christmas Creek: Apelech, Puch, Wanam). The inland countries are 'on top' and the coastal countries are 'bottom side'. This dichotomy remains the most deep-seated political and cultural cleavage within the Aurukun population.

#### PANEL B

##### MOTHER SHARK AT MAN-YELK

The second panel shows two men (8) with spears (one holding a spearthrower also) and a large shark (7). The men have feather cockades and are engaged in a ritual enactment that is based on what appears to have been a seasonal physical process as well: the removal of juvenile sharks (theelicheny) from the pregnant mother shark (kuunger) followed by the releasing of the living mother back into the waters. This is part of Apelech ceremonial performance, in which carvings of sharks are used.

The mythic reference is to the Shark totemic story complex focused on the area of Man-yelk (#233), which is the large estuary of the Kirke River just inland from Cape Keerweer. Shark is

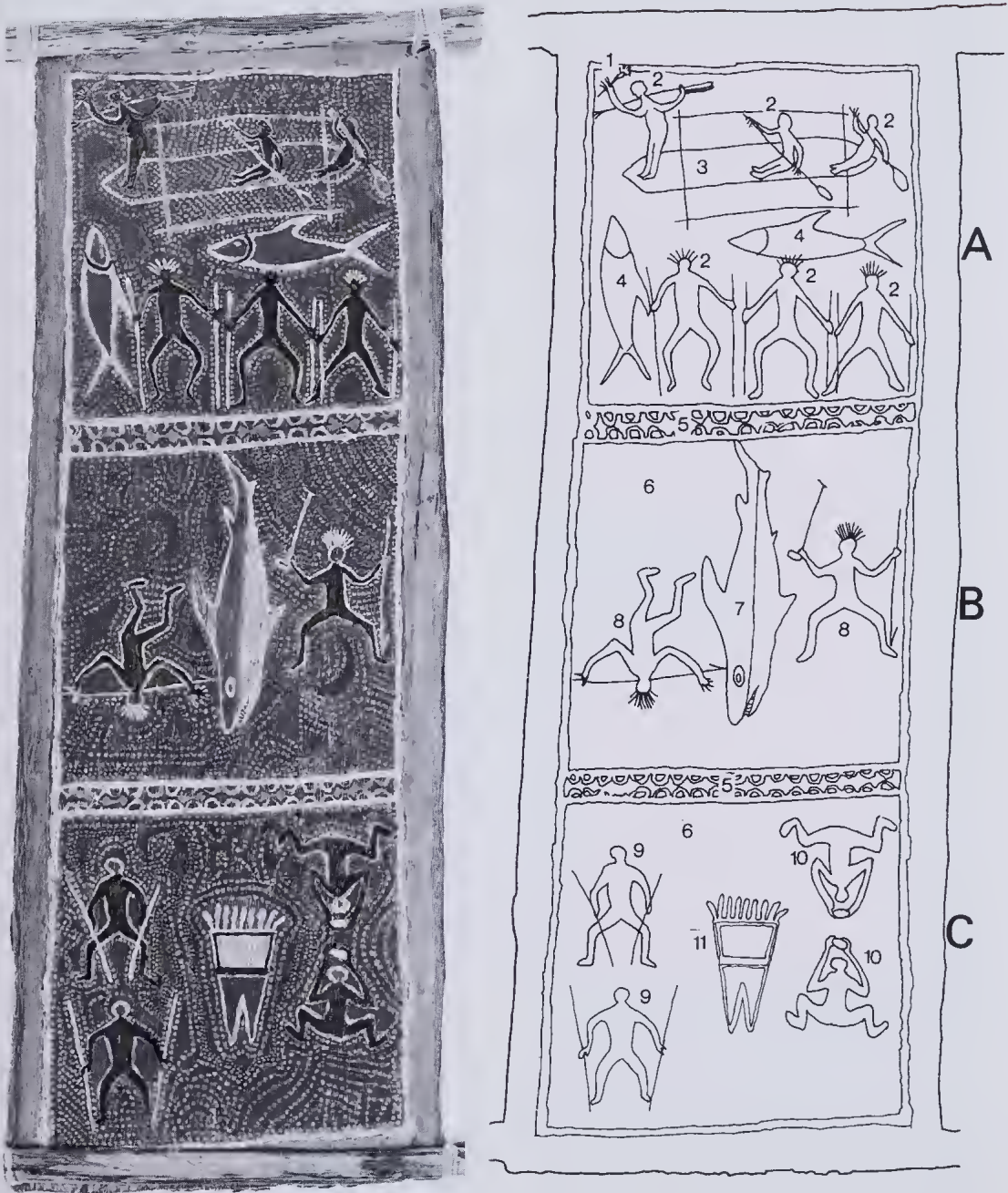


FIG. 2. Bark painting by Angus Namponan of Aurukun (left) and schematic sketch of major motifs within the painting (right) with numbers in brackets added to each individual motif for reference in the text.

a major totem of the clans whose lands surround this estuary, and the surname Wolmby, for example, is a mission spelling of the male totemic name Waalempay, '[Shark's fin] making ripples'. The Wolmby/Peemuggina clan own the Aayk estate, focused on the swamp, well and sandy living area known as Aayk (Wik-Ngathan, Wik-Elken) or Thuul (Wik-Mungkan), #85.

The dominant narrative for the Shark complex is that of the Two Young Women, Quails who at the end of the story turned into Sharks. They travelled via Iincheng (#88) and Pulthalpempang (#1), which are on the western side of the estuary, to the point where the Kirke fans out into its estuary just near the coast. One stood on the south side of the river singing her own totemic mourning song, or Wuungk, at a place called Uuk-miipeng (#91). The other sang her own, different Wuungk from a point on the opposite bank of the river at Poenp (#52), although in the details on the tape, Wolmby identifies it as Thiich (#58), which is northeast of Poenp and nearby. The name Thiich was given after much attempted remembering and I believe the consensus would be that the place was actually Poenp, which is a Shark totemic centre, a story place and an initiation ground. A published version of this story is to be found in my commentary on the Namponan/Peemiggina/Wolmby sculptures of the Two Young Women (Sutton, 1988:26–28). That volume also contains a brief biography of Namponan which I do not reproduce here.

I (Sutton, 1988) drew attention to one of the themes in this story, that of sexuality and fertility. The image of panel B is a direct reference to the ritual and economic practice of perpetuating the life of the Mother Shark while taking her young for sustenance, itself a powerful image of reproduction, conservation and revitalisation. Men would spear the pregnant sharks with blunt spears (uucheng pelpen), said to have 'no barb' (although those in the painting appear to have a single barb). They would roll her over, cause her to miscarry by kicking, extract the young via the cloaca, 'throwing out the blood', and then turn her over. They would sing Wuungk (mourning songs) as they did this, once, then twice - she would start to move - then thrice, and she would swim away alive. The mother shark was not killed, as she was sacred in this state. The meat of the juvenile sharks was by law meat for all ages and both genders (minh kaangketh), something that had to be shared, otherwise there would be 'spear talk'.

This Shark complex is vital to the Apelech mythic and ceremonial cycle that extends geographically from just south of Archer River to between the Knox and Kendall Rivers in coastal western Cape York Peninsula. (For published material on this cycle see Sutton (1987:84)). The fine dotting (6) is said to be Apelech dotting. At first, Namponan said he only added the fine dots for decorative effect (yaay 'for no deep reason', to 'flashim'), but then on second thoughts moved into an explanation of the symbolism of the dots that closely parallels that given in Sutton (1988:28–29). He said that the dots refer to the ceremony called Apelech [literally 'Clear (of Water)'], as they do also to the clarification of the salt waters of the coast and estuaries after the wet season sediments have settled and a big saltwater tide has come up. Wolmby, making the reference narrower, adds that Namponan's dots in panel B 'are dots for Mother Shark'. The shimmering brilliance conveyed by this fine dotting is a metaphor of spiritual power and life-giving forces.

#### PANEL C

##### TWO THIRSTY SPIRITS AT MOOLENCH

Two male spirit-images (9) are shown dancing Apelech ceremony, holding ceremonial poles. They have just been ritually sent, as spirit-images of the deceased are still sent soon after a death, to a site in the area just south of Cape Keerweer. There they encounter two women (10) who are sitting squeezing the white fluid out of the flesh of stingrays - the species are given as the flat-tailed ray, whip-tailed ray, and file stingray. The white objects in their hands are the lumps of stingray flesh. The women are sitting, but as they are shown with legs apart their sexuality is probably being indicated. They are said to be very attractive.

The location of the myth is a well, depicted by the geometric form in the centre (11). This form contains the triangular base designs so distinctive of the painting tradition of this area. (The use of triangles is rare in traditional Aboriginal art, the other main area where they are found being northeast Arnhem Land. In both cases, long-established foreign artistic influence - in Arnhem Land from the Macassans, here from Torres Strait - is probably the origin.) The name of the site is given in this case as Thum-merriy (#147), a site which in the 1970s was assigned jointly to the Gothachalkenin/Landis/Eundatumweakin clan and the northern Yunkaporta clan, whose

estates respectively largely lie south and north of here. (Details of locations are in Sutton et al., 1990) This is a well-known site name and refers to what was once a major residential base camp. The details given by Namponan and Wolmby in this case, however, suggest that while this is a useful cover-term for the area the location of the story is actually Moolench (#2179). This is an extremely dangerous place where a monster called Wuthelpal (also Nguthelpal) lives, a huge snake-like being with a mane of long hair and feathers, resembling a 'lion'. A carved and painted representation of Wuthelpal, by Francis Yunkaporta, is in the possession of David Martin of Canberra. The late Noel Peemuggina and the late Charlie Yunkaporta are said to have actually seen this monster in this area. On the tape the site is said to be near the Moving Stone (#881=2146), a place of major spiritual importance in the region and claimed by northern Yunkaportas.

The site also has water fairies and several totemic centres (for Barramundi, Bandicoot, Clear Saltwater [Ngak Apelech], and Red Anus). Its scrub is a place where one cannot dig for turkey eggs. If you do, you will get leprosy, and the sores on your arms will swell up like measles if you do this. Its ritual danger acted as a shield for Billy Wildfellow, deceased progenitor of all living members of the Gothachalkenin/Landis/Eundatumweakin clan, as he would go here to hide after killing someone or stealing a woman. While both Namponan and Wolmby assign ownership of the site to northern Yunkaportas, it is also claimed (not without dispute) by descendants of Billy Wildfellow, one of whom is Wolmby's wife. During the taped discussion he inserts mention of their claims.

In the story as given by Namponan and Wolmby, the two men approached the working women and asked for water from the well. They gave water to the men, who washed their mouths and then drank. The men demanded more water, which they received, then more and more water. The women continued to give them water from the well next to the swamp. The day wore on, the sun was setting, and still the men demanded and received water. The level of water in the well was getting low. The woman who had been doing the talking finally refused to give any more, and left, going to Warpang (#114), which is north of the well site and in Namponan's own clan country. The women told the men that the well site was to be theirs, and went back north to Warpang - a sequence which implies a dissociation of land

interests of the two clans Namponan/Karntin and northern Yunkaporta. (Members of these clans are, if in the same putative generation, parallel classificatory cousins.) The women were afraid that the men might come and attack them during the night, and they heard the men singing Apelech songs. 'Ah, who are those spirits?' they asked.

The story as given on the tape is rather fragmentary and I had difficulty in translating parts of it, which are mostly in a language I do not know well (Wik-Elken). Further clarification could be obtained if a fuller version of this myth could be recorded and accurately translated.

## DISCUSSION

Although Percy Trezise is said to have tried to introduce bark painting to Aurukun in the early 1970s, and odd examples mainly painted by Mornington Islanders resident at Aurukun do appear among works coming out of Aurukun from time to time, the medium has never become a common one in the region. Namponan's own preferred medium is wood carving, and he regularly carves crocodiles for sale (unpainted) and sacred sculptures for house-opening ceremonies, such as those illustrated in Sutton (1988:26). Namponan is locally recognised as a specialist artist and his son Gary has produced many drawings and some paintings for sale or for book illustrations. Gary Namponan spent some time at Batchelor, NT, training in visual arts techniques. The Namponan family are the main participants in the AIATSIS film *Familial Places* by David and Judith MacDougall.

The painting is characterised by those features often said to be very typical of bark paintings in the Northern Territory: symmetry, fineness of execution, a contrast between solid primary motifs and a detailed infill, and a 'quotative' approach to the representation of sacred myth in the sense that only one or two episodes from a story are shown, thus implying the rest of the story.

Some of what makes this work distinctive stylistically within Aboriginal Australia lies in the partial use of perspective, and in the linear approach to dotting. Some of this dotting describes triangular forms and tendril-like hooks that are unusual in the Aboriginal classical tradition, although there are echoes elsewhere (such as the diamonds of northeast Arnhem Land and the paisleys of Ernabella). The dotting generally appears to have been begun in parallel to the

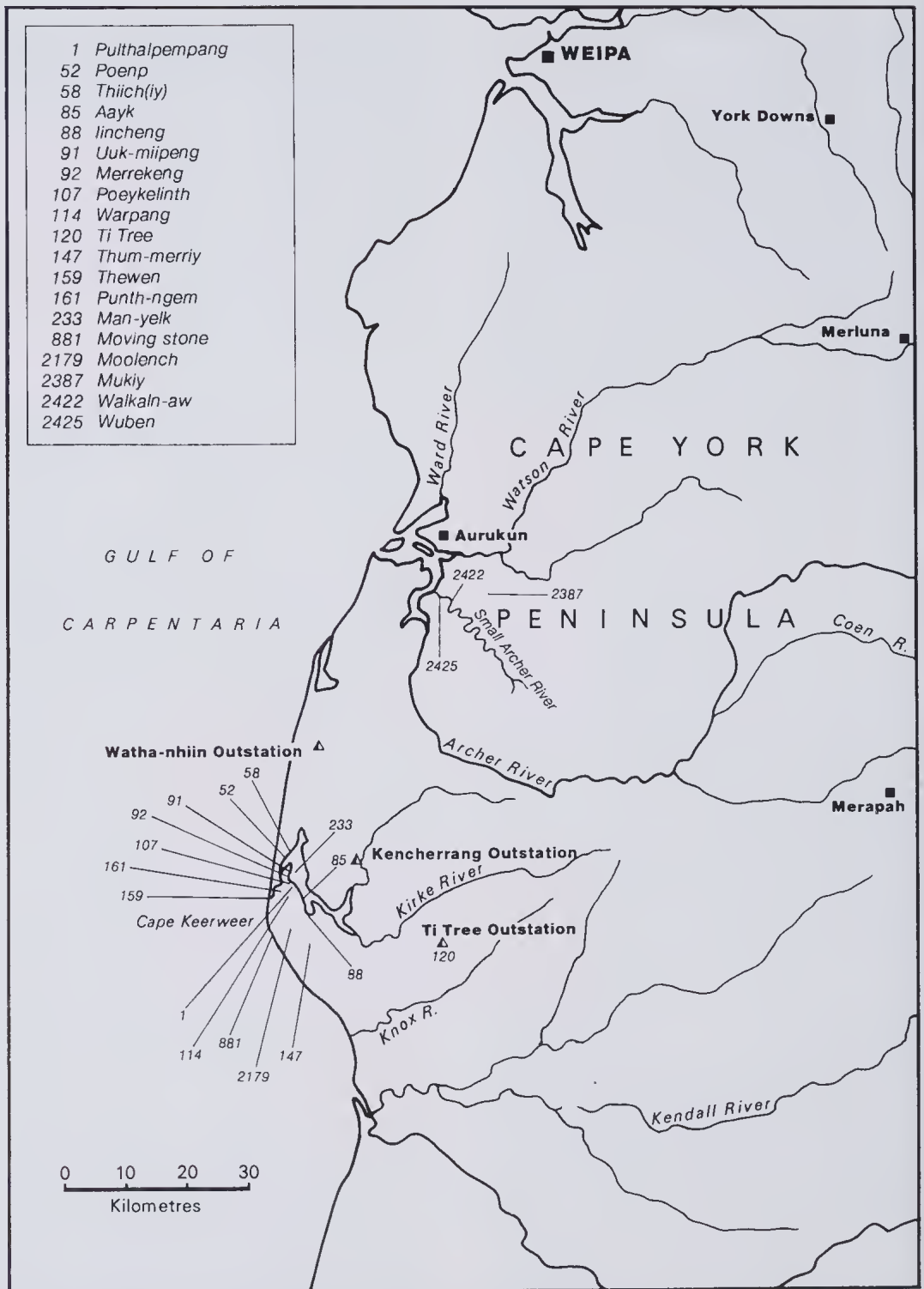


FIG. 3. Map of area showing sites mentioned in text in the Aurukun to Cape Keerweer area..



envelope of each primary motif, in this sense reminding one of the multiple parallel outlines of focal motifs in much art of Papua New Guinea.

### LITERATURE CITED

- BARTLETT, J. 1989. Australian anthropology. 14–70. In 'Cultural exhibition of Queensland' (Saitama Prefectural Museum: Saitama).
- MCCONNELL, U. 1957. 'Myths of the Mungkan'. (MUP: Melbourne).
- MORPHY, H. 1981. The art of northern Australia. 53–65. In 'Aboriginal Australia' (Aust. Gallery Dir. Council: Canberra). 192p.
- SUTTON, P. (ed.) 1987. 'Mystery and change'. In Clunies Ross et al. (eds) 'Songs of Aboriginal Australia'. (Oceania: Sydney).
1988. 'Dreamings: the art of Aboriginal Australia'. (Braziller/Viking: New York).
- SUTTON P., MARTIN, D., VON STURMER, J., CRIBB, R. AND CHASE, A. 1990. 'Aak: Aboriginal estates and clans between the Embley and Edward Rivers, Cape York Peninsula'. (Sth. Aust. Museum: Adelaide).

### APPENDIX

#### NAMPONAN BARK PAINTING: SUMMARY TRANSLATION OF FIELD TAPES

On 2 November 1990, at Aurukun, Cape York Peninsula, I interviewed Angus Namponan, accompanied by Ray Wolmby, and made two field tapes (nos. 254 & 255). The relevant field notes are PS Book 65:201–202. Angus Namponan is speaking Wik-Elken (= Wik-Ngatharr) and English; Ray Wolmby and Peter Sutton are speaking Wik-Ngathan, some Wik-Elken, and English.

To understand the pronominal, kin and country references the reader should know that Namponan is married to a woman of the Wolmby/Peemuggina clan whose country is focused around Aayk on the Kirke River estuary, and that this woman is a parallel cousin and clan 'sister' of Ray Wolmby and Peter Sutton. Peter Sutton was taken as a son by Ray Wolmby's father's brother, and the two are therefore parallel cousins and clan brothers. For this reason Namponan calls both of them brother in law as well as cousin (in Aboriginal English, *bandji*, originally from the colloquial 'fancy [man]', hence sometimes *bandjiman*). His wife is a Peemuggina (Wolmby). Namponan's clan estate adjoins that of the Wolmby/Peemuggina clan on

the northeast and both belong to the Apelech ceremonial group and the Cape Keerweer political spectrum. His mother's estate was focused on a place called *lincheng*, whose chief patrilineal inheritors have effectively abandoned it in favour of *Kenchrrang* area. The *lincheng* estate adjoins both his own and that of Ray Wolmby, and its future tenancy is often under discussion, as in a veiled way it is here. Furthermore, to understand why Wolmby refers to the focal site of panel C as belonging to the *Gothachalkcnin/Landis/Eundatumweakin* clan when Namponan refers to it as belonging to the northern *Yunkaportas*, one must know that those two clans have conjoint interests at or near the site as it is close to the edges of both estates. One also has to know that Wolmby's wife is a *Landis*, and not to insert a word on behalf of their interests would contravene the principle of in-law respect which is otherwise so clearly evident in the formality of speech in this conversation.

Please note that what follows is partly translation, partly summary, and partly verbatim transcript. Spelling conventions are slightly different from those described in Aak, in which the dot represents the unstressed vowel schwa. Here and elsewhere in this paper schwa is represented by /e/. There are thus two values for the letter /e/: in an initial syllable, or the first syllable in a hyphenated word, it has something like the value of /e/ in English 'bet'. Elsewhere it has the neutral value of /e/ in English 'ashes'. Doubled letters represent long vowels. The digraph /oe/ (long: /ooe/) represents a high to mid central lightly rounded vowel like French /eu/, /th/ is a tense lamino-interdental stop, /ch/ is a tense lamino-palatal stop, /nh/ is a lamino-interdental nasal, /ny/ is a lamino-palatal nasal, /ng/ is a dorso-velar nasal, /r/ is a rhotic glide, /rr/ is a rhotic flap/trill, and /' / is a glottal stop. Other values are as in the International Phonetic Alphabet. AN is Angus Namponan, RW is Ray Wolmby, and PS is Peter Sutton.

#### TAPE 254 [TRACK 2, last few minutes only]

PS: Draws attention to tripartite structure of image, to suggest dealing with one at a time.

RW: Panel B: This Shark is the Mother Thing [avoidance of ordinary word for meat, typical of reverence for totemic references].

AN: Panel A: This is a torch meat [i.e. a fish speared at night by torchlight], these are Milkfish (*minh ceth*), this one here, a meat of the night, as barramundi is also. Spearing night-time.

PS: Where is that place?

AN: This place is on Small Archer River [the 'Tompaten Creek' of standard maps]. The three men, after having gone torch spearing, then danced ceremony.

PS: What are they dancing bandji?

AN: They were not dancing Apelech, but Winchenem.

PS: What is the name of that place?

RW: Say Mukiy.

AN: Mukiy no way, no way, no way. It is called a totemic centre for that animal, an 'aw' in Wik-Mungkan. This same species, this Bonefish, its totemic centre is up east here. Wuben; not Wobeb. That is the Milkfish [= Bonefish] totemic centre, and it is theirs [oblique reference to Pambeagan clan].

#### PANEL B:

AN: But this one here is different, it is ours (1 plural incl.); the story about that other one is finished. Our story here is different, it is Apelech, this Shark here (Kuunger), and the country is Aayk.

RW: Kuunger, that Mother Shark. It comes from our (1 dual incl.) country, Iincheng, Iincheng...

AN: The country is Aayk, what we call Man-yelk, the whole place, it's Man-yelk.

PS: All in one?

AN: East/west, north/south, it's all Man-yelk. It's that open place where you [PS] and we camped at one time [in 1977, at the time Familiar Places was filmed]. It's Man-yelk. Two men are dancing Apelech. That big mother Shark, they use spears with ....

END TAPE 254

#### TAPE 255 TRACK 1:

PS: Sorry, bandji, can you just start that story again?

AN: They spear the Mother Shark with kalk pelpen, also called uucheng pelpen, with no barb. They kick her about the genital area, while she is belly up. They throw out the blood, grab them by the lower parts, take out the baby sharks (at the stage known as little theelicheny). They never killed the Mother, never, she is sacred ([surrounded by] hard taboos), because she is the Mother Shark. Later [i.e. in living memory] it was exactly the same. They kept the babies. But men did not kill the Mother, that's very sacred.

RW: Brother in law, excuse me, it's like this: they would sing Wuungk [site-specific mourn-

ing song largely controlled by women] in our (1 dual incl.) language ...

AN: Yes, they sang Wuungk those two [Quail Women], you [PS] know how to sing that Wuungk, you have been singing that Wuungk. This one now [i.e. men would sing Wuungk relating to the sites Uuk-miipeng and Poenp] over the Mother Shark on the shore. The Shark would then get up. The old people [= ancestors, forebears] would be watching, as the Shark thrashed its tail (pubpubpub), watching, then: 'It's going now'. A little bit more then: 'OK, she's all right now'. The Mother was never killed, no way, very sacred. [Note: /pub!/ is the ending of one of the Shark Wuungk songs, and is a regular ideophone specifically denoting a shark's tail threshing water.]

RW: Very sacred.

PS: Too true.

AN: The baby sharks were pulled from her belly [euphemism], from her womb [English term used, avoidance of Aboriginal anatomical term between in-laws]. They would keep on pulling them out. Then they would 'tie them up' [a cryptic reference to processing by singeing the skin, shredding the meat, leaching the milky liquid out of it, then enclosing the liver in the meat and tying the whole into a paperbark bundle to be set by the fire to re-heat]. Then they would eat. This was minh kaangketh, meat for everyone - not just a few people would eat it, the whole family would eat it around there. That's how it was.

RW: Yes, minh kaangketh, that means every person got to share, otherwise that one is spear talk brother. That's a word belonging to that tribe of you and me, belonging to that place. Of our ancestors from there. It's different, unique. If brother in law talk I respect him ...[?].

#### PANEL C:

AN: The other one [panel], I took it [story] from further that way, south [i.e. south of Man-yelk], brother Sydney's and Clive's family, Francis and Bruce, this is their story [i.e. a story of a site belonging to northern Yunkaportas from Moving Stone area just south of Cape Keerweer]. This is a story about a person's spirit image. Those ones were different, about real people, but this one is about spirits. From there, where did they come from, before? Well, before, people would rise in anger, like, they would go and camp out and look around to check on what people were doing and then do something in return to them [simulation of

- revenge expeditions is implied]. Like that. These two gave a hiding to ...[?]
- RW: Younger brother, it's like this: [refers to our country Thewen [i.e. the mouth of the Kirke River, in which Wolmbys have a strong interest]...]
- AN: This one here we are talking about, the last one.
- PS: What is this [refers to geometric object in centre]?
- AN: What is this? It's a well. RW: It's a well, it belongs to those cousins of ours [i.e. northern Yunkaportas and, probably, Landises].
- PS: The name of this place?
- AN: There, where is it...
- RW: Thum-merriy, isn't it?
- AN: Thum-merriy, Thum-merriy, Thum-merriy [my information is that it is Moolench, not far away but different, PS].
- PS: Is that a sorcery well or not?
- AN: That well is a swamp at a poison ground. Only senior people can go there, not young people or just anybody. Only the senior people know the footroad on which to go into this well.
- RW: Excuse me bandji, can I chop your word there. Brother please, I tell you: that same story there, that's a place where one can't dig for scrub turkey eggs (minh thoycken), or for long yams (may kuth), and if you do you'll get leprosy. I'm telling you it's a sacred and tabooed place.
- PS: It's Thum-merriy is it, and not Moolench?
- RW: Sacred place.
- PS: And these two are women eh?
- AN: Not men, two 'things' [avoidance of word for women (pu'eth), which contains the stem 'vagina', inappropriate between brothers in law]. Those two [women] were squeezing the flesh of flat-tailed stingray (minh yuumel). Whip-tailed stingray (wengeny), flat-tailed stingray and file stingray (punyp) they were squeezing, that morning.
- RW: Tell brother they were squeezing it in the scrub.
- AN: Not inside the scrub, because that's a forbidden place, a poison ground. Have you seen the Moving Stone? The scrub lies near there, and they were squeezing the meat just outside the scrub. These two man spirit images were sent there with Apelech ceremony. They were dancing Apelech holding those sticks. Where might they have been dancing?
- RW: My cousin, now see here my brother in law: This Wuthelpal is there. The one we call Wuthelpal is there, at their country. It's like a big snake like that tree you see there. Our deceased father's 'older brother' [actually father's younger parallel cousin, but respect form dictates use of senior category if deceased], the father of Peter [Peemuggina, i.e. Noel Pcemuggina], he saw it. The one we call Wuthelpal.
- AN: A huge snake, but with feathers.
- RW: With feathers. In the morning he blows just like a siren. Waaaaaaa! Like that he calls. It's in the country of our deceased mother's older brother in the south there, and of our cousins [the deceased uncle is probably Charlie Yunkaporta]. That's the country of Luke, Geofrey and Cora [nee Yunkaporta].
- AN: Yes, these two were squeezing meat. The two spirit men saw them. These were spirits, but the women were real people. Those white things in their hands are the meat they were squeezing. They said to the women: 'Hey, fetch water for us, give us water, we are thirsty.' One woman said: 'Wait you two, I will find some.' The spirit man's mate ran away frightened. 'Ghosts came upon us!' They found water for the two spirit men, who washed their mouths. They drank and drank. 'Fetch more water!' the two spirits said. More water was fetched from the well. There is a swamp there, a lagoon. They drank. More was given to them. 'No, fetch more! We're not satisfied yet.' They fetched more. 'Oh, this is going on a long time', one of the [?women] said. The sun was going down and the two were wanting to go. The water was getting smaller. 'I won't fetch any more water for you two'. She went back to - where is that place?
- RW: Warpang.
- AN: Ah yes, Warpang, they went there, right through.
- PS: Those two...?
- AN: No, this one went first, the other one ?gave more water to the spirits: 'Finished here eh?'
- PS: The two women?
- AN: No, men.
- PS: The two men ran away to Warpang eh?
- RW: Those two returned north to Warpang. 'Oh this is too long' they said. 'This is your water here, you stay here.' Those two then went back north to Warpang. Their country is there. Luke, Cora and the others, it is theirs, they returned to it.
- AN: The two [women] spoke in fear: 'Those spirits might come and find us tonight. They might attack us, hit us.' Those two heard the

spirit men singing Apelech songs. 'Ah, who are these spirits?'

PS: What is yoypeng?

RW: Koethoeth [spirit]. It's Big Language of ours (1 dual incl.).

AN: It's a newly sent spirit, sent with Wuungk singing.

RW: We call it koethoeth, and also yoypeng - Big Language, Wikmuneas' language has it also ...

PS: What are all those small dots?

AN: That's nothing really [yaaya], I just did that to make it look attractive ['flashim'].

RW: Younger brother, I just want to [yaaya] smoke a little tobacco. PS: Mm [assent].

AN: [reconsidering the last question:] What are the dots? These little dots here are Apelech. Like in the sea too, bandji, this water, like at the first during March or June/July the Clear Water has not yet come. Then there is a big tide and a very heavy saltwater tide rises up. That is when Apelech [Clear Water] then rises up.

