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FOSSIL MOLLUSC TYPE SPECIMENS IN THE SOUTH AUSTRALIAN MUSEUM 1. POLYPLACOPHORA

BY K. L. GOWLETT-HOLMES & B. J. MCHENRY

Summary

The South Australian Museum collection of fossil chiton types is the largest in the southern hemisphere. It contains primary type material, and some secondary types, of 63 species and subspecies. A further species is represented only by secondary types. All species are from the Tertiary strata of Victoria, South Australia, Tasmania and New Zealand. Species are listed alphabetically according to the original name of the genus or species.

FOSSIL MOLLUSC TYPE SPECIMENS IN THE SOUTH AUSTRALIAN MUSEUM

1. POLYPLACOPHORA

K. L. GOWLETT-HOLMES & B. J. MCHENRY

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The South Australian Museum collection of fossil chiton types is the largest in the southern hemisphere. It contains primary type material, and some secondary types, of 63 species and subspecies. A further species is represented only by secondary types. All species are from the Tertiary strata of Victoria, South Australia, Tasmania and New Zealand. Species are listed alphabetically according to the original name of the genus or species.

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Most of the fossil chiton types in the South Australian Museum are due to the work of E. Ashby, mainly in conjunction with B.C. Cotton and W.G. Torr. Other fossil chiton types are the result of the work of Cotton & Godfrey. Since Cotton & Godfrey (1940) little has been published on Australian fossil chitons, and no further types have been added to the collection.

We believe that the South Australian Museum collection of fossil chiton types is the largest in the southern hemisphere and one of the more significant collections in the world. It includes type material for 64 species or subspecies, all of which have been verified by us according to available material and information. The specimens are all individual valves, and are listed as 'complete' when the insertion plates and sutural lamina are present, as 'incomplete' when these are missing or the valve slightly damaged, or as 'fragment' when less than half of the valve is present in one piece.

In the following list, species are arranged alphabetically in families under the original name at the time of description. Changes in familial status have been cross-referenced. The present status of each species is, unless indicated otherwise, according to van Belle (1981), except that the family Afossochitonidae is not recognised following Gowlett-Holmes (1987). The following abbreviations are used in the text: NMV = Museum of Victoria, Melbourne; N.Z. = New Zealand; S.A. = South Australia; SAMA = South Australian Museum, Adelaide; Tas. = Tasmania; Vic. = Victoria.

STRATIGRAPHICAL NOTES

All fossil chiton types in the South Australian Museum come from the Tertiary strata of Victoria, South Australia, Tasmania and New Zealand, ranging from early Miocene to late Pliocene (Tables 1, 2). During this study it was noticed that there were several inaccuracies and ambiguities in the geological data of the original type descriptions, so it is necessary to make some corrections and clarifications at this stage. According to Johnston (1877), the fossiliferous beds at Table Cape, Tasmania, occur at two small bluffs near the township of Wynyard. The Table Cape Group exposed here includes two formations; the Freestone Cove Sandstone (the 'Crassatella Beds' of Johnston) which grades upwards into the overlying Fossil Bluff Sandstone (Banks 1962). Ashby (1929) proposed the 'Lower Bed' at Table Cape to be the type locality and horizon for *Loricella gigantea* Ashby & Torr, 1901. Quilty (1972) refers to 'chiton plates in the lower six inches' of the Freestone Cove Sandstone and we believe this to be the level from which the Ashby specimens were collected. At that time, the age of the fossil deposits at Table Cape was thought to be Eocene (Johnston 1880, 1885; Pritchard 1896) and was until quite recently believed to be Janjukian (Banks 1962). Later studies (Quilty 1966; Ludbrook 1967a, 1973) have shown these strata to be Longfordian, thus the Janjukian age of the Table Cape chiton types needs further consideration.

The original description of *Lepidopleurus clifdenensis* Ashby, 1929 states that this species is from Clifden at the southern end of the South Island of New Zealand and is Hutchinsonian (basal early Miocene) in age, but no stratigraphical data are supplied. Both B.L. Wood in Suggate *et al.* (1978) and Ludbrook (1967b) indicate that Hutchinsonian strata at Clifden are most likely the Clifden Limestone, and so we believe this to be the formation from which this species was collected.

The fossil locality at Gellibrand River, Victoria, occurs in either the Longfordian–Batesfordian Gellibrand Marl or the underlying Janjukian Longfordian Clifton Formation. Both of these units crop out on the

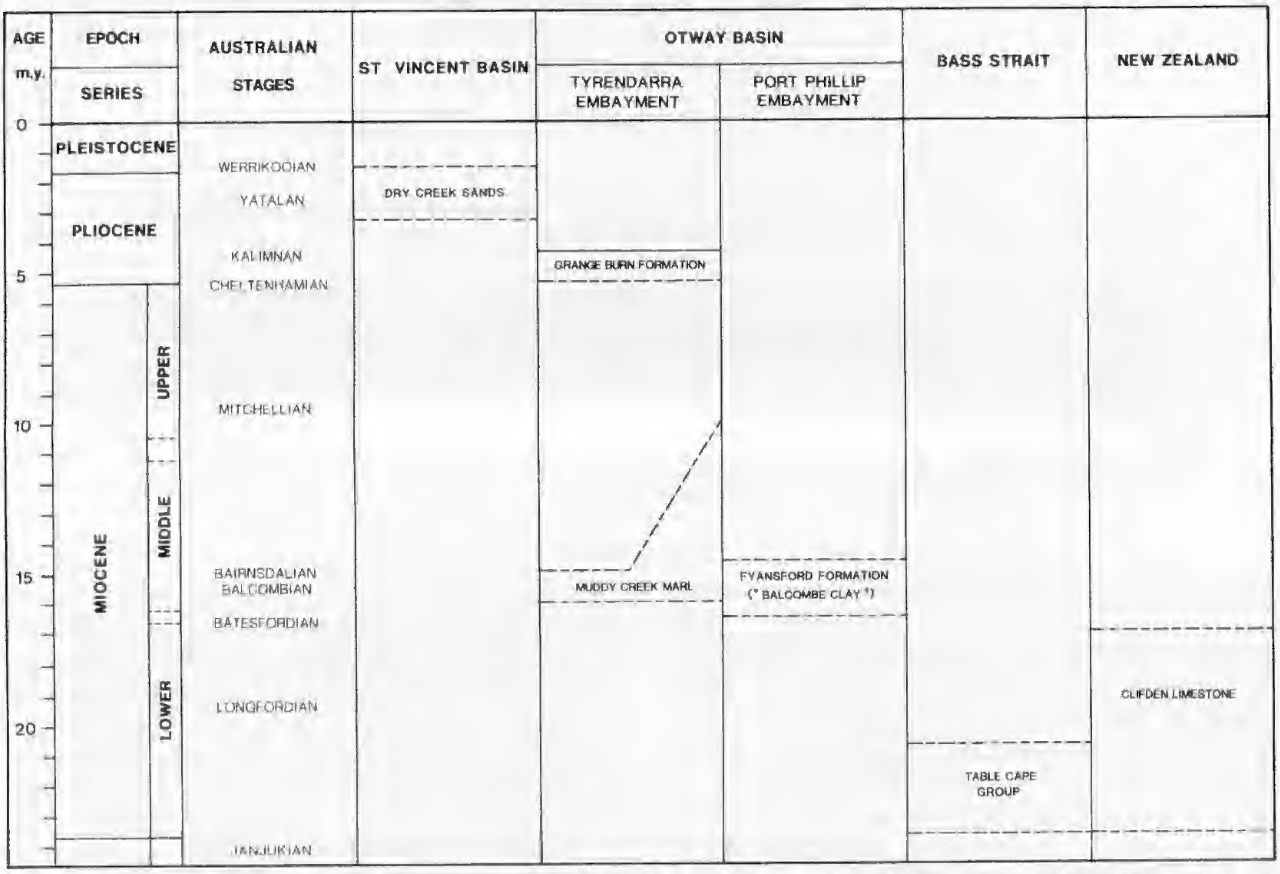

TABLE 1. Generalised correlation chart for the relevant fossil chiton horizons of south-eastern Australia and New Zealand.

ADELAIDE PLAINS DRY CREEK SANDS UPPER PLIOCENE	MACDONDONALDS, FORSYTHS GRANGE BURN FORMATION MIDDLE PLIOCENE	CLIFTON BANK MUDDY CREEK MARL MIDDLE MIOCENE	MORNINGTON BALCOMBE CLAY LOWER-MIDDLE MIOCENE	BASS STRAIT TABLE CAPE GROUP LOWER MIOCENE	NEW ZEALAND CLIFDEN LIMESTONE LOWER MIOCENE
Acanthochiton (Eoplax) adelaidae *Chiton (Anthochiton) tricostalis relata* *Cryptoplax ludbrookae*	*Acanthochiton drunus* *A. forsythensis* *A. (Lirachiton) inexpectus* *A. singletoni* *A. trianguloides* *Afossochiton (Telochiton) magnicostatus* *A. sulci* *Anthochiton duodeni* *A. macdonaldensis* *A. octocostatus* *Cryptoplax numicus* *C. sicus* *Callistochiton greedi* *C. inexpectus* *C. reticulatus* *Callochiton macdonaldi* *Isochnochiton cossyrus* *I. durius* *I. neglectus* *I. numantius* *I. tisurus* *I. vatenae* *I. vinazus* *Belchiton pulcherrimus* *Lepidopleurus babidus* *L. badioides* *L. sephus* *L. sinervus* *L. singus* *L. uxellus* *Molachiton naxus* *Loricella concava* *L. magnipustulosa*	*Acanthochiton casus* *A. pilsbryoides* *A. sabratus* *Afossochiton cudmorei* *A. (Telochiton) dendus* *A. (Telochiton) iscus* *Callistochiton reticulatus* *Ischnochiton (Rasiella) cliftonensis* *Lepidopleurus badioides* *L. diversigranosus* *L. magnogranifer* *L. nivarus* *L. pamphilius* *L. relatus* *Aulacochiton erma* *Lorica oculea* *L. varena* *Oochiton halli*	*Acanthochites (Notoplax) granulosis* *A. rostratus* *Acanthochiton balcombiensis* *Callochiton (Ocellochiton) sulci*	*Chiton fossicus* *C. paucipustulosa* *Lorica affinis* *L. compressa* *Loricella gigantea*	*Lepidopleurus clifdensis*

TABLE 2. Geographic and stratigraphic distribution of SAMA fossil chiton types. Species are listed under their original names, see text for changes and synonymies.

coast of western Victoria approximately 1 km north of the mouth of the Gellibrand River (Abele *et al.* 1976). Although the type specimens of *Plaxiphora concentrica* and *P. gellibrandi* were designated as coming from this locality, subsequent examination of the valves by the authors has led us to believe that the specimens are in fact recent examples of the living species *Plaxiphora (P.) albida*, and not fossil remains at all.

Species described from Mornington, Balcombe Bay and Schnapper Point, Victoria, all come from the early (Batesfordian) to middle (Bairnsdalian) Miocene Balcombe Clay, a unit within the Fyansford Formation which crops out along the eastern coast of Port Phillip Bay, Vic., in the region of Mornington. The two main fossil localities for this formation are Fossil Beach (the type section for the Balcombian Stage) and south of Manyung Rocks. It should be noted that at Schnapper Point the exposed sediments belong to the non-fossiliferous fluviatile Baxter Sandstone of Mitchellian to Cheltenhamian age (Gostin 1966), so it appears that the fossils described from this locality must represent material from either Fossil Beach or south of Manyung Rocks.

The species described from the Hamilton area of Victoria come from the fossil localities at MacDonalds (Bank), Clifton Bank and Forsyths (Bank). The locality at Clifton Bank occurs in the Balcombian–Bairnsdalian Muddy Creek Marl which crops out on Muddy Creek. Disconformably overlying this formation is the Kalimnan (early Pliocene) Grange Burn Formation which occurs on Muddy Creek at MacDonalds (Bank) and on Grange Burn at Forsyths (Bank) (Spencer-Jones 1971). It should be noted that Ashby's locality for Clifton Bank is incorrect, as it is situated on Muddy Creek not Grange Burn.

The species described from South Australia are from Torrensville Bore and Holden's Bore at Woodville, both in western suburbs of Adelaide. All three species come from the late Pliocene (Yatalan) Dry Creek Sands.Where possible, the original type localities have been updated.

Family **ACANTHOCHITONIDAE**

Genus **Acanthochites** Risso, 1826

Acanthochites (Notoplax) granulosus Ashby & Torr, 1901
Trans. R. Soc. S. Aust. **25**(2): 139, pl.4, fig. 9.
= *Protochiton granulosus* (Ashby & Torr, 1901) (PROTOCHITONIDAE).
Syntypes: T844, 1 incomplete median valve, from Schnapper Point, Mornington, Vic., Balcombe Clay, early to middle Miocene (Batesfordian – Bairnsdalian), collector and date of collection unknown.T845, 1 incomplete median valve, same collection data as T844.
Note: See note on Schnapper Point in the Stratigraphical Notes.

Acanthochites rostratus Ashby & Torr, 1901
Trans. R. Soc. S. Aust. **25** (2): 140, pl. 4, fig. 5.
= *Afossochiton rostratus* (Ashby & Torr, 1901).
Holotype: T841, 1 incomplete median valve, from Schnapper Point, Mornington, Vic., Balcombe Clay, early to middle Miocene (Batesfordian – Bairnsdalian), collected by R. Tate and J. Dennant, date of collection unknown.
Note: See note on Schnapper Point in Stratigraphical Notes. Type unique.

Genus **Acanthochiton** Gray, 1821 em. Iredale, 1915.

Acanthochiton (Eoplax) adelaidae Ashby & Cotton, 1936.
Rec. S. Aust. Mus. **5** (4): 510, fig. 2.
= *Notoplax adelaidae* (Ashby & Cotton, 1936).
Holotype: P10159 (ex D12882), 1 incomplete median valve, from 151 m depth, Torrensville Bore, Adelaide, S.A., Dry Creek Sands, late Pliocene (Yatalan), collected by W.J. Kimber, date of collection unknown.
Note: Type unique.

Acanthochiton balcombiensis Ashby, 1939
Proc. Linn. Soc. Lond. **151**(3): 188, pl. 3, fig. 4.
= *Acanthochitona balcombiensis* Ashby, 1939.
Holotype: P10160, 1 incomplete median valve, from Balcombe Bay, Mornington, Vic., Balcombe Clay, early to middle Miocene (Batesfordian–Bairnsdalian), collected by F.A. Cudmore, date of collection unknown. Note: Type unique.

Acanthochiton casus Ashby & Cotton, 1939
Rec. S. Aust. Mus. **6**(3): 214, pl. 20, fig. 30.
= *Acanthochitona casa* Ashby & Cotton, 1939.
Holotype: P4349, 1 incomplete median valve, from Clifton Bank, Muddy Creek, Hamilton, Vic., Muddy Creek Marl, early to middle Miocene (Balcombian–Bairnsdalian), collected by W. Greed, date of collection unknown.
Note: Cotton and Weeding (1941) suggest this species may be a juvenile of *Afossochiton cudmorei* Ashby, 1925, which is followed by van Belle (1981). However, we believe the specimen is adult and represents a distinct species of *Acanthochitona*. Type unique.

Acanthochiton drunus Ashby & Cotton, 1939
Rec. S. Aust. Mus. **6**(3): 214, pl.20, fig. 29.
= *Acanthochitona druna* Ashby & Cotton, 1939.
Holotype: P4348, 1 incomplete median valve, from MacDonalds (Bank), Muddy Creek, Hamilton, Vic., Grange Burn Formation, early Pliocene (Kalimnan), collected by W. Greed, date of collection unknown.
Note: Type unique.

Acanthochiton forsythensis Ashby & Cotton, 1939
Rec. S. Aust. Mus. **6**(3): 213, pl. 20, fig. 27.
=*Acanthochitona forsythensis* Ashby & Cotton, 1939.
Holotype: P4345, 1 incomplete median valve, from Forsyths (Bank), Grange Burn, Hamilton, Vic., Grange Burn Formation, early Pliocene (Kalimnan), collected by W. Greed, date of collection unknown.
Paratype: P10156, 1 incomplete median valve, with same collection data as holotype.
Note: The specimen from Clifton Bank recorded by Ashby & Cotton (1939) is missing, presumed lost.

Acanthochiton (Lirachiton) inexpectus Ashby & Cotton, 1939
Rec. S. Aust. Mus. **6** (3): 215, pl. 20, fig. 31.
=*Notoplax (Bassethullia) inexpecta* (Ashby & Cotton, 1939).
Holotype: P4350, 1 complete posterior valve, from MacDonalds (Bank), Muddy Creek, Hamilton, Vic., Grange Burn Formation, early Pliocene (Kalimnan), collected by W. Greed, date of collection unknown.
Note: Generic placement follows Gowlett-Holmes (1987). Type unique.

Acanthochiton pilsbryoides Ashby & Cotton, 1939
Rec. S. Aust. Mus. **6**(3): 216, pl .20, fig. 27.
= *Acanthochitona pilsbryoides* Ashby & Cotton, 1939.
Holotype: P4346, 1 complete median valve, from Clifton Bank, Muddy Creek, Hamilton, Vic., Muddy Creek Marl, early to middle Miocene (Balcombian–Bairnsdalian), collected by W. Greed, date of collection unknown.
Note: Type unique.

Acanthochiton sabratus Ashby & Cotton, 1939
Rec. S. Aust. Mus..**6**(3): 215, pl. 20, fig. 25.
= *Acanthochitona sabrata* Ashby & Cotton, 1939.
Holotype: P4344, 1 incomplete median valve, from Clifton Bank, Muddy Creek, Hamilton, Vic., Muddy Creek Marl, early to middle Miocene (Balcombian–Bairnsdalian), collected by W. Greed, date of collection unknown.
Note: Originally labelled and registered as *Acanthochiton parus*, later corrected to *A. sabratus*. *A. parus* may have been the original manuscript name, but was never published. Type unique.

Acanthochiton singletoni Cotton & Godfrey, 1940
'The Molluscs of South Australia Part II' p. 570, fig. 588.
= *Acanthochitona singletoni* Cotton & Godfrey, 1940.
Holotype: P4341, 1 complete median valve, from MacDonalds (Bank), Muddy Creek, Hamilton, Vic., Grange Burn Formation, early Pliocene (Kalimnan), collected by W. Greed, date of collection unknown.
Note: This specimen was originally recorded as *Afossochiton cudmorei* Ashby, 1925 by Ashby & Cotton (1939), and incorrectly labelled 'holotype' on the plate caption. Type unique.

Acanthochiton trianguloides Ashby & Cotton, 1939
Rec. S. Aust. Mus. **6**(3): 216, pl. 20, fig. 28.
= *Acanthochitona trianguloides* Ashby & Cotton, 1939.
Holotype: P4347, 1 incomplete median valve, from Forsyths (Bank), Grange Burn, Hamilton, Vic., Grange Burn Formation, early Pliocene (Kalimnan), collected by W. Greed, date of collection unknown.
Note: Type unique.

Genus **Afossochiton** Ashby, 1925

Afossochiton cudmorei Ashby, 1925
Proc. R. Soc. Vic. (NS) **37**(2): 179, pl. 18, figs 6, 7.
Paratypes: P10150, 1 incomplete median valve, from Clifton Bank, Muddy Creek, Hamilton, Vic., Muddy Creek Marl, early to middle Miocene (Balcombian–Bairnsdalian), collector and date of collection unknown. T846, 1 incomplete median valve, same collection data as P10150.
Note: P10150 is registered as from Balcombe Bay, Vic. and labelled as from MacDonalds, Muddy Creek. However, as it is definitely Ashby's (1925) figured specimen 'No. 2, paratype' we regard both the register and the label as incorrect. T846 corresponds to Ashby's (1925) specimen 'No. 3, paratype'. Holotype in NMV (P13311).

Afossochiton (Telochiton) dendus Ashby & Cotton, 1939
Rec. S. Aust. Mus. **6**(3): 211, pl. 20, fig. 24.
= *Afossochiton dendus* Ashby & Cotton, 1939.
Holotype: P4342, 1 incomplete anterior valve, from Clifton Bank, Muddy Creek, Hamilton, Vic., Muddy Creek Marl, early to middle Miocene (Balcombian–Bairnsdalian), collected by W. Greed, date of collection unknown.
Note: Type unique.

Afossochiton (Telochiton) iscus Ashby & Cotton, 1939
Rec. S. Aust. Mus. **6**(3): 212, pl. 19, fig. 20.
= *Afossochiton iscus* Ashby & Cotton, 1939.
Holotype: P4339, 1 complete posterior valve, from Clifton Bank, Muddy Creek, Hamilton, Vic., Muddy Creek Marl, early to middle Miocene (Balcombian–Bairnsdalian), collected by W. Greed, date of collection unknown.
Note: Type unique.

Afossochiton (Telochiton) magnicostatus Ashby & Cotton, 1939
Rec. S. Aust. Mus. **6**(3): 212, pl. 20, fig. 23.

=*Afossochiton magnicostatus* Ashby & Cotton, 1939.
Holotype: P4343, 1 incomplete median valve, from MacDonalds (Bank), Muddy Creek, Hamilton, Vic., Grange Burn Formation, early Pliocene (Kalimnan), collected by W. Greed, date of collection unknown.
Note: Type unique.

Afossochiton sulci Ashby & Cotton, 1939
Rec. S. Aust. Mus. **6**(3): 210, pl. 20, fig. 21.
Holotype: P4340, 1 complete anterior valve, from MacDonalds (Bank), Muddy Creek, Hamilton, Vic., Grange Burn Formation, early Pliocene (Kalimnan), collected by W. Greed, date of collection unknown.
Note: Type unique.

Genus **Notoplax** H. Adams, 1861

Molachiton naxus Ashby & Cotton, 1939
=*Notoplax (Bassethullia) inexpecta* (Ashby & Cotton, 1939).
see LEPTOCHITONIDAE

Family **CHITONIDAE**

Genus **Anthochiton** Thiele, 1893

Anthochiton duodeni Ashby & Cotton, 1939
Rec. S. Aust. Mus. **6**(3): 235, pl. 20, fig. 38.
= *Chiton (Rhyssoplax) duodeni* (Ashby & Cotton, 1939).
Holotype: P4357, 1 incomplete median valve, from MacDonalds (Bank), Muddy Creek, Hamilton, Vic., Grange Burn Formation, early Pliocene (Kalimnan), collected by W. Greed, date of collection unknown.
Note: Type unique.

Anthochiton macdonaldensis Ashby & Cotton, 1939
Rec. S. Aust. Mus. **6**(3): 234, pl. 21, fig. 39.
= *Chiton (Rhyssoplax) macdonaldensis* (Ashby & Cotton, 1939).
Holotype: P4359, 1 complete posterior valve, from MacDonalds (Bank), Muddy Creek, Hamilton, Vic., Grange Burn Formation, early Pliocene (Kalimnan), collected by W. Greed, date of collection unknown.
Note: Type unique.

Anthochiton octocostatus Ashby & Cotton, 1939
Rec. S. Aust. Mus. **6**(3): 235, pl. 21, fig. 40.
=*Chiton (Rhyssoplax) octocostatus* (Ashby & Cotton, 1939).
Holotype: P4360, 1 half median valve, from MacDonalds (Bank), Muddy Creek, Hamilton, Vic., Grange Burn Formation, early Pliocene (Kalimnan), collected by W. Greed, date of collection unknown.
Note: Type unique.

Genus **Chiton** Linnaeus, 1758

Chiton fossicus Ashby & Torr, 1901
Trans. R. Soc. S. Aust. **25**(2): 140, pl. 4, fig. 4.
= *Chiton (Rhyssoplax) fossicus* Ashby & Torr, 1901.
Holotype: T840, 1 incomplete median valve, from Table Cape, Tas., Table Cape Group, early Miocene (Longfordian), collected by R. Tate and J. Dennant, date of collection unknown.
Note: Type unique.

Chiton paucipustulosus Ashby & Torr, 1901
Trans. R. Soc. S. Aust. **25**(2): 141, pl. 4, fig. 2.
= *Loricella paucipustulosa* (Ashby & Torr, 1901) (SCHIZOCHITONIDAE).
Holotype: T839, 1 complete median valve, from Table Cape, Tas., Table Cape Group, early Miocene (Longfordian), collected by R. Tate and J. Dennant, date of collection unknown.
Note: A specimen of this species in the collection (P4366) is labelled 'Pleisiotype'. This specimen is Ashby and Cotton's (1939) 'Hypotype' and has no type status. Type unique.

Chiton (Anthochiton) tricostalis relata Ashby & Cotton, 1936
Rec. S. Aust. Mus. **5**(4): 509, fig. 1.
= *Chiton (Rhyssoplax) tricostalis relatus* Ashby & Cotton, 1936.
Holotype: P10157 (ex D12883), 1 incomplete median valve, from 151m depth, Torrensville Bore, Adelaide, S.A., Dry Creek Sands, late Pliocene (Yatalan), collected by W.J. Kimber, date of collection unknown.
Note: Type unique.

Family **CRYPTOPLACIDAE**

Genus **Cryptoplax** Blainville, 1818

Cryptoplax ludbrookae Ashby, 1940
Trans. R. Soc. S. Aust. **64**(2): 266.
Holotype: P4285; 1 complete anterior valve, from 103–117 m depth, bore at Holden's Motor Body Works, Woodville, Adelaide, S.A., Dry Creek Sands, late Pliocene (Yatalan), collected by S.A. Department of Mines, 1934.
Note: Type unique.

Cryptoplax numicus Ashby & Cotton, 1939
Rec. S. Aust. Mus. **6**(3): 219, pl. 19, fig. 18.
Holotype: P4337, 1 incomplete median valve, from MacDonalds (Bank), Muddy Creek, Hamilton, Vic., Grange Burn Formation, early Pliocene (Kalimnan), collected by W. Greed, date of collection unknown.
Note: Type unique.

MacDonalds (Bank), Muddy Creek, Hamilton, Vic., Grange Burn Formation, early Pliocene (Kalimnan), collected by W. Greed, date of collection unknown.
Paratypes: P12829, 1 incomplete anterior valve and 1 incomplete median valve, with same collection data as holotype.
Note: The anterior valve in lot P12829 is Ashby & Cotton's (1939) 'Hypotype'.

Family **ISCHNOCHITONIDAE**

Genus **Callistochiton** Dall, 1882

Callistochiton greedi Ashby & Cotton, 1939
Rec. S. Aust. Mus. **6**(3): 232, pl. 21, fig. 41.
Holotype: P4369, 1 half median valve, from Forsyths (Bank), Grange Burn, Hamilton, Vic., Grange Burn Formation, early Pliocene (Kalimnan), collected by W. Greed, date of collection unknown.
Paratypes: P12823, 2 median valve fragments, with same collection data as holotype.
Note: Ashby and Cotton (1939) list 4 paratype fragments. The label of P12823 states '1 sent USA Dec 1938', so the 4th fragment is presumed lost before registration, as register only lists 2 specimens.

Callistochiton inexpectus Ashby & Cotton, 1939
Rec. S. Aust. Mus. **6**(3): 233, pl.21, figs 41, 42.
Holotype: P4372, 1 incomplete median valve, from MacDonalds (Bank), Muddy Creek, Hamilton, Vic., Grange Burn Formation, early Pliocene (Kalimnan), collected by W. Greed, date of collection unknown.
Paratypes: P4373, 1 complete posterior valve, with same collection data as holotype. P12818, 1 incomplete median valve and 1 incomplete posterior valve, with same collection data as holotype.
Note: P4373 is Ashby and Cotton's (1939) 'Hypotype', labelled and registered as 'Pleisiotype'. All three lots originally labelled and registered as *Callistochiton affinis*, an unpublished name, and later corrected to *C. inexpectus*.

Callistochiton reticulatus Ashby & Cotton, 1939
Rec. S. Aust. Mus. **6**(3): 233, pl. 21, figs 44, 45.
Holotype: P4370, 1 incomplete median valve, from MacDonalds (Bank), Muddy Creek, Hamilton, Vic., Grange Burn Formation, early Pliocene (Kalimnan), collected by W. Greed, date of collection unknown.
Paratypes: P4371, 1 incomplete median valve, from Clifton Bank, Muddy Creek, Hamilton, Vic., Muddy Creek Marl, early to middle Miocene (Balcombian – Bairnsdalian), collected by W. Greed, date of collection unknown. P4381, 1 incomplete posterior valve, from Forsyths (Bank), Grange Burn, Hamilton, Vic., Grange Burn Formation, early Pliocene (Kalimnan), collected by W. Greed, date of collection unknown. P12820, 2 half median valves and 1 incomplete posterior valve, with same collection data as P4381.
Note: Ashby & Cotton (1939) list a 'Hypotype' (P4383) from the same locality as the holotype, which could not be found in the collection, however, the register lists P4383 from Forsyths. P4381 is labelled 'Pleisiotype' (='Hypotype') but the locality on the label (Forsyths) differs from the locality in the register (MacDonalds). We believe the 2 specimens were confused before registration, that the 'Hypotype' specimen of Ashby & Cotton (1939) has been lost, and replaced by P4381, which is part of the lot of 4 specimens from Forsyths mentioned by Ashby & Cotton (1939), the remainder of the lot being P12820.

Genus **Callochiton** Gray, 1847

Callochiton macdonaldi Ashby & Cotton, 1939
Rec. S. Aust. Mus. **6**(3): 227, pl. 21, fig. 46.
Holotype: P4368, 1 incomplete median valve, from MacDonalds (Bank), Muddy Creek, Hamilton, Vic., Grange Burn Formation, early Pliocene (Kalimnan), collected by W. Greed, date of collection unknown.
Note: Type unique.

Callochiton (Ocellochiton) sulci Ashby, 1939
Proc. Linn. Soc. Lond. **151**(3): 187, pl. 3, figs 1–3.
= *Ocellochiton sulci* (Ashby, 1939).
Holotype: P10158; 1 incomplete median valve, from Balcombe Bay, Mornington, Vic., Balcombe Clay, early to middle Miocene (Batesfordian–Bairnsdalian), collected by F.A. Cudmore, date of collection unknown.
Paratypes: P26776, 1 incomplete anterior valve and 1 incomplete posterior valve with same collection data as holotype.

Genus **Ischnochiton** Gray, 1847

Ischnochiton (Radsiella) cliftonensis Ashby & Cotton, 1939
Rec. S. Aust. Mus. **6**(3): 231, pl. 19, fig. 14.
= *Lavenachiton cliftonensis* (Ashby & Cotton, 1939) (INCERTAE SEDIS).
Holotype: P4333, 1 incomplete median valve, from Clifton Bank, Muddy Creek, Hamilton, Vic., Muddy Creek Marl, early to middle Miocene (Balcombian–Bairnsdalian), collected by W. Greed, date of collection unknown.
Note: Type unique.

Ischnochiton cossyrus Ashby & Cotton, 1939
Rec. S. Aust. Mus. **6**(3): 229, pl. 20, fig. 37.
Holotype: P4356, 1 incomplete posterior valve, from MacDonalds (Bank), Muddy Creek, Hamilton, Vic., Grange Burn Formation, early Pliocene (Kalimnan), collected by W. Greed, date of collection unknown.
Note: Type unique.

Ischnochiton durius Ashby & Cotton, 1939
Rec. S. Aust. Mus. 6(3): 230, pl. 20, fig. 33.
= *Ischnochiton cossyrus* Ashby & Cotton, 1939.
Holotype: P4352, 1 incomplete posterior valve, from MacDonalds (Bank), Muddy Creek, Hamilton, Vic., Grange Burn Formation, early Pliocene (Kalimnan), collected by W. Greed, date of collection unknown.
Note: Type unique.

Ischnochiton neglectus Ashby & Cotton, 1939
Rec. S. Aust. Mus. 6(3): 231, pl. 20, fig. 34.
Holotype: P4353, 1 half median valve, from Forsyths (Bank), Grange Burn, Hamilton, Vic., Grange Burn Formation, early Pliocene (Kalimnan), collected by W. Greed, date of collection unknown.
Paratypes: P12819, 2 fragments of median valves with same collection data as holotype.

Ischnochiton numantius Ashby & Cotton, 1939
Rec. S. Aust. Mus. 6(3): 229, pl. 19, fig. 16.
Holotype: P4335, 1 incomplete posterior valve, from Forsyths (Bank), Grange Burn, Hamilton, Vic., Grange Burn Formation, early Pliocene (Kalimnan), collected by W. Greed, date of collection unknown.
Note: Type unique.

Ischnochiton tisurus Ashby & Cotton, 1939
Rec. S. Aust. Mus. 6(3): 228, pl. 19, fig. 15, pl. 20, fig. 35.
= *Ischnochiton vinazus* Ashby & Cotton, 1939.
Holotype: P4334, 1 half median valve, from MacDonalds (Bank), Muddy Creek, Hamilton, Vic., Grange Burn Formation, early Pliocene (Kalimnan), collected by W. Greed, date of collection unknown.
Paratypes: P12838, 1 fragment of a median valve, with same collection data as holotype, P26767, 1 half median valve, from Forsyths (Bank), Grange Burn, Hamilton, Vic., Grange Burn Formation, early Pliocene (Kalimnan), collected by W. Greed, date of collection unknown.
Note: One paratype of this species, Ashby & Cotton's (1939) 'Hypotype' P4354, is now the holotype of *Ischnochiton varenae* Cotton & Godfrey, 1940.

Ischnochiton varenae Cotton & Godfrey, 1940
'The Molluscs of South Australia Part II' p. 570, fig. 579
Holotype: P4354, 1 incomplete posterior valve, from Forsyths (Bank), Grange Burn, Hamilton, Vic., Grange Burn Formation, early Pliocene (Kalimnan), collected by W. Greed, date of collection unknown.
Note: This specimen was originally a paratype of *Ischnochiton tisurus* Ashby & Cotton, 1939 [Ashby & Cotton's (1939) 'Hypotype']. Type unique.

Ischnochiton vinazus Ashby & Cotton, 1939
Rec. S. Aust. Mus. 6(3): 228, pl. 20, fig. 36
Holotype: P4355, 1 half median valve, from Macdonalds (Bank), Muddy Creek, Hamilton, Vic., Grange Burn Formation, early Pliocene (Kalimnan), collected by W. Greed, date of collection unknown
Paratypes: P12828, 2 fragments of median valves with same collection data as holotype.

Genus **Ocellochiton** Ashby, 1939

Lorica oculea Ashby & Cotton, 1939
= *Ocellochiton sulci* (Ashby, 1939).
see SCHIZOCHITONIDAE

Lorica varena Ashby & Cotton, 1939
= *Ocellochiton sulci* (Ashby, 1939).
see SCHIZOCHITONIDAE

Family LEPTOCHITONIDAE

Genus **Belchiton** Ashby & Cotton, 1939

Belchiton pulcherrimus Ashby & Cotton, 1939
Rec. S. Aust. Mus. 6(3): 221, pl. 19, fig. 10.
= *Leptochiton pulcherrimus* (Ashby & Cotton, 1939).
Holotype: P4329, 1 incomplete median valve, from MacDonalds (Bank), Muddy Creek, Hamilton, Vic., Grange Burn Formation, early Pliocene (Kalimnan), collected by W. Greed, date of collection unknown.
Paratype: P12799, 1 incomplete median valve, with same collection data as holotype

Genus **Lepidopleurus** Risso, 1826

Lepidopleurus babidus Ashby & Cotton, 1939
Rec. S. Aust. Mus. 6(3): 226, pl. 19, fig. 6.
= *Leptochiton babidus* (Ashby & Cotton, 1939).
Holotype: P4325, 1 half median valve, from MacDonalds (Bank), Muddy Creek, Hamilton, Vic., Grange Burn Formation, early Pliocene (Kalimnan), collected by W. Greed, date of collection unknown.
Paratype: P12821, 2 median valve fragments, with same collection data as holotype.

Lepidopleurus badioides Ashby & Cotton, 1939
Rec. S. Aust. Mus. 6(3): 222, pl. 19, fig. 4, pl. 21, fig. 47.
= *Leptochiton badioides* (Ashby & Cotton, 1939)
Holotype: P4323, 1 incomplete posterior valve, from Clifton Bank, Muddy Creek, Hamilton, Vic., Muddy Creek Marl, early to middle Miocene (Balcombian – Bairnsdalian), collected by W. Greed, date of collection unknown.
Paratypes: P4358, 2 fragments of a median valve, from Forsyths (Bank), Grange Burn, Hamilton, Vic., Grange Burn Formation, early Pliocene (Kalimnan), collected by W. Greed, date of collection unknown. P12804, 2 fragments of a posterior valve, with same collection data as P4358. P12805, 1 incomplete

median valve, with same collection data as P4358.
Lepidopleurus clifdenensis Ashby, 1929
Trans. N. Z. Inst. **60**: 367, pl. 32, figs 8a, 8b.
= *Leptochiton clifdenensis* (Ashby, 1929).
Holotype: P10162, 1 fragment of a median valve, from Clifden, South Island, N.Z., Clifden Limestone, early Miocene (Hutchinsonian), collector and date of collection unknown.
Note: Type unique. Ashby (1929b) lists two fragments of the holotype, the second fragment is missing, presumed lost.

Lepidopleurus diversigranosus Ashby & Cotton, 1939
Rec. S. Aust. Mus. **6**(3): 227, pl. 19, figs 1, 9.
= *Leptochiton diversigranosus* (Ashby & Cotton, 1939).
Holotype: P4328, 1 incomplete posterior valve, from Clifton Bank, Muddy Creek, Hamilton, Vic., Muddy Creek Marl, early to middle Miocene (Balcombian–Bairnsdalian), collected by W. Greed, date of collection unknown.
Paratype: P4320, 1 incomplete median valve, with same collection data as holotype. Note: The paratype P4320 is Ashby & Cotton's (1939) 'Hypotype'.

Lepidopleurus magnogranifer Ashby, 1925
Proc. R. Soc. Vic. (NS) **37**(2): 171, pl. 18, fig. 1.
= *Leptochiton magnogranifer* (Ashby, 1925).
Holotype: T847, 1 incomplete median valve, from Muddy Creek, Hamilton, Vic., exact stratum not recorded, collected by J. Dennant and R. Tate, date of collection unknown.
Note: A label with the holotype lists the locality as Clifton Bank, (Muddy Creek, Hamilton, Vic., Muddy Creek Marl, early to middle Miocene (Balcombian–Bairnsdalian), which is the type locality defined by Ashby and Cotton (1939) with their 'Pleisiotype' (P4322), which is not a valid type.Type unique.

Lepidopleurus nivarus Ashby & Cotton, 1939
Rec. S. Aust. Mus. **6**(3): 222, pl. 19, fig. 5.
= *Leptochiton nivarus* (Ashby & Cotton, 1939).
Holotype: P4324, 1 incomplete median valve, from Clifton Bank, Muddy Creek, Hamilton, Vic., Muddy Creek Marl, early to middle Miocene (Balcombian – Bairnsdalian), collected by W. Greed, date of collection unknown.
Paratypes: P26744, 2 fragments of median valves, with same collection data as holotype.

Lepidopleurus pamphilius Ashby & Cotton, 1939
Rec. S. Aust. Mus. **6**(3): 222, pl. 19, fig. 2.
= *Protochiton granulosus* (Ashby & Torr, 1901) (PROTOCHITONIDAE)
Holotype: P4321, 2 fragments of a median valve, from Clifton Bank, Muddy Creek, Hamilton, Vic., Muddy Creek Marl, early to middle Miocene (Balcombian – Bairnsdalian), collected by W. Greed, date of collection unknown.
Note: Type unique.

Lepidopleurus relatus Ashby & Cotton, 1939
Rec. S. Aust. Mus. **6**(3): 224, pl. 19, fig. 12.
= *Leptochiton magnogranifer* (Ashby, 1925).
Holotype: P4331, 2 fragments of a median valve, from Clifton Bank, Muddy Creek, Hamilton, Vic., Muddy Creek Marl, early to middle Miocene (Balcombian–Bairnsdalian), collected by W. Greed, date of collection unknown.
Paratypes: P12807, 1 median valve fragment, with same collection data as holotype. P12808, 1 median valve fragment, with same collection data as holotype.
Note: After examining both types, we agree with Cotton & Weeding (1941) and van Belle (1981) in synonymising this species with *L. magnogranifer* (Ashby, 1925). However, the types of the latter are much more worn than the types of *L. relatus*, not the reverse, as was stated by Cotton & Weeding (1941). The holotype was broken into two pieces subsequent to its description.

Lepidopleurus sephus Ashby & Cotton, 1939
Rec. S. Aust. Mus. **6**(3): 225, pl. 19, fig. 11.
= *Leptochiton sephus* (Ashby & Cotton, 1939).
Holotype: P4330, 1 incomplete median valve, from Forsyths (Bank), Grange Burn, Hamilton, Vic., Grange Burn Formation, early Pliocene (Kalimnan), collected by W. Greed, date of collection unknown.
Note: Type unique.

Lepidopleurus sinervus Ashby & Cotton, 1939
Rec. S. Aust. Mus. **6**(3): 225, pl. 19, fig. 7.
= *Leptochiton sinervus* (Ashby & Cotton, 1939).
Holotype: P4326, 1 fragment of an anterior valve, from Forsyths (Bank), Grange Burn, Hamilton, Vic., Grange Burn Formation, early Pliocene (Kalimnan), collected by W. Greed, date of collection unknown.
Paratype: P26743, 2 fragments of an anterior valve, with same collection data as holotype.

Lepidopleurus singus Ashby & Cotton, 1939
Rec. S. Aust. Mus. **6**(3): 226, pl. 19, fig. 8.
= *Leptochiton singus* (Ashby & Cotton, 1939)
Holotype: P4327, 1 complete posterior valve, from MacDonalds (Bank), Muddy Creek, Hamilton, Vic., Grange Burn Formation, early Pliocene (Kalimnan), collected by W.Greed, date of collection unknown.
Note: Type unique.

? *Lepidopleurus uxellus* Ashby & Cotton, 1939
Rec. S. Aust. Mus. **6**(3), 223, pl.19, fig.13.
= *Leptochiton uxellus* (Ashby & Cotton, 1939).
Holotype: P4332, 1 incomplete posterior valve, from

Forsyths (Bank), Grange Burn, Hamilton, Vic., Grange Burn Formation, early Pliocene (Kalimnan), collected by W. Greed, date of collection unknown. Note: Type unique.

Genus **Molachiton** Ashby & Cotton, 1939

Molachiton naxus Ashby & Cotton, 1939
Rec. S. Aust. Mus. **6**(3): 220, pl. 20, fig. 32.
= *Notoplax (Bassethullia) inexpecta* (Ashby & Cotton, 1939) (ACANTHOCHITONIDAE)
Holotype: P4351, 1 half median valve, from MacDonalds (Bank), Muddy Creek, Hamilton, Vic., Grange Burn Formation, early Pliocene (Kalimnan), collected by W. Greed, date of collection unknown. Note: Generic placement follows Gowlett-Holmes (1987). Type unique.

Family **MOPALIIDAE**

Genus **Plaxiphora** Gray, 1847

Plaxiphora concentrica Ashby & Torr, 1901
Trans. R. Soc. S. Aust. **25**(2): 138, pl. 4, fig. 8.
= *Plaxiphora (P.) albida* (Blainville, 1825) (Recent species).
Holotype: T836, 1 complete posterior valve, from Gellibrand River, Vic., early Miocene, collector and date of collection unknown.
Note: We believe that this valve is from a recent specimen, and that the age and stratum are incorrect. We therefore regard it as a synonym of *P. (P.) albida*, an extant species. Type unique.

Plaxiphora gellibrandi Ashby & Torr, 1901
Trans. R. Soc. S. Aust. **25**(2): 139, pl. 4, fig. 1.
= *Plaxiphora (P.) albida* (Blainville, 1825) (Recent species).
Holotype: T837, 1 complete posterior valve, from Gellibrand, Vic., early Miocene, collector and date of collection unknown.
Note: The age and stratum are apparently in error as the valve is from a recent specimen. Type unique.

Family **PROTOCHITONIDAE**

Genus **Protochiton** Ashby, 1925

Acanthochites (Notoplax) granulosus Ashby & Torr, 1901
= *Protochiton granulosus* (Ashby & Torr, 1901).
see ACANTHOCHITONIDAE

Lepidopleurus pamphilius Ashby & Cotton, 1939
= *Protochiton granulosus* (Ashby & Torr, 1901).
see LEPTOCHITONIDAE

Family **SCHIZOCHITONIDAE**

Genus **Aulacochiton** Shuttleworth, 1853

Aulacochiton erma Cotton & Godfrey, 1940
'The Molluscs of South Australia Part II' p. 570, fig. 588.
= *Lorica compressa* Ashby & Torr, 1901.
Holotype: P4286, 1 incomplete median valve, from Clifton Bank, Muddy Creek, Hamilton, Vic., Muddy Creek Marl, early to middle Miocene (Balcombian–Bairnsdalian), collector and date of collection unknown.
Note: Van Belle (1981) considers *A. erma* to be a distinct species, but after comparing the holotypes of this species and *Lorica compressa*, we believe they are conspecific, and that the holotype of *A. erma* is a very weathered example of *L. compressa.* Type unique.

Genus **Lorica** H. & A. Adams, 1852

Lorica affinis Ashby & Torr, 1901
Trans. R. Soc. S. Aust. **25**(2): 137, pl. 4, fig. 7.
= *Lorica compressa* Ashby & Torr, 1901.
Holotype: T843, 1 incomplete median valve, from Table Cape, Tas., Table Cape Group, early Miocene (Longfordian), collected by R. Tate and J. Dennant, date of collection unknown.
Note: The locality and age were not given by Ashby & Torr (1901), but the type is clearly labelled 'Table Cape', which is the locality given for this species by Ashby (1925). Type unique.

Lorica compressa Ashby & Torr, 1901
Trans. R. Soc. S. Aust. **25**(2): 136, pl. 4, fig. 6.
Holotype: T842, 1 incomplete median valve, from Table Cape, Tas., Table Cape Group, early Miocene (Longfordian), collected by R. Tate and J. Dennant, date of collection unknown.
Note: The locality and age were not given by Ashby & Torr (1901), but the type is clearly labelled 'Table Cape', which is the locality given for this species by Ashby (1925). Type unique.

Lorica oculea Ashby & Cotton, 1939
Rec. S. Aust. Mus. **6**(3): 237, pl. 21, fig. 48.
= *Ocellochiton sulci* (Ashby, 1939) (ISCHNOCHITONIDAE).
Holotype: P4362, 1 incomplete median valve, from Clifton Bank, Muddy Creek, Hamilton, Vic., Muddy Creek Marl, early to middle Miocene (Balcombian–Bairnsdalian), collected by W. Greed, date of collection unknown.
Paratype: P12817, 1 incomplete median valve with same collection data as holotype.

Lorica varena Ashby & Cotton, 1939
Rec. S. Aust. Mus. **6**(3): 238, pl. 21, fig. 49.

= *Ocellochiton sulci* (Ashby, 1939) (ISCHNOCHITONIDAE).
Holotype: P4361, 1 incomplete median valve, from Clifton Bank, Muddy Creek, Hamilton, Vic., Muddy Creek Marl, early to middle Miocene (Balcombian–Bairnsdalian), collected by W. Greed, date of collection unknown.
Note: Type unique.

Genus **Loricella** Pilsbry, 1893

Loricella concava Ashby & Cotton, 1939
Rec. S. Aust. Mus. **6**(3): 236, pl. 21, fig. 51.
Holotype: P4367, 1 incomplete posterior valve, from MacDonalds (Bank), Muddy Creek, Hamilton, Vic., Grange Burn Formation, early Pliocene (Kalimnan), collected by W. Greed, date of collection unknown.
Note: Type unique.

Loricella gigantea Ashby & Torr, 1901
Trans. R. Soc. S. Aust. **25**(2): 137, pl. 4, fig. 3.
Holotype: T838, 1 incomplete anterior valve, from Schnapper Point, Mornington, Vic., Balcombe Clay, early to middle Miocene (Batesfordian–Bairnsdalian), collected by R. Tate and J. Dennant, date of collection unknown.
Note: Ashby (1925) states the above locality is in error for the Freestone Cove Sandstone ('Lower Beds'), Table Cape, Tas., early Miocene (Longfordian). See note on Schnapper Point in Stratigraphical Notes. Type unique.

Loricella magnopustulosa Ashby & Cotton, 1939
Rec. S. Aust. Mus. **6**(3): 235, pl. 21, figs 50, 53.
Holotype: P4365, 1 incomplete anterior valve, from MacDonalds (Bank), Muddy Creek, Hamilton, Vic., Grange Burn Formation, early Pliocene (Kalimnan), collected by W. Greed, date of collection unknown.
Paratype: P4364, 1 half median valve, same collection data as holotype.
Note: P4364 is Ashby & Cotton's (1939) 'Hypotype'. The two paratypes listed by Ashby & Cotton (1939) are missing, presumed lost.

Chiton paucipustulosa Ashby & Torr, 1901
= *Loricella paucipustulosa* (Ashby & Torr, 1901).
see CHITONIDAE

Genus **Oochiton** Ashby, 1929

Oochiton halli Ashby, 1929
Proc. R. Soc. Vic. (NS) **41**(2): 222, pl. 24, figs 1a, b, 2, 3a-c, 8a, b.
Neotype: P4393, 1 complete anterior valve, from Clifton Bank, Muddy Creek, Hamilton, Vic., Muddy Creek Marl, early to middle Miocene (Balcombian–Bairnsdalian), collected by W. Greed, date of collection unknown.
Note: Neotype selected by Ashby & Cotton (1939) to replace type destroyed by fire in Ashby's house on March 9, 1934. This specimen was selected to replace 'holotype of the head valve of this species' according to Ashby & Cotton (1939), however the holotype was a median valve according to Ashby (1929a). As none of the types listed by Ashby (1929a) could be found, we believe that they were all destroyed by fire, and that the anterior valve listed above is a valid neotype.

INCERTAE SEDIS

Genus **Lavenachiton** Cotton & Godfrey, 1940

Ischnochiton (Radsiella) cliftonensis Ashby & Cotton, 1939
= *Lavenachiton cliftonensis* (Ashby & Cotton, 1939).
see ISCHNOCHITONIDAE

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ON AUSTRALIAN HERSILIIDAE FROM THE SOUTH AUSTRALIAN MUSEUM (ARACHNIDA : ARANEAE) SUPPLEMENT TO THE REVISION OF THE AUSTRALIAN HERSILIIDAE

BY B. BAEHR & M. BAEHR

Summary

A collection of hersiliid spiders from the South Australian Museum is examined. Tamopsis forresti sp. nov. from north-western Queensland and T. ediacare sp. nov. from central south Australia are newly described. New records are given for T. eucalypti (Rainbow), T. queenslandica Baehr & Baehr, T. raveni Baehr & Baehr, and T, fickerti (L. Koch), mainly from South Australia and central Australia, and the range of some species are considered extended.

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B. BAEHR & M. BAEHR

BAEHR, B. & BAEHR, M. 1988. On Australian Hersiliidae from the South Australian Museum (Arachnida: Araneae). Supplement to the revision of the Australian Hersiliidae. *Rec. S. Aust. Mus.* **22** (1): 13–20.

A collection of hersiliid spiders from the South Australian Museum is examined. *Tamopsis forresti* sp. nov. from north-western Queensland and *T. ediacarae* sp. nov. from central south Australia are newly described. New records are given for *T. eucalypti* (Rainbow), *T. queenslandica* Baehr & Baehr, *T. raveni* Baehr & Baehr, and *T. fickerti* (L. Koch), mainly from South Australia and central Australia, and the ranges of some species are considerably extended.

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The collection of Hersiliidae from the South Australian Museum, Adelaide (SAMA), comprises about 25 specimens from Queensland, South Australia and Western Australia. Because two new species and several new records, mainly from central Australia, are involved, it is worth noting in a separate paper, regarded as a supplement to our recent revision of the Australian Hersiliidae (Baehr & Baehr 1987). This supplement is evidence of the little known fauna of more remote regions of Australia, especially in inland areas. Measurements were taken as indicated previously (Baehr & Baehr 1987).

Abbreviations

ALE – anterior lateral eye
AME – anterior median eye
bS – basal segment of posterior lateral spinneret
LB – total length of body
LL – total length of 1st leg
PLE –posterior lateral eye
PLS – posterior lateral spinneret
PME – posterior median eye
tS – terminal segment of posterior lateral spinneret
I – 1st leg
II – 2nd leg
III – 3rd leg
IV – 4th leg

Classification

In our revision of the Australian Hersiliidae all known species were transferred from *Chalinura* or *Tama*, respectively, to a new genus *Tamopsis*. All newly described species, with exception of the singular *Hersilia australiensis* Baehr & Baehr, also belong to *Tamopsis*. As the collection from the SAMA comprises only species of *Tamopsis*, apart from a single juvenile *Hersilia* specimen (N11979100) which we are unable to determine, no generic diagnosis needs to be included.

Tamopsis eucalypti (Rainbow)

Tama eucalypti Rainbow, 1900: 487

This species is widely distributed in south-eastern Australia from south-east Queensland through eastern New South Wales, Victoria to Eyre Peninsula in South Australia. Specimens from SAMA are identified by the conspicuous shape of the female vulva.

New records

South Australia: 2 females (N 1987181), Belair NP, Mt Lofty Ranges, i. 1936, Coll. H. Womersley; 1 female (N1987182), Fullarton, Adelaide, x. 1935, Coll. H. Womersley; 5 females (N 1987183), Adelaide, 1936, Coll. H. Womersley.

Tamopsis* cf. *queenslandica Baehr & Baehr (Fig. 4)

Baehr & Baehr, 1987: 372

This species was newly described from a male and female from southern Queensland and from New South Wales, respectively. It belongs to a group of several closely related species characterized by the depressed eye area and rather similar male palpi and female vulvae (see Baehr & Baehr 1987).

The single specimen from the SAMA is doubtfully assigned to *T. queenslandica* by virtue of the shape of its female vulva. This assignment, however, is somewhat hypothetical, because the specimen was apparently dried out and, as a consequence, is rather damaged. Hence the vulva is difficult to examine. If our determination is right, this would mean a considerable expansion of the range of this species right through central Australia to the Northern Territory–Western Australian border. It is worth noting in this connexion that both original records of *T. queenslandica* are from west of the Great Dividing Range. Perhaps this is an inland species.

New record

Western Australia: 1 female (N 1987184), Gill Pinnacle, Schwerin Mural Crescent, 24°54'S; 128°46'E, xi. 1963, Coll. P. Aitken & N.B. Tindale.

Tamopsis raveni Baehr & Baehr
(Fig. 4)

Baehr & Baehr, 1987; 373

Another species of the *queenslandica* group and extremely closely related to *T. queenslandica*. *T. raveni* was previously known only from a single locality in south-east Queensland. The single female specimen from the SAMA is assigned to this species mainly by the shape of its vulva.