RW: Younger brother, listen to this please. Look at this dot here, their language, cousin Angus's group [...], in their language, minh eeth [Milkfish]. June, July, August, September, then October, that is the time for these Milkfish. Look here, October month. This one here is December month, minh kuunger [Mother Shark reproducing], these dots here of our cousin's, are dots for Mother Shark. Mother Shark is pregnant October/November before she gives birth to them. Those are those dots you see of our [cousin]. Here on top the dots are of [Small] Archer [River], theirs [Pambegans']. Have you not seen, January, February, March, April, May, June, July, August, then it is time for that fish, August month.

AN: January, February, March, April, May, June, July. [Note: this recitation is a way of remembering the last month mentioned, usually.]

RW: Same month that Story there brother, that dot there on top. This one thaperem [?Shark] here is October month. The Mother is pregnant, before she sends forth her children. But our (1 du incl) ancestors, those others [...] used to grab the tail, turn her over (?) - cousin can tell you. And those deceased mother's brothers also did it. [I.e. Namponan's male forebears are

included, not just Wolmbys, hunting on the same shores.]

PS: What about this one here [motif 5]? Circle eh?

RW: Cousin will tell you.

AN: This is exclusively theirs, these large circles, from on top. East - like, what, they're Winchenem dots, very large ones. But Apelech has small dots. One of these Stories belongs to Winchenem, this one here: canoe, these fish, three persons. These are the same three persons here in the canoe [and dancing below]. They are dancing an important [ritually 'Big'] meat. One is holding a light in his hand, and a spear.

PS: Paperbark eh?

AN: Yes, a paperbark torch.

RW: Cousin, can I talk?

[RW then tells long story in Wik-Ngathan about the two women in the lower image (panel C), but gives location of events as in the area of Ti Tree Lagoon [site 120] well inland. This is not the subject of the painting, and as the story comes from someone other than the artist I have not transcribed it in detail here.

Also the story about the Two Young Women of Cape Keerweer, begun as track ends.]

## TRACK 2

Continuation of Two Young Women story by RW. Details are essentially the same as the version in Sutton (1988:27-28), and not transcribed here.

RW: Dwells again on panel B, refers to country of Gothachalkenin/Landis/Eundatumweakin clan and the danger place where one cannot dig for turkey eggs. The sores swell up like measles if you do this. Place is next door to northern Yunkaportas' country.

RW: [Tells a Crocodile story about the places called Poeykelinhth [107] and Punhth-ngem [161/2527]. Not relevant to the painting so not translated here.]

AN: Later I'll do some other paintings like this, with stories.

RW: [Tells 'Dreamtime' story about the place Iincheng [88] and the catching of many Catfish (Minh Ka'ey species). Not directly relevant to the painting so not translated here.]

RW: [Tells another story re Crippled Man near Uuk-Miipeng [91], Merrekeng [92]. Not relevant to the painting so not translated here.]

END TAPE

# NOMENCLATURE AND DISTRIBUTION OF SOME AUSTRALASIAN ANTS OF THE MYRMICINAE (HYMENOPTERA: FORMICIDAE)

ROBERT W. TAYLOR

Taylor, Robert W. 1991 08 01: The nomenclature and distribution of some Australasian ants of the Myrmicinae (Hymenoptera: Formicidae). *Memoirs of the Queensland Museum* 30(3): 599-614. Brisbane. ISSN 0079-8835.

Some Australian, New Caledonian, New Guinean, eastern Melanesian and SE Asian species of Myrmecinae are reviewed. A neotype is established for *Calyptomyrmex schraderi* Forel. New synonymies (senior names listed first) include: *Calyptomyrmex beccarii* Emery = *C. schraderi*, *Cardiocondyla nuda* Mayr = *C. nuda atalanta* Forel, *Dilobocondyla cataulacoidea* (Stütz) = *D. cataulacoidea concolor* Viehmeyer, *Epopostruma quadrispinosa* Forel = *E. quadrispinosa ferruginea* Forel, *Oligomyrmex corniger* Forel = *O. corniger parvicornis* Forel and *Pheidologeton affinis* (Jerdon) = *P. affinis australis* Forel = *P. australis mjobergi* Forel. *Dilobocondyla cataulacoidea fulva* Viehmeyer (Singapore) and *Oligomyrmex corniger sodalis* Emery are raised to species. *Calyptomyrmex beccarii* (= *C. schraderi*), *Dilobocondyla cataulacoidea*, *Oligomyrmex atomus* Emery, *Oligomyrmex crassiusculus* Emery, with 2 others unidentified to species in *Oligomyrmex*, *Rhopalomastix rothneyi* Forel and *Vollenhovia oblonga* Fr. Smith, with 3 others unidentified to species in *Vollenhovia*, are listed for the first time from Australia, *Calyptomyrmex beccarii* from Timor, and *Cataulacus setosus* Fr. Smith, *Rhopotromyrmex wroughtonii* Forel from New Guinea, *Dilobocondyla*, *Rhopalomastix* and *Vollenhovia* from Australia, *Cataulacus* from mainland New Guinea, and *Calyptomyrmex* from Timor and New Caledonia.

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This paper reviews the status of specific names available for Australian, New Caledonian, and some New Guinean and SE Asian ants of the Myrmecinae. Some species names are synonymised and most previous subspecies are either raised to species or shown to be junior synonyms. A neotype is established for *Calyptomyrmex schraderi* Forel, which is considered a junior synonym of *C. beccarii* Emery. Range extensions are cited for several genera

Type-compared voucher specimens of most relevant species are deposited in the Australian National Insect Collection (ANIC). Several species are now represented there by paratypes or syntypes, some of which were generously donated for this project by the Muséum d'Histoire Naturelle, Geneva, or the Naturhistorisches Museum, Basel, Switzerland.

The genera discussed here may be discriminated using my key to the Myrmecinae (Hölldobler and Wilson, 1990:56-58).

In several cases undescribed species, or species doubtfully known to have been formally named, are provided with ANIC Ant Species Voucher Numbers, which take the form 'Genus

sp.no.N (ANIC)'. These are an interim measure because our ability to expedite the formal naming of taxa cannot keep up with the need to refer to them in scientific discussion. The philosophy is discussed by Taylor (1983:115-117).

Distributions are mostly given using 1° coordinates (Taylor, 1987)(e.g. 12/143 = 12°S, 143°E). All latitudes are south, unless noted. Publication details for species are given in the references cited, in Taylor and Brown (1985), or in Taylor (1987) and are not repeated here. Various collectors are indicated as follows: AC = A. Calder, JEF = J.E. Feehan, PJMG = P.J.M. Greenslade, BBL = B.B. Lowery, GBM = G.B. Monteith, PMR = P.M. Room, RWT = R.W. Taylor, GIT = G.I. Thompson, PSW = P.S. Ward, TAW = T.A. Weir. NP = National Park, SF = State Forest; Australian States and Territories are abbreviated.

Abbreviations for institutions, with the names of cooperating curators, whose help is greatly appreciated, are: ANIC, Australian National Insect Collection, CSIRO, Canberra; BMNH, Natural History Museum, London, U.K. (Barry Bolton); MCSN, Museo Civico di Storia

Naturale 'Giacomo Doria', Genoa, Italy (Dr R. Poggi, Dr V. Raineri); MCZC, Museum of Comparative Zoology, Cambridge, Mass., USA; MHNG, Muséum d'Histoire Naturelle, Geneva, Switzerland (Dr C. Besuchet); NHRS, Swedish Museum of Natural History, Stockholm, (Dr P. Persson); MVMA, Museum of Victoria, Melbourne (Mr K. Walker); NHMB, Naturhistorisches Museum, Basel, Switzerland (Dr M. Brancucci); NHMW, Naturhistorisches Museum, Vienna, Austria (Dr M. Fischer); OXUM, University Museum, Oxford, U.K. (Dr C. O'Toole); QMBA, Queensland Museum, Brisbane (Drs E.C. Dahms and G.B. Monteith); and ZMHB, Museum für Naturkunde, Humboldt-Universität, Berlin, Germany (Dr F. Koch).

## SYSTEMATICS

### *Calyptomyrmex* Emery, 1887

At least 8 Australian species are represented in the ANIC. The only available Australia-based name is *C. schraderi* Forel, 1901. The Moluccan and Melanesian *C. beccarii* Emery is recorded from Australia and *schraderi* is designated its junior synonym. *C. beccarii* is undoubtedly indigenous to Australia, and the other 7 species probably endemic. *C. beccarii* is recorded from Timor. The ANIC has specimens of an undescribed species from New Caledonian.

The large proportion of unnamed Australian species is not surprising, considering that Baroni Urbani (1975) raised the number of Oriental/SE Asian species from 2 to 6. Bolton (1981) described 7 sub-Saharan African species additional to the 9 previously named.

#### DISTRIBUTION

From the tip of Cape York Peninsula along the east coast and Great Dividing Range to near Mackay.

### *Calyptomyrmex beccarii* Emery, 1887

*Calyptomyrmex beccarii* Emery, 1887, Amboina (Ambon (03/128), Indonesia).

*Calyptomyrmex schraderi* Forel, 1901:50.

The first record from New Guinea was by Emery (1897). The queen was described from New Guinea by Szabó (1910). *Weberidris* Donisthorpe (Maffin Bay (02/138), West Irian) is a junior synonym of *Calyptomyrmex*, and its type species, *W. rufobrunnea* Donisthorpe, 1948, a synonym of *C. beccarii* (Brown, 1951).

This is the only species of the genus in available

collections from northern Melanesia. Specimens in the ANIC are from: Papua New Guinea: Yawsora near Wewak (03/143), Lae (06/147), Lejo and Popondetta (08/148) (PMR, RWT, T.E. Woodward).

Workers from northern Cape York Peninsula provide the first Australian records: Lockerbie (10/142) (6–10 vi 1969, GBM); Iron Range (12°42'S, 143°08'E) (nest in rotting log, rain forest, 9–15 vi 1971, RWT & JEF).

*C. beccarii* was recently taken for the first time on Timor (ANIC) by Donat Agosti: East Timor: Salele, 23 km W of Suai. Suai Kab. (40m, secondary forest on limestone over fossil coral reef, Winkler bag sample, sifted leaf mould, August, 1990).

Specimens in the ANIC from Sarawak and the Philippines which are similar to *C. beccarii*, might indicate that *beccarii* is widespread in the Indo-Australian area, but could be referable to *C. glabrata* Viehmeyer, 1916, which was originally described from Singapore as *C. beccarii* var *glabrata*, and raised to species rank by Baroni Urbani (1975). I have not further investigated *glabrata*, but suspect that it might be a junior synonym of *C. beccarii*.

*C. schraderi* was described with type locality 'Australia' from an alate queen and a male. The types were destroyed in Hamburg during World War II (Prof O. Krauss, pers. comm.). It seems circumstantially likely that they originated from far northern Cape York peninsula, within the known range of *C. beccarii*. The *schraderi* type description applies readily to available *beccarii* queens, and the two taxa are declared synonyms for that reason. A worker from the Iron Range colony listed above is here designated neotype of *C. schraderi* (ANIC7923).

#### OTHER AUSTRALIAN SPECIES

*Calyptomyrmex* sp.no.1 (ANIC): Gap Creek, Mt Cook NP, Mt Webb NP (15/145).

*Calyptomyrmex* sp.no.2 (ANIC): Cape Tribulation, Mt Sorrow, Noah Creek (16/145).

*Calyptomyrmex* sp.no.3 (ANIC): 4 km E of Lake Barrine, Crystal Cascade near Cairns, Kuranda (16/145).

*Calyptomyrmex* sp.no.4 (ANIC): Lake Eacham NP (17/145).

*Calyptomyrmex* sp.no.5 (ANIC): Graham Range, Mulgrave River Rd (17/145).

*Calyptomyrmex* sp.no.6 (ANIC): 2 km W of Paluma, 5 km W of Paluma (18/146); Bluewater Range, Finch Hatton Gorge (21/148).

*Calyptomyrmex* sp.no.7 (ANIC): Cannon Vale (20/148).

These ants are small, cryptic in colour and behaviour, and seldom collected. All specimens are from rain forest, and all are workers, except the sole alate queen of sp.no.4. (which, despite caste differences, is considered specifically dis-

tinct from other series). Most are from Berlese funnel samples of leaf mould.

### *Cardiocondyla* Emery, 1869

The widespread tramps *C. nuda* (Mayr) and *C. wroughtonii* (Forel) have been recorded from mainland Australia (Taylor, 1987). *C. nuda nereis* Wheeler, originally described from Norfolk Island (29/168), was synonymised under *C. emeryi* Forel by Bolton (1982), constituting the first report of that vagrant species from Australian territory. *C. nuda atalanta* Forel, 1915: 75, (Kimberley district (17/127), WA, 2 syntypes, MHNG) is considered here to be a junior synonym of *C. nuda*. I have not examined types of *C. nuda*. My concept of that species follows Wilson and Taylor (1967), after due consideration of ANIC specimens from Australia, Melanesia, and Polynesia. This synonymy is proposed with reservation, since *C. nuda*, as presently conceived (e.g., by Wilson and Taylor, 1967) seems to comprise a complex of several species. Resolution of nomenclature and synonymy is beyond the scope of this study.

Several apparently Melanesia-based species from Arnhem Land, NT, or northern Cape York Peninsula (ANIC) are under investigation.

*Cardiocondyla* is not known from New Caledonia, despite extensive collecting there.

### *Cataulacus* Fr. Smith, 1853

#### *Cataulacus setosus* Fr. Smith, 1860

*Cataulacus setosus* Fr. Smith, 1860:114, pl.1, fig.7, worker; type locality: Batchian (Batjan, 00/127), Indonesia.

*Cataulacus* is arboreal, palaeotropical and represented in the Afrotropical, Malagasy and Oriental regions. It was reviewed by Bolton (1974). The most easterly records were of *C. setosus* from Mindanao, Philippines, Batjan in the Moluccas and Waigeo Island (00S/130) west of the Vogelkop, New Guinea (Bolton, 1974). *C. setosus* is here recorded further east on New Guinea at Lumi (02°38'S, 142°02'E), Torricelli Mountains: 400–500m, strays on rain forest vegetation (4–13 Aug. 1984, R.J. Kohout) (ANIC, QMBC).

### *Dilobocondyla* Santschi, 1910

#### *Dilobocondyla cataulacoidea* (Stitz, 1911) (Figs 1–4)

*Podomyrma* (*Mesomyrma*) *cataulacoidea* Stitz, 1911:

364, figs 10–12, worker; type locality: Kaiser-Wilhelmsland, New Guinea.

*Dilobocondyla cataulacoidea* (sic!) var. *concolor* Vieh Meyer, 1914:40, worker; type locality: Sattelberg (near Finschhafen, 06/147), PNG.

I compared the holotype worker of *D. cataulacoidea concolor* with 2 syntype workers (one headless) of *D. cataulacoidea* (ZMHB). Differences between these nominal taxa are consistent with Vieh Meyer's diagnosis of *concolor*, and possibly indicate that the latter is a good sibling species. I think this unlikely, however, and consider these specimens conspecific. Gastral sculpture of the *cataulacoidea* types is distinct from that of the *concolor* holotype and from other ANIC specimens of *D. cataulacoidea*. All specimens have an anterior band of fine, somewhat irregular longitudinal striation on the first gastral tergite. In the *cataulacoidea* types remaining surfaces of the sclerite are finely shagreened and opaque, while in other specimens these areas are smooth and highly reflective (Fig. 4). Intensity of the anterior gastral striation varies somewhat, but the striae are relatively less well developed in the *cataulacoidea* types, and especially weak near the mid-line. Such differences would not support separate specific status in the related *Podomyrma*. If two species are found to be represented here, all specimens I have seen, except the *cataulacoidea* types, would be referable to *D. concolor*.

Melanesian material in the ANIC is from Papua New Guinea: Lae (06/147), Bulolo (07/146), Kokoda (08/147), Popondetta and Girua (both 08/148); (BBL, PMR, RWT).

*Dilobocondyla* is recorded here for the first time from Australia. Specimens have been collected in northern areas of Cape York Peninsula, as follows: Lockerbie Scrub (10/142) (a single worker, 19–22 iv 1977, GBM) (Figs 1–4); 9km NE of Mt Tozer, 12°43'S, 143°17'E (4 workers collected by pyrethrum fogging of vines, rain forest edge, 5–10 July 1986, TAW & AC). (ANIC and QMBA).

*Dilobocondyla fulva* Vieh Meyer, 1916 based on a worker from Singapore (4 syntypes examined, 2 workers, 2 queens (1 alate); all NHMB) is a separate species, abundantly distinct from *D. cataulacoidea*. A type-compared voucher from Singapore is in the ANIC. *Dilobocondyla* is not known from New Caledonia.

### *Epopostruma* Forel, 1895

*Epopostruma* is endemic to Australia. *E. frosti* (W.L. Brown, 1948) with type locality, 'N. (= Neu) Mecklenburg', SA, comes from present-

day Gomersal (34/138), renamed from the German during World War I.

### *Epopostruma monstrosa* Viehmeyer, 1925

The holotype (Trial Bay (30/153), NSW (ZM HB)) is damaged and incomplete (postpetiolic, detached gaster and several legs mounted on a rectangular card), with a red 'Type' label, another (autograph) reading '*Epopostruma monstrosa* Viehm', and no locality labels. W.L. Brown (1952) considered it to be a *Mesostruma*, but unrecognisable to species. Review of *Epopostruma* specimens in the ANIC shows, however, that the type can be matched sufficiently by intact specimens to justify use of its name. Compared to other species the postpetiole has distinctive shape, lateral armament and sculpture, and the base of the first gastral tergite is smooth and shining with unusual, nearly effaced traces of incised vermiculate microsculpture. Type-compared vouchers are from NSW: 8km SW of Jamberoo (34/150) (7 Oct 1976, PSW), and other material from NSW: near Mt Nullum (28/153), and Vic.: Werribee Gorge (37/144), Queens-town, near Hurstbridge (37/145) (all leg. BBL).

### *Epopostruma quadrispinosa* Forel, 1895

*Epopostruma quadrispinosa* Forel, 1895: 422.

*Epopostruma quadrispinosa ferruginea* Forel, 1910: 51.

The worker holotype of *E. quadrispinosa* (Mackay (21/149), (MHNG)) matches a voucher from Myall Lakes (32/152), NSW (19 6 1977, C. Lentfer), except that the microsculpture separating the foveate punctures of the frons, mesosomal dorsum and nodes is slightly less distinctly incised. The conspecificity of these specimens seems assured. Two workers and a dealate queen from a nest at Kanangra Walls NP (34/150), NSW (2 12 1977, BBL) are identified as *E. quadrispinosa*. The workers have foveae of the mesosomal dorsum densely packed, so that the centre of the promesonotal section lacks a median afoveate strip, though one is present in the other specimens discussed above. Also, their postpetioles are more transverse, and the petiole of each has a pair of minute, but distinct, acute dorsolateral denticles. The latter are presumably homologous with slight, obtuse angles in the same positions on the holotype and Myall Lakes specimens. The Kanangra Walls queen, is considered conspecific with the holotype queen of *E. quadrispinosa ferruginea* (Type locality NSW (MHNG)), securing the above synonymy.

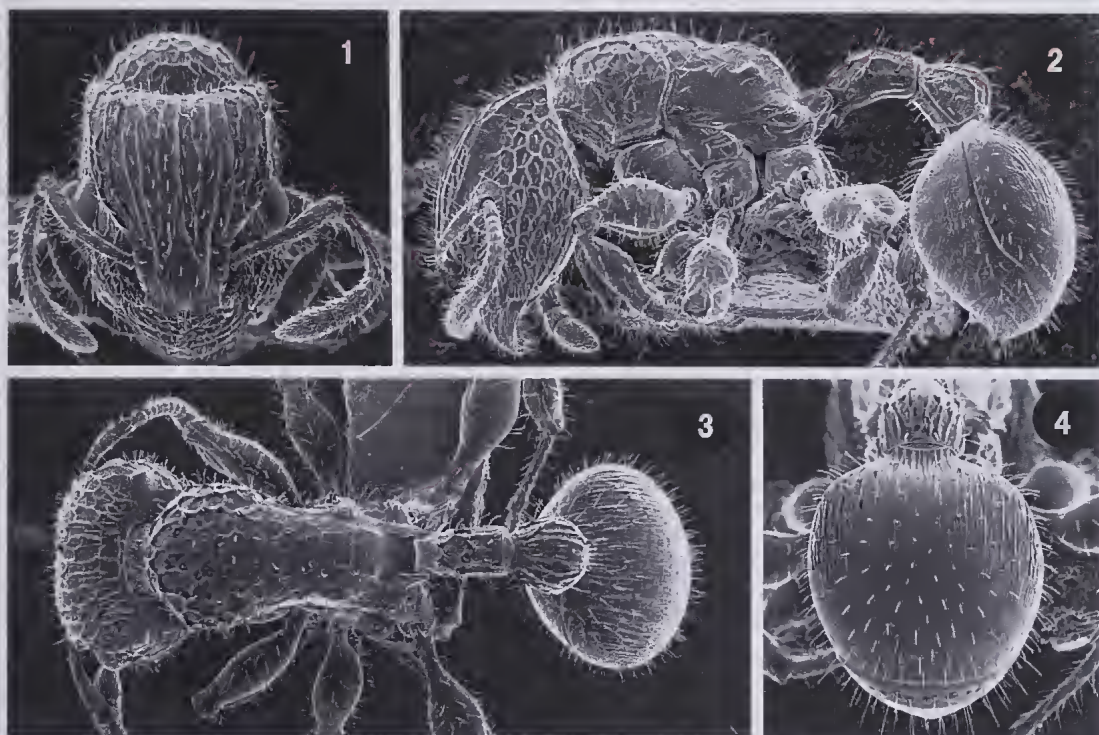
### Mayriella Forel 1902

The type, *M. abstinens* Forel, 1902, was described from Mackay (21/149). Subsequently named Australian taxa are *M. overbecki* Viehmeyer, 1925 (Trial Bay (30/153), NSW), which was considered a junior synonym of *M. abstinens* by Wheeler (1935); *M. spinosior* Wheeler, 1935 (Cairns District (16/145), Qld); and *abstinens* subspecies *hackeri* Wheeler, 1935 (Brisbane; 27/153) and *venustula* Wheeler, 1935 (Mt. Tamborine; 27/153). Records of *M. abstinens* include Arthurs Seat (38/144), Vic (Wilson, 1957), and SA (Greenslade, 1979). *M. abstinens* is an established introduced species at Auckland, NZ (Taylor, 1961).

I consider Australian *Mayriella* intractable at species level, and cannot understand Wheeler's (1935) classification using his types, MCZC specimens, and extensive ANIC material. Wheeler's species are not clearly discriminated, and the descriptions, figures and key are inadequate. The genus could include anything from a single variable species to 3 or more sibling species. I suspect the former, but hesitate to synonymise available names under *abstinens*, because ANIC holdings display so much (generally between-sample) variation in size, propodeal spination and intensity of sculpture and colour, and because some series include winged or dealate queens, while others have specimens which could be ergatoid queens. The aggregate name *M. (abstinens)* may be used for Australian specimens. For ease of indexing *M. hackeri* and *M. venustula* should be species, rather than subspecies. These procedures partly follow Article 6 of the ICZN (3rd edn, 1985).

*M. (abstinens)* is represented in the ANIC and QMBA collections from Qld: 14 km W by N of Hope Vale Mission (15/144); Gap Creek, Mt Cook NP, Mt Webb NP, Shiptons Flat (15/145); Alexandra Bay, Black Mountain Rd, Kuranda, Mt Lewis, Thornton Range (16/145); 1.6 km SW of Yungaburra, Gadgarra, Lake Eacham NP, McNamee Creek, Mt Haig, Mt Nomico, Pingin Hill near Innisfail, Tully Falls NP (17/145); 40 mile Scrub (18/144); Gayundah Creek and Missionary Bay on Hinchinbrook Island (18/146); Seaforth (20/148); Eungella, Eungella NP (21/148); Kroombit Tops (24/151); Cooloola (26/153); Bald Knob, Imbil, Kenilworth, Traveston (26/152); Burpengary, Camp Mt, Mt Mee SF, Somers Dam, Boombana NP, Goodna, Miala NP, Mt Coot-tha, Mt Nebo, Reedy Creek (27/152); Brisbane, Joalah NP, Tamborine Mountain (27/153); Cunninghams Gap (28/152); Lamington NP near Binna Burra Lodge (28/153); from NSW: 15 km E of Legume, 20 km N of Urbenville (28/152); 15 km E of Lismore, Blue Knob Mountain, Mt Warning, Murwillumbah, Tomewin (28/153);





FIGS 1–4 *Dилоbocondyla cataulacoidea* Stitz, worker (Lockerbie Scrub (10/142), Qld); standard views. Head width (across eyes) 1.03 mm; gastral width 0.99 mm; Weber's length of mesosoma 1.29 mm.

Dorrigo NP, Macksville, Tuckers Knob (30/152); Bruxner Park (30/153); Oxley Highway 72 km W of Wauchope (31/151); Eccleston (32/151); 10 mi S of Mangrove Mountain, Burns Bay, Jerusalem Bay, Lane Cove, Ourimba SF, Riverview College, St Ives (33/151); Foxground, Gerroa, Kanangra Boyd NP, Minnamurra Falls, Mt Keira, Mt Saddleback (34/150); Tallaganda SF (35/149); Clyde River at Castle Flat, Pigeon House Range (35/150); from the ACT: Brindabella Ranges at Blundells Creek Rd, Lees Spring, Mt Gingera, Oororal Valley, Picadilly Circus (35/148); Black Mountain, Mt Majura, Yarralumla (35/149); from Vic.: Mt Buffalo (36/146); Queenstown, Warburton (37/145); Mt Oberon (39/146); from SA: Christensen Park, Sevenhill (33/138); South Para (34/138); West Bay Kangaroo Island (35/136); Belair, Bridgewater, Englebrook, Maclaren Flat (35/138). The high elevations of records from the ACT and Victorian alps imply that *M. (abstiniens)* might be expected to occur in Tasmania.

Most northern samples are labelled 'rainforest', sometimes with qualification (e.g. 'swampy', 'relict', 'gallery'). Others, especially from more southern localities, are from 'medium sclerophyll', 'wet sclerophyll', or subalpine woodland or forest. Nest series are from soil between stones, or under covering fallen wood or stones.

The only species from outside Australia is *M.*

*transfuga* Baroni Urbani (1977), from western Bhutan. The ANIC has specimens provisionally assigned to this species, from Singapore: Nee Soon; West Malaysia: Penang; Ulu Gombak; Upper Gombak Valley; Western Sarawak: Kampong Segu; Semengoh; Sabah: Sepilok; Umas Umas. Most were collected from rainforest berlesates. *Mayriella* is not known from New Caledonia.

#### Mesostruma W.L. Brown, 1948

*Mesostruma* is endemic to Australia being known in Qld, NSW, Vic. and SA (Taylor, 1973). Four species are now listed from WA.

New ANIC records of *Mesostruma* are:

*M. browni* Taylor (previous records in Taylor, 1962, 1973) Qld: Cania Gorge NP (24/150) (rain forest, 10 Oct. 1984, I.D. Naumann); Mt Coot-tha (27/152) (ex leaf litter, 11–20 iii 1971, GBM); Curtis Farm, Canungra (28/153) (stick brushings, rain forest, 31 Mar. 1979, GBM). NSW: Kiwarrak SF, Taree (31/152) (iv 1975, T. Kingston); 37 km WSW of Coramba (30/153) (28 vi 76, W. Allen); Dharug NP (33/151) (10 9 76, BBL).

*M. eccentrica* Taylor (previous records in Taylor, 1973): SA: Kangaroo Island (35/136); 5 mi S Rocky

River (Sept 1972, PJMG); Ravine des Casoars (11 1 73, PJMG). WA (unless otherwise attributed all were collected at honey baits set at night on tree trunks by BBL on various August dates in 1983, 1984 and 1986): Eneabba (29/115) (including sites 14–34km E of the town), mallee and dry sclerophyll; 10km S of New Norcia (30/116), dry sclerophyll; Pithara (30/116) (dry sclerophyll, on *Eucalyptus* trunk, early morning, 21 Sept. 1988, B.E. Heterick; BEH collection); Wongan Hills (30/116), dry sclerophyll; Moore River (160 km S of Eneabba) at highway 1 (31/116), tall gums; Westdale (32/116) (dry sclerophyll, in litter at base of *Eucalyptus* tree, 1987, M. Jacobs; BEH collection); Narrogin (32/117), mallee, dry sclerophyll; Hopetoun (33/120), mallee.

*M. exolympica* Taylor (previous records in Taylor, 1973): SA: Alligator Gorge (32/138) (5 6 74, PJMG); Mt Remarkable (32/138) (29 4 73, PJMG); The Bluff (33/139) (20 7 73, PJMG); South Para (34/138) (1975–77, B. Hutson); Belair (35/138) (1973, PJMG); Belair NP (35/138) (dry sclerophyll, 8 10 72, BBL); Bridgewater (35/138) (1975–77, B. Hutson); Englebrook (35/138) (20 10 73, C.A. Kirkby).

*M. laevigata* W.L. Brown (previous records in Taylor, 1972): SA: Penong (31/133) (on mallee, early morning, 4 viii 1984, BBL); 1km W of Poochera (32/134) (nocturnal strays, mallee, 12 July 1990, B. Heterick); Mt Remarkable (32/138) (24 4 73, PJMG); 10 km E of Melrose (32/138) (5 6 74, PJMG); 5km E of Blyth (33/138) (limestone ridge, mallee, 8 June 1983, BBL). WA (all leg. BBL, collected at honey baits on tree trunks, at night): Narrogin (32/117), dry sclerophyll; Balladonia (32/123), dry sclerophyll.

*Mesostruma* sp.no.1 (ANIC). 2 damaged specimens from WA: Geraldton (28/114) (22 5 1963, C. Mercovich). They have apparently teratological mesosomal anomalies; additional specimens are needed to describe this species.

*Mesostruma* sp.no.2 (ANIC). This species seems close to *M. turneri* (Forel). Records are: SA: Monarto South (35/139) (Mallee, 23 7 69, C.A. Kirkby); Black Oak Creek, Koonamore (32/139) (litter, 25 7 72, PJMG). WA: 23 km ESE of Cocklebidy (32/126) (nocturnal stray, tree heath, 25 x 1977, RWT).

*Mesostruma* sp.no.3 (ANIC). Close to *M. browni*, but with a more deeply emarginate occipital border, less obtuse occipital angles, and with the propodeal lamellae less extensive. NSW: Braidwood/Captains Flat Rd junction E of Queanbeyan (35/149) (dry sclerophyll woodland, 8 vi 71, S. Misco). ACT: Black Mountain (35/149) (dry sclerophyll woodland, 19 9 33, T. Greaves). Vic.: Emmett Vale, near Wanganella (55/144) (salt bush, 5 v 73, D. Briese).

These records cover all *Mesostruma* specimens I have seen, except the unique types of *M. loweryi* Taylor (Willaston (34/138), SA), and *M. turneri* (Forel) (Mackay (21/149), Qld).

### *Metapone* Forel, 1911

Australian representation of *Metapone* ex-

ceeds published records. Four species have been described (Wheeler, 1919; Taylor, 1987). Eleven putative Australian species are represented in the ANIC or QMBA:

*Metapone leae* Wheeler, 1919:183: Qld: Tamborine Mountain (27/153) syntype queens.

*Metapone tillyardi* Wheeler, 1919:187: NSW: Dorrigo (30/152) syntype workers.

*Metapone tricolor* McAreevey, 1949:4: NSW: Nyn-gan (31/147) holotype queen.

*Metapone* sp.no.1 (ANIC): Qld: near Lake Barrine (17/145) workers (RWT & JEF).

*Metapone* sp.no.2 (ANIC): Qld: near Kuranda, (16/145) (RWT & JEF) workers.

*Metapone* sp.no.3 (ANIC): Qld: Kuranda (16/145) (F.P. Dodd) queen; near Mossman (16/145) (GBM & GIT) queens; McNamee Creek (17/145) (RWT & JEF) workers, queen.

*Metapone* sp.no.4 (ANIC): Qld: near Mossman (16/145) (GBM & GIT) queen.

*Metapone* sp.no.5 (ANIC): Qld: near Mossman (16/145) (GBM & GIT) queen.

*Metapone* sp.no.6 (ANIC): NSW: Lane Cove (33/151), Sydney (BBL) queen, males.

*Metapone* sp.no.7 (ANIC): NSW: Brooklana (30/152) (A.M. Lea) queen; Sunshine Bay, near Batehaven (35/150) (J.A.L. Watson and RWT) workers.

*Metapone* sp.no.8 (ANIC): Tas.: Flinders Island (40/147–148), Bass Strait (J. Calaby) workers.

Despite caste differences between series, the above putative species are considered distinct. The *mjobergi* diagnosis applies to species 1 and 2, and one might be *mjobergi*. Known Australian species could therefore number 10 or 11. Alate queens of species 3, 4 and 5 are sympatric (pit-fall traps) along Mossman Bluff Track, 5–10 km W of Mossman (360 and 480m, 1–16 Jan 1989). Most Qld and northern NSW samples are from rain forest, the colonies from rotting logs, and usually associated with termites. Other samples are from areas where rainforest is scarce or absent. The Sunshine Bay series of sp.7 was taken with termites from a rotting section of the trunk of a standing willow (*Salix*) tree at a seaside caravan park. Two species of termites (*Kaloter-mes*, and *Glyptotermes*, J.A.L. Watson, pers. comm.) were also present. The queen of sp.6 was collected indoors, apparently attracted to light at St Ignatius College, and presumably originating from a nest in the surrounding gardens or local relict rain forest patches. The Lane Cove males were collected nocturnally at light near relict rain forest on the Sydney Harbour foreshore, only a few kms from the heart of the city. *Metapone* has not been previously recorded from Tasmania.

Species 3 has a peculiar proboscis-like, extended clypeus which also occurs in a smaller

*Metapone* species collected from a termite-mined rotting log in rain forest (now clear-felled), in the Gogol Valley, near Madang (05/145), PNG (20–23 6 1972, RWT).

Eleven *Metapone* species from the rest of the world are: two each from Madagascar and Sri Lanka, and one each from Taiwan, Truck Island (Micronesia), Luzon, Mindanao, Sarawak, Sumatra and New Guinea (Gregg, 1958). ANIC contains undescribed species from New Guinea, New Ireland, New Britain, and San Cristoval, Solomon Islands. *Metapone* is not known from New Caledonia.

**Myrmecina Curtis, 1829**

The species diversity of *Myrmecina* is not resolved. However, the genus is far more widespread and diverse than implied by the single previous record from Mackay (21/149), the type locality of the sole named continental species, *M. rugosa* Forel, 1902.

The minimum generic distribution of *Myrmecina* in Australia, based on ANIC and QMBA collections, includes the following grid cells:

NT: 11/136, 15/136. Qld: 12/143, 13/143, 15/145, 16/145, 17/145, 17/146, 18/145, 18/146, 19/146, 20/148, 21/148, 21/149, 22/150, 23/150, 24/151, 26/151, 26/152, 27/152, 28/152, 28/153. NSW: 27/152, 28/152, 28/153, 29/152, 30/149, 30/152, 30/153, 31/151, 32/151, 33/145, 33/151, 34/150, 35/150. ACT: 35/148, 35/149.

Marginal localities are Rimbija Island, and Batten Point near Borrooloola, NT; Iron Range, N Qld; Hinchinbrook Island, Qld; Hillston, NSW; Black Mountain, ACT and Clyde Mt, NSW. Habitats indicated on labels range from rain forest to dry sclerophyll woodland. High elevation records include summits of Mts Bartle Frere (1622m) and Bellenden Ker (1561m) (both 17/145), the highest in Qld; Isaksson Ridge, at 1050m, in Wiangaree SF (28/153), N NSW, where specimens were taken in *Nothofagus moorei* forest; and Bulls Head, ACT (35/149), probably at over 1500m elevation in alpine woodland. *Myrmecina* probably occurs also at least in southern coastal NSW and eastern Vic. The sole specimen from Hillston (30/149), NSW, I suspect to be mislabelled.

I have briefly reviewed available mounted ANIC material, and estimate at least 8 species, including several mixed lots taken in sympatric association. *M. rugosa* seems to be represented only by its syntypes. *Myrmecina* is not known from New Caledonia.

Some species appear to be significantly variable - if not there must be a rich *Myrmecina* fauna in eastern Australia. The possibility that northern species might be outliers of the diverse New Guinea fauna has not been investigated.

**Oligomyrmex Mayr, 1867**

Five Australian species (Taylor and Brown, (1985; Taylor, 1987) are reduced here to 3 by the synonymy of *O. corniger parvicornis* with *O. corniger*, and transfer of *O. (Octella)pachycerus* to *Solenopsis*. *O. mjobergi* Forel and *O. norfolkensis* Donisthorpe are probably good species close to *O. corniger*, and *O. corniger sodalis* (New Caledonia) is raised to species rank.

Four Melanesia-based species are recorded from northern Australia: *O. atomus* Emery; a related sibling *Oligomyrmex* sp.no.1 (ANIC); *O. crassiusculus* (Emery); and *Oligomyrmex* sp.no.2 (ANIC).

The key identifies more distinctive Australian species, but not those of the intractable 'corniger group' (*corniger*, *mjobergi*, *norfolkensis* and *sodalis*). Other undescribed Australian *corniger*-group species are in the ANIC, where *Oligomyrmex* is represented from the following grid cells:

NT: 11/133, 12/132, 14/132; Qld: 10/142, 12/143, 13/143, 16/145, 17/145, 17/146, 18/146, 19/146, 19/147, 21/148, 21/149, 22/147, 24/151, 25/153, 26/151, 26/152, 27/152, 27/153, 28/152; NSW: 28/153, 29/152, 30/152, 30/153, 31/151, 32/151, 33/149, 33/150, 33/151, 34/150, 34/151, 35/149, 35/149, 35/150, 36/149, 37/149; Vic.: 38/145; SA: 32/137, 33/138, 34/138, 34/139, 36/139; WA: 32/116.

Because of their small size most ANIC specimens recline in spirit, in tubes sorted to genus, or in generically indexed, serially numbered vials of mixed ants, including many extracted from bulk berlesatcs. Few series are presently represented by mounted material suitable for critical examination or sorting to species. All of this material has been reviewed in establishing the generic distribution just summarised.

**Key to some Australian species (workers)**

- 1. Antennae 9- segmented. . . . . 2.
  - Antennae 11- segmented. . . . . 4.
- 2. Front of head in minor and major workers with coarse, opaque, granular sculpturation, lacking smooth, shining areas. . . . . 3
  - Frons of minor and major workers either smooth and shining, or with extensive smooth areas between fine striae. . . . . species of the *O. corniger* group
- 3. Promesonotum of minor workers entirely sculptured, without smooth, shining areas. . . . . *Oligomyrmex atomus* Emery

Median disc of promesonotum in minor workers extensively smooth and shining. . . . . *Oligomyrmex* sp.no.1 (ANIC)

4. Major workers lacking fronto-occipital horns. . . . . *Oligomyrmex crassiusculus* (Emery)

Major workers with distinct fronto-occipital horns. . . . . *Oligomyrmex* sp.no.2 (ANIC)

### *Oligomyrmex atomus* Emery, 1900

*Oligomyrmex atomus* Emery, 1900: 328, pl. 8, fig. 30, worker, soldier from New Guinea: Hansemann Mts, Tamara I., Beliao I.

*Oligomyrmex atomus* has been used (Mann, 1919; Wilson, 1962; Wilson and Taylor, 1967; Taylor, 1976) for 2 similar species ranging from New Guinea to Samoa. Wilson and Taylor (1967) stated that workers from Fiji and Samoa could be distinguished from New Guinean and Solomon Islands' specimens 'by the following 2 worker characters: promesonotum and mesonotum smoother and more shining in Fiji-Samoan samples; occipital horns of major shorter (c. 0.04 mm long as opposed to 0.05 mm in New Guinea and Solomons specimens)'. They thought this difference perhaps borderline to specific distinctiveness but preferred to consider 'all the populations conspecific'. That conclusion must now be revised.

Two minute *Oligomyrmex* morphotypes satisfying the *atomus* diagnosis are present in ANIC and QMBA from the Claudie River rainforest tract at Iron Range (12/143). They represent the two forms specified by Wilson and Taylor. Being separately deployed in colonies, and intimately sympatric, they must be regarded as distinct species. The majors are virtually indistinguishable, but the minor workers are easily identified by differences in mesosomal sculpture. The more heavily sculptured species is provisionally identified as *O. atomus*, despite difficulties with putative type material of that name (see below), and the other designated *Oligomyrmex* sp.no.1 (ANIC).

I have examined several putative types of *O. atomus* (MCSN) as follows: (1) A major worker, bearing the following labels: (a) 'Hansemann', followed by an illegible word (autograph), (b) 'TYPUS' printed in red on a white tag with a thin red frame, (c) '*Oligomyrmex atomus* Emery' (autograph on a white label); (2) 2 pins labelled 'N. Guinea, Biró' (autograph), without other labels - thus lacking indication of type status. The first of these has 8 minor workers glued in pairs on 4 small rectan-

gular card mounts. They all meet the prescription specified above for *O. atomus*. The second pin has 3 pairs of similarly mounted minor workers. Five of them are sp.no.1 (ANIC), and the other *O. atomus*.

Three original localities were listed by Emery when he described *O. atomus* (see heading above); there are no clear indications regarding the specification of types, or whether a holotype was established; and the relevant specimens are unlikely to be adjacent in the MCSN, where ant collections from separate sources are not fully integrated, and Emery's personal collection is kept separate from that of the museum. Also, some original material, perhaps including a specified *atomus* holotype, was probably returned by Emery to its source, the Hungarian Natural History Museum in Budapest. Confident nomenclature of the 2 species recognised here will require the integration and direct study of the various MCSN holdings, the recognition and assembly of all relevant type or original specimens, wherever they are housed, and, if there is no holotype, the declaration of an *O. atomus* lectotype. These tasks are beyond the present project and application of *atomus* is arbitrary, though probably sustainable when the nomenclature is resolved.

Australian specimens identified here as *O. atomus* are from Qld: Iron Range (12°42'S, 143°08'E) (ex rotting log, rain forest, 9-15 vi 1971, RWT & JEF).

Those identified as *Oligomyrmex* sp.no.1 (ANIC) are from NT: Radon Creek near Mt Brockman (12/132) (berlesate, sieved litter, 14 July 1979, GBM); Qld: Bamaga (10/142) (rain forest leaf mould berlesate, 20 v 1953, E.N. Marks); Iron Range (12°42'S, 143°08'E) (several series, ex rotting logs, rain forest, 9-15 vi 1971, RWT & JEF).

ANIC specimens from New Guinea include both species. Both are represented also in ANIC holdings from the Solomon Islands of Guadalcanal and Kolombangara (collected and donated by PJMG); *O. atomus* alone from Ysabel and San Cristoval; and *O. sp.1* from Malaita, Nggela, Rendova and Vella Lavella. Each mounted Solomons sample, incidentally, includes only one of the 2 species. The absence of records of both species from some of the Solomon Islands is probably due to deficiencies in available collections, but this might not be the case for the many series from Rennell and Bellona Islands which I reviewed in 1976. They contain only *O. atomus*. This, with the fact that *Oligomyrmex* sp.1 is known alone from Samoa, supports the hypothesis that these ants represent good species and not mere conspecific morphs.

**Oligomyrmex corniger** Forel, 1902*Oligomyrmex corniger* Forel, 1902: 449*Oligomyrmex corniger parvicornis* Forel, 1915: 70. syn.nov.

*O. corniger* is represented in the MHNG by syntype specimens from various localities. Three major workers pointed on 1 pin, and 3 minors on another, are labelled 'Mackay, Qld, Turner, 14'; a damaged alate queen is from 'Sydney (Froggatt) 76'; and 2 males on one pin have 'Austr. (Froggatt) 112'. All carry red 'Typus' labels, and white data labels hand-written by Forel, each of which includes the species name. The word 'type' appears also on the worker data-labels. The original localities cited by Forel were Mackay (21/149), Qld, Southport (27/153), Qld, and Sydney (33/151), NSW.

*O. corniger parvicornis* syntypes in the MHNG include (1) 3 major workers on a single pin labelled '122, Herberton, Qld, Mjöberg, Janr. 1913'; (2) two pins from 'Cedar Creek (present-day Ravenshoe), Qld, April 1913 (Mjöberg)', one with 3 minor workers, the other with 2 alate queens; (3) a single male with printed labels 'Malanda; Qld, Mjöberg'. All the preceding have red 'Typus' labels. The ANIC has 2 major workers on 1 pin labelled 'Herberton, Qld (Mjöberg)', with a yellow 'Cotypus' tag (ex MHNG). Herberton, Malanda and Ravenshoe are within a radius of about 15 km in the Evelyn Tableland area of North Qld (17/145). I consider the worker specimens of all these series to be conspecific. To avoid possible future nomenclatural problems a major worker from the Mackay series (MHNG) is designated lectotype of *O. corniger*, and one from 'Cedar Creek' lectotype of *O. corniger parvicornis*. The ANIC *parvicornis* paralectotypes provide Australian paradigms.

**Oligomyrmex sodalis** Emery, 1914*Oligomyrmex corniger sodalis* Emery 1914: 412; type locality New Caledonia.

The ANIC has 3 major and 3 minor worker syntypes mounted on a single pin. They are similar to Australian *O. corniger*, but the majors have the middle section of the mesosomal dorsum substantially more inflated.

**Oligomyrmex crassiusculus** (Emery, 1900)*Pheidologeton (Aneleus) similis* Mayr var *crassiuscula* Emery, 1900: 328, worker; type locality: New

Guinea: Friedrich-Wilhelmshafen (present day Madang) (05/145).

*Aneleus (Aneleus) similis* Mayr var *crassiuscula* Emery, 1922: 214.*Oligomyrmex crassiusculus*, Ettershank, 1966: 123.

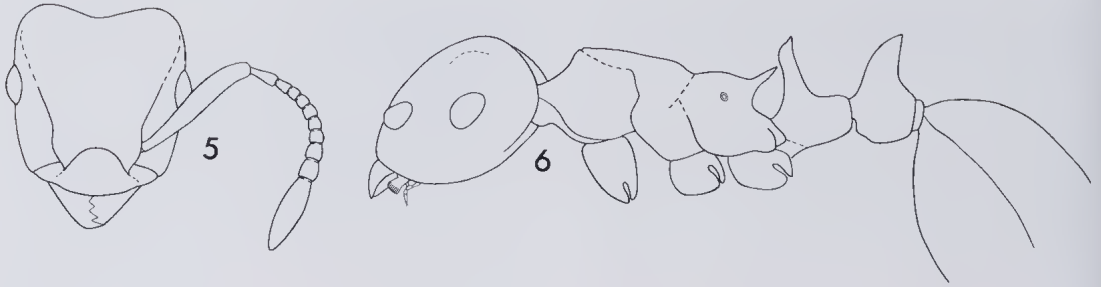
During its period of taxonomic use *Aneleus* Emery, 1900, accommodated various Papuan species of *Oligomyrmex* habitus but with 11-segmented antennae. They are now assigned to *Oligomyrmex*, following Ettershank (1966), and are indicated in his check-list of its species (Ettershank, 1966: 123). *O. crassiusculus* is further distinguished by the absence of fronto-occipital horns in the major workers. This loss seems to have arisen independently in several lineages of *Oligomyrmex*, and is known as well in otherwise unexceptional species with 8-segmented antennae. *O. crassiusculus* is the only known hornless Australian species. The probability that *crassiusculus* is a junior synonym of *O. similis* Mayr, which was its original nominotypical subspecies, has not been investigated because I have been unable to locate type material of *similis*.

I examined 2 syntype minor workers of *O. crassiusculus* (MCSN), carded separately on 1 pin, with the following labels: (a) N. Guinea Biró, (b) *Aneleus similis* Mayr var *crassiuscula* Emery (both labels hand written), and (c) the printed word 'typus' on red card. Two ANIC major workers and a minor, mounted on a single pin, from Qld: Iron Range (12°42'S, 143°08'E) (rain forest, 9–15 vi 1971, RWT & JEF) match the types, and provide type-compared ANIC vouchers. They are from one of several samples which constitute the only known Australian records of *O. crassiusculus*.

*Pheidologeton (Aneleus) minimus* of Emery (1900) represents another Melanesian *Oligomyrmex* with 11-segmented antennae, which is not known from Australia (syntypes MCSN: a minor and a major worker separately carded on 1 pin; labels: (a) N. Guinea Biró (autograph), (b) typus (in red on white card with thin red border), (c) *Pheidologeton minimus* Emery (autograph).

**Oligomyrmex sp.no.2**

I cannot assign to any Melanesian or SE Asian species a further '*Aneleus*' which is known from several series (ANIC) from rotting wood at Iron Range (12°42'S, 143°08'E) (rain forest, 9–15 vi 1971, RWT & JEF). This taxon seems close to *O. armatus* Donisthorpe.



Figs 5,6 *Peronomyrmex* sp., worker (Clohesey River (16/145), Qld), standard views; dimensions unknown.

***Peronomyrmex* Viehmeier, 1922**  
(Figs 5, 6)

*Peronomyrmex* is represented in collections only by the holotype (ANIC) of *P. overbecki* Viehmeier (1922: 213; Trial Bay (30/153), NSW) (Taylor, 1970). It was collected by Hans Overbeck while interned during World War I (Musgrave, 1932). Close to *Podomyrma* Fr. Smith, it might be expected to nest in hollow twigs, or in beetle or other galleries in larger standing timber. Host plant specificity is possible, based upon observations on *Podomyrma*, and nocturnal foraging activity is likely.

Six workers of an apparent second species of *Peronomyrmex* (cf. Figs 5,6 with figs 1–3 of Taylor, 1970) were collected on the Clohesey River (16/145) 'nr Mareeba NQ', on 14 June 1937 by T.G. Greaves. The specimens have been lost, probably while with J.J. McAreavey in the late 1950s or 60s. In 1957 McAreavey loaned some to W.L. Brown jr at the MCZC, who arranged the preparation of illustrations which were later reproduced in an unpublished typescript 'Codex' of the Australian ant fauna by McAreavey, a copy of which is in the ANIC formicid section archives. The specimens were returned to McAreavey (W.L. Brown pers. comm.). Two of the 3 original drawings, the relevant Greaves notebook, and copies of the Brown/McAreavey correspondence are in the ANIC formicid archives. Greaves notebook entry reads '1338/NQ; Genus? Six workers from log in *Casuarina* forest above rain forest'.

Although not backed by voucher specimens this record is significant.

***Pheidologeton* Mayr, 1862**  
***Pheidologeton affinis* (Jerdon), 1851**

*Oecodoma affinis* Jerdon, 1851:110; type locality: India.

*Pheidologeton affinis australis* Forel, 1915, p.68, worker, queen; type locality: Cedar Creek (present-day Ravenshoe) (17/145), Qld.

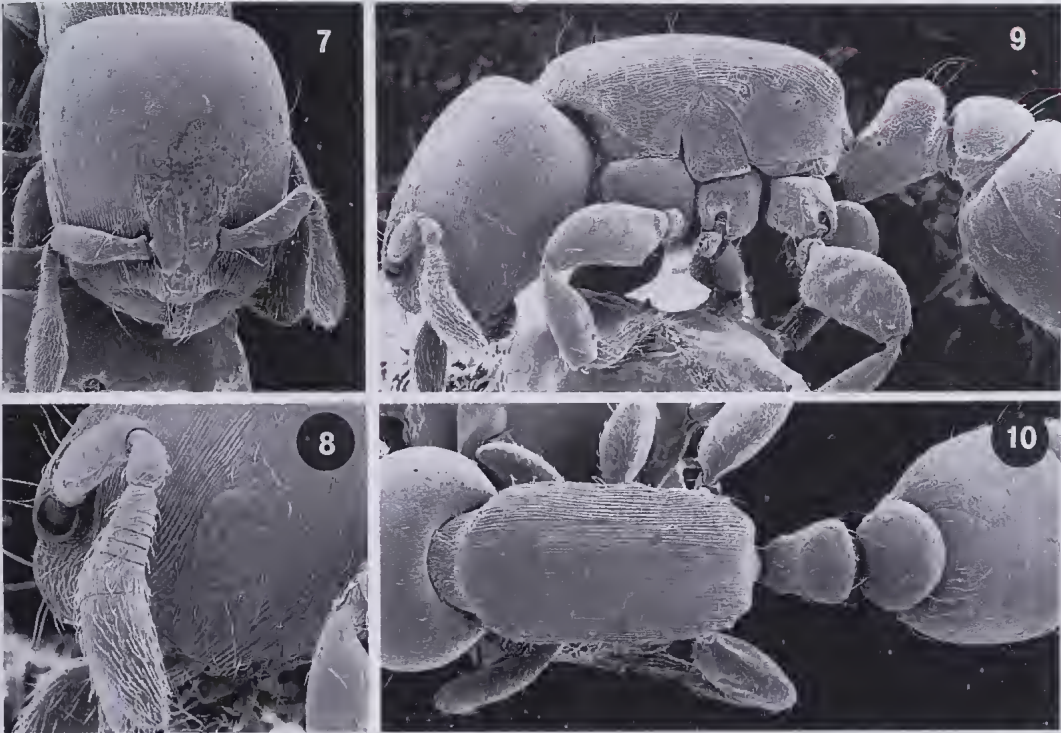
*Pheidologeton australis mjobergi* Forel, 1918, p.723, queen; type locality: Atherton (17/145), Qld.

New Guinean and Australian *Pheidologeton* I have seen seem to be conspecific. They match Indian, Bornean and Philippines specimens (ANIC) of *P. affinis* (Jerdon). Recognition of the two Australian subspecies synonymised above cannot be justified. The relevant type localities are about 35km apart in the Atherton/Evelyn Tableland, N Qld, and the types are conspecific. I have never taken this species on the Atherton Tableland, and suspect that it is not present there, limited perhaps by the relatively cold winter climate. The Atherton type locality, at least, is probably not precisely attributed.

ANIC and QMBA have material from NT: Darwin at Holmes Jungle (12/130); Baroalba Gorge, Sawcut Gorge (12/132). Torres Strait Islands: Darnley I (09/143); Maer I (09/144); Moa (= Banks) I (10/142). Qld: Lockerbie, Lockerbie Scrub (10/142); Iron Range (12/143); McIlwraith Range (13/143); 3 km NE of Mount Webb, Gap Creek, Mt Finnigan at Moses Creek, Mt Webb NP, Rounded Hill, Shiptons Flat (15/145); Black Mountain Rd, Cairns, Cape Tribulation, Cooper Creek, Kuranda, Mossman Gorge, Pirate Beach, Thornton Range (16/145); Crawford's Lookout, Gordonvale, Koombooloomba, Mareeba, The Boulders Park, Tully, Upper Mulgrave River (17/145); Clump Point, Seymour Range (17/146); Mt Cudmore Range (18/146).

Papua New Guinean samples (ANIC) of *P. affinis* are from at or near the following localities: Mussau I: Talumalas (01/149), New Britain: Komgi (04/151); Yalom (04/152). Mainland Papua New Guinea: Finisterre Range at Gusap River valley (05/146); Tapini (08/146); Kokoda, Tagao Rd (08/147); Girua, Popondetta, Sangara (08/148); Rubulogo Creek 15 mi N of Port Moresby (09/147); Managalase area (09/148); *Pheidologeton* is not known from New Caledonia.

Numbers of minor and major workers of the



FIGS 7-10 *Rhopalomastix rothneyi* Forel, worker (Spear Creek (16/145), Qld); standard views, and detail of antenna and eye (Fig 7). Maximum head width 0.45 mm; eye length 0.08 mm; Weber's length of mesosoma 0.59 mm

larger, Asian species *P. diversus* (Jerdon) were recently intercepted in quarantine at Darwin Airport, NT (in straw packing around cement statue from Indonesia, 1 April 1990, I. Hazelgrove). This species is not known in Australia.

**Rhopalomastix** Forel, 1900  
**Rhopalomastix rothneyi** Forel, 1900  
 (Figs 7-10)

This Asia-based species was first reported from Australia without detailed locality records (Taylor and D.R. Brown, 1985). They are: Qld: Spear Creek (16°42'S, 145°23'E) near Mount Molloy (c.600m, complex sclerophyll vine forest, 3-10 Nov 1975, V.E. Davies and R. Raven); Graham Range (17°17'S, 145°57'E) (20m, rain forest, berlesate, stick brushing, 9 April 1979, GBM); 14 km. WSW of Yeppoon (23°11'S, 150°37'E) (males collected at light, open *Eucalyptus* forest, PSW, 8 1 89). Samples are in QMBA and ANIC.

*R. rothneyi* is the senior of several available SE Asian names listed in Chapman and Capco, (1951). The others are not convincingly distinct. Their status has not been further reviewed in

assigning the name *R. rothneyi* to Australian samples. The genus is not known from New Guinea or New Caledonia.

**Rhoptromyrmex** Mayr, 1901

The two known Australian *Rhoptromyrmex* species, *R. melleus* (Emery, 1897) and *R. wroughtonii* Forel, 1902, have been adequately characterised, illustrated and keyed by Brown (1964) and Bolton (1986), and aspects of their biology discussed.

Keys to Australian species,  
 after Brown (1964) and Bolton (1986).

(Workers)

Propodeal spines long, about twice as long as the distance separating the centres of their bases; their length approximating the width of the pronotum. Head and mesosomal dorsum mainly finely and densely reticulate-punctate; longitudinal costulae few or weak.  
 ..... *Rhoptromyrmex melleus* (Emery)

Propodeal spines much shorter; less than twice as long as the distance separating their

bases; clearly shorter than the width of the pronotum. Head, and usually the mesosomal dorsum, with fine, close longitudinal sculpturing prominent.

.....*Rhoptromyrmex wroughtonii* Forel

(Queens)

Ventral process of petiole a low, keel-like convexity.... *Rhoptromyrmex melleus* (Emery)

Ventral process of petiole a massively extended flange..... *Rhoptromyrmex wroughtonii* Forel

(Males)

Dorsum and sides of head entirely with evenly distributed fine, dense sculpturing.  
..... *Rhoptromyrmex melleus* (Emery)

Dorsum and sides of head with extensive smooth, shining areas.....  
.....*Rhoptromyrmex wroughtonii* Forel

***Rhoptromyrmex melleus* (Emery, 1897)**

*R. melleus* ranges from Sulawesi through New Guinea to northern Cape York Peninsula, where it has been reported only from rain forest at Tozer Gap, Iron Range (12/143) (Brown, 1964). More recent records (ANIC, QMBA) are from Qld: West Claudie River (12/143) (rain forest, 3–10 Dec. 1985, GBM & D. Cook); 14 km W by N of Hopevale Mission (15/144) (a single male, rain forest litter berlesate, 7–10 May 1981, AC & JEF).

Melanesian records additional to those of Brown (1964) are from at or near the following centres: New Britain: Yalom (04/152); Valoka. Mainland Papua New Guinea: Baiyer River Sanctuary, Mingende (05/144); Goroka (06/145); Bupu River near Lae (06/147); Bulolo, McAdam Park near Wau (07/146); Kokoda (08/147); Popondetta, Sangara (08/148); Hombrom Bluff (09/147). Elevations specified on labels range from 2m to 5,200ft.

*R. melleus* is one of a substantial number of tropical Papuan ant species (including *Calypatomyrmex beccarii* and the 4 *Vollenhovia* species, discussed below) known in Australia only from the Mid Cape York Peninsula rainforests at Iron Range and/or the Mellwraith Ranges (13/143), and occasionally also from the Tip-of-Peninsula forests (10/142) at Lockerbie and/or Bamaga (which are relatively poorly collected, probably explaining the lack of comparable records). *Dilobocondyla cataulacoidea* is one of the latter group.