New record

South Australia: 1 female (N 1987185), Oaktrees, Brown Hill Creek Reserve, Adelaide foothills, i. 1965, Coll. C. Luscombe. This record extends considerably the range of *T. raveni* to the south-west.

Tamopsis forresti sp. nov
(Figs 1, 2, 4)

Types

Holotype: male (N 1987186), N.W. Queensland, 1.5 km W. by N. of Riversleigh Homestead, collected by beating bushes on dry area above Gregory River, 30. iv. 1986, Coll. J. A. Forrest. Paratype: 1 female (N 1987187), same data.

Diagnosis

Medium sized species with high eye area, large AME and moderately elongate legs, recognized by male palpus with a large, spoon-shaped, hooked process and a small lateral process on median apophysis and with three elongate lateral processes at apex of lateral apophysis, and by unique shape of female vulva.

Description of holotype (male)

Measurements: Body length: 3.48 mm. Cephalothorax length: 1.48 mm; width: 1.40 mm. Abdomen length: 2 mm; width: 1.65 mm. Legs: I: 10.04 mm, II: 9.28 mm, III: 3.72 mm, IV: 9.08 mm. Ratio: 1: 0.92: 0.37: 0.90. Ratio LB/LL: 0.35. PLS length: 1.84 mm; bS: 0.48 mm; tS: 1.36 mm. Eye ratio: 1: 0.33: 0.78: 0.67.

Colour: Cephalothorax light brown, eye area, border, several radial spots, and dorsal groove piceous to blackish. Clypeus dirty white, with two dark spots. Chelicerae greyish to brown. Abdomen mottled, with distinct lancet-shaped median stripe and lateral borders dark; posteriorly with some transverse light and dark bands. Ventral surface light. Legs light, conspicuously annulate, femora anteriorly–ventrally striped with black.

Cephalothorax: Circular, slightly narrower than abdomen. Eye area considerably raised, clypeus slightly higher than eye area. AME by far largest, PLE slightly smaller than PME. Distance AME/AME slightly less than diameter of AME, distance AME/ALE about equal to diameter of AME. Distance PME/PME about half of diameter of PME, distance PME/PLE about equal to diameter of PLE. Chelicerae about $1\frac{1}{4}$ x as long as wide, posteriorly with 3 minute teeth. Sternum setose.

Abdomen: Elongate oval. Dorsally with 5 pairs of rather circular muscular pits. Ventral muscular pits in a v-shaped arrangement. PLS slightly shorter than abdomen.

Legs: Measurements see above. Moderately elongate, III slightly longer than 1/3 of I.

Palpus: Median apophysis strongly contorted, apex with wide, membraneous area within, terminally with a large, spoon-shaped process, and laterally with a shorter, curved process which is conspicuously napped outside. Lateral apophysis also contorted, apex deeply excised, laterally of excision bearing three elongate, slender, finger-like, hook-shaped structures. Inner finger apically curved away from palpus.

Description of paratype (female)

Measurements: Body length: 3.60 mm. Cephalothorax length: 1.44 mm; width: 1.40 mm. Abdomen length: 2.16 mm; width: 2.28 mm. Legs: I: 8.16 mm, II: 7.72 mm, III: 3.04 mm, IV: 7.44 mm. Ratio: 1: 0.95: 0.37: 0.91. Ratio LB/LL: 0.44. PLS length: 1.92 mm; bS: 0.48 mm; tS: 1.36 mm. Eye ratio: 1: 0.5: 0.88: 0.88.

Colour: Very similar to male holotype. Abdomen still more mottled, legs more contrastingly coloured.

Cephalothorax: Similar to male, but much narrower than abdomen. Clypeus slightly higher. Eyes smaller, especially AME smaller in relation to ALE, ALE nearly half as large as AME. PME and PLE of about equal size.

Abdomen: Slightly wider than long, rather triangular. Arrangement of dorsal and ventral muscular pits as in male. PLS slightly longer in relation to abdomen than in male.

Legs: Measurements see above. Moderately elongate. II about as long as in male.

Epigyne: Laterally with a large opening covered by a plate. Parts of vulva low, widely separated.

Vulva: With two receptacula seminis, though inner receptaculum characteristically bent and prolonged ventrally, apex slightly recurved. Only outer receptaculum glandular beneath capsule. Introductory duct bent, v-shaped, posteriorly produced.

Distribution

Thus far known from north-western Queensland close to Northern Territory border.

Habits

Not exactly known. Caught by beating bushes near river. Collected in April.

Relationships

This species is certainly closely related to *T. trionyx* Baehr & Baehr from southern Queensland. The male palpi of both species are fairly similar and they are recognized by their long, finger-like processes at the apex of the lateral apophysis. The palpus of *T. forresti*, however, differs in that the inner process of the lateral apophysis is curved outside rather than inwards, and that the median apophysis possesses a strong lateral process. As the female of *T. trionyx* is as yet unknown, nothing can be said on differences of female epigyne and vulva. The epigyne of *T. forresti*, however, is outstanding within the *tropica* group to the form of the inner receptaculum seminis.

Identification

For identification the key to species in our revision (Baehr & Baehr 1987) should be altered as following:

Couplet 16 – cancel 'Southern central Queensland .... *trionyx* sp. nov.'

then add

'16 a. Lateral border of MA not modified to a spoon-like process, inner finger of LA curved inwards. Southern central Queensland, ... *trionyx* Baehr & Baehr

– Lateral border of MA modified to a spoon-like process, napped outside, inner finger of LA curved outwards. North-western Queensland .... *forresti* sp. nov.'

Couplet 37 – alter to

' – Smaller species with wider body, less than 4.5 mm long. Legs and PLS rather stout. Lateral RS directed horizontally or posteriorly. Bridge of V not a narrow clasp .... 37 a.'

then add

'37 a. Lateral RS very small, directed horizontally. ID not strongly v-shaped. North-western Queensland .... *leichhardtiana* Baehr & Baehr

– Lateral RS large, elongate, directed posteriorly, apex conspicuously incurved. ID strongly v-shaped. North-western Queensland .... *forresti* sp. nov.'

Tamopsis ediacarae sp. nov.

(Figs 3, 4)

Holotype

Female (N 1987188), South Australia, Ediacara (W. of Leigh Creek), 15. v. 1961.

Diagnosis (male unknown)

Medium-sized species with high eye area, large AME and rather elongate legs, characterized by vulva with two equal receptacula seminis on each side, strongly coiled basal parts of introductory ducts, and anteriorly a wide bar.

Description

Measurements: Body length: 4.64 mm. Cephalothorax length: 1.88 mm; width: 1.88 mm. Abdomen length: 2.76 mm; width: 2.62 mm. Legs: I: 14.08 mm, II: 13.40 mm, III: 4.60 mm, IV: 12.48 mm. Ratio: 1: 0.95: 0.33: 0.89. Ratio LB/LL: 0.33. PLS length: 2.48 mm; bS 0.68 m; tS: 1.80 mm. Eye ratio: 1: 0.4: 0.8: 0.9.

Colour: Light-coloured. Cephalothorax medially whitish, laterally dark yellow. Eye area, lateral borders, and some radial spots blackish. Clypeus and chelicerae wholly yellow. Abdomen rather light, slightly mottled, with lancet-shaped median stripe and lateral borders fading brown. Legs and palpi very light, inconspicuously annulate. PLS laterally near base and apically in last third with distinct dark spots.

Cephalothorax: Circular, as long as wide. Eye area strongly raised, clypeus slightly higher than eye area. Eyes rather small, AME largest, PME slightly smaller than PLE. Distance AME/AME slightly less than diameter of AME. Distance PME/PME more than half of diameter of PME, distance PME/PLE about equal to diameter of PLE. Chelicerae rather elongate, about $1^3/_4$x as long as wide. Sternum heart-shaped, setose.

Abdomen: Rather wide, almost as wide as long, slightly trapezoidal, much wider than cephalothorax. Dorsally with 5 pairs of circular muscular pits. Ventral muscular pits in a slightly v-shaped arrangement. PLS rather short, considerably shorter than abdomen.

Legs: Measurement see above. Elongate, III c. 1/3 as long as I.

Epigyne: Laterally with an opening covered by a plate. Parts of vulva widely separated, anteriorly with a wide, sclerotized bridge.

Vulva: Wide, with two receptacula seminis and a basal bulbus on each side. Receptacula glandular in basal half. Introductory duct basally strongly coiled and produced outwards.

Distribution

Lake Eyre Basin, central eastern South Australia.

Habits

Unknown, type collected in May.

Relationships

T. ediacarae belongs to the large *tropica* group. Judging from the shape of the female epigyne and vulva and from relative length of legs and PLS, *T. ediacarae* is certainly most closely related to *T. pseudocircumvidens* Baehr & Baehr from south-western Australia which has a fairly similar vulva. However, the following differences are to be noted: lack of conspicuous median black stripe on clypeus in *T. ediacarae*, slightly different ratio of eye size, greater relative length of PLS, transverse bar of vulva located far anteriorly instead of medially, and introductory duct strongly coiled at base.

Since both species are known only from the female holotypes, it is at present impossible to decide whether they are actually species or just strongly varying specimens of common species with very wide range. From our experience, however, distribution of the same hersiliid species across the Nullarbor Plain is rather unlikely.

Identification

For identification the key to species in the revision (Baehr & Baehr 1987) should be altered as following:

Couple 36 – cancel

'South-western Australia..............................

.... *pseudocircumvidens* Baehr & Baehr'

then add

'36 a. Bridge located rather posteriorly between RS. ID basally not coiled (Fig 34). South-western Australia .... *pseudocircumvidens* Baehr & Baehr

–Bridge located rather anteriorly at apex of RS. ID basally strongly coiled. Eastern central South Australia .... *ediacarae* sp. nov.'

Tamopsis fickerti (L. Koch)
(Fig. 5)

Chalinura fickerti L. Koch, 1876: 830

This is a widely distributed species in eastern Australia, though not yet reliably recorded either from Victoria or South Australia. Females of this species are at first glance recognized by their heart-shaped median plate in the epigyne.

New records

South Australia: 1 female (N 1987189), Renmark, 27.iv.1981, Coll. R.V. Southcott; 1 male (N 1987190), Mitcham, Adelaide, 14. xi. 1986, Coll. R. V. Southcott; 1 male (N 1987191), Bellevue Heights, Adelaide, 5. xii.1979, Coll. A. Bowie; 5 females, 1 juv. (N 1987192), Belair N.P., Mt Lofty Ranges, i.1936, Coll. H. Womersley; 2 females (N 1987193), Belair N.P., 16.ii.1936, Coll. H. Womersley.

Habits

For habits of this species see Baehr & Baehr (1987). Several label notes of the SAMA specimens give evidence of a rather common occurrence of *T. fickerti* on walls and houses. In the wild, however, this is a true tree-inhabiting species, living on the bark of diverse eucalypts.

T. fickerti seems to be rather common in the environs of Adelaide and is perhaps distributed over the whole of south-eastern Australia from south-eastern Queensland to at least Adelaide in South Australia.

Discussion

As demonstrated by the present work, the Australian Hersiliidae fauna is not yet adequately known. Certainly still more species are likely to be discovered and the range of most species is far from being exactly known, because several species are only known from single specimens or from a single locality. This is certainly due to the inadequate exploration of vast areas, especially in central, western, and north-western Australia, and also to the difficulties of collecting such extremely well-camouflaged spiders as Hersiliidae which commonly sit motionless in small hollows on the bark of trees or attached on branches.

The following comments stress or slightly alter those in our revision (Baehr & Baehr 1987):

1. Northern Queensland is one of the regions possessing the most diverse hersiliid fauna. Most species, however, are rather unspecialized. Although the newly described *T. forresti* of north Queensland belongs to a derivative species group, within this group it is also rather unspecialized.

2. Some species are far more widely distributed than hitherto realized. This applies mainly to species occurring in well-wooded eastern, south-eastern, and southern Australia, where tree-dwelling species are able to spread more easily over wide ranges.

3. No species were previously known from central Australia and very few from South Australia, but both faunas are more diverse than supposed.

Acknowledgments

We are indebted to Dr David C. Lee (Adelaide) for the loan of the specimens from the SAMA.

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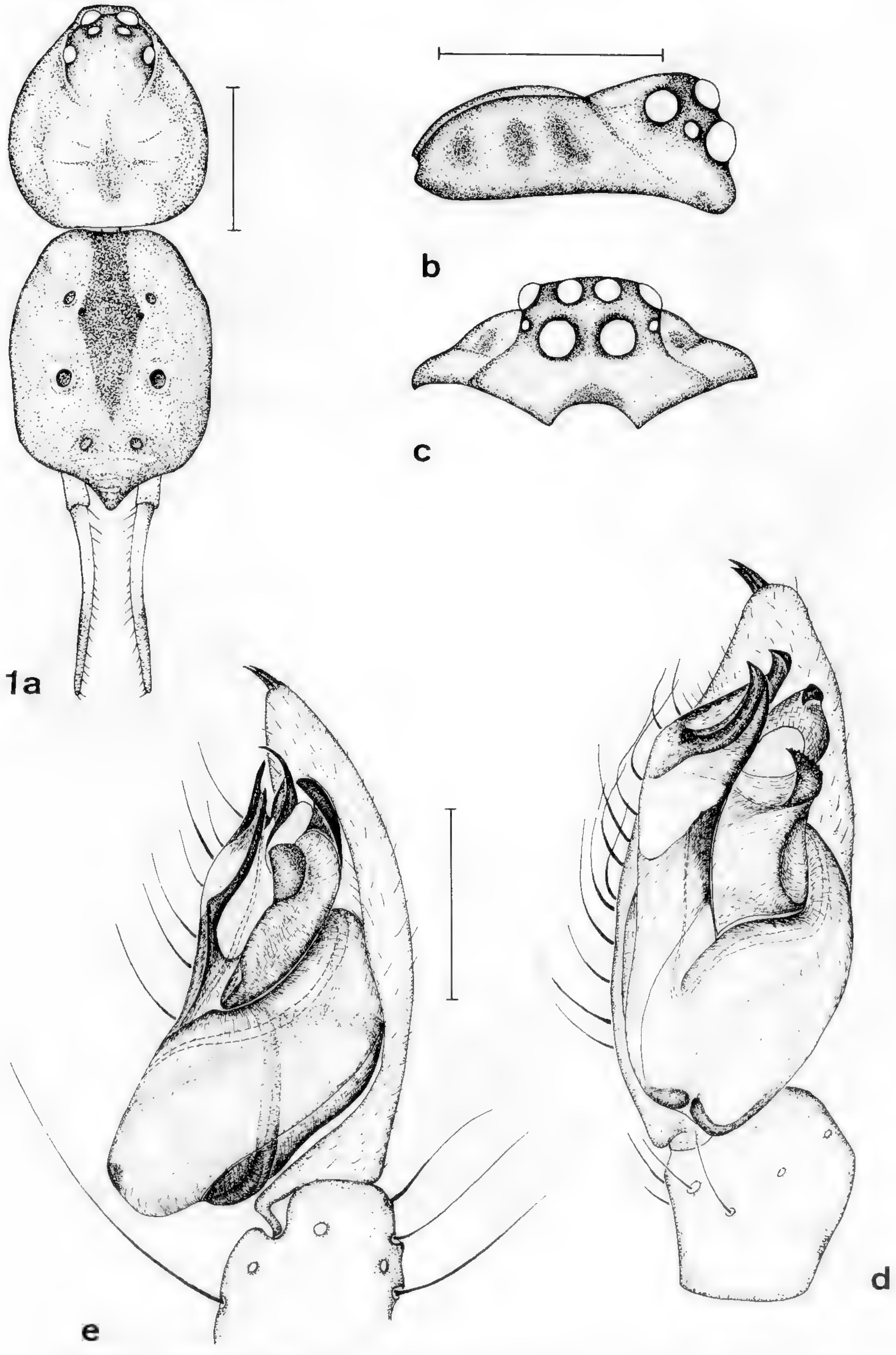


FIGURE 1. *Tamopsis forresti* sp. nov., male holotype. a, Body shape; b, Lateral view of head; c, Frontal view of head; d, Ventral view of palpus; e, Lateral view of palpus. Scales: a, b, c: 1 mm, d, e: 0.25 mm.

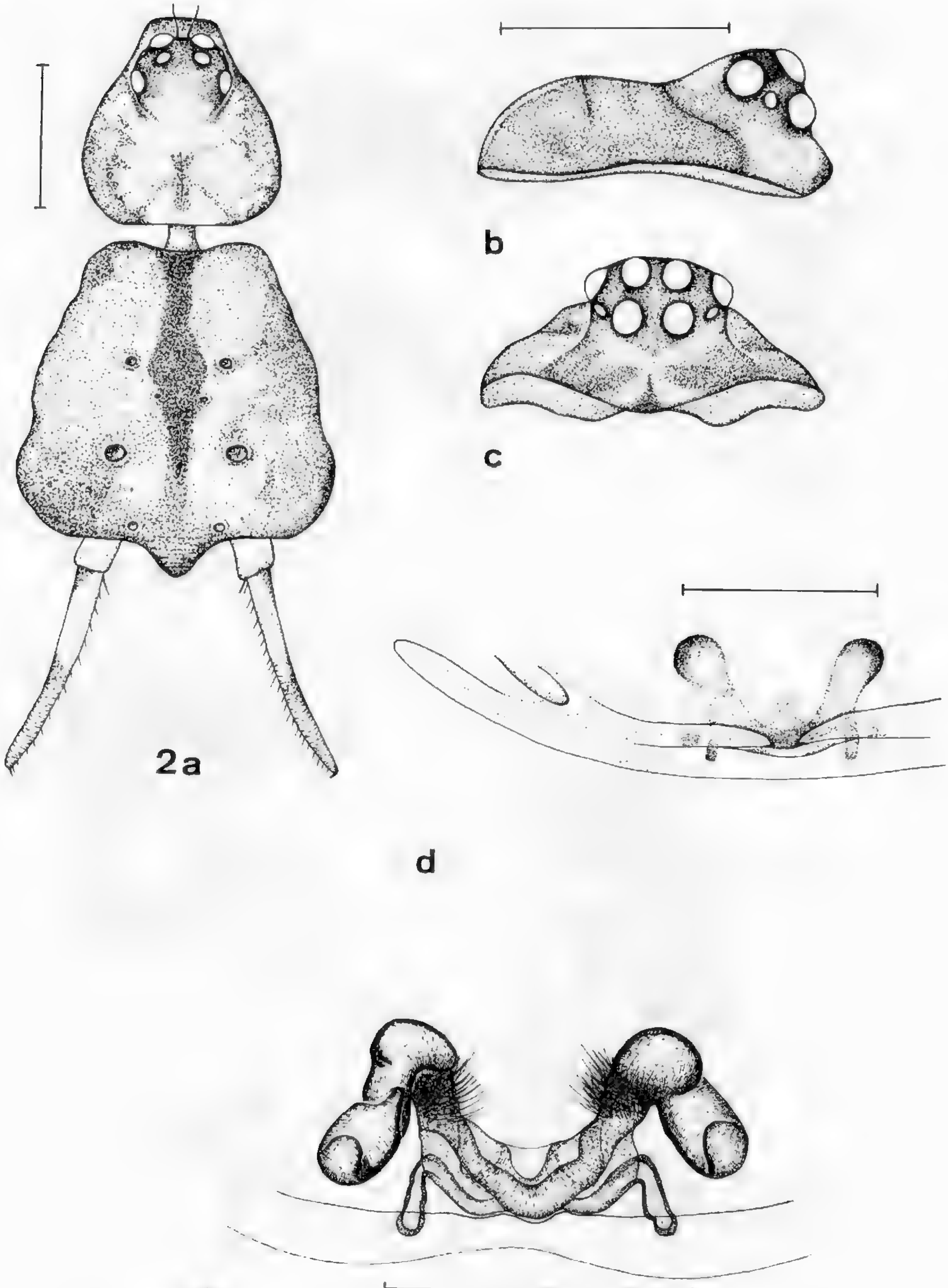


FIGURE 2. *Tamopsis forresti* sp. nov., female paratype. a. Body shape; d. Lateral view of head; c. Frontal view of head, d. Epigyne; e. Vulva. Scales: a, b, c: 1 mm, d, e: 0.25 mm.

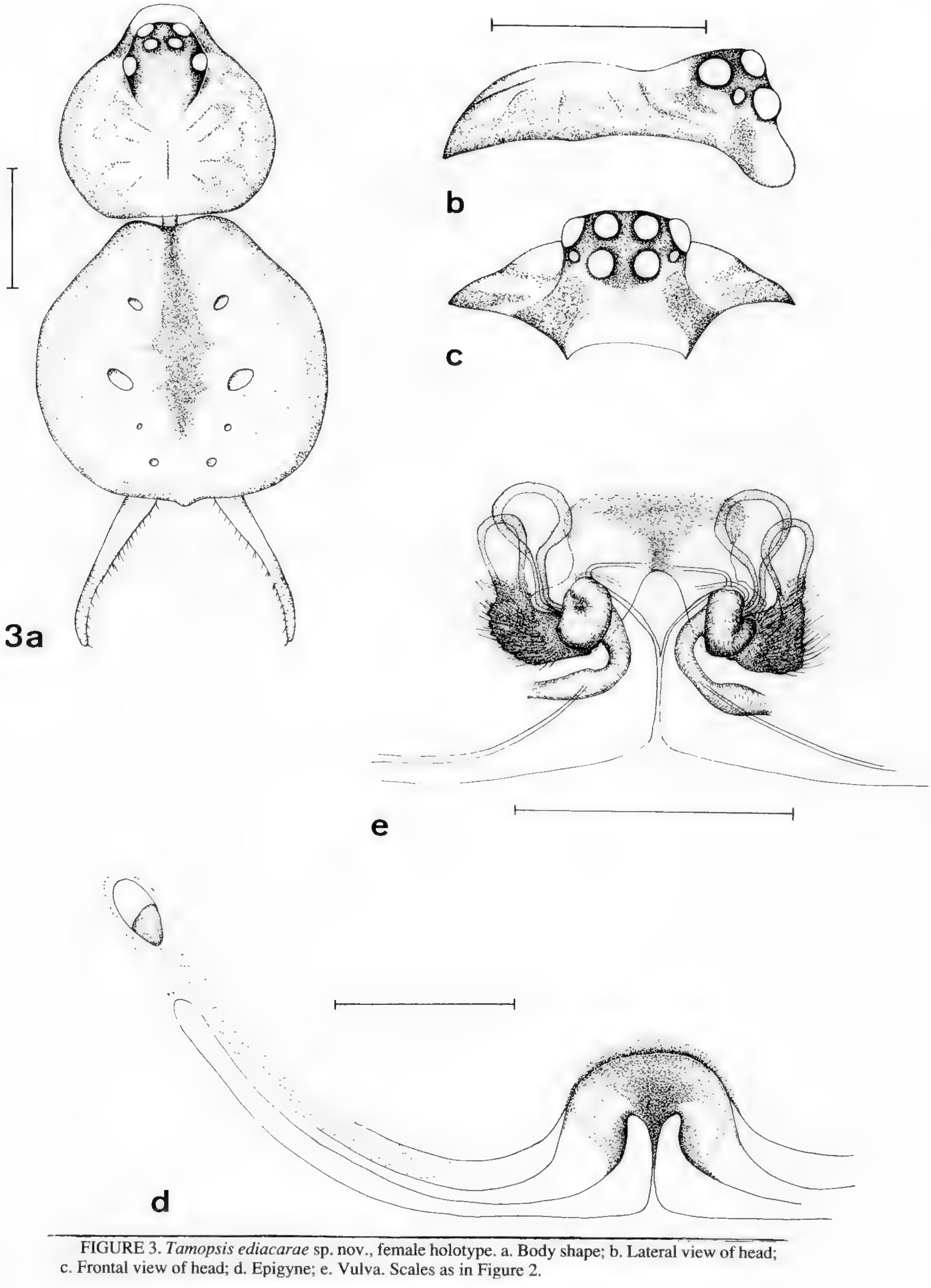


FIGURE 3. *Tamopsis ediacarae* sp. nov., female holotype. a. Body shape; b. Lateral view of head; c. Frontal view of head; d. Epigyne; e. Vulva. Scales as in Figure 2.

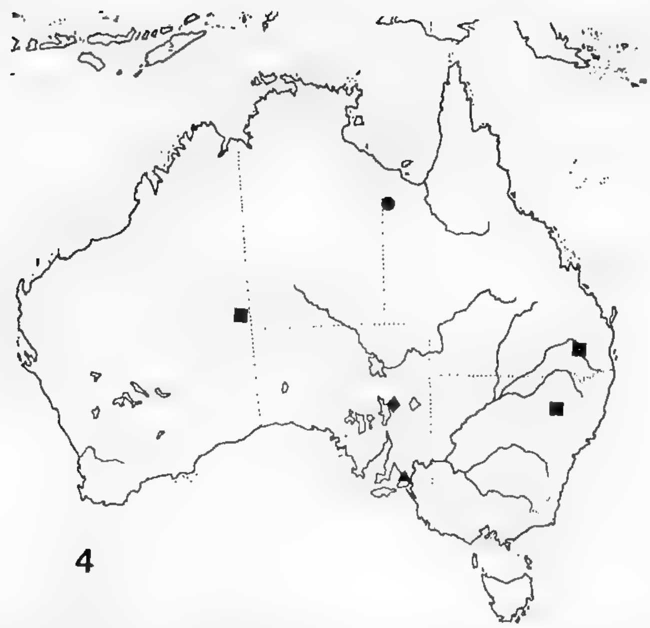


FIGURE 4. Distribution of *Tamopsis queenslandica* Baehr & Baehr: ■, *T. raveni* Baehr & Baehr; ▲, *T. forresti* sp. nov.: ●, and *T. ediacarae* sp. nov.: ♦.

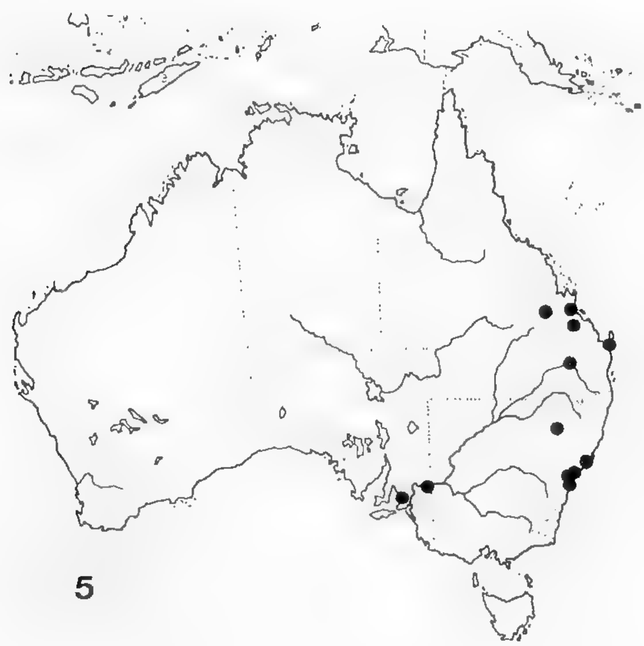


FIGURE 5. Distribution of *Tamopsis fickerti* (L. Koch), revised map.

REVISION OF AUSTRALIAN HALIPILIDAE (COLEOPTERA)

BY C. H. S. WATTS

Summary

The Australian halipilids are revised. All belong to the genus Haliplus. Eight species are recognised, four of which are new : H. alastairi sp. nov, H. nicholasi sp. nov, H. stepheni sp. nov. and H. sindus sp. nov. The synonymy of H. australis Clark with H. testudo Clark 1985 is confirmed. A key to species is provided and relationships between species briefly discussed.

REVISION OF AUSTRALIAN HALIPILIDAE (COLEOPTERA)

C. H. S. WATTS

WATTS, C. H. S. WATTS 1988. Revision of Australian Halipilidae (Coleoptera). *Rec. S. Aust. Mus.* **22** (1): 21–28.

The Australian halipilids are revised. All belong to the genus *Haliplus*. Eight species are recognised, four of which are new: *H. alastairi* sp. nov, *H. nicholasi* sp. nov, *H. stepheni* sp. nov. and *H. sindus* sp. nov. The synonymy of *H. australis* Clark with *H. testudo* Clark 1985 is confirmed. A key to species is provided and relationships between species briefly discussed

C.H.S. Watts, South Australian Museum, North Terrace, Adelaide, South Australia 5000. Manuscript received 17 June 1987.

The Australian Halipilid fauna is small with only eight known species. All belong to the worldwide genus *Haliplus*. Halipilids can be recognised from all other Australian aquatic Coleoptera by the large post-coxal plates which cover the bases of the hind legs. They are found among aquatic vegetation in still water around the coast from Adelaide eastward to Darwin. In addition, two species occur in the south-west of Western Australia and one in Tasmania. No specimens are known from the north-west. Both adult and larval stages are aquatic. No larvae of Australian species have been described. They are rare in collections and although I think this is to some degree a reflection of collecting pressure it is clear that they are not abundant. Structurally, Australian *Haliplus* fall into two clear groups. One, consisting of *H. fuscatus*, *H. gibbus* and *H. bistriatus*, is characterised by relatively small size, grooved pronotal process, well marked pronotal plicae with a depressed area between them, interstrial punctures absent or subobsolete, and a relatively narrow head. The other group, *H. testudo*, *H. alastairi*, *H. stepheni*, *H. nicholasi* and *H. sindus*, have a flat pronotal process, no pronotal plicae, no depressed area at back of pronotum and have a moderate number of punctures in most interstriae. The only major taxonomic work on Australian halipilids is that of Clark (1862) who described four species from south-eastern Australia. Regimbart described two New Guinean species in 1899 and Wehncke described *H. bistriatus* from Adelaide in 1880. The collections from which specimens were examined are listed under the following abbreviations:

AM	Australian Museum, Sydney
ANIC	Australian National Insect Collection
BMNH	British Museum (Natural History), London
CW	Private Collection of Author
MCZ	Museum of Comparative Zoology, Harvard
EUQ	Entomology Department, University of Queensland.
NMV	National Musuem of Victoria
NTM	Northern Territory Museum
SAMA	South Australian Museum
QM	Queensland Museum
QPI	Queensland Department of Primary Industry, Mareeba

SYSTEMATICS

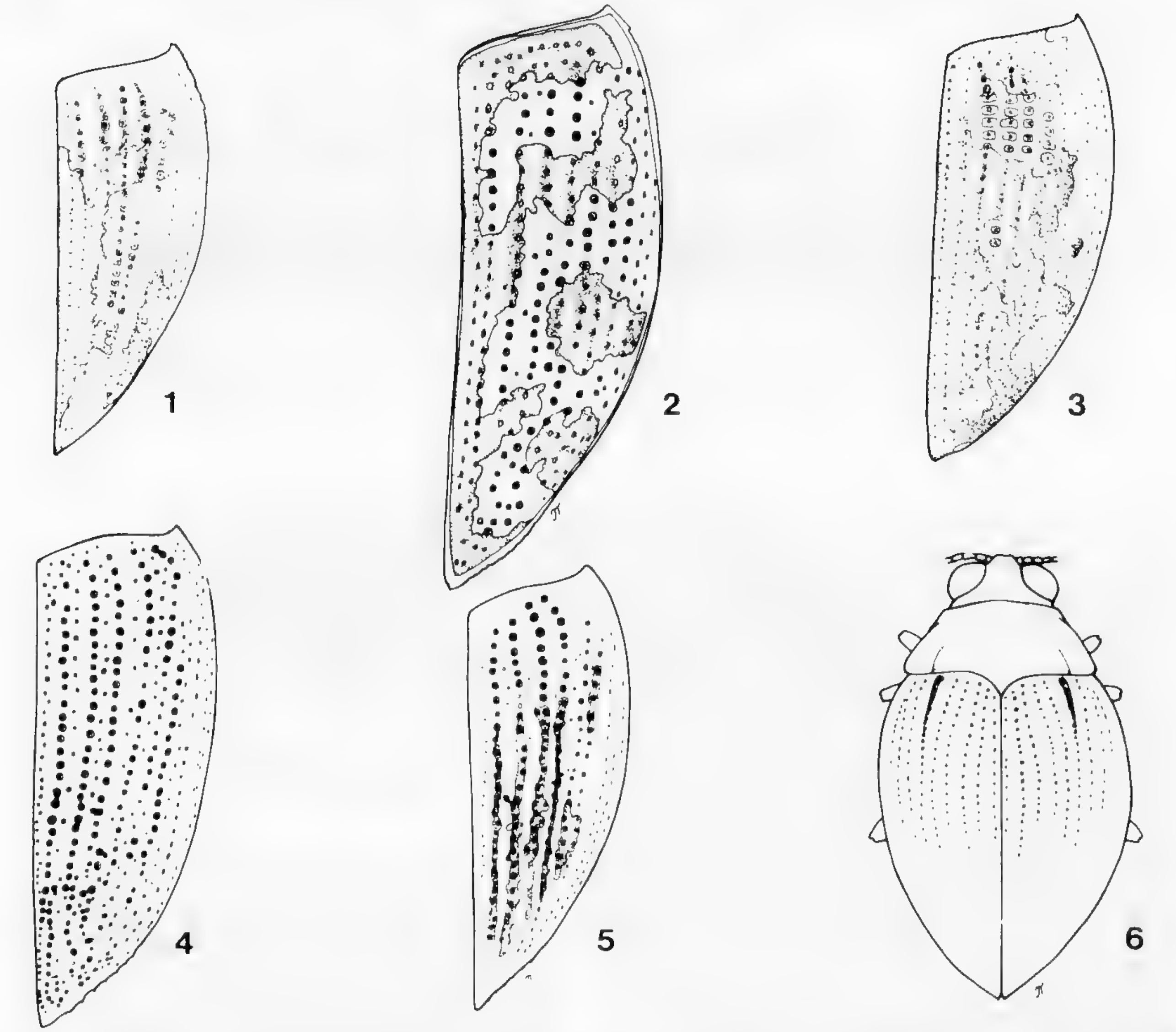
KEY TO AUSTRALIAN *HALIPLUS*

1. Pronotum with short to moderate plicae (Fig. 6), area between plicae depressed; pronotal process grooved; interstrial punctures lacking or subobsolete 6
   Pronotum lacking plicae, hind portion not depressed; pronotal process flat; interstrial punctures sparse but well marked 2

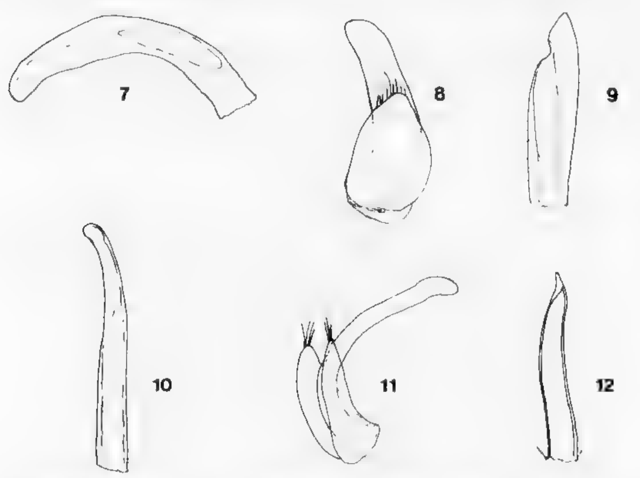
2. (1)<2.5 mm long; upper surface uniformly yellow-brown.......... *sindus* sp. nov.
   >2.5 mm long; elytron usually with dark spots or markings 3

3. (2)Punctures and striae over most of elytron except laterally black, first interstria yellow-brown for most of its length (Figs 4 & 5). Elytral plicae weak, often reduced to 2–3 deeply impressed punctures.......... *testudo* Clark
   First interstria of elytron black for most of its length; rest of elytra patterned as in Figs 1–3. Elytral plicae absent or short but well marked 4

4. (3) Elytral plicae short but well marked, elytron pattern as in Fig 3.......... 5
   Elytral plicae absent; elytron pattern as in Fig. 3 .... *nicholasi* sp. nov.



FIGURES 1–6. 1, Colour pattern on elytron of *H. alastairi*; 2, ditto *H. stepheni*; 3, ditto *H. nicholasi*; 4 & 5, ditto, *H. testudo* extreme examples; 6, dorsal view of *H. bistriatus* showing elytral and pronotal plica.



FIGURES 7–13. 7, Lateral view of aedeagus of *H. alastairi*; 8, dorsal view of aedeagus of *H. gibbus*; 9, dorsal view of aedeagus and paramere of *H. gibbus*; 10, ditto *H. alastairi*; 11, lateral view of aedeagus and paramere of *H. fuscatus*; 12, lateral view of aedeagus and paramere of *H. fuscatus*.

5. (4)1–5 punctures in first interstria of elytron, 0–1 in third. Elytron without dark markings along anterior margin (Fig. 2) .... *stepheni* sp. nov.
10-20 punctures in first interstria of elytron, 3–7 in third. Elytron without dark markings along anterior margin (Fig. 1) .... *alastairi* sp. nov.

6. (1) Elytral plicae moderately-well marked; pronotal plicae curved (Fig. 6)............*bistriatus* Wehncke
Elytral plicae absent or virtually so; pronotal plicae straight 7

7. (6) Aedeagus broad (Figs 8 & 9)...........*gibbus* Clark
Aedeagus narrow (Figs 11 & 12)...*fuscatus* Clark.

Haliplus sindus sp. nov.

Description (number examined 2)

Length 1.7 – 2.4 mm. Yellow-brown. Oval, broadest at shoulders, narrowing rather abruptly at apex. Elytron weakly and broadly triangularly flanged about one quarter way from apex, tip sharply pointed, weakly serrated at shoulder. Head with scattered punctures about size of eye facets. Pronotum wider behind than in front, sides weakly convex when viewed from above, with scattered large punctures, hind margin produced backwards in a small nearly equilateral triangle in midline. Elytron smooth, shiny, with well marked strial punctures, stronger laterally, sutural stria small but distinct, a very few scattered interstrial punctures except in interstriae three–four and five–six which lack punctures. Elytral plicae short, crescent shaped, well impressed. Pronotal process flat, wider slightly behind, with large scattered punctures. Front portion of mesosternum weakly concave, broader than pronotal process with sides sharply undercut with scattered well marked punctures, sides of mesosternum with a few very large punctures, much smaller in midline. Coxal lobes more densely covered with punctures, large towards sides to very small in midline.

Types

Holotype, sex unknown, Qld 'Bentinck Is. "Ninyilki" 6th June, 1963, P. Aitken, N.B. Tindale', in SAMA. Paratype F, 1, 'Homehill Qld. 7.4.63 C.W.' in CW.

Distribution (Fig. 14)

Known only from the type localities.

Remarks

The small size and lack of pronotal plicae readily separate this rare species from other Australian *Haliplus*. It does not appear to be closely related to any other Australian species.

Haliplus nicholasi sp. nov.
(Fig. 3)

Description (number examined 4))

Length 3.3 – 4.1 mm. Oval, broadest at shoulders. Elytron only weakly tapering until final one third; apical one quarter weakly flanged and serrated; humeral angles weakly serrate. Head relatively broad between eyes; red-brown with scattered punctures about the size of eye facet; punctures at rear larger. Pronotum wider behind than in front, sides evenly diverging or slightly concave; strongly punctured particularly around margins, with an almost impunctate transverse band acrosspronotum behind middle; hind margin broadly triangularly produced in midline; reddish-brown. Antenna short, reaching to just behind middle of pronotum, five apical segments larger than rest, apical segment twice length of penultimate. Elytron reddish-brown with extensive black markings. Strial punctures on elytron large laterally, progressively weaker toward suture. Sutural punctures well marked, a little larger and much more numerous than those between stria one and two. Interstrial punctures small, sparse, absent from interstriae three to four. Elytral plicae absent, position marked by row of three or four punctures. Pronotal process flat, widening slightly toward rear, with scattered well marked punctures of varying size. Front section of mesosternum flat, not bordered by raised margin but margins sharply undercut; wider than pronotal process; punctured as on pronotal process; sides moderately covered with large punctures, much smaller towards midline. Coxal lobes more densely covered with punctures, those towards sides smaller than on sides of mesosternum, those towards midline about same size. Abdominal segments with one or two transverse bands of small to moderate punctures, apical segments with a few large punctures. Underside reddish-brown, legs a little darker.

Male: Protarsi a little exposed.

Types

Holotype, F 'Townsville, Qld. Feb 1972 T. Ingeldew', in NMV. Paratypes, 1, M, 'Homehill Qld. 7.4.63 CW', 2FF, 'Cairns Qld. 16.4.63 CW' in CW.

Distribution

Fig. 14. Known only from the type localities near Cairns and Townsville in North Queensland.

Remarks

A little known species, resembling the widespread *H. testudo*. It is slightly smaller, has fewer interstrial punctures, and differently patterned elytra. The aedeagus of the only known male specimen has been lost. The pattern on the elytra resembles in some respects that in *H. signatipennis* Regimbart from new Guinea. *H. nicholasi* differs from this species (and from the other known new Guinea species, *H. ferruginipes* Regimbart) in lacking punctures between stria three and four, and in lacking the transverse depression at the base of the pronotum present in these species.

Haliplus testudo Clark
(Figs 4 & 5)

Haliplus testudo Clark, 1862, p. 400
Haliplus australis Clark, 1862, p. 400. Syn. after Watts, 1985 and re-examination of types.

Types

H. testudo. Lectotype, F, right hand specimen of two mounted on card. No locality, previously with BMNH type and syntype labels, here designated. Companion specimen designated paralectotype. *H. australis*, Lectotype, F, no data except hand written BM label, previously with BMNH type and syntype labels, here designated.

Description (number examined 118)

Length 3.2 – 4.1 mm. Oval, widest at shoulders, tapering towards apex of elytra, lateral margin of elytron serrate in apical one quarter. Head relatively broad between eyes, yellow to yellow-brown, moderately covered with punctures about same size or slightly larger than facets of eye. Antenna stout, reaching over half way back on pronotum, apical five segments noticeably larger than rest, apical a little longer than penultimate. Pronotum relatively short, wider behind than in front, lateral margins evenly diverging or slightly bowed out when viewed from above; unevenly covered with scattered moderate to large punctures which are densest around margins, with an almost impunctate band across pronotum behind middle; hind margin with small but well marked backward extension in midline; yellow to yellow-brown, some punctures particularly towards rear outlined in black. Elytron yellow to yellow-brown, punctures and usually stria also black. Strial punctures well marked, a little larger than those on pronotum, those in striae one to three smaller than others. Sutural punctures small but quite dense and well impressed, about size of those in interstria one to two. Interstrial punctures numerous, one third to half size of ones in striae, absent or very sparse in area between suture and first stria, alternate interstriae starting between striae three and four have fewer punctures with the more lateral ones virtually impunctate. Elytral plicae absent or represented by two to three enlarged sometimes contiguous punctures in stria five. Pronotal process broad, flat, diverging slightly behind, with well marked lateral ridges, sparsely punctured. Mesosternum sparsely punctured, punctures large, laterally subobsolete in midline; well-marked ridges running backwards from pronotal process for about half length of segment. Coxal lobes large, strongly punctured laterally, weakly in midline. Abdominal segments with one or two transverse rows of small punctures. Apical segments with some moderate to large punctures in apical half. Underside yellow-brown with darker motlings particularly at bases of legs.

Male: Basal two joints of protarsi a little expanded.

Variation: Some specimens reddish all over.

Distribution: (Fig. 14)

Coastal regions from Darwin to Melbourne. Also from Charleville, Qld.

Remarks

By far the commonest and most widespread Australian halipilid. A variable species with yellowish specimens predominating in the south and darker reddish specimens in the north. In some southern specimens the characteristic black pigment around elytral punctures and striae is greatly reduced (Fig. 4). In some there are vague darker patches on the elytron suggestive of *H. alastairi* or *H. nicholasi* but in all specimens that I have seen the dark elytral striae have been separated by yellow-brown. In all but a few examples the elytral plicae are virtually absent. The aedeagus is variable in lateral view, with some specimens, notably those from more southern localities, being much wider in the middle.Separable from the other species lacking pronotal plicae by characters mentioned under *H. alastairi* and *H. nicholasi*.

Haliplus alastairi sp. nov.
(Figs 1, 7, 10)

Description (number examined 16)

Length 3.0–3.6 mm. Oval, tapering quite rapidly behind shoulders. Humeral angle of elytron serrate, apical one quarter of elytron weakly flanged and weakly serrate. Head relatively broad between eyes, dark yellow-brown, moderately punctate; punctures larger than eye facets. Pronotum wider behind than in front; lateral margins evenly diverging when viewed from above; strongly punctured particularly around margins, with an almost impunctate band across pronotum behind middle and a row of three to six noticeably larger punctures above hind margin at each corner; hind margin with small sharply triangular extension in the midline; reddish brown. Antenna reaching beyond middle of pronotum, last five segments larger than rest, apical about 1.5x longer than penultimate. Elytron reddish brown, with dark-brown to black markings. Strial punctures will marked, about size of pronotal punctures, those in striae one to three smaller than others. Sutural punctures well marked, as large as and more numerous than punctures between striae one and two. Interstrial punctures rather sparse, about one quarter to one third size of those in adjacent striae, alternate interstrial starting from between striae three and four have fewer punctures with the more lateral ones impunctate. Elytral plicae short (three to four punctures long) but usually deeply impressed; punctures on humeral angle between plica and edge of elytron large and crowded. Pronotal process relatively narrow, flat, quite strongly punctured. Front portion of mesosternum a little wider than pronotal process, flat or even slightly convex, sides rounded, undercut but not ridged. Mesosternum rather sparsely punctured, punctures strong at sides, small but well-impressed in midline. Coxal lobes more densely but still only moderately covered with punctures, those at sides moderate, about size of those in stria on elytron, those towards midline small but well impressed. Abdominal segments with one or two transverse bands of moderate punctures, apical segment with a few larger punctures. Underside reddish with darker areas, particularly legs which are mainly dark red-brown.

Male: Two basal segments of protarsi a little expanded.

Variation: One specimen from Tambourine Mountain, Qld that I refer to this species has the elytral plicae reduced to short series of slightly enlarged punctures.

Types

Holotype, M. '12°36'S 132°52'E Magela Creek, N.T. 1 Km NNW of Mudginbarry HS. 25.v.73. Matthews & Upton' in ANIC. Paratypes: 1, 'Cardstone Qld 4-16. i-1966 K Hyde'. 1, 'Cooktown N.Q. 1/71 GB', 2, 'Katherine, N.T. at light. 9.ii.68 J.A.L. Watson', 1, 'King River, 2, 14°30'S:143°20' E.22.vi.68. F. Parker' all in ANIC. 1, 'Lake Buchanan Qld. 21°30'S 145°50'E B.Timms 25/9/83', in CW; 1, 'Cairns C.J.W.' in QM.

Distribution (Fig. 13)

The east coast of Cape York and the top end of the Northern Territory. If the specimen from Tambourine Mountain near Brisbane does belong to this species it may indicate a more extensive range down the Queensland coast.

Remarks

Morphologically close to *H. testudo*, *H. nicholasi* and *H. stepheni* but averaging smaller than the first two of these species (3.0 mm compared with 4.0 mm and 3.3 mm respectively) with a more spindle shaped and less parallel sided form. The elytral plicae are well marked in all the specimens I have seen whereas they are virtually absent in all but a few specimens of *H. testudo* and *H. nicholasi*. The larger number of interstrial punctures separate it from *H. stepheni*. The colour pattern on the elytron differs from these species. The aedeagus is very similar to that of *H. stepheni*. It is a little thinner in dorsal view to *H. testudo*.

Haliplus stepheni sp. nov.
(Fig. 2)

Description (number examined 13)

Length: 2.8–3.0 mm. Oval, tapering quite rapidly from about half way back on elytrae. Humeral angle of elytron serrate, apical quarter of elytron weakly flanged and weakly serrate. Head relatively broad between eyes, dark yellow-brown, shiny, moderately punctate, punctures larger than eye facet. Pronotum wider behind than in front; lateral margins evenly diverging when viewed from above except for extreme front portions; sparsely covered with large punctures, impunctate areas on disc, row of larger punctures along hind edge at each side, laterally depressed in middle near hind edge, hind margin with small triangular extention in the midline, coloured as on head. Antenna reaching nearly to elytron, last five segments larger than rest, apical about same length as penultimate. Elytron dark yellowish-brown, with well defined dark pattern (Fig. 2). Strial punctures well marked, about size of those on pronotum, those on disc smaller than others, sutural punctures numerous, well marked, about half the size of those in adjacent striae. Interstrial punctures small and sparce, those in alternate interstria starting from interstriae 1–2 very sparse, lateral areas impunctate. Elytron plica short, 3–6 punctures long, deeply impressed, punctures between plica and edge of elytron only a little longer than others and not particularly crowded. Pronotal process relatively narrow, flat, quite strongly punctured. Front portion of mesosternum a little wider than pronotal process, flat except for front edge which is sharply depressed, sides slightly undercut, sparsely punctured with a row of punctures on vertical surface along sides, center virtually impunctate. Coxal lobes more densely but still only moderately covered with punctures, those at sides about size of those in lateral elytral striae, those towards midline small but well impressed. Abdominal segments with one or two bands of small punctures, apical segment with a few larger punctures, underside reddish with darker areas, particularly legs which are mainly dark red-brown.

Male: Last five joints of antenna a little smaller.

Types

Holotype, M. 'AUSTRALIA, N.T. Humpty Doo, 6 km E., 9.ii-4. iii.1987. R.I. Storey' in SAMA. Paratypes same data, 8 in QPI, 2 in C.W.

Distribution

Known only from the type locality near Darwin, N.T.

Remarks

A strikingly marked species separated from *H. alastairi* and *H. nicholasi* by the extension of black markings along front margin of elytron. Some individuals also have a dark patch on the front edge of the pronotum in the midline. The presence of well marked elytral plicae distinguish it from *H. nicholasi* and the greatly reduced number of interstrial punctures from *H. alastairi*. The pronotum is more strongly folded than in the other species and there is a hint of a basal depression in some specimens. The aedeagus is very similar to that of *H. alastairi*. It is a little thinner in dorsal view to *H. testudo*.

Haliplus bistriatus Wehncke
(Fig. 6)

Haliplus bistriatus Wehncke, 1880, p. 72.

Types

None located. (They are not in BMNH nor Paris National Museum.)

Description (number examined 39)

Length 2.5–3.4 mm. Oval, sides of elytra subparallel in central half. Elytron weakly flanged in apical one quarter. Head relatively narrow; yellow-brown; sparsely covered with scattered small punctures about the size of eye facets. Antenna short, reaching to about middle of prothorax, apical five segments noticeably larger than rest, apical segment largest. Pronotum wider behind, sides weakly bowed outwards when viewed from above; hind margin widely triangularly produced backwards in middle; with well marked plica reaching one third way across pronotum, curving inwards; area between plicae depressed; strongly punctured, particularly at sides and at front; yellow-brown with front margin and area between plica darker. Elytron dark yellow-brown with striae, other than at sides, outlined in dark-brown to black. Striae composed of rather large well impressed punctures, those in inner two striae about half size of others. Interstrial area impunctate, sutural row of punctures sparse and very small. Elytral plica moderately marked, a little longer than pronotal plica. Pronotal process broad, with row of strong punctures along edges, concave in cross-section. Mesosternum raised in forward midsection, without lateral ridge but sharply undercut; front portion same width as pronotal process and slightly depressed in midline; midline with scattered small punctures, larger towards rear, lateral sections covered in many strong punctures. Punctures on coxal plate vary from very strong laterally to subobsolete in midline, largest slightly smaller than those at sides of mesosternum. Abdominal segments with small to moderate sized but well marked punctures; apical segment strongly punctured. Undersides dark yellow-brown with extensive dark mottlings.

Male: Protarsi a little expanded.

Distribution (Fig. 13)

Coastal Queensland from Brisbane to Cooktown.

Remarks

H. bistriatus appears to be relatively common in coastal Queensland where it is the only *Haliplus* with pronotal plicae and depressed basal area of pronotum. It is readily separated from the more southerly *H. gibbus* and *H. fuscatus* with which it shares these characters, by the larger and distinctly curved pronotal plicae and the presence of well marked, though short, elytral plicae. The aedeagus is distinctive. The type locality is given as Adelaide. In the absence of the type this must throw doubt on my identification of this Queensland species. However, the description fits this species particularly in the unique (in Australia) character of having both pronotal and elytral plicae. This species has also been recorded from New Caledonia by Fauvel (1883) whose specimens were identified by Wehncke.

***Haliplus gibbus* Clark**
(Figs 8 & 9)

Haliplus gibbus Clarke, 1862, p. 400.

Type

H. gibbus, lectotype, M. with genitalia extracted, 'S. Aust. Bakewell 59/24', previously with BM(NH) type and syntype labels, in BMNH, here designated.

Description (number examined 32)

Length 2.4–3.2 mm. Widely oval. Lateral edges of elytra parallel in central half. Elytron weakly flanged in apical quarter. Head relatively narrow, yellow-brown, sparsely punctured with small punctures about size of eye facet. Antenna short, reaching to about middle of prothorax, ten segmented, apical segment largest, next four subequal and noticeably larger than rest. Pronotum wider behind, sides smoothly diverging or slightly bowed except for hind corners where subparallel for short distance, hind margin widely triangularly produced backwards in middle, well marked sharp plicae to one quarter to one third width of pronotum, subparallel or weakly converging, positioned in line with front corners of pronotum, area between plicae depressed, moderately punctate, punctures uneven in size and distribution small on disc large at sides, yellow-brown, with front margin and area between plica often darker. Elytron yellow-brown with striae on disc outlined in dark-brown or black, some specimens with vague darker patches on elytron, nine elytral striae composed of moderately impressed punctures, those on inner two or three striae weaker, interstriae impunctate, sutural punctures sparse, very small, elytral plicae absent but punctures at front of stria five close together and often with their lateral margins accentuated. Pronotal process broad, margins ridged, concave in cross section. Mesosternum raised, weakly longitudinally depressed on forward midsection, fornt corners wider than adjacent pronotal process with distinct tendency to be bulbous and delineated from rest of mesoternum by fine line running backwards for about half length of segment. Lateral lobes of mesoternum with a few very large punctures, midline with subsolete to moderate punctures, larger behind. Coxal lobes strongly punctured laterally, weakly so towards midline. Undersde yellow-brown often with considerable brown-black areas, paerticularly pronotal process, lateral areas of mesosternum, first three abdominal segments ane parts of legs. Abdominal segments weadly punctured except apical one which has a few stronger ones.

Male: Protarsi weakly expanded.

Distribution (Fig. 13)

The wetter areas of southern W.A., S.A., Victoria and Tasmania. A southern species. Populations of either this species or *H. fuscatus* or some very similar species are also known from Lake Gailee in Central Queensland and near Katherine in the N.T. Unfortunately these are only represented in collections (CW & SAMA) by females so their taxonomic status is uncertain.