***Rhoptromyrmex wroughtonii* Forel, 1902**

This species is more widespread in Asia than *R. melleus*, ranging from southern India to Yunnan and western Szechuan, Hainan, Taiwan, Malay Peninsula, Indonesia, the Philippines,

New Guinea and Cape York Peninsula. It was recorded in Australia by Brown (1964) only from Qld: Crawford's Lookout, west of Innisfail (17/145). At that time there were no Melanesian records.

*R. wroughtonii* is recorded for the first time from New Guinea. Relevant ANIC and QMBA records are: Papua New Guinea: Mingende (05/144) (5,000ft, common in grassland, 11 1 68, BBL); Goroka (06/145) (5,200ft, common in lawns, 10 1 68, BBL); Bulolo (07/146) (2,400ft, edge of pine plantation, 28 12 70, BBL). Qld: Mt Finnigan (15/145), 37 km S of Cooktown, 1050m, berlesate, litter and moss, 21 April 1962, GBM, D. Yeates and D. Cook); 1.5 km NW of Cape Tribulation (16/145) (near sea level, rain forest berlesate, sieved litter, 2 Oct. 1962, GBM, D. Yeates and GIT); Cape Tribulation (16/145) (40m, rain forest berlesate, sieved litter, 13 Oct. 1980, GBM); (berlesate, 21–28 Mar 1984, AC & TEW); Mossman Gorge (16/145) (several series including males and alate queens taken at light, 200ft, 27–29 x 1966, RWT); Noah Head (16/145) (40m, rain forest berlesate, sieved litter, 16 Oct. 1980, GBM).

This species is one of a group of Papuan ant species in Australia, whose ranges in eastern Qld extend to the Base-of-Peninsula rain forests of the Cooktown/Townsville tract (and sometimes beyond, to about Mackay (21/149) or Rockhampton (23/150), or occasionally further south). *Pheidologeton affinis*, discussed above, is another example.

Some of these species (including *P. affinis*, and probably *R. wroughtonii*) occur across northern Australia in appropriate habitats, including the network of gallery rain forest which follows the streams of Cape York Peninsula, the Top End of the Northern Territory, and the Kimberleys. Some of them are encountered in such habitats not far west of the Atherton and Evelyn Tablelands, which constitute an altitudinal (300m) gap in their distribution. Examples are *Leptogenys diminuta* Fr. Smith (Taylor, 1988), and the Green Weaver Ant, *Oecophylla smaragdina* (Fabricius) (Lokkers, 1986).

The most southern known locality for *R. wroughtonii* is Crawford's Lookout (17°37'S, 145°48'E), at about 320m. The ant fauna of the surrounding rain forest contains a number of Papuan elements which are found there at approximately their highest local elevations of record, and are apparently absent at higher altitudes only a few km to the west. The same is true of the ant fauna at similar elevations further north along the Black Mountain Road, near Kuranda (16/145), northwest of Cairns. The ant faunas of these sites differ from those of well-known higher altitude Atherton Tableland rain



forests, such as the National Parks at Lake Eacham and Lake Barrine (both at c. 640m), which have poorer ant faunas, generally lacking Papuan species.

**Solenopsis** Westwood, 1841  
**Solenopsis pachycera** (Forel, 1915)

*Oligomyrmex (Octella) pachycerus* Forel, 1915: 69

*O. pachycerus* was erected as type of monotypic *O. (Octella)*, on the grounds that the holotype had 8-segmented antennae. Examination of the type (Ravenshoe (= Cedar Creek) (17/145), Qld (NHRS)) shows it to be the worker of a small *Solenopsis* species. The specimen has its right antenna 9-segmented (confirmed with SEM), and the left antenna 10-segmented, as is usual in *Solenopsis* (confirmed by light compound microscopy of the detached, funiculus). It is otherwise not unusual, but I cannot match it in ANIC. Most other small *Solenopsis* species from north Qld rainforests have a small supernumerary tooth on each side of the anterior clypeal border, adjacent to the ipsilateral tooth of the median pair, and a small erect tooth under the petiolar peduncle. Neither of these features is present in the *S. pachycera* type. Additionally it has somewhat larger propodeal spiracles than specimens of other similarly-sized local *Solenopsis* species, and almost totally lacks the propodeal sculpture seen in some of them. This is the only named eastern Australian *Solenopsis* with a type locality north of Vic.

**Vollenhovia** Mayr, 1868

*Vollenhovia* ranges from the Seychelles, Sri Lanka and Burma through E and SE Asia to Taiwan, Korea, Japan, the Philippines and Melanesia (including the Solomon Islands, Fiji, Vanuatu (New Hebrides) and New Caledonia), eastwards to Western Samoa. The Papuan *V. oblonga* Fr. Smith occurs in NE coastal Qld (Taylor and Brown, 1985). '*Vollenhovia turneri*' Forel (1910) (Kuranda (16/145), Qld) was transferred to *Chelaner* by Ettershank (1966), and thence to *Monomorium* by Bolton (1987).

Of c. 60 available names in *Vollenhovia*, 13 have New Guinean types (Ettershank, 1966; Wilson & Taylor, 1967). Museum holdings in Australia suggest several undescribed species in New Guinea and in eastern Melanesia. Emery (1921) distinguished a number of infraspecific taxa and infrasubspecific entities among 21 species. This could imply substantial synonymy among available names. Some species are

widespread, and sometimes infraspecifically variable (*V. oblonga* and *Vollenhovia* sp. no. 1 (ANIC) below). *Vollenhovia* needs comprehensive taxonomic attention because its affinities are unclear, and few of its species can be identified with confidence.

**Vollenhovia oblonga** (Fr. Smith, 1860)

*Myrmica oblonga* Fr. Smith, 1860: 107.

*Vollenhovia oblonga* Fr. Smith; Emery, 1897: 560.

Emery (1921) recognised *oblonga* as a widespread polytypic species, which he listed from the Seychelles, Burma, Malacca, Sumatra, Borneo, Mentawai, Sinabang, Batjan, Luzon, New Guinea and New Caledonia. It was reported from Vanuatu by Wilson & Taylor (1967). Emery (1921) distinguished 7 subspecies and 3 infrasubspecies. Most myrmecologists reject subspecies and, assuming that Emery was correct in recognising these forms as conspecific, the relevant names would now be considered synonyms. That is my usage here, though I choose not to formalise the implied synonymies. In Emery's system *V. oblonga pedestris* (Fr. Smith) (type locality: Tondano (01N/125), Sulawesi (= Celebes), Indonesia) was used for material from New Guinea, adjacent islands and New Caledonia.

Australian records of *V. oblonga* (ANIC, QMBA) are all from the rain forest tract surrounding the West Claudie River at Iron Range (12/143) as follows: 11km ENE of Mt Tozer, in dry beetle-excavated log (11–16 July 1986, TAW & AC); Iron Range (12°42'S, 143°08'E), several series from nests in rotting logs, or smaller decaying wood on the ground (9–15 vi 1971, RWT & JEF); Lamond Hill (vi 76, Davies and Raven); West Claudie River, pyrethrum knockdown (3–10 Dec. 1985, GBM & D. Cook).

ANIC New Guinea holdings are from Vanimo (02/141), Pes near Aitape (03/142), Gogol Valley near Madang (05/145), Lae (06/147), Wau (07/146), Kokoda (08/147); collectors: BBL, RWT.

Mann (1919) reported *V. oblonga* (as *V. pedestris*) to be 'one of the commonest ants in the Solomons', with records from San Cristoval, Santa Cruz, Malaita and Ysabel Islands. It was listed from Rennell Island by Wilson (1962) and Taylor (1976). The ANIC has much Solomon Islands material (mostly collected and donated by PJMG). The apparently endemic Samoan *V. pacifica* was considered to be 'a peripheral cognate of *oblonga*' (Wilson and Taylor, 1967).

Other Australian *Vollenhovia* species

Three other *Vollenhovia* species are repre-

sented in the ANIC and QMBA from the Iron Range area (12/143). All, like *V. oblonga*, appear to represent Asian and/or New Guinean taxa, rather than the products of radiation in Australia. If so they share the biogeographical history of many of the better-known ant species recorded from rainforest at Iron Range (Taylor, 1972). Appropriate Asian or Melanesian species names, are not at present determinable. These taxa have therefore been assigned ANIC species numbers. They came from the tract of rain forest discussed above under *V. oblonga*. All known Australian *Vollenhovia* species are intimately sympatric. Their diversity contributes to the New Guinean facies of the Iron Range rainforest ant fauna.

The Iron Range and other mid-Cape York Peninsula rainforests, while relatively depauperate in ant species compared to those of Asia and lowland New Guinea (even though very diverse and morphologically varied by Australian standards), are much more closely related myrmecologically to the lowland rain forests of New Guinea than to those of the more southern base-of-Peninsula forests of the Cooktown/Townsville tract (though a few of the Iron Range species are found in low altitude rain forest between Cooktown and Townsville, or even further south - see comments above under *Rhoptromyrmex*). Very few ant species in Australia-based groups are found in rain forest at Iron Range, but they are prominent in the base-of-Peninsula forests at all elevations. Entomologically and otherwise the mid-Peninsula rain forests (and doubtless also the myrmecologically less-well-known tip-of-peninsula rain forest tracts) may be represented as biogeographic enclaves of New Guinea contained within continental Australia (Taylor, 1972). They are, in effect, Melanesian rainforests vicariantly isolated by Torres Strait and Australian savanna. These rainforests are thus of extreme environmental importance, justifying conservation.

The relevant records are:

*Vollenhovia* sp.no.1 (ANIC). Iron Range, 2 series from nests in rotting logs (9-15 vi 1971, RWT & JEF).  
*Vollenhovia* sp.no.2 (ANIC). 3km ENE of Mt Tozer, berlesate, flood debris (1-4 July 1986, TAW); 9km ENE of Mt Tozer, berlesate, litter (5-10 July 1986, TAW); 11km ENE of Mt Tozer, in dry beetle-excavated log (11-16 July 1986, TAW & AC); Claudie River, berlesate, leaf mould (20-24 vii 1978, RWT & J.F. Lawrence); Iron Range, several series from nests or foraging in rotting logs, or smaller decaying wood on the ground (9-15 vi 1971, RWT & JEF); West

Claudie River, pyrethrum knockdown (3-10 (variously cited on labels) Dec. 1985, GBM & D. Cook ).

*Vollenhovia* sp.no.3 (ANIC). 3km ENE of Mt Tozer, berlesate, flood debris (1-4 July 1986, TAW); alate queen, flight intercept trap (28 June - 16 July 1986, TAW); 11km ENE of Mt Tozer, berlesate, litter (11-16 July 1986, TAW).

These species are recognisable among Melanesian and Asian specimens in the ANIC: sp.no.1: (1) Papua New Guinea: Hayfield near Maprik (03/143) c.150m; 35 km W of Mt Hagen (05/144) c.2500m; Bulolo (07/146) c.730m; Wau (07/146) c.1,200 and 1,500m; collectors: G. Baker, BBL. RWT. (2) Various specimens collected and donated by PJMG from the following Solomon Islands: Choiseul, Guadalcanal, Malaita, Nggela, and Reef I (Santa Cruz Is). Specimens of the unidentified species listed from Rennell I by Taylor (1976) are identified here as *Vollenhovia* sp.no.1. (3) Samples from Philippines collections gathered by BBL during August and September, 1978, as follows: Philippines: Luzon: Mt Makiling; Mindanao: near Malaybalay. Most non-Australian specimens have the median, longitudinally striate sections of the head and promesonotum (see key below) generally less distinctly specified than in Australian material.

sp.no.2: Papua New Guinea: Bulolo (07/146) 1060m (29 xii 1967, BBL), 1220m (xii 1970, BBL); Kokoda Rd, Oivi Creek (08/147) c.150m (8 I 1971, BBL); Solomon Islands: San Cristoval: Kira Kira; Warahita River (PJMG).

sp.no.3: PNG: Bulolo (07/146), 1220m (xii 1970, BBL); Tapini (08/146) 1000-1200m (August 1962, RWT).

It is difficult to sort New Guinea *Vollenhovia* specimens to putative species without detailed study. Sp.no.2 (ANIC) and sp.no.3 (ANIC) are variable, and widely sympatric on New Guinea, as at Iron Range (only those New Guinea series most closely matching Iron Range samples have been listed above).

Key to the Australian species (workers)

1. Propodeal dorsum mesially smooth and shining, essentially unsculptured. . . . . 2.

Propodeal dorsum entirely opaque and non-reflective, distinctly and densely sculptured. 3.

2. Promesonotal dorsum extensively to largely smooth and shining, especially mesially, with only a few elements of superficial to distinct sculpturing, quite unlike the dense, regular sculpturation of the frons. ....  
 . . . . . *Vollenhovia oblonga* Fr.Smith

Promesonotum evenly opaque, with dense sculpturing closely similar to that of the frons - bilaterally densely punctate, with a narrow, very finely longitudinally striate median strip. . . . *Vollenhovia* sp.no.1 (ANIC)

3. Propodeum armed posterolaterally with small but distinct subacute denticles. Petiolar dorsum longer than wide, posterodorsally shagreened, the sculpturing with a clear transverse trend. .... *Vollenhovia* sp.no.2 (ANIC)

Propodeum lacking posterolateral denticles, though the margins of the declivitous face may be (presumably homologously) bilaterally tumose. Petiolar dorsum approximately as wide as long, its posterodorsal section loosely shagreened, without a transversetrend.....  
 ..... *Vollenhovia* sp.no.3 (ANIC)

The New Caledonian *Vollenhovia* fauna

Emery (1914) recorded *V. oblonga* (as *V. oblonga pedestris*), and *V. denticulata* Emery, 1914 from New Caledonia. *V. denticulata* has been reported from Lasema, Fiji, and Espiritu Santo, Vanuatu (Wilson & Taylor (1967). These records and other secondary citations in *Vollenhovia* need checking in light of the taxonomic complexity in the genus revealed by modern collections. ANIC New Caledonian specimens placed as *V. denticulata* are variable, and appear likely to include representatives of several sibling species. The same is true of New Caledonian material similar to *V. oblonga*. Ward (1984) also alluded to the possibility of substantial diversity in New Caledonian *Vollenhovia*.

**Vombisidris** Bolton, 1991

Australian species discussed by Taylor (1989) as *Leptothorax australis* Wheeler and *L. renateae* Taylor and the New Guinean *L. bilongrudi* Taylor, were assigned to *Vombisidris* by Bolton, 1991. Bolton described 9 new species, mostly from single specimens collected from rainforest vegetation by insecticide fogging. *Vombisidris* thus comprises 1 species from India, 4 from Borneo, 3 from Sulawesi, and 2 each from New Guinea and Cape York Peninsula. *Leptothorax* is not known from Australia.

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LITERATURE CITED

BARONI-URBANI, C. 1975. Primi reperti del genere *Calyptomymex* Emery nel subcontinente Indiano. *Entomologica Basiliensia* 1: 395-411.  
 1977. Ergebnisse der Bhutan-Expedition 1972 des Naturhistorischen Museums in Basel; Hymenoptera: Fam. Formicidae Genus *Mayriella*. *Entomologica Basiliensia* 2: 411-414.  
 BOLTON, B. 1974. A revision of the palaeotropical arboreal ant genus *Cataulacus* F. Smith (Hymenoptera: Formicidae). *Bull. Br. Mus. nat. Hist. Ento.* 30: 1-105.  
 1981. A revision of six minor genera of Myrmicinae (Hymenoptera: Formicidae) in the Ethiopian zoogeographical region. *Bull. Br. Mus. nat. Hist. Ento.* 43: 245-307.  
 1982. Afrotropical species of the myrmicine ant genera *Cardiocondyla*, *Leptothorax*, *Melissotarsus*, *Messor* and *Cataulacus* (Formicidae). *Bull. Br. Mus. nat. Hist. Ento.* 45: 307-370.  
 1986. A taxonomic and biological review of the tetramoriine ant genus *Rhoptromymex* (Hymenoptera: Formicidae). *Systematic Entomology* 11: 1-17.  
 1987. A review of the *Solenopsis* genus-group and revision of Afrotropical *Monomorium* Mayr. (Hymenoptera: Formicidae). *Bull. Br. Mus. nat. Hist. Ento.* 54: 263-452.  
 1991. New myrmecine ant genera from the Oriental Region (Hymenoptera: Formicidae). *Syst. Entomol.* 16: 1-13.  
 BROWN, W.L. jr. 1951. New synonymy of a few genera and species of ants. *Bull. Brooklyn Ento. Soc.* 46: 101-106.  
 1952. The dacetine ant genus *Mesostruma* Brown. *Trans. R. Soc. S. Aust.* 75: 9-13.  
 1964. Genus *Rhoptromymex*, revision of, and key to species (Insecta: Hymenoptera: Formicidae). *Pilot Register of Zoology Cards* 11, 13, 14.  
 CHAPMAN, J.W. AND CAPCO, S.R. 1951. Check list of the ants (Hymenoptera: Formicidae) of Asia. *Mon. Inst. Sci. Tech., Manila* 1: 1-327.  
 EMERY, C. 1897. Viaggio do Lamberto Loria nella Papuasias orientales XVII. Formiche raccolte nelle Nuova Guinea dal Dott. Lamberto Loria. *Annali del Museo Civico di Storia Naturale Giacomo Doria* 18: 546-594.  
 1900. Formicidarum species novae vel minus cognitae in collectione Musaei Nationalis Hungarici, quas in Nova-Guinea, Colonia Germanica, collegit L. Biró, Publicato Secunda. *Természetrázi Füzetek* 23: 310-338.  
 1914. Les Fourmis de la Nouvelle-Calédonie et des

- les Loyalty. in Sarasin, F. and J. Roux Nova Caledonia, Zoologie 1: 393-437.
1921. Hymenoptera Fam. Formicidae Subfam. Myrmicinae in Wytman, P. (ed.) Genera Insectorum fasc. 174A pp 1-94.
1922. Hymenoptera Fam. Formicidae Subfam. Myrmicinae in Wytman, P. (ed.) Genera Insectorum fasc. 174C: 207-397.
- ETTERS HANK, G. 1966. A generic revision of the world Myrmicinae related to *Solenopsis* and *Pheidologeton* (Hymenoptera: Formicidae). Aust. J. Zool. 14: 73-171.
- FOREL, A. 1910. Formicides australiens reçus de MM. Froggatt et Rowland Turner. Revue Suisse de Zoologie 18: 1-94.
1915. Results of Dr. E. Mjöberg's Swedish Scientific Expeditions to Australia 1910-13. 2. Ameisen. Arkiv för Zoologi. 9(16): 1-119
1918. Etudes myrmécologiques en 1917. Bull. Soc. Vaudoise des Sci. Nat. (5) 51: 717-727.
- GREGG, R.E. 1958. Two new species of *Metapone* from Madagascar (Hymenoptera: Formicidae). Proc. Ento. Soc. Wash. 60: 111-121.
- GREENSLADE, P.J.M. 1979. A guide to ants of South Australia. South Australian Museum, Adelaide 44 pp.
- HÖLLDOBLER, B AND WILSON, E.O. 1990. The Ants. (Belknap: Cambridge, Mass). 732p.
- LOKKERS, C. 1986 The distribution of the weaver ant, *Oecophylla smaragdina*, in northern Australia (Hymenoptera: Formicidae). Aust. J. Zool. 34: 683-687.
- MANN, W.M. 1919. The ants of the British Solomon Islands. Bull. Mus. Comp. Zool. 43: 273-391.
- MUSGRAVE, A. 1932. Bibliography of Australian entomology 1775-1930 with biographical notes on authors and collectors. (Royal Zoological Society of NSW: Sydney). 380p.
- SZABÓ, J. 1910. Formicides nouveaux ou peu connus des collections du Musée National Hongrois. Ann. hist.-nat. Musei nat. Hungarici 8: 364-369.
- TAYLOR, R.W. 1961. Notes and new records of exotic ants introduced into New Zealand. NZ Entomologist 2: 28-37.
1962. New Australian dacetine ants of the genera *Mesostruma* Brown and *Codiomyrmex* Wheeler (Hymenoptera: Formicidae). Breviora 152:1-10.
1970. Characterization of the Australian endemic ant genus *Peronomyrmex* Viehmeyer (Hymenoptera: Formicidae). J. Aust. Entomol. Soc. 9: 209-211.
1972. Biogeography of insects of New Guinea and Cape York Peninsula. 213-230. In D. Walker (ed.) 'Bridge and barrier: the natural and cultural history of Torres Strait'. (Research School of Pacific Studies, ANU: Canberra)
1973. Ants of the Australian genus *Mesostruma* Brown (Hymenoptera: Formicidae). J. Aust. Entomol. Soc. 12: 24-38.
1976. The ants of Rennell and Bellona Islands. Natural History of Rennell Island, British Solomon Islands 7: 73-90.
1983. Descriptive taxonomy: past, present and future. 93-134. In E. Highley and R.W. Taylor (eds) 'Australian systematic entomology: a bicentenary perspective'. (CSIRO, Division of Entomology: Canberra).
1987. A checklist of the ants of Australia, New Caledonia, and New Zealand. CSIRO Div. Entomol. Rept 41: 1-92.
1988. The nomenclature and distribution of some Australian and New Caledonian ants of the genus *Leptogenys* Roger (= *Prionogenys* Emery, N. Syn.) (Hymenoptera: Formicidae: Ponerinae). General and Applied Entomology 20: 33-37.
1989. Australian ants of the genus *Leptothorax* Mayr (Hymenoptera: Formicidae: Myrmecinae). Mem. Qd Mus. 27: 605-610.
- TAYLOR, R.W. AND BROWN, D.R. 1985. Hymenoptera: Formicoidea. 1-149, 306-348. In Zoological Catalogue of Australia, Volume 2. Australian (Govt Publ. Service: Canberra).
- VIEHMEYER, H. 1922. Neue Ameisen. Arch. für Naturgesch. 88A: 203-220.
- WARD, P.S. (1984). A revision of the ant genus *Rhytidoponera* (Hymenoptera: Formicidae) in New Caledonia. Aust. J. Zool. 32: 131-175.
- WHEELER, W.M. 1919. The ants of the genus *Metapone* Forel. Annals Ento. Soc. Amer. 12: 173-191.
1935. The Australian ant genus *Mayriella* Forel. Psyche 42: 151-160.
- WILSON, E.O. 1957. The *tenuis* and *selenophora* groups of the ant genus *Ponera* (Hymenoptera: Formicidae). Bull. Mus. Comp. Zool., Harv. 116: 353-386.
1962. The ants of Rennell and Bellona Islands. Natural History of Rennell Island, British Solomon Islands 4: 13-23.
- WILSON, E.O. AND TAYLOR, R.W. 1967. The Ants of Polynesia. Pac. Insects Mons 14: 1-109.

# A NEW THERAPHOSID SPIDER FROM THE CAMERON HIGHLANDS, MALAYSIA

RICHARD C. WEST

West, R.C. 1991 06 01: A new theraphosid spider from the Cameron Highlands, Malaysia. *Memoirs of the Queensland Museum* 30(3): 615-619. Brisbane. ISSN 0079-8835.

*Lyrognathus liewi* sp. nov. is described from the rainforests of westcentral Malaysia. This is the first record of the genus outside its type locality of Assam, India. □*Theraphosid spider, Malaysia, rainforests.*

Richard C. West, Royal British Columbia Museum, 675 Belleville Street, Victoria, British Columbia, Canada V8V 1X4; 20 August 1990.

Pocock (1895) described *Lyrognathus crotalus*, the type species, from a single female. *L. pugnax* Pocock, 1900 and *L. saltator* Pocock, 1900 from North Khasi Hills and Shillong, respectively are the only other species assigned. Sex was not mentioned for these single specimens. Gravely (1915) examined *L. crotalus*, determined earlier by Hirst, from the Khasi Hills and *L. pugnax* determined by himself, from the Garo Hills and doubted whether they were distinct species. Gravely (1935) considered the three species of *Lyrognathus* synonymous and the genus close to *Selenocosmia* with the exception of the one character of leg IV being incrassate. Gravely (1935) described two males from Khasi Hills as *Selenocosmia pugnax* but assumed they might belong to *Lyrognathus*. Pocock's type material at the British Museum, Natural History is apparently too fragile to loan and examine therefore I offer no opinion on specific synonymies in the genus. I follow Raven (1985) in maintaining *Lyrognathus* and *Selenocosmia* as separate taxa.

Between October 1986 and July 1988, I received eight female *Lyrognathus* from Mr. K.C. Liew, Taiping, Malaysia. This new species of *Lyrognathus* is a new generic record for Malaysia and an extension of range for the genus.

## MATERIALS AND METHODS

Measurements are in millimetres, except ocular measurements are made at the same magnification and each unit is 0.055 mm. Measurements of the diameters of the median eyes are from above, those of the lateral eyes were made from the side. The width of the eyegroup refers to the distance between the two outer eyes but also includes the diameters of these eyes. The ratio of the eyes is expressed in units which are taken from the divisions of the micrometer scale. The

eyes are measured across their greatest width and the distance between the eyes is measured along the shortest distance. The median ocular quadrangle formed by the median eyes is measured to include the eyes and the ratios are obtained in the same way as the ratio of the eyes; AME— anterior median eyes; ALE— anterior lateral eyes; PME— posterior median eyes; PLE— posterior lateral eyes; MOQ— median ocular quadrangle.

Segments of legs are measured dorsally in a straight line from articulation to articulation. Claws are not included in measurements of tarsi. The leg formula expresses relative lengths of the legs from longest to shortest length. Spination patterns are recorded from the specimen according to the following conventions: v—ventral, p—prolateral, d—dorsal and r—retrolateral; spine positions are reported from distal to proximal, unpaired spines are listed as 1, paired or a transverse series of 3 spines are listed as 2 or 3.

Spermathecae were dissected out and the muscle coat removed with fine needles. Illustrations were made with the assistance of a squared eyepiece reticule.

## *Lyrognathus* Pocock, 1895

*Lyrognathus* Pocock, 1895:170,175; Pocock, 1900: 187,202; Simon, 1903:954,956; Gravely, 1915a: 415; Gravely, 1915b:284; Gravely, 1935:83; Roewer, 1942:264; Bonnet, 1957:2675; Brignoli, 1983:132; Raven, 1985:38,118; Platnick, 1989:105..

*Selenocosmia (Lyrognathus)* Gravely, 1935:83.

## TYPE SPECIES

*Lyrognathus crotalus* Pocock, 1895; by monotypy.

## DIAGNOSIS

All tarsi integral with tarsi IV divided by setae and tibia and metatarsus IV strongly incrassate.

Prolateral surface of maxillae with numerous bacilliform lyra setae acting against a line of spike setae (strikers) on the retromargin of the cheliceral furrow.

#### REMARKS

*Lyrognathus* differs from other Selcnocosiinae primarily by the tibia and metatarsi IV being strongly incrassate. With the exception of this character *L. liewi* is similar to female *Coremiocnemis validus* (Pocock, 1895) not only from the same locality but in color, size and possessing the same horizontally aligned peg-like setae on the intercheliceral face.

#### DISTRIBUTION, HABITAT AND BURROW

*L. liewi* is known from the wet dipterocarp and montane rainforests of Cameron Highlands, Pahang, in the main range and from Baling, Kedah, and Grik, Perak, in the eastern range of west Malaysia. Female *L. liewi* make a silk-lined burrow averaging 50–100cm in length and 3cm in diameter enlarging into a small chamber distally. The burrow usually has a leaf-lined or twig debris collar that is flush with the ground on the rainforest floor; sloping ground on open forest fringes or roadsides is preferred. When disturbed *L. liewi* will readily bite. 'Orang Asli' people call these large mygalomorphs 'Teifoo' or Earth tiger and believe the bite is fatal.

#### *Lyrognathus liewi* sp. nov. (Figs 1–11, Table I)

#### ETYMOLOGY

For Mr. K. C. Liew who collected the specimens and supplied the natural history information.

#### MATERIAL

Holotype ♀ and seven paratype ♀♀ Cameron Highlands, Pahang, West Malaysia, 4°41'N; 101°52'E. Holotype ♀ and two paratype ♀♀ QM Nos 15460, 15461 and 15462, respectively; other five paratype ♀♀ in author's collection. Locations 3 ♀♀, off 24th mi. Road, Cameron Highlands, Pahang, Malaysia, Oct.–Nov. 1986, coll. K.C. Liew; 5 ♀♀, off 24th mi. Road, Cameron Highlands, Pahang, Malaysia, July 4–12, 1988, coll. K.C. Liew; 2 ♀♀ (dried) Baling, Kedah, and 1 ♀ (dried) Grik, Perak, Malaysia, Nov. 1980, coll. H. Wong.

#### DIAGNOSIS

Large mygalomorph spider. Female with tibia

and metatarsus IV strongly incrassate, metatarsus IV tapering distally. Retrolateral face of patella, tibia and metatarsus IV with dense brush of hair, tapering distally on metatarsus IV. Females with horizontally aligned short and long peg-like (thorny) setae on intercheliceral face. Spermathecae variable, bilobed on holotype female, both tri- and bilobed on paratype females. Males unknown.

#### DESCRIPTION

Holotype female. Carapace 18.54mm long, 15.40mm wide. Abdomen (slightly collapsed) 20.90mm long, 14.03mm wide. Total length 39.44mm.

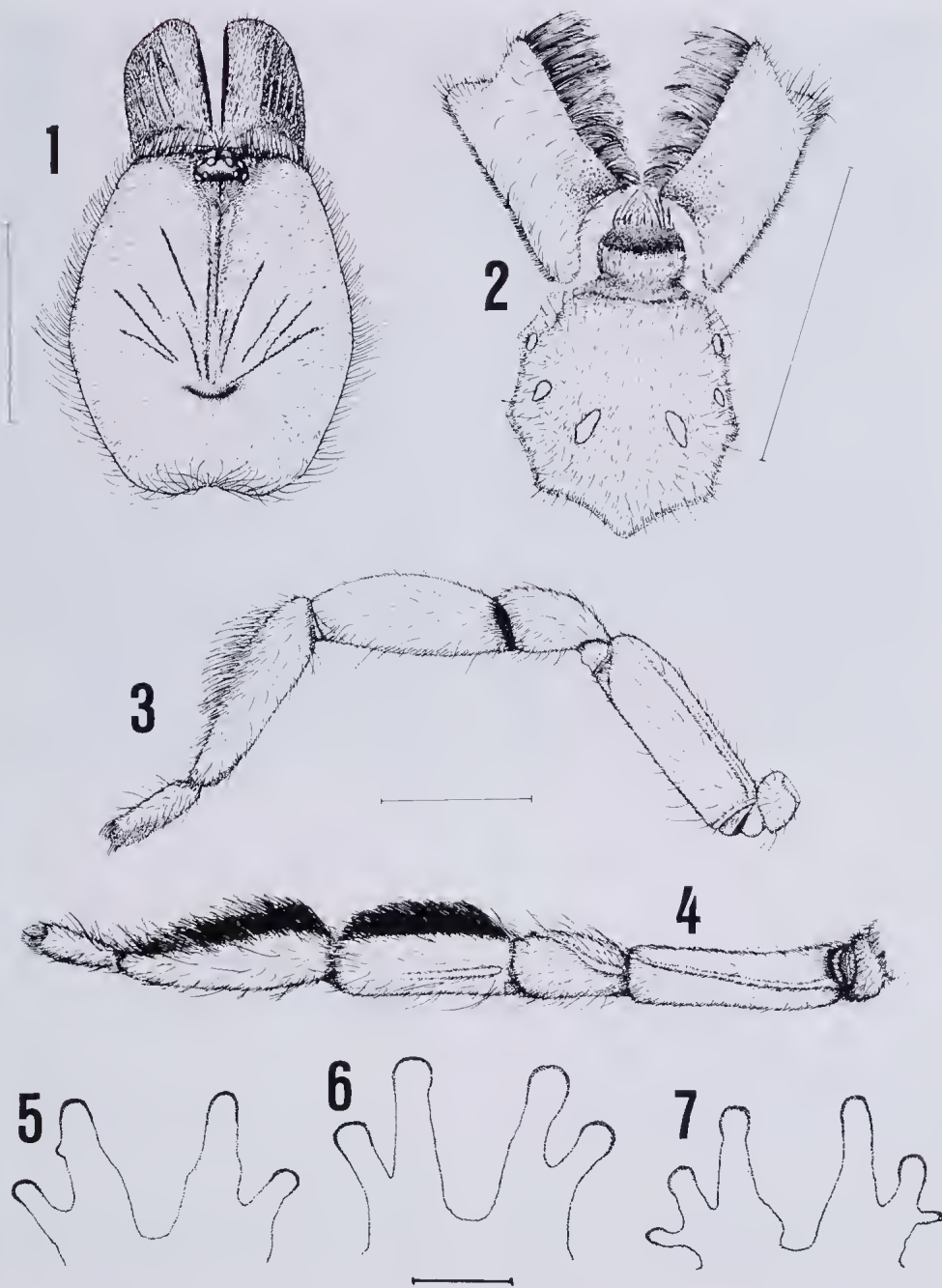
*Colour.* Carapace uniform brown; legs I, II and palp light brown, all femora dark brown, legs III and IV dark brown, longer red brown hairs on leg IV; chelicerae light brown on dorsal and lateral surface; abdomen entirely dark brown with longer red brown hairs on dorsal and lateral surfaces. In alcohol carapace, legs and chelicerae entirely dark red brown, abdomen and dense brush of hair on leg IV dark brown.

*Carapace.* Fovea broad, closed, procurved; uniformly hirsute, cuticle almost obscured; eight long setae in group in front of AME, two long setae between ALE-PLE, ten long setae in a group between PLE, few short anteromedial bristles; clypeus about one AME diameter long; striae shallow; caput strongly arched; lateral margins with longer setae, anterior margin with many long bristle setae.

*Eyes.* Tubercle rectangular, distinct, higher posteriorly, sloping in front to anterior margin; group occupies 0.26 of headwidth; group front width: back width: length, 49:49:21, ratio of AME:ALE:PME:PLE, 10:6:5:5; MOQ front width: back width: length, 27:37:23; interspaces (as diameters of an AME): AME-AME, 0.5; AME-ALE, 0.4; ALE-PLE, 0.6; PME-PLE, 0.1; PME-PME, 2.7.

*Chelicerae.* Stout; rastellum absent; 14–16 closely set teeth on promargin of furrow, many granular teeth basomesally; long line of short and long spike setae (strikers) on the retromargin of the furrow; c. 25 modified horizontally aligned peg-like setae, short and stout, pointed apically.

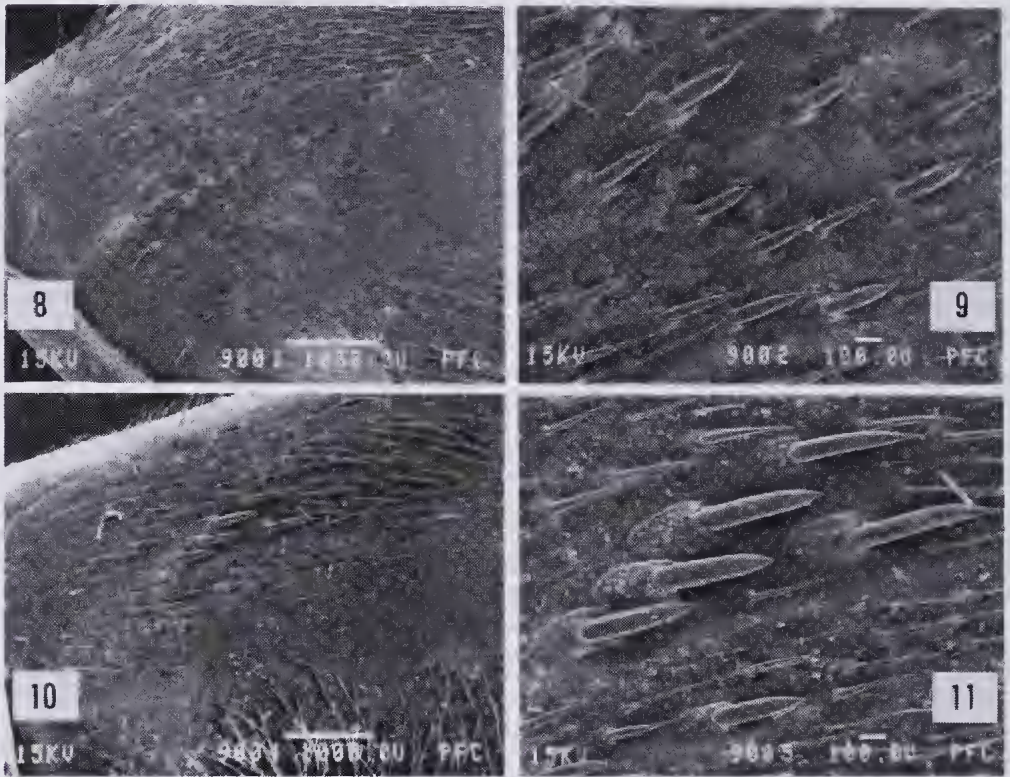
*Labium.* 2.64 long, 3.69 wide; rectangular, anteriorly slightly procurved; with dense group of over 300 cuspules on anterior third; labiosternal suture consisting of deep groove with two lateral sigilloid elongate lobes, slightly raised, glabrous.



FIGS 1-7. *Lyrognathus liewi*, female from Cameron Highlands; 1, Cephalothorax and chelicerae, dorsal view. 2, Sternum, maxillae, labium and chelicerae, ventral view. 3, Leg IV, dorsal view. 4, Leg IV, prolateral face. 5, 7, Spermathecae of paratype females, dorsal view. 6, Spermathecae of holotype female, dorsal view. Scale line = 1cm (Figs 1-4), =1mm (Figs 5-7).

*Maxillae*. 8.09 length behind, 6.38 length front, 3.74 width; broad; average 200 cuspsules on inner corner; anterior lobe distinct; serrula not

evident; maxillae and labium covered with long erect bristles and short hairs; prolateral surface



FIGS 8,9. *Coremiocnemis validus* Pocock, 1895, female from Cameron Highlands, scanning electron micrographs. 8, Chelicerae, proteral face showing peg-like setae. 9, Chelicerae, proteral face showing peg-like setae enlarged. 10,11. *Lyrognathus liewi*, paratype female from Cameron Highlands, scanning electron micrographs. 10, Chelicerae, proteral face showing peg-like setae. 11, Chelicerae, proteral face showing peg-like setae enlarged. Scale line = 1mm (Figs 8,10), 0.1mm (Figs 9,11).

with distinct area of bacilliform setae forming a lyra.

**Sternum.** 8.36 long, 8.09 wide; round; short brown prostrate hairs interspersed with erect short dark brown bristles obscuring cuticle, longer marginally; posterior sigilla oval, 1.16 long, 2.09 from margin; middle sigilla oval, 0.94 long, 0.66 from margin; anterior sigilla (barely visible) round, 0.39 long, 0.55 from margin; all sigilla glabrous.

**Legs.** IV much thicker and longer than I, II and III; patella, tibia and metatarsi IV incrassate, thicker retrolaterally with erect brush of hair adding to the effect; ventral coxae with dense mat of short brown prostrate hairs interspersed with short erect dark brown bristles as on sternum; femoral setal mat obscures cuticle of dorsal and ventral surface and proteral face of III and IV, femur I, II, and palp with wide glabrous band on 1/2-2/3 of proteral face, IV with wide glabrous band on 2/3 of retrolateral face, narrow

glabrous band on 1/2 to full length of retrolateral face of femur I, II, III and palp; all patellae with one or two narrow dorsal glabrous bands; all metatarsi with one proximal dorsal narrow glabrous band; patellae, tibiae, metatarsi and tarsi with short prostrate hairs interspersed with longer more erect hairs, IV much more hirsute than others obscuring cuticle; spines present on distal metatarsi.

**Scopula.** Deep dense pile for full length of all tarsi, metatarsi I and II; equally dense but distally for 1/2 of metatarsi III and 1/3 metatarsi IV; metatarsi and tarsi IV divided by setae.

**Spines.** Metatarsi I, v1; II, v3; III, v2d2; IV v3d2.

**Claws.** Palpal and paired claws bare; unpaired claws absent; claws do not project beyond the scopula.

**Trichobothria.** 4-5 in a single dorsal row of tibia I for full length; 2-3 irregular rows, each row proximally retrolateral, distally dorsal;



TABLE 1. Leg measurements of *Lyrognathus liewi* holotype female.

	Leg 1	Leg 2	Leg 3	Leg 4	Palp
Femur	14.02	11.72	10.78	14.69	9.08
Patella	9.02	7.87	6.99	8.80	5.67
Tibia	9.90	7.98	6.77	12.21	6.49
Metatarsus	8.42	7.70	8.91	15.40	—
Tarsus	4.95	4.57	4.40	5.50	5.94
Total	46.31	39.84	37.85	56.60	27.18

metatarsi and tarsi I trichobothrial zone marked also by short setae; 70–80 long filiform and short clavate on tarsi I in a broad band.

*Spermathecae*. Variable; usually bilobed; branches confluent before vulval chamber; inner branch longer than outer branch.

*Spinnerets*. Posterior medians 2.53 long; basal, middle, distal and total length of posterior lateral articles 3.41, 2.59, 2.81, 8.81 long respectively.

#### ACKNOWLEDGEMENTS

I thank Dr. Robert J. Raven for encouraging me and commenting on this manuscript, Mr. K.C. Liew for bringing the spiders to my attention, Mr. Lee Humble and Ms Leslie Manning for Scanning Electron Microscopy, Pacific Forestry Centre, British Columbia, Ms Karen Udall-Ékmann for the illustrations and Mrs Lynn West for carefully typing the manuscript. This work was funded in part by the Exline-Frizzell Fund for Arachnological Research, California Academy of Sciences, California, and the Royal British Columbia Museum, British Columbia.

#### LITERATURE CITED

- BONNET, P. 1957. *Bibliographia Araneorum*. Toulouse, vol. 2: 1027-3026.
- BRIGNOLI, P.M. 1983. A catalogue of the Araneae described between 1940 and 1981. Manchester, British Arachnological Society: i-xii, 1-755.
- GRAVELY, F.H. 1915a. The evolution and distribution of Indian spiders belonging to the sub-family Aviculariinae. *J. Asiatic Soc. Bengal* 10:411-420.
- 1915b. Notes on Indian mygalomorph spiders, I. *Rec. Ind. Museum* 11:257-287.
1935. Notes on Indian mygalomorph spiders, II. *India Zool. Survey, Rec.* 37(1):69-84.
- PLATNICK, N.I., 1989. *Advances in Spider Taxonomy 1981-1987: A supplement to Brignoli's A catalogue of the Araneae described between 1940 and 1981*. Manchester, Manchester University Press: i-vii + 1-673.
- POCOCK, R.I. 1895. On a new and natural grouping of some of the Oriental genera of Mygalomorphae, with descriptions of new genera and species. *Ann. Mag. Nat. Hist., ser. 6*, 15: 165-184.
1900. The fauna of British India, including Ceylon and Burma. Arachnida. London, 279p.
- RAVEN, R.J. 1985. The spider infraorder Mygalomorphae (Araneae): cladistics and systematics. *Bull. Amer. Mus. Nat. Hist.* 182(1):1-180.
- ROEWER, C.F. 1942. *Katalog der Araneae*. Bremen, Paul Budy Bd. 1, i-viii + 1-1040.
- SIMON, E. 1903. *Histoire Naturelle des Araignes*. Paris, Roret, 2 (4): 669-1080.



SALTICIDAE (ARACHNIDA: ARANEAE) OF ORIENTAL, AUSTRALIAN AND  
PACIFIC REGIONS, VII. *MOPSOLODES*, *ABRACADABRELLA* AND  
*PSEUDOSYNAGELIDES* - NEW GENERA FROM AUSTRALIA

MAREK ZABKA

Zabka, M. 1991 08 01: Salticidae (Arachnida: Araneae) of Oriental, Australian and Pacific Regions, VII. *Mopsolodes*, *Abracadabrella* and *Pseudosynagelides* - new genera from Australia. *Memoirs of the Queensland Museum* 30(3): 621-644. Brisbane. ISSN 0079-8835

Three unrelated genera of Salticidae: *Mopsolodes*, *Abracadabrella* and *Pseudosynagelides* are described from Australia. Their relationships and distribution are discussed. Diagnoses and figures of 10 species are given, including 9 new species: *Mopsolodes australensis*, *Abracadabrella lewiston*, *A. birdsville*, *Pseudosynagelides yorkensis*, *P. raveni*, *P. australensis*, *P. monteithi*, *P. elae* and *P. bunya*. A key for identification of species of *Pseudosynagelides* is proposed. □ *Salticidae*, *Mopsolodes*, *Abracadabrella*, *Pseudosynagelides*, *taxonomy*, *Australia*.

Marek Zabka, Zakład Zoologii WSR-P, 08-110 Siedlce, Poland; 1 October, 1990.

According to Davies and Zabka (1989) at least 57 salticid genera have been recorded from Australia. Most of them are endemic for the continent and it seems that with further research the number of endemics will grow considerably. During the last 20 years substantial progress in taxonomic research of Salticidae of Australia and surroundings has been made. Papers by Proszynski, Wanless, Balogh, Chrysanthus, Zabka and others provided descriptions of many new genera and species and revisions of some taxa described earlier. Full bibliography of papers involved is given by Zabka (1987a) and Davies and Zabka (1989). The present paper is the next in series that started in 1987 to deal with Oriental, Australian and Pacific fauna (Zabka 1987a,b, 1988, 1990). It provides descriptions of three new genera and of nine new species - all of them recorded from Australia only.

#### MATERIAL AND METHODS

The paper is based on material from several collections listed below. Mean (in brackets) and ranges are given in millimetres. Leg spination format follows Platnick and Shadab (1975). Details of terminology and abbreviations are presented for each genus. Dissected epigynes were digested in lactic acid for 10-30 min. or in 10% KOH for 12-48 hrs at room temperature, rinsed in distilled water, stained in ethanol solution of chlorazol black E under control and mounted in glycerin. The drawings were made using grid system.

#### COLLECTIONS STUDIED

AMS Australian Museum, Sydney  
QMB Queensland Museum, Brisbane  
SAMA South Australian Museum, Adelaide  
ZMH Zoologisches Institut und Zoologisches Museum, Universität Hamburg

#### ABBREVIATIONS USED

AEW - anterior eyes width, ag - accessory gland, AL - abdomen length, c - conductor, ca - retrolateral cymbial apophysis, CL - cephalothorax length, co - copulatory opening, CW - cephalothorax width, da - retrodorsal tibial apophysis, dca - dorsal cymbial apophysis, e - embolus, EFL - eye field length, ep - epigynal pocket, f - femur, fd - fertilization duct, fp - femoral process, id - insemination duct, m - metatarsus, ms - metatarsal spines, p - patella, PEW - posterior eyes width, s - spermatheca, sr - seminal reservoir, ta - retrolateral tibial apophysis, tg - tegulum, tga - tegular apophysis, ti - terminal incision, tr - trochanter.

#### *Mopsolodes* gen. nov.

#### TYPE SPECIES

*Mopsolodes australensis* sp. nov.

#### ETYMOLOGY

The generic name is a combination of names *Sandalodes* and *Mopsus* and it is masculine in gender.

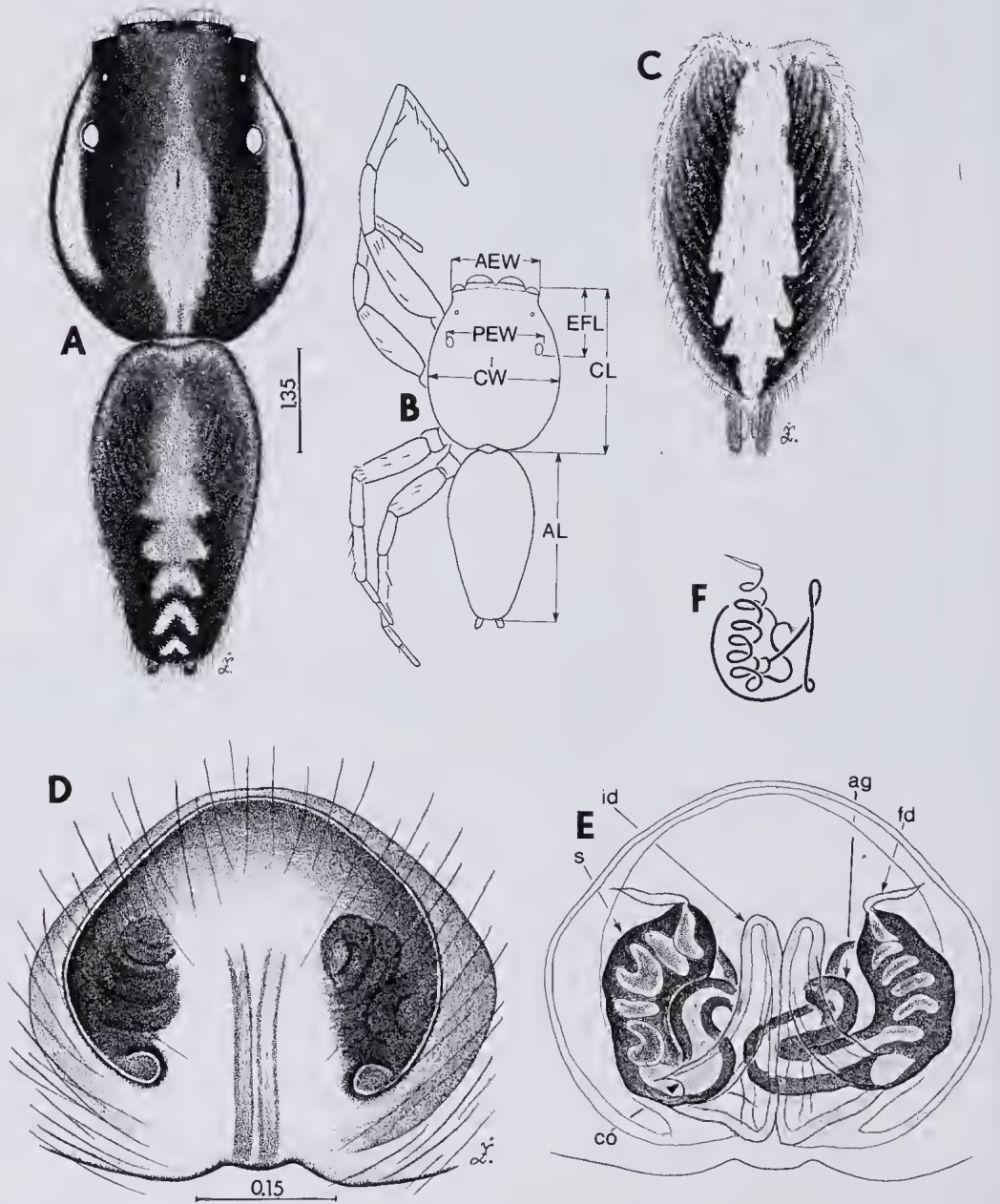


FIG. 1. *Mopsolodes australensis* sp. nov. A, colour pattern of male. B, dimensions of the body. C, abdominal pattern of female. D, E, genitalia.

#### DIAGNOSIS

In comparison to related *Sandalodes* and *Mopsus* internal structures of female genitalia much longer - especially insemination ducts, male's cephalothorax without protruding, pink-like fringe.

Description (Fig. 1). Medium to large-size spider, 6.50–9.10 mm in body length. Cephalothorax robust, high. Abdomen elongate. Chelicerae of unident pattern with one retromarginal tooth and two promarginal teeth. Legs long with numerous spines. Leg I the strongest and

longest, leg III longer than IV. Male palpal organ with thin embolus (e), tegulum (tg) bag-like, seminal reservoir (sr) not meandering, retrolateral tibial apophysis (ta) with small teeth. Female genitalia with long, membranous insemination ducts (id), spermathecae (s) large, strongly sclerotized, multichambered, accessory glands (ag) long.

#### RELATIONSHIPS, BIOLOGY AND DISTRIBUTION

Body form and genitalic structure suggest relationship to *Sandalodes* and *Mopsus*, from Australia and New Guinea (Davies, Zabka 1989). Genitalia of *Mopsolodes*, however, are more complex, its internal structures elongate, especially insemination ducts and accessory glands. Protruding, punk-like fringe on male's cephalothorax missing, while present in both genera mentioned above. According to Simon (1903) *Mopsus* and *Sandalodes* belong to *Thyeneae* and *Hyllae* respectively. Petrunkevitch (1928) follows Simon's division in general and puts *Mopsus* and *Sandalodes* into *Thyeniinae* and *Hyllinae*. Both authors seem to be creating groups (subfamilies) of unrelated genera. In fact, *Mopsus*, *Sandalodes* and *Mopsolodes* are closely related and probably originated in separation from other generic groups. In comparison to *Mopsus* that occurs in rainforest or similar humid habitats, most *Mopsolodes australensis* have been collected in dry *Eucalyptus* forest from Brisbane to Torres Strait (Fig. 3), mostly on understory vegetation. Only single individuals have been taken from nests in leaves and litter of oak forest and rainforest. Unlike *Sandalodes* no specimen has been found under *Eucalyptus* bark.

#### *Mopsolodes australensis* sp. nov. (Figs 1-3)

##### MATERIAL EXAMINED

Queensland: Holotype: ♂, Allotype: ♀, Paratypes: 2♂, juv., Davies Ck., NEQ, Summer 1971-72, N. Clyde Coleman, QMB S479; ♀, Mossman, 2.II.1972, QMB S4782; ♂, Thompson Lagoon, 7 miles E Edward River Mission, sweeping grass, 8.VI.73, V. Davies, QMB S4780; 2♂, Eureka Ck., 11.II.1972, N. Clyde Coleman, QMB S4787; 1♂, 2♀, Atherton Tableland, near Mareeba, nests in leaves, XII.1982, QMB S4791; ♀, 7 km NE Musgrave Stn., sweeping grass, 4.VI.1973, V. Davies, QMB S4788; ♀, Torres Strait, Horn Is., 24-29.I.1975, R. Raven, QMB S4785; ♀, Springfield Stn., W Mt. Garnet, 1.IX.1979, K. McDonald, QMB S4789; ♀, Oak Forest, N. Clyde Coleman, 7.X.1971, QMB S4784; 3♂, ♀, 2juv.,

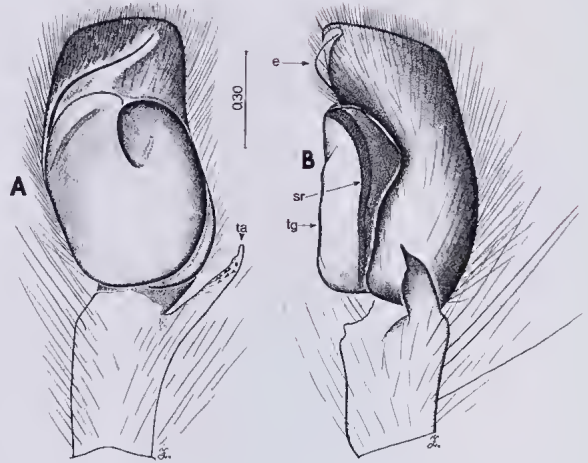


FIG. 2. *Mopsolodes australensis* sp. nov.: male palpal organ.

Rochedale State Forest, sweeping, litter, 20.IX.1979, 11.X.1979, 7.XII., V. Davies, R. Raven, QMB S4777-9; 2♀, Molloy Rd., 18.II.1972, N. Clyde Coleman, QMB S4786; 4♀, Brisbane, Mt. Cooth-tha, dry *Eucalyptus* forest, sweeping grass, 15.VIII., 21.XI.1987, M. Zabka, ZMH A86/89. Northern Territory: Paratype: ♂, Radon Ck., rainforest, 14-16.VII.1979, G. Monteith, D. Cook, QMB S4783.

##### DIAGNOSIS

Same as for the genus.

*Male* (Fig. 1A,B). Cephalothorax brown with lighter median part and sides, the last and fovea

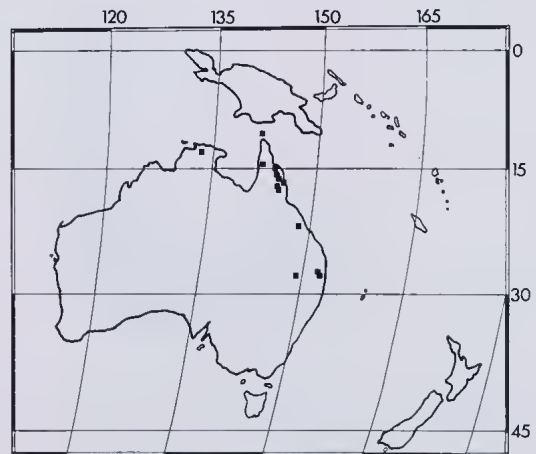


FIG. 3. Distribution of *Mopsolodes australensis* sp. nov.

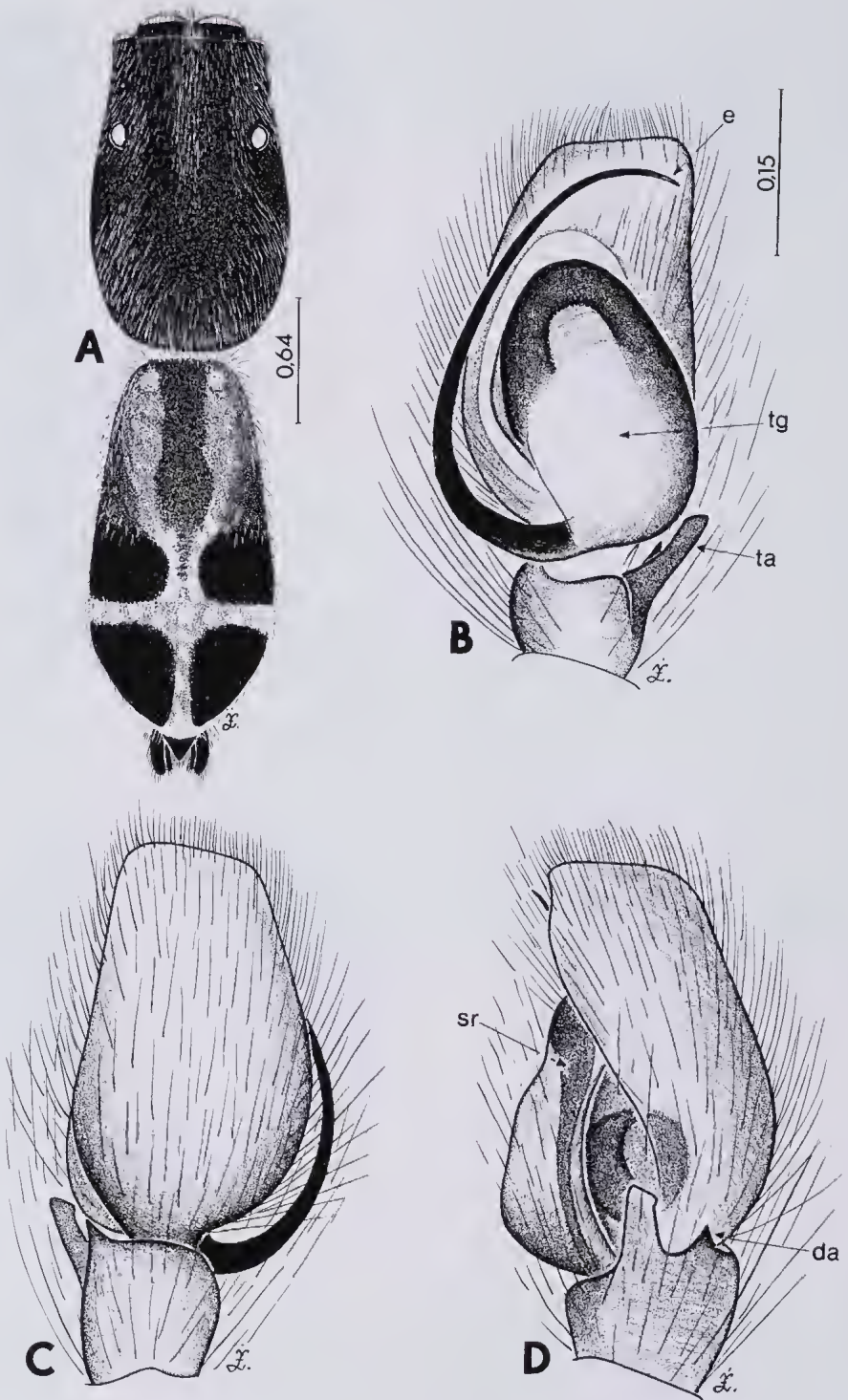


FIG. 4. *Abracadabrella elegans* (L. Koch, 1879), ♂, general appearance and palpal organ.