Haliplus fuscatus Clark
(Figs 11 & 12)

Haliplus fuscatus Clark 1862, p. 400.

Type

H. fuscatus, Holotype, F, no data, in BMNH, locality given as Adelaide by Clark.

Description (number examined 13)

As for *H. gibbus* except for the aedeagus which is much narrower.

Distribution (Fig. 13)

Victoria, S.A. (type) and Rottnest Island, W.A.

Remarks

Does not appear to be as common as *H. gibbus*, nor as widespread. I have been unable to separate this species from *H. gibbus*. Although only known for certain from Rottnest Island, W.A. and Victoria, further collecting will undoubtedly extend its known distribution (See also note under *H. gibbus*). The type of *H. fuscatus* is a female and as such I cannot assign it to either of the two species of southern Australian *Haliplus* with weak or absent elytral plicae and straight pronotal plicae. Future studies may well show that *H. fuscatus* is a synonym (senior) for *H. gibbus* and that the species described above as *H. fuscatus* is new. In a previous publication (Watts 1985) I listed *H. fuscatus* and *H. gibbus* as synonyms since I was unable to separate the types.

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FIGURE 13. Distribution map of *H. fuscatus, H. bistriatus, H. alastairi* and *H. gibbus*.

FIGURE 14. Distribution map of *H. sindus, H. testdo, H. nicholasi* and *H. stepheni*.

OSTEOLOGICAL DIFFERENCES OF THE AXIAL SKELETON BETWEEN LASIORHINUS LATIFRONS (OWEN, 1845) AND VOMBATUS URSINUS (SHAW, 1800) (MARSUPIALIA : VOMBATIDAE)

BY G. G. SCOTT & K. C. RICHARDSON

Summary

Many of the bones from the axial skeleton of the extant hairy-nosed wombat, Lasiorhinus latifrons (Owen, 1845) and common wombat Vombatus ursinus (Shaw, 1800) are statistically significantly different. The gross morpohological features are summarised to facilitate rapid specimen identification at the generic level.

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SCOTT, G.G., & RICHARDSON, K.C. 1987. Osteological differences of the axial skeleton of *Lasiorhinus latifrons* (Owen, 1845) and *Vombatus ursinus* (Shaw, 1800) (Marsupialia: Vombatidae). *Rec. S. Aust. Mus.* **22** (1): 29–39.

Many of the bones from the axial skeleton of the extant hairy-nosed wombat, *Lasiorhinus latifrons* (Owen, 1845) and common wombat, *Vombatus ursinus* (Shaw, 1800) are statistically significantly different. The gross morphological features are summarised to facilitate rapid specimen identification at the generic level.

A number of newly recognised diagnostic differences are recorded: (i) atlas, (a) transverse processes, short and cylindrical in *L. latifrons*, but long and flat in *V. ursinus*, (b) cranial articular surface, dorsal border begins above root of transverse process in *L. latifrons*, but below in *V. ursinus*, (c) intervertebral foramen, small in *L. latifrons*, but large in *V. ursinus*, (d) neural arch, tubercle present at the apex in *L. latifrons*, but a sulcus in *V. ursinus*, (e) transverse foramen, almost enclosed by bone in *V. ursinus*, but open in *L. latifrons*, (f) lamina, cranial border flat in *L. latifrons*, but arched in *V. ursinus*;(ii) axis, (a) transverse processes, extend laterocaudally beyond caudal surface of vertebral body in *V. ursinus*, but terminate level with, or before, caudal surface of vertebral body in *L. latifrons*, (b) dens, directed craniodorsally, apex lies above dorsal surface of vertebral body in *L. latifrons*, but projects cranially, and apex lies below dorsal surface of vertebral body in *V. ursinus*; (iii) manubrium of sternum, (a) articular process for clavicle, conical in *L. latifrons*, but laterally flattened in *V. ursinus*; (b) clavicular notch, shallow in *L. latifrons*, but deep in *V. ursinus*. Significant differences in size were found for: (i) axis, lamina thickness, lamina diameter, dens length; (ii) thoracic vertebrae, dorsoventral diameter of body of all but the 3rd vertebra; craniocaudal diameter of vertebral body of 1st, 2nd, 7th, 9th, 10th, 11th, 12th and 13th vertebrae; (iii) lumbar vertebrae, maximum transverse process diameter of 1st, 2nd and 3rd vertebrae. (iv) sacral vertebrae, maximum transverse process diameter of 2nd, 3rd and 4th vertebrae; and (v) shaft diameter for ribs 11, 12 and 13.

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The common wombat *Vombatus ursinus* (Shaw, 1800) was first discovered by Bass on Clarke Island in Bass Strait in 1797. Although the skull aroused considerable taxonomic discussion from 1800, it was only in 1838 that Owen first described its axial skeleton. Owen added to this description in 1839. Subsequent work on the axial skeleton by Everett (1853) and Home (1853) provided no new information.

Even though the hairy-nosed wombat *Lasiorhinus latifrons* (Owen, 1845) was first discovered in 1845, it was in 1867 that Murie described its axial skeleton and compared it with *V. ursinus*. Other workers such as Lydekker (1894), Murie (1892) and Marlow (1965) confirmed, in part, many of Murie's (1867) findings, but added little to the existing information.

To date the descriptions of the axial skeleton of the two wombat genera have lacked adequate detail. In many instances, they were not accompanied by figures or definitions to allow ready specimen identification especially of isolated small bones.

This paper presents a number of newly recognised diagnostic features and incorporates, where valid, previously described diagnostic features.

MATERIALS AND METHODS

Specimens

Bones of the axial skeleton of *L. latifrons* and *V. ursinus* were examined in the collections of the Australian Museum, Sydney; Museum of Victoria, Melbourne; Queensland Museum, Brisbane; South Australian Museum, Adelaide; and Western Australian Museum, Perth. For this study additional specimens of *L. latifrons* were collected at Blanchetown, Roonka and Swan Reach in South Australia; and of *V. ursinus* over the Great Dividing Range and adjacent regions.

Measurements

The morphology of the axial skeleton bones was examined and any diagnostic features not previously recorded in the literature noted. Both adult and juvenile specimens were examined, but only bones from adults were compared for diagnostic purposes. Linear measurements were made with vernier callipers on adult specimens.

Axial Skeleton Measurements

1. Atlas
   - (i) lamina, craniocaudal diameter at summit;
   - (ii) maximum dorsoventral height from apex of arch to ventral surface of body.

2. Axis
   - (i) maximum dorsoventral height from apex of spinous process to ventral surface of body;
   - (ii) lamina, thickness at point of maximum constriction dorsal to the caudal articular surface;
   - (iii) lamina, craniocaudal diameter at point of maximum constriction dorsal to the caudal articular surface;
   - (iv) dens, length from ventral surface to apex;
   - (v) dens, maximum lateral diameter;
   - (vi) vertebral body, dorsoventral diameter at midline;
   - (vii) vertebral body, craniocaudal diameter, including dens, at midline;
   - (viii) spinous process, length from apex of vertebral foramen to summit of spine.

3. Cervical Vertebrae
   - (i) maximum combined diameter of the transverse processes.

4. Thoracic Vertebrae
   - (i) vertebral body, dorsoventral diameter at midline;
   - (ii) lamina, craniocaudal diameter at point of maximum constriction dorsal to caudal articular surface;
   - (iii) spinous process, length from apex of vertebral foramen to summit of spine;
   - (iv) maximum combined diameter of the transverse processes;
   - (v) maximum dorsoventral height from apex of spinous process to ventral surface of body;
   - (vi) vertebral body, craniocaudal diameter at midline.

5. Lumbar Vertebrae
   - (i) maximum combined diameter of the transverse processes.

6. Sacral Vertebrae
   - (i) maximum combined diameter of the transverse processes.

7. Coccygeal Vertebrae
   - (i) maximum combined diameter of the transverse processes.
   - (ii) vertebral body, craniocaudal diameter at midline.

8. Sternum
   - (i) manubrium, craniocaudal length at midline;
   - (ii) maximum diameter opposite articular surfaces for 1st ribs.

9. Ribs
   - (i) shaft, maximum diameter immediately distal to tubercle.

Osteological terminology used is as in the *Nomina Anatomica Veterinaria* (Habel *et al.* 1983).

Analysis

Methodology includes Student's t-test, 2-'tailed', and bivariate analysis (Simpson *et al.* 1960). Bivariate regression analysis of specimens of known sex shows no significant sexual dimorphism for any of the characters examined, so measurements of both sexes were combined.

Results

General

Size range overlap exists between *V. ursinus* and *L. latifrons* for most measurements. However, *V. ursinus* is significantly larger for:

1. Axis, (i) lamina, dorsoventral thickness ($P < 0.001$); (ii) lamina, craniocaudal diameter ($P < 0.001$); (iii) dens, length ($P < 0.001$).
2. Lumbar vertebrae, maximum combined diameter of the transverse processes of the 1st, 2nd and 3rd vertebrae ($P < 0.001$).
3. Sacral vertebrae, maximum combined diameter of the transverse processes of the 2nd, 3rd and 4th vertebrae ($P < 0.001$).

L. latifrons is significantly larger than *V. ursinus* for:

1. Thoracic vertebrae, (i) vertebral body, dorsoventral diameter, T2 and 11 ($P < 0.001$); T1, 4, 6, 7 and 12 ($P < 0.01$); and T5, 8, 9, 10 and 13 ($P < 0.05$); (ii) Vertebral body, craniocaudal diameter, T1 ($P < 0.001$); and T2, 7, 9, 10, 11, 12 and 13 ($P < 0.05$).
2. Lumbar vertebrae, maximum combined diameter of the transverse processes of the 1st, 2nd and 3rd vertebrae ($P < 0.001$).
3. Sacral vertebrae, maximum combined diameter of the transverse processes of the 2nd, 3rd and 4th vertebrae ($P < 0.001$).
4. Ribs, shaft diameter of the 12th and 13th ($P < 0.001$) and 11th ($P < 0.05$).

Axial skeleton measurements for both taxa are given in Tables 2–16.

Specific

Vertebral Column

As Owen (1839), Wood Jones (1923), Lydekker (1894), Murie (1867) and Marlow (1965) correctly pointed out, *V. ursinus* and *L. latifrons* possess different numbers of vertebrae in several parts of their vertebral column (Table 1).

Cervical Vertebrae

These are the smallest vertebrae, excluding the coccygeal vertebrae. Only the atlas and axis show any consistent gross morphological differences.

Linear measurements show no significant differences between the two wombat genera (Table 2.)

Atlas:

	L. latifrons	*V. ursinus*
Transverse process.	short and cyelindrical.	long and dorsoventrally flattened.
Cranial articular surface.	begins above level of transverse process.	begins below level of transverse process.
Intervertebral foramen.	small.	large.
Tubercle.	present at apex of neural arch.	absent, a sulcus.
Transverse foramen.	open.	almost enclosed
Lamina.	cranial border flat.	arched.
Ventral arch incomplete.	V-shaped.	shallow.

Axis:

	L. latifrons	*V. ursinus*
Dens.	directed craniodorsally, apex lies above dorsal surface of vertebral body.	directed rostrally, apex lies below dorsal surface of vertebral body.
Spinous process.	short and thick.	long and narrow.
Transverse process.	terminates level with, or before, caudal surface of vertebral body.	terminates beyond caudal surface of vertebral body.

Significant size differences in the axis were found for: (i) dorsoventral lamina thickness, (ii) craniocaudal lamina diameter, and (iii) dens length (Table 3).

No gross morphological or significant size differences were found between the two taxa for the five caudal cervical vertebrae (Table 4).

Thoracic Vertebrae

These are morphologically similar in the two wombat taxa. *L. latifrons* is significally larger than *V. ursinus* in dorsoventral diameter of the vertebal body for the following vertebrae: T2 and 11 ($P < 0.001$); T1, 4, 6, 7 and 12 ($P < 0.01$); T5, 8, 9, 10 and 13 ($P < 0.05$) (Table 5). There were no significant size differences between the two wombats for craniocaudal diameter of the lamina (Table 6), and length of the spinous process (Table 7). Maximal combined diameter of the transverse processes decreases from T1 to a minimum at the 12th vertebra in *V. ursinus*, but at the 13th in *L. latifrons*. There is no significant size difference between the measurments appearing in Table 8. Maximum dorsoventral height of the vertebrae also decreases caudally to a point of minimum size at the 13th vertebra in *V. ursinus*, but 12th in *L. latifrons*. There is no significant size difference between the measurements in Table 9. Contrary to this, craniocaudal diameter of the vertebral body increases caudally in both genera. *L. latifrons* is significantly larger than *V. ursinus* for vertebrae: T1 ($P < 0.001$) and T2, 7, 9, 10, 11, 12, 13 ($P < 0.05$) (Table 10). Mammillary processes usually present at the 12th thoracic vertebra in *V. ursinus*, progressively increase in size to the second lumbar vertebra, then decrease in size to the end of the sacrum. In *L. latifrons* they were generally present at the 13th thoracic vertebrae then progressively increased in size to the fourth lumbar vertebra, and decreased in size to the end of the sacrum. This is only of diagnostic value when measurements for dorsoventral vertebral body diameter (Table 5) and craniocaudal vertebral body diameter (Table 10) are also available.

Lumbar Vertebrae

These are morphologically similar in the two wombat taxa. However, *V. ursinus* possesses four, but *L. latifrons* has six lumbar vertebrae (Table 11). Maximum combined diameter of the transverse processes of the first three vertebrae is significantly greater in *V. ursinus*; there is no size overlap between the two genera.

Sacral Vertebrae

In defining the number of sacral vertebrae in *V. ursinus*, Owen (1867) said: 'if we regard those vertebrae only as sacral which join the ossa innominata then there are but three. If on the other hand, anchylosis is the test, then the sacral vertebrae may vary from 3 to 4–5, in number in different specimens'. On the anchylosis criterion none of the *V. ursinus* specimens that we examined had only three vertebrae, but the majority (46.1%, n = 22) possessed four. On the other hand three out of four of the *L. latifrons* specimens that we examined had four vertebrae. In addition, the *L. latifrons* sacrum is rostrally broader but narrows more sharply caudally i.e. the 5th vertebra is approximately

44% narrower than the 1st in *L. latifrons*, but 21% narrower in *V. ursinus*. There are no gross morphological differences in the individual vertebrae to distinguish them between the two wombat taxa. Linear measurements show significant differences for the following vertebrae: S2, 3 and 4 ($P<0.001$) (Table 12).

Coccygeal Vertebrae

There are no consistent gross morphological or significant size difference in the individual bones to distinguish them between the two wombat taxa (Tables 13 and 14).

Manubrium of the Sternum

Gross morphological differences in the manubrium of the two wombat genera were found in the following features:

	L. latifrons	*V. ursinus*
Articular process for the clavicle.	conical.	laterally flattened.
Clavicular notch.	shallow.	deep.

There were no significant size differences for measurements appearing in Table 15. Other sternebrae from the wombats were similar in form for each species.

Ribs

These are similar in the two wombat genera. The cranial ribs are more curved than those succeeding them, and maximum shaft diameter generally decreases caudally through the rib series. The rib shaft diameters for *V. ursinus* are significantly smaller than those for *L. latifrons* for ribs: 11 ($P<0.05$), 12 ($P<0.001$) and 13 ($P<0.001$) (Table 16).

Discussion

Vertebral differences in the axial skeleton mirror variations in burrowing behaviour of *L. latifrons* and *V. ursinus*. For example, differences in the morphology of the atlas and axis are reflected in Angas' (1861) observation that *V. ursinus* does not hold its head as erect as does *L. latifrons* when standing. Indeed this is suggested by the dorsocranial orientation of the dens of the axis in *L. latifrons*, as well as by the presence on the skull of a well developed nuchal crest at the junction of the parietal and occipital bones for the attachment of *mm. rectus capitis*. In contrast the dens of *V. ursinus* is directed cranially and the parietal bone is flat. However, the transverse processes of the atlas of *V. ursinus* are very large indeed when compared to those in *L. latifrons*. This allows a greater surface area for muscle attachment, particularly *mm. obliquus capitis* and *mm. intertransversarii longus*, and probably facilitates a greater degree of head rotation, as well as more powerful lateral and dorsal head movements in *V. ursinus*.

As for the difference in the number of thoracic vertebrae and thus thoracic ribs, Owen (1838) believed that *V. ursinus* had the greater number i.e. 15 pairs of ribs because 'The pressure to which the trunk of the Wombat must occasionally be subjected, in its subterranean burrowings, is probably the condition of the development of the additional pairs of ribs'. Unfortunately *L. latifrons* is also 'a thorough adept in the art' of burrowing (Angas 1861).

The reason probably lies with *V. ursinus* being greater in body size. However, the point of minimum combined vertebral transverse process diameter, and minimum overall dorsoventral size of the vertebrae, which together indicate the centre of greatest spinal mobility, occurs at about the same point, the anticlinal vertebra, in the axial skeleton of both genera. This supports Slijper's (1946) conclusion that the inclination of the neural spine does not depend on the construction of the trunk in its entirety, but instead must be affected only by the demands of the muscles and ligaments attached to them. In other words, the reason for *V. ursinus* having 15 pairs of ribs, while *L. latifrons* only has 13 pairs, is a structural reflection of the need to transmit a greater visceral weight via the ribs, and the oblique and transverse abdominal muscles, directly to the body's axis than does *L. latifrons*.

Slijper (1946) also found that spinous process length is proportional to the mechanical demands of the body. They are on average, with the exception of thoracic vertebrae 6, 7 and 8, the longest in *L. latifrons*. This provides the added mechanical advantage of a longer lever to move the diaphragmatic vertebrae which, together with two fewer ribs, would undoubtedly increase the ability of *L. latifrons* to bend its body laterally into curving tunnels.

Unfortunately no mobility studies of the wombat vertebral column have yet been undertaken. But the general gross morphology of the cervical, thoracic and lumbar vertebrae suggest a shift in vertebral column mobility. The cervicals are very mobile in both dorsoventral and lateral directions, especially in the cranial part of the column, in both genera, because of the 'free' and 'unembracing' nature of the union between the pre-and postzygapophyses of successive cervical vertebrae. Thoracic vertebral mobility is particularly great in both genera.

However, the 14th and 15th thoracic vertebrae in *V. ursinus* are decidedly lumbar-like in appearance, but possess ribs! Indeed lumbar vertebrae numbers 3–6 in *L. latifrons* are more comparable in size to 1–4 in *V. ursinus* (Table 11). In both genera, lumbar vertebrae of the postdiaphragmatic region of the spine are much less mobile in the dorsal direction and almost absolutely immobile in the ventral direction. Lateral mobility is negligible, the vertebrae being 'locked' together by their pre- and postzygapophyses. However, the mobility of the lumbosacral joint appears to be comparatively great in both directions in both genera, though the union between the two is more 'free' in *L. latifrons*.

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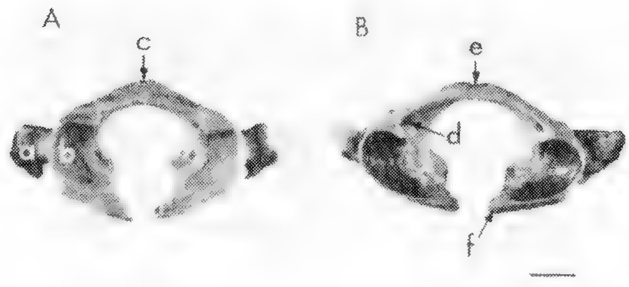

FIGURE 1. Atlas of (A) *L. latifrons* and (B) *V. ursinus*. Where a, transverse process; b, cranial articular surface; c, arrowed, dorsal tubercle; d, arrowed, intervertebral foramen; e, arrowed, dorsal sulcus; f, arrowed, incomplete ventral arch. Scale line is 1 centimetre.

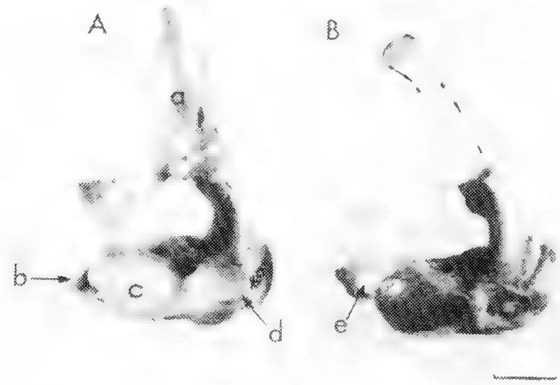

FIGURE 2. Axis of (A) *L. latifrons* and (B) *V. ursinus*. Where a, spinous process; b, arrowed, transverse process; c, cranial articular surface; d, arrowed, dens; e, vertebral foramen. Scale line is 1 centimetre.

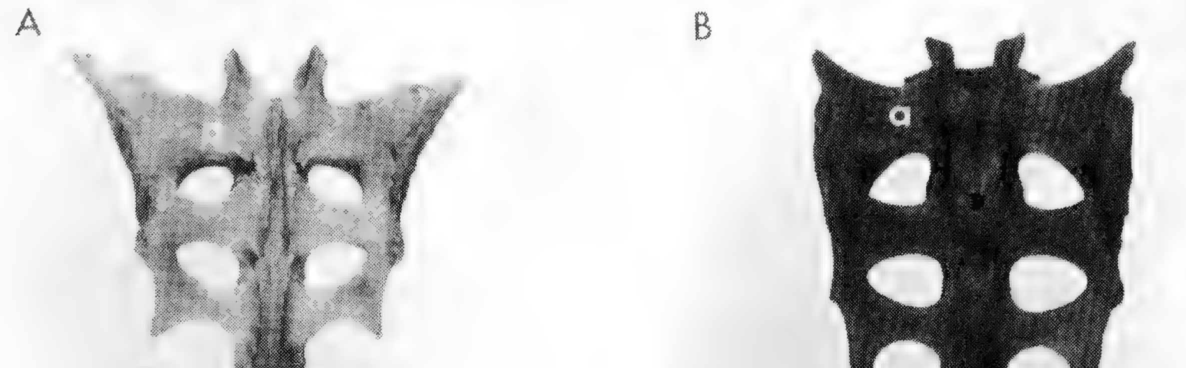

FIGURE 3. Sacral and coccygeal vertebrae of (A) *L. latifrons* and (B) *V. ursinus*. Where a, sacral vertebrae; b, coccygeal vertebrae. Scale line is 1 centimetre.

C. Kemper, South Australian Museum; for making material available to us; and to Dr D. Kitchener, Western Australian Museum for the specimens used in the photographs. Drs C.P. Groves and D. Horton both gave valuable advice and support over the duration of the project. We wish to thank Mr G. Griffiths for photography and Ms D. Passmore for so carefully typing the paper and its earlier drafts. The project was primarily supported by an Australian National University Research Grant.

FIGURE 4. Manubrium of sternum of (A) *L. latifrons* and (B) *V. ursinus*. Where a, arrowed, articular process for clavicle; b, arrowed, articular process for 1st rib. Scale line is 1 centimetre.

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TABLE 1. Vertebral formula in *V. ursinus* and *L. latifrons*

Vertebrae	*V. ursinus*	*L. latifrons*
cervical	7	7
thoracic	15	13
lumbar	4	6
sacral	4	4
caudal	10-12	15-16

TABLE 2. Atlas dimensions (mm) in *V. ursinus* and *L. latifrons*. Measurements: (1), craniocaudal diameter of the lamina; (2), maximum dorsoventral height of the vertebra.

Measurements (mm)	*V. ursinus*			*L. latifrons*		
	n	mean	sd	n	mean	sd
(1)	14	13.6	1.82	6	13.0	1.90
(2)	14	30.3	1.94	6	30.7	2.68

TABLE 3. Axis dimensions (mm) in *V. ursinus* and *L. latifrons*. Measurements: (1), maximum dorvosentral height of the vertebra; (2), dorsoventral thickness of the lamina; (3), craniocaudal diameter of the lamina; (4), dens length; (5), maximum lateral diameter of the dens; (6), dorsoventral diameter of the body; (7), craniocaudal diameter of the vertebral body; (8), spinous process length.

Measurements (mm)	*V. ursinus* n	mean	sd	*L. latifrons* n	mean	sd
(1)	20	45.7	2.23	8	42.3	3.60
(2)	19	3.1	0.56	7	2.6	0.40 ***
(3)	21	11.2	0.72	8	9.1	1.60 ***
(4)	19	9.7	1.01	6	7.9	0.78 ***
(5)	20	8.0	0.72	9	8.0	1.15
(6)	20	10.9	0.88	8	10.0	1.88
(7)	19	26.5	1.20	8	26.0	2.02
(8)	17	28.6	2.07	7	25.4	4.20

*** $P < 0.001$

TABLE 4. Cervical vertebrae, maximum combined diameter of the transverse process (mm) in *V. ursinus* and *L. latifrons*.

Measurements (mm)	*V. ursinus* n	mean	sd	*L. latifrons* n	mean	sd
C 1(atlas)	14	63.3	4.09	5	55.6	4.11
2 (axis)	17	37.3	1.69	4	35.8	0.67
3	18	41.7	2.67	7	42.4	2.31
4	18	50.0	2.93	5	47.3	2.69
5	21	55.3	3.44	6	49.7	2.64
6	19	58.1	2.79	4	53.2	3.18
7	19	59.2	2.94	5	52.5	1.52

TABLE 5. Thoracic vertebrae, dorsoventral diameter of the vertebral body (mm) in *V. ursinus* and *L. latifrons*.

Measurements (mm)	*V. ursinus* n	mean	sd	*L. latifrons* n	mean	sd
T 1	9	10.2	0.62	4	11.5	0.99 **
2	11	10.8	0.46	4	12.7	0.99 ***
3	11	11.1	0.72	4	13.2	2.38
4	12	11.2	0.62	3	13.7	2.16 **
5	12	11.1	0.74	4	12.7	1.99 *
6	12	11.1	0.68	4	12.8	1.69 **
7	12	11.1	0.80	3	12.8	1.40 **
8	11	11.1	0.82	4	12.4	1.41 *
9	10	11.2	0.78	4	12.4	1.18 *
10	9	11.2	0.81	4	12.5	1.19 *
11	11	11.1	0.86	4	13.0	0.80 ***
12	11	11.7	0.92	4	13.5	1.15 **
13	11	12.1	0.96	4	13.7	1.08 *
14	11	12.9	1.17			
15	8	13.5	1.37			

* $P < 0.05$; ** $P < 0.01$; *** $P < 0.001$.

TABLE 6. Thoracic vertebrae, craniocaudal diameter of the lamina (mm) in *V. ursinus* and *L. latifrons*.

	V. ursinus			*L. latifrons*		
Measurements (mm)	n	mean	sd	n	mean	sd
T 1	8	9.1	0.70	5	9.7	0.89
2	11	11.6	0.89	5	11.6	1.60
3	11	14.9	0.99	5	14.1	2.21
4	12	15.7	0.99	4	14.9	2.01
5	12	16.2	2.24	4	15.1	2.53
6	12	17.9	2.22	5	16.1	1.10
7	12	18.0	2.00	4	16.5	2.27
8	11	17.7	1.90	4	1.71	2.05
9	10	17.0	2.21	4	18.2	2.04
10	9	15.8	1.56	4	17.8	1.45
11	11	16.1	1.63	4	19.4	2.08
12	11	16.1	1.66	4	19.0	2.53
13	11	16.7	1.70	4	18.9	2.32
14	11	17.1	1.57			
15	8	17.5	2.47			

TABLE 7. Thoracic vertebrae, length of the spinous process (mm) in *V. ursinus* and *L. latifrons*.

	V. ursinus			*L. latifrons*		
Measurements (mm)	n	mean	sd	n	mean	sd
T 1	8	43.8	1.74	4	48.7	3.49
2	10	43.5	1.72	3	48.9	2.54
3	10	42.0	1.26	4	46.4	4.25
4	11	45.2	1.63	4	47.6	4.02
5	10	47.5	2.41	3	50.8	2.62
6	12	48.2	3.69	5	47.2	3.53
7	11	46.1	5.21	4	45.0	5.35
8	10	42.7	2.82	4	41.0	7.39
9	10	39.6	4.45	3	40.7	2.83
10	9	34.6	2.90	4	34.9	3.63
11	10	31.3	5.32	3	32.0	6.67
12	11	26.9	2.48	3	29.5	5.66
13	10	25.0	2.12	3	26.9	5.12
14	11	23.5	1.70			
15	8	22.9	2.25			

TABLE 8. Thoracic vertebrae, maximum combined diameter of the transverse processes (mm) in *V. ursinus* and *L. latifrons*.

	V. ursinus			*L. latifrons*		
Measurements (mm)	n	mean	sd	n	mean	sd
T 1	10	56.2	2.80	5	50.8	4.91
2	12	48.9	2.00	5	43.1	3.78
3	13	45.7	2.53	5	39.0	2.46
4	12	43.0	2.36	4	39.3	3.76
5	12	41.0	2.90	4	37.7	1.65
6	12	38.2	1.73	5	35.8	2.01
7	12	36.5	1.47	4	34.5	1.96
8	11	35.0	1.22	4	35.2	2.01
9	10	35.2	1.28	4	34.1	2.77
10	10	34.3	1.23	4	32.6	2.58
11	12	33.0	1.60	4	32.7	3.83
12	12	32.7	1.50	4	32.6	3.34
13	12	33.9	2.01	4	31.6	1.40
14	12	36.5	2.48			
15	9	39.0	2.58			

TABLE 9. Thoracic vertebra, maximum dorsoventral height (mm) in *V. ursinus* and *L. latifrons*.

Measurements (mm)	*V. ursinus*			*L. latifrons*		
	n	mean	sd	n	mean	sd
T 1	9	52.3	5.16	4	59.0	6.79
2	11	49.6	4.59	3	51.4	7.30
3	10	45.6	3.67	3	50.0	6.54
4	11	44.5	2.86	3	50.5	5.17
5	9	43.7	1.21	3	50.5	7.09
6	12	43.1	1.84	4	51.9	5.40
7	12	42.7	1.87	3	52.8	5.71
8	10	42.7	2.27	4	49.8	4.88
9	10	42.4	2.13	3	47.9	3.12
10	9	41.6	2.08	4	45.4	1.68
11	11	41.6	2.74	3	44.5	3.68
12	11	40.9	2.40	3	43.9	4.37
13	11	40.7	2.13	3	44.0	5.14
14	11	41.3	1.60			
15	8	43.7	1.94			

TABLE 10. Thoracic vertebrae, craniocaudal diameter of the vertebral body (mm) in *V. ursinus* and *L. latifrons*.

Measurements (mm)	*V. ursinus*			*L. latifrons*		
	n	mean	sd	n	mean	sd
T 1	11	10.8	0.94	4	12.8	0.69 ***
2	13	13.3	0.77	4	14.9	1.68 *
3	14	14.5	105	4	15.5	1.77
4	13	14.5	1.04	3	15.9	1.46
5	13	14.7	1.29	4	15.8	2.29
6	13	15.1	1.14	4	1.67	1.38
7	13	15.5	1.18	3	17.4	0.35 *
8	12	16.2	1.08	4	17.1	2.17
9	11	16.4	0.97	4	18.3	1.59 *
10	11	16.6	1.23	4	19.5	2.17 *
11	11	17.0	1.30	4	20.6	2.38 *
12	13	17.4	1.11	4	20.9	3.00 *
13	13	17.6	0.98	4	21.7	3.32 *
14	13	18.5	1.43			
15	10	19.7	1.25			

* $P < 0.05$; *** $P < 0.001$

TABLE 11. Lumbar vertebrae, maximum combined diameter of the transverse processes (mm) in *V. ursinus* and *L. latifrons*.

Measurements (mm)	*V. ursinus*			*L. latifrons*		
	n	mean	sd	n	mean	sd
L1	17	69.6	5.00	4	48.0	2.90 ***
2	16	88.9	6.39	4	61.3	4.78 ***
3	16	98.5	6.77	4	73.3	5.83 ***
4	14	90.3	6.45	4	88.4	9.26
5				3	91.5	9.45
6				3	92.8	2.38

*** $P < 0.001$

TABLE 12. Sacral vertebrae, maximum combined diameter of the transverse processes (mm) in *V. ursinus* and *L. latifrons*.

Measurements (mm)	*V. ursinus* n	mean	sd	*L. latifrons* n	mean	sd
S 1	13	78.7	5.73	4	82.4	3.30
2	13	69.0	3.93	4	59.8	3.08 ***
3	13	66.7	4.39	4	50.8	3.57 ***
4	13	64.1	3.62	4	51.4	4.20 ***
5	7	62.6	3.34	1	46.2	0.00
6	2	58.8	0.00			

*** $P < 0.001$

TABLE 13. Coccygeal vertebrae: maximum combined diameter of the tranverse processes (mm) in *V. ursinus* and *L. latifrons*.

Measurements (mm)	*V. ursinus* n	mean	sd	*L. latifrons* n	mean	sd
Co 1	12	58.5	4.92	3	48.8	2.77
2	13	56.5	5.13	3	52.2	2.74
3	11	47.6	5.14	3	47.4	1.72
4	12	39.1	3.14	2	44.5	0.00
5	9	30.8	2.45	2	38.6	0.00
6	5	19.7	4.68	3	31.1	1.53
7	2	11.6	0.00	1	18.0	0.00
8				1	10.6	0.00
9				1	7.0	0.00

TABLE 14. Coccygeal vertebrae, craniocaudal diameter of the vertebral body (mm) in *V. ursinus* and *L. latifrons*.

Measurements (mm)	*V. ursinus* n	mean	sd	*L. latifrons* n	mean	sd
Co 1	11	17.9	0.64	3	17.2	1.07
2	13	17.1	0.80	3	16.5	1.40
3	12	16.2	0.56	3	16.4	0.67
4	13	15.0	0.88	2	15.0	0.00
5	11	13.8	1.06	2	14.3	0.00
6	6	11.2	1.42	3	13.9	1.46
7	2	8.2	0.00	1	11.2	0.00
8	1	7.0	0.00	1	8.8	0.00
9				1	6.1	0.00

TABLE 15. Sternum, manubrium dimensions (mm) in *V. ursinus* and *L. latifrons*. Measurements: (1), maximum craniocaudal lengths; (2), maximum diameter opposite the articular surfaces for the 1st ribs.

Measurements (mm)	*V. ursinus* n	mean	sd	*L. latifrons* n	mean	sd
(1)	11	44.3	3.10	3	46.0	7.80
(2)	11	32.9	2.72	3	28.9	5.08

TABLE 16. Rib diameter (mm) in *V. ursinus* and *L. latifrons*.

	V. ursinus			*L. latifrons*		
Measurements (mm)	n	mean	sd	n	mean	sd
1	7	10.1	1.12	6	8.8	0.33
2	12	8.4	0.61	4	7.9	1.16
3	13	8.4	0.67	11	8.5	0.68
4	13	8.4	0.78	9	7.9	0.80
5	11	8.2	0.84	5	8.1	1.27
6	9	8.3	0.77	6	8.5	1.11
7	11	7.9	0.48	7	7.9	1.17
8	11	7.8	0.53	6	8.1	0.60
9	11	7.2	0.51	6	7.4	0.29
10	8	7.1	0.77	5	7.5	0.65
11	11	5.3	1.15	5	6.7	0.81 *
12	11	4.5	1.01	6	6.3	0.30 ***
13	9	4.3	0.46	6	5.5	0.60 ***
14	9	4.5	0.98			
15	5	5.1	0.63			

* $P < 0.05$, *** $P < 0.001$

AUSTRALITES FROM THE VICINITY OF FINKE, NORTHERN TERRITORY, AUSTRALIA

BY W. H. CLEVERLY

Summary

Australites from the vicinity of Finke, Northern Territory, are generally larger and less weathered than those of inland localities in Western Australia. Specific gravity studies show the presence of two populations, one of which contains the larger australites. Amongst notable specimens is one derived from a button which had an exceptionally large spherical primary body nearly 36 mm in diameter.

AUSTRALITES FROM THE VICINITY OF FINKE, NORTHERN TERRITORY, AUSTRALIA

W. H. CLEVERLY

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Australites from the vicinity of Finke, Northern Territory, are generally larger and less weathered than those of inland localities in Western Australia. Specific gravity studies show the presence of two populations, one of which contains the larger australites. Amongst notable specimens is one derived from a button which had an exceptionally large spherical primary body nearly 36 mm in diameter.

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The australites considered in this paper form the major part of the Finke Collection which is registered under T1308–T1341, T1343–T1369, T1375–T1389 and T1393–T1407 in the tektite collection of the South Australian Museum, Adelaide. The australites were acquired by purchase in 1972 from the former Apatula Mission located at Finke, N.T. (134°34'E, 25°35'S).

Ms J.M. Scrymgour of the South Australian Museum took a representative grab sample and chose other australites from the parcel available for sale, which she estimated to number between 10 000 and 12000. When choosing specimens, the most weathered and 'shapeless' were excluded which increased slightly the classifiable percentage in this material.

Some of the largest and most interesting specimens had been sold before the residue was offered to the Museum. It was inescapable, therefore, that even the grab sample should be representative only of the residue and that the chosen material should have been both degraded by prior sales and further affected by selection.

Mr G. McTavish of the Apatula Mission stated that nearly all the australites were found 'within 30 miles' (48 km) of Finke (Fig. 1), but the distance is certainly vague, being hearsay from Aboriginal collectors, and the intensity of occurrence and/or collection may have varied greatly with direction from the Mission. An exception are the 18 specimens from the more southerly localities named in Fig. 1 outside the 48 km radius. The 1838 specimens of the Finke collection may be reduced by these 18 and the 9 spurious ones detected to leave 1811 from the vicinity of Finke. The 1811 comprise the representative sample of 304 (T1389) and 1507 chosen specimens. Differences between these two groups and from the original parcel are to be expected. Thus there are 40.2% of essentially complete australites of mean weight 4.4 g in the grab sample and 45.7% of mean weight 4.2 g in the chosen material. The effects of prior sales cannot be estimated. In view of these uncertainties, the 1811 specimens are henceforth treated as a single unit, but the inherent bias needs to be considered when making comparison with samples from elsewhere.

Finke is near the northern boundary of the australite strewnfield, whichever of several suggested boundaries is preferred. It is the most northerly centre in its longitude around which australites have been found in quantity. There is partial overlap of the provenance with that of the Kennett Collection which is also held by the South Australian Museum. All localities of the small excluded southern group of the Finke Collection lie within the provenance of the Kennett Collection (Fig. 1) and some of them were visited by Mr Kennett in his collecting (Fenner 1940).

The large number of australites known from the Finke and Charlotte Waters regions (~18 000 - 20 000) may appear remarkable but a huge area is also involved. The average density represented is only about one australite per square kilometre. A larger number has been collected from a very much smaller area in Western Australia (Cleverly 1986).

Morphology

A morphological classification of the 1811 australites is presented in Table 1 using the system of Cleverly (1986). Representatives of 30 of the 48 recognised shape types are present, a large number considering the severity of the climate in central Australia. However, only 17 shape types, a more realistic number, are present in the grab sample.

Extracts have been made from Table 1 for comparison in Table 2 with a sample from Edjudina Station (centred 122°21'E, 29°49'S), a typical inland area of Western Australia from which a sample of comparable size is available. The percentage of classifiable specimens (Table 2) is distinctly higher at

Finke. This percentage varies with the degree of exactitude written into the system of classification, but when the same system is used by the same person, the principal residual cause of difference between representative samples is the intensity of weathering and erosion. There is some evidence that the lesser degree of weathering of the Finke australites is real rather than the result of bias in the sample. There are 49 specimens in the Finke collection showing radial secondary schlieren on the anterior surface. Such schlieren are particularly sensitive indicators of the degree of weathering because they were within the last film of migrating secondary melt, a layer only a few tenths of a millimetre thick. The schlieren are made more evident by light differential etching but are readily removed by abrasion. There do not appear to be any published abundance figures but personal experience is that it would be unusual to find more than a fraction of that number in a collection of comparable size from inland Western Australia. One only such specimen was found in 1883 australites from Edjudina Station. Nor is it likely that all such specimens could have been selected for the Finke Collection unless the large parcel were scrutinized exceptionally carefully. Even if this were so, the abundance would be about 8 per 1883 of the original parcel, i.e. 8 times that at Edjudina.

The percentages of the plan view shapes (round, oval and so on) are much the same at Finke as at Edjudina Station (Table 2), but this similarity may perhaps extend to any locality for which a sufficiently large and representative sample is available. However, the elevational shape abundances differ markedly. Flanged and allied fragile forms and indicators still in progress towards more stable lens and core forms total 13.9% at Finke against only 2.8% at Edjudina Station (Table 2). Even in the degraded grab sample the total is 5.7%, confirming the lesser degree of weathering at Finke.

The mean weight of 4.24 g for complete specimens is rather high but there is evidence in the core/lens abundance ratio of 0.74 (and 1.26 in the grab sample) compared with only 0.49 at Edjudina that a high mean weight was to be expected.

In summary, the less weathered condition and larger mean weight of the Finke specimens compared with those from Edjudina Station are at least partly real rather than the result of bias in the sample.

Specific gravity

The specific gravity (S.G.) is of special interest because Chapman *et al.* (1964) found that the frequency diagram of S.G. for the Kennett Collection from an adjoining and partially overlapping provenance is bimodal, suggesting the presence of two australite populations. They further noted that the difference between component populations was one of size only. The 28 large cores investigated by them belonged to the component of lower density, whilst medium-sized lenses and small cores included both components. Subsequently Chalmers *et al.* (1976: 32) noted the presence of two components further south in the Lake Torrens – Lake Eyre region and drew attention to the explanation offered initially by Summers (1913) that a band of australites of low S.G. is present between Victoria and the Lake Eyre region and a more widely distributed population of higher S.G. A frequency diagram for a sample of 202 specimens from Finke (Fig. 2) is also bimodal but differs in detail from both the preceding.

If only one of the populations contains large individuals of low density, its existence should be evident on a mass–S.G. scatter diagram, but attention is first drawn to a relationship between mass and S.G. which is compounded with variation resulting from the chemistry. Australites contain bubble cavities of a range of size and irregular distribution. It is therefore expected that the largest individuals of a population as the largest samples of a heterogeneous material will have the best chance of representing average material for that population and will show a relatively small variation in S.G. from one specimen to another. When successively smaller sizes are considered, the ratio of surface to volume increases, and with it the probability that cavities will be breached; hence the upper limit of S.G. rises. But simultaneously, if cavities of significant size are present but are not exposed, their effect upon the S.G. is greater than for large australites and the lower limit falls. Thus the entire range of S.G. is extended. For example, 29 unusually large australites from south-western Australia (Cleverly 1974, 1981; Cleverly & Scrymgour 1978; Scrymgour 1978) of average mass exceeding 170 g have specific gravities extending over a range of only 0.3 units whilst a sample of 46 specimens from Kulin West, which is about central to the region, and of mass ranging down to 1 g have S.G. values extending over 0.6 units. Thus, for a large sample, if mass is plotted as ordinate against S.G. as abscissa, the points representing individuals are likely to fall within a triangular area with its base on the x-axis, the largest individuals with small variability of S.G. occupying the apical region and the smallest ones occupying the broader base of the triangle.

There may also be an effect related to sample size. A numerically small sample usually shows a small variation in S.G. but a larger sample may contain the more extreme and rarer variations in size and chemistry and hence show a larger range of S.G. This effect is unlikely to be a major cause of difference when the sample numbers (29 and 46 in the above example) are of the same order.

Consider now the scatter diagram for the Finke sample (Fig. 3). The log-linear plot accommodates the large range of mass in which the number of individuals decreases rapidly with increase in mass, but has the effect of bending the sides of the two triangles which may be visualized as enclosing all except two points. One of the exceptional points could be accounted for by a bubble cavity in the order of 4 mm diameter; the other exceptional specimen is perhaps an import to the area. To assist in defining the apices of the triangles, the S.G's of 27 additional large specimens were determined. The apices are approximately on the modal S.G. values previously established. Most of the larger specimens including all those weighing more than 28 g are in the triangle corresponding to the lower mode and it is also clear from the frequency polygon for larger specimens in Fig. 2 that their contribution is especially to the lower mode. There are thus two australite populations. The one of lower modal S.G. has a larger range of size than the one of high modal S.G.

Notes on Individual Specimens

Folded Bowl T1340

Dimensions 11.5 x 4.6 x 7.1 mm. Weight 0.431 g. Small bowls sometimes failed during a late stage of ablation flight by folding on a hinge, the opposing sides folding backward away from the pressure on the convex anterior surface (Cleverly 1979). The least folded specimens simply show undulation of the rear margin. More intensely folded specimens show the sides increasingly high relative to the ends of the hinge until contact is made at the mid-point of the 'lips'. This last is the degree of folding shown by the Finke specimen (Fig. 5 A1–A4), which has an elliptical area of fused contact *c.* 4 x 1 mm representing about 10% – 15% of the area of the sides. The calculated original dimensions of the bowl (Cleverly 1977) are very approximate because of somewhat asymmetrical folding and distortion. It was a round or slightly oval bowl, *c.* 10 x 9 x 5 mm (Fig. 4A and B).

Buttons T1311 and T1314

The button T1311 (Fig. 5 B1–B3) is one of several which are surprisingly well preserved. The state of preservation has prompted the making of some measurements and calculations relating to the primary body and its secondary development for comparison with buttons from Victoria. The less well-preserved button T1314 (Fig. 5C) was also measured and calculated. The results for this second button are placed in brackets immediately after those of T1311.

The radius of the primary sphere (Fig. 4C) was determined from two traverses of the posterior surface of flight in planes normal to the surface and at right angles to each other using a travelling vernier microscope. This tedious method has the advantage over projection of an enlarged profile that observations are made on parts which would otherwise be obscured by flange, thus reducing the risk that an oblately spheroidal primary body will be mistaken for a sphere. The radii are 8.6 (10.5) mm and 8.8 (11.0) mm. Using the mean radius, the primary sphere had volume 2.76 (5.20) cm³ and the mass was 6.66 (12.77) g, provided that the primary sphere had the same S.G. 2.415 (2.449) as the button formed from it.

The radius of curvature of the anterior surface, which is complicated by the presence of flow ridges, was determined from profiles projected with a lantern. These profiles in the same planes as the traverses of the posterior surface have radii 11.2 (13.7) mm and 11.0 (12.7) mm respectively. The volume of the body of the button (i.e. the button less the flange) was then calculated as 1.18 (2.57) cm³ by regarding the body as comprising segments of two spheres of known radii, base to base.

The volume of the button was calculated as 1.72 (3.20) cm³ from loss of weight in pure toluene at known temperature and thus of known S.G. Hence by difference, the volume of the flange is *c.* 0.54 (0.63) cm³.

The volume of the secondary body at the time when the frontal surface first encroached upon the 'equator' of the primary sphere was calculated as 1.82 (3.65) cm³ by the same method as for the body. It was assumed that curvature of the anterior surface was the same then as now (dotted line of Fig. 4C), an assumption likely to only approximately correct. From that time onward the flanks of the secondary body, previously divergent rearward, became increasingly convergent. Melt stripped from the anterior surface could be caught in the eddy currents behind the leading edge and curled into the protective 'shadow' of the cooler posterior surface i.e. flange-building could commence.

Since the volume of the body is 1.18 (2.57) cm³, the volume of material stripped from the anterior surface during the potentially flange-forming stage was 0.64 (1.08) cm³. The flange volume is 0.54 (0.63) cm³ and therefore 85% (59%) of the stripped material was retained upon the button as flange.

The above may also be expressed in terms of percentages of the volume of the primary sphere. Thus the total loss from the frontal surface was 57.1 (50.6)%, but 19.7 (12.2)% was retained as flange, so that the volume of the button and net loss from the primary body are: –

100 – 57.1 + 19.7 = 62.6% Loss 37.4%
(100 – 50.6 + 12.2 = 61.6% Loss 38.4%)

These figures are within the wide limits found by Baker (1962) for buttons from Victoria.

Buttons T1309

One specimen (Fig. 5D) has a distinct roll in the posterior surface of the flange and a gap beneath it suggesting that whilst still hot the flange was partially detached and pushed backward. A similar specimen has been noted and illustrated by Fenner (1940: 174 and Pl. IV, Ala 7 and 10), but whether an entrapped bubble was the cause of weakness and detachment or whether the air-filled gap is the result of the detachment is not clear.

The other specimen (Fig. 5 E1 and E2) has a distinct gap in the flange. Two possibilities are suggested :

(i) This is a stage beyond that of the previous specimen and a short length of flange was completely detached. If so, it is puzzling that orientation should have been maintained and the scar smoothed by further ablation. Flow ridges are continuous around the dip in the edge (Fig 5 E2).

(ii) The specimen is one half of a symmetrical flanged dumbbell which was ablated to the stage of separation. Again, the maintenance of orientation presents a problem though it would need to persist only briefly after separation to smooth the break.

Round indicator I T1375

This specimen (Fig. 5 F1 to F3) derived from a button is uniquely large for its type amongst the estimated 60 000 australites which the writer has examined. It has dimensions 35.7 x 29.3 x 20.5 mm including the surviving remnants of stress shell and flange. Mass 21.326 g, S.G. 2.438. The primary sphere had diameter 35.9 mm, volume *c.* 24 cm^3 and mass *c.* 59g on the assumption that it had the same S.G. as the indicator.

The manner of development of secondary bodies is size-dependent. The largest primary bodies were not ablated to an extent sufficient for flanges to form but they usually shed the stress shell spontaneously to become cores. Primary bodies of medium to small size were ablated to the stage when a flange could develop but the total expansion and contraction were less than for large bodies and the stress shell was usually retained, perhaps to be lost later together with flange during terrestrial residence. The upper limit of size for the medium group is usually placed at about 30 mm diameter for spheres or 30 mm thickness for other bodies measured parallel to the line of flight. Thus, for example, the largest primary sphere of 23 buttons studied by Baker (1962: 277) was 27.1 mm diameter.

The large round indicator I draws attention to a shadowy and ill-defined category of behaviour between the medium-sized 'flange-forming' primary bodies and the larger 'core-forming' primary bodies. The 30 mm dimension is not necessarily the upper limit of size for bodies which developed flanges but only the usual limit for those with incontrovertible evidence of having done so. The larger the body, the more readily would it discard the stress shell with the flange. Baker (1962: 302) has listed a round indicator I derived from a primary sphere 34.7 mm diameter. That specimen and the one under discussion with primary sphere 35.9 mm diameter represent the known upper limit of 35 – 36 mm for the category in which flange was formed and almost immediately lost again when the stress shell was detached. In rare instances such as these two specimens a remnant of the flange survives to indicate beyond doubt that flange development occurred. The Finke specimen is also exceptional in its degree of preservation, having a shallow obtuse ridge upon the anterior surface marking a line of parting of the stress shell (Cleverly 1987).

Complementary to the preceding specimen is a teardrop-indicator II having only a short length of the butt of the flange (Fig. 5 G1 – G3). The styles of the two specimens are very similar. It is likely that the teardrop was in the same size category, but reconstruction of the parent body is not possible with confidence. Obtuse ridges are present on the anterior surface of this specimen also.

Acknowledgments

I thank Ms J. M. Scrymgour for information on the acquisition and provenance of the Finke Collection and Dr Brian Mason for specific gravity data on the Lake Torrens–Lake Eyre australites. Ms J. M. Wearne drafted Figures 1–4. Mr M. K. Quartermaine processed my photographs used in Figure 5.

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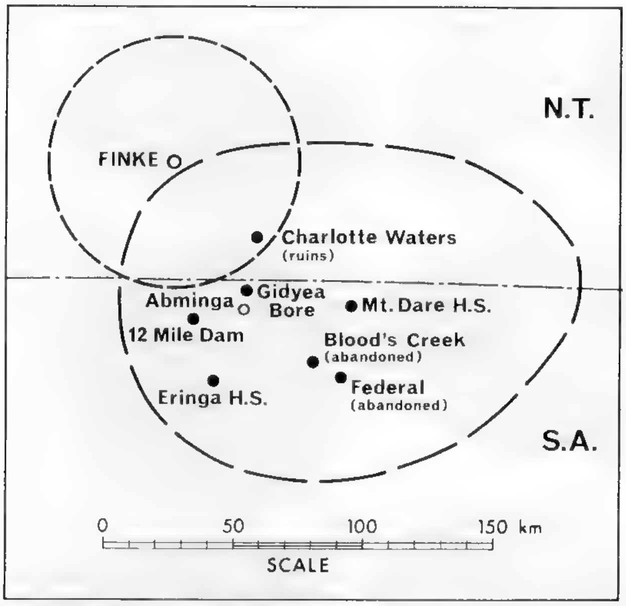

FIGURE 1. Map of country adjoining the Northern Territory/South Australian border showing provenances of the Finke and Kennett australite collections. Finke and Abminga (open circles) were stations on the now abandoned Central Australian Railway.

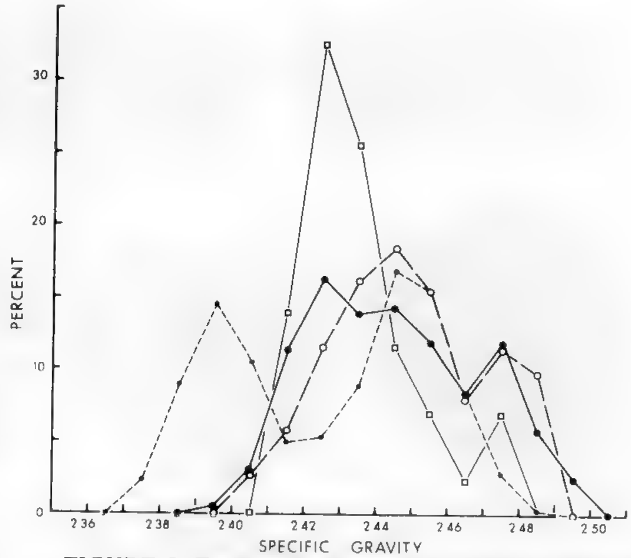

FIGURE 2. Frequency polygons of specific gravity for australites. Filled circles – sample of 202 from vicinity of Finke. Open circles – 420 from Charlotte Waters region (from Chapman *et al.* 1964 Fig. 7). Dots – 761 from Lake Torrens – Lake Eyre region (adapted from Chalmers *et al.* 1976 Fig. 15). Open squares – 46 specimens each weighing more than 11 g from vicinity of Finke.