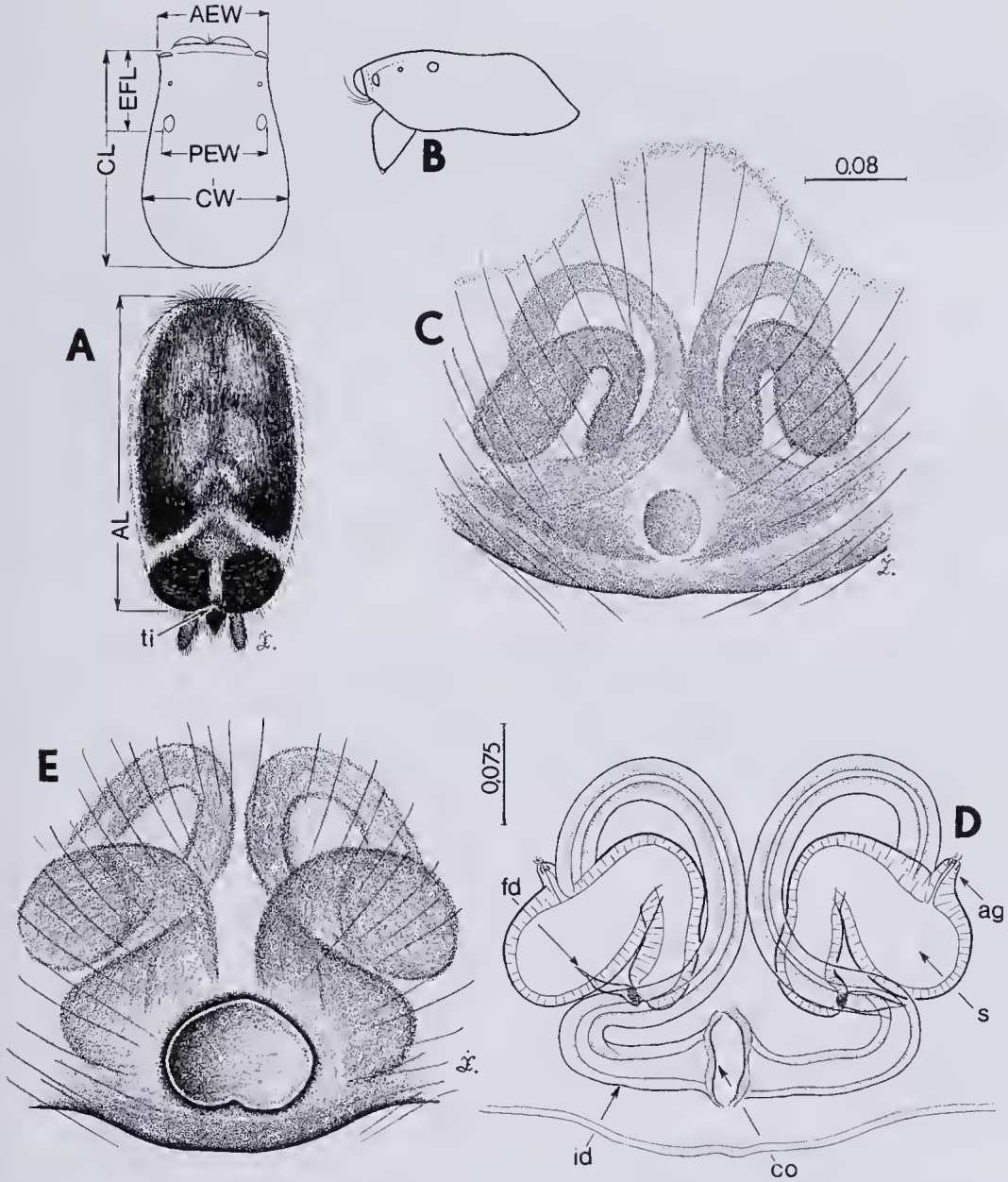


FIG. 5. *Abracadabrella elegans* (L. Koch, 1879), ♀. A, dorsal aspect. B, lateral view of cephalothorax. C-E, genitalia. A-D, syntype. E, specimen from Brisbane.

region covered with white hairs. Abdomen dark-grey with grey-yellow herring-bone median belt covered with numerous hairs. Spinnerets grey-brown. Clypeus and chelicerae brown, the last rather long. Maxillae and labium dark-brown with light tips, sternum orange, venter grey, darker centrally. Legs I brown with white hairs

on ventral femora. Coxae, trochanters and femora of other legs yellow, distal segments brown, all legs with long spines.

Dimensions. CL 3.16–3.96 (3.63), CW 2.50–3.16 (2.95), EFL 1.18–1.51 (1.40), AEW 1.78–2.17 (2.02), PEW 1.78–2.17 (2.03), AL 3.49–5.14 (4.48).

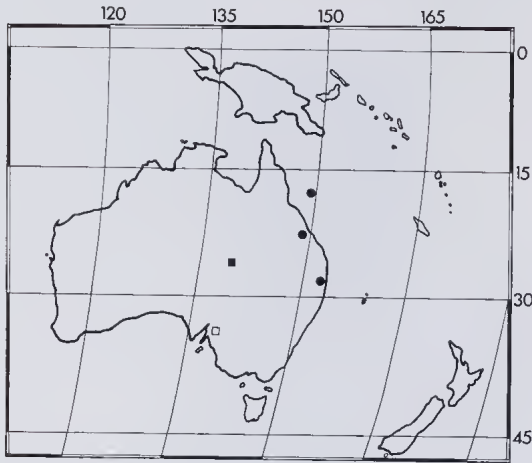


FIG. 6. Distribution of *Abracadabrella*

- *A. birdsville* sp. nov.
- *A. elegans* (L.K.)
- *A. leviston* sp. nov.

*Female*. Cephalothorax as in male. Abdomen (Fig. 1C) also similar, but central belt more contrasting. Lateral surfaces light. Spinnerets long, dirty-brown. Clypeus yellow with similar long hairs. Chelicerae long, dirty-orange with a frontal projection. Pedipalps yellow, darker distally, maxillae orange with yellow tips, labium long, darker laterally, sternum yellow, venter light, darker medially. Legs I orange-brown, darker distally, other legs lighter, spines as in male.

Epigyne (Fig. 1D-F) in a form of large depression, internal structures translucent. Insemination ducts long, membranous, spermathecae strongly sclerotized, multichambered, accessory glands distinctive.

Dimensions. CL 3.16-3.89 (3.51), CW 2.50-3.03 (2.75), EFL 1.32-1.46 (1.37), AEW 1.81-2.11 (1.95), PEW 1.84-2.24 (2.03), AL 4.42-5.28 (4.82).

### *Abracadabrella* gen. nov.

#### TYPE SPECIES

*Marptusa elegans* L. Koch, 1879.

#### ETYMOLOGY

The name is a random combination of letters and feminine in gender.

#### DIAGNOSIS

Body form rather flat, similar to some species of *Afraflacilla*-*Pseudicius* group but stridulatory

organ absent. Female's abdomen usually with terminal incision. The structure of epigyne similar to that of some *Holoplatys* species and to one undescribed genus, but body form and male's palpal organs completely different.

Description (Figs 3,4). Medium spiders, 3.50-6.70 mm in length. The body slender, elongate and rather flat. In some species - especially in females - abdomen with terminal incision (ti). Chelicerae of unident pattern, promargin with 2 teeth, retromargin with 1. Leg I the strongest, leg IV the longest. Male palpal organ with long embolus (e), bag-like tegulum (tg), retrolateral (ta) and retrodorsal (da) tibial apophyses. Insemination ducts (id) very long, ~S'-shaped, spermathecae (s) one-chambered, their distal parts elongate, accessory glands (ag) distinctive.

Remarks on synonymy. *A. elegans* (L. K.), the only previously known species, was described by Koch (1879) as *Marptusa elegans* and than wrongly transferred to *Ocrisiona* by Simon (1901).

#### RELATIONSHIPS, BIOLOGY AND DISTRIBUTION

The genus does not have any relatives among described salticid genera. Some similarities of female genitalia to one of undescribed Australian genera can well be convergence only. Body form and colour pattern similar to *Afraflacilla*-*Pseudicius* group but lack of stridulatory organs is a distinctive difference. The only data concerning biology of particular species come from labels. Some specimens were collected under *Eucalyptus* bark, others on vegetation. The genus has been recorded from Queensland and South Australia (Fig. 6).

#### *Abracadabrella elegans* (L. Koch, 1879) comb. nov. (Figs 4-6)

*Marptusa elegans* L. Koch, 1879: 1119.

*Ocrisiona elegans*: Simon, 1901: 602, 608.

#### MATERIAL EXAMINED.

Queensland: Syntype: ♀, Peak Downs, (Mus. Godefroy, 16529), ZMH; ♂, Great Barrier Reef, Binstead Isl., 11.XII.1979, R. Buckley, QMB S4593; 2 ♀, Brisbane, Everton Park, in wasps' nest, 6.III.1973, M. Archer, QMB S4568.

#### DIAGNOSIS

Embolus of male palpal organ shorter than in the species described below, retrodorsal tibial apophysis cone-shaped, abdominal pattern distinctive.



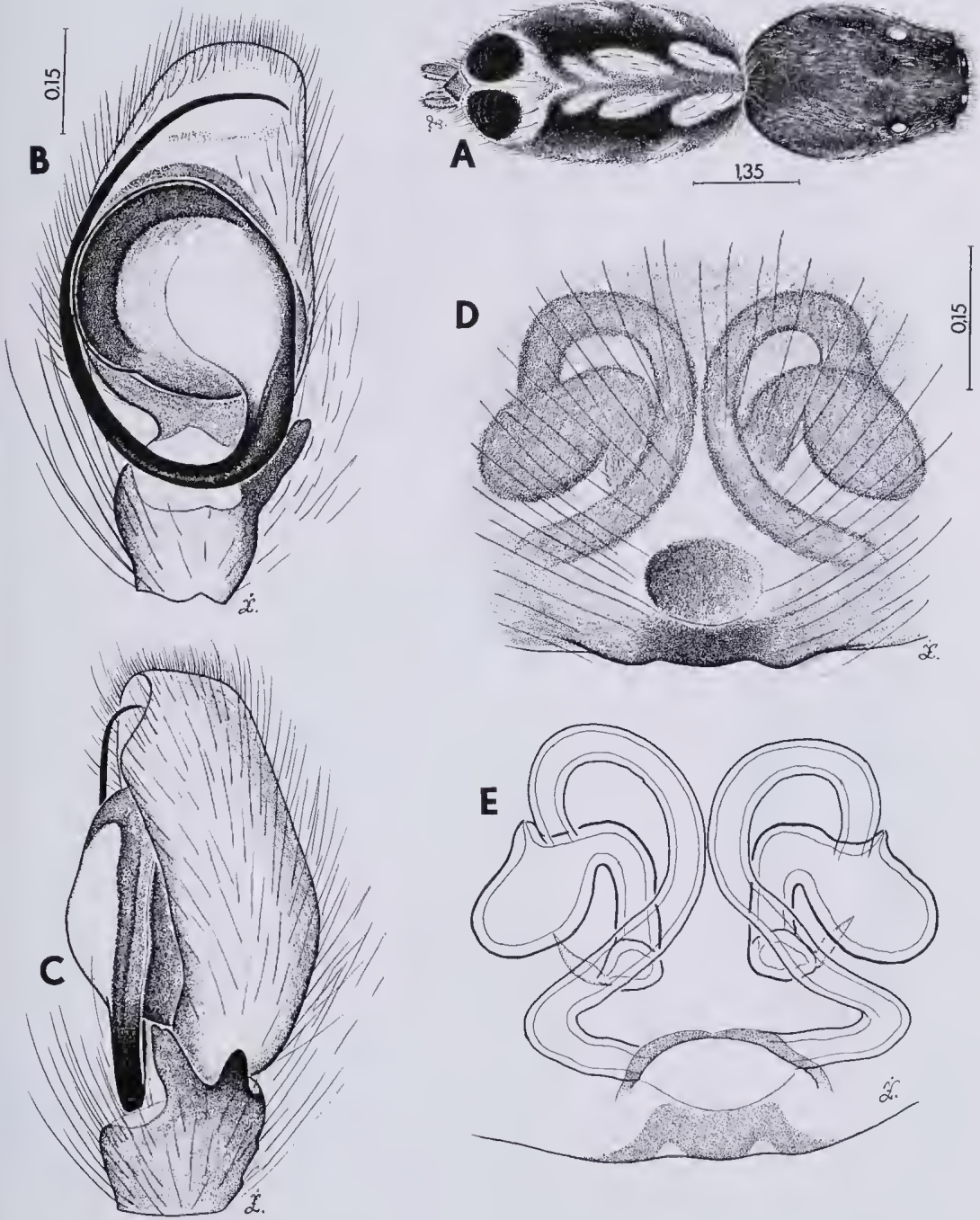


FIG. 7. *Abracadabrella birdsville* sp. nov. A, general appearance of female. B,C, palpal organ of male. D,E, genitalia of female.

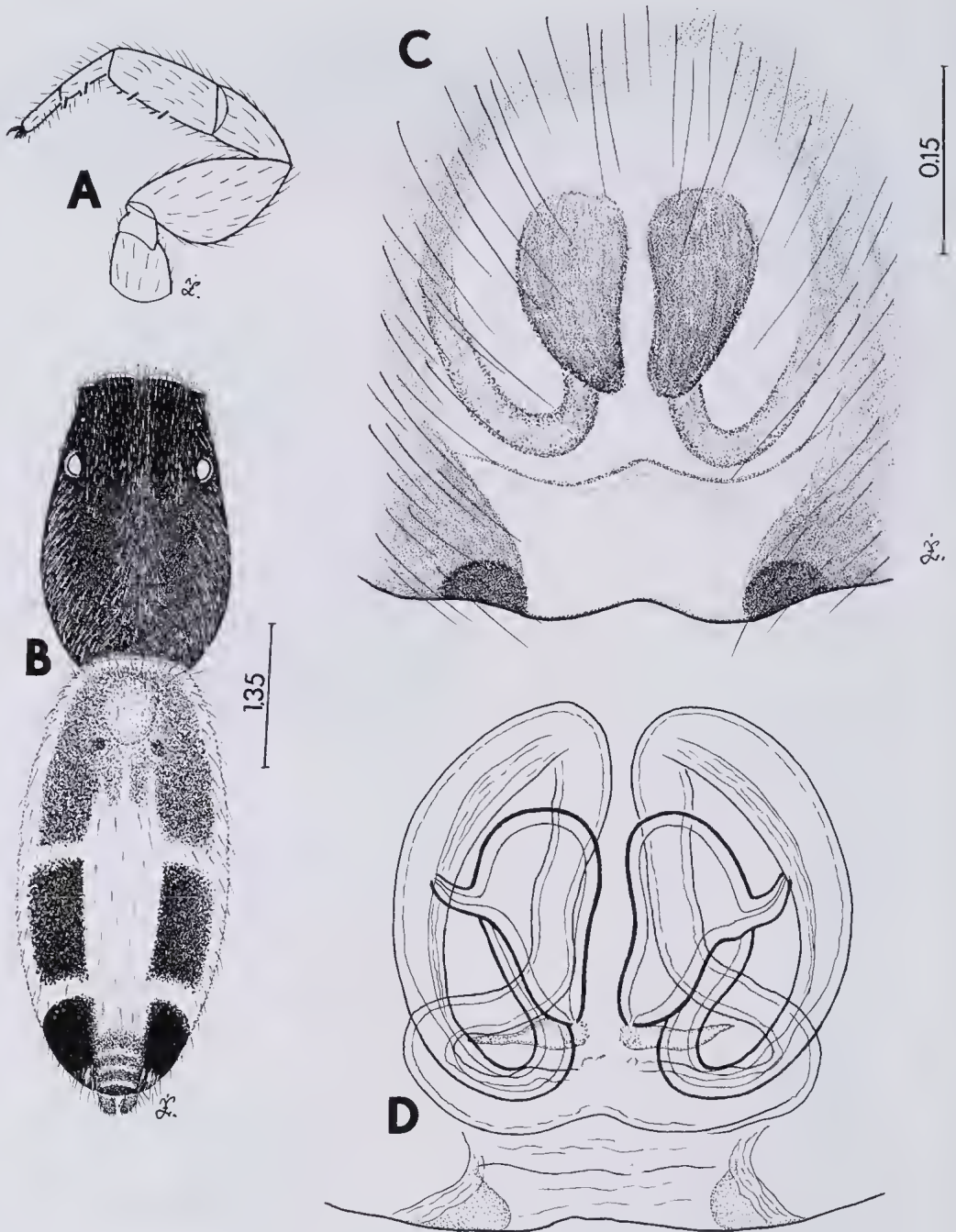
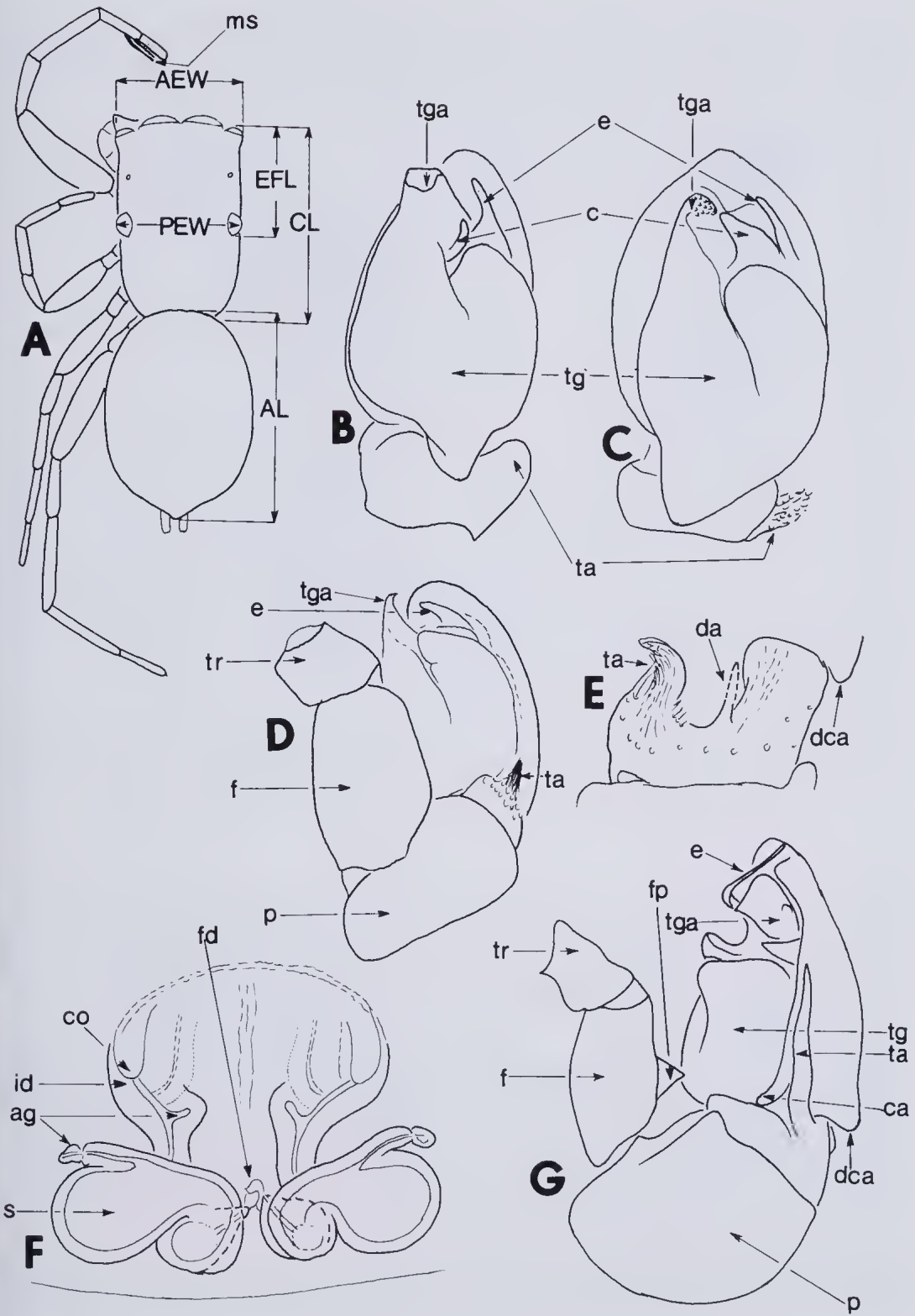


FIG. 8. *Abracadabrella lewiston* sp. nov., ♀, leg I, general appearance and genitalia.

FIG. 9. Morphological characters of *Pseudosynagelides*: A, general appearance. B-E, palpal organ and its comparison to *Synagelides* (G). F, genitalia of female.



*Male* (Fig. 4A). Eye field dark-brown, thorax slightly lighter. Light hairs numerous along median part and laterally. Abdomen with black and light posterior spots forming cross-like pattern. Clypeus brown with white hairs and 3 strong bristles. Chelicerae rather long, light-brown. Maxillae orange-brown, labium and sternum dirty-brown. Venter light-grey-brown. Spinnerets dark-brown. Legs covered with white and brown hairs, particular segments yellow to brown.

Palpal organ (Fig. 4B-D), with small, cone-shaped retrodorsal apophysis on tibia.

Leg spination. tI: p0-1, r0-0; mI: p1-1, r1-1; tII: p0-1, r0-0; mII: p1-1, r1-1.

Dimensions. CL 1.59, CW 1.02, EFL 0.59, AEW 0.78, PEW 0.83, AL 1.86.

The male described for the first time.

*Female* (Fig. 5A,B). Cephalothorax as in male, abdomen slightly different, with terminal incision. Spinnerets grey. Clypeus, chelicerae, maxillae, labium and sternum as in male. Venter grey centrally, lighter laterally. Leg I proximally yellow, distally darker, other legs lighter.

Epigyne's oval depression close to the epigastric furrow (Fig. 5C-E). Insemination ducts long, distal parts of spermathecae elongate.

Leg spination. tI: p0-0 or 0-1; mI: p1-1, r1-1; mII: p0-1, r0-1.

Dimensions. CL 1.76, CW 1.17-1.19 (1.18), EFL 0.62, AEW 0.83-0.87 (0.85), PEW 0.88-0.90 (0.89), AL 2.69-2.75 (2.72).

#### *Abracadabrella birdsville* sp. nov.

(Figs 6,7)

##### MATERIAL EXAMINED.

Queensland: Holotype: ♂, L. Muncoonie via Birdsville, beating, 16.XI.1976, A. Berg, R. Raven, QMB

S14148; Allotype: ♀, same data, QMB S14149; Paratypes: 2♂, ♀, 3juv. same data, QMB S14150.

##### DIAGNOSIS

The species can be recognized by abdominal pattern, long embolus and round top of retrodorsal tibial apophysis.

*Male*. Cephalothorax brown, darker on eye field, covered with numerous whitish hairs. Abdomen with characteristic pattern of brown, black and yellowish spots, covered with numerous brown and light hairs. Spinnerets greyish-brown. Clypeus brown with light hairs and 3 strong bristles in its median part. Chelicerae dark-brown, maxillae, labium and

sternum lighter, the last with white hairs. Venter light-grey, darker centrally. Leg I dark-brown, II brown, III and IV orange, darker laterally and around joints. All legs covered with numerous light and brown hairs.

Palpal organ (Fig. 7B-C) similar to that in *A. elegans* but embolus longer, tegulum oval and retrodorsal tibial apophysis larger, rounded at the top.

Leg spination. mI: p1-1, r0-1; mII: p1-1 or p0-1, r0-0.

Dimensions. CL 2.50-2.64 (2.57), CW 1.84, EFL 0.79-0.86 (0.84), AEW 1.15-1.18 (1.17), PEW 1.19-1.25 (1.23), AL 2.90-3.63 (3.36).

Female colour pattern (Fig. 7A) almost identical to male. Pedipalps yellow covered with white lateral hairs forming flags. Legs generally lighter: I orange-brown, others yellow, all darker around joints.

Epigyne and internal genitalia (Fig. 7D,E) almost identical to previous species.

Leg spination as in male.

Dimensions. CL 2.44-2.64 (2.54), CW 1.66-1.78 (1.72), EFL 0.79-0.86 (0.82), AEW 1.12, PEW 1.18, AL 3.69-3.82 (3.75).

#### *Abracadabrella lewiston* sp. nov.

(Figs 6,8)

##### MATERIAL EXAMINED

South Australia: Holotype: ♀, Two Wells, Lewiston Park, bark of *Eucalyptus* (fallen trees), 29.VI.1970, T.T.H. Szent-Ivany, SAMA N1988336.

##### DIAGNOSIS

Body form more elongate, colour pattern and epigyne different from two previous species.

Female (Fig. 8B). Thorax brown, eye field darker. Whole cephalothorax covered with numerous white hairs. Abdomen with small anterior scutum, and yellow and grey-brown pattern darkening posteriorly. Clypeus brown, covered with numerous white hairs. Chelicerae dark-brown; pedipalps yellow with light hairs. Maxillae and labium brown, sternum lighter with dark margin. Venter beige. Leg I (Fig. 8A) light-brown, others yellow-orange.

Spermathecae and accessory glands of female genitalia (Fig. 8C-D) of different shape than in other species.

Leg spination. tI: p1-1, r1-1; mI: p1-1, r1-1; tII: r0-1; mII: p1-1, r1-1.

Dimensions. CL 2.70, CW 1.78, EFL 0.89, AEW 1.19, PEW 1.25, AL 3.89.

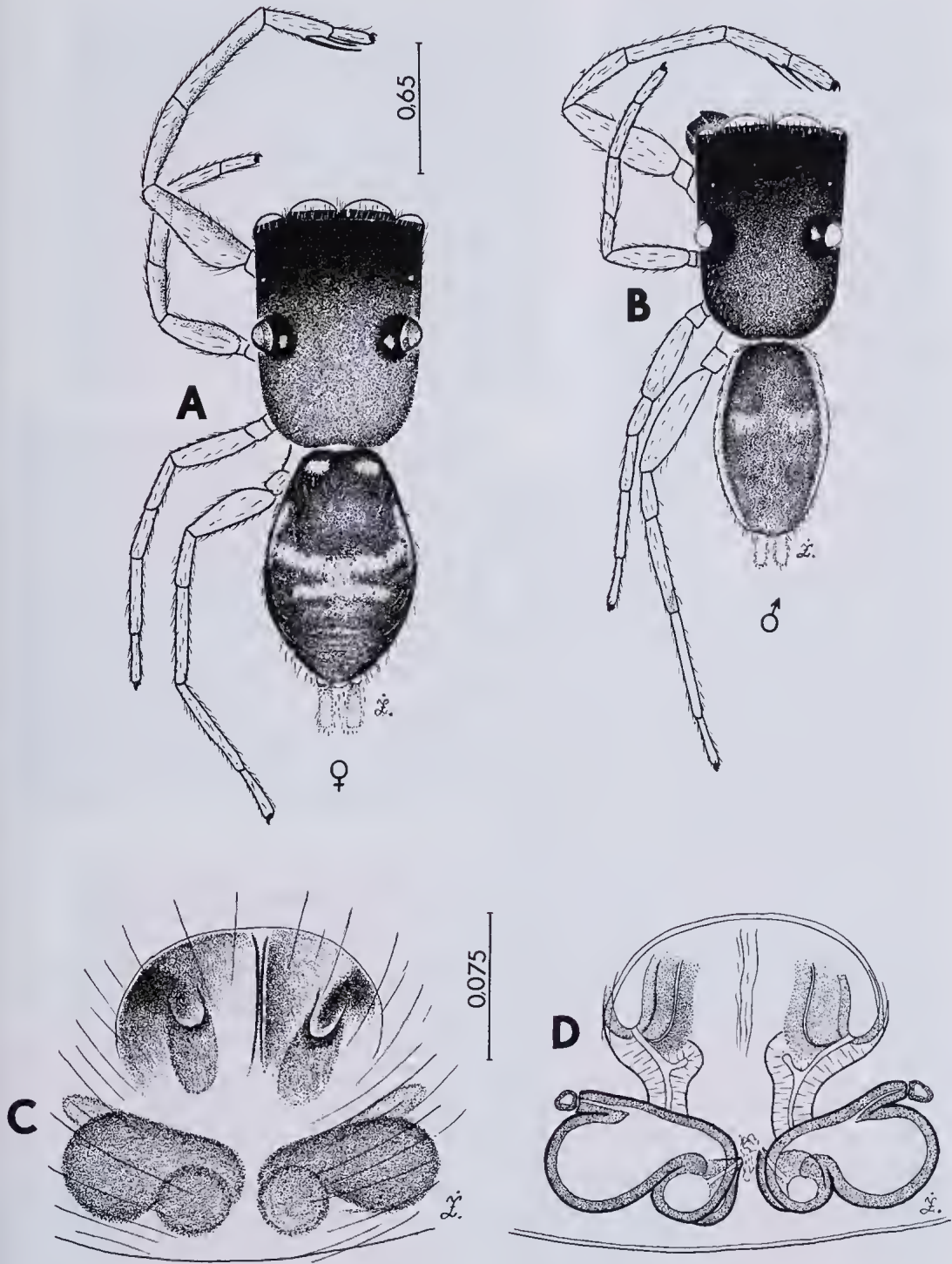


FIG. 10. *Pseudosynagelides yorkensis* sp. nov.: general appearance of both sexes and genitalia of female.

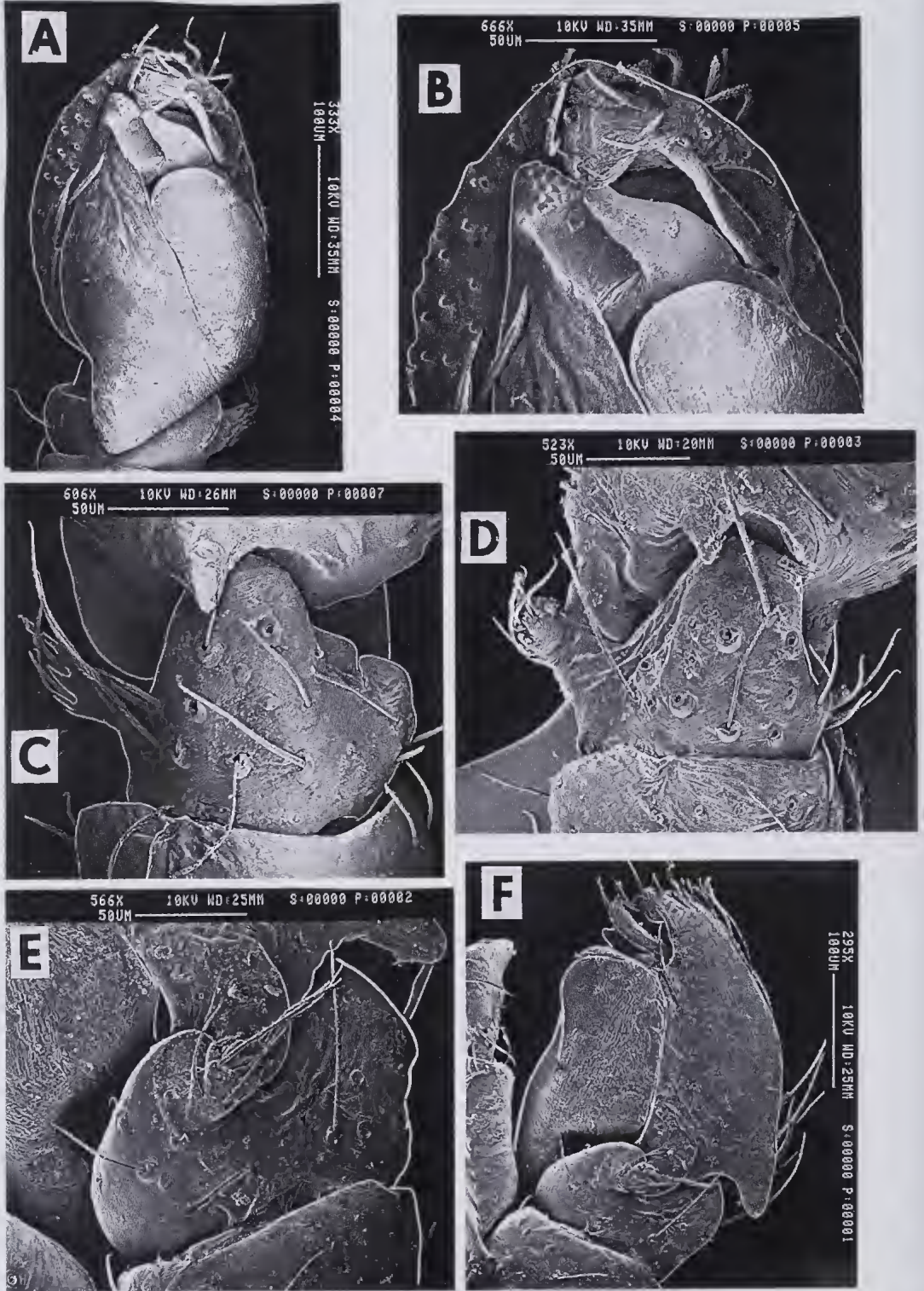


FIG. 11. *Pseudosynagelides yorkensis* sp. nov.: male: palpal organ.

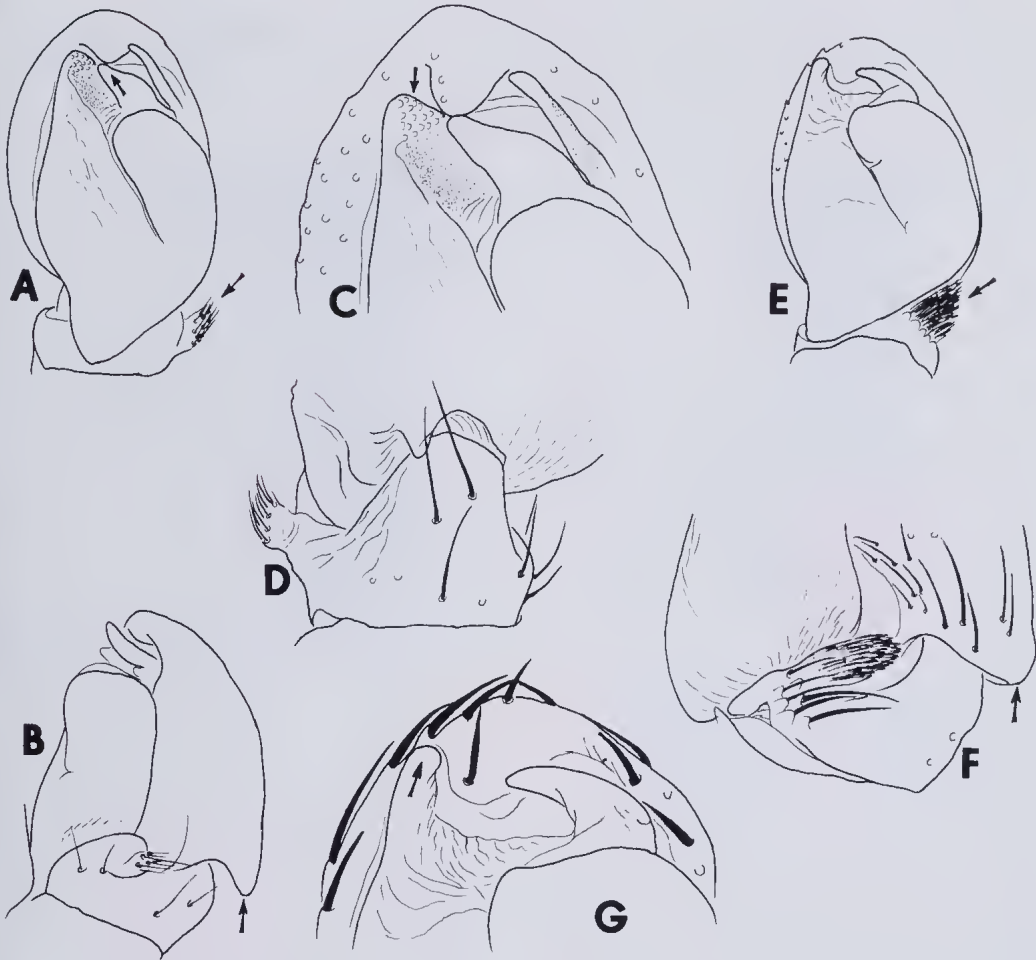


FIG. 12. Male palpal organs of *Pseudosynagelides yorkensis* sp. nov. (A-D) and *Pseudosynagelides raveni* sp. nov. (E-G).

### *Pseudosynagelides* gen. nov.

#### TYPE SPECIES:

*Pseudosynagelides yorkensis* sp. nov.

#### ETYMOLOGY

Like *Synagelides*; masculine.

#### DIAGNOSIS

Body form similar to Asiatic genus *Synagelides*, but genitalia structure simpler and metatarsal spines missing.

Description (Fig. 9). Tiny to small spiders, ranging up to 2.90 mm in body length. Cephalothorax slender, its surface textured, posterior lateral eyes set on distinctive tubercles. Abdomen with scutum in some species, sometimes with transverse light stripes forming

pseudo-mimic pattern. Chelicerae with one or two small promarginal teeth and one retromarginal, unident tooth. Sternum large. Spinnerets rather long. Legs long and delicate, usually light, with longitudinal dark stripes, metatarsi 1 with four ventral spines (ms). Male palpal organ with fixed, vertical connection between femur (f) and patella (p). Retrolateral (ta) and, in some species, retrodorsal (da) apophyses on tibia present. Tegulum (tg) with large apophysis (tga) in its apical part, embolus (e) single or accompanied by conductor (c). Cymbium with retrolateral (ca) and dorsal apophyses (dca). Epigyne relatively simple, sometimes with anterior pocket (ep). Copulatory openings (co) cup-like. Insemination ducts (id) broad, accessory glands (ag) double. Spermathecae (s) large, fertilization ducts (fd) normal.

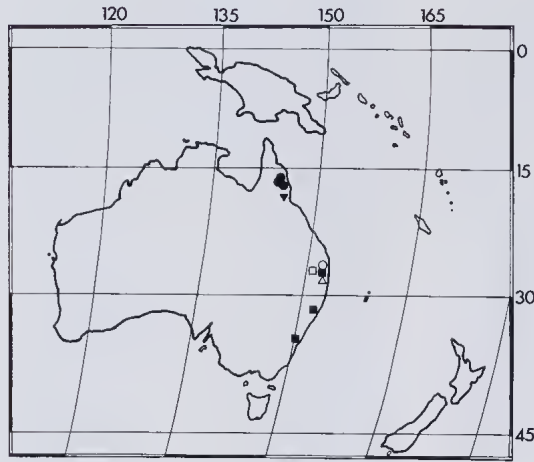


FIG. 13. Distribution of *Pseudosynagelides*  
 ○ *P. australensis* sp. nov.    ▼ *P. monteithi* sp. nov.  
 □ *P. bunya* sp. nov.        ■ *P. raveni* sp. nov.  
 Δ *P. elae* sp. nov.         ● *P. yorkensis* sp. nov.

RELATIONSHIPS

*Synagelides* Bsenberg & Strand (Fig. 9D) seems the only relative of the genus (Bohdanowicz 1988). Both are highly specialized and distinctive for their body form and unique for their genitalic structure. Their subfamily status remains an open question. Petrunkevitch (1928) puts *Synagelides* into *Synagelinae* – together with many other accidental genera. Proszynski (1976), on the other hand, creates *Synemosyninae* for some ant-mimic genera (including *Synagelides*) but also his decision seems controversial. Probably separate subfamilies for both discussed genera would be the best solution.

BIOLOGY AND DISTRIBUTION

All species were collected from rainforest litter, mostly by pitfall trapping in tropical and subtropical Queensland;

*P. raveni* has also been recorded from New South Wales (Fig. 13). Distribution of the genus, so distant from Asiatic *Synagelides*, looks mysterious. The more so as no related spider has ever been found east and south of Viet-Nam (Zabka 1985) - perhaps because of lack of litter material from the area. At the present stage only hypotheses regarding real distribution and origin of both discussed genera are possible. The problem should be cleared up because of its zoogeographical and evolutionary implications.

KEY TO THE SPECIES OF  
*PSEUDOSYNAGELIDES*

Males.

- 1. Conductor present ..... 2  
     Conductor absent ..... 3
- 2. Abdomen without scutum, with light lateral band, tegular apophysis knobby on the top, dorsal cymbial apophysis present, retrolateral tibial apophysis small ..... *P. yorkensis*  
     Tegular apophysis with apical collar (see arrow on Fig. 15C), retrolateral tibial apophysis large, spatular, dorsal cymbial apophysis missing ..... *P. monteithi*
- 3. Tibial apophysis single, brush-like, oriented dorsally ..... *P. raveni*  
     Two tibial apophyses present ..... 4
- 4. Retrolateral tibial apophysis large, hooked, dorsal cymbial apophysis present ..... *P. bunya*.  
     Retrolateral tibial apophysis smaller, different in shape ..... 5
- 5. Tibial apophyses small, embolus with very distinctive ridge ..... *P. elae*  
     Tibial apophyses larger, retrolateral one oriented apically, embolus without distinctive ridge ..... *P. australensis*

Females.

- 1. Abdomen with scutum epigyne with anterior pocket, spermathecae pear-shaped .....  
     ..... *P. raveni*  
     Abdomen without scutum, with light pattern, epigyne without pocket, spermathecae elongated ..... *P. yorkensis*

*Pseudosynagelides yorkensis* sp. nov.  
(Figs 10, 11, 12A-D, 13)

MATERIAL EXAMINED

Queensland: Holotype: ♂, Thornton Peak, N of Daintree, 610 m, site 40, rainforest survey, litter, XI.1975, M.R. Gray, AMS KS7653; Allotype: ♀, same data, AMS KS21059; Paratypes: 5♂, 5♀, 3 juv., same data, AMS KS21060; 2♂, 1juv., 4.5 km W of Cape Tribulation, 750 m, rainforest, site 9, Berlesate 436, sieved litter, 29-30.IX.1982, G.B. Monteith, D.K. Yeates, G.I. Thompson, QMB S4699; ♂, 3.5 km W of Cape Tribulation, 680 m, rainforest, Berlesate 517, sieved litter, I.1983, G.B. Monteith, QMB S4692; ♂, ♀, same locality, site 7, Berlesate 482, 2.X.1982, G.B.



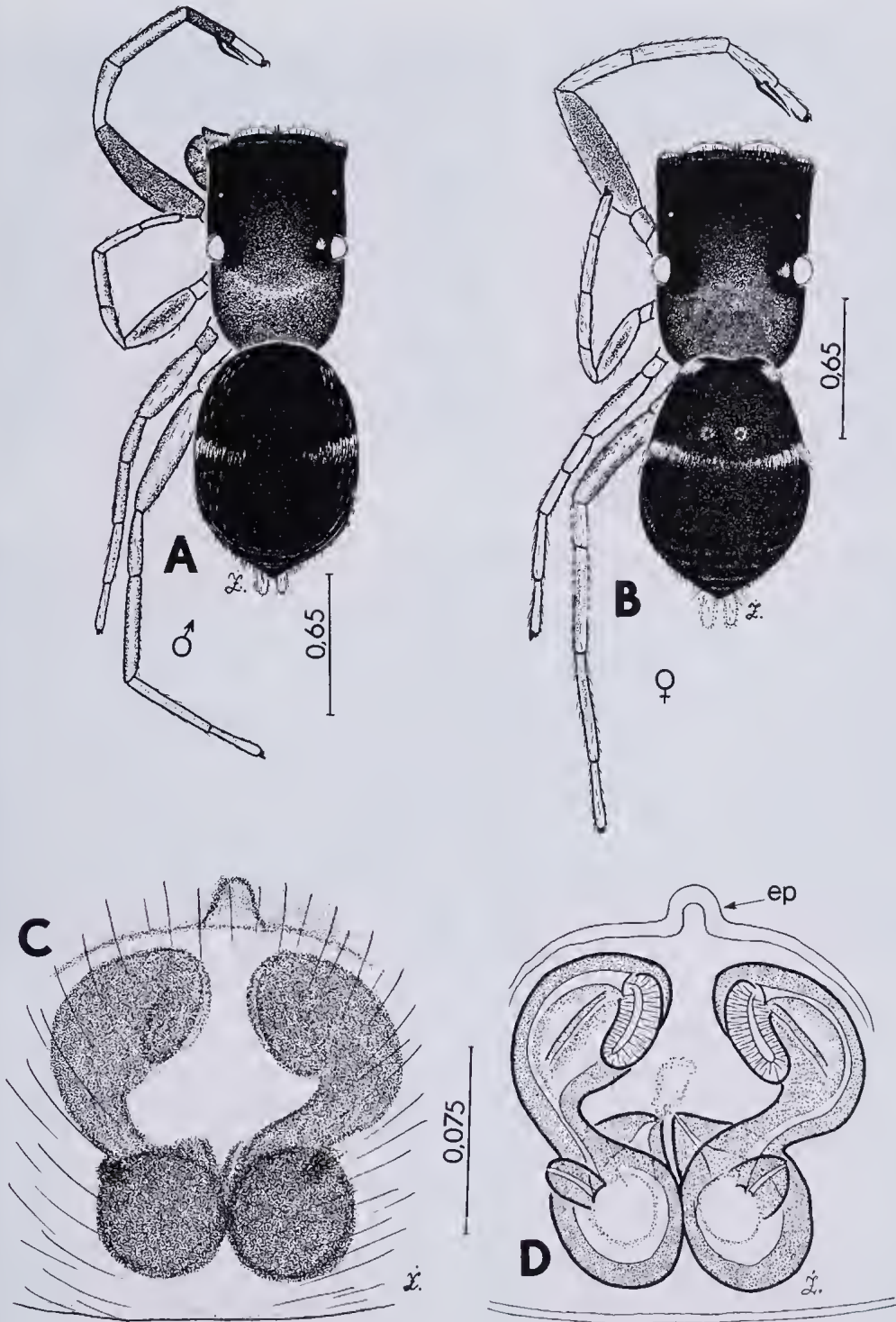


FIG. 14. *Pseudosynagelides raveni* sp. nov. general appearance of both sexes and genitalia of female.

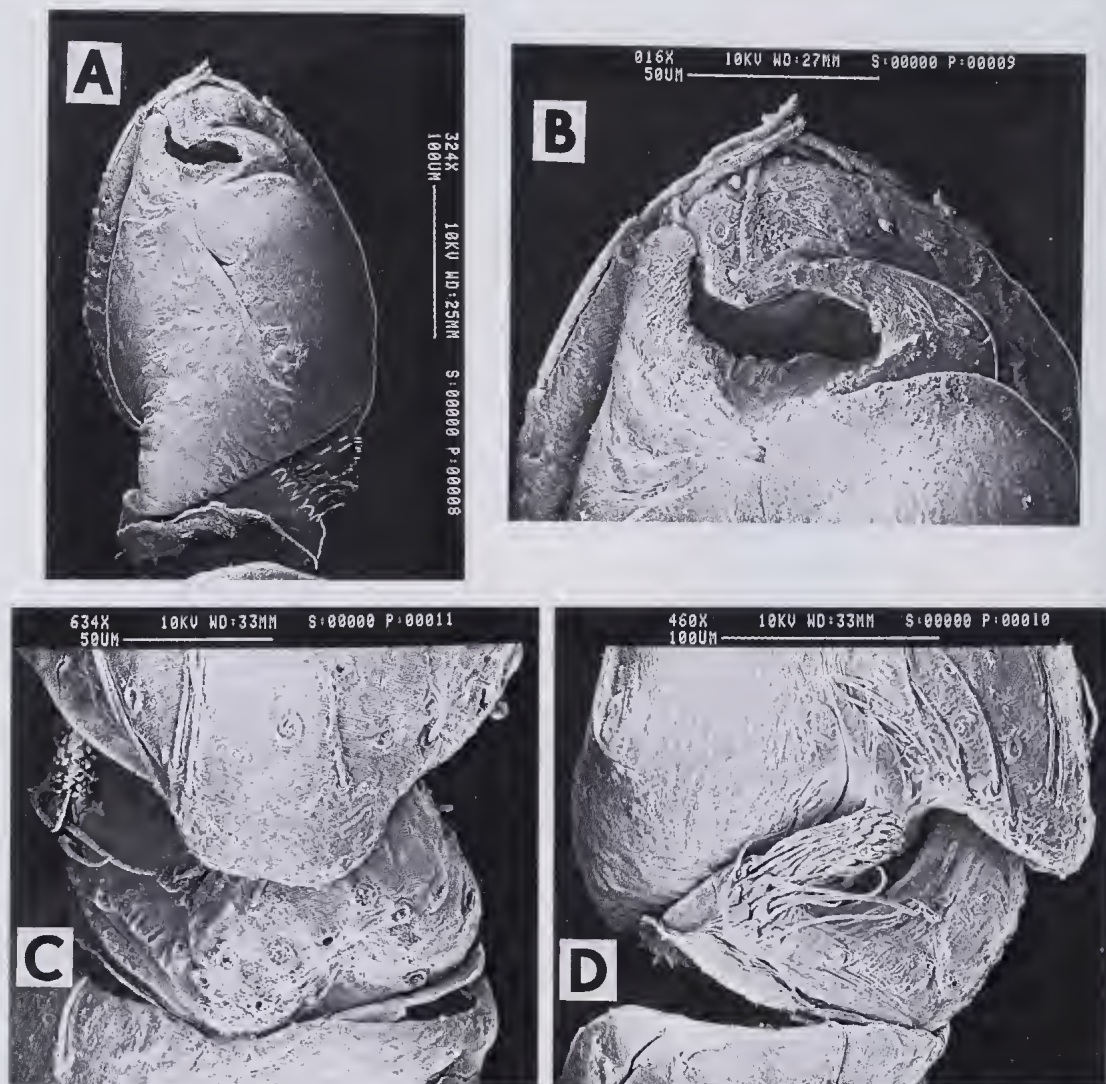


FIG. 15. *Pseudosynagelides raveni* sp. nov. male: palpal organ.

Monteith, D.K. Yeates, G.I. Thompson, QMB S4706; ♂, Mt. Finnigan summit via Helenvale, 1100 m, rainforest, pyrethrum knockdown, 28.XI.1985, G.B. Monteith, D. Cook, QMB S4768; 5♂, 5♀, 2juv., 2.5 km N Mt. Lewis via Julatten, 1040 m, rainforest, Berlesate 611-613, sieved litter, 3.XI.1983, D.K. Yeates, G.I. Thompson, QMB S4714, S4715, S4739

#### DIAGNOSIS

Abdominal scutum in both sexes missing. Male palpal organ with conductor, tegular apophysis knobby on the top, dorsal cymbial apophysis distinctive. Female epigyne without pocket.

*Male* (Fig. 10B). Cephalic part dark-grey to

black, thorax dirty- orange to brown. Whole cephalothorax covered with grey and black hairs. Median part of abdomen dirty-yellow to dirty-orange, laterally darker. Along sides white-yellow band present. Spinnerets long, dirty-orange. Chelicerae pale-yellow to orange, maxillae, labium and sternum orange to dirty-orange. Venter yellow to pale-orange. Legs pale-yellow to dirty-orange, darker laterally. Leg I the darkest, with 2 pairs of metatarsal spines.

Palpal organ (Figs 11, 12A-D) with conductor, tegular apophysis knobby on the top.

Dimensions. CL 0.99-1.10 (1.03), EFL 0.58-0.60 (0.59), AEW 0.68-0.76 (0.72), PEW 0.73-0.80 (0.76), AL 0.95-1.15 (1.03).

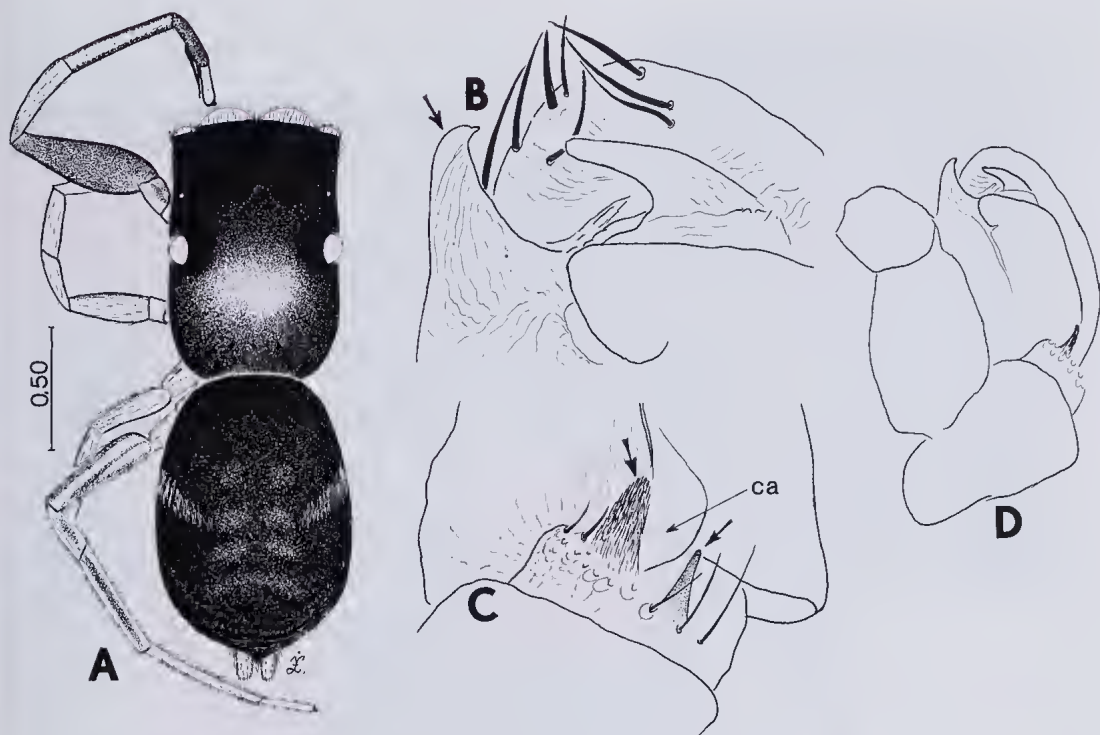


Fig. 16. *Pseudosynagelides australensis* sp. nov. male: general appearance and palpal organ.

*Female* (Fig. 10A). Cephalothorax similar to that in male. Abdomen more robust, dark-grey with light pattern formed by tufts of hairs. Spinnerets long, light. Chelicerae, maxillae, labium, sternum and legs similar to that in male, venter whitish.

Genitalia (Fig. 10C,D) relatively simple, proximal parts of insemination ducts cup-like and accessory glands in their proximal parts. Spermathecae double-chambered, elongate.

Dimensions. CL 1.20-1.25 (1.23), EFL 0.66-0.71 (0.69), AEW 0.80-0.85 (0.84), PEW 0.85-0.90 (0.88), AL 1.25-1.50 (1.32).

***Pseudosynagelides raveni* sp. nov.**  
(Figs 12E-G, 13-15)

**MATERIAL EXAMINED**

Queensland: Holotype: ♂, Allotype: ♀, Rochedale State Forest, litter, 30.VI.1980, V. Davies, R. Raven, QMB S4749. New South Wales: Paratypes: ♂, ♀, Benandarah State Forest, 8 km N of Batemans Bay, in litter, pitfall trap, 30.XI.1978, AMS KS2286; ♀, Lorne State Forest, Kendall Forest, Mena Cement

area, site 87.2, in litter, pitfall trap, 27.VIII.1978, D. Milledge, AMS KS19453.

**ETYMOLOGY**

For Dr. Robert Raven, Queensland Museum, Brisbane.

**DIAGNOSIS**

Abdominal scutum in male present. Female epigyne with anterior pocket. Male palpal organ without conductor, retrolateral tibial apophysis brush-like, oriented dorsally, dorsal cymbial apophysis missing.

*Male* (Fig. 14A). Eye field dirty-brown, thorax brown, lighter medially, with radial darker stripes towards lower margin. Abdomen with blackish scutum and with traces of transverse stripe of white hairs. Spinnerets yellow. Clypeus grey-brown, chelicerae dirty-yellow. Maxillae, labium and sternum light-grey. Venter blackish, medially lighter. Femora and metatarsi I grey-brown, proximal patella dark dorsally, tibia with dark dorsal and ventral stripes. Leg II dark along femur, patella and tibia, leg III additionally with metatarsal stripe, leg IV also with tarsal stripe.

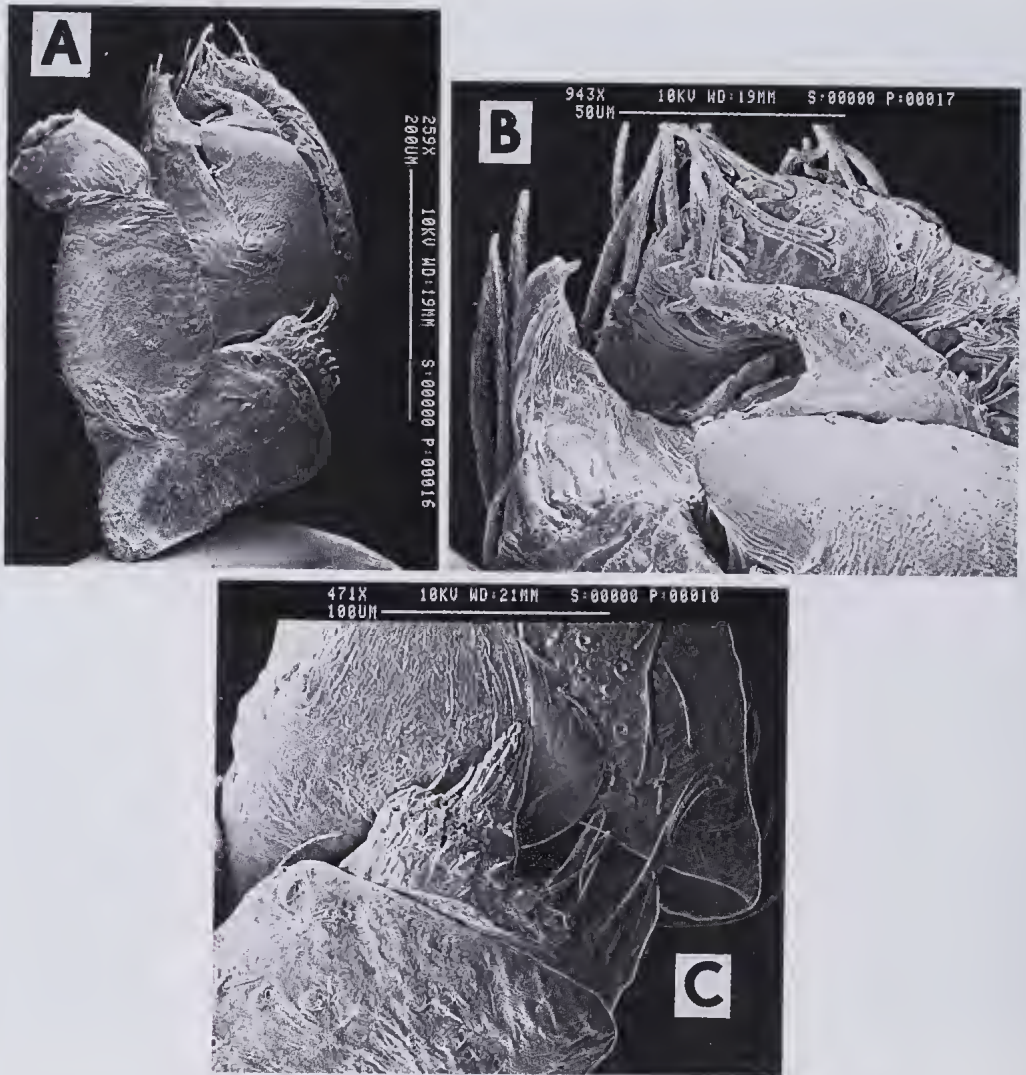


Fig. 17. *Pseudosynagelides australensis* sp. nov.: male: palpal organ.