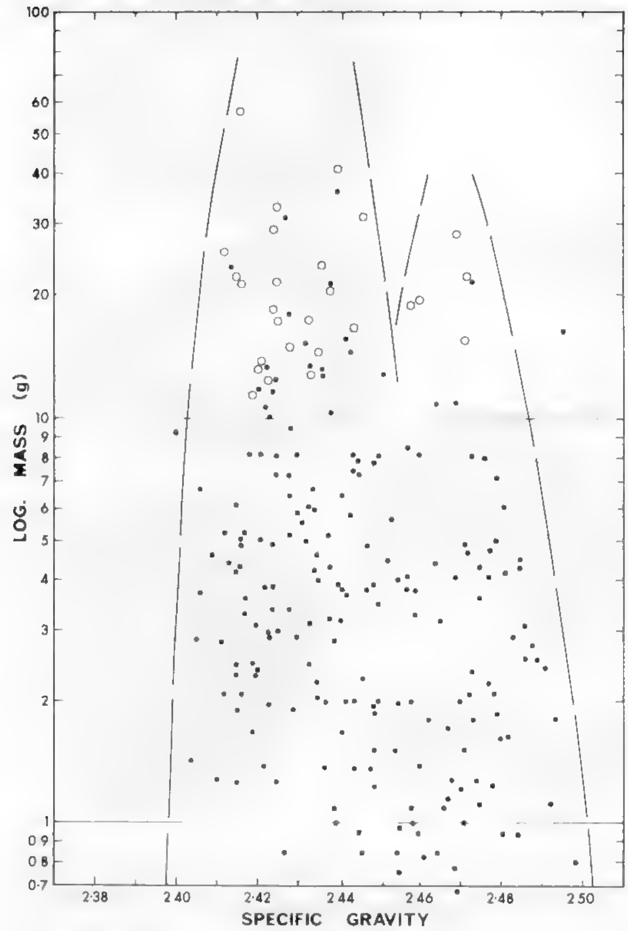

FIGURE 3. Semi-logarithmic plot of mass against specific gravity for a sample of 202 australites from the vicinity of Finke less five points in the lower mass range closely coincident with others. The open circles represent 27 additional specimens weighing more than 11 g each which are not part of the random sample. The broken lines are an interpretation of the distribution.

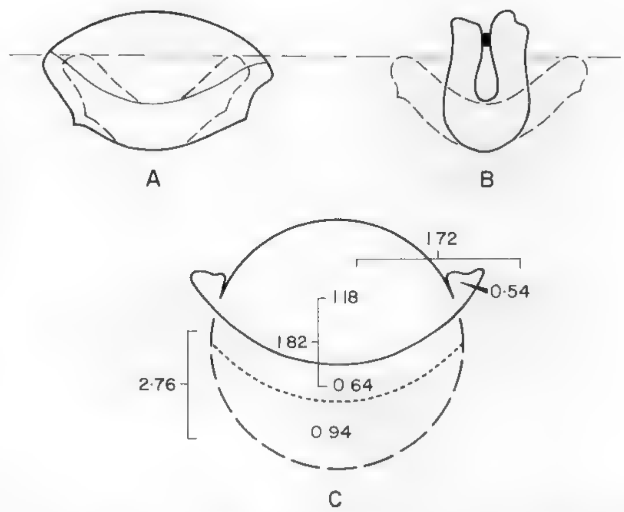

FIGURE 4. A. Side view of folded bowl T1346 with restored cross-sectional shape of bowl (broken line) within it. B. End view of folded bowl T1346 and restored pre-folding shape (broken line). C. Cross-section of button T1311 with restoration of spherical primary body (broken line) and profile of anterior surface when flange-building commenced (dotted line). Figures are volumes of various parts in cubic centimetres.

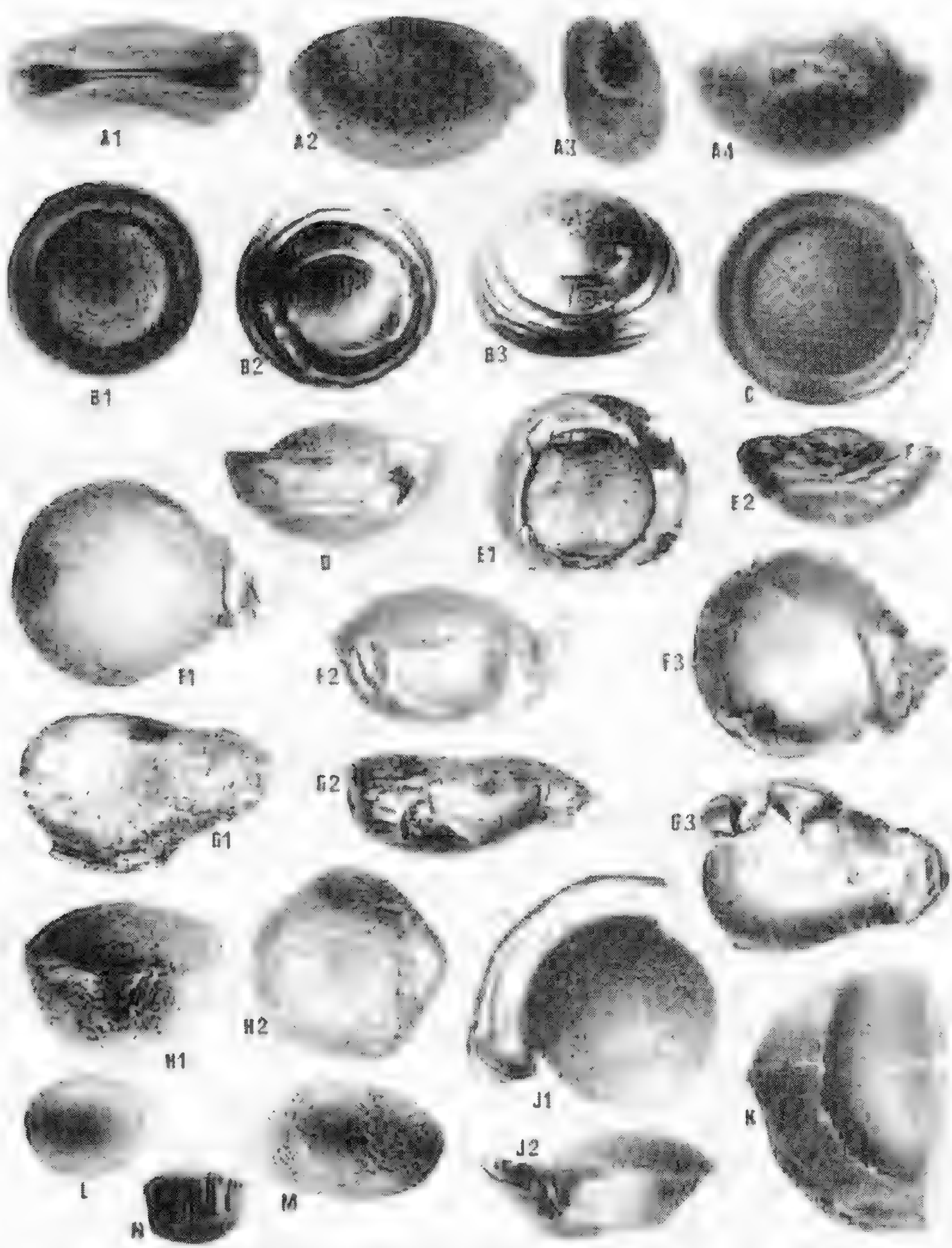

FIGURE 5. Australites from the vicinity of Finke, N.T. In side views, direction of flight is towards bottom of page.
A. Folded round or slightly oval bowl, T1346, 11.5 mm long. A1. Posterior view. The narrow pale streak along the middle is the fused union between the sides. A2. Side view (lower side of A1). A3. End view (right-hand end of A1). A4. Same side view as A2 but in transmitted light. Narrow elliptical area near 'lips' is the area of fused contact.
B. Button, T1311, 20.5 mm. diameter. B1. Posterior view. B2. View slightly oblique to anterior surface showing left-handed helical flow ridge. B3. View very oblique to anterior surface showing some of the radial secondary schlieren.
C. Button, T1314, 25.6 – 24.7 mm diameter, posterior view.
D. Button, T1309, 21.8 mm diameter, side view showing roll in flange towards upper right and torn hole below it.
E. Button, T1309, 20.2 mm wide. E1. Posterior view showing lack of flange at one side. E2. Side view looking into the flange gap and showing continuity of flow ridges around the gap.
F. Round indicator I, T1375, 35.6 mm across. F1. Posterior view showing small flange remnant at right. F2. Side view with remnant of flange and stress shell at right. F3. Front view showing complex flow-ridges on remnant of stress shell.
G. Teardrop-indicator II, T1375, 39.4 mm long. G1. Posterior view showing remnants of stress shell around narrow end and below, latter with short length of bulb of flange. G2. Side view showing flow ridges on stress shell. G3. Front view with flow ridges on stress shell above and at right.
H. 'Tailed' or 'beaked' core, T1389, 35.5 mm across. H1. Side view. H2. View somewhat oblique to front surface to emphasize the 'beak'.
J. Round indicator I, T1315, 23.7 mm wide. J1. Rear view showing large remnant of flange. J2. Side view.
K. Fragment of hollow core, T1402, 36.5 mm high.
L. Broad oval core, T1389, 24.6 mm long, rear view showing flow swirl.
M. Narrow oval core, T1389, 35.5 mm long, rear view.
N. 'Small' round core, T1389, 17.5 mm diameter, side view.

TABLE 1. Morphological classification and masses of australites from vicinity of Finke, N.T.

Shape type	Number of specimens			Masses of complete specimens, g		
	Complete	Broken	Total	Lightest	Heaviest	Mean
Button	9	11	20	2.90	7.85	4.78
Round Bowl	1	-	1	0.43	-	-
Round indicator I	68	21	89	0.97	21.33	3.28
Lens	262	173	435	0.39	4.60	1.78
Round indicator II	25	-	25	2.44	21.74	7.52
Round Core	199	44	243	1.21	31.40	5.80
Broad oval canoe	1	-	1	1.23	-	-
Broad ocal indicator I	2	-	2	3.22	3.60	3.41
Broad oval lens	24	11	35	0.78	4.30	1.99
Broad oval indicator II	5	-	5	3.67	10.14	6.06
Broad oval core	43	14	57	1.29	57.50	8.56
Narrow oval plate	-	1	1	-	-	-
Narrow oval canoe	1	3	4	5.93	-	-
Narrow oval indicator I	2	1	3	1.49	4.29	2.89
Narrow oval lens	34	30	64	0.69	6.29	2.53
Narrow oval indicator II	5	-	5	1.49	21.96	7.78
Narrow oval core	27	15	42	3.21	18.92	8.30
Boat-canoe	1	1	2	0.83	-	-
Boat-indicator I	2	-	2	2.65	4.48	3.56
Boat-lens	11	9	20	1.00	7.14	3.10
Boat-core	16	6	22	4.80	28.20	12.48
Dumbbell-indicator I	1	1	2	4.33	-	-
Dumbbell-lens	11	12	23	1.02	5.82	3.05
Dumbbell-indicator II	1	-	1	6.56	-	-
Dumbbell-core	13	15	28	2.24	14.47	8.31
Teardrop-lens	5	3	8	1.37	4.98	2.66
Teardrop-indicator II	1		1	15.58	-	-
Teardrop-core	1	-	1	2.76	-	-
Conical core	37	4	41	0.93	6.05	2.98
Aberrant	3	3	6	0.62	5.84	3.27
	811	378	1189		Mean	4.24
Fragments			583			
Flakes and flaked cores*			39			
			1811			

* 'Core' as used by the anthropologist.

TABLE 2. Comparison between australites from the vicinity of Finke, N.T., and Edjudina Station, W.A.

	Finke N.T.	Edjudina Station, W.A.
Complete or essentially so %	44.8	43.8
Incomplete but classifiable %	20.9	9.7
Total classifiable %	65.7	53.5
Fragments %	32.2	43.0
Flakes and flaked cores %	2.1	3.5
Round forms %	71.8	70.3
Broad oval forms %	8.8	7.2
Narrow oval forms %	10.1	9.2
Boat forms %	3.9	4.1
Dumbbell forms %	4.6	7.1
Teardrop forms %	0.8	2.1
Flanged, disc, plate, bowl and canoe forms %	2.5	0.4
Indicators I %	8.3	1.4
Lens forms %	49.4	65.1
Indicators II %	3.1	1.0
Cores %	36.7	32.1
Cores/lens forms	0.74	0.49
Number of complete australites	811	824
Mean mass of above (g)	4.24	2.40
Total number of specimens	1811	1883
Mean mass of all specimens (g)	3.37	1.94

THE LIMITS ON FIGHTING IN AN ABORIGINAL COMMUNITY

BY ISOBEL WHITE

Summary

This brief paper describes fighting at Yalata, an aboriginal community in the far south-west of South Australia and compares this favourably with the uncontrolled aggression and violence in western society.

THE LIMITS ON FIGHTING IN AN ABORIGINAL COMMUNITY

ISOBEL WHITE

WHITE, I. M. 1988. Fighting in an Aboriginal Community. *Rec. S. Aust. Mus.* **22** (1): 49–51 .

This brief paper describes fighting at Yalata, an aboriginal community in the far south-west of South Australia and compares this favourably with the uncontrolled aggression and violence in western society.

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Every newspaper today carries reports of deaths and grave injuries caused by terrorism, violence and aggression, covering a whole range of brutality, from the bashing of harmless old women, to bombing of buildings, to full-scale war. These reports come from the so-called civilised world of Europe, the Middle East and the Americas. Moreover a rash of violence has broken out on the sports field, even in Australia. All this has made me reconsider the instances of aggression and violence I witnessed in a remote Aboriginal community nearly twenty years ago. This shocked me at the time but more recently I have come to the conclusion that the Aboriginal anger and antagonism I witnessed were mild compared with what is in the news today, that the amount of bodily injury was strictly controlled and that after an episode of violence, aggression was quiescent for some time. Consciously or unconsciously Aborigines had so ordered their outbreaks of aggression and violence that death and injury were controlled and minimised. This is unlike what happens in the western world where perpetrators of violence, even in time of so-called peace, take little account of the amount of death and injury they cause, or whether their victims are those responsible for the original conflict.

Yalata is an Aboriginal community situated in mallee, western myall and melaleuca scrub on the coastal strip between the head of the Great Australian Bight and the Nullarbor Plain in the far west of South Australia.

The inhabitants are Western Desert people who first came south to the newly constructed railway line in the 1920s and 1930s. Most congregated during the 1930s and 1940s around the United Aboriginal Mission (U.A.M.) at Ooldea and were induced to move even further south in the early 1950s to Yalata Lutheran Mission after the U.A.M. withdrew quite suddenly from Ooldea (White 1985: 222–223). They were prevented from returning to their own territory during the period of nuclear weapons experiments at Maralinga and Woomera (Brady 1987). The new Yalata Aboriginal Reserve was outside their own territory and when I visited them they still felt displaced and landless (White 1985: 226); but they had become economically dependent on European–Australian's (White 1985: 217–219).

At the same time they maintained their language (Pitjantjatjara and other Western Desert dialects) and much of their traditional culture, including some of their ceremonial life. Boys were initiated, though I was told that the rituals were abbreviated; for example, the period of seclusion only lasted a few weeks. While the initiation ceremonies still included the bestowal of a daughter by the circumciser, the promise was not always fulfilled, leading to some of the fighting described below. A rain ceremony was performed each year (White 1979). For my benefit the women performed a number of their secret ceremonies with great enthusiasm (White 1975: 132–133) but they were not teaching these to the girls in the old manner and they admitted they did not perform them in my absence. When I last paid a visit to Yalata in 1981 my friends told me that their last performance was the one I saw in 1973.

The descriptions of fighting in this paper are based on my experience during fieldwork at intervals between 1969 and 1973, each visit lasting between three weeks and two months.

I am not considering here the killings that occurred in this community following breaches of the laws against sacrilege. I know little of the events behind such deaths, which fall into quite a different category from the open brawling whose origin normally lay in disputes over marriages, betrothals and adultery, entirely secular matters. T.G.H. Strehlow (1970: 112–122) while describing punishment involving many deaths in Central Australia for sacrilege of various kinds, emphasises that these were quite different from personal quarrels arising from such matters as marital disputes. These personal quarrels would be settled by the persons involved with the help of their kin. Though some bodily injuries were tolerated killing should not occur, except that the Aranda punishment was death for incest between a man and his mother-in-law and for the seduction of the wife of an important ritual leader.

Before I first pitched my tent in the 'big camp', about 15 km from the mission headquarters, the white mission staff at Yalata warned me that 'the Aborigines were always brawling' and that I would find these brawls noisy and alarming. I admit I was at first frightened when loud quarrelling broke out a week or two later. But I soon found that I was not in the least threatened and that I might as well observe what was happening. At this and later incidents I noted particularly that these conflicts followed a fairly regular pattern and that noise far outran action. Injuries were limited and seldom serious and when one or other of the protagonists was hurt the fighting normally ceased at once, though there might be some incidental quarrels and injuries in other parts of the camp. Similarly in these peripheral quarrels action stopped as soon as any injury occurred. Unfortunately some of the rules went by the board if the contestants were drunk, so that serious, sometimes fatal, injury resulted, though I did not witness such an event. Moreover when there were drunken people about there might be danger involved to non-participants. Care was always taken to keep out of the way of such irresponsible individuals. On one such occasion the adult women of 'my family', including myself, picked up toddlers and babies in order to be ready to evacuate the family campsite.

These events seemed to me equivalent to a weekly visit to the movies or to a sporting fixture in our society, and certainly less dangerous than some sporting events have become. Just as the amount of alcohol available increases the danger at football and cricket matches, so the danger increased with the amount of alcohol available in the camp, where there were no police present to attempt control and perhaps to become the target of all spectators. To an outsider, life in the camp at an Aboriginal settlement may seem rather dull for the inhabitants and these fights certainly livened up the daily round and were a matter for excited discussion for many days afterwards.

The standard order of events was as follows: loud shouting would be heard from one part of the camp and most of the inhabitants would rush to the scene as supporters of the contestants or as observers. Usually those supporters who felt themselves involved in the dispute would take off their clothes, the main combatants having already done so. For example, when an old couple near me heard the raised voices of their daughter and son-in-law they immediately hurried towards the contest taking off their clothes and throwing them aside as they ran. Each adult man would pick up his spears and spearthrower in his left hand and his fighting boomerang in his right, more as a gesture of strength and alertness than with any intent to use them immediately.

It seems there were rules about the choice of weapons. Sometimes the protagonists would have spears and spearthrowers or perhaps knives but when I witnessed a quarrel between two brothers (same father, different mothers) they had no weapons at all but merely wrestled. Where spears, or knives, were used, skill was needed so that the wound was in the fleshy part of the thigh and did not cause too much bleeding. For such an injury men did not always go to the mission nurse. They were proud of their scars, which would have been less obvious if skilfully stitched. The only wound of this kind I actually saw at close quarters (I drove the injured woman to the mission for treatment) was in the thigh of the daughter mentioned above, inflicted with a knife by her disappointed lover when he realised she was returning to her much older husband. Her wound was deep and painful but not dangerous. This particular dispute broke out into violence or near violence at intervals over several days. Some hours after this knifing, there was another hour of shouting and abuse between the lover and members of the woman's kin and affines. Then the 'big men' of the camp moved in on him with their weapons at the ready (as I describe later) but instead of obeying them and ceasing to threaten violence he produced a rifle and threatened them. By now it was very late at night and all retired to their own camps, but in the morning the tables were turned on the young man when two policemen arrived from Ceduna and arrested him. I was told that the camp leaders had taken the unusual step of asking the mission superintendent to send for the police, because the young man had behaved in a way they could not counter, in producing a rifle. Moreover this was not the first time he had seduced a woman of their community; a year before he had eloped with a much younger unmarried girl and had managed to travel on a train to Kalgoorlie with her, before her male kin caught up with them and managed to bring her back.

The above account represents an unusual series of events and I now return to the more normal processes of a camp fight. When fighting first broke out it was interesting to observe the behaviour of the children. Clearly they knew they must not join in the ring of observers, either because of instruction from their parents, or because they were too frightened by the noise of quarrelling. I am not sure at what age they could join in. I only knew that when I observed these scenes all children between the ages of about five and fifteen immediately gathered in small groups and retired to the outer periphery of the camp where they lit their own small fires and stayed until the noise and shouting died down. In the meantime, as I have already described, the adult women stayed close by babies and toddlers, ready to pick them up if they felt there might be danger.

Margaret Bain, who has lived for many years with Pitjantjatjara speaking communities, told me that by carrying a child, a man or a woman signalled that he or she was not involved in the quarrel. I have never heard of a child being injured in these brawls, certainly not by intention, and not by accident because of measures taken by both adults and children.

While the original contestants were shouting at each other and preparing for action, subsidiary quarrels would be disinterred so that it soon sounded as though everyone was shouting loudly. This made the dogs bark and howl frantically and the noise was quite deafening. (I made a tape-recording of one such episode.) The original dispute was likely to concern, immediately or marginally, a proportion of the inhabitants. Here is an example: the two brothers who wrestled together were fighting over a woman. Meanwhile their old blind father was begging them to desist, claiming it was not proper for brother to fight brother. The older of the two brothers had been deprived of his promised wife some years before because the girl was supported by her mother in her preference for another man. (For this the mother had been speared by the disappointed young man.) Now the mother of the younger brother resurrected the dispute and loudly accused the mother of the girl of causing the present fight, because her son would not now have been fighting his brother about a woman if that girl had been given to her proper husband in the first place. I knew both these two older women well; they had cooperated in the performance of women's ceremonies and I had not suspected that the old dispute was still an issue between them.

The main fight was the pretext for many other old conflicts to be revived and for old disagreements to be aired very loudly. There was even a resurgence of rivalry between the two dominant groups in the camp, the Pitjantjatjara and the Yankuntjatjara, normally almost indistinguishable after two or three generations of living together and intermarrying; now each accused the other of horrible customs. Another reason for further quarrels to break out in various parts of the camp was that some of the shouting consisted of sexual boasting by one of the men, whom I had recognised as a local Don Juan. Since these boastings were likely to involve married women within hearing, several new quarrels would break out between these and their husbands, or between the husbands and the boaster. In the end it seemed that half the people were shouting abuse at the other half, at the tops of their voices.

This would go on for an hour or two, by which time there would be a small number of minor injuries. One or other of the original protagonists might have been hurt so that that particular fight would have ceased. But by now everyone would be tired and mothers would complain that their children should be allowed to sleep. Eventually the senior men, the 'big men' of the community, would intervene. Each in turn would put brushwood on his fire so that it would send flames several feet into the air and he would stand in front of it for all to see. He would first proclaim on the rights and wrongs of the main quarrel. He would then say something to the effect that the young men must stop fighting now, they had had their chance to settle their disturbances, they had caused a lot of noise and disturbance but now everyone had had enough and it was time to stop. In turn several of these older men would repeat this performance. With their weapons in their hands they would then move in a circle against those still fighting, thus showing the power of the leaders against the younger men. Quickly the noise would cease, people returned to their own camps and soon all would be asleep.

In the morning there might be a few with headaches or in pain from injury, but there would be peace in the camp and the contestants from the previous night would seem to have resolved their quarrels. Certainly all the furore had had a cathartic effect. It had been salutary to have had all the dissension out in the open and for once to tell one's neighbours exactly what one thought of them. All the evil remarks and accusations seemed to have been forgotten, though they might be a pretext for a later conflict. Aggression was limited to a few hours at intervals of some weeks. Occasionally, in the middle of the night, the silence would be broken by a man voicing his grievances and shouting abuse at some other person. The rest of the time in my observation these Western Desert people behaved in a quiet, restrained and dignified manner. Conversations were carried on in low voices and shouting was seldom heard. Even against misbehaving children voices were not raised. The chief noise in the camp was of dogs barking rather than of human voices.

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THE ARCHAEOLOGY OF THE COOPER BASIN : REPORT ON FIELDWORK

BY E. WILLIAMS

Summary

This paper presents the results of the first season of fieldwork of an archaeological study of the Cooper Basin near Innamincka, South Australia.

THE ARCHAEOLOGY OF THE COOPER BASIN: REPORT ON FIELDWORK

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This paper presents the results of the first season of fieldwork of an archaeological study of the Cooper Basin near Innamincka, South Australia.

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Australia is a dry continent — 60% of its land surface is covered in arid vegetation while a further 22% is covered in semi-arid species (Williams 1979, V.I. Fig. 1). In the past at the height of the last glaciation, an even greater proportion of the continent lay within the arid zone (Bowler 1982). Yet until recently, little archaeological research was carried out in arid Australia, despite the importance of the region to questions about the colonisation of the continent. The work which has been carried out suggests that a number of areas within what is now the arid zone, were occupied during the Pleistocene. Dates of 20 000 years BP and older come from sites in the Hamersley Plateau, north-western W.A. (Maynard 1980, Brown 1987); the Cleland Hills, central western N.T. (Smith 1987); Koonalda Cave, southern S.A. (Wright 1971); and Lake Yantara, north-western N.S.W. (Dury & Langford-Smith 1970). Whilst these sites show that much of the drier part of the continent was utilized during the Pleistocene, it appears that the most intensive occupation took place during the mid to late Holocene (Gould 1977; Hughes & Lampert 1980; Lampert 1985; Smith 1983, 1987).

Although much archaeological work has been undertaken recently in many parts of the arid zone, little was known about the archaeology of one area, the dunefields of north-eastern South Australia. This project was initiated to expand our knowledge of the region. The area chosen for study is that section of the Cooper Basin near Innamincka, South Australia (Fig. 1). It comprises a number of features — the main Cooper channel, an ancillary channel — the North-west Branch, and an extensive series of clay-pan lakes in the Cooper flood-out zone lying within the Strzelecki dunefield. These lakes are the only ones which regularly fill with water for thousands of square kilometres. My particular focus is the lakes, since little is known about either the prehistoric occupation or the environmental history of these features.

There are a number of reasons why this project can tell us more about the occupation of arid Australia. The first is that while the region is an extremely arid one — it receives one of the lowest rainfall readings of any in Australia (125 mm per annum) and is mostly covered by a large dunefield, the Strzelecki, there are reliable water resources there. This made the area an important one for Aboriginal settlement, at least in the recent past (Sturt 1849). The Cooper drains the Channel Country of central Queensland and every year the wet season rains come down the river, filling a succession of deep waterholes on the Cooper at Innamincka and then the Coongie lakes, 100 km to the north-west. The large waterholes on the Cooper and its overflow channel, the North-west Branch are permanent, while the lakes hold water from between five months to most of the year, depending on their location relative to the channel. While the abundant (albeit seasonal) water resources make this area atypical when compared to many parts of the arid zone, this region can tell us much about how people in the past dealt with fluctuations in water availability. This is because although there are large, reliable waterholes near Innamincka, there are few permanent water resources in the surrounding region. Early explorers such as Sturt (1849) and Burke & Wills (1861) always retreated back to this stretch of the Cooper because of a lack of reliable water anywhere else — upstream or downstream.

Even the upper reaches of the river contain very little standing water, much less than around Innamincka and the channel does not always flow (Gregory & Gregory 1884: 205–206, Jones 1979). In order to reach the lakes and permanent waterholes, the initial colonisers would have had to push through extremely arid areas and would have thus needed to develop a flexible economic system which could deal with these variations in water availability. Such hydrological fluctuations have characterised the Cooper drainage basin for at least the last 20 000 years. It was probably only prior to 30 000 yBP that there were abundant water resources throughout the region.

The second reason why this area was chosen for study concerns the probability of finding Pleistocene archaeological material there. Wasson's work on the sedimentary and climatic history of the dunefields, which is described later, has shown that exposures of

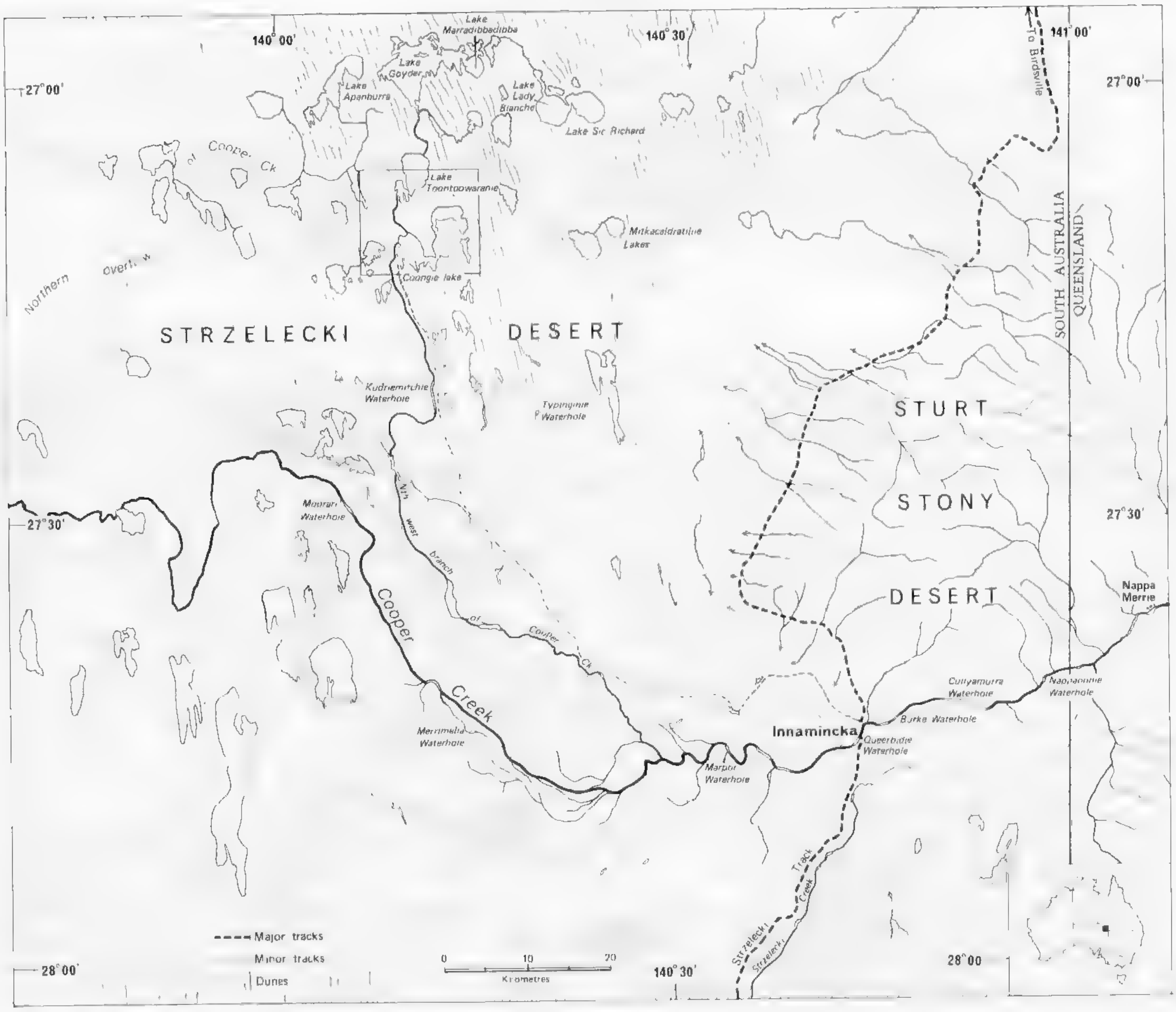

FIGURE 1. Locality map.

Pleistocene sediments are common in these landforms and the region is thus a promising one in which to look for early sites. As well, his work provides a valuable framework in which to place work on the history of Aboriginal occupation.

The major aim of the project is to obtain baseline archaeological data for the region and if possible, determine whether it was first settled during the Pleistocene. The question of the Pleistocene occupation of the arid zone is a contentious one. Bowdler (1977) believes that aridity was a major problem in the colonisation of Australia. She claims that the first settlement of the arid zone occurred quite late — around 12 000 yBP, after people had first colonised the coastline and then the major river systems. She believes that once the coastline was settled, people then moved up the major river systems taking with them a specialised 'coastal' economy, expressed as a dependence on fish, shellfish and small mammals. She suggests that the move away from the major river systems and the development of a non-aquatic adaptation or 'desert' economy only appears quite late, after about 12 000 yBP and involves a shift from aquatic foods to the wide-scale and specialized exploitation of grass-seed and a dependence on larger mammals, especially macropods. It appears, however, that recent work in the Northern Territory refutes this model. An excavation of Puritjarra rockshelter in the Cleland Hills, has revealed an archaeological sequence extending back 22 000 years (Smith 1987). This site is located in an extremely arid area, well away from major drainage systems, in a region which would have also been very dry throughout the late Pleistocene. Smith's work shows, therefore, that people were living in the core arid zone well before that predicted by Bowdler's model. Other research by Smith refutes further aspects of the model. His work on grindstone morphology shows, for example, that the intensive exploitation of seed plants did not take place until the late Holocence, which is much later than Bowdler predicted. This adaptation could therefore not have triggered the initial colonisation of arid areas (Smith 1986).

Smith's data suggest that people had pushed into the arid core of the continent by at least 22 000 yBP. It appears these early colonists had a fairly generalised economy, lacking for example a specialised seed-grinding technology. While the development of the more detailed model awaits further publication of Smith's work, one aim of my project will be to look at the issue of Pleistocene occupation as regards north-eastern South Australia. Is there evidence for Pleistocene occupation here and if so, what type of economy did the early colonists possess?

As well as this interest in Pleistocene occupation I have a number of other aims. The first is to determine when the most intensive period of occupation took place — was it during the mid to late Holocene period, as other work to the south, and in other regions has shown (Hughes & Lampert 1980; Lampert 1985; Lampert & Hughes 1987; Smith 1983, 1987)? Secondly, the information on prehistoric sites will be ultimately used to form a number of management proposals to protect the archaeological material from a number of threats including oil and gas exploration, pastoralism and tourism. Here I will be working closely with the Aboriginal Heritage Branch of the South Australian Department Australian of Environment and Planning.

The project is funded for three years and this paper reports on the results of this, the first field season. Given the preliminary nature of the work, my data and conclusions will be fairly general. Before describing the results of the fieldwork, I will first provide an environmental context for the research by presenting below information on the geography of the region and then on climatic change.

Environmental Setting

The region has a hot, dry, desert climate with short, cool to cold winters. Rainfall is extremely low (125 mm per annum) and unreliable, while mean annual evaporation is very high (3800 mm per annum). There is no distinct seasonal pattern to the rainfall distribution.

Within the region there are two distinct land-systems (Laut *et al.* 1977, Hughes & Lampert 1980). These are briefly described here, because as I will outline later, the nature of the archaeological material varies with land system.

i. Merninie Environmental Association

This land-system lies in the eastern part of the study area to the east of the Birdsville track (Fig. 1). It consists of a gently undulating stony plain with low silcrete-capped rises. Here the Cooper is confined within a narrow floodplain and comprises a series of permanent waterholes each up to several kilometres long. East-west trending dunes have formed along the margins of both banks of the river and Hughes (Hughes & Lampert 1980) notes that they broadly resemble those of the Cooper flood-out zone to the west (see below). The vegetation in this land-system consists of occasional stands of mulga (*Acacia aneura*) and a sparse low shrubland of native fuchsia (*Eremophila* spp.) and dead finish (*Acacia tetragonophylla*) over tufted grasses such as saltbush (*Atriplex* spp.) and Mitchell grass (*Astrebla pectinata*). The Cooper channel and floodplain is fringed by woodlands of river red gum (*E. camaldulensis*), coolibah (E. *microtheca*) and coolibah box (*E. intertexta*).

Stony land-systems which have similar landforms and vegetation are also found in this general region and lie to the north-west, north and north-east of the study area. They are virtually identical to the Merninie landsystem and are therefore not described here. More information on them can be obtained from Laut *et al.* (1977).

ii. Cooper Creek Environmental Association

This land-system covers most of the study area, lying to the west and north-west of Innamincka. It comprises the Cooper flood-out zone and consists of a field of parallel dunes and interconnected claypans periodically flooded by Coopers Creek. A number of the larger claypans form lakes. Some of these, for example the Coongie Lakes system (Fig. 1) are filled annually by freshes of water which come down the Cooper from the Channel Country of northern and western Queensland. These lakes fill from an overflow channel of the Cooper, the North West Branch, but only one or two lakes hold water for more than six months of the year. Other lakes and claypans are filled either with the Cooper flood-out, or by prolonged local precipitation.

The dunefield consists mostly of longitudinal dunes which trend north-south. Transverse dunes are found on the northern (downwind) sides of floodflats (Twidale 1972, Wasson 1983). Both types of dunes are rich in clay with the clay occurring in sand-size aggregates or 'pellets'. The vegetation on the dunes and around the lakes is variable, ranging from samphire (*Arthrocnemum* spp.) and chenopod shrublands of old man saltbush to lignum (*Muehlenbeckia cunninghamii*) and canegrass (*Eragrostis australasica*). The floodplains and channels of the major river systems are fringed by the same tree species as noted for the previous land-system i.e. river red gum, coolibah and coolibah box.

The region has not always been environmentally stable and over time there have been significant changes in the climate and landforms. Given the scale of these changes, they would have undoubtedly affected human occupation, and are therefore outlined here.

Environmental History

The clay-rich linear and transverse dunes have been studied by Wasson and preserve a sediment record of climatic change in the region (Bowler & Wasson 1984; Gardner *et al.* 1987; Wasson 1984, 1986). The presence of clay pellets suggests that the dunes were formed when muds and fine sands deposited by the Cooper were deflated from salinized swales. The floodplain sediment was derived from alluvium deposited directly by the Cooper or, where areas were cut off from a direct supply of flood sediment, from saline groundwater-controlled deflation. The pelletization of the clays requires the salinisation of sediments and this occurs in a regime of fluctuating saline groundwater. As well as this mode of formation there is now recent evidence which suggests that clay pellet formation can occur without salts as long as there is a supply of fresh alluvium (Gardener *et al.* 1987).

The dunes contain four main stratigraphic units. The uppermost is a modern mobile aeolian sand, mostly quartzose with rounded clay pellets. Below this is a unit which also comprises quartzose sand and clay pellets and is late Holocene in age. The next unit has a similar composition of quartzose sand and clay pellets and as well has some carbonate formation and was deposited between 13 000 and 23 000 yBP. The lowermost unit also contains quartzose sand and clay pellets but is also slightly reddened and has pronounced carbonate formation. Thermoluminescence dating of this unit suggests it may have been deposited as long ago as 240 000 yBP (Gardner *et al.* 1987). Analysis of these sediments and of other features in the regions and in other areas gives the following environmental sequence beginning with the late Pleistocene (Bowler & Wasson 1983; Wasson 1994, 1986).

About 50 000 years ago lakes in the southern half of Australia were noticeably expanded. At this time also the Cooper was depositing predominantly sandy alluvium in contrast to the muds and silts it deposits today. This suggests the river was discharging water at an increased velocity relative to the present and could indicate a greater discharge overall. If this was the case then it is probable that the lakes in the study area, like those in southern Australia, were also noticeably larger.

The lakes in southern Australia remained full for some time although after about 30 000 yBP there was some oscillation in lake levels. This lasted until around 22 000 yBP when the lakes began to dry up. About this time too, the Cooper ceased depositing predominantly sandy alluvium and began depositing a mixture of sand, silt and clay, indicating a decrease in stream velocity. The presence of the clays in the floodplain sediment initiated the period of clay pellet formation in the swales between the dunes. During this time a major phase of dune building began and continued until the terminal Pleistocene. The most intensive periods of sediment mobilistion took place between 16 000 and 20 000 yBP at the height of the last glaciation. Dune building was triggered by a combination of factors: an increase in wind speed, radiant summer energy and pressure gradients, and a decrease in humidity. These also induced a lowering of the water table, increasing the salinization of the clay-rich floodplain sediments.

At around 12 500 yBP there was another significant climatic shift in the region when frequent flooding of the outer areas of the Cooper floodplain ceased. This removed most of the sediment available for dune building and the dunes ceased accumulating sediment. Dune building began again in the late Holocene, although on a smaller scale than in the late Pleistocene. This event mostly involved a reworking of older dune units and there does not seem to have been a return to the climatic conditions of the last glaciation. Wasson believes that this mobilisation of sediment is linked to shifts in climate, reflected by falling lake levels in eastern Australia. He also outlines the possibility that it may be related to a more intensive occupation of the region by Aboriginal groups through the firing of vegetation for example, but notes that there is insufficient evidence to look at this hypothesis at present (Wasson 1986).

The data presented above show that the region has undergone significant climatic change in the last 50 000 years. This has undoubtedly affected Aboriginal occupation of the area and I will be focusing on this issue by looking at the occupation history of the lake systems. As I will show below (by citing historical accounts of Aborigines), the lakes were an important focus for settlement. An analysis of the archaeology of these areas can not only provide information on prehistoric occupation but, as well, data on climatic change, through the study of the sedimentary history of dunes associated with the lakes. As well, information derived from the latter work can be compared with Wasson's chronology derived from his work on the dunefield.

Before presenting the results of the survey work, I will first put the data within an ethnographic context, by briefly summarizing the historical accounts of Aboriginal subsistence and settlement patterns for the region.

Historical Accounts of Aboriginal Subsistence and Settlement

Historical records show that the Cooper and its associated lakes were the main focus of settlement in the region (Sturt 1849, Burke & Wills 1861, McKinlay 1862). These areas were densely populated. Sturt saw a camp of between 300 to 400 people about 50 km east of Nappa Merrie station in Queensland (1849: II, 75–79). North of Innamincka, around the Coongie lakes, McKinlay saw over 300 people at Hamilton Creek, 200–300 people along the North West Branch of the Cooper just south of Coongie and at least 150 people around the Lake Lady Blanche (1862: 37, 38, 46). Most groups, however, were smaller than these large aggregations. Camps of between 20 and 40 people were common and some settlements seemed to have been occupied on a semi-permanent basis (Sturt 1849, Burke & Wills 1861, McKinlay 1862). Huts at these camps were substantial domed structures (Horne & Aiston 1924).

The main food consumed in the vicinity of the lakes and river country was fish and mussels, water birds and nardoo (*Marsilea* spp.), a small clover-type plant that grows on floodflats. The sandhill country was also utilized, and as Jones (1979) has shown, was more productive than the lakes and rivers as regards food plants and small mammals. Staples obtained from the dune fields comprised a wide variety of seed plants, especially native millet (*Panicum decompisium*) and 'Munyeroo' (*Portulaca* spp.), and roots and tubers, especially 'yams' (probably *Impomaea* sp.) (Jones 1979, Kerwin & Breen 1981). Snakes, other reptiles, and many species of small mammals were used as food resources.

Jones (1979) has studied the historical material and has developed a model of subsistence and settlement patterns which is supported by the available historical evidence. He shows that while people mostly lived close to the major water sources, after rain, groups pushed out into the dunefields to exploit the plant foods which had germinated and to obtain the grubs, reptiles and small mammals which were abundant here. As the surface water in claypans between the dunes began to dry up, people moved back on to the creeks, rivers and lakes to harvest the plants such as *Panicum* and nardoo now ripening on the floodplain. As well as this pattern of seasonal movement, Jones observes that some groups remained on the lakes and river throughout the year. In these areas there were sufficient resources to support semi-permanent settlement (e.g. King in Burke & Wills 1861). Jones also found that the stony country contained significantly fewer food resources than other land-systems and was not a favoured area for settlement (e.g. Sturt 1849: II, 43).

From this brief overview of the historical material we can hypothesize that the largest sites will be found in areas which have permanent or semi-permanent water sources. Surface campsite material will be found in the dunefields but sites will be smaller than those on the margins of lakes and permanent waterholes.

These ideas, along with those concerning Pleistocene occupation, are discussed in the light of field data in the following section. The results of previous work in the region are discussed first.

Previous Archaeological Research in the Area

The previous work in the region has comprised short-term studies of small areas as part of environmental consultancy projects (Hiscock 1984, Hughes 1983, Lance & Hughes 1983) and 'reconnaissance' trips to appraise the archaeological potential of a region (Hughes & Lampert 1980, Lampert 1985). Almost all surveys were restricted to the region south of my study area, to the dunes and the main Cooper channel and little work was carried out on the lake. Although none of this work has involved long-term studies and it did not look at the lake systems, sufficient surveys have been done to isolate some trends in site type and distribution. These are outlined below.

The survey found that sites are common in the region and that site type varies with land-system and environmental context. Quarries, stone arrangements and engraving sites are restricted to the stony country i.e. the Merninie land-system. General artefact scatters, shell middens and burial sites are found in both the stony country and the Cooper flood-out zone, but shell middens are restricted to the margins of lakes and permanent waterholes of the main stream and river channels. General artefact scatters were found to be the most common site type in the region.

As regards the age of sites, it was found that most sites dated (on typological grounds) to the mid to late Holocene. Pleistocene sites are extremely rare, at least in the dunefield and around the main Cooper channel. The only Pleistocene site found is an Aboriginal hearth, site 'JSN' dated by Wasson (1983). The hearth lies in the middle of the dunefield, about 270 km south-west of Innamincka and 90 km west of Strzelecki creek. Two dates have been obtained — 13 850 ± 190 yBP (ANU 2278) and 13 150 ± 830 yBP (ANU 2279). Because of the rarity of Pleistocene sites in the region, Lampert (1985) has hypothesized that the region was not settled on any permanent basis until the late Holocene and that any Pleistocene material found resulted from occasional trips made by the prehistoric inhabitants to the region from better watered areas to the south-west, such as the Flinders Ranges (see also Lampert & Hughes 1987).

Does this patterning of archaeological material also apply to the lake systems? In the following section I present my data for the lakes and conclude with a discussion on this issue in the light of my findings.

Field Work

Preliminary Work

The study area is very remote and there are logistic problems in running field work there. For this, my first field season, I concentrated therefore on a relatively accessible area — the lakes around and including Coongie. I began planning my field work by first examining colour aerial photographs of the region (Fig. 2). Using these I isolated features relevant to the archaeology of the area and these are discussed below.

The photos showed that some lakes (Coongie, Marroocoolcannie, Marroocutchanie and Toontoowarannie) fill on a regular basis while others (Apachirie and Mitkacaldratillie) do not. Although the last two lakes do not consistently hold water now, they do however have lake-shore features and thus regularly filled some time in the past. As well as this difference in water levels today, there is a distinction between these two groups of lakes in regard to a particular type of dune feature. On the lakes in the first group there is a pale coloured dune or series of dunes, trending north-west to south-east, which lies on the north-east margin of the flood-out zone of each lake. These features are absent on the last two lakes noted above. The dunes range in orientation from 15° to 30° west of north. They appear to be transverse dunes or Twidale's 'leeside mounds' (1972: 85–86) and are similar to the lunettes or clay dunes of semi-arid regions. Such features are formed when longshore drift transports debris to beaches or the lee shore of lakes. This sediment is then locally redistributed by the wind before being trapped by vegetation close to the lake margin. The reasons for their presence on lakes in the first but not the second group is unclear, but is possibly linked to higher water levels some time in the past. As well, there are a series of these dunes within the flood-out zone between Toontoowarannie

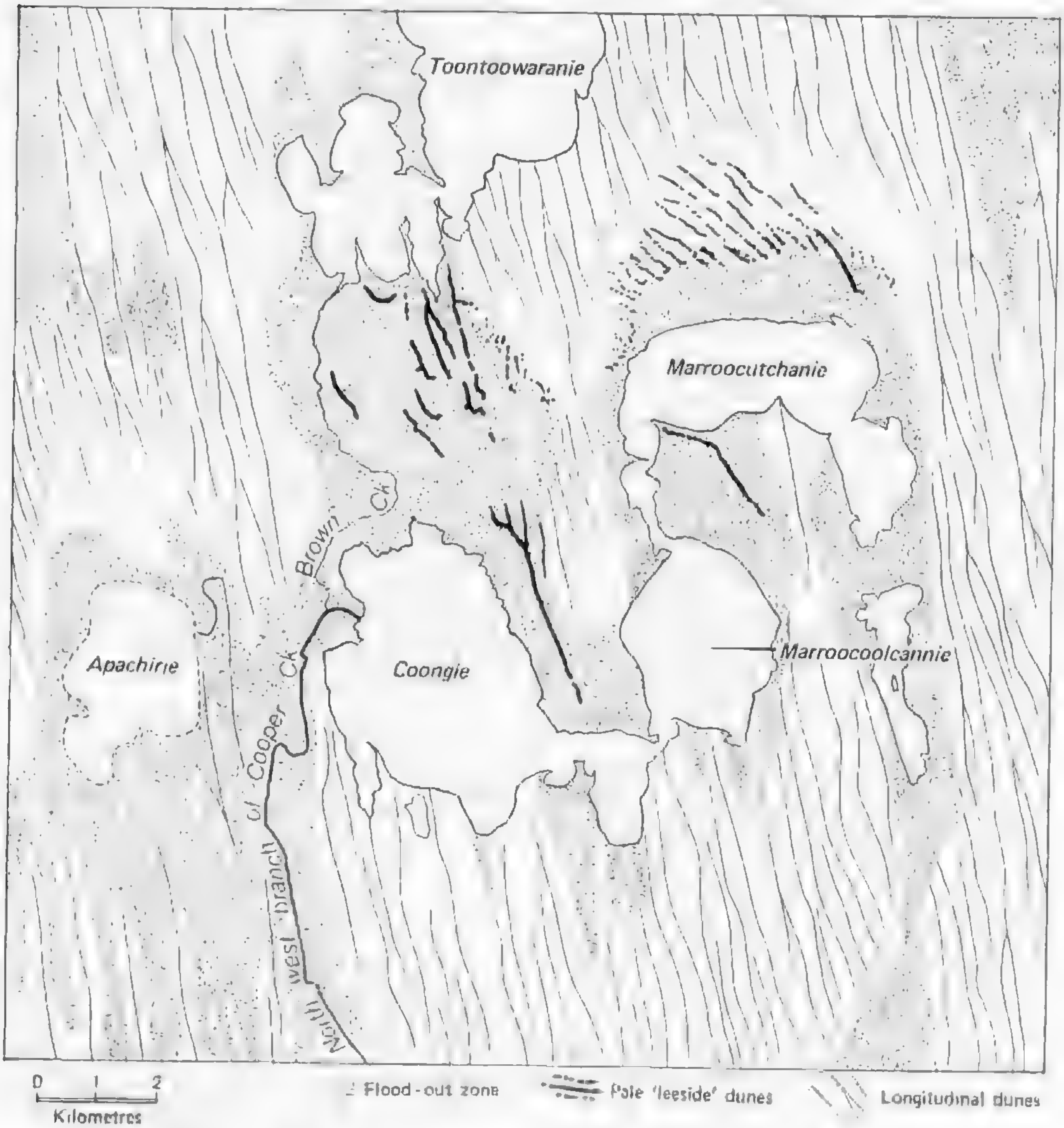

FIGURE 2. Part of the Coongie Lakes showing the pale-coloured 'leeside' dunes.

and Coongie. The mode of formation of these features is unclear because they are not directly associated with the lake shore as are the other dunes. A priority of the field work was to examine both types of dunes to determine how and when they were formed and whether they contain *in situ* Pleistocene archaeological material as do the lunettes of the Willandra and Darling lakes.

As well as looking at these pale dunes I examined exposures of Pleistocene sediments in the longitudinal dunefield, for *in situ* archaeological material. I also looked at sites generally around the lakes and creeks, to obtain information on site type and location.

The field surveys

In June and July 1986 I made two trips to the Cooper from a base in Broken Hill. The time spent in the field totalled five weeks. On both trips, work was curtailed because of heavy, unseasonal rainfall but despite this I managed to obtain data relevant to the issues outlined above.

During this field work I concentrated on getting an overview of the archaeology of the lakes. I surveyed sections of five lakes (Coongie, Marroocoolcannie, Marroocutchanie, Toontoowarannie and Goyder) and while I mainly concentrated on checking the pale dunes described earlier, I also looked at lake margins where there were no pale dunes and also at some parts of the main longitudinal dune field. General comments about site type and distribution are noted first, followed by a discussion of sites on the pale dunes.

In all areas surveyed I found that artefact density and site size increased as one approached permanent water sources. Site density was extremely low away from the lakes and major river channels. Because of the large number of artefact scatter sites seen, I did not record every site and instead only noted either very large sites or sites where I collected material for dating purposes. Record cards for these sites are held by the Aboriginal Heritage Branch, South Australia. Artefact scatters were the most common site type found and these comprised a scatter of artefacts exposed as a lag on dune blow-outs, where the more compacted Pleistocene sediment was exposed.

On many sites, freshwater mussel shell was associated with the artefact scatters, but this material was restricted to those areas where permanent or semi-permanent water was present i.e. the larger lakes and permanent waterholes on the channels. There was some variation in the quantity and distribution of shell relative to other archaeological material. I found, for example, that large midden sites, where shell is the dominant archaeological material, were restricted to areas where natural mussel beds were particularly abundant i.e. the margins of lakes close to inlet channels and the edges of large, permanent waterholes. Small scatters of shell, similar to Meehan's (1982) 'dinnertime camps' were scattered intermittently around the margins of the larger lakes and channels. Future work will look at these differences in distribution in more detail.

In virtually all cases the archaeological material was not *in situ* and had apparently deflated down from Holocene units. Typologically, most, if not all artefacts, dated to the mid to late Holocene. The main artefact types were tula adzes and adze slugs, small scrapers, cores, flakes and fragments of large, flat sandstone grindstones of the type described by Smith (1986). As well, largish, cube-shaped silcrete cobbles which were often ground on one or more surfaces were common. Cores and flakes were small in size and noticeably reduced and this is probably due to the fact that raw material sources lie some distance away (more than 50 km), in the stony country. Occasionally larger flakes and horse hoof cores were present. Favoured raw materials were silcrete, quartzite, chert and chalcedony. Hearth material, usually fragments of burnt termite mound, was often scattered across sites and occasionally fragmented human bone was also found. Isolated hearths were also present. Within the longitudinal dunefield proper, I saw only one site where material was not lying in the upper section of the late Holocene unit. This is Ellar Creek 1, which comprised a termite mound hearth *in situ*, lying near the base of the late Holocene unit. The hearth dates to 3080 ± 170 yBP (ANU 5428).

As noted earlier, sites increase in size and the density of material increased as sites became closer to permanent water. At Typingimie waterhole, for example, a permanent waterhole on an intermittent drainage line within the longitudinal dunefield, there was a higher density of material, especially termite mound heat retainers, than on sites in the dunefield generally. The largest sites in the study area were found on the margins of the lakes close to either inlet or outlet creeks and on the edge of large, permanent waterholes on the main watercourses. Especially large sites were found on the lakes near outlet creeks, towards the southern end of the lakes. Sites of this type include Lake Toontoowarannie sites 1 and 2, which comprise 7000 square metres and 10 000 square metres of shell midden respectively. The archaeological material on these two sites is similar to that outlined earlier and consisted of fragmented mussel shell, artefacts, scattered heat retainers and fragmented burials. As well, there were the remains of a collapsed 'gunyah' on the former site. Shells and artefacts on these sites lie either within late Holocene sedimentary units or are deflated down from Holocene units to lie as float on exposed Pleistocene sediments. A sample of shell from this site was submitted for dating and as expected, is late Holocene — 330± 80 yBP (ANU 5425). Such large and complex sites are not normally characteristic of arid areas and thus reflect the importance of the lakes to the region. Their presence is consistent with the high population densities observed by the early explorers.