Palpal organ (Figs 12E-G, 15A-D) with hook-like embolus and brush-like retrolateral tibial apophysis, conductor absent.

Dimensions. CL 0.99-1.05 (1.12), EFL 0.54-0.55 (0.54), AEW 0.62-0.65 (0.64), PEW 0.67-0.68 (0.67), AL 1.07-1.10 (1.09).

*Female* (Fig. 14B). Cephalothorax similar to the male. Abdomen without distinctive scutum, dark, with transverse stripe of white hairs, lighter apodemes and two anterior white spots. Spinnerets yellowish. Chelicerae, maxillae, labium

and sternum pale-grey. Venter dark-grey with large median light spot. Leg I pale, only patella and tibia distally darker. Femur and tibia with dark-grey dorsal stripe. Legs II-IV pale-yellow with dark stripes along femur, patella and tibia.

Epigyne (Fig. 14C,D) with anterior pocket. Double accessory glands present. In comparison to *P. yorkensis* insemination ducts and spermathecae of different shape.

Dimensions. CL 1.05-1.25 (1.12), EFL 0.60-

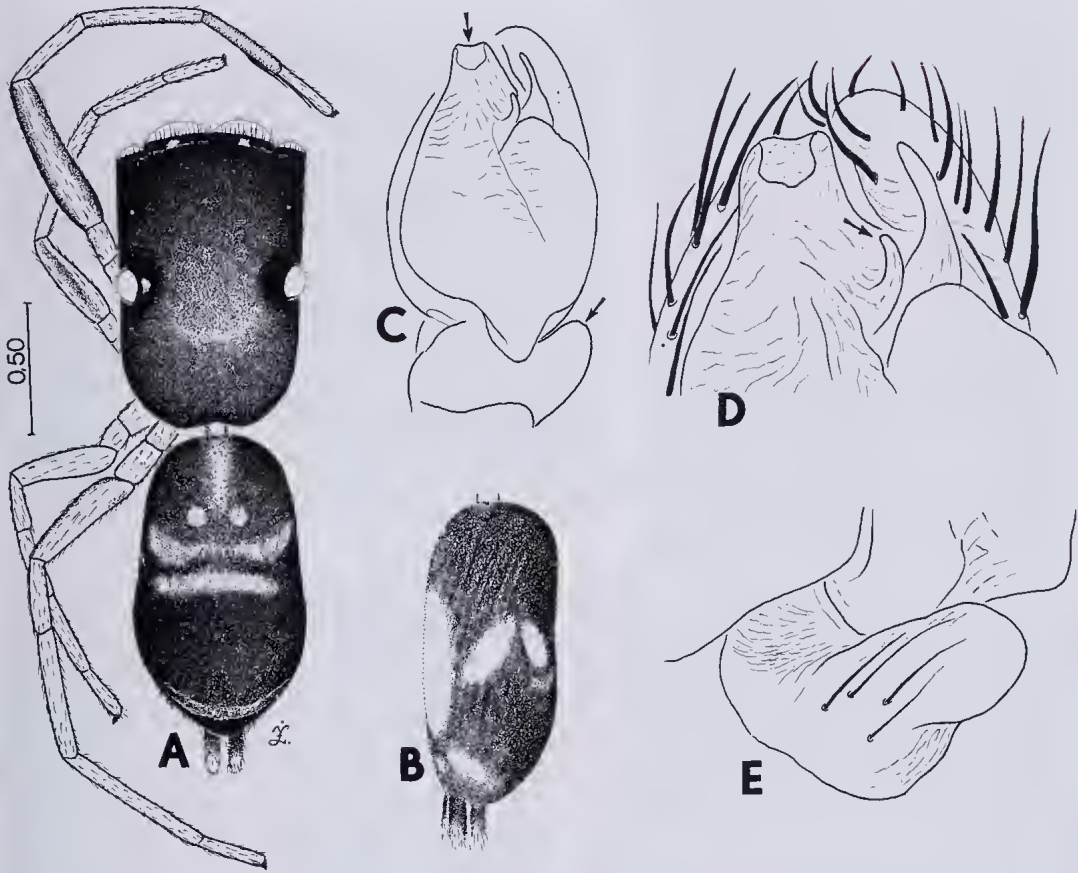


FIG. 18. *Pseudosynagelides monteithi* sp. nov. ♂ general appearance, lateral view of abdomen and palpal organ.

0.70 (0.64), AEW 0.70-0.76 (0.73), PEW 0.74-0.85 (0.77), AL 1.05-1.60 (1.30).

***Pseudosynagelides australensis* sp. nov.**  
(Figs 13,16,17)

**MATERIAL EXAMINED**

Queensland: Holotype: ♂, Rochedale State Forest, litter, pitfall traps, 2.IX-11.X.1979, V. Davies, R. Raven, QMB S4750.

**DIAGNOSIS**

Abdomen with characteristic colour pattern. Two tibial apophyses present: retrolateral one brush-like, but unlike *P. raveni* oriented apically. Dorsal cymbial apophysis and conductor missing.

*Male* (Fig. 16A). Eye field dark-brown, thorax lighter, dirty. Central part of cephalothorax dark-orange. Abdomen similar to that in *P. raveni*, with brown scutum and lighter pattern. Spin-

nerets yellow. Clypeus dark, chelice-rae, maxillae and labium orange, sternum dirty-orange. Venter dark-grey with dirty-orange median stripe. Leg I with grey-brown femur and metatarsus, tibia dark dorso-ventrally. Other segments yellowish. Leg II-IV lighter with dark longitudinal stripes - especially on prolateral surfaces.

Palpal organ (Figs 16B-D, 17A-C) very similar to *P. raveni*, but retrolateral tibial apophysis of different shape, also retrodorsal apophysis present.

Dimensions. CL 1.00, EFL 0.62, AEW 0.64, PEW 0.68, AL 1.12.

The female is unknown.

***Pseudosynagelides monteithi* sp. nov.**  
(Figs 13,18,19)

**MATERIAL EXAMINED**

Queensland: Holotype: ♂, Windin Falls, NW Mt.

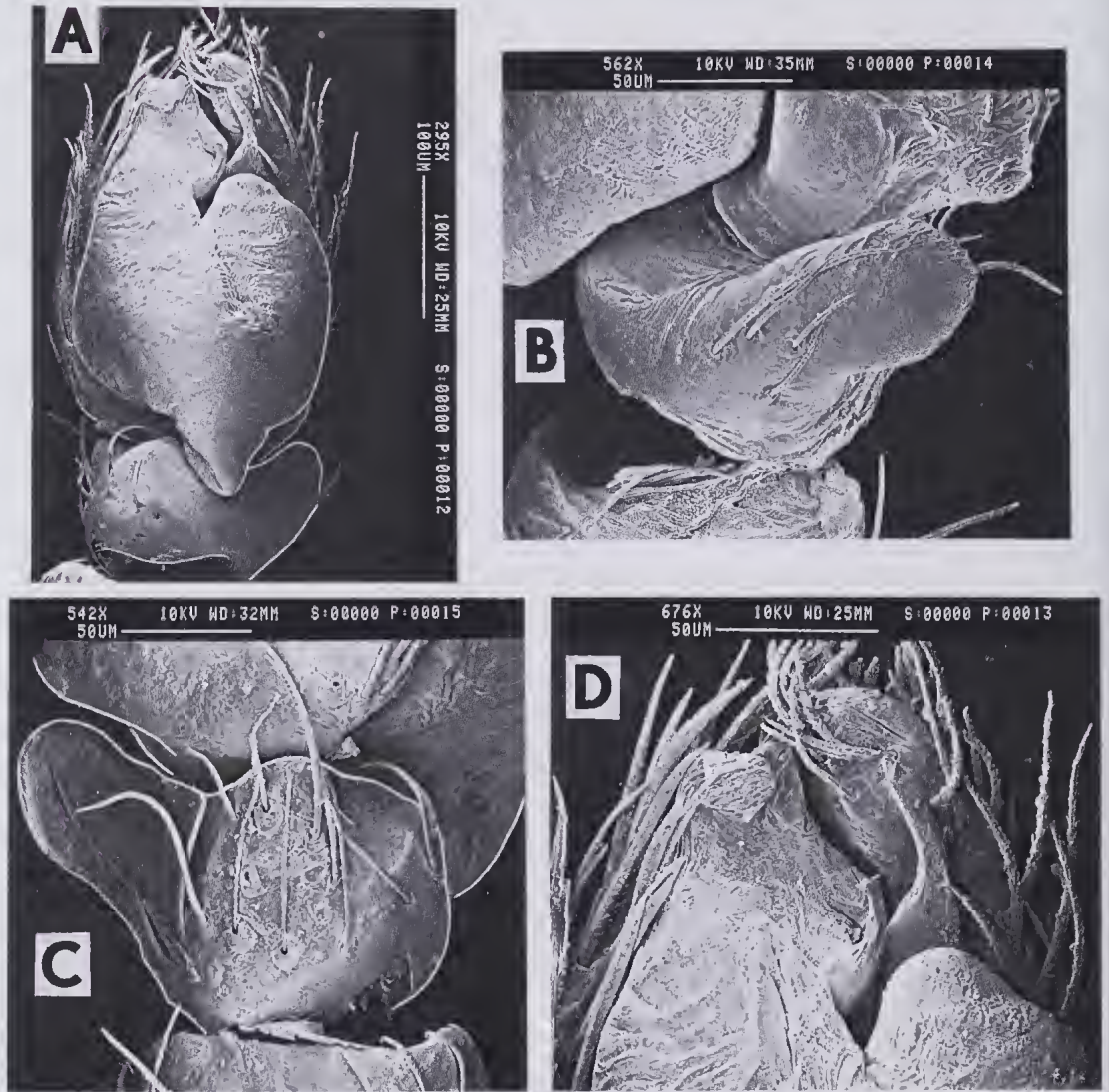


FIG. 19. *Pseudosynagelides monteithi* sp. nov. male: palpal organ.

Bartle-Frere, 580 m, Berlesate 244, 9.X.1980, G.B. Monteith, QMB S4718.

#### ETYMOLOGY

For Dr. Geoffrey Monteith, Queensland Museum, collector of a large part of the material studied.

#### DIAGNOSIS

Abdominal scutum absent, colour pattern similar to the female of *P. yorkensis*. Palpal organ with conductor, tegular apophysis with apical collar. Tibia with single retrolateral spatular apophysis.

*Male* (Fig. 18A,B). Eye field dark-brown, thorax dirty-orange-brown, lighter centrally. Abdomen rather elongate, without scutum, dark-grey with lighter, yellowish pattern. Spinnerets grey with yellow tips. Clypeus dark, chelicerae and sternum dirty-orange, maxillae and labium yellowish, venter dark with large light spot. Femur I grey, lighter dorso-ventrally, tibia yellow, darker laterally, metatarsus dirty-orange, tarsus yellow. Other legs yellow with dark longitudinal stripes on prolateral femoral surfaces.

Palpal organ (Figs 18C-E, 19A-D) with wide spatular retrolateral tibial apophysis, conductor present, tegular apophysis with apical collar.

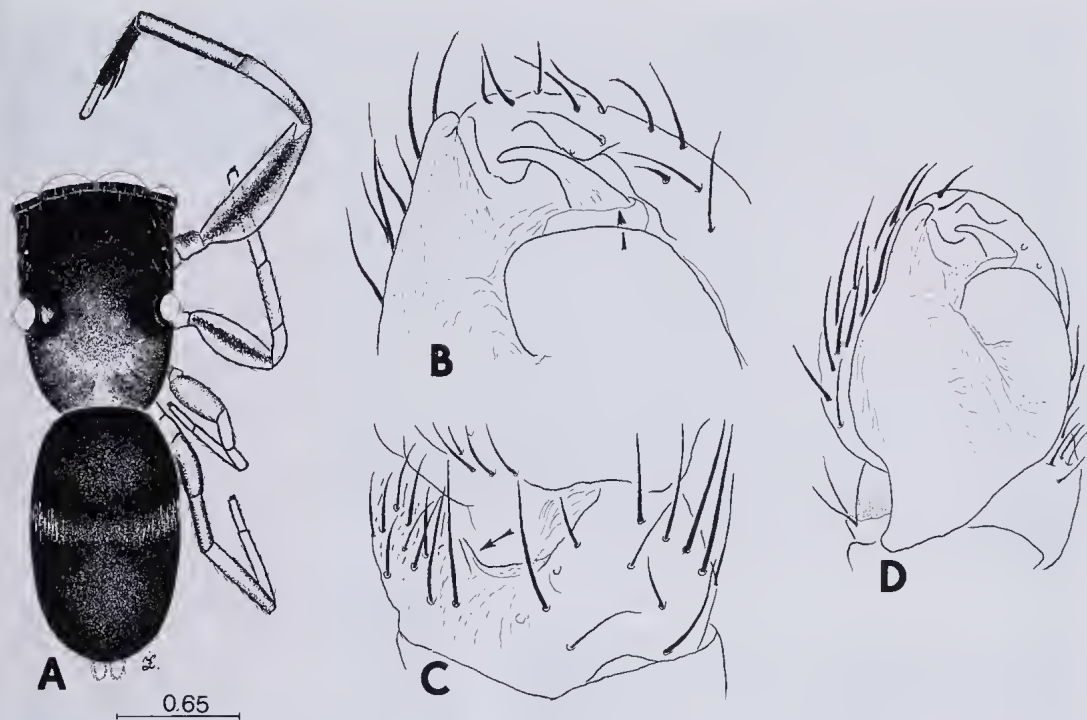


Fig. 20. *Pseudosynagelides elae* sp. nov. ♂, general appearance and palpal organ.

Dimensions. CL 1.05, EFL 0.55, AEW 0.71, PEW 0.73, AL 1.10.

The female is unknown.

*Pseudosynagelides elae* sp. nov.  
(Figs 13,20,21)

MATERIAL EXAMINED

Queensland: Holotype: ♂, Upper Tallebudgera Valley, Below Springbrook, 550 m, rainforest, pitfall traps, 8.I-17.III.1985, G.B. Monteith, D. Cook, G.I. Thompson, QMB S4698.

ETYMOLOGY

For my wife Elizabeth (Ela in Polish).

DIAGNOSIS

Colour pattern and palpal organ similar to *P. raveni*, but tibia wider with two apophyses and the basis of embolus with distinctive ridge.

*Male* (Fig. 20A). Eye field dark, thorax lighter with radial darker lines. Abdomen with scutum, dark-brown, with transverse lighter stripe. Spinnerets yellow. Clypeus almost black, chelicerae, maxillae and labium grey-orange, sternum similar with dirty margin. Venter grey-brown with wide central yellowish stripe. Leg I with

dark metatarsus and femur, other segments light, darker around joints, tibia darker dorsoventrally. Other legs light, darker laterally. Femora of all legs with prolateral dark stripe.

Palpal organ (Figs 20B-D,21A-D) similar to *P. raveni* but embolus slightly different and tibia with additional retrodorsal apophysis.

Dimensions. CL 1.15, EFL 0.70, AEW 0.82, PEW 0.82, AL 1.35.

The female is unknown.

*Pseudosynagelides bunya* sp. nov.  
(Figs 13,22,23)

MATERIAL EXAMINED

Queensland: Holotype: ♂, Bunya Mts, rainforest, Berlesate 200, sieved litter, 2.X.1979, G.B. Monteith, QMB S4718.

DIAGNOSIS

Tibia of palpal organ with two apophyses - retrolateral one hooked. Conductor missing.

*Male* (Fig. 22A). Cephalothorax dirty-brown, lighter centrally. Abdomen with dark, dirty-brown scutum, two spots of white anterior spots and transverse median stripe. Spinnerets yellowish. Clypeus dark, chelicerae, maxillae and

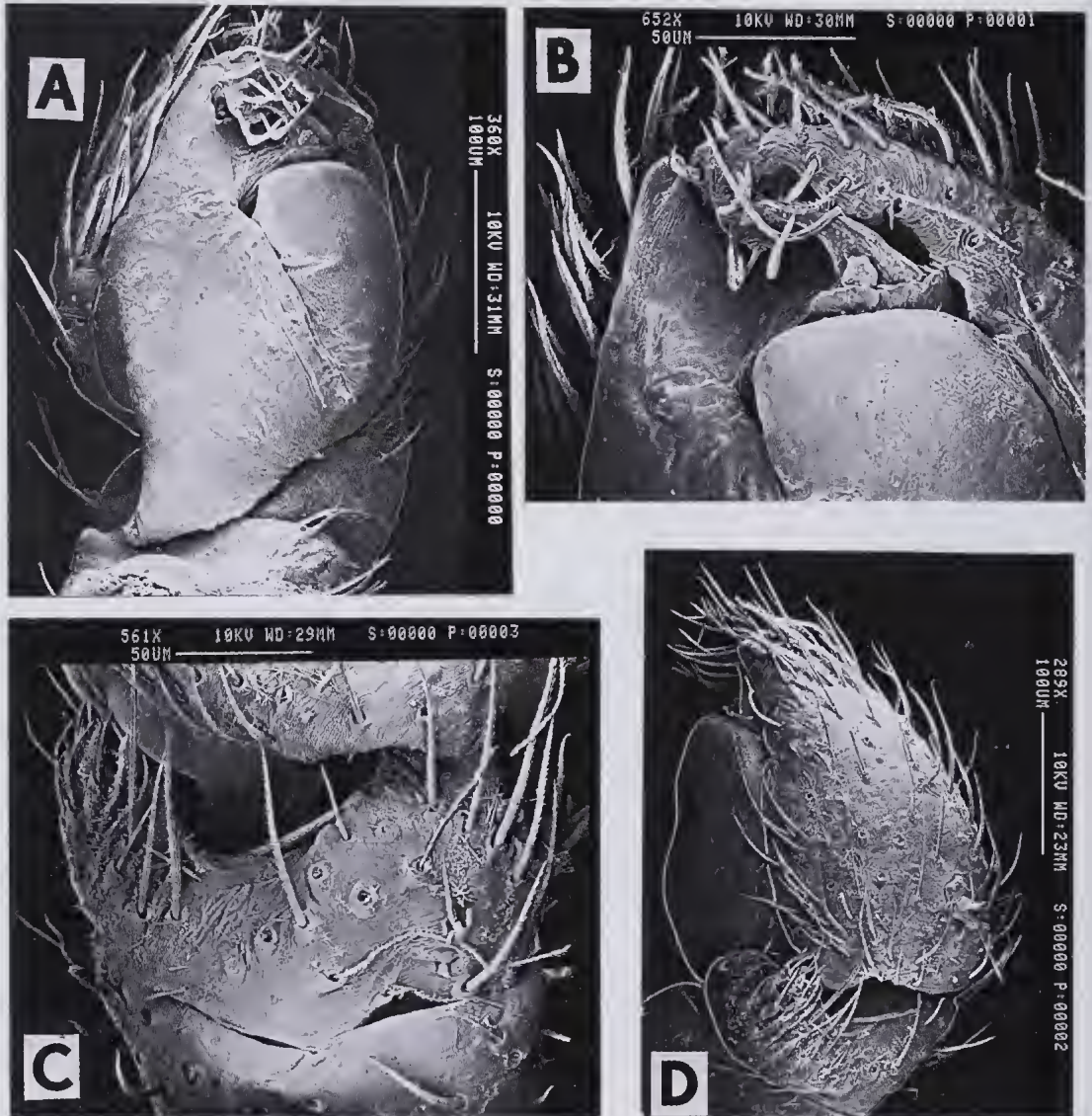


FIG. 21. *Pseudosynagelides elae* sp. nov., ♂, palpal organ.

labium dirty-orange, sternum dirty-yellow with darker margin. Venter dark-grey, with light median stripe. Femur I dirty-brown, patella and tibia lighter, other segments yellow. Further legs lighter with dark prolateral stripes, especially on femora.

Palpal organ (Figs 22B-D, 23A-D) with characteristic retrolateral tibial apophysis. Embolus hook-like, conductor absent.

Dimensions. CL 1.20, EFL 0.66, AEW 0.80, PEW 0.85, AL 1.25.

The female is unknown.

#### ACKNOWLEDGEMENTS

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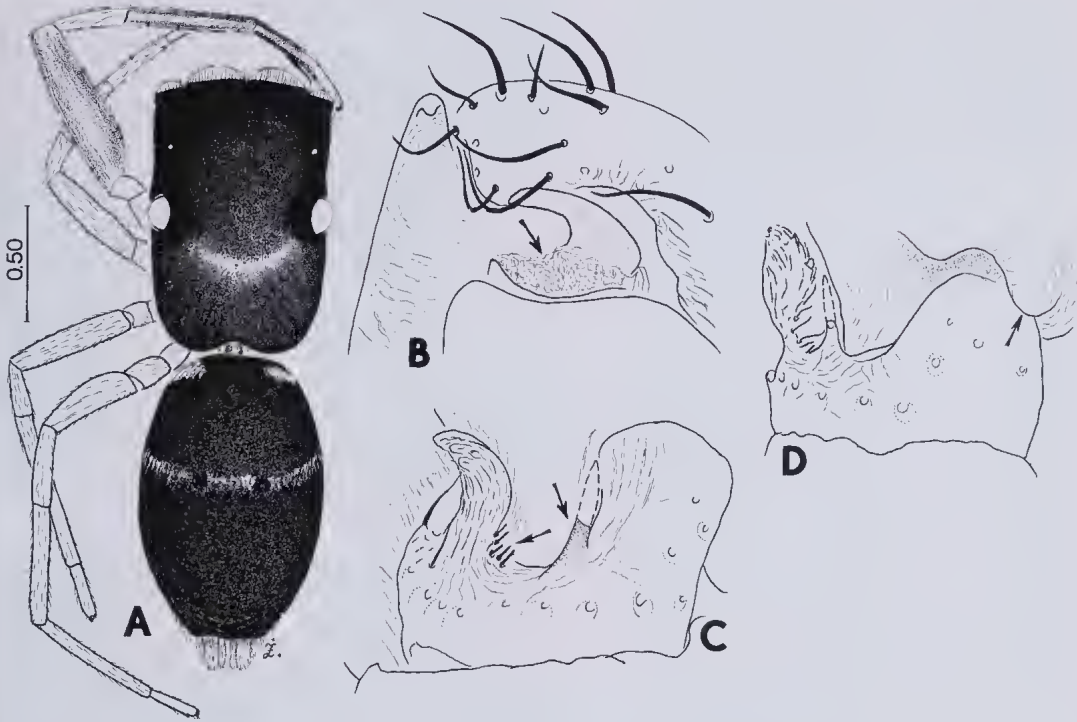


Fig. 22. *Pseudosynagelides bunya* sp. nov., ♂, general appearance and palpal organ.

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#### LITERATURE CITED

- BOHDANOWICZ, A. 1988. Salticidae from the Nepal Himalayas. The genus *Synagelides* Bösenberg & Strand 1906. Courier Forsch.-Inst. Senckenberg 93: 65–86.
- DAVIES, V.T. AND ZABKA, M. 1989. Illustrated keys to the genera of jumping spiders (Araneae: Salticidae) in Australia. Mem. Qd Mus. 27(2): 189–266.
- KOCH, L. 1879. Die Arachniden Australiens, nach der Natur beschrieben und abgebildet. 2: 1045–1156 (Bauer & Raspe: Nürnberg).
- PLATNICK, N.I. AND SHADAB, M.U. 1975. A revision of the spider genus *Gnaphosa* (Araneae: Gnaphosidae) in America. Bull. Amer. Mus. Nat. Hist. 155(1): 1–66.
- PETRUNKEVITCH, A. 1928. Systema Araneorum. Trans. Conn. Acad. Arts Sci. 29: 1–270.
- PROSZYNSKI, J. 1976. Studium systematyczno-zoogeograficzne nad rodziną Salticidae (Aranei) Regionów Palearktycznego i Nearktycznego. Rozprawy WSP, Siedlce [6]: 1–260.
- SIMON, E., 1901. Histoire naturelle des Araignées 2(3): 381–668.
1903. Histoire naturelle des Araignées 2(4): 669–1080.
- ZABKA, M. 1985. Systematic and zoogeographic study on the family Salticidae (Araneae) from Viet-Nam. Ann. zool. 39(11): 197–485.
- 1987a. Salticidae (Araneae) of Oriental, Australian and Pacific Regions, I. Genera *Clynotis* and *Tara*. Ann. zool. 40(10): 437–450.
- 1987b. Salticidae (Araneae) of Oriental, Australian and Pacific Regions, II. Genera *Lycidas* and *Maratus*. Ann. zool. 40(11): 451–482.
1988. Salticidae (Araneae) of Oriental, Australian and Pacific Regions, III. Ann. zool. 41(14): 421–479.
1990. Salticidae (Araneae) of Oriental, Australian and Pacific Regions, IV. Genus *Ocrisiona* Simon, 1901. Rec. Austral. Mus. 42: 27–43.

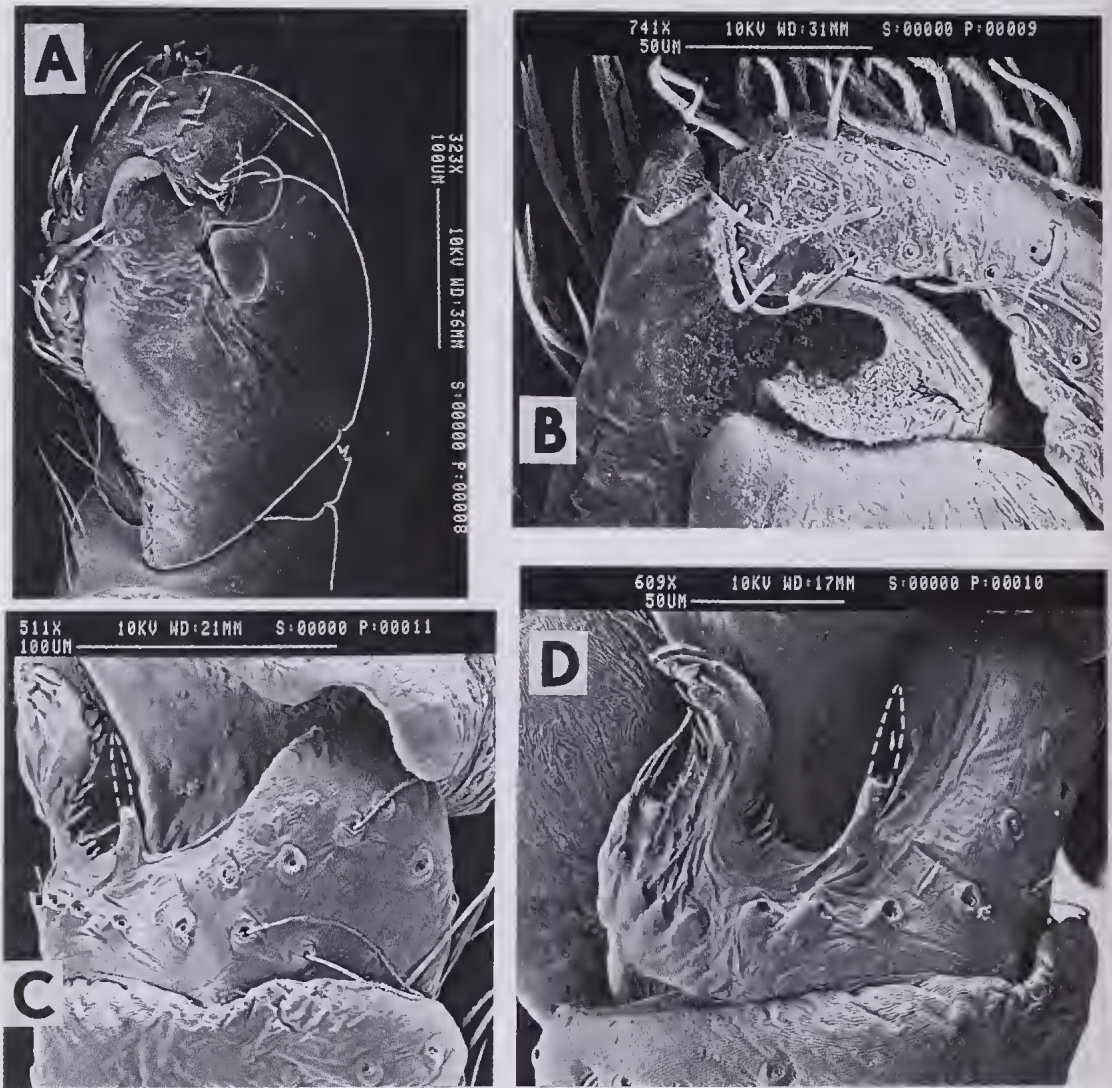


Fig. 23. *Pseudosynagelides bunya* sp. nov., ♂, palpal organ.