Apart from these large sites, smaller scatters of artefacts, shells, hearth material and bone were found on the flanks of the longitudinal dunes along the margins of the lakes. These are larger than the sites found in the dunes away from the lakes. Examples of this type include Marroocoolcannie Sites 1 and 2. At the latter site there was also an area of burnt bone and shell. This material appears to be *in situ* and the bone, although not identified formally as yet, appears to be that of fish and small mammal species. This is consistent with the enthno-historical data outlined earlier which identifies fish and small mammals as important food sources. At both sites most of the material was again deflating from Holocene units onto Pleistocene deposits. At Site 1, mussel shell which is *in situ* dates to 1020 ± 80 yBP (ANU 5427) while at Site 2 a termite mound hearth dates to 1130 ± 110 yBP (ANU 5429).

As regards the pale-coloured dunes noted earlier, I surveyed exposures along the length of these dunes on Coongie, Marroolcoolcannie, Marroocutchanie, Marradibbadibba and in the floodplain between Toontoowarannie and Coongie. With the exception of a site at Marradibbadibba — Lake Goyder 1, I found that all archaeological material was deflating down from the upper, recent units. The sites were all similar and resembled the smaller lake-margin sites such as the Marroocoolcannie Sites 1 and 2 described above i.e. scatters containing artefacts, burnt termite mound and fragmented human bone. Shell midden material and large artefact scatters were scarce except for one large shell midden (Marrootcoochanie 1), on the north-west end of the Marroolcoolcannie dune, which in turn lies close to the inlet of Lake Marrootcoochanie. This is the only section of one of these white dunes which lies near the inlet channel of a lake. As well as general artefact scatters, a mounded burial (Browne Creek Burial Site) of the type described by Elkin (1937) was found in an area of pale dunes between Toontoowarannie and Coongie. The relative lack of material on these dunes, except for where they are close to inlet channels, reinforces the trends in site patterning noted earlier for the lakes generally. It suggests that source-bordering dunes in this area were not especially favoured for occupation as such. Future work will explore this proposition further.

The one site found within the lower part of one of the white dunes was Lake Goyder 1 and it lies within a white dune on the north-western margin of Lake Marradibbadibba. It is similar to the sites described earlier, with some exceptions. Heat retainer material is calcrete rather than termite mound and there is a burial and a small scoop hearth of burnt soil about 1 m across, lying within more consolidated sediments which are below what appears to be a recent unit. A sample of charcoal from the hearth is quite young, 810 ± 130 yBP (ANU 5424).

It is difficult to determine the significance of this date, given that it is much younger than expected. It is possible the sample was contaminated, possibly by recent floodwaters. Air photos reveal that this locality was submerged for some time during the 1974 floods. While I am unable to resolve this problem, there are other clues to the age and origin of the white dunes. Soil samples taken from the pale dunes associated with the present lake shores of Marootcootchanie and Marradibbadibba (features between Coongie and Toontoowarannie were not examined because of a lack of time), comprise sand rather than clay pellets, suggesting that the dunes originated from beaches. Since a number of the dunes are now some distance from present lake margins (Fig. 2) it seems that they were formed in the past at a time of higher lake levels. The morphology and colour of the dunes associated with the lakes in the whole of the Coongie system generally, suggest that they are late Holocene rather than Pleistocene features, (B. Wasson pers. comm.), indicating that the most recent rise in lake levels occurred some time during this period. Further work will be carried out on this hypothesis, before I relate my work back into Wasson's chronology.

As well as the site described above, work around Goyder and Marradibbadibba revealed other items of interest. While sites in this area were generally similar to those on the lakes further south, there was a greater variety of artefact types and raw materials here. An edge-ground hatchet manufactured from green stone was found on one of the sites (Lake Goyder 2) and flaked greenstones and rock-crystal was found on other sites. These differences seem to result from a relative lack of amateur collecting in these more remote lakes rather than for example, differences in site function or availability of raw materials. Goyder is not closer than Coongie to sources of these rock types and there appears to be no difference in food resources between the lakes. Many artefacts have been removed from around Coongie and from Coongie south to Innamincka by specialist collectors (see for example the collections in the South Australian Museum) and also by stockmen and tourists. The more remote areas in the lake system to the north of the old Coongie station, are not visited as much and fewer artefacts seem to have been collected from there. Collecting is an ongoing problem and will get worse as tourism increases. I will therefore take this into account when quantifying data on artefacts for the region in the future.

Conclusions

I found that there are specific constraints on the location and distribution of sites in the Coongie system. The availability of permanent or semi-permanent water, for example, is probably the most important. Allowing for this, the presence of large, complex sites in the region, reinforces the historical data that population densities here (at least for the recent past) were high.

Regarding the chronology of settlement, I have found it difficult to look at the issue of Pleistocene settlement. I have confirmed that Pleistocene archaeological material is rare, but this could be partly due to the fact that most dunes associated with the lakes are quite recent. The dunes are recent, because the Coongie system is still operating. Future fieldwork will explore the issue of Pleistocene occupation further, with a study of Pleistocene-aged dunes associated with a series of now-dry lakes, located north of the Coongie.

Allowing for these problems with Pleistocene contexts, I would argue that the relatively late appearance of a more intensive occupation is a real phenomenon. I have surveyed many exposures of Pleistocene sediments in longitudinal dunes near the lakes and have found only more recent sites. Other researchers working closer to the main Cooper Channel have found the same pattern. It seems, therefore, that although the region was first occupied during the late Pleistocene, the area was only exploited on an intermittent basis until the mid to late Holocene. This pattern is also seen in other parts of the arid zone. How can we account for this phenomenon — can it be explained by factors such as climatic change for example? For the Coongie, it is possible there were higher lake levels in the late Holocene, and this could be having some impact on occupation. It is unlikely, however, that environmental shifts alone can explain this phenomenon. Higher ground water levels were present in the region in the late Pleistocene and in neighbouring areas such as Lake Frome during the early and mid-Holocene (Singh 1981), yet there is no evidence for corresponding increases in population at these times. Could the patterning be explained by another model, such as a continental-wide process of economic intensification during the mid to late Holocene, as outlined by Lourandos (1985)? Whilst it is tempting to see the Coongie data as supporting such a proposition, I have argued elsewhere (Williams 1987) that the detection of intensification in the archaeological record is complex. Given the preliminary nature of my work in the Coongie, I will therefore leave a more detailed discussion of this issue until I have completed further fieldwork.

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ABORIGINAL USE OF SUBTERRANEAN PLANT PARTS IN SOUTHERN SOUTH AUSTRALIA

BY P. A. CLARKE

Summary

This paper discusses the importance of underground plant parts as sources of food, medicine, string fibre, narcotics, pigments and drinking water in southern South Australia. Information was obtained from contemporary Aboriginal accounts and historical sources. In spite of an earlier view of the flora of the region as providing meagre food resources, it appears that some root species were very important. The paper also suggests that Aborigines in this area more actively managed their resources than has previously been thought.

ABORIGINAL USE OF SUBTERRANEAN PLANT PARTS IN SOUTHERN SOUTH AUSTRALIA

P.A. CLARKE

CLARKE, P. A. 1988. Aboriginal use of subterranean plant parts in southern South Australia. *Rec. S. Aust. Mus.* **22** (1): 73–86.

This paper discusses the importance of underground plant parts as sources of food, medicine, string fibre, narcotics, pigments and drinking water in southern South Australia. Information was obtained from contemporary Aboriginal accounts and historical sources. In spite of an earlier view of the flora of this region as providing meagre food resources, it appears that some root species were very important. The paper also suggests that Aborigines in this area more actively managed their resources than has previously been thought.

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Although some early southern South Australian ethnographers reported plant roots as significant sources of food, Cleland (1957, 1966) considered that the flora was unable to provide significant Aboriginal food sources. The failure of Cleland to take into account the early reports of plant use in historical records and early ethnographies of the region has been documented for Victoria by Gott (1982, 1983) and by myself for southern South Australia (Clarke 1985a, 1985b, 1986a, 1986b). This article argues that Cleland's view can be seen as a reflection of an earlier opinion that Aborigines were wholly passive occupants of their landscape. In pursuing this aim, the study of Aboriginal plant use from southern South Australia is placed into a broader perspective of southern Australian Aborigines as being active managers of their environment and resources. In some cases, plant use records from outside southern South Australia are used as a guide to the species of root that could have been used in this region.

Sources and Methods

For the purposes of this article, southern South Australia is defined as the area receiving rainfall of at least 35 cm annually (Fig. 1). This region contains the lower portion of Eyre Peninsula, Yorke Peninsula, the Mt Lofty Ranges, the Fleurieu Peninsula, the Lower Murray River and Lakes, Kangaroo Island and the South East. Information obtained from early historical sources has been supplemented by consultations with Aboriginal people from the south-eastern region. This has been part of an ongoing, long-term research project involving the South Australian Museum and the Ngarrindjeri community. The project, begun in 1981, aims to record aspects of Aboriginal culture in this region. Major contributors, to the project and to this paper, include Ron Bonney and Lola Cameron-Bonney from Kingston in the South East of South Australia. Ron Bonney is a descendant of West Coast Aboriginal people but was brought up among the Moandik (his term for people of the Kingston area) in the South East of South Australia. He also has detailed knowledge of the Lower Murray cultural region. Lola Cameron-Bonney is a descendant of the Milmandjeri/Temperamindjeri groups from the northern end of the Coorong. Her family has had a deep interest in Aboriginal medicine and healing practices going back to pre-contact times. Another Milmandjeri/Temperamindjeri descendant who has provided important information is Fran Kernot from Kingston. The most significant sources from the Ngarrindjeri community of the Lower Murray have been Dick Koolmatrie and George Trevorrow from the Coorong and Meningie area, and Henry and Jean Rankine from Raukkan (Point McLeay) on the southern shore of Lake Alexandrina.

An ethnobotanical collection gathered during fieldwork in the Lower Murray and the South East by Steve Hemming and myself is being permanently lodged in the South Australian Museum. This collection at present numbers over sixty specimens with plant use records for over forty species; much of this is new information. Although the Museum has an existing ethnobotanical collection of about fourteen hundred specimens from most parts of Australia, the southern region was poorly represented before commencement of this project.

An analysis of the historical sources of ethnobotanical information from this region appears in Clarke (1986b). In the present paper, scientific plant names given are those used in 'The Flora of South Australia' (Jessop & Toelken 1986). South Australian Museum specimens referred to are referenced in the Endnotes by Anthropology Register number and by collector or source. The plant use information put forth in this paper should not be considered as a complete listing of all plant roots that would have been used traditionally by Aboriginal people in southern South Australia. This is because ethnobotanic data historically have been recorded in a fragmented fashion and it is unlikely that I have located records for all the species that were used. However, it is likely that most of the major root species that were significant as foods were recorded by the sources cited in this paper. This paper also takes into account the possiblity that the Aboriginal use for some species, as recorded from contemporary oral sources, has significantly changed since European settlement. There are, in addition, plant species found in southern South Australia for which no record exists of Aboriginal usage. The underground parts of some of these, however, have been recorded as being utilized by Aborigines elsewhere in Australia. These are listed in Table 1. The distribution within South Australia of the main species discussed in this paper is summarized in Table 2.

European naming of plants used by Aborigines requires discussion before we can move on to the data in the paper. Nearly all the plants that the colonists encountered in Australia were totally unknown to

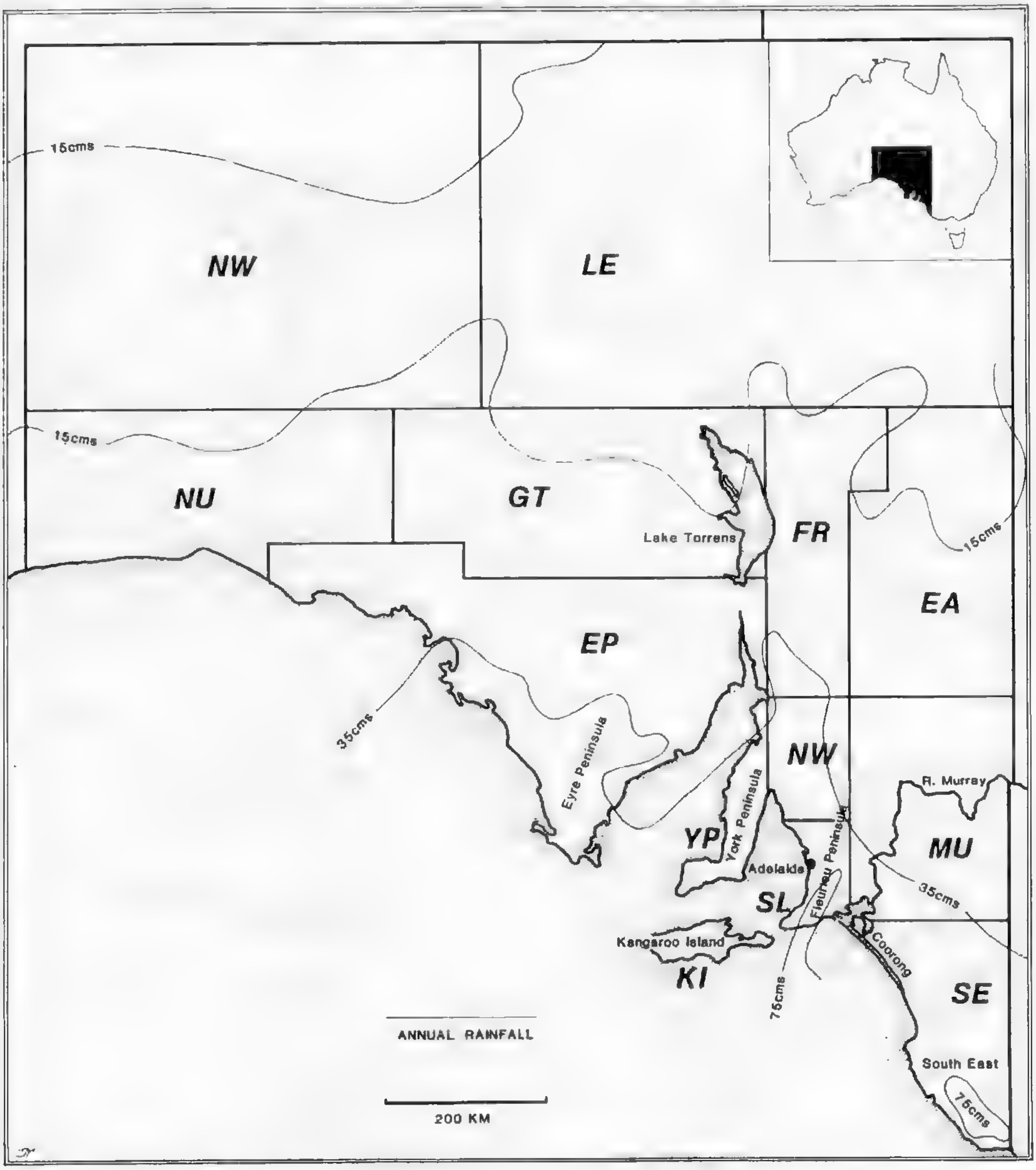

FIGURE 1. Locality map of South Australia showing district abbreviations used in Tables 1 and 2.

TABLE 1. A list of other possible sources of edible tubers.

Species	Common Name	Family	Locality For Recorded Use	Source	Occurrence in S.A.
Arthropodium milleflorum (DC.) Macbr (=*A. paniculatum*)	Pale vanilla-lily	Liliaceae	Vic.	von Mueller 1878: 213	SE
Arthropodium strictum R. Br	Lily	Liliaceae	Vic.	von Mueller 1878: 213	NW FR EP NL MU YP SL KI
Bulbine bulbosa (R. Br.) Haw.	Bulbine lily	Liliaceae	Vic.	von Mueller 1878: 212	FR EP NL MU YP SL SE
Burchardia umbellata R. Br.	Milkmaid	Liliaceae	Vic.	von Mueller 1878: 212	EP SL KI SE
Caladenia species	Spider orchid	Orchidaceae	Vic.	von Mueller 1878: 212	Statewide
Caesia vittata R. Br.	Pale grass lily	Liliaceae	Vic.	von Mueller 1878: 213	FR EA EP NL MU YP SL KI? SE
Chamaescilla corymbosa (R. Br.) FvM ex Benth.	Blue squill	Liliaceae	Vic.	Hope & Coutts 1971: 107	Southern S.A.
Clematis microphylla DC.	Old man's beard	Ranunculaceae	W. Vic.	Dawson 1881: 20	FR EA EP NL MU YP SL KI SE
Convolvulus species	Bindweed	Convolvulaceae	W. Vic.	Dawson 1881: 20	Southern S.A.
Crinum flaccidum Herbert	Murray lily	Amaryllidaceae	E. States?	Maiden 1889: 20	LE GT FR EA EP MU
Cyrtostylis species	Gnat orchid	Orchidaceae	Vic.	von Mueller 1878: 212	FR EP NL MU YP SL KI S
Dicksonia antarctica Labill.	Tree fern	Dicksoniaceae	E. States?	Gunn cited Maiden 1889: 22	SL? SE?
Dipodium species	Hyacinth orchid	Orchidaceae	Vic.	von Mueller 1878: 212	SL SE
Diuris species	Donkey orchid	Orchidaceae	W. Vic.	Dawson 1881: 20	Southern S.A.
Gastrodia sesamoides R. Br.	Native potatoes	Orchidaceae	Tas.	Irvine 1957: 118	SL KI SE
Geranium species	Geranium	Geraniaceae	Vic.	von Mueller 1878: 212	Southern S.A.
Glossodia species	Wax-lip orchid	Orchidaceae	Vic.	von Mueller 1878: 212	NL SL SE
Lyperanthus species	Fire orchid	Orchidaceae	Vic.	von Mueller 1878: 212	Throughout southern districts
Microtis species	Onion orchid	Orchidaceae	Vic.	von Mueller 1878: 212	Throughout southern districts
Nymphoides crenata (F.v M.)Kuntze (= *Limnanthemum crenatum*)	Wavy marshwort	Menyanthaceae	N. Qd	Palmer 1883: 100	LE MU
Nymphoides geminata (R.Br.)Kuntze (= *Limnanthemum geminatum*)	Entire marshwort	Menyanthaceae	N. Qd	Roth 1901: 13	KI
Portulaca oleracea L.	Common pigweed	Portulacaceae	L. Eyre Basin	Cleland *et al.* 1925:	NW LE GT FR EA YP SL SE
Prasophyllum species	Midge orchid	Orchidaceae	Vic.	von Mueller 1878: 212	Throughout southern districts
Pterostylis species	Green-hood orchid	Orchidaceae	Vic.	von Mueller 1878: 212	Throughout southern districts
Santalum murrayanum (T. L. Mitchell) C. Gardener (= *Fusanus persicarius*)	Bitter quondong, Ming	Santalaceae	E. States?	Maiden 1889: 32	FR EP MU YP SL SE
Sonchus species	Sow thistle	Compositae	E. States?	Hooker cited Maiden 1889: 59	Statewide
Thelymitra species	Sun orchid	Orchidaceae	Vic.	von Mueller 1878: 212	Throughout southern districts
Thysanotus patersonii R. Br.	Fringe lily	Liliaceae	Musgrave Ra.,S.A.;	Cleland & Johnston 1937: 213,	All areas except LE
			Vic.		von Mueller 1878: 212
Thysanotus tuberosus R. Br.	Fringe lily	Liliaceae	Vic., N.W. Aust.	von Mueller 1878: 212 Crawford 1982: 42	SE
Wurmbea species (= *Anguillaria* species)	Early Nancy, Blackman's potatoes	Liliaceae	Vic. Mallee & Wimmera	von Mueller 1878: 213	Statewide

TABLE 2. South Australian localities of main species with useful subterranean parts.

Species	Family	Locality within S.A. (See Fig. 1 for area codes)
Boerhavia dominii	NYCTAGINACEAE	NW LE GT FR EA EP NL MU YP SL
Bolboschoenus caldwellii	CYPERACEAE	LE FR EP NL MU SL SE
Bolboschoenus medianus	CYPERACEAE	MU SL SE
Cyperus species	CYPERACEAE	Statewide
Dianella longifolia	LILIACEAE	Southern districts
Drosera whittakeri	DROSERACEAE	NL MU SL KI SE
Eucalyptus dumosa	MYRTACEAE	FR EA? EP NL MU SE
Eucalyptus fasciculosa	MYRTACEAE	MU SL KI SE
Eucalyptus gracilis	MYRTACEAE	NW NU GT FR EA EP NL MU YP SL SE
Eucalyptus incrassata	MYRTACEAE	NU EP NL MU YP SL KI SE
Eucalupnus oleosa	MYRTACEAE	Statewide
Lavatera plebeia	MALVACEAE	Statewide
Microseris scapigera	COMPOSITAE	GT FR EA EP NL MU YP SL KI SE
Oxalis species	OXALIDACEAE	Statewide
Polyporus mylittae	POLYPORACEAE	Southern districts
Pteridium esculentum	DENNSTAEDTIACEAE	EP SL KI SE
Santalum murrayanum	SANTALACEAE	FR, EP MU YP SL SE
Triglochin procerum	JUNCAGINACEAE	LE, MU SL KI SE
Typha species	TYPHACEAE	NW LE FR MU YP SL KI SE
Xanthorrhoea species	LILIACEAE	NW FR EP YP NL MU SL KI SE

science. The folk terms that were used for plants in the settler's country of origin were often imposed upon plants to which they generally showed only superficial resemblance. For example, the early ethnographies of southern South Australia contain descriptions of Aboriginal edible roots which are cited as native potato, native parsnip, native radish, native carrot, native dandelion, onion grass and native truffles. There is evidence to suggest that some of these descriptions have been used independently in several accounts of different species. Some also appear to have had the status of commonly used names whereas others seem to have been used only by ethnographers when attempting to describe a species with no other name.

Determining the reasons for a plant being given a particular name is sometimes difficult. In some cases, the names refer to the use and properties of the species. In other cases, the plants were named solely on appearance. For example, most records of roots described as being like a radish are considered by Gott (1983) to be *Microseris scapigera* due to the similarity between the root of the latter and the cultivated radish. However *Microseris scapigera* is also commonly referred to as the yam daisy because of the similarity of the above ground parts of the plant with those of common daisies. To make the task of identifying some of these European terms today even more difficult, some of the folk terms associated with Aboriginal words for edible roots may have only been used for a short period in fairly restricted, local areas.

The transfer of plant names between Aborigines and Europeans also occurred. There are many records of the use by Aborigines of Aboriginal terms for European foods and plants. For example, there are the Adelaide words 'parangota' for potato and 'parre' for rice (Wyatt 1879: 174, Williams 1839: 295, Teichelmann & Schuermann 1840: 37). The term parangota was also used for an unidentified species of Aboriginal root food. On the other hand, Aboriginal terms for Australian plants were sometimes adopted by Europeans and, in some cases, their use has continued to the present. Examples of this are 'Pitjuri' (widely used term for *Duboisia hopwoodii*), 'Mantari' (South Australian and Victorian term for the fruit, *Kunzea pomifera*), and 'Murnong' (Victorian term for *Microseris scapigera*).

Ethnographic Details of Root Use

Boerhavia dominii Meikle & Hewson
NYCTAGINACEAE

This species is commonly called tar-vine and has been suggested by Cleland (1966: 135 – his name *B. diffusa* L.) as the possible identity of one of the roots listed by Schuermann (1879: 216) as having been eaten by the Port Lincoln Aborigines. Black, in his 'Flora of South Australia' (1943: 333), mentions that the root was eaten by Aborigines but does not give a source or locality for this statement. It is highly likely that *B. dominii* is often the plant described in the ethnographic record under the category 'edible roots'. Apart from in the South East region, this species is found throughout southern South Australia.

Bolboschoenus sp. CYPERACEAE

This species is most likely the 'poolilla' described by Angas (1847a: 101) as a 'triangular species of grass or reed' and eaten by the Aboriginal people of the Murray River. Eyre (1845, 2: 254, 269) refers to reed roots called 'belillah' that were an important source of food and found in abundance on the flats of the Murray. Eyre described them as walnut-sized and prepared by being roasted and pounded between stones into a thin cake. Gott (1982: 59–62) considers the 'belillah' to be *Scirpus medianus* **V. Cook** which is a synonym for *Bolboschoenus medianus* (**V. Cook**) **Sojak**. In this article I follow Jessop & Toelken (1986: 2007) and refer to this plant by the latter name. Cleland collected roots of a species of *Scirpus* (or *Bolboschoenus*?) from the mouth of the Inman River, south of Adelaide, in January 1940 and wrote that they were probably eaten[1]. However, he did not state the reasons for this suggestion. Von Mueller (1878: 213) lists *Scirpus maritimus* (called *Bolboschoenus caldwellii* (**V. Cook**) **Sojak** by Jessop & Toelken 1986: 2007) as a source of edible roots used as food by Victorian Aboriginal people. It was apparently an edible root species that was available in autumn and was roasted. This species is widespread in southern South Australia.

Cyperus sp. CYPERACEAE

Tindale (1974: 60) states that the Peramangk people of the Mt Lofty Ranges were able to exist all year round without venturing onto the plains because of the availability of *Cyperus* corms. *Cyperus* species have been recorded as major food source from other regions such as Central Australia (Cleland & Johnston 1933: 115, 118; 1937: 213) and north-western Australia (Crawford 1982: 40). It is possible that some of the records of 'Native Onions' refer to species of *Cyperus*. For example, Tindale (1981: 1880) records that the southern South Australian Aborigines ate the onion grass corms throughout the year except during the growing season. However, Tindale's records of *Cyperus* and onion grass corms mentioned above may also refer to a species of *Bolbschoenus*, as this genus is also in the Cyperaceae family.

Dianella longifolia R.Br. LILIACEAE

The reddish brown roots of this plant, commonly referred to as the pale flax-lily, were boiled and the solution taken internally for colds according to Lola Cameron-Bonney. It was termed peeintook by the Milmandjeri/Temperamindjeri, but was called pintook by the Moandik[2].

Drosera whittakeri Planchon DROSERACEAE

D. whittakeri, or the scented sundew, is the most likely species referred to by Worsnop as an Aboriginal source of pigment:

> The native tribes around Adelaide obtained a brighter red pigment from the bulbous roots of the small sundew plant, which contains a small red pustule between the brown outer skin and the white inner bulb. This red pustule they used to scrape off and mix with fat for coloring the fillet of opossum hair-twine which they bound round their heads (Worsnop 1897: 15).

The blister-like growth or pustule of this bulb may have been used for decorating the large bark shields made by the Adelaide people for deflecting reed-spears. Stephens records that during their manufacture they 'received a coating of pipeclay or lime, and were then ... ornamented with red bands made from the juice of a small tuber which grew in abundance on the virgin soil' (1890: 487).

It is interesting to note that it is European oral tradition in South Australia that early settlers in the Adelaide area also used this species of sundew as a source of pigment for ink (R. Matthews pers. comm.). It is highly likely that the use of this plant by Europeans was copied from Aboriginal people in the area.

Eucalyptus sp. MYRTACEAE

Eucalyptus roots were sometimes used as a source of drinking water and as food. The need to obtain water for drinking from plant roots in the southern South Australian region was probably confined to the mallee areas of Eyre Peninsula, Yorke Peninsula, Murray region (away from the river) and parts of the South East. This is because surface supplies of freshwater are scarce in these areas, despite relatively high annual rainfalls. Elsewhere in the southern regions, water from springs and soaks appears to have been available all the year round. For instance, Hemming (1985: 25) records the ease with which Aborigines of the Fleurieu Peninsula obtained drinking water from coastal springs during the summer months even when local creeks and soaks had dried up. Gara (1985: 6–11) discusses methods of obtaining water in arid regions of South Australia. Smyth (1878: 220–221) also records similar uses of the *Eucalyptus* roots from the mallee areas of Victoria.

Magarey (1895) provides the most detailed account of water extraction from roots. Some of Magarey's data on root water comes from coastal areas of the Great Australian Bight and depends on the data of Eyre (1845, 1: 349–351, 359, 2: 248–249). Margarey describes in detail the trees that were used by the Aborigines as a supply of root water and the methods for the extraction of it. In his list of 'water-trees', Magarey (1895: 4) includes species of *Eucalyptus* such as *E. dumosa* **Cunn. ex Schauer**, *E. gracilis* **FvM**, *E. incrassata* **Labill.**, *E. oleosa* **FvM ex Miq.**, and *E. fasciculosa* **FvM** (Magarey's *E. paniculata*). All of these trees exist in the mallee areas of southern South Australia. It was through the availability of root water that the Aborigines were able to enter arid regions. The Ngarkat people of the Murray Mallee relied heavily on root water and only needed to travel to the Murray River at times when severe drought had decreased their otherwise reliable sources of water (Tindale 1974: 62).

The use of *Eucalyptus* roots as food is recorded by Maiden (1889: 27) who says that the South Australian Aborigines powdered the bark of the root of *E. dumosa* and perhaps other species and ate it by itself or with other plants. Maiden claims that it was called 'Congoo' but does not mention the area in which this name was used. This mallee is found over much of southern South Australia and the areas to the east of the Flinders Ranges. Eyre (1845, 2: 250) states that the smaller roots, less than an inch (2.5 cm) in diameter, were used as food by the Aborigines (presumably from southern Australia). He records that:

> The roots being dug up, the bark is peeled off and roasted crisp in hot ashes; it is then pounded between two stones, and has a pleasant farinaceous taste, strongly resembling that of malt. I have often seen the natives eating this ... but it is, probably, only resorted to when other food is scarce (Eyre 1845, 2: 250, see also p. 224, 251, 273).

There is also a record of the use of *Eucalyptus* roots as medicine. Moriarty (1879: 52) states that rushes and the roots of the Mallee tree were boiled (presumably together) and drunk for internal afflictions by the Narrinyeri (Ngarrindjeri). Lower Murray Aboriginal person, Laura Kartinyeri, says that the roots of a species of *Eucalyptus* were boiled and the solution drunk for colds. Dawson (1881: 57) recorded the use of the roots of a narrow-leaved species of gum tree as a cure for indigestion. In this case, the roots were infused in hot water and the resulting solution drunk as a tonic.

Lavatera plebeia Sims — MALVACEAE

The roots of a white flowering variety of mallow were recorded as commonly used as food by the Aborigines of South Australia (Bailey, cited in Maiden 1889: 37). They were described as having the consistency of parsnips. Maiden considers that this plant is *L. plebeia*, tha Australian hollyhock or mallow. Wyatt (1879: 170) lists in his Adelaide and Encounter Bay vocabulary the terms 'kannoonta' for mallow plant and 'peecharra' for mallow shrub. The latter appears to have been used as a source of fibre for string making: Wyatt (1879: 176) records the term 'teeyappe peecharra' as 'chewed fibre of mallow'. Eyre (1845, 2: 311) states that the fibres of the root of the mallow were used in net making, though he does not state in what area. *L. plebeia* has been recorded as used for this purpose elsewhere, such as the northern Flinders Ranges (Cleland & Johnston 1939: 176) and the Lake Eyre Basin (Clarke n.d.).

Microseris scapigera (Sol. ex A. Cunn.)Schultz-Bip. — COMPOSITAE

This species, commonly known as the yam-daisy, is possibly another of the many plants recorded simply as 'edible root' from southern South Australia. The tuber is recognized as one of the major food sources for Victorian Aborigines (Gott 1983: 2) and the fact that it occurs widely in southern South Australia suggests that it was probably a major source in this region also. Bellchambers (1931: 132) states that of all the tubers eaten by the Murray River Aborigines, he thought the yam was the most prized. Unfortunately it is not clear whether Bellchambers' 'yam' is *M. scapigera*, and it is possible that he is referring to another root species.

In the Adelaide and Encounter Bay area, the edible root terms 'umba' and 'yungumba' were said to be *Microseris* by Wyatt (1879: 176). One of the Port Lincoln terms for 'edible root', 'ngamba', (Schuermann 1879: 216) probably referes to *M. scapigera*, as it is similar to terms for *Microseris* recorded in cognate languages, such as that recorded from the Adelaide and Encounter Bay area. The yam-daisy was used on the west coast of South Australia. The South Australian Museum has specimens of *Microseris* roots that were registered in 1913 as an Aboriginal food from Elliston[1]. Also, *Namba* is the recorded word for this species used by the Adnyamathanha of the Northern Flinders Ranges (McEntee 1986: 11 — his Adnamatana). Berndt & Vogelsang (1941: 10) list the term *Ngumpa* for 'Yam' from the Ngadjuri people of the Mid-North. In view of the fact that Berndt and Vogelsang recorded different words for wild potato and wild carrot, it is likely that their yam refers to a single species, such as *Microseris*, rather than being a collective term for all edible roots. Gott (1983: 14–15) suggests that the lower Murray term *Ngamko*, meaning 'native radish' (Moorhouse 1935: 30), is likely to be *M. scapigera*. Another possible record of the yam-daisy is provided by Sanders (1907, 9: 69) who states that the local Aboriginal families in the Echunga area, dug up the roots of a 'dandylion', called 'waldies'. Gott (1983:14–15) also considers that the Booandik terms 'Moorna' or 'Mar-o-ngire,' described as 'edible roots' by Smith (1880: 129), refer to this species in the South East. Gott (1983: 8) quotes a note by Bailey on a specimen of *Microseris* from South Australia in the Queensland Herbarium, which states that the colonists of South Australia used to eat the roots of this plant following the practice of the Aborigines who relied on it as food.

Oxalis sp. — OXALIDACEAE

Angas (1847a: 84) records that in the South East, Aboriginal women dug up the edible roots of a species of *Oxalis*. For the Adelaide people, Stephens claims that:

> The root most sought after is a highly nutritious oxalis resembling a small carrot and tasting like cocoanut. It is dug up chiefly by the women, with a heavy pointed stick five feet long which they force, by throwing, into the earth to the depth of about eight inches, thereby bringing up the object of their search. It is very abundant and discovered

by leaf. Three persons have been lost since the foundation of this colony, who would probably have been saved had they known where to look for the root (Stephens 1923, 7).

There are other records of edible 'Native Carrots' that may refer to *Oxalis*.

Polyporus mylittae Bertr. POLYPORACEAE

The common names for this species of fungus – native truffle and Blackfellows bread (Daley 1931: 28) –suggest its edible qualities. The species is possibly the edible fungus mentioned also by Eyre (1845, 2: 269) as found below the ground. Maiden (1889: 46) records that the Tasmanian Aborigines looked for truffles in the ground about the vicinity of a dead tree. The South Australian Museum has specimens of *Polyporus mylittae* listed as Aboriginal foods from Myponga (South Australia)[4], Lake Albert (South Australia)[5], Gippsland (Victoria)[6] and north Tasmania[7]. Most of the above specimens measure above 5 cm in length, breadth and height. The biggest is from Tasmania and measures 26.5 by 16 by 10 cm. The ethnographic record indicates that this species was used as food despite Cleland's (1966: 135) doubt that it could be eaten due to its toughness.

Dawson (1881: 20) records a species of large underground fungus from western Victoria called native bread, about the size of an ordinary turnip, that was eaten uncooked and which tasted, in his words, 'very good'. Smyth (1878: 209) claims that the native truffle 'was much sought after by the natives' and that he had seen specimens weighing several pounds; further, that in some districts, a fungus weighing fifty pounds (about 23 kg) is occasionally found. Bonwick (1870: 15) states that in Tasmania, this fungus was peeled and then roasted before being eaten. However, Daley (1931: 28) claims that it was generally eaten raw by the Australian Aborigines, the dirt simply being shaken off. In view of evidence, it is difficult to support Cleland's doubts about this fungi. Other species of subterranean fungus were probably also eaten.

Pteridium esculentum (Forst.f.) Cockayne DENNSTAEDTIACEAE

This species is commonly called bracken fern and it is listed here as a probable source of food for the southern South Australian region. Its use in Tasmania has been documented by Robinson (cited in Gott 1982: 64). In this record, the rhizomes and young fronds were chewed. Dawson (1881: 20) claims that the western Victorian Aborigines made a kind of bread from the root of the common fern that was roasted in hot ashes and beaten into a paste with a stone. It is possible that Dawson was referring to bracken (Gott 1985: 8). Maiden (1889: 54) states that the starchy rhizomes of this plant were eaten both raw and roasted but he does not give any locality. Mathews (1903: 73) recorded the Bungandity name 'Me-e' for bracken fern in the South East and Smith (1880: 129) recorded the term 'Maa-aa' for fern root for the same group of people (Smith's Booandik). In Tasmania, according to Robinson (cited in Hiatt 1967: 130), bracken roots were cut into short pieces and roasted in ashes.

In spite of the records of the use of this fern outside South Australia, it does not appear to have been a major food source in the southern South Australian region. It was not mentioned by early ethnographers and it was not known as a food source by Ron Bonney and Lola Cameron-Bonney who were able to describe several other types of edible roots for the South East region. However, Bonney did maintain that they were edible because pigs will eat the roots. It was possibly a food only resorted to by humans in difficult times.

Triglochin procerum R.Br. JUNCAGINACEAE

This species, commonly called water ribbons, has numerous and very fleshy roots. It is possibly the 'Maraerow' recorded by Bellchambers (1931: 132) as a food with 'succulent roots'. Cleland (1966: 132) suggests that the tubers of *T. procerum* were used by the Aborigines of the coastal areas of Adelaide and contiguous regions. He lodged at the Museum a food specimen of this plant from the Onkaparinga River at Noarlunga, south of Adelaide, but did not give the source of his information concerning its Aboriginal use[8]. Use of this root species as food has been recorded from Victoria (von Mueller 1878: 213) and Arnhem Land (Specht 1958: 483). In the latter account, it was eaten raw or cooked in the fire for about ten minutes and apparently had a nutty taste. On Groote Eylandt the roots were eaten raw or roasted in the hot sand under the fire and were an important part of the diet (Levitt 1981: 39). This is a palatable, easily obtained food which was probably highly prized.

Typha sp. TYPHACEAE

The recorded Aboriginal names for most edible roots described as growing on river banks and in water for the southern South Australian region probably refer to *Typha*, commonly known as the flag or bulrush. This is especially so for such roots also listed as a source of fibre for string making. Angas (1847a: 55) states that in southern South Australia the bulrush root was chewed and then the fibres scraped, using freshwater mussel shells, for the purpose of making cord for their mats and baskets. Angas (1847a: 90) records that this fibre is also converted into rope out of which the southern Aborigines make their fishing lines and nets for hunting and fishing. Teichelmann & Schuermann (1840: 53) describe the Adelaide word 'warnpa' as 'a farinaceous root growing on the river banks, the nutritious part is eaten and the tough parts made into strings, nets, etc.'. Gell (1904: 94) also recorded this word from this area but he simply described it as an 'aquatic plant'. However, based on the fact that 'wampa' was an aquatic plant whose root was used as both a food and for fibre, it is most likely to be *Typha*.

In the Lower Murray River area, *Typha* appears to have had the name 'Moomoorookee' applied to the whole plant and 'Menungkerre' to the root (Taplin 1859–79: 47). Ngarrindjeri people, Henry and Jean Rankine, use the term, 'Manungkari', for the bulrush in general. Cleland (1966: 138) records 'Manungkari' as the Murray River name for 'Typha', but he gives no separate name for the root. Fran Kernot states that she and her family used to eat the bulrush root when they lived along the Coorong in the 1940s and into the 1960s. The name she gave for the plant was 'milmuruki' and she described it as being two feet long (about 60 cm). It was cooked in ashes or boiled. Ron Bonney said that the Moandik name for the Bulrush was 'manakari' and that the root was about eighteen inches long (approximately 45 cm) and was easy to pull out. He stressed that this food source was available throughout the year.

The importance of *Typha* to the overall diet of the South East Aborigines is summed up by Angas (1847a: 89) who states that the 'staff of their existence is the bulrush root which the women gather among the reeds...'. Once on his trip through southern South Australia, Angas (1847a: 59) met an Aboriginal woman carrying an infant on her back chewing the 'favourite bulrush root'. Another child was standing alongside also chewing a long piece of bulrush. Angas (1847a: 92) recorded the name of a Lower Murray Aboriginal person 'Chembillin', meaning chewing the bulrush root'.

Eyre also stressed the usefulness of *Typha* or the broad flag-reed, as he called it. He states, for example, that: 'In all parts of Australia, even where other food abounds, the root of this reed is a favourite and staple article of diet among the aborigines' (Eyre 1845, 2: 62). Further, he records that the bulrush was the staple food source through out the year on the Lower Murray but that it tasted best after the floods had receded and the tops had decayed and been burnt off (1845, 2: 269). Krefft says, concerning the bulrushes, that on the New South Wales section of the Murray River:

> at a certain period, I believe January and February to be the months, the women enter these swamps, take up the roots of these reeds, and carry them in large bundles to their camp; the roots thus collected are about a foot to eighteen inches in length, and they contain besides a small quantity of saccharine matter, a considerable quantity of fibre. The roots are roasted in a hollow made into the ground, and either consumed hot or taken as a sort of provision upon hunting excursions... (Krefft 1862, 5: 361).

Angas (1847a: 58) says that bulrush roots were steamed between heated stones beneath ovens or cooking fires resembling kilns. Angas (1847b: plate 47) illustrates such a kiln. Beveridge (1889: 71) states that on the Murray, the outer cortex of the bulrush root was removed and the inner part chewed. Angas (1847a: 90) claimed that he saw large numbers of heaps of the fibrous parts of the bulrush roots in the shape of pellets around the campsites. Dawson (1881: 20) notes for the western districts of Victoria, that the root of the bulrush was eaten uncooked as a salad and had a taste resembling celery. Thomas (1906: 116) records that in South Australia the bulrush root was usually eaten with mussels. The roots were sometimes taken as provisions during hunting and gathering activities as noted in the accounts of Krefft and Angas cited above.

Taplin (1859–79: 151) indicates that the Aborigines of the Lower Murray River area were often paid by settlers to collect large amounts of bulrush root. Mason, Aboriginal Protector on the Lower Murray in the 1850s, lent a boat to some Aboriginal people from the Point McLeay Mission so that they could collect 'Moomoorooke' for a storekeeper at Wellington on the Murray. Taplin on one occasion went with the Aboriginal women to collect the roots in the Point McLeay Mission whale boat; he notes that he gave them a good price for the plants (1859–79: 57). This is not the only record of Europeans using this root: Mr G.W. Batty, a long time European resident of the Victor Harbor area, remembers the bulrush also being eaten by local settlers up until the 1920s[9].

Xanthorrhoea sp. LILIACEAE

The ethnographic record of southern South Australia suggests that the roots, at least of some species of *Xanthorrhoea* –commonly called grasstree or yacca, were eaten. Schuermann, describing the plant foods of the Port Lincoln Aborigines, claimed that:

> the only root known to me as eaten in the raw state is that of the grasstree which grows in great abundance on the barren hills and plains of Port Lincoln, and is consumed by the natives in prodigious quantities at different seasons of the year (Schuermann 1879: 216).

Angas (1847a: 84) records that the roots of the smaller species of *Xanthorrhoea* (probably *X. minor* **R.Br.**) of the South East were eaten. Of the smaller species of grasstree, Angas reports that:

> They eat only the lower portion of the leaves at their junction with the root, drawing them out of the ground, and biting off that part which was underneath the soil: the flavour resembles that of a nut (Angas 1847a: 203).

According to Pate & Dixon (1982: 141), probably only the young roots would have been utilised.

Ron Bonney stated that witchetty grubs (larvae of wood-boring and root-feeding beetles and moths) could be obtained from the roots of the *Xanthorrhoea*.

Unknown species–medicine LEGUMINOSAE

Dick Koolmatrie, an Aboriginal man from Meningie, said that the root of a yellow flowered plant called 'Koorunthunta' was used as a cure for coughs and colds. The long root was boiled and then chewed to 'get the oil out'. Laura Kartinyeri says that this plant is a bush which has red and yellow flowers like that of a pea. She said that the root tasted like liquorice powder and that it was used as a medicine. Ron Bonney and Lola Cameron-Bonney say that the roots of this plant were boiled and the solution used for stomach trouble and that it is 'good iron medicine for problems with the blood'. They said that the flowers were like a yellow pea with a red-brown centre. The leaveswere said to be long. Ron Bonney claims that it was called *Koorunthunta*. However, Lola Cameron-Bonney said that her grandfather, Alfred Cameron, had called it 'Koolunthunta'. This probably reflects a difference in dialect. I previously considered this plant to be the yam daisy (*Microseris scapigera* (Sol. ex A. Cunn.) Schultz-Bip. based on a brief description given by Dick Koolmatrie (Clarke 1985a: 5). More recent fieldwork with Ron Bonney, Lola Cameron-Bonney and Laura Kartinyeri suggests that the classification of this plant is not amongst the Compositae (as is *Microseris*) but rather in the Leguminosae. The identity of this species will only be known for certain when a specimen can be obtained. Despite several attempts to find this plant with Ron Bonney and Lola Cameron-Bonney, we have not been able to do so. The lack of remaining large stands of mallee scrub in the upper Coorong area has made finding this root species (and others) difficult.

Unknown species – narcotic Family unknown

Angas (1847: 73) refers to a plant root that was obtained from the scrub and which was frequently used to cause intoxication. Cleland (1966:120) considers it to be Anthocercis myosotidea **FvM** [now known as *Cyphanthera myosotidea* (**FvM**) **Haegi**], and may have based this on a suggestion by von Meuller (1878: 222–223) that species of this genus be tested for the 'stimulating power' of pitjuri [Duboisia hopwoodii (**FvM**)**FvM**], a well known narcotic used in central Australia and closely related to *Anthocercis*. I previously considered that this narcotic was possibly the roots of *Duboisia* or *Nicotiana* (Clarke 1987: 12–13). Latz (pers. comm.), however, states that it is unlikely that the roots of these plants would have been used in preference to the leaves. Gott (pers. comm.) suggests that it may be the roots of the ming [*Santalum murrayanum* (T.L. Mitchell) C.Gardner]. Stone (1911: 445) records that the root and bark of this plant were used by the Lake Boga people of Victoria to make a stupefying drink.

Unknown species – food LEGUMINOSAE?

Sanders (1907–9: 69) records that the roots of a species of vetch, called 'Tidlars', were eaten by the Echunga people.

Unknown species – food Family unknown

Ron Bonney and Lola Cameron-Bonney state that wild onions were eaten by the Aboriginal people in the South East region. The brief description given of the appearance of this plant indicates that is not a species of *Cyperus*. Field trips to the remnant pockets of scrub in this area have not yet produced a specimen. Thus its identity remains unknown for the present.

Unknown species – food Family unknown

A species known by contemporary Aboriginal people as wild parsnip is another root that was used as food in the South East. A specimen of it is yet to be found.

Unknown species – food Family unknown

According to Lola Cameron-Bonney, the Coorong Aboriginal people ate a wild potatoes that they called 'Murunguoonl'. Ron Bonney claimed that the same plant was called 'Punmanthi' by the Moandik. Without a specimen, the identity of this plant is uncertain.

Unknown species – food Family unknown

Ron Bonney and Lola Cameron-Bonney described a type of wild carrot that not only had an edible root like a carrot but had a similar top as well. This plant grew in the sandhill areas of the South East and the Hummocks of the Coorong. Recent attempts to locate this plant for identification have failed as it now appears to be locally very rare. It is possible that the 'Wild Carrots' mentioned by Sanders (1907–9: 69) as being eaten by the Echunga people, may refer to a species of *Bulbine*, *Oxalis* or similiar plant.

The Significance of Roots

Of the food sources listed and discussed above, 17 different plants with subterranean parts were definitely used in the southern South Australian region. A further 30 were possibly used. This is some indication of the diversity of root food available in the temperate regions across southern Australia. In the south-west of Western Australia, Grey (1841: 263, 291) recorded the use of 29 types of root and there were probably others. In Victoria, Gott (1982: 60) states that 218 species were possibly used, 166 of these being orchids. Plomley (cited in Gott 1892: 60) lists 10 different root species for Tasmania although there would undoubtedly be many more. It appear from ethnographic and contemporary sources that at least some species of roots (*Microseris, Typha, Triglochin* and *Oxalis* for example) held a significant place in the diet of southern South Australian Aborigines because they were available for all or most of the year. Some roots, such as those of the *Eucalyptus*, were probably more important as drought or 'hard time' foods.

In spite of the difficulty in obtaining from the historical record quantitative data on the proportions of plant and animal foods in the Aboriginal diet, the early ethnographies provide an indication of the range of foods available. It is assumed that those foods approaching the status of staples are present in the ethnographic record. It is also clear that some of the early travellers through southern South Australia were struck by the reliance of Aborigines on certain species of roots. As noted, Angas (1847a: 89) considered the bulrush root to be 'staff of their existence'. This was based on his many sightings of Aboriginal people gathering and eating bulrush roots during his trip through southern South Australia. Another record of Aborigines collecting tubers is from Eyre. As he approached the Flinders Ranges from the south on 10 May 1839, he 'found a good many natives digging yams' (1984: 198). On 27 June 1840, as he was travelling just south of Crystal Brook, in the northern Mount Lofty Ranges, he 'came suddenly upon a small party of natives engaged in digging yams, of which the plains were full ...' (1845, 1: 42).

Eyre noted that the root called 'Belillah' (probably *Bolboschoenus medianus*) was an important food source and, which, as we have noted, was abundant on the flats of the Murray (Eyre 1845 2: 269). Eyre's interest in Aboriginal use of roots appears to be based, in part on his use of them to supplement his own food and water provisions when travelling across Australia on his expeditions (1845, 1: 370–371, 2: 56–57, 62–64, 72, 248–249).

However, not all early accounts of Aboriginal food and food-getting in southern Australia illustrate the importance of plants. Some sources have a bias towards foods resulting from male activities. This was possibly because most of the early accounts are from men. This historical record certainly documents the division of labour by gender for food production. For example, Teichelmann states that when the Adelaide people are travelling: 'The men start first, carrying nothing but a small net bag and hunting implements,- the women, burdened like camels, follow, gather & prepare on the road vegetable food for the night, whilst the men are looking out for meat' ... (Teichelmann 1841: 7).

This division was enshrined in mythology, too. Teichelmann describes how, in the Adelaide Aboriginal beliefs, 'The Pleiades are girls gathering roots and other vegetables; the Orion are boys, and are hunting' (1841: 9). Men hunted larger game that, generally, would have contributed less in quantity to the overall requirements, but which was probably more highly valued by the group.

Another factor contributing to possible bias in the ethnographic record was that events such as the spearing of emu and kangaroo may have left a more enduring impression on the memories of the recorder than those of the daily gathering of, for example, bulrush roots by the women and children. Thus the recording of hunting and gathering techniques, often written up many years after the events were observed, has tended to over-emphasize the hunting aspect and to devalue the gathering component. For example, Worsnop (1897) and Taplin (1874) have published detailed accounts of fishing and snaring for southern South Australia, which barely mention plant foods. Similarly, Bulmer states that the food of the Aborigines of the Lower Murray (New South Wales/Victorian section), Wimmera, Gippsland and Maneroo districts 'consisted chiefly of animal substances, to which were added a few vegetables and some roots, which must have been very hard of digestion' (Bulmer 1887: 15).

Early sources, such as Bulmer, did not appreciate the seasonal fluctuation of meat and vegetable foods. Some animal foods, such as fish, emu and kangaroo, may have been highly favoured foods when available. Yet vegetable foods such as roots were probably the main stay when meat was not easily obtainable. A report from the Statistical Society in 1842 gives some idea of the seasonality of Aboriginal food in the Adelaide area[10]. In spring, vegetables and grubs were mainly eaten. With the commencement of summer, the eggs and young of birds were eaten as were kangaroos, emus, fish and lizards. During the hottest part of the year, possums and *Acacia* gum were obtained, while in autumn, berries and nectar were available. In the winter, a variety of roots were consumed, as were possums and other animals. The report illustrates that roots were used as food at a time of the year when other food sources, perhaps more highly favoured, were not procurable.

Another factor distorting the views of early writers on the southern Aboriginal diet was the rapidity with which indigenous root and many other vegetable foods were replaced by European foodstuffs. Information given by Aboriginal people today on bush foods obtained in the Lower Murray area in the last 50 to 60 years, indicates far less use of roots than of other indigenous foods such as fish, water fowl, kangaroo, emu and berries. The European food obtained from farms and towns probably led to a significant decrease in consumption of less favoured vegetable foods. As stated above, the bulrush root, for example, contains a great deal of fibre. All indigenous roots used as food sources with unfavourable properties (in taste or texture or difficulty of procurement or preparation) would have been replaced by foods such as European potatoes, turnips, flour and rice. This fact must be taken into consideration when reconstructing Aboriginal plant food lists from contemporary sources.

The above reasons, as well as the lack of quantitative data on the importance of vegetable food, led scholars such as Cleland to understate the role of this component in the overall diet of Aborigines. Cleland considered plant foods in southern South Australia to be 'hardly procurable' and believed that the Aborigines were essentially meat-eaters (1966: 188–119). Gott (1982, 1983) and myself (Clarke 1985a, 1986b) have undertaken detailed historical analyses of Aboriginal plant use records combined with field work with Aboriginal people in an attempt to refute this position as it applies to southern Australia. Cleland's treatment of Aboriginal plant use in southern Australia does not reflect the diversity of plant use and relies on inadequate documentation of use. He also did not fully appreciate the amount of information on plant use that could have been gleaned from the ethnographic record and from Aboriginal informants of the period in which he conducted his research.

Passive Wanders or Active Resource Managers?

Assuming Cleland was mistaken in his view, the question, then, is how he came to his conclusion about the poor food value of the southern Australian vegetation. Cleland had a medical background and made significant scientific contributions in the areas of medicine, human biology, ethnology and botany. He published widely from the 1900s through to the 1960s in these fields. Cleland (1966) claims that the Aborigines remained hunters and gatherers primarily because the Australian continent did not have plants and animals suitable for agriculture and pastoralism. He maintains that:

> The animal and vegetable surroundings of the first comers to Australia were singularly unfavourable for the development of a pastoral or an agricultural people. In fact such knowledge as they might have possessed in regard to these matters before their arrival could have been of little or no use and must have been quickly forgotten from want of application (Cleland 1966: 113).

This statement illustrates how Cleland linked the Australian biota closely with the development (or perhaps even degeneration) of the Aboriginal mode of subsistence. It is probable that the (mistakenly) low estimates ofAustralia's Aboriginal population levels prior to colonization had a significant influence on Cleland's views concerning the carrying capacity of the southern Australian environment. For example, he argued that 'To what extent these areas [south and central Australia] were occupied depended primarily on the availability of food and water' (Cleland 1966: 126). Cleland's approach reflects the influence that the biological sciences had on his ethnographic work. Working largely with medical and biological models, Cleland treated the population levels and distribution of Aboriginal hunters and gatherers as with any other non-human organisms, and as the product of a set of environmental determinants, largely independent of the cultural dimension. However, it is now widely accepted by researchers studying hunters and gatherers, that in general, the lack of intense pressure exerted by the hunting and gathering mode of subsistence is such that food alone would not limit long term population growth (see Williams & Hunn 1982). Cleland relies on and reinforces an old view of the stereotypic hunter and gatherer as a passive food collector with little or no control over the environment.

These stereotypes have been attacked by Hallam (1975, 1986) whose description of Aboriginal land use patterns in the south-west of Western Australia, an area similar in some respects to south-eastern Australia, illustrates how the Aboriginal people living here actively managed their resources. This region had a comparatively large, semi-sedentary population living in areas close to their main food resources – for example, the swamps where bulrush roots were obtained and the 'warran' grounds where yams (*Dioscorea hastifolia* Endl.) were procured. So intensive, extensive and successful were the efforts of the hunters and gatherers in the exploitation of their resources in this area (including firing the vegetation), that it is difficult to refer to the Aborigines as passive food collectors. Similarly, in Tasmania, Hiatt (1968: 212, 219) suggests that the burning of the vegetation was used by the Aboriginal people there to convert rain forest vegetation into sclerophyll forest. Sclerophyll forest was a better food-producing environment and its encouragement by use of fire is suggested by Hiatt to be a deliberate action.

Throughout the southern South Australian region, burning of the vegetation appears to have been a common Aboriginal practice. One report from 1851 in a South Australian newspaper describes the problems the Port Lincoln land owners of the lower Eyre Peninsula had with the Aboriginal people 'burning the runs, which is [the] ...customary mode of hunting game ...'[11]. Another newspaper report from the same area in 1841 states: 'Independently of the danger which follows in the wake of a tribe of natives carrying fire-sticks through ripe grass, two or three feet high, they always set fire to scrubby places whenever a small patch is found, in order to hunt'.[12]

From the Adelaide area, another newspaper records that in 1839, an Aboriginal man named Williamy was charged with firing the grass in the park-lands. However, he was released due to lack of proof of malicious intent as it was considered by the Aboriginal people 'a necessary and laudable practice annually to burn off withered grass on their hunting-grounds to facilitate and hasten the growth of the young grass of which the native animals are so fond'.[3] Finlayson states that in the Adelaide Hills, during early February 1837: 'the natives had set fire to the long dry grass to enable them more easily to obtain the animals and vermin on which a great part of their living depends' (1902–3: 40–1). The regular burning off of the Lakes area of the Lower Murray region was apparently a sufficient threat to the local farmers for it to be reported in the Aboriginal Protector's Report of 1850. Here it was noted some land owners were offering incentives, in the form of goods, to Aboriginal people if they could get through the dry season without causing a serious bushfire[4]. These accounts and others indicate that the burning off of the vegetation in southern South Australia frequently resulted from Aborignal activity.

Although most accounts of firing are linked by observers to hunting practices, it is possible that Aboriginal people also used fire to open up the country by removing the understory to allow easier travelling and to promote the growth of grass for game species. Eyre remarked at length on the wide, open plains to the north of Adelaide. He appears to have been puzzled by them, particularly when there were remnants of large growths of timber nearby. In other places, the dense mallee type vegetation had pockets or grassy openings that to Eyre were like 'oases of the desert'. Eyre suggests that 'the plains found interspersed among the dense scrubs may probably have been occasioned by fires, purposely or accidentally lighted by the natives in their wanderings'... (1845, 1: 36). It is interesting to note that Eyre considered these grass plains to be an improvement on the dense *Eucalyptus dumosa* scrub as they provided feed for his horses and were easier to traverse. Many of the food-plant species discussed in this paper would benefit from the opening of the understory and the build-up of ash produced from regular burnings. Ellis discusses the role of fire in producing the open grasslands in the Adelaide area, stating that 'Certainly the area surrounding the present site of metropolitan Adelaide was the scene of deliberate Aborginal environmental manipulation, almost entirely dependent upon the use of fire' (1976: 113). Aboriginal people would not only have realised that they had an effect on the ability of the environment to produce food, but also appear to have actively used firing as a resource management tool.

Another important part of resource management was the replanting of tubers. This has been recorded from several parts of Australia. Gregory (1887: 131) states that the Aborigines of the west coast of Australia, 'invariably re-insert the head of the yams so as to be sure of a future crop'. Irvine (1970: 278) describes the practice in the above record as cultivation. Tindale (1977: 349) records a similar practice by the women of Flinders Island, Queensland. Batey (cited in Frankel 1982: 44) records that in Sunbury, Victoria, there existed numerous mounds which were caused by the 'accidental gardening' that occurred while gathering 'myrong' (*Microseris scapigera* as identified by Frankel), Batey suggested that Aboriginal people must have realised the effect they were having on the numbers of edible roots in the ground. Digging would have helped disperse and replant the undersized tubers for collecting in the future.

The evidence, both direct and by extension from similar environments, seems to point to Aboriginal people in southern Australia, taking much more active role in the use of their land and resources than earlier observers such as Cleland suggested.

Conclusion

Subterranean plant parts appear to have provided a varied and reliable source of food for the Aborigines of southern Australia. Certain species were also important for other hunting and gathering activities as they provided fibre for net bags and fishing nets. Other species were used as medicines, narcotics, sources of water and as pigment. Work with contemporary Aboriginal people from the Lower Murray and South East regions of South Australia is significantly increasing our knowledge of plant root usage. Although this type of information does not provide accurate quantitative use data, it can provide an indication of the value certain species could have had in the pre-European subsistence pattern. The view put forth by Cleland suggesting the insignificance of southern vegetation types in providing food is not supported by the evidence provided here. Cleland may have been restricted to his collection of data by the brief that only 'traditional' Aborigines could supply data on the uses of plants and plant-use. Data from contemporary Aboriginal sources cited in this paper suggest that this is incorrect. A fuller and more accurate view of Aboriginal use of the Australian environment may be gained by focusing on Aborigines as resource managers instead of as merely passive inhabitants of their landscape.

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Steve Hemming and myself on our field-trips. I am grateful to Robert Foster who assisted me in locating particular historical accounts. In preparing the data and ideas in this paper, I owe much to Steve Hemming. Comments on drafts of this paper were also received from Peter Sutton, Beth Gott and Peter Latz. Jenni Thurmer prepared the figure.

Endnotes

1. S.A. Museum specimen A68311. Cleland collection.

2. All references in this paper to contemporary Aboriginal descriptions and information comes from notes and tapes made on fieldtrips to the South East and the Lower Murray by Steve Hemming and myself at various times during 1986 and 1987. These are lodged in the S.A. Museum Archives.

3. S.A. Museum specimen A2084. Symes & Lewis

4. S.A. Museum specimen A1776. Advertiser Co. collection.

5. S.A. Museum specimen A1781. Source unknown.

6. S.A. Museum specimens A1778 & A27233. Thorup & Wait collection; S.A. Museum specimen A1779. Tate collection.

7. S.A. Museum specimen A1777. Phillipson collection.

8. S.A. Museum specimen A68304. Cleland collection.

9. Interview with Mr. G.W. Batty concerning early Victor Harbor history (6/11/86) S.J. Hemming & P.A. Clarke.

10. Transactions of the Statistical Society, *South Australian* 11 Jan. 1842, pp. 11–12.

11. *Observer* 31 May 1851, page 5

12. *Adelaide Chronicle and S. Aust. Literary Record* 22 Dec. 1841, page 3

13. *South Australian Gazette and Colonial Record* 9 March 1839, page 7.

14. Aboriginal Protectors Report *South Australian Gazette and Colonial Record* 20 April 1850, page 4.

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AMENDED TYPE LOCALITIES OF FIVE SPECIES OF SPIDERS (ARACHNIDA : ARANEAE) DESCRIBED BY H. R. HOGG IN 1905

BY D. HIRST

Summary

Lycosa gilberta, L. molyneuxi, L. phyllis, L. stirlingae and Dolomedes habilis were described by H.R. Hogg in 1905 from specimens sent to England from the South Australian Museum. Type specimens are lodged in the South Australian Museum, with the exception of Lycosa stirlingae, the whereabouts of which is unknown (McKay 1985). In the same work, McKay also stated the whereabouts of three female Lycosa habilis types as unknown, the generic change having been made by Rainbow (1911). Recently two of these types were located in the South Australian Museum collection and have been found to be Dolomedes.

AMENDED TYPE LOCALITIES OF FIVE SPECIES OF SPIDERS (ARACHNIDA: ARANEAE) DESCRIBED BY H. R. HOGG IN 1905

Lycosa gilberta, *L. molyneuxi*, *L. phyllis*, *L. stirlingae* and *Dolomedes habilis* were described by H. R. Hogg in 1905 from specimens sent to England from the South Australian Museum. Type specimens are lodged in the South Australian Museum, with the exception of *Lycosa stirlingae*, the whereabouts of which is unknown (McKay 1985). In the same work, McKay also stated the whereabouts of three female *Lycosa habilis* types as unknown, the generic change having been made by Rainbow (1911). Recently two of these types were located in the South Australian Museum collection and have been found to be *Dolomedes*.

The vials contain labels giving the locality as 'Gilbert River', or 'Gilbert River, Riverina', the state being omitted. Hogg, in his introduction, stated that they were 'chiefly from the north side of the River Murray in New South Wales'. This locality has not been questioned by subsequent revisers (Rainbow 1911; McKay 1975, 1985), although both authors had appeared to be in doubt over the type locality of *Lycosa gilberta*; Rainbow's being 'Australia', while McKay (1985) recorded the locality as 'Gilbert River, Riverina, S.A.', all other type localities of the species above being given as from New South Wales.

During a routine check of localities I found there was a Gilbert River near Riverton in South Australia. Knowing also that A. Molyneux, the collector of the above material, had sent specimens to the South Australian Museum from nearby Tanunda, my suspicions were aroused. From further enquiries I learnt that A. Molyneux had lived and worked in that area of South Australia. Subsequent searches of the relevant maps, the Gazetteer and enquiries to both the South Australian Geographical Names Board and the Geographical Names Board of New South Wales failed to show the existence of a Gilbert River in the Riverina of New South Wales.

It is postulated that 'Riverina' on the labels is a misspelling of Riverton. This small town is situated on the Gilbert River, a tributary of the Light River in South Australia. All type specimens referred to above are here considered to have been collected from Gilbert River, Riverton, South Australia. (34°10'S, 138°45'E).

As McKay (1975) considered the 'Gilbert River area is of special significance in the clarification of species within the "leuckartii" group', this new light on the type locality should provide for more fruitful research in the future on that group of wolf spiders.

Acknowledgments

I wish to express my thanks to Hans Mincham for information regarding A. Molyneux.

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GENERA NABIS LATREILLE AND STENONABIS REUTER (HEMIPTERA: NABIDAE) IN AUSTRALIA

BY N. G. STROMMER

Summary

Descriptions of three species of Nabis Latreille and and seven species of Stenonabis Reuter are presented. Two new species, Stenonabis henriettae sp. nov. and Stenonabis morningtoni sp. nov., are described and illustrated. A key to Nabis and Stenonabis is provided.

GENERA *NABIS* LATREILLE AND *STENONABIS* REUTER (HEMIPTERA: NABIDAE) IN AUSTRALIA

N.G. STROMMER

STROMMER, N.G. 1988. Genera *Nabis* Latreille and *Stenonabis* Reuter (Hemiptera: Nabidae) in Australia. *Rec. S. Aust. Mus.* 22(2): 79-93.

Descriptions of three species of *Nabis* Latreille and seven species of *Stenonabis* Reuter are presented. Two new species, *Stenonabis henriettae* sp. nov. and *Stenonabis morningtoni* sp. nov., are described and illustrated. A key to *Nabis* and *Stenonabis* species is provided.

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First investigations and preliminary descriptions of the Australian species of *Nabis* Latreille and *Stenonabis* Reuter were done by Dr I.M. Kerzhner (1969). His work was mainly based on the material of the South Australian Museum, Adelaide (SAMA).

Additional material for the present paper was supplied by the Queensland Museum, Brisbane (QM); Entomology Department, Queensland University, St Lucia (EUQ); Australian National Insect Collection, Canberra (ANIC); Western Australian Museum, Perth (WAM); Australian Museum, Sydney (AM); Museum and Art Galleries of the Northern Territory, Darwin (NTM); Zoological Museum der Humbold-Universität, Berlin, DDR (ZBM).

Other abbreviations of the Museums: AMNH — American Museum of Natural History, New York, USA; BMNH — British Museum Natural History; ZIN — Zoological Institute, Leningrad, USSR.

The common species *Nabis biformis* Bergroth, previously known only from New Zealand (Kerzhner 1969), is here recorded from Australia. The macropterous form of *Nabis fraternus* Kerzhner is recorded and described. The female genitalia in *Nabis biformis* Bergroth and *Nabis fraternus* Kerzhner are illustrated for the first time. Both macro- and brachypterous forms of these two species are redescribed with the use of the additional material from other Museums in Australia. *Nabis kinbergii* Reuter, previously misidentified in Australia as *Nabis capsiformis* Germar (Kerzhner 1981, Woodward 1982, Woodward & Strommer 1982) is redescribed.

Out of 11 species of *Stenonabis* known in Australia so far, 2 species are newly described, 1 species (*S. geniculatus* Erichson) is described fully in the first time, 4 other species (*S. imitator* Kerzhner, *S. roseus* Kerzhner, *S. nitidicollis* Kerzhner, *S. darwini* Kerzhner) are redescribed with the use of additional material; the remaining 3 species (*S. communis* Kerzhner, *S. robustus* Kerzhner, and *S. australicus* Kerzhner) are presented in Kerzhner (1969). New illustrations are given for the female genitalia in *Stenonabis geniculatus* Erichson, and male genitalia in *Stenonabis roseus* Kerzhner, *Stenonabis darwini* Kerzhner and *Stenonabis nitidicollis* Kerzhner. A previously unrecorded, brachypterous form of *Stenonabis nitidicollis* Kerzhner is described.

Genus Nabis Latreille, 1802

Type-species: *Cimex vagans* Fabricius, 1787 = *Cimex ferus* Linnaeus, 1758, designated by Westwood, 1840.

Body rather narrow, with sides parallel or slightly widening in middle of abdomen, especially in females. Head margins behind eyes nearly parallel; ocelli set rather wide apart. Antennae without dark rings; legs often with dark patches or short lines on femora, but without dark or black rings. Pronotum without punctation and with brown pattern on fore lobes, comprised of series of irregularly-shaped and sized brown patches. Connexivum yellowish, very rarely with dark patches, separated underneath from abdominal sternites by a groove and elevated in middle part of abdomen in a cylindrical form.

Paramere variously shaped, but most often with body of blade semicircular; aedeagus with a variable number of sclerites; vagina symmetrical or asymmetrical, with 1-2 parietal glands.

Macropterous and brachypterous forms, but hemelytra nearly always reaching end of abdomen. The genus includes subgenera *Nabis*, *Tropiconabis* and *Reduviolus*, differentiated from one another by the form of the genitalia; subgenus *Reduviolus* is not represented in tropical areas (Kerzhner 1981).

At the suggestion of Dr I.M. Kerzhner, the two Australian species of the genus *Nabis* have been placed in the new sub-genus *Australonabis*. Besides these two closely related species (*N. biformis* and

N. fraternus) discussed below, the subgenus includes *N. larvatus* Kerzhner from New Caledonia.

Key to Australian Species of *Nabis*

1 — Always macropterous. Length of fore femora less than 2.3 mm. Aedeagus with 3 sclerites. Vagina with a dorsal sack covering base of common overduct (Subg. *Tropiconabis*) .... *Nabis kinbergii* Reuter
— Mostly brachypterous. Length of fore femora 2.5-3.1 mm. Aedeagus with numerous similar sclerites in basal part and with 4 or 5 dissimilar sclerites in apical part. Vagina without dorsal sack (Subg. *Australonabis*) 2

2 — Aedeagus with 5 sclerites in apical part; vagina symmetrical, with rounded or flat base; walls of vagina without sclerotized bands .... *Nabis biformis* Bergroth
— Aedeagus with 4 sclerites in apical part. Vagina slightly asymmetrical, with cone shaped base and sclerotized bands in right wall .... *Nabis fraternus* Kerzhner

Australonabis subgen. nov.

'*Nabis biformis* Bergr.-Gruppe': Kerzhner, 1969: 346.

Type-species: *Reduviolus biformis* Bergroth, 1927.

Species with pronounced wing reduction: in most specimens of *N. biformis* and in all known specimens of *N. fraternus*, hemelytra about twice the length of scutellum, without membrane, while *N. larvatus* is apterous. Disc of paramere nearly semicircular, with pointed apex; aedeagus with a row of numerous similar sclerotized plates in basal half and some additional sclerites in apical half (4–5); vagina without sack covering its opening, with or without sclerotized bands in the wall.

Distinguished from the other subgenera by the unique sclerotized structures in the basal part of the aedeagus.

Nabis biformis (Bergroth)
(Figs 1a, b, c, d)

Reduviolus biformis Bergroth, 1927: 681.
?*Nabis lineatus* Hutton, 1904, 372 pp. (non Dahlbom, 1851).
Nabis biformis Kerzhner, 1969: 346–347, Fig. 43.

Macropterous form

Head: pale yellow with dark areas behind eyes and ocelli, pale brown longitudinal stripe between ocelli and eyes and broad dark brown median stripe beneath; clypeus brownish. Antennifers brown, antennal segments brownish yellow, segment II with brown apex; rostral segments I and II pale yellow beneath, brown dorsally, segments III and IV brownish. Eyes and ocelli reddish brown. Short shiny yellow hairs, becoming denser behind eyes and ocelli and a few longer ones dorsally; medium-sized and rather dense hairs beneath. Sides behind eyes parallel.

Thorax: pronotum yellowish with dark brown markings: broad median longitudinal stripe becoming narrower on collar and hind lobe; brown pattern on fore lobe and additional pale brown parallel stripes on each side of median one on hind lobe. Small dark dots on collar and hind lobe. Pronotum as long as head, laterally distinctly sinuate, with base about 2.5 or more times broader than apex; fore lobe slightly convex, 1.2 times longer than hind lobe, latter strongly declivous, forming an angle with fore lobe. Scutellum large, wider than long, with pointed apex, dark brown, with 2 yellow rounded patches on sides. Hemelytra reaching end of abdomen; corium and clavus covered with short pale hairs, corium with prominent yellow veins and dark clavus; membrane hyaline, transparent, with distinctive dark veins. Coxae yellowish with dark brown patches basally, both anteriorly and posteriorly; femora pale yellow with touch of pinkish tones and brown markings: 2 rows of short transverse parallel stripes (15–16) laterally and irregular row of dots dorsally; tibiae yellow with brown apices and bases. Legs covered with pale, medium-sized hairs, becoming dense ventrally and with sparse long ones laterally and dorsally; tibiae with 2 rows of dark, very small teeth ventrally.

Abdomen: brownish beneath, covered with short decumbent hairs.

Brachypterous form

Head: as in macropterous form.

Thorax: hind lobe of pronotum pale yellow with indistinct additional stripes on sides of median one; punctuation on collar and hind lobe of pronotum indistinct; pronotum a little shorter than head, at sides slightly sinuate behind middle, at base 2 or less times as broad as at apex; hind lobe not forming angle with fore lobe, 2.5 times shorter than fore lobe. Scutellum smaller than in macropterous form, a little wider than long. Hemelytra short, more than twice as long as scutellum, without membrane; outer margin of corium incurved posteriorly, apical angle somewhat distant from lateral margin of abdomen, apical margin obliquely straight, forming right angle with apical margin of outer corium.

Abdomen: brown with yellow patches on connexivum beneath or yellow with brown median stripe dorsally.

Male genitalia: parameres large, with body of blade broad and apex curved (Fig. 1a, b); aedeagus with numerous similar sclerites (plates) in basal part and with 5 dissimilar sclerites in apical part, with 2 of them dentate (Fig. in Kerzhner 1969).

Female genitalia: vagina symmetrical, with rounded or flat base; base of vagina without sclerotized bands; parietal glands asymmetrical in shape and unequal in size, with their posterior parts (loops) lying on dorsal side and anterior loops on ventral side of vagina; right gland larger, with dorsal and ventral loops of equal size, left gland much smaller, with ventral loop much larger than dorsal one (Fig. 1c, d).

Type material

Syntypic series from New Zealand, examined by Kerzhner (1969) — 1 ♀, macropterous, Henderson, Auckland, 14 Mar. 1922, ad Lizzia (Albizzia?), Myers; 1 ♀, brachypterous, Herne Bay, Auckland, 24 Feb. 1919, G. Howers; 1 ♀, brachypterous, Whangarei, 18 Feb. 1923, J.G. Myers; 1 ♀, brachypterous, N. Auckland, Peu.(?), T.R. Harris (all BMNH).

Other material examined

Tasmania: 1 ♂, brachypterous, 7 mls W. Rosebury, 18 Feb. 1963, I.F.B. Common & M.S. Upton (ANIC); 1 ♂, brachypterous, Lake Dobson Rd., 8 Feb. 1955, T.E. Woodward, bracken fern (QM); 1 ♀, macropterous, Devonport, 16 Feb. 1967, G. Monteith (QM); 1 ♀, brachypterous, Waratah, A.M. Lea, former paratype of *Nabis fraternus* Kerzhner; New South Wales: 1 ♂, brachypterous, Barrington Tops, via Salisbury, 28–30 Dec. 1965, T. Weir (QM); 1 ♀, macropterous, 1 ♀, brachypterous, Mt. Dromedary, nr Narooma, 2100 ft., 4 Feb. 1969, M.S. Upton, Taylor, Cardale (ANIC); 3 ♀, brachypterous, Pilot Hill, Bago, Forest below (?), 12 Mar. 1957 (ANIC); Australian Capital Territory: 1 ♂, brachypterous, Blundells, 31 Jan. 1970, E.F. Riek (ANIC); Victoria: 1 ♂, brachypterous, Frankston, Melb., 17 Jan. 1955, T.E. Woodward (QM); 2 ♀, brachypterous, Beech Forest, 4? 1937, R.V. Fyfe (ANIC).

Measurements

In Kerzhner (1969).

Remarks

N. biformis was described from New Zealand by Bergroth (1927) from 3 females, but he did not examine the genitalia. Kerzhner (1969) re-examined supposedly the same syntypes together with additional material from New Zealand and provided measurements both macro- and brachypterous forms and drawings of the male genitalia. The above description of the macro- and brachypterous forms together with the description of the female genitalia are prepared from material examined from various locations in Australia.

Examination of the material from Australia shows that *N. biformis* is a rather common species widely distributed in New South Wales, Australian Capital Territory, Victoria and Tasmania. The species is very similar in appearance and in most measurements to *N. fraternus* Kerzhner, and distinguished from the latter by its longer legs, antennae and rostrum, but it is very difficult to separate the two species without comparing their genitalia. The male genitalia of *N. biformis* differ from those of *N. fraternus* by the presence of 2 additional dentate sclerites in the distal part of the aedeagus, by the noticeably broader body of the blade of the paramere and its curved apex. The difference in the female genitalia is not as marked as in the male, but the vagina of *N. biformis* lacks the sclerotized bands in the right wall and has a rounded base (ovally protruding in *N. fraternus*).

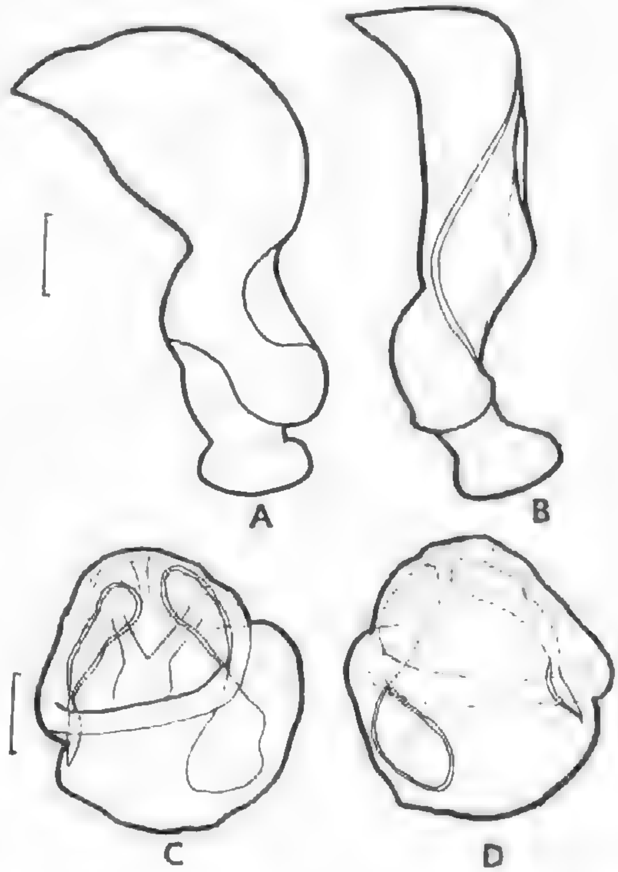

FIGURE 1. *Nabis biformis* Bergr.: a — paramere, lateral view; b — the same, from below; c — vagina, view from above; d — the same, from below.

Nabis fraternus Kerzhner
(Figs 2a, b, c, d)

Nabis fraternus Kerzhner, 1969: 347–349, Fig. 44.

Macropterous form

Head: pale yellow with brownish areas in front of and behind eyes; longitudinal median stripe pale brown between ocelli and eyes, fading toward base of clypeus; broad median stripe beneath; clypeus and antennifers dirty yellow. Antennae brownish yellow, segment II with brown apex; rostral segments I and II pale yellow ventrally, brown dorsally; segments III and IV brownish. Eyes shiny, silvery; ocelli yellow with red rim.

Thorax: pronotum dirty yellow with pale brown median longitudinal stripe becoming narrower on hind lobe and with indistinct brown pattern on fore lobe; small dark dots on collar and hind lobe. Pronotum a little longer than head, at sides distinctly sinuate behind middle, at base about 2.3 times broader than apex. Fore lobe nearly flat, 1.3 times longer than hind lobe, latter strongly declivous, forming an angle with fore lobe. Scutellum yellow with wide dark brown median stripe becoming narrow toward apex and with irregular brown areas basally and laterally. Coxae yellow with brown bases; femora pinkish yellow with brown markings: 2 rows of short transverse parallel stripes (12–13) and an irregular row of dark brown dots dorsally; tibiae yellow with brown apices, fore tibiae with 2 dark rings on basal 1/2, all tibiae with 2 longitudinal rows of small teeth ventrally. Hemelytra dirty yellow, reaching end of abdomen or little shorter; corium with prominent yellow veins and small dark dots basally and on clavus; membrane hyaline, transparent, with indistinct veins; corium and clavus covered with short decumbent hairs.

Abdomen: yellowish beneath, with brown median stripe; connexivum brownish, with pinkish tones.

Brachypterous form

Head: as in macropterous form, but with dark brown eyes and ocelli; brownish median stripe between eyes and ocelli widening toward base of clypeus.

Thorax: pronotum with dark brown median stripe not narrowing on hind lobe and less prominent punctation on collar and hind lobe; fore lobe convex, raised above collar, hind lobe not forming angle with fore lobe. Scutellum smaller than in macropterous form, a little longer than wide. Legs without pinkish tones, fore tibiae without visible rings on basal 1/2. Hemelytra very short, dirty yellow, without visible dots on base of corium and clavus, more than twice as long as scutellum; membrane absent

Abdomen: dark brown beneath, with yellow median stripe, yellowish brown dorsally, with brown median longitudinal stripe and yellow connexivum.

Male genitalia: paramere large, with relatively narrow body of blade and slightly curved apex (Figs 2a, b); aedeagus with 4 dissimilar sclerites in apical part and numerous similar plates in basal part (Fig. in Kerzhner 1969).

Female genitalia: vagina slightly asymmetrical, with cone shaped base and sclerotized bands on right wall; parietal glands asymmetrical and of unequal size; left gland much smaller, with its ventral loops larger than dorsal ones (Fig. 2c, d).

Type material

Holotype — 1 ♂, brachypterous, Tasmania, Waddamana, R. Ouse, below outlet, 20 Feb. 1936, Parker (BMNH); paratypes — 3 ♀, brachypterous, the same location (BMNH, ZIN, not examined), but the fourth paratype, ♀, brachypterous, Tasmania, Waratah, A.M. Lea (SAMA), has been examined and found to be a specimen of *Nabis biformis*.

Other material examined

New South Wales: 1 ♀, macropterous, Byron Bay, 25 Nov. 1971, N. Monroe (EUQ); Tasmania: 1 ♀, brachypterous, Miena, Great L., 17 Feb. 1955 (EUQ); 1 ♂, brachypterous, Duck Cr., nr Dee, 12 Feb. 1955, T.E. Woodward (EUQ).

Measurements

Macropterous form: head length 1.40, preocular part 0.70, postocular 0.25, length of eyes 0.45, width across eyes 0.90, interocular distance 0.40, width in front of eyes 0.45, behind eyes 0.60. Length antennal segments I 1.10, II 1.75, III 1.75, IV 1.45; length rostral segments II 1.10, III 1.0, IV 0.45. Median length of pronotum 1.50, collar 0.25, fore lobe 0.70, hind lobe 0.55; anterior width 0.70, posterior width 1.60; width of scutellum 0.90, length 0.80. Length fore femora 2.60, tibiae 2.00, mid femora 2.25, tibiae 1.85, hind femora 3.35, tibiae 3.60. Length of body 8.7 mm, width across hemelytra 1.7 mm (♀ from material examined).

Brachypterous form: in Kerzhner (1969).

Remarks

Nabis fraternus Kerzh. is a rather rare species known so far from New South Wales and Tasmania and is represented both by macro- and brachypterous forms. It is very similar to *N. biformis* and is separated most convincingly by the construction of the genitalia.

Subgenus **Tropiconabis** Kerzhner, 1968

Type-species (original designation): *Nabis capsiformis* Germar, 1938.

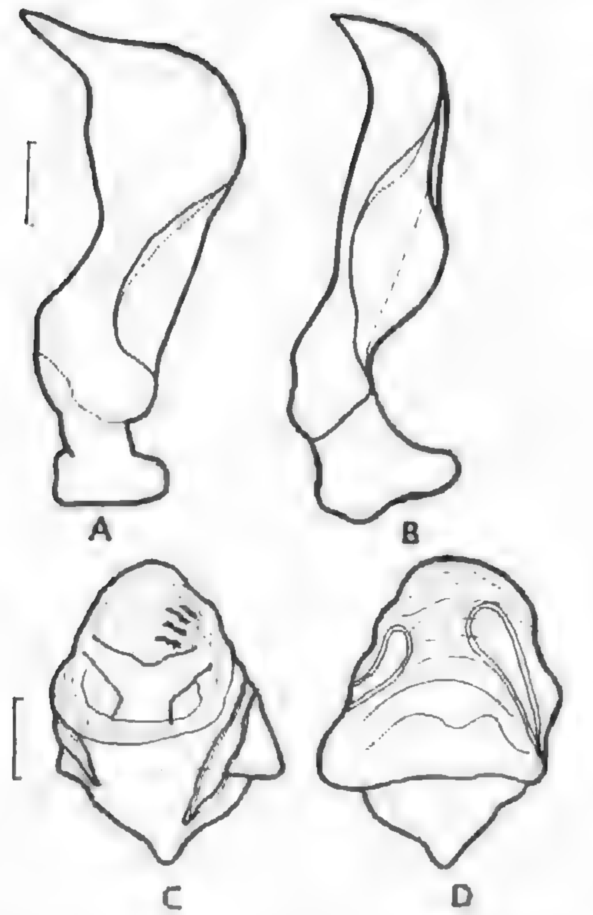

FIGURE 2. *Nabis fraternus* Kerzh.: a — paramere, lateral view; b — the same, from below; c — vagina, view from above; d — the same, from below.

Macropterous species, with wings extending well beyond end of abdomen. Paramere small, with semicircular blade; aedeagus with two larger sclerites pointing in opposite directions, and third, smaller one; vagina with oval sack covering base of common oviduct dorsally, with (*N. capsiformis*) or without (*N. kinbergii*) division on left and right parts. The subgenus is represented in tropics and subtropics and includes, besides *N. capsiformis* and *N. kinbergii*, *N. maoricus* Walker (New Zealand) and *N. consimillis* Reuter (Ecuador, Peru, Galapagos Is). In Australia there is only one species, *N. kinbergii*.

Nabis kinbergii Reuter
(Figs 3a, b, c)

Nabis kinbergii Reuter, 1872: 90 (part)
Sastrapada nigrolineata Distant, 1920: 159 (syn. with *N. kinbergii* by Kerzhner, 1981).
Nabis nigrolineata: Cheesman, 1927: 158
Nabis tasmanicus Remane, 1964: 257 (syn. with *N. nigrolineatus* by Kerzhner 1969).
Nabis nigrolineatus: Kerzhner, 1969: 354–355
Tropiconabis nigrolineatus: Kerzhner, 1968; 852; Woodward, 1982: 143–146.
Nabis (Tropiconabis) kinbergii: Kerzhner, 1981: 294–296.
Nabis capsiformis: auct, non Germar: non Woodward & Strommer, 1982: 306.

Description

Head: dull, with shiny clypeus and antennifers, yellow with dark brown areas in front of and behind eyes and with median longitudinal stripe between ocelli and eyes, broadening toward clypeus; antennifers and base of clypeus brownish. Head beneath brown greyish or greyish white, or head entirely pale yellow with darkish areas in front of and behind eyes and antennifers; pale beneath. Eyes and ocelli shiny, reddish brown, yellowish brown or silvery brown. Antennae brownish yellow or yellowish brown with segment I yellow ventrally. Rostral segment I yellow with brown base, segment II and III yellowish brown, yellow ventrally, segment IV with brown apex. Head covered with short pale hairs dorsally and on antennae and rostrum, becoming longer and denser ventrally on clypeus and rostral segment I.

Thorax: pronotum dull, yellow, dirty yellow or pale greyish yellow, with dark brown markings: brown median longitudinal stripe, becoming much narrower on collar and hind lobe, brown pattern on fore lobe and very indistinct additional pale brown stripes, two on each side of median one; where pronotum very pale, only pattern on fore lobe visible. Scutellum yellow, orange yellow or pale yellow with broad brown or darkish median stripe reaching or not reaching its apex. Pronotum longer than head, at sides slightly sinuate behind middle, at base ♂ 1.8–2.1, ♀ 2.2–2.3 times broader than at apex. Fore lobe slightly convex; hind lobe slightly raised above fore lobe. Coxae yellow or pale yellow; legs entirely yellow or brownish yellow; sometimes fore femora with row of short horizontal parallel brown stripes externo-laterally; fore and mid tibiae with 2 rows of very small brown teeth ventrally. Hemelytra translucent, sometimes transparent, dirty yellow or pale yellow to whitish, exceeding end of abdomen by up to 1/2 their length; corium with prominent yellow or pale yellow veins, these sometimes with irregular brown markings; clavus brownish, dirty yellow or pale yellow with brown apex, with short decumbent hairs; membrane with brownish veins. Ventrally thorax yellow with dark brown meso- and meta-sternum and with dark brown longitudinal stripe on mesopleura becoming much narrower on metapleura; sometimes entirely pale yellow, without brown markings or with very pale ones.

Abdomen: yellowish brown with yellow connexivum and median stripe, or sometimes entirely pale yellow with or without median stripe, covered with small decumbent hairs.

Male genitalia: paramere with inner margin angularly incised at junction of shank and blade, apex of blade curved (Fig. 3a); aedeagus with 3 sclerites, one of them large, next to very small one, pointing in same direction, third sclerite of medium size, pointing in opposite direction to other two (Fig. 3b).

Female genitalia: vagina entirely membranous, thin-walled, without division into right and left lobes (in contrast to *N. capsiformis*, Fig. 3c).

Type material

Lectotype of *kinbergii* (designated by Kerzhner, 1981) 1 ♀, 'Sydney', Kinberg, Naturhistoriska Riksmuseet, Stockholm; Holotype of *nigrolineata*, ♀, Central New Caledonia, 17.XI.1914, P.D. Montague (BMNH); Holotype of *tasmanicus*, ♂, Tasmania, King I., Lea, Zool. Mus., Helsinki University, paratypes from Bismarck Is, Australia and Fiji (the same Museum) and in Dr R. Remane's collection (Mahrburg/Lahn, BRD).

Other material examined

Northern Territory: 1 ♂, Magela Cr.; Queensland: 1 ♂, Lake Idamea, Glenormiston St, 1 ♀, Normanton, 1 ♂, Mornington, 1 ♀, Cunnamulla; New South Wales: 1 ♀, Upper Williams R.; South Australia: 1 ♂, 1 ♀, L. Eyre, 1 ♂, 1 ♀, Wirreanda Cr., 1 ♂, nr Victory Well, Everard Pk., 1 ♂, Athelstone, 1 ♂, 1 ♀, Mt. Lofty, 1 ♀, Coward Spring, 1 ♂, Jirry's Well; Fiji: 1 ♀; New Hebrides (now Vanuatu), 1 ♂, 1 ♀ (specimens from various collections in Australia).

Measurements

Head length ♂ 1.00–1.05, ♀ 1.05–1.10, preocular part ♂, ♀ 0.50–0.55, postocular part ♂ 0.15–0.20, ♀ 0.20, length of eyes ♂ 0.30–0.35, ♀ 0.35; width across eyes ♂ 0.70–0.80, ♀ 0.75–0.80, interocular distance ♂ 0.35–0.37, ♀ 0.35–0.40, width in front of eyes ♂ 0.40, ♀ 0.40–0.45, behind eyes ♂ 0.50–0.55, ♀ 0.55, width of eyes ♂ 0.17–0.20, ♀ 0.22. Length antennal segments I ♂ 1.05–1.20, ♀ 0.90–1.05, II ♂ 1.60–1.80, ♀ 1.45–1.80, III ♂ 1.65–1.70, ♀ 1.50–1.60, IV ♂ 0.90–1.00, ♀ 0.90. Length rostral segments II ♂ 0.85, ♀ 1.00, III ♂ 0.85, ♀ 1.00, IV ♂ 0.40, ♀ 0.40–0.45. Median length of pronotum ♂ 1.10–1.35, ♀ 1.30–1.40, collar ♂, ♀ 0.20, fore lobe ♂ 0.50, ♀ 0.50–0.55, hind lobe ♂ 0.45–0.60, ♀ 0.60–0.65; anterior width ♂, ♀ 0.70, posterior width ♂ 1.30–1.50, ♀ 1.55–1.60. Length of scutellum ♂ 0.55, ♀ 0.60, width ♂ 0.65–0.70, ♀ 0.75. Length fore femora ♂ 2.10–2.15, ♀ 2.00–2.05, tibiae ♂ 1.60–1.75, ♀ 1.70–1.75; mid femora ♂ 1.85, ♀ 1.75–2.10, tibiae ♂ 1.75, ♀ 1.80; hind femora ♂ 2.75, ♀ 2.80–3.10, tibiae ♂ 3.40–3.50, ♀ 3.25–3.55. Length of body ♂ 7.0–8.7 mm, ♀ 8.5–9.7 mm; width across hemelytra ♂ 1.4–1.75, ♀ 1.6 mm (examined material).

Remarks

In Australia, New Zealand and some islands in the Western Pacific, *N. kinbergii* replaces another widespread and very similar species *N. capsiformis* Germar (Kerzhner 1968, 1969, 1981), with which it had been confused in Australia for years (Woodward 1982, Woodward & Strommer 1982). Detailed examination of the male and female genitalia of large numbers of specimens (all previously referred to *N. capsiformis*) from different regions of Australia, undertaken by Dr Kerzhner, Dr T.E. Woodward and by the present author, convince us that *N. kinbergii* is one of the most common and widespread species of *Nabidae* in all parts of Australia, including Tasmania.

The species was first recognized as distinct from *N. capsiformis* by Remane (1964), who described it as *N. tasmanicus*. Later it was found that *Sastrapada nigrolineatus* Distant from New Caledonia is not a junior synonym of *N. capsiformis*, but a senior synonym of *N. tasmanicus*. However, an earlier name *N. kinbergii* Reuter, based on a female from Sydney and two females from Buenos-Aires, had been synonymized with *N. capsiformis* until Kerzhner (1981) designated the specimen from Sydney as lectotype, thus making *N. nigrolineata* a synonym of *N. kinbergii*; however, the females from Buenos-Aires belong to *N. capsiformis*.

N. kinbergii is very similar in appearance and in most measurements to *N. capsiformis*. Comparison of *N. kinbergii* with the description given by Kerzhner (1981) of *N. capsiformis* shows no significant differences. However, there are obvious differences in the male and female genitalia, best seen in a comparison of the aedeagi which have quantitative differences: the absence of the small hook (sclerite) in *N. capsiformis*; the parameres in *N. capsiformis* are concavely and more shallowly excavated than in *N. kinbergii*. The vagina in *N. capsiformis* is distinctly divided into smaller, thick-walled right lobe and much larger membranous left lobe, while in *N. kinbergii* the vagina consists only of the thin-walled lobe (Remane 1964, Woodward 1982).

Genus **Stenonabis** Reuter, 1980

Type-species (original designation): *Coriscus annulicornis* Reuter, 1882.

Body more or less elongated. Head behind eyes with approximately parallel sides. Ocelli set wide

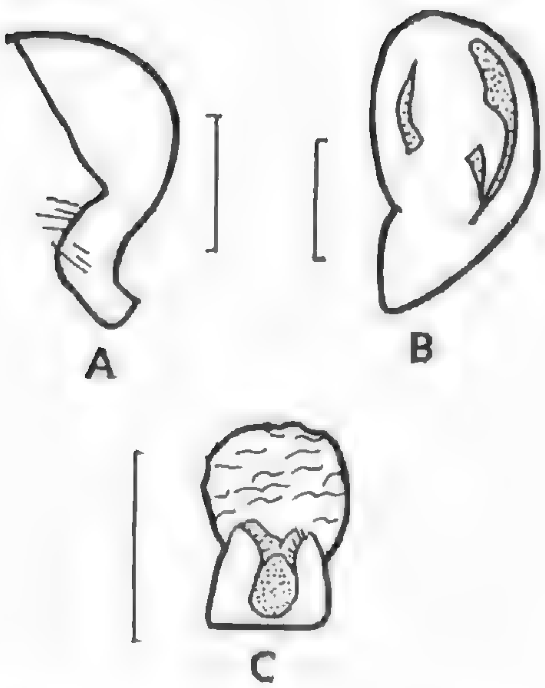

FIGURE 3. *Nabis kinbergii* Reut.: a — paramere; b — aedeagus; c — vagina.

Antennae and legs long, often with dark rings. Collar and hind lobe of pronotum with prominent punctuation; fore lobe with characteristic pattern of brown patches. Connexivum seen from below not separated from abdominal segments by impression or groove; often with dark patches.

Parameres of diverse shape, often with complex outlines; aedeagus with various set of sclerites in shape of hooks, plane or dentate plates, etc. Vagina of various shape, more often asymmetrical, with two parietal glands.

Majority of species macropterous, some represented both by macro- and brachypterous forms; hemelytra sometimes considerably reduced.

The genus is widely distributed in Australia, except for the western regions.

KEY TO THE AUSTRALIAN SPECIES OF *STENONABIS*

1 — Dark median longitudinal stripe on hind lobe of pronotum more or less widening toward base; hind femora dark apically 2
— Dark median longitudinal stripe on hind lobe of pronotum usually not widening toward base; if so widening (*S. roseus*), all femora not dark apically 3

2 — Outer vein of corium (R+M) and cubital vein (Cu), at least distally, pink or pinkish or hemelytra short; total length of body 6.0-7.6 mm . ... *nitidicollis* Kerzhner
— Veins of corium without pink tones; macropterous; total length of body 7.75-9.60 mm .. .. *darwini* Kerzhner

3 — All femora yellowish, without dark tones 4
— Hind or mid femora dark or black 5

4 — Narrow and long, with yellow or yellowish pink body and outer vein of corium bright pink or pink, at least distally; macropterous; total length of body 9.5-10.1 mm, width across hemelytra 1.95-2.15 mm .... *roseus* Kerzhner
— Broader, with derty yellow body and veins of corium without pink tones; macropterous or brachypterous; total length of body 8.0-9.4 mm, width across hemelytra 2.0-2.9 mm .... *robustus* Kerzhner

5 — Dark median longitudinal stripe on pronotum uniformly wide for its whole length 6
— Dark median longitudinal stripe wider on collar and fore lobe and noticeably narrower on hind lobe of pronotum 7

6 — Pronotum with additional stripes on each side of median stripe, very indistinct on hind lobe of pronotum; brachypterous; total length of body 7.0-7.1 mm .... *geniculatus* Erichson
— Pronotum with additional stripes on each side of median stripe, distinct on hind lobe of pronotum; macropterous; total length of body (♂) 8.0 mm .... *morningtoni* sp. nov.

7 — Whole body, including head and clypeus, dull; total length 7.5-7.9 mm .... *australicus* Kerzhner
— Body not entirely dull 8

8 — Hind lobe of pronotum more shiny than fore lobe; extreme lateral stripe on hind lobe broad, unbroken; one of two others, closest to median stripe, reduced to small patch at base of pronotum; total length of body 6.7-7.3 mm ... . *communis* Kerzhner
— Hind and fore lobes of pronotum equally shiny, the rest of body dull, all three additional stripes on each side of hind lobe noticeable, but nearly always broken 9

9 — At least radio-medial vein (R+M) of corium distally pink or pinkish; eyes reddish brown; blade of paramere relatively narrow, with a large hook; vagina asymmetrical; total length of body 7.0-8.6 mm .... *imitator* Kerzhner
— Radio-medial vein of corium without pink or pinkish tones; eyes pinkish brown; blade of paramere broad, with relatively small hook; vagina symmetrical; total length of body 7.75-8.25 mm .... *henriettae* sp. nov.

Stenonabis henriettae sp. nov.
(Figs 4a, b, c, d, e, f)

Description

Head: slightly shiny except very shiny vertex, clypeus and median stripe on collar; pale yellow, with pale brown stripe between eyes dorsally, widening toward base of clypeus, eyes and ocelli reddish brown, clypeus and antennifers brownish; head beneath dirty yellow. Antennal segments I and II, except brown apex, dirty yellow, segments III and IV yellowish brown. Rostral segments yellowish brown dorsally and yellow ventrally. A few hairs dorsally, shorter sparse hairs ventrally and very short dense ones behind eyes dorsally.

Thorax: pronotum yellow, with pale brown median stripe, becoming narrower on hind lobe; two additional parallel brownish stripes on collar laterally and brownish pattern on fore lobe; three brownish broken parallel stripes on both sides of median one on hind lobe.

Collar and hind lobe of pronotum with distinct punctation; collar with shallow transverse impression in middle; demarcation between fore and hind lobes distinct; anterior margin of pronotum slightly concave, posterior margin nearly straight, lateral margins shallowly concave between lobes, fore lobe slightly raised above collar; hind lobe slightly raised above fore lobe; fore lobe 1.2–1.5 times shorter than hind lobe. Scutellum dull, dirty yellow with dark brown median stripe not reaching apex and with shallow impression in middle. Legs brownish yellow. Coxae and trochanters stramineous; fore and mid femora pale yellow dorsally, brownish with irregular yellow patches ventrally; hind femora stramineous except brown distal one-fifth; all tibiae brownish yellow, brown distally. Hemelytra brownish with yellow veins and yellow areas between them, with brown apex; clavus with two rows of indistinct punctures along basal half of claval suture; membrane yellow, translucent, with brown veins and without closed cells (rarely with 1 or 2); hemelytra surpassing apex of abdomen. Ventrally thorax brownish, meso- and metapleura with dark brown stripe laterally, meron and metepisternum yellow.

Abdomen: yellow beneath with brown median and lateral longitudinal stripes on each side of median one; genital segment brown, with long light hairs. Abdomen in females dull, in males very shiny, covered with short yellow hairs.

Male genitalia: paramere of medium size, with wide blade, prominent hook laterally and small tooth on top of blade (Figs 4a, b, c); aedeagus large, with number of differently shaped sclerites (Fig. 4d).

Female genitalia: Vagina small, symmetrical, thin-walled, with light transverse wrinkles and large parietal glands (Figs 4e, f).

Type material

Holotype — 1 ♂, North Queensland, Henrietta Cr., Palmerston Nat. Park, 23 Jan. 1970, G.B. Monteith (QM); Paratypes — 3 ♀, same data as for holotype (QM).

Other material examined

North Queensland: 1 ♂, 1 ♀, Iron Range, Cape York Pen., 26 May–2 June 1971, B.K. Cantrell; 1 ♂, Iron Range, Middle Claudie R., 19–20 Oct. 1974, M.S. Moulds; 1 ♂, Iron Range, 16–23 Nov. 1965, G. Monteith; 1 ♂, Dividing Range, Cape York Pen., 15 km W. of Captain Billy Cr., 142°45′ E., 11°40′ S., 4–9 July 1975, G. Monteith (all specimens QM).

Measurements

Head length ♂ 1.05–1.10, ♀ 1.05–1.25, preocular part ♂ 0.55–0.60, ♀ 0.55–0.70, postocular part ♂ 0.15, ♀ 0.10–0.15, length of eyes ♂ 0.35, ♀ 0.35–0.40; width across eyes ♂ 0.85, ♀ 0.80–0.85, interocular distance ♂ 0.35, ♀ 0.30–0.35, width in front of eyes ♂, ♀ 0.40–0.45, width of eyes ♂, ♀ 0.25, width behind eyes ♂, ♀ 0.60–0.65; length antennal segments I ♂ 1.10, ♀ 1.05–1.35, II ♂ 1.50, ♀ 1.35–1.50, III ♀ 1.60–1.85 (♂ missing), IV ♀ 1.55–1.60. Length rostral segments II ♂ 1.05, ♀ 1.10–1.20, III ♂, ♀ 0.95–1.05, IV ♂, ♀ 0.50. Median length of pronotum ♂ 1.50–1.70, ♀ 1.60–1.70, fore lobe ♂ 0.55, ♀ 0.55–0.65, hind lobe ♂ 0.65–0.85, ♀ 0.75–0.85, collar ♂ 0.25–0.30, ♀ 0.30; anterior width ♂ 0.70, ♀ 0.75–0.85, posterior width ♂ 1.55, ♀ 1.70–1.90. Scutellum length ♂ 0.55–0.70, ♀ 0.65–0.70, basal width ♂ 0.75, ♀ 0.80–0.85, commissure ♂ 0.95–1.00, ♀ 0.95–1.15. Length fore femora ♂ 2.50–2.55, ♀ 2.30–2.65, tibiae ♂ 2.25–2.55, ♀ 1.75–2.35, mid femora ♂ 2.30–2.45, ♀ 2.15–2.50, tibiae ♂ 2.05–2.30, ♀ 2.00–2.95, hind femora ♂ 3.00–3.30, ♀ 3.00–3.50, tibiae ♂ 3.50–3.75, ♀ 3.25–4.00. Length of body ♂ 7.75–8.10 mm, ♀ 8.00–8.75 mm; width across hemelytra ♂ 1.60 mm, ♀ 1.75–2.05 mm (type material).

Remarks

S. henriettae is found so far only in Queensland. It is very close in appearance and body measurements to *S. communis* and *S. imitator*; from the former it differs by the less shiny hind lobe of pronotum, from the latter by the absence of the pink tones of the veins of the corium. The difference between the male and female genitalia of *S. henriettae* and these two species is very obvious: the presence of the hook on the top of the blade of the paramere (lacking in *S. communis* and *S. imitator*) and the asymmetrical vagina and parietal glands (symmetrical in these two species).

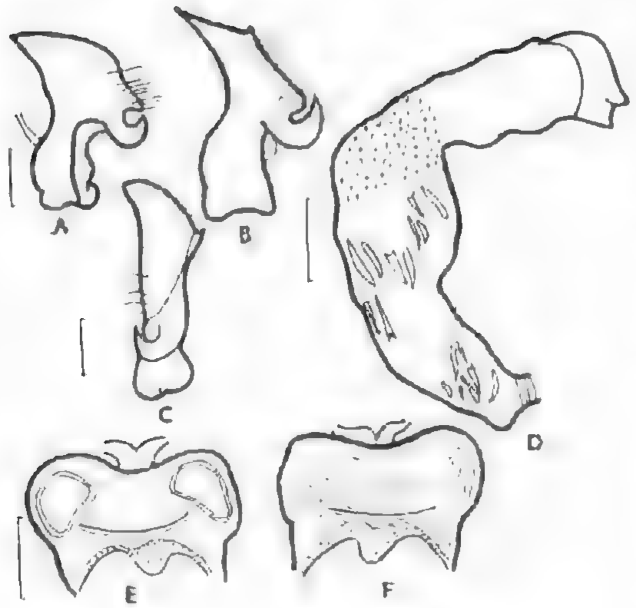

FIGURE 4. *Stenonabis henriettae* sp. nov.: a, b, c — paramere, various positions; d — aedeagus; e — vagina, view from above; f — the same, front below.

Stenonabis imitator Kerzhner
(Figs 5a, b, c, d, e)

Stenonabis imitator Kerzhner, 1969: 310–312, Fig. 17.

Description

Head, collar and pronotum slightly shiny, hemelytra and scutellum dull, sometimes whole body except clypeus dull.

Head: dirty yellow with darkish clypeus; sometimes areas in front of and behind eyes and longitudinal stripe between eyes brownish yellow with brown clypeus; head beneath yellow to brownish yellow, sometimes whitish. Eyes and ocelli reddish brown or brown; antennifers brown, antennae and rostrum yellow or dirty yellow, antennal segment II brown apically.

Thorax: pronotum yellow or dirty yellow with median longitudinal stripe becoming very narrow and sometimes indistinct on hind lobe; collar yellow with median and two additional lateral stripes, sometimes indistinct; fore lobe with pale brown or brown, sometimes very indistinct, pattern; hind lobe with additional stripes on each side of median one: broad curved lateral and two narrower, broken, indistinct stripes between lateral and median. Collar with shallow punctures, those on hind lobe of pronotum deeper and denser; fore lobe raised above collar, hind lobe raised above front lobes basally; anterior and posterior margins of pronotum nearly straight; lateral margins slightly concave; fore lobe separated from hind by shallow impression. Scutellum yellow to dirty yellow with dark brown diffused median longitudinal stripe. Coxae yellow to dirty yellow, trochanters yellow; femora yellow to dirty yellow; hind (sometimes also mid) femora brown apically; tibiae yellow to dirty yellow, brown apically. Hemelytra yellow to dirty yellow; veins of corium and claval suture yellow with brownish lateral margins; R + M vein of corium pink or pinkish distally; apex of corium brown; membrane opaque, yellow or brownish yellow, with straight brown veins. Ventrally thorax yellow or brownish yellow; sometimes meso- and metasternum brownish; pleura yellow with broad median stripe, sometimes meso- and metapleura brownish yellow or dark brown.

Abdomen: yellow or brownish yellow ventrally with brown narrow median longitudinal stripe and broader lateral stripes on each side of median; sometimes all stripes fused together, diffused or indistinct, in this case whole abdomen becoming brownish yellow; sometimes median stripe and two lateral very indistinct, in this case whole abdomen appears brownish; connexivum dirty yellow or brownish.

Male and female genitalia: in Kerzhner (1969).

Type material

Holotype — 1 ♂, Queensland, Cairns District, A.M. Lea (SAMA); Paratypes — 4 ♂, 2 ♀ same data as for holotype (SAMA, ZIN, examined except for material from ZIN).

Other material examined

North Queensland: 1 ♂, Mossman, 25 March 1967, M.S. Upton (ANIC); 1 ♂, 1 ♀, The Boulders, via Babinda, 15 Dec. 1966, B. Cantrell (EUQ); 1 ♂, Innisfail, at light, 16 May 1954, P. Kennedy (EUQ); Northern Territory: 1 ♂, 1 km SE of Batchelor, at light, 12 Apr. 1966, N. McFarland (SAMA).

Measurements

In Kerzhner (1969).

Remarks

S. imitator is very similar in appearance and body measurements to *S. communis* and *S. henriettae*, but differs very clearly in the male and female genitalia; it also differs from these species in the pink tones of R + M vein of the corium (*S. henriettae*), in the less shiny hind lobe of the pronotum (*S. communis*).

Stenonabis geniculatus (Erichson)
(Figs 6a, b)

Nabis geniculatus Erichson, 1842: 282.
Reduviolus (Stenonabis) geniculatus: Reuter, 1908: 108.
Stenonabis geniculatus: Kerzhner, 1969: 300.

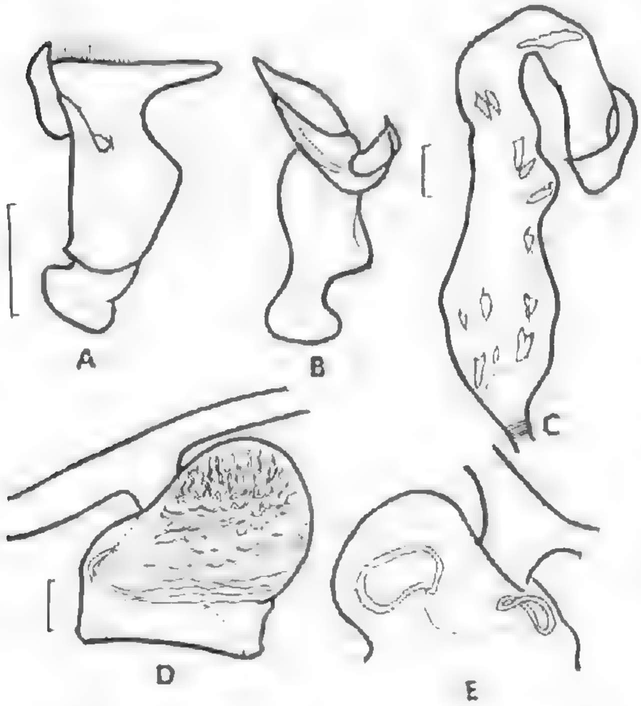

FIGURE 5. *Stenonabis imitator* Kerzh.; a — paramere, lateral view; b — the same, from below; c — aedeagus; d — vagina, view from above; e — the same, from below (Kerzhner 1969).

Description

Head, pronotum and abdomen shiny, hemelytra and scutellum dull.

Head: brown, whitish beneath; clypeus and juga smooth and more shiny than rest of head; head dorsally with two dark brown parallel lines between eyes, diverging toward clypeus; eyes and ocelli large, reddish brown. Antennal segments I and II yellow, II brown apically (segments III and IV missing). Rostral segment I yellowish brown, segment II brownish yellow, III and IV pale brown.

Thorax: pronotum yellowish brown with wide median longitudinal stripe; additional stripes on hind lobe of pronotum rudimentary, represented by two dark brown patches at base on each side of median stripe. Collar and hind lobe of pronotum with coarse punctures; demarcation between fore and hind lobe indistinct; anterior and posterior margins of pronotum slightly concave; lateral margins shallowly concave between lobes; fore lobe arched and raised above collar, hind lobe flat, short. Scutellum with wide black median stripe reaching apex and dirty yellow sides and with transverse impression basally. Coxae dark brown, hind ones yellow basally; trochanters brownish yellow; fore femora dark dorsally and yellowish brown ventrally, with elongated yellow, irregularly shaped patch on lateral surface distally and with yellow areas on ventral surface distally; mid femora yellowish brown, dark brown apically, with two small yellow patches on inner surface, third basal patch indistinct; hind femora brownish yellow with about distal 1/4 dark brown; fore tibiae dirty yellow, mid and hind tibiae yellow, dark brown apically. Fore femora stout, slightly swollen in basal half, mid femora with distal half thicker than basal one, hind femora thin. Coxae covered with short decumbent hairs, becoming longer and denser on femora, especially on ventral surface. Hemelytra very short, cover first visible tergite laterally, their apical margins straight, oblique, directed toward apex of scutellum, with a few very short hairs; membrane extremely short, hardly noticeable.

Abdomen: yellowish brown, with dark brown median longitudinal stripe dorsally; lateral margins and end of abdomen ventrally brownish yellow. Short decumbent yellow hairs ventrally, smooth and hairless dorsally, except for hairy lateral margins.

Male genitalia: unknown.

Female genitalia: vagina asymmetrical, very wrinkled above and beneath, with pointed rounded apex; parietal glands large, nearly symmetrical, visible from above (Fig. 6a, b).

Type material

Holotype — 1 ♀, brachypterous, Tasmania, Schayer (ZBM, examined).

Other material examined

Tasmania: 1 ♀, brachypterous, Cynthia Bay, Lake St Clair, 7-8 Feb, 1967, G. Monteith (QM). Males unknown.

Measurements

Head length 1.10-1.15, preocular part 0.55-0.60, postocular 0.10, length of eyes 0.45; width across eyes 1.00-1.05, interocular distance 0.45, width in front of eyes 0.50-0.55, width of eyes 0.25, width behind eyes 0.75. Length antennal segments I 0.70-0.75, II 1.00-1.15, III 1.20, (IV segment missing); length rostral segments II 1.00, III 1.00, IV 0.50. Median length of pronotum 1.55, fore lobe 0.75-0.80, collar 0.20-0.30; anterior width 0.95; posterior width 1.70-1.75; length of scutellum 0.55, width 0.60. Length fore femora 1.80-1.85, width 0.50, tibiae 1.75; mid femora 2.00, width 0.40-0.45, tibiae 1.70-1.75; hind femora 2.50, tibiae 2.75. Length of body 7.0-7.1 mm, width across abdomen 2.7-2.8 mm (holotype and another ♀ from Tasmania).

Remarks

S. geniculatus is a rare species; the specimen examined differs from the type by the general dark brown colour of the body and appendages (brownish yellow in the type), by the presence of two parallel dark brown lines between the eyes dorsally (lacking in the type) and by the evenly brown colour of the abdomen (yellow with a brown median longitudinal stripe in the type); the size and proportions of the body in the two specimens are very close. The species differs from the other Australian species by the markings of the pronotum and the structure of the female genitalia.

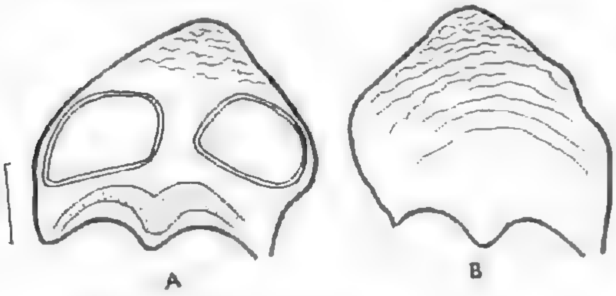

FIGURE 6. *Stenonabis geniculatus* Erich.: a — vagina, view from above; b — the same, from below.

Stenonabis roseus Kerzhner
(Figs 7a, b, c)

Stenonabis roseus Kerzhner, 1969: 306–307, Fig. 14.

Description

Light-coloured species: head and hind lobe of pronotum very shiny, collar and fore lobes less shiny, hemelytra and scutellum dull. Main colour pinkish yellow to dirty pink. Head, antennae, rostrum, legs and hemelytra pale, without any dark markings.

Head: Pinkish yellow with pinkish clypeus and brownish red eyes; antennifers darkish; antennal segment I pinkish yellow, other segments, as well as rostral ones, dirty yellow.

Thorax: Collar and fore lobe of pronotum pinkish yellow, hind lobe yellow; collar, pronotum and scutellum with light brown, rather narrow median stripe, sometimes widening at base of pronotum; fore lobe with light brown pattern; hind lobe with 2 or 3 additional broken pale brown stripes on each side of median one, sometimes without any visible additional stripes. Collar with dense punctures; pronotum with fore and hind lobes separated by shallow impression; anterior and posterior margins of pronotum slightly curved, lateral margins shallowly concave between lobes; hind lobe gradually raised toward hind margin; punctures on hind lobe coarser and deeper anteriorly, becoming finer and shallower posteriorly. Scutellum with yellow sides. Coxae and trochanters stramineous; fore femora pinkish yellow with about proximal 1/5 stramineous; mid and hind femora dirty yellow with about proximal 1/2 stramineous; all tibiae dirty yellow. Hemelytra pinkish yellow, well surpassing apex of abdomen, clavus and membrane basally dirty yellow, clavus with two rows of indistinct punctures alongside basal 1/2 of claval suture; all veins of corium or at least Cu vein pinkish or pink; membrane with brown veins. Ventrally thorax yellow with brown lateral stripe on each side.

Abdomen: shiny, brownish yellow beneath, except segments I–IV which are stramineous, with broken brown longitudinal stripes laterally, covered with extremely short decumbent hairs; connexivum brownish with yellow oval patch on each segment; genital segment pale brown.

Male genitalia: parameres large, with pointed apical process of blade and double hook ventro-laterally (Fig. 7a, b); aedeagus with few plane sclerites (Fig. 7c).

Female genitalia: in Kerzhner (1969).

Type material

Holotype — 1 ♀, Queensland, Cairns District, A.M. Lea (SAMA); Paratypes — 2 ♀, the same data (SAMA, ZIN; examined except for material from ZIN).

Other material examined

Queensland: 1 ♂ (head and pronotum missing), West Normandy R., 40 mi? of Cooktown, 5 May 1970, G. Monteith (QM); 1 ♀, Kuranda, 28 Dec. 1963, G. Monteith (QM).

Measurements

In Kerzhner (1969). Length of body 9.50–10.0 mm, width across hemelytra 2.10–2.15 mm (type material).

Remarks

S. roseus is known so far only from North Queensland and is distinguished from other species by its large and light pinkish body and appendages, by the markings of the pronotum and the structure of the male and female genitalia.

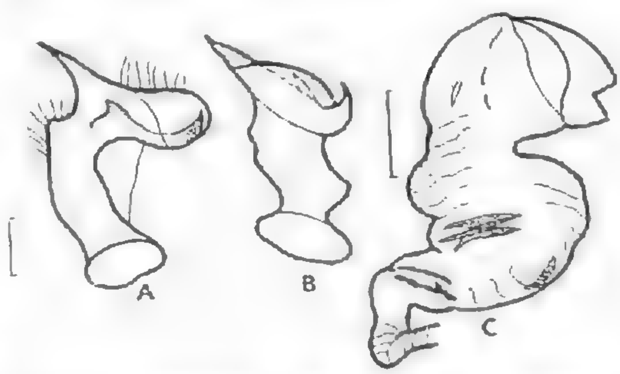

FIGURE 7. *Stenonabis roseus* Kerzh.: a, b — paramere, various positions; c — aedeagus.

Stenonabis nitidicollis Kerzhner
(Figs 8a, b, c, d)

Stenonabis nitidicollis Kerzhner, 1969: 307–308, Fig. 15.

Macropterous form

Head: brownish yellow, shiny, appearing whitish beneath; areas around eyes pale yellow; two dark brown parallel longitudinal lines restricting brownish areas between eyes; eyes and ocelli reddish brown. Antennae and rostrum yellow to dirty yellow, antennal segment II with dark brown ring at about distal 1/5. Short yellow hairs distally, white pubescence and longer sparse hairs ventrally; sides behind eyes nearly straight.

Thorax: pronotum shiny yellow with narrow brown median stripe, more or less widening at posterior margin of very shiny hind lobe; additional brown stripe on collar on each side; fore lobe with brown pattern; hind lobe with curved brown stripe on each side of median one, sometimes widening at posterior margin. Collar and hind lobe of pronotum with sparse, fine punctures; anterior and posterior margins of pronotum nearly straight, lateral impression between lobes shallow, demarcation between lobes indistinct medially; fore lobe slightly raised above collar, hind lobe raised toward posterior margin. Scutellum slightly shiny with wide black median stripe reaching apex. Legs brownish yellow to pale yellow, coxae pale yellow to dirty yellow with fore coxae brownish anteriorly; fore and mid femora brownish yellow, pale on inner surface and with short brown transverse stripes on outer surface; hind femora brownish yellow with brown ring near distal 1/5; all tibiae pale yellow with brownish ring apically. Hemelytra slightly shiny brownish yellow; commissure and veins of corium yellow with brownish rim along both sides, R+M and Cu veins of corium red for about posterior 1/2 and on border with membrane between veins thus forming triangular cell; space between veins yellow to dirty yellow; membrane hyaline, yellow, with brownish straight veins. Hemelytra reaching end of abdomen; covered with short yellow hairs basally and for 3/4 length laterally. Ventrally thorax yellow, metasternum with dark brown patch medially, pleura yellow with dark brown, nearly black longitudinal stripe on each side.

Abdomen: yellow beneath, with brown median longitudinal stripe and another one on each side of median; connexivum yellow with pinkish narrow external edge and small pinkish spots on each segment.

Brachypterous form

Head: dorsally dark brown, appearing whitish beneath; rostral segments I and II dirty yellow (segments III and IV and antennae missing).

Thorax: pronotum shiny, with coarse punctures on collar and hind lobe; anterior margin of pronotum slightly concave, posterior margin curved; demarcation between lobes indistinct; hind lobe not raised above fore lobe; pronotum shorter than in macropterous forms. Black median stripe on scutellum not reaching apex; scutellum with truncate apex, wider than long. Hemelytra dirty yellow, with indistinct veins, very short, covering first visible tergite laterally, apical margin straight, oblique, directed toward apex of scutellum, with few short hairs; membrane absent.

Abdomen: shiny, covered with short decumbent silvery hairs.

Male genitalia: paramere of medium size and distinct shape, with oblique tooth on top of blade and hook laterally (Fig. 8a, b, c); aedeagus small, with numbers of sclerites (Fig. 8d).

Female genitalia: in Kerzhner (1969).

Type material

Holotype — 1 ♀, New South Wales, Engadine (?) (difficult to read label), 6 Dec. 1958 (AMNH, not examined).

Other material examined

Queensland: 1 ♂, macropterous, Bald Mt. area, 3000′–4000′ via Emu Vale, 26–30 (month omitted) 1975, G. Monteith (QM); 1 ♂, macropterous, Crater Nat. Park, Atherton Tbld., 25 Apr. 1970 (QM); 1 ♀, macropterous, Brisbane, 5 Oct. 1962, E.A. Bernays (QM); 1 ♂, brachypterous, Upper Brookfield, 14 Apr. 1962, T.E. Woodward (QM).

Measurements

Macropterous form: head length ♂ 1.00, ♀ 1.05, preocular part ♂ 0.50, ♀ 0.55, postocular ♂ 0.10, ♀ 0.15, length of eyes ♂, ♀ 0.35; width across eyes ♂ 0.80–0.85, ♀ 0.85, interocular distance ♂ 0.35–0.40, ♀ 0.35, width in front of eyes ♂ 0.35–0.40, ♀ 0.45, behind eyes ♂ 0.55–0.60, ♀ 0.60. Length antennal segments I ♂ 0.85–0.95, ♀ 0.90, II ♂, ♀ 1.25, III ♂ 1.40, ♀ 1.50, IV ♂, ♀ 1.50. Length rostral segments II ♂ 0.95–1.00, ♀ 1.00, III ♂ 0.80–0.95, ♀ 0.95, IV ♂, ♀ 0.50. Median length of pronotum ♂ 1.40–1.50, ♀ 1.60; collar ♂, ♀ 0.25, fore lobe ♂ 1.0, ♀ 1.4 times shorter than hind lobe: ♂ 0.55–0.60, ♀ 0.55 and ♂ 0.60–0.65, ♀ 0.80 respectively; anterior width ♂ 0.65–0.70, ♀ 0.70, posterior width ♂ 1.60–1.70, ♀ 1.75. Scutellum length ♂ 0.60–0.65, ♀ 0.90, width ♂ 0.75, ♀ 1.00. Length fore femora ♂ 1.95–2.10, ♀ 2.00, tibiae ♂ 1.60–1.85, ♀ 1.80, mid femora ♂, ♀ 2.00, tibiae ♂ 1.60–1.85, ♀ 1.75, hind femora ♂ 2.50–2.75, ♀ 2.50, tibiae ♂ 2.75–3.25, ♀ 3.00. Total length of body: ♂ 6.0–7.5 mm, ♀ 7.6 mm; width across hemelytra ♂ 1.5–1.7, ♀ 1.7 mm (material examined).

Brachypterous form: head length (♂) 1.00, preocular part 0.51, postocular part 0.15, length of eyes 0.37, width behind eyes 0.15; antennae missing. Length rostral segment II 1.00 (III and IV missing). Median length of pronotum 1.25, collar 0.20; hind lobe very short, 1.3 times shorter than fore lobe

(0.45 and 0.60 respectively); anterior width of pronotum 0.75, posterior 1.50; scutellum length 0.60, width 0.75. Length fore femora 2.10, tibiae 1.85, mid femora 2.00, tibiae 1.75, hind femora 2.75, tibiae 3.25. Length of body (♂) 6.75, width across hemelytra 1.65 mm (examined material).

Remarks

S. nitidicollis differs from other species by its small size, by the kind of markings of the pronotum and by the structure of the male and female genitalia.

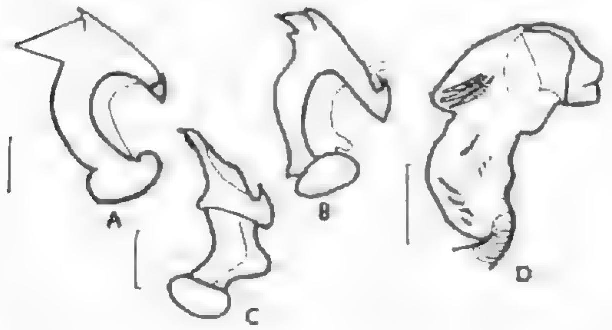

FIGURE 8. *Stenonabis nitidicollis* Kerzh.: a, b, c — paramere, various positions; d — aedeagus.

Stenonabis darwini Kerzhner
(Figs 9a, b, c)

Stenonabis darwini Kerzhner, 1969: 304–306, Fig. 13.

Description

Upper side of body slightly shiny, scutellum dull.

Head: brown; areas near eyes dirty yellow dorsally, with 2 dark brown lines, parallel between eyes and diverging before base of clypeus. Eyes and ocelli reddish brown; antennifers and antennal segments brownish yellow, segment II dark distally; rostral segments dirty yellow, segment IV dark distally.

Thorax: collar and pronotum dirty yellow, with dark brown markings: median longitudinal stripe, narrower on hind lobe distally and widening again basally, and 1 or 2 additional stripes on each side of median one so that all 5 stripes parallel and more prominent posteriorly; fore lobe with brown pattern. Collar and hind lobe of pronotum with fine punctures; anterior and posterior margins of pronotum straight, lateral margins shallowly concave between lobes. Scutellum dark brown, nearly black, with 2 small yellow patches laterally. Coxae and trochanters brownish yellow; fore femora yellow on inner and brownish on outer surface, mid femora brownish yellow on about proximal half and dark brown distally, hind femora with about proximal 2/3 yellow and about distal 1/3 brown; all tibiae yellow with dark brown apices. Hemelytra almost reaching apex of abdomen; clavus, corium and membrane yellow; corium with yellow, membrane with brown veins; membrane hyaline, with or without closed cells and with 9 or 10 veins at posterior margin. Ventrally thorax dark brown.

Abdomen: brownish yellow, with small yellow spot on each segment of connexivum, covered with short silver hairs, genital segment with long pale ones.

Male genitalia: parameres small, with tooth on top of blade medially and large hook laterally (Fig. 9a, b); aedeagus small, with 6 sclerites (2 dentate and 4 plane) in basal half (Fig. 9c).

Female genitalia: in Kerzhner (1969).

Type material

Holotype — 1 ♀, Darwin, G.F. Hill (SAMA) (examined).

Other material examined

Northern Territory: 1 ♂, 1 ♀, 5 km NW of Cahills Crossing, East Alligator River, 28 May 1973, M.S. Upton (ANIC); Queensland: 1 ♂, Lockerbie Area, Cape York, 13–27 Apr. 1973, G. Monteith (QM).

Measurements

Head length ♂ 1.05–1.35, ♀ 1.20–1.35, preocular part ♂ 0.55–0.75, ♀ 0.64–0.75, postocular part ♂ 0.15–0.20, ♀ 0.14–0.20, length of eyes ♂ 0.35–0.40, ♀ 0.40–0.43; width across eyes ♂ 0.80–0.95, ♀ 0.83–0.95, interocular distance ♂, ♀ 0.30–0.40, width in front of eyes ♂ 0.45–0.50, ♀ 0.44–0.50, behind eyes ♂ 0.60–0.65, ♀ 0.60–0.70. Length antennal segments I ♂ 1.30–1.50, ♀ 1.36–1.75, II ♂ 2.00–2.10, ♀ 2.10–2.35, III ♂ 2.45, ♀ 2.10–2.35, IV missing. Length rostral segments II ♂ 0.85–1.10, ♀ 0.86–1.10, III ♂ 0.95–1.00, ♀ 0.79–1.00, IV ♂ 0.50–0.55, ♀ 0.36–0.55. Median length of pronotum ♂ 1.45–1.70, ♀ 1.50–1.80, fore lobe ♂ 0.65, ♀ 0.60–0.70, collar ♂ 0.25–0.30, ♀ 0.30–0.35, anterior width ♂ 0.60–0.75, ♀ 0.70–0.80, posterior width ♂ 1.45–1.65, ♀ 1.50–1.75. Median length of scutellum ♂ 0.75, ♀ 0.70–0.75, basal width ♂ 0.70–0.80, ♀ 0.70–0.75. Length fore femora ♂ 2.45–2.50, ♀ 2.65–3.30, tibiae ♂ 2.25–2.50, ♀ 2.35–2.75, mid femora ♂ 2.25–2.75, ♀ 2.35–2.75, tibiae ♂ 2.25–2.50, ♀ 2.25–2.65, hind femora ♂ 3.40–4.00, ♀ 3.65–4.50, tibiae ♂ 3.70–4.25, ♀ 3.60–4.65. Length of body ♂ 7.75–9.00 mm, ♀ 8.80–9.60 mm, width across hemelytra ♂ 1.30–1.75 mm, ♀ 1.50–1.80 mm (material examined).

Remarks

S. darwini is known so far from the Northern Territory and Queensland and is distinguished from other Australian species by the narrow body, dark coloration, proportions and markings of the pronotum and the structure of the male and female genitalia.

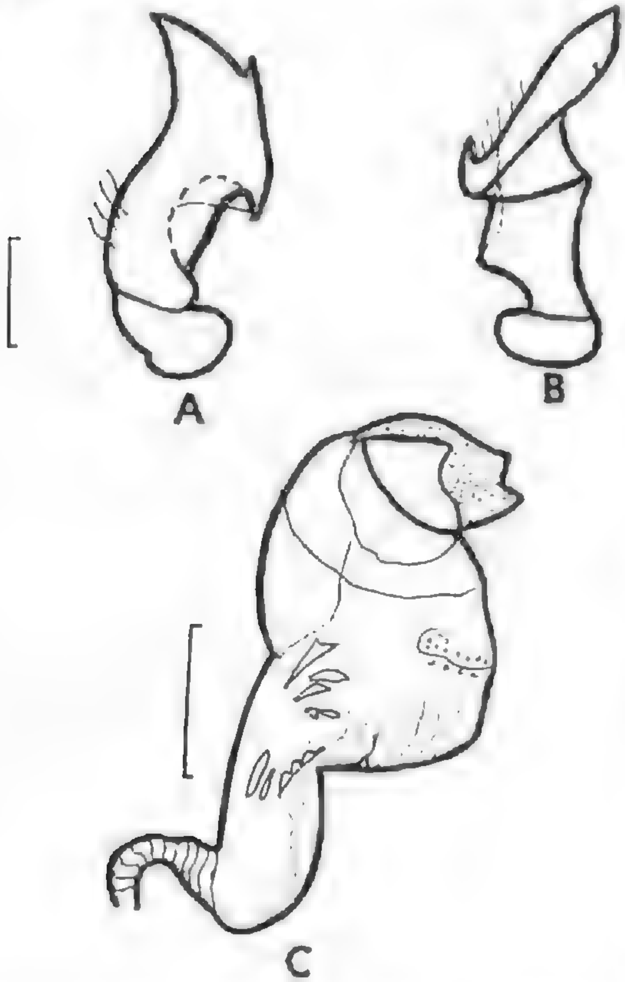

FIGURE 9. *Stenonabis darwini* Kerzh.; a — paramere, lateral view; b — the same, from below; c — aedeagus.

Stenonabis morningtoni sp. nov.
(Figs 10a, b, c, d)

Description

Head dorsally, pronotum and abdomen shiny, scutellum, hemelytra and thorax dull.

Head: dark brown dorsally except for dirty yellow areas around eyes; appears whitish beneath. Antennal segments I and II brown (III and IV missing); rostral segments yellow except for brown I one; antennal segment II with brownish distal fifth. Short silver hairs ventrally and on areas around eyes dorsally and a few long fine hairs on each side laterally. Ocelli large, shiny, nearly touching posterior margin of head, with anterior margins in front of level of posterior margins of eyes.

Thorax: pronotum yellow with wide brown median longitudinal stripe; collar brownish ventrally, with narrow brown additional stripe on each side of median one laterally; fore lobe with brown pattern; hind lobe with 2 parallel brownish stripes laterally on each side of median one, one of them, nearest to median, broken and indistinct. Collar with very fine and hind lobe of pronotum with coarse punctures; fore lobe raised above collar rather steeply, hind lobe raised above fore lobe gradually toward base of pronotum; demarcation between lobes indistinct; anterior margin of fore lobe slightly convex, posterior margin of hind lobe nearly straight; lateral margins of pronotum shallowly concave, nearly straight between fore and hind lobes; fore lobe 1.15 times longer than hind lobe. Scutellum yellow with broad black median longitudinal stripe reaching its apex and with basal impression and pointed apex. Thorax beneath yellowish brown with yellow metasternum and dark brown meso- and metapleura. Legs brownish yellow, coxae and trochanters yellow, fore coxae brown anteriorly; fore femora dirty yellow on inner lateral surface and much darker outside dorsally and ventrally; mid and hind femora dirty yellow, pale yellow basally, brown apically, with indistinct pale brown ring medially; all tibiae brownish yellow. Hemelytra brownish yellow with indistinct veins, corium covered with two rows of punctures alongside basal 1/2 of claval suture; membrane greyish yellow, translucent, with 3 closed cells; hemelytra surpassing apex of abdomen.

Abdomen: brown beneath, with yellowish brown basal area and dirty yellow connexivum; abdomen covered with short dense silver hairs; small shiny areas free of hairs on II basal segment of connexivum.

Male genitalia: parameres large, with wide blade and 3 hooks on it, big hook ventro-laterally with pointed apex and 2 smaller ones dorsally, one of these at base of blade and another on top of blade medially (Fig. 10a, b, c); aedeagus of medium size, with 6 rather big sclerites (3 plane and 3 with forked end, Fig. 10d).

Type material

Holotype — 1 ♂, macropterous, Qld, Mornington Cr. (? not clear writing), J. Mission, 15 May 1963, N.B. Tindale and P. Aitken (SAMA). Females unknown.

Measurements

Head length 1.15, preocular part 0.60, postocular part 0.15, length of eyes 0.40; width across eyes 0.85, interocular distance 0.30, width in front of eyes 0.45, behind eyes 0.55. Length antennal segments I 0.85, II 1.25; length rostral segments II 0.80, III 0.95, IV 0.30. Median length of pronotum 1.70, collar 0.30, fore lobe 0.75, hind lobe 0.65; anterior width 0.85, posterior width 1.80. Scutellum length 0.85, width 1.00. Length fore femora 2.00, tibiae 1.55, mid

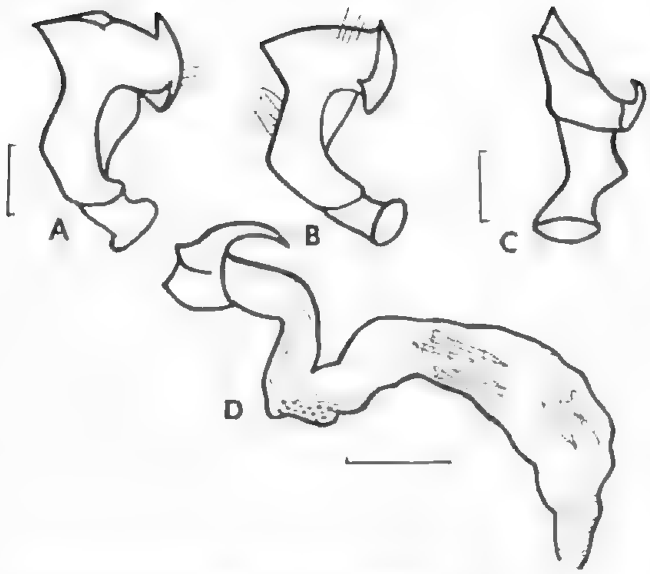

FIGURE 10. *Stenonabis morningtoni* sp. nov.: a, b, c — paramere, various positions; d — aedeagus.

femora 1.90, tibiae 1.75, hind femora 2.60, tibiae 2.80. Length of body 8.0 mm, width across hemelytra 2.2 mm (holotype).

Remarks

The species is known only from type locality in Queensland. It is close in appearance to other *Stenonabis* species, but is clearly distinguished by the kind of markings of the pronotum and by the distinct shape of the male genitalia.

Acknowledgments

This study was supported and the facilities provided by the Museum of Victoria, for which special thanks are due to Dr A. Neboiss and Mr K. Walker. For the loan of the material, the author is grateful to the Museums listed in the Introduction. Particularly appreciated was the help of the late Dr T.E. Woodward and Dr I.M. Kerzhner, of the Zoological Institute, Academy of Science, USSR, in the preparation of this paper. (Dr Kerzhner helped especially with the drawings of the female genitalia in *Nabis fraternus* and *Nabis biformis*, as well as the 'Remarks' to *Nabis kinbergii*).

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APPENDICULAR OSTEOLOGICAL DIFFERENCES BETWEEN LASIORHINUS LATIFRONS (OWEN, 1845) AND VOMBATUS URSINUS (SHAW, 1800) (MARSUPILIA : VOMBATIDAE)

BY G. G. SCOTT & K. C. RICHARDSON

Summary

Brachial, antebrachial and carpal bones from the hairy-nosed wombat (Lasiorhinus latifrons) and common wombat (Vombatus ursinus) are, with the exception of the first and second carpal bones, all distinguishable. Likewise the pelvis, femur, tibia, fibula and epipubic bones from the hairy-nosed wombat (L. latifrons) and common wombat (V. ursinus) all have specific characteristic differences. To facilitate rapid specimen identification at the generic level, the different gross morphological features are summarised.

APPENDICULAR OSTEOLOGICAL DIFFERENCES BETWEEN *LASIORHINUS LATIFRONS* (OWEN, 1845) AND *VOMBATUS URSINUS* (SHAW, 1800) (MARSUPIALIA: VOMBATIDAE)

G.G. SCOTT & K.C. RICHARDSON

SCOTT, G.G. & RICHARDSON, K.C. 1988. Appendicular osteological differences between *Lasiorhinus latifrons* (Owen, 1845) and *Vombatus ursinus* (Shaw, 1800) (Marsupialia: Vombatidae). *Rec. S. Aust. Mus.* 22(2): 95–102.

Brachial, antebrachial and carpal bones from the hairy-nosed wombat *(Lasiorhinus latifrons)* and common wombat *(Vombatus ursinus)* are, with the exception of the first and second carpal bones, all distinguishable. Likewise the pelvis, femur, tibia, fibula and epipubic bones from the hairy-nosed wombat *(L. latifrons)* and common wombat *(V. ursinus)* all have specific characteristic differences. To facilitate rapid specimen identification at the generic level, the different gross morphological features are summarised.

A number of consistently different features between specimens of the two genera have been recognised during this study. In the forelimb the scapula has a large process present on its caudal angle in *L. latifrons*, but only a tubercle is present in *V. ursinus*. The scapula spine is narrow in *L. latifrons*, and broad in *V. ursinus*. The coracoid process groove which accommodates the bicipital tendon is wide in *L. latifrons*, but narrow in *V. ursinus*. The scapula articular tuberosity is vestigial in *L. latifrons*, but well developed in *V. ursinus*. A deep triangular fossa is adjacent to the scapula infra-articular tuberosity in *L. latifrons*, but absent in *V. ursinus*. The clavicular shaft has a convex medial surface in *L. latifrons*, but this is sharp and sickle-shaped in *V. ursinus*. A large ridge on the laterodorsal surface of the shaft in *L. latifrons* is vestigial in *V. ursinus*. The sternoclavicular surface is roughened with a deep fossa in *L. latifrons*, but roughened having a fossa confluent with a deep groove in *V. ursinus*. The acromioclavicular articular surface has a large tubercle in *L. latifrons*, which is vestigial in *V. ursinus*. The clavicular breadth, diameter of the humeral head, and the width of the humeral shaft are all significantly different.

Many previously unrecorded, consistent differences were found in the hindlimb. The pelvic iliac crest is directed laterally and forms a right angle with body of ilium in *L. latifrons*, but is 'sickle-shaped' in *V. ursinus*. Its lateral extremity is expanded in *L. latifrons*, but pointed in *V. ursinus*. The iliopectineal eminence is a large process in *L. latifrons*, but a small tubercle in *V. ursinus*. The pelvic ischiatic tuberosity is narrow, approximately 20 mm, in *L. latifrons*, but wide, approximately 40 mm, in *V. ursinus*. Epipubic bones are quite distinct, with the articular surface broad and elongate in *L. latifrons*, but narrow in *V. ursinus*. Its proximal ventral surface is deeply concave in *L. latifrons*, but flat in *V. ursinus*. The femur has few distinguishing features; the greater trochanter is deeply grooved in *L. latifrons*, but is only a tuberosity in *V. ursinus*. On the tibia the medial intercondylar eminence is long craniocaudally in *L. latifrons*, but pointed in *V. ursinus*. The articular surface for the lateral condyle of the femur is circular in *L. latifrons*, but elongate in *V. ursinus*. Other than a number of trivial differences in the fibula the only reliable, readily recognisable difference is that the medial and caudal borders of its plantar surface are rounded in *L. latifrons*, but square in *V. ursinus*. The pelvic length and breadth, femur length and fibular length are all significantly different.

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Individual bones, particularly small ones such as the carpals, tarsals and phalanges, are commonly found once decomposition, disarticulation and weathering all play their part on the body of a dead animal. These bones, commonly scattered over the terrain, may be found individually, sometimes a few together, and occasionally large numbers in a protected site or archaeological digging. Whatever the case, the identification of these bones is often difficult. In some instances species identification may be biased by modern perceptions of zoogeographic boundaries.

This study collates the scanty information previously published on osteology of the wombat forelimb (Owen 1838, Murie 1867, De Vis 1892, Scott 1915) as well as that of the hindlimb (Owen 1838, Murie 1867, De Vis 1892). It describes the diagnostic features of bones of the forelimb and hindlimb of the hairy-nosed wombat *(Lasiorhinus latifrons)* and of the common wombat *(Vombatus ursinus)* which separate the extant genera.

Materials and Methods

Specimens

Bones of the forelimb and hindlimb of *L. latifrons* and *V. ursinus* were examined in the collections of the Australian Museum, Sydney; British Museum (Natural History), London; Museum of Victoria, Melbourne; Queensland Museum, Brisbane; South Australian Museum, Adelaide; and

Western Australian Museum, Perth. For this study additional specimens of *L. latifrons* were collected at Blanchetown, Roonka and Swan Reach in South Australia; and of *V. ursinus* over the Great Dividing Range and adjacent regions.

Measurements

The morphology of individual bones of the forelimb was examined and any distinguishing features noted. Adult and juvenile specimens were examined, but only bones from adults were compared for diagnostic purposes. Linear measurements were made with vernier calipers on adult specimens.

Forelimb Measurements

1. Scapula
   (i) breadth, measured from the cranial angle to the caudal angle.
   (ii) length, measured from the supraglenoid tubercle to the cranial angle.
2. Clavicle
   (i) length, measured from the clavicle–acromion articular surface to the clavicle–sternum articular surface.
   (ii) breadth, measured at the point of maximum constriction of the shaft proximal to the clavicle–sternum articular surface.
3. Humerus
   (i) length, measured from the proximal surface of the head to the distal surface of the capitulum.
   (ii) head diameter, measured lateromedially.
   (iii) deltoid tuberosity, maximum height above the shaft.
   (iv) articulating condyles, width measured from the lateral surface of the lateral epicondyle to the medial surface of the medial epicondyle.
   (v) shaft width, minimum measurement proximal to the deltoid tuberosity, but distal to the greater tubercle.
4. Ulna
   (i) length, measured from the proximal olecranon to the distal surface of the styloid process.
5. Radius
   (i) length, measured from the proximal surface of the head to the distal surface of the styloid process.

Hindlimb Measurements

1. Pelvis
   (i) length, from the proximal surface of the iliac crest to the distal surface of the ischial tuberosity.
   (ii) breadth, from the medial surface of the iliac tuberosity to the lateral surface of the iliac process.
2. Femur
   (i) length, from the proximal surface of the head to the distal surface of the medial condyle.
   (ii) shaft diameter, midway along the shaft.
3. Tibia
   (i) length, from the proximal surface of the intercondylar eminence to the distal surface of the medial malleolus.
   (ii) shaft diameter, midway along the shaft.
4. Fibula
   (i) length, from the proximal surface of the lateral condyle to the distal surface of the lateral malleolus.
   (ii) shaft diameter, midway along the shaft.

The bones of the distal forelimb and hindlimb were examined only for morphological differences. Osteological terminology used is as in the 'Nomina Anatomica Veterinaria' (Habel *et al.* 1983).

Analysis

Where appropriate Student's t-test, 2-'sided', and bivariate analysis (Simpson *et al.* 1960) was used. Bivariate regression analysis of specimens of known sex shows no significant sexual dimorphism for any of the characters examined, so measurements of both sexes were combined.

RESULTS

Measurements

For most features measured there was an overlap in the range of measurements between *V. ursinus* and *L. latifrons*. However, clavicle breadth, humerus shaft width, the lateromedial diameter of the humeral head, pelvis breadth and femur length were all significantly larger ($P < 0.001$) in *V. ursinus*. Pelvis length ($P < 0.01$) and fibula length ($P < 0.05$) were also larger in *V. ursinus*. Forelimb measurements for both genera are given in Table 1. Hindlimb measurements for both genera are given in Table 2.

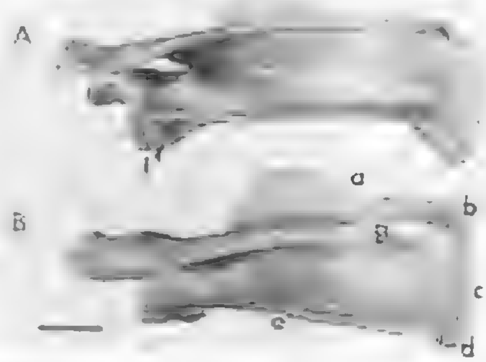

FIGURE 1. Dorsal view of the left scapula in (A) *L. latifrons* and (B) *V. ursinus*. Where a, cranial border; b, cranial angle; c, vertebral border; d, caudal angle; e, caudal border; f, arrowed, infra-articular tuberosity; g, spine. Scale line is 2 cm.

Morphology

The following morphological features were found to be diagnostically different for the two genera:

Scapula

	L. latifrons	*V. ursinus*
Caudal angle	large process	small tubercle
Dorsal spine	about 3 mm wide	about 6 mm wide
Coracoid process	deep and widely grooved, no fossa	narrow groove, large fossa present
Infra-articular tuberosity	(i) vestigial	well-developed
	(ii) deep triangular fossa present	no fossa, only roughened surface

Clavicle

	L. latifrons	*V. ursinus*
Shaft		
(i) Medial surface	convex	sharp and sickle-shaped
(ii) Laterodorsal surface	large ridge	vestigial
Sternal articular surface	deep fossa present	fossa confluent with a deep groove
Scapula articular surface	large tubercle present	vestigial

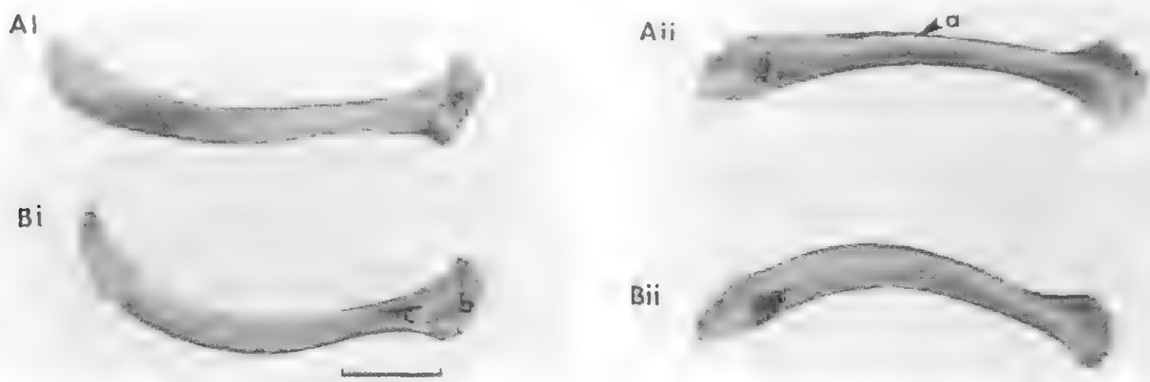

FIGURE 2. Right clavicle in (A) *L. latifrons* and (B) *V. ursinus*. (i) is a dorsolateral view, (ii) is a medial view. a, arrowed, large ridge; b, fossa; c, groove. Scale line is 2 cm.

TABLE 1. Forelimb measurements (mm) for *L. latifrons* and *V. ursinus*.

	L. latifrons			*V. ursinus*		
	n	mean	sd	n	mean	sd
Scapula breadth	6	49.0	7.58	21	53.6	3.13
Scapula length	6	119.6	7.41	19	122.5	4.09
Clavicle length	4	81.5	3.03	14	83.9	4.74
Clavicle breadth	5	6.3	0.70	14	7.3	0.59***
Humerus length	7	108.1	7.89	29	121.7	3.82
Humerus diameter	7	26.9	2.23	28	29.8	1.35**
Humerus deltoid tuberosity height	13	27.2	2.00	29	27.2	1.43
Humerus articular condyle width	9	50.6	3.55	25	54.5	1.97
Humerus shaft width	19	13.1	1.19	29	14.6	0.85***
Ulna length	4	141.9	10.90	13	154.2	6.95*
Radius length	4	109.8	6.41	10	115.7	4.97

* $P < 0.05$, ** $P < 0.01$, *** $P < 0.001$

TABLE 2. Hindlimb measurements (mm) for *L. latifrons* and *V. ursinus*.

	L. latifrons			*V. ursinus*		
	n	mean	sd	n	mean	sd
Pelvis length	3	184.5	20.54	17	206.9	8.16**
Pelvis breadth	5	56.7	3.65	14	71.6	4.28***
Femur length	3	141.2	1.33	25	156.3	5.76***
Femur shaft diameter	3	14.5	0.63	27	15.1	0.81
Tibia length	3	116.1	7.13	14	122.8	5.20
Tibia shaft diameter	5	8.5	0.65	15	9.0	0.76
Fibula length	4	110.7	0.38	10	116.8	4.73*
Fibula breadth	6	7.0	0.44	9	6.9	0.60

* $P < 0.05$, ** $P < 0.01$, *** $P < 0.001$

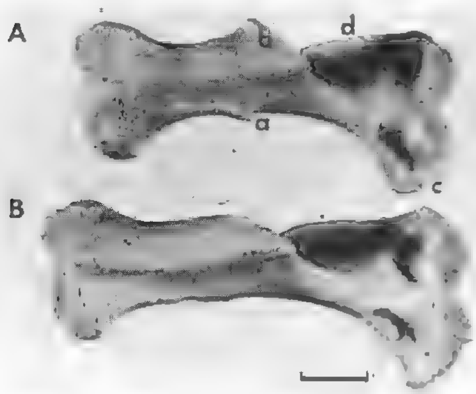

FIGURE 3. Cranial view of the left humerus in (A) *L. latifrons* and (B) *V. ursinus*. Where a, teres tuberosity; b, deltoid tuberosity; c, medial epicondyle; d, lateral epicondyloid crest. Scale line is 2 cm.

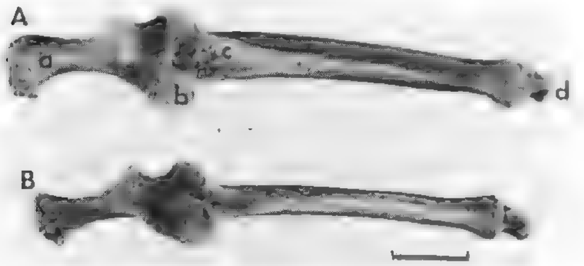

FIGURE 4. Lateral view of the left ulna in (A) *V. ursinus* and (B) *L. latifrons*. Where a, olecranon; b, arrowed, coronoid process; c, arrowed, pit for the radial tuberosity; d, styloid process. Scale line is 2 cm.

Humerus

	L. latifrons	*V. ursinus*
Deltoid tuberosity	acutely angled ridge	shallow angled ridge
Teres tuberosity	small	elongate
Lateral epicondyloid crest	straight caudal border	shallowly convex proximally, concave distally

Ulna

	L. latifrons	*V. ursinus*
Anconeal process		
(i) cranioproximal surface	ridge	large process
(ii) viewed laterally	cranial surface parallel to caudal surface	sickle-shaped
Coronoid process	elongated	circular
Shaft		
(i) Depression for radial tuberosity	shallow	larger circular pit
(ii) Lateral surface	flat proximally, and concave distally	concave

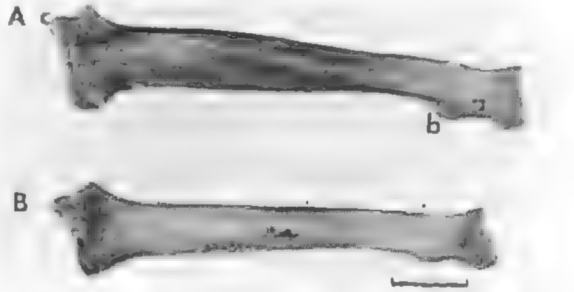

FIGURE 5. Craniomedial view of the left radius in (A) *V. ursinus* and (B) *L. latifrons*. Where a, neck; b, radial tuberosity; c, arrowed, styloid process. Scale line is 2 cm.

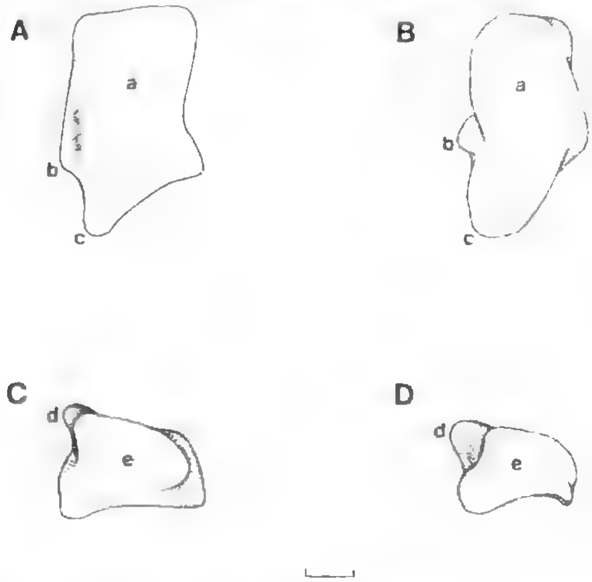

FIGURE 6. Proximal view of left radial carpal bone in (A) *L. latifrons* and (B) *V. ursinus*. Where a, radial surface; b, palmar tuberosity; c, medial tubercle. Proximal view of right ulnar carpal bone in (C) *L. latifrons* and (D) *V. ursinus*. Where d, palmar tuberosity; e, ulnar surface. Scale line is 5 mm.

Radius

	L. latifrons	*V. ursinus*
Neck	shallow concavity proximal to radial tuberosity	deeply concave
Shaft		
Lateral surface	flat	deep oblique depression

Distal forelimb
Radial carpal bone:

	L. latifrons	*V. ursinus*
Palmar tuberosity	small	large
Medial tubercle	small and tapered	massive and blunt

Ulnar carpal bone:

	L. latifrons	*V. ursinus*
Ulnar articular facet	small and oval	large, concave and semi-circular
Accessory carpal articular facet	small	circular with pronounced lateral tubercle
Palmar facet elongate for 3rd and 4th carpal bones		circular

Accessory carpal bone:

	L. latifrons	*V. ursinus*
Ulnar carpal articular facet	lateral border short and square	lateral border elongate
Medial proximal tubercle	small	pronounced
Shaft	broad and flat	constricted in middle

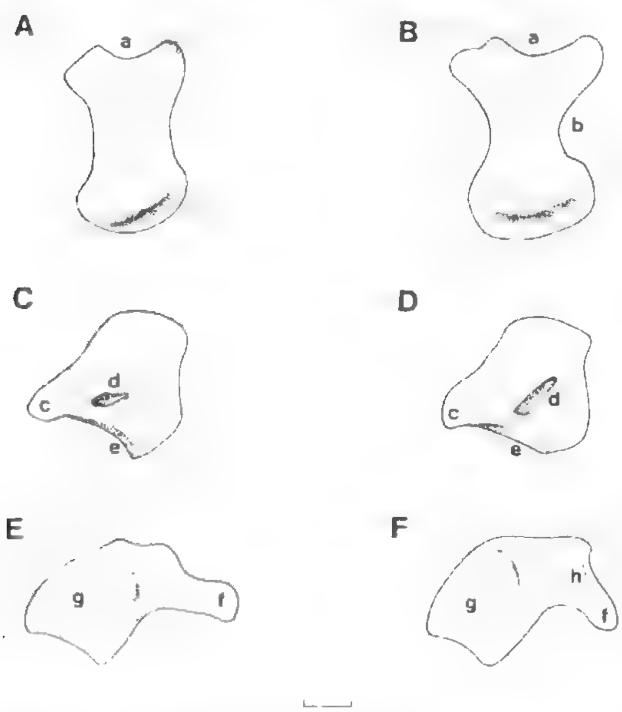

FIGURE 7. Proximal view of the right accessory carpal bone in (A) *L. latifrons* and (B) *V. ursinus*. Where a, proximal facet for the ulnar carpal bone; b, constricted shaft. Medioproximal view of the right 3rd carpal bone in (C) *L. latifrons* and (D) *V. ursinus*. Where c, medial process; d, sulcus; e, articular surface for 3rd metacarpal. Proximal view of the right 4th carpal bone in (E) *L. latifrons* and (F) *V. ursinus*. Where f, hamulus; g, articular facet for ulnar carpal bone; h, fossa. Scale line is 4 mm.

Third carpal bone:

	L. latifrons	*V. ursinus*
Mediodistal process	large and pointed	broad and squat
Proximal sulcus	shallow	deep

Fourth carpal bone:

	L. latifrons	*V. ursinus*
Palmar articular facet for 4th and 5th metacarpals	small and shallow	large and deep
Hamulus	narrow	broad at its base
Body of ulnar carpal separated from hamulus by —	shallow fossa	deep fossa

No consistent gross morphological differences were found for the first carpal bone, second carpal bone, metacarpals or phalanges.

Pelvis

	L. latifrons	*V. ursinus*
Iliac crest	(i) points laterally and forms sharp angle with body of ilium	points caudally 'sickle-shaped'
	(ii) lateral extremity broad	pointed
Iliac fossa	present	absent
Iliopectineal eminence	large	small
Ramus of pubic bone	same width as pubic bone between the obturator foramina	half width of pubic bone between the obturator foramina
Rectus femoris m. origin	deep fossa on body of ilium	indistinct
Surface area of Ischiatic table	approximately same as obturator foramen	much smaller
Ischiatic tuberosity	narrow, approximately 20 mm wide at point of maximum width	well-developed, approximately 40 mm wide

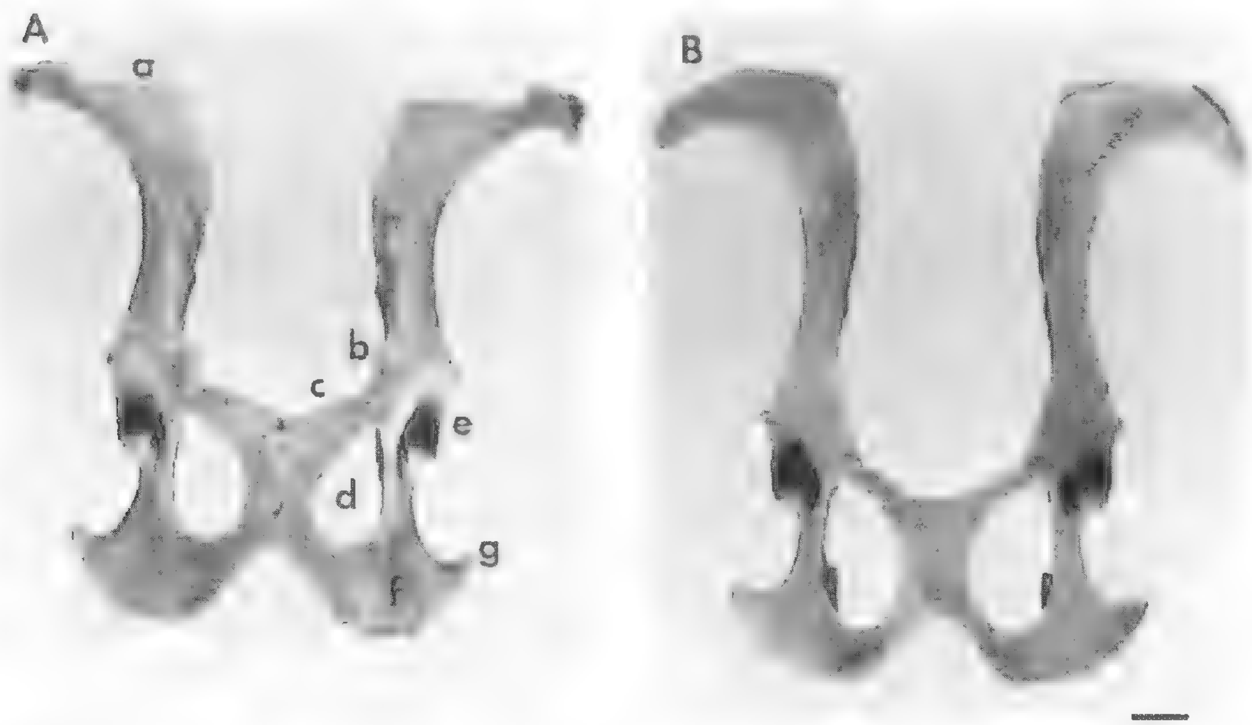

FIGURE 8. Ventral view of the pelvis in (A) *L. latifrons* and (B) *V. ursinus*. Where a, iliac crest; b, arrowed, iliopectineal eminence; c, arrowed, pecten; d, obturator foramen; e, acetabulum; f, ischiatic table; g, ischiatic tuberosity. Scale line is 2 cm.

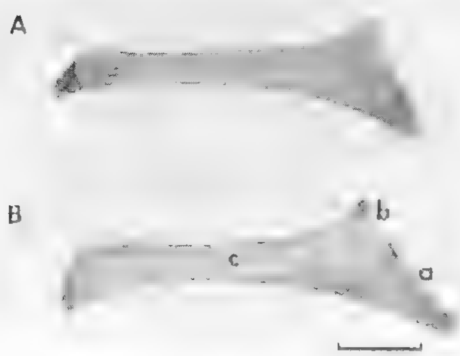

FIGURE 9. Dorsal view of right epipubic bone in (A) *L. latifrons* and (B) *V. ursinus*. Where a, articular surface for pecten of pubis; b, arrowed, proximal tubercle; c, shaft. Scale line is 2 cm.

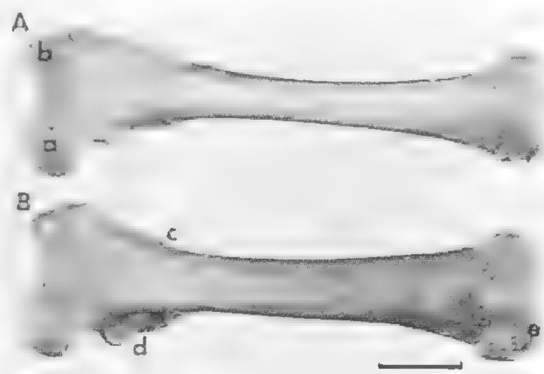

FIGURE 10. Cranial view of left femur in (A) *L. latifrons* and (B) *V. ursinus*. Where a, head; b, greater trochanter; c, 3rd trochanter; d, lesser trochanter; e, medial condyle. Scale line is 2 cm.

Epipubic bone

	L. latifrons	*V. ursinus*
Articular surface for pectin of pubic bone	elongate with medial surface much broader than lateral surface	narrow elongate with parallel sides
Proximal ventral surface	concave	flat
Lateral tubercle	indistinct	pronounced

Femur

	L. latifrons	*V. ursinus*
Greater trochanter	deeply grooved	indistinct groove
Lesser trochanter	present	pronounced
Third trochanter	pronounced	present

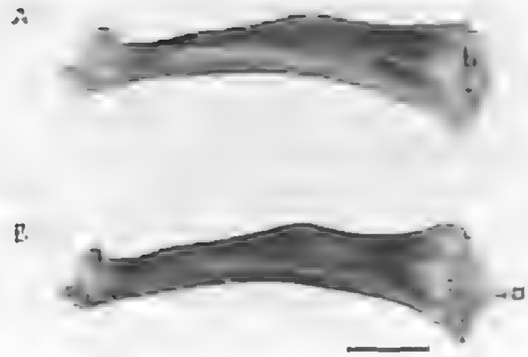

FIGURE 11. Lateral view of left tibia in (A) *L. latifrons* and (B) *V. ursinus*. Where a, arrowed, medial intercondylar eminence; b, arrowed, articular surface for fibula. Scale line is 2 cm.

Tibia

	L. latifrons	*V. ursinus*
Medial intercondylar eminence	same size as lateral	larger than lateral
Lateral condyle		
(i) lateral surface	almost flat	angled
(ii) articular surface for lateral condyle of femur	circular	elongate

Fibula

	L. latifrons	*V. ursinus*
Malleolus (plantar view)	rounded, medial surfaces	square

Distal hindlimb

Tarsal bone morphology varied considerably within each genus. No diagnostic differences were found between the two wombat genera for the tibiotarsal, fibular tarsal, central tarsal bones, or for 1st, 2nd, 3rd and 4th tarsal bones. No morphological differences were observed for the metatarsals and phalanges.

Discussion

This study found that a number of the morphological features claimed by Murie (1867) as being diagnostically significant for separating the forelimb bones of *L. latifrons* from those of *V. ursinus* are not reliable. For instance Murie's claim that a marked difference exists between the proportion of length to breadth of the scapula of the two wombat taxa (56% in *L. latifrons* and 72% in *V. ursinus*) was found to be marginal. Other differences such as scapula shape and curvature of the scapular spine, as well as the variations in depth of the sulcus for the bicipital tendon as described by Murie (1867) were found to be inconsistent and of no diagnostic value.

Likewise Murie (1867) claimed that the anterior border of the ilium points downwards in *L. latifrons*, but outwards in *V. ursinus*, and that the femoral shaft breadth is greatest in *L. latifrons*. He also reported that the fibula length was equal in both wombat genera, and that the fibula shaft was straighter in *L. latifrons*. None of these findings are supported in this study.

The current study tabulates a number of diagnostic morphological differences allowing many individual wombat bones of the appendicular skeleton to be identified to generic level. In addition to this it was noted that the scapula of *V. ursinus* bears a larger surface area for the insertion of M. trapezius and M. deltoidius than does the scapula of *L. latifrons*. However, the *L. latifrons* scapula possesses a larger and more developed surface for the insertion of M. rhomboideus and M. serratus ventralis. The significance of this difference in muscle insertion sites is reflected not only in differences in the overall structural mechanics of the thoracic limb of the two wombat taxa, but also in differences in their burrowing and locomotor behaviour.

For example, *V. ursinus* more readily accommodates the actions of the trapezius muscle to elevate and protract the limb and the deltoideus muscle to flex the shoulder joint as well as to lift the humerus. By contrast *L. latifrons* is more adapted to accommodate the action of rhomboideus muscle which elevates and retracts the limb and shoulder. The ventral serrate muscle supports the trunk, and carries the trunk forward or backward. These features are probably linked to *L. latifrons* being a plains dweller which digs burrows into a flat, usually limestone-underlaid, topography; while *V. ursinus* is an inhabitant of the mountainous eucalyptus forests, and commonly resorts to digging its burrows into decomposed granite.

The bones of the forearm in both genera are well adapted for pronation and supination, both important prerequisites for their burrowing. It is also evident, that except for relative size, the general overall morphological structure of the forelimb skeleton in the wombat is quite similar to those of the kangaroo and the koala.

Ultimately, differences in forelimb osteology of *L. latifrons* and *V. ursinus* can be explained by reference to differences in their myology and structural mechanics. Sonntag (1923), and more recently Hildebrand (1974) have set the lead in this respect. However, Sonntag only looked at the myology of *V. ursinus*, while Hildebrand only considered the structural mechanics of the forelimb of *L. latifrons*. In both cases their work was generalised and did not attempt to explain the functional anatomy of the two wombat genera.

Of all the hindlimb bones studied, the pelvis shows more pertinent morphological differences between the two extant wombat species. However, relating these differences to the functional anatomy of the pelvis, and the hindlimb in general, awaits comprehensive information on the musculature of the hindlimb in the two wombat species. No detailed work has been done on wombat hindlimb myology. Waterhouse (1846), Macalister (1850), Sonntag (1923), and Elftman (1929) provided only general information on wombat *(V. ursinus)* musculature. Their studies described the origins and insertions of a small number of muscle groups, but lacked detail, definitions and figures. In most instances they are of little value for interpreting the functional musculoskeletal anatomy of the pelvic region of the two wombats.

Although this paper has compared the osteological differences of the hindlimb of *L. latifrons* and *V. ursinus*, the interpretation of these differences in terms of their respective functional anatomy awaits a detailed investigation of the myology of the pelvic limb.

Acknowledgments

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TWO NEW LARVAL MITES (ACARINA: ERYTHRAEIDAE) ECTOPARASITIC ON NORTH QUEENSLAND CICADAS

BY R. V. SOUTHCOTT

Summary

Two new larval mites are described, ectoparasitic on cicadas from Cape York Peninsula, Queensland ; Leptus torresianus sp. nov. on Venustria superba Goding & Froggatt and Tamasa doddi Goding & Froggatt; Caeculisoma mouldsi sp. nov. on the same two species of cicadas and also on Mardalana suffusa Distant and Psaltoda fumipennis Ashton. Leptus torresianus larvae were attached to the denser chitin of the cicadas (first leg tibiae). Most Caeculisoma mouldsi larvae were attached to the wing veins, on both surfaces of both pairs of wings.

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R.V. SOUTHCOTT

SOUTHCOTT, R.V. 1988. Two new larval mites (Acarina: Erythraeidae) ectoparasitic on north Queensland cicadas. *Rec. S. Aust. Mus.* 22(2): 103–116.

Two new larval mites are described, ectoparasitic on cicadas from Cape York Peninsula, Queensland: *Leptus torresianus* sp. nov. on *Venustria superba* Goding & Froggatt and *Tamasa doddi* Goding & Froggatt; *Caeculisoma mouldsi* sp. nov. on the same two species of cicadas and also on *Mardalana suffusa* Distant and *Psaltoda fumipennis* Ashton. *Leptus torresianus* larvae were attached to the denser chitin of the cicadas (first leg tibiae). Most *Caeculisoma mouldsi* larvae were attached to the wing veins, on both surfaces of both pairs of wings.

R.V. Southcott, Honorary Research Associate, South Australian Museum, North Terrace, Adelaide, South Australia 5000. Manuscript received 24 August 1987.

Erythraeid larval mites attach as ectoparasites to a wide variety of terrestrial arthropods (insects, collembolans, arachnids) (Oudemans 1912; Southcott 1946, 1961b; Greenslade & Southcott 1980; Welbourn 1983). Various host usages of cicadas have been recorded. Ishii (1953) recorded that *Leptus kyushuensis* Ishii (Leptinae) parasitized three species in Japan: *Graptosaltria colorata* (Stål), *Meimuna opalifera* (Walker) and *Platypleura kaempferi* Matsumara; from New Zealand *Momorangia jacksoni* Southcott (Callidosomatinae) was recorded from *Melampsalta oromelaena* Meyers, and *Momorangia vallata* Southcott was recorded from *Melampsalta oromelaena* and *Melampsalta* sp. (Southcott 1972); Welbourn (1983: 138) recorded *Leptus* sp. on *Magicicada septendecim* (L.) in the United States.

Various erythraeid mite larvae have been found on other Homoptera e.g. in the families Aleyrodidae, Aphididae, Cercopidae, Cicadellidae, Delphacidae, Fulgoridae, Membracidae, Psyllidae (e.g. Oudemans 1910, 1912; Pussard & André 1929; Southcott 1946, 1961b, 1966, 1972; André 1951; Kawashima 1958, 1961a, b; Smiley 1968; Sõmermaa 1973; Tseng *et al.* 1976; Yano & Ehara 1982; Welbourn 1983; Young & Welbourn 1987).

Mr M.S. Moulds, Sydney, N.S.W., observed (pers. comm. 1987) small red mites parasitizing cicadas in north Queensland, and forwarded six pinned cicadas. Five of them had dried mites attached to the legs, wings and thorax, which represent two undescribed species of Erythraeidae larvae. These are described below as *Leptus torresianus* sp. nov. and *Caeculisoma mouldsi* sp. nov. (Fig. 1 A–D shows a cicada and mites *in situ*).

Seta and other terminology follows Southcott (1961a, b, c; 1963, 1972). All measurements are in micrometres (μm) unless otherwise stated. Two new shield measurements AAS and LX are introduced here. AAS is the distance between centres of bases of AL scutala and ASens of the same side. LX is the distance of the levels of the AL scutalae behind the anteromost point of the scutum. (see Figs 2A–E). These measurements introduce a slight redundancy, since

$$AAS^2 = \left(\frac{AW-SBa}{2}\right)^2 + (ASBa-LX)^2$$

assuming perfect symmetry. Nevertheless, they appear useful in specific diagnoses of erythraeid mites.

The types of both species are deposited in the South Australian Museum.

Genus **Leptus** Latreille, 1796

For synonymy *see* Southcott (1961b: 514).

Diagnosis (for larva)

See Southcott (1961b: 514).

Remarks

This is a cosmopolitan genus, with many species having been described as adults, and others as larvae. Although in some cases correlation between larvae to deutonymphs had been recorded (Southcott 1961b: 517–521), a full correlation of a larva to the deutonymph and adult in *Leptus* (an unidentified North American species) was achieved only in 1973, by Treat (1975).

Larvae parasitise a wide variety of terrestrial arthropods (Oudemans 1912; Southcott 1961b, 1984; Treat 1975; Welbourn 1983).

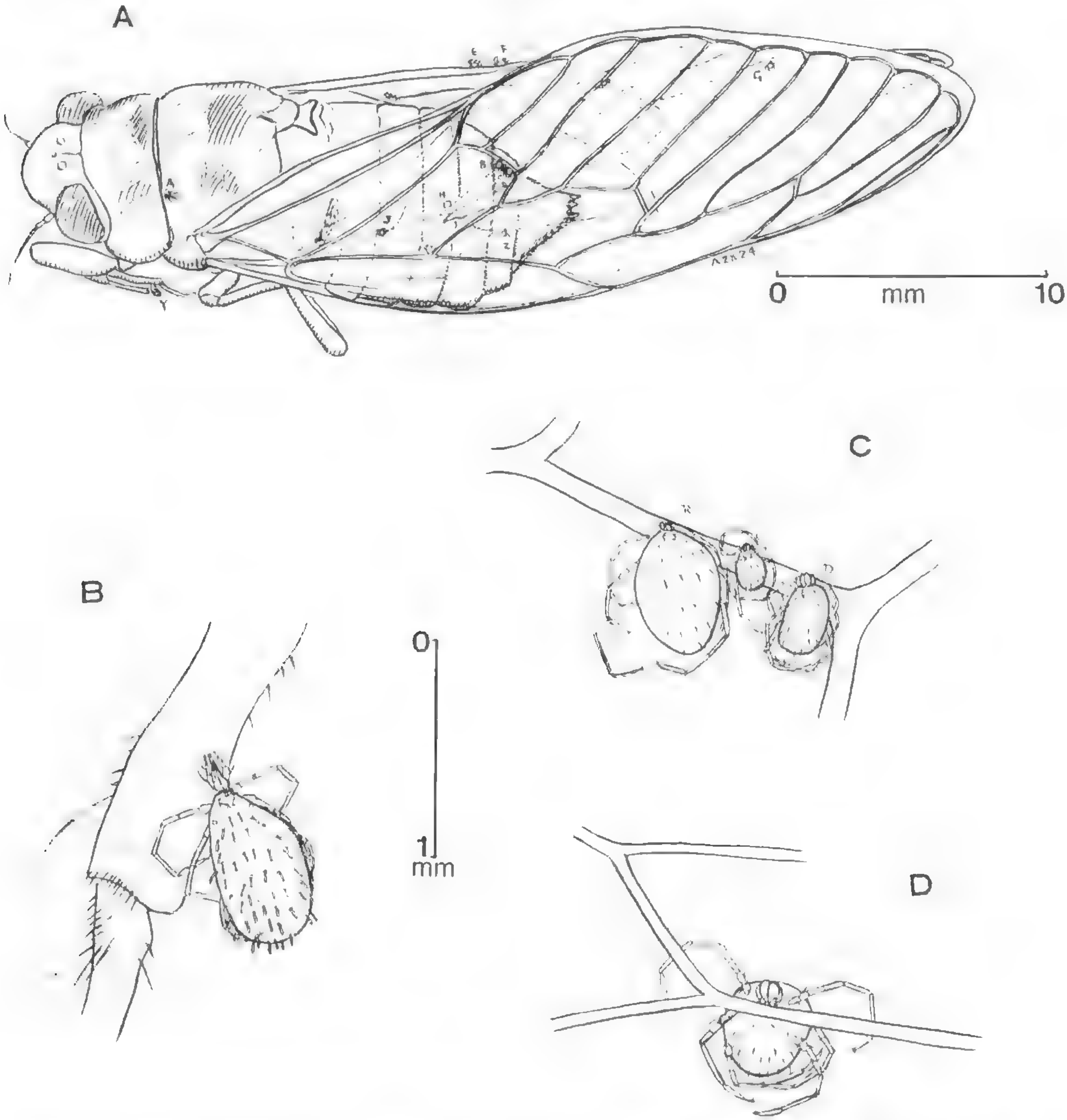

FIGURE 1. North Queensland cicada and its ectoparasitic mites. A, cicada, *Venustria superba* G. & F., A2824, preserved dry, with ectoparasitic larval erythraeid mites *in situ*, serials ACA2308, 2309. Mite Y, attached to right tibia I is *Leptus torresianus* sp. nov., holotype, ACA2308. Other mites are *Caeculisoma mouldsi* sp. nov., ACA2309 series; mite J, attached to inferior surface of left hind wing is holotype of *C. mouldsi*. B, holotype of *L. torresianus*, attached to lateral end distally of right tibia I. C, mites, *C. mouldsi*, specimens ACA2309B, C, D attached to vein of dorsal surface of left anterior wing. D, mite ACA2309Z, *C. mouldsi*, seen in transparency, attached to wing vein on inferior surface of left posterior wing. All drawings to nearest scale.

Leptus torresianus sp. nov.
(Figs 3A, B, 4A, B, 5)

Description of Larva (principally holotype, supplemented by paratypes)

Colour in dried state red. Idiosoma (mounted) of normal ovoid shape for genus, length (partially fed) 897, width 498, overall length from tip of mouthparts to posterior pole of idiosoma 1118.

Dorsal scutum moderately sclerotized, and forms approximately an equilateral triangle. Central part of its anterior border produced to a low protuberance, containing the anterior sensilla. Lateral borders short, sloping anterolaterally. Posterolateral

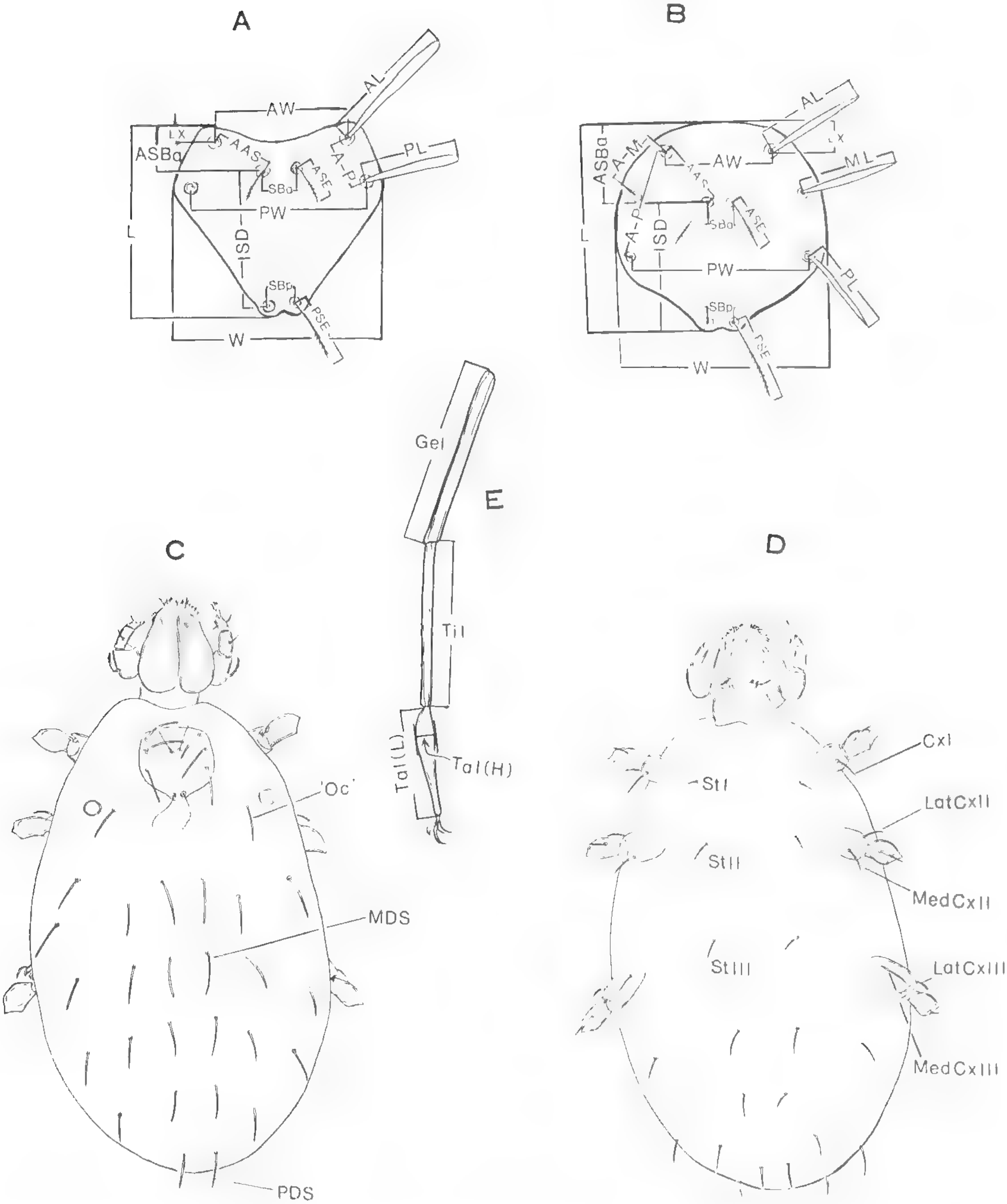

FIGURE 2. Explanatory diagrams for conventions of abbreviations and measurements used for the larval erythraeid mites. A, dorsal scutum of a larval erythraeid mite with two pairs of scutalae (*Leptus*). B, dorsal scutum of a larval erythraeid mite with three pairs of scutalae (*Caeculisoma*). C, dorsal view of *Caeculisoma* sp., with legs omitted beyond trochanters. Oc. 'ocular seta'; MDS mid-dorsal setae; PDS posterior dorsal setae.

borders concave. Posterior pole of scutum rounded, enclosed in two narrow bars of chitin not meeting in the middle. Scutal scobalae curved, blunted, a little clavate, with dense covering of short, pointed, pigmented setules. Sensillary setae filiform, with fine setules distally.

Standard and other data of scutum and legs as in Table 1.

Eyes circular, 1+1, posterolateral to scutum, 24 across.

Dorsum of idiosoma with 50 setae, slightly clavate, with pigmented but only slightly outstanding setules; setae arranged approximately 4, 6, 8, 8, 8, 8, 4, 4.

Ventral surface of idiosoma: sternalae I bushy, blunted, more or less parallel-sided, sternalae II similar, 40 long; between levels of coxae II and III are four setae, anterior pair (sternalae III) bushy, expanding, 26 long, and posterior pair (sternalae IV) more medial, bushy but more slender, 42 long.

TABLE 1. Standard data for *Leptus torresianus* sp. nov. larvae.

Character	Holotype ACA2308	Paratype ACA2311A	Paratype ACA2311B	Mean
AW	102	92	94	96
PW	114	102	108	108
SBa	15	12	13	13.3
SBp	16	15	13	14.7
LX	13	24	14	17
ASBa	9	36	16	20.3
ISD	48	39	58	48.3
L	76	73	84	77.7
W	121	111	115	115.7
AAS	42	38	40	40
A-P	16	16	19	17
AL	62	58	64	61.3
PL	*c*.65	67	67	66.3
ASE	*c*.30	31	33	31.3
PSE	*c*.60	*c*.55	46	53.7
DS	45–58	38–58	51–56	57.3*
'Oc.'	45	42	47	44.7
MDS	53	49	55	52.3
PDS	58	58	56	57.3
GeI	160	155	158	157.7
TiI	230	228	226	228
TaI(L)	162	165	—	163.5
TaI(H)	21	20	—	20.5
TiI/GeI	1.44	1.47	1.43	1.45
GeII	130	122	140	130.7
TiII	199	195	—	197
TaII(L)	140	138	—	139
TaII(H)	20	20	—	20
GeIII	155	139	155	149.7
TiIII	288	267	288	281
TaIII(L)	160	156	157	157.7
TaIII(H)	20	21	22	21
TiIII/GeIII	1.86	1.92	1.86	1.88
AW/ISD	2.13	2.36	1.62	2.04
ISD/A-P	3.00	2.44	3.05	2.83
AW/A-P	6.38	5.75	4.95	5.69
StI	42	38	44	41.3
CxI	83	73	—	78
CxII	*c*.22	25	—	23.5
CxIII	40	*c*.40	48	42.7
TiI/AW	2.25	2.48	2.40	2.38
TiIII/AW	2.82	2.90	3.06	2.93
TiIII/TiI	1.25	1.17	1.27	1.23
AW/AL	1.65	1.59	1.47	1.57
AL/AAS	1.48	1.53	1.60	1.54

*For the maxima of DS

Between and behind coxae III 16 setae, 38–50 long, arranged 4, 4, 6, 2; setae well setulose, blunted, slightly expanding, posteriors tending to be more clavate and resembling posterior dorsal idiosomalae. Coxalae 1, 1, 1, arising as figured, Coxala I parallel-sided, terminally tapering to a blunted point, and carrying many fine, pointed setules; coxalae II, III blunted, well setulose, somewhat clavate.

Legs normal; lengths (including coxae and claws) I 935, II 860, III 1015.

Leg specialized sensory setae (lengths in parentheses): SoGeI.42d(29), SoGeI.59d(29), VsGeI.92d(6), SoTiI.66d(35), SoTiI.75d(42), SoTiI.87d(25), VsTiI.89pd(5), VsGeII.91pd(9), SoTiII.04d(29), SoTiII.88d(23), SoTiIII.03d(36).

Tarsus I with SoTaI.62d(38); tarsus II with SoTaII.42d(18). Tarsal claws: anterior almost straight with terminal ventral hook; middle longest, falciform, smooth; posterior recurved, with ventral setules (*see* Fig. 3).

Gnathosoma: chelicerae with rounded posterior element to bases, smooth, tapering to long anterior projections; length 205, maximum width of bases 122; ventral surface with faint transverse striations. With two pairs of hypostomalae, pointed, nude: anterior dorsal, 20 long, posterior ventral (also near tip of hypostome) *c.* 60 long. Palpal setal formula 0, 0, 1, 1, 3, 7. Palpal femorala and genuala well setulose, tapering, pointed, not clavate, tibialae setulose. Palpal supracoxala not identified. Palpal tibial claw smooth, with a single terminal hook.

Material examined

Holotype: Queensland: C.R.E.B. [a Queensland Regional Electricity Board] Road, nr Mt Hemmant, N. of Daintree, 2.i.1984, M.S. & B.J. Moulds, in rainforest; larva attached to lateral aspect of distal end of R. tibia I of cicada *Venustria superba* Goding & Froggatt (A2824) (*see* Fig. 1A, B), N1987194 (ACA2308).

Paratypes: Mt Hartley, nr Roseville, S. of Cooktown, 1.i.1984, M.S. & B.J. Moulds; on distal end of R. tibia I of cicada *Tamasa doddi* (Goding & Froggatt) (A2826), two larvae N1987195 and N1987196 (ACA2311A, B).

Remarks on taxonomy

Leptus torresianus sp. nov. is placed in the group of *Leptus* larvae with one femoral seta and one genual seta on the palp, which includes the majority of described members of the genus. However it differs from all described larvae with the preceding character set in having two specialized sensory setae (spinalae or solenoidalae) on leg genu I. All others of this group have only one spinogenuala, except *L. stieglmayri* (Oudemans, 1905) from Brazil, which has five (Oudemans 1912: 165). Some other *Leptus* larvae have two or more such setae on genu I, but they also have two palpal femoral setae (scobalae) — these being *L. echinopus* Beron, 1975, from Bulgaria, with five spinalae on genu I, and *L. southcotti* Beron, 1975, from Bulgaria, with two spinalae on genu I.

Remarks on biology

Leptus larvae appear generally to prefer hard, heavily chitinized parts of their hosts on which to attach by their mouthparts e.g. tibia in the case of *L. torresianus*. Treat (1975: 224) has also commented on this preference of an unnamed North American larval *Leptus* for an externally exposed sclerotized area: 'There is no seeking of soft membranes or crevices'. They are presumably able to utilize a small apparently mobile tooth on the tip of the cheliceral digits (*see* Fig. 4B) as a gouging or boring piece.

Etymology

The specific name is from the Torresian region of northern Australia.

Genus **Caeculisoma** Berlese, 1888

For synonymy *see* Southcott (1961b: 524, 1972: 25).

Diagnosis (for larva)

See Southcott (1972: 25).

Caeculisoma mouldsi sp. nov.
(Figs 6A-C, 7A, B, 8)

Description of larva (principally from holotype, supplemented by paratypes)

Colour in dried state red. Idiosoma (mounted) of normal ovoid shape, length (partially fed) 600; width 385; overall length from tip of mouthparts to posterior pole of idiosoma 710.

Dorsal scutum approximately oval, with slightly concave anterior margin and rounded anterolateral angles. Anterolateral borders almost straight; posterolateral borders evenly rounded. Posterior sensillary bosses protrude a little at posterior pole of scutum. Scutalae curved, tapering, blunted, lightly setulose with adnate setules. Sensillary setae filiform, with a few distal setules.

Standard data as in Table 2.

Eyes 1+1, circular, 22 across.

Dorsal idiosoma setae curved, tapering, pointed, with a few adnate setules; arranged 2, 7, 6, 6, 4, 4, total 29.

Ventral surface of idiosoma: sternalae curved, tapering, pointed, with a few setules; II 40 long, III 36. Behind coxae III about 12 similar setae, 33–38 long, arranged 4, 4, 2, 2. Coxala I slender, tapering,

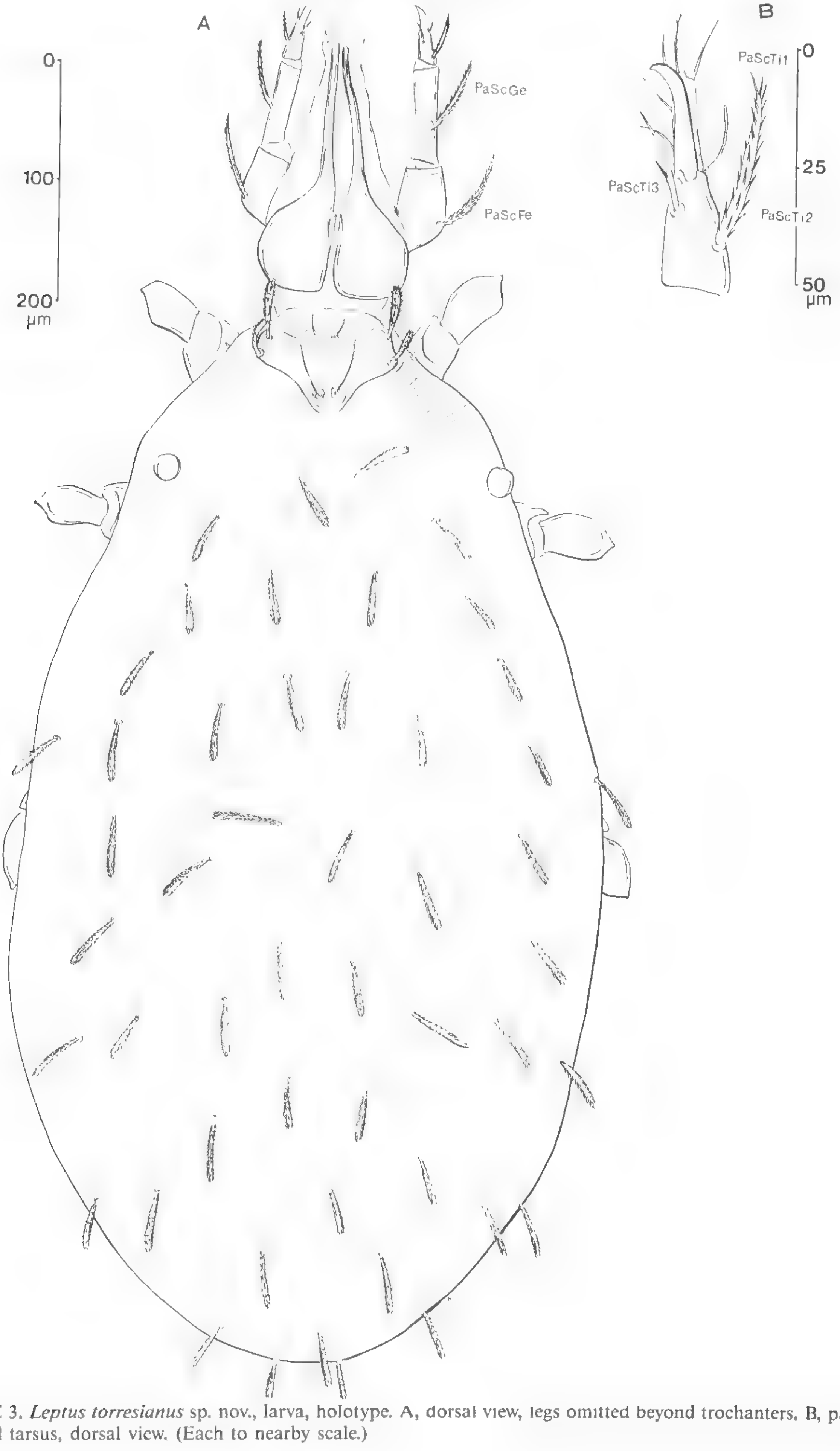

FIGURE 3. *Leptus torresianus* sp. nov., larva, holotype. A, dorsal view, legs omitted beyond trochanters. B, palpal tibia and tarsus, dorsal view. (Each to nearby scale.)

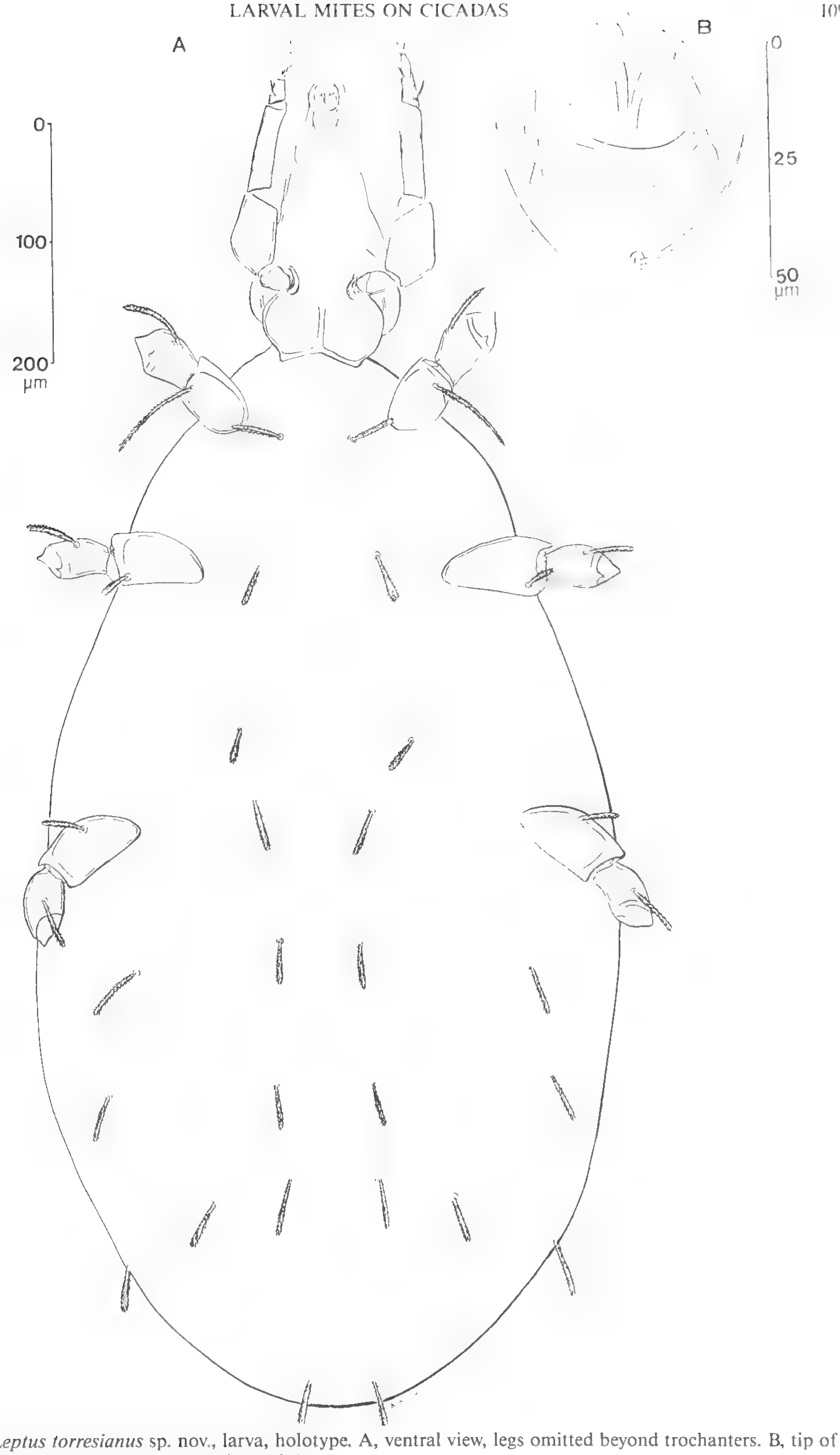

FIGURE 4. *Leptus torresianus* sp. nov., larva, holotype. A, ventral view, legs omitted beyond trochanters. B, tip of gnathosoma, ventral view. (Each to nearby scale.)

TABLE 2. Data on larvae of *Caeculisoma mouldsi* sp. nov.

Character	Holotype	n	range	mean	s.d.	c.v.
AW	68	43	58–75	68.33	3.3432	4.8931
MW	77	43	72–82	77.16	2.7683	3.5876
PW	76	45	69–80	76.11	2.4423	3.2088
SBa	9	46	7–11	9.13	0.9800	10.7333
SBp	14	48	11–15	13.81	0.9600	6.9500
LX	7	38	5–9	6.24	1.1954	19.1660
ASBa	29	38	24–33	28.50	2.3452	8.2288
ISD	61	41	48–66	57.24	3.4408	6.0108
L	95	38	84–100	92.21	3.9808	4.3170
W	96	44	87–101	93.25	3.1852	3.4157
AAS	35	41	34–41	36.00	1.3038	3.6218
A–M	17	46	14–22	17.50	1.9061	10.8922
A–P	45	46	37–50	43.63	2.9010	6.6491
AL	54	33	35–56	48.18	5.2408	10.8771
ML	58	41	44–64	53.90	5.1176	9.4943
PL	56	45	38–56	47.18	4.1522	8.8011
ASE	44	44	35–49	41.59	3.1425	7.5557
PSE	67	41	55–68	63.37	3.0146	4.7574
DS	40-63	50	47–64*	56.43	4.0466	7.1712
Oc.	63	49	47–64	56.61	4.0353	7.1280
MDS	55	50	38–57	46.04	3.6809	7.9951
PDS	55	50	42–55	47.36	3.2561	6.8753
GeI	147	51	131–153	142.75	4.9673	3.4798
TiI	201	50	175–206	186.70	7.0138	3.7567
TaI(L)	154	50	129–155	144.16	5.8322	4.0457
TaI(H)	18	50	16–22	18.60	1.3401	7.2049
TiI/GeI	1.37	49	1.17–1.39	1.3018	0.0491	3.7719
GeII	140	51	122–142	131.06	5.0296	3.8376
TiII	174	51	156–182	169.14	5.5462	3.2791
TaII(L)	147	51	131–151	140.43	4.1533	2.9576
TaII(H)	18	51	16–21	18.59	1.0035	5.3987
TiII/GeII	1.24	51	1.19–1.35	1.2906	0.0418	3.2374
GeIII	157	50	140–165	151.10	5.8910	3.8988
TiIII	259	51	240–279	255.96	9.7118	3.7942
TaIII(L)	156	51	137–164	152.84	5.5834	3.6531
TaIII(H)	16	51	14–18	16.35	0.9343	5.7134
TiIII/GeIII	1.65	50	1.58–1.86	1.6942	0.0615	3.6309
AW/ISD	1.19	39	1.03–1.44	1.1941	0.0857	7.1750
ISD/A–P	1.36	41	1.16–1.53	1.3159	0.0814	6.1857
AW/A–P	1.51	38	1.30–1.86	1.5621	0.1211	7.7539
StI	29	28	27–38	31.43	3.7061	11.7923
CxI	49	40	37–58	49.75	4.1618	8.3654
LatCxII	38	48	26–40	34.94	3.1244	9.1560
MedCxII	45	42	36–53	45.19	3.1487	6.9675
LatCxIII	33	42	25–38	32.07	3.6519	11.3867
MedCxIII	49	41	36–49	43.78	3.4894	7.9701
TiI/AW	2.96	42	2.46–3.05	2.7305	0.1491	5.4640
TiIII/AW	3.81	43	3.35–4.26	3.7614	0.2244	5.9670
AW/AL	1.26	28	1.20–1.97	1.4218	0.1881	13.2264
AL/AAS	1.54	29	0.97–1.62	1.3500	0.1498	11.0988

*For maxima of these setae

pointed, with a few setules. Lateral coxala II curved, blunted, lightly setulose, lateral III similar; medial coxalae II, III as described for coxala I.

Legs normal; lengths (including coxae and claws): I 790, II 750, III 915.

Leg specialized sensory setae (lengths in parentheses): SoGeI.85d(36), VsGeI.90pd(5). SoTiI.65d(60), CpTiI.73d(7), SoTiI.74d(55), VsTiI.87pd(5). VsGeII.92pd(5). SoTiII.07d(51), SoTiII.79d(27). SoTiIII.06d(50).

Tarsus I with SoTaI.33d(48); long, tapering, pointed. Tarsus II with SoTaII.43d(31), terminally expanding a little, blunted. Tarsal claws as for genus, all falciform. The posterior tarsal claw is somewhat obtusely-angled about halfway along, with a few ventral setules.

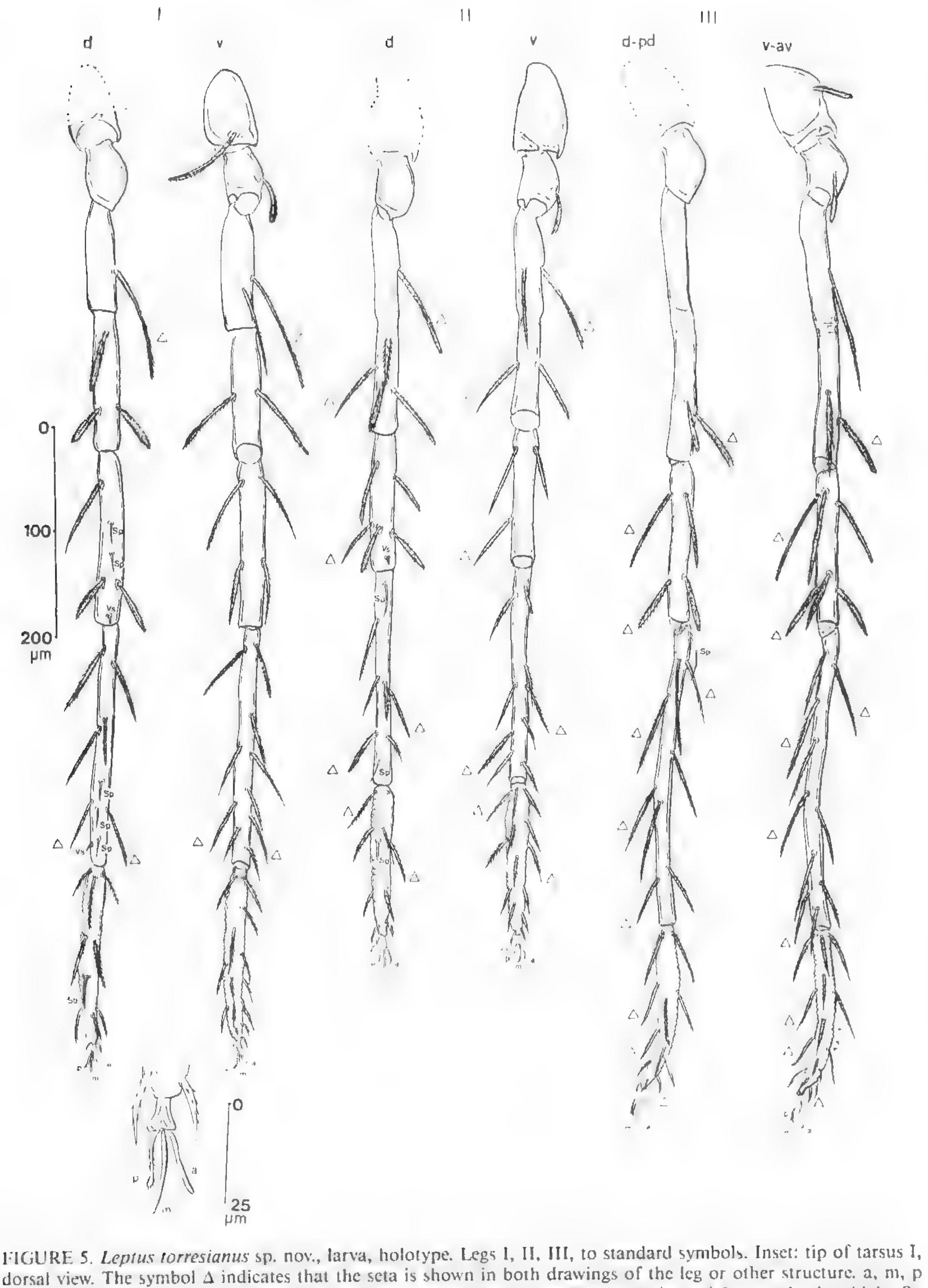

FIGURE 5. *Leptus torresianus* sp. nov., larva, holotype. Legs I, II, III, to standard symbols. Inset: tip of tarsus I, dorsal view. The symbol Δ indicates that the seta is shown in both drawings of the leg or other structure. a, m, p indicate anterior, middle and posterior tarsal claws, respectively. Vs vestigiala. So is used for tarsal solenoidala, Sp for other leg solenoidala (spinala), as in author's terminology.

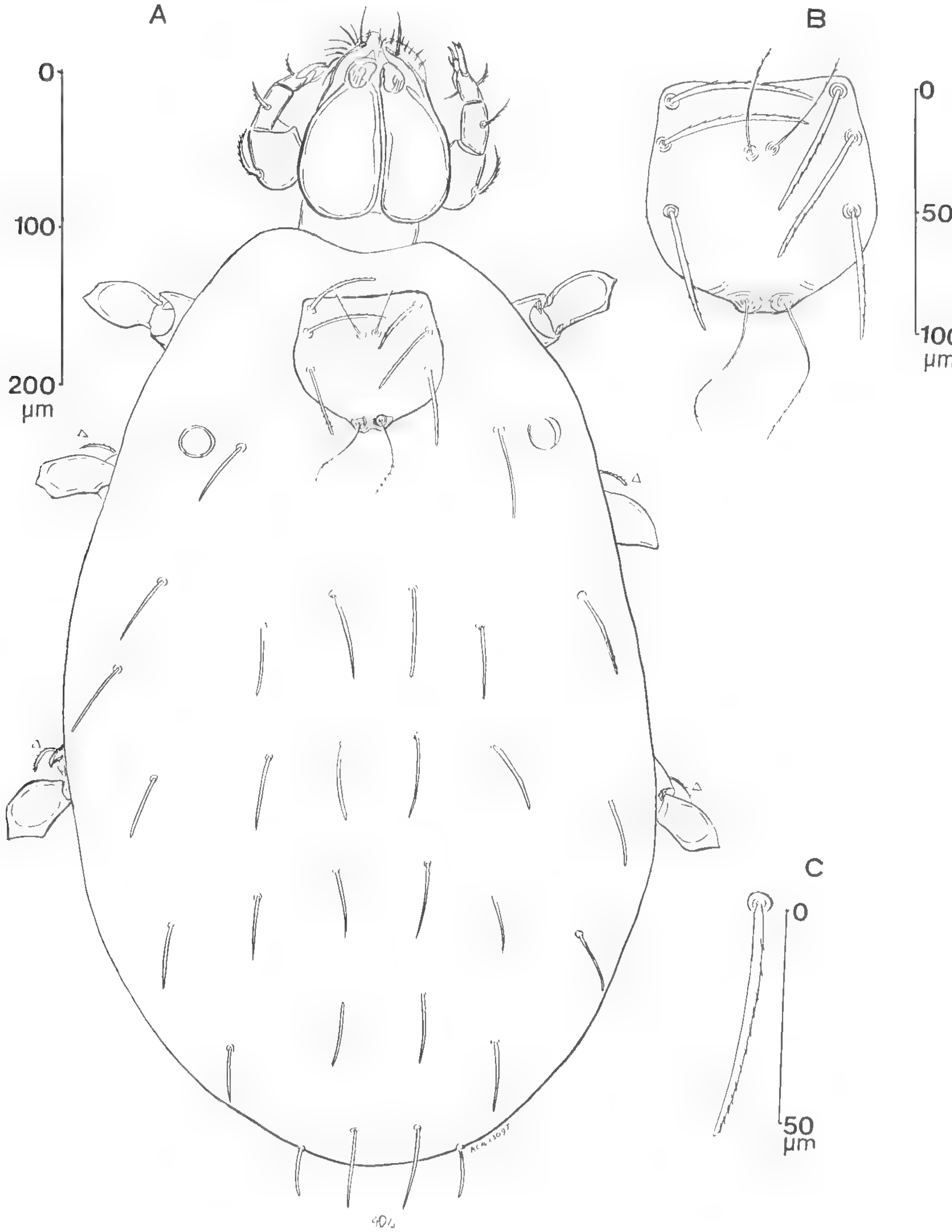

FIGURE 6. *Caeculisoma mouldsi* sp. nov., larva, holotype. A, dorsal view, legs omitted beyond trochanters. B, dorsal scutum. C, dorsal idiosomal seta. (Each to nearest scale.)

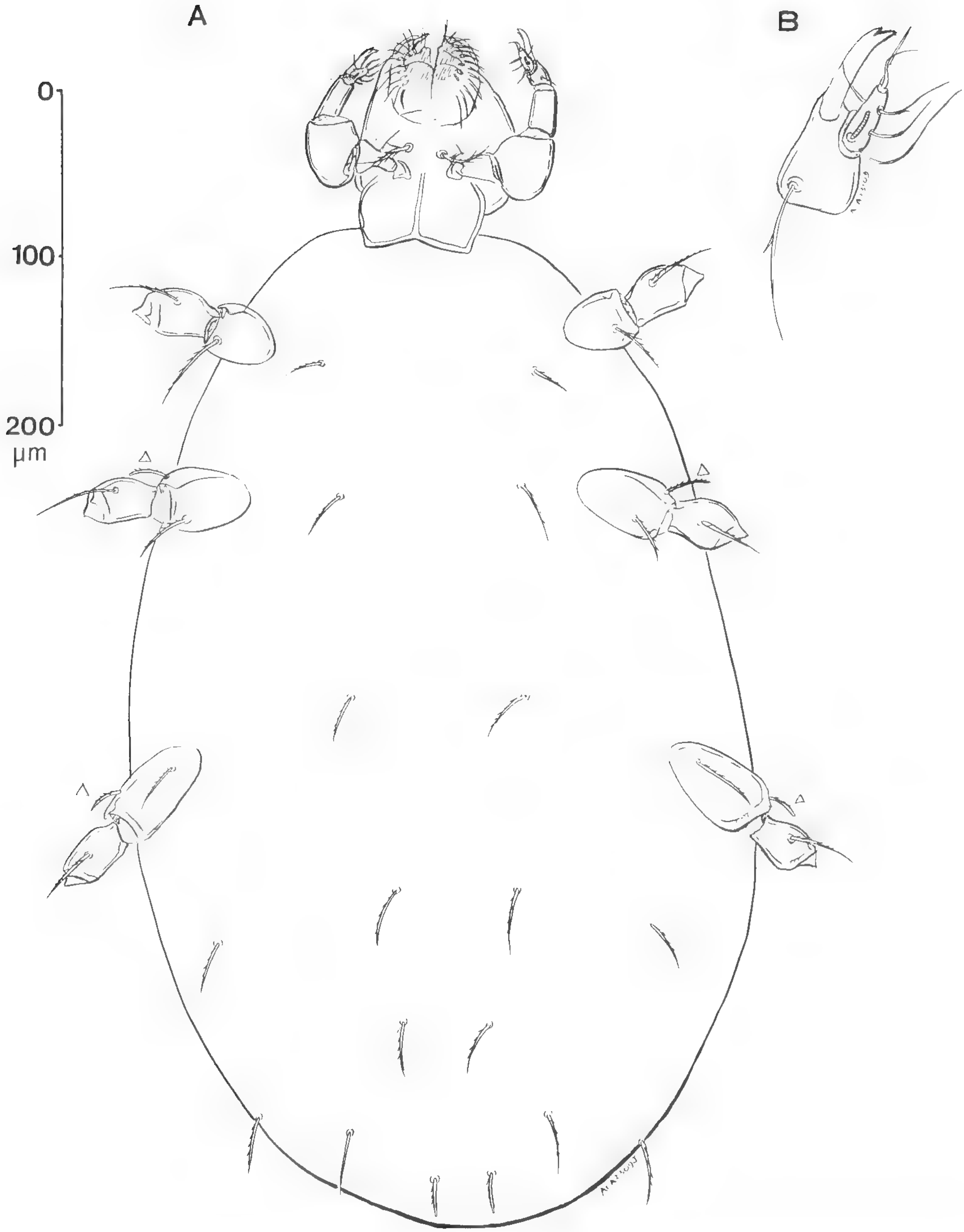

FIGURE 7. *Caeculisoma mouldsi* sp. nov., larva, holotype. A, ventral view, legs omitted beyond trochanters. B, palpal tibia and tarsus, ventral view, from paratype ACA2310D (not to scale).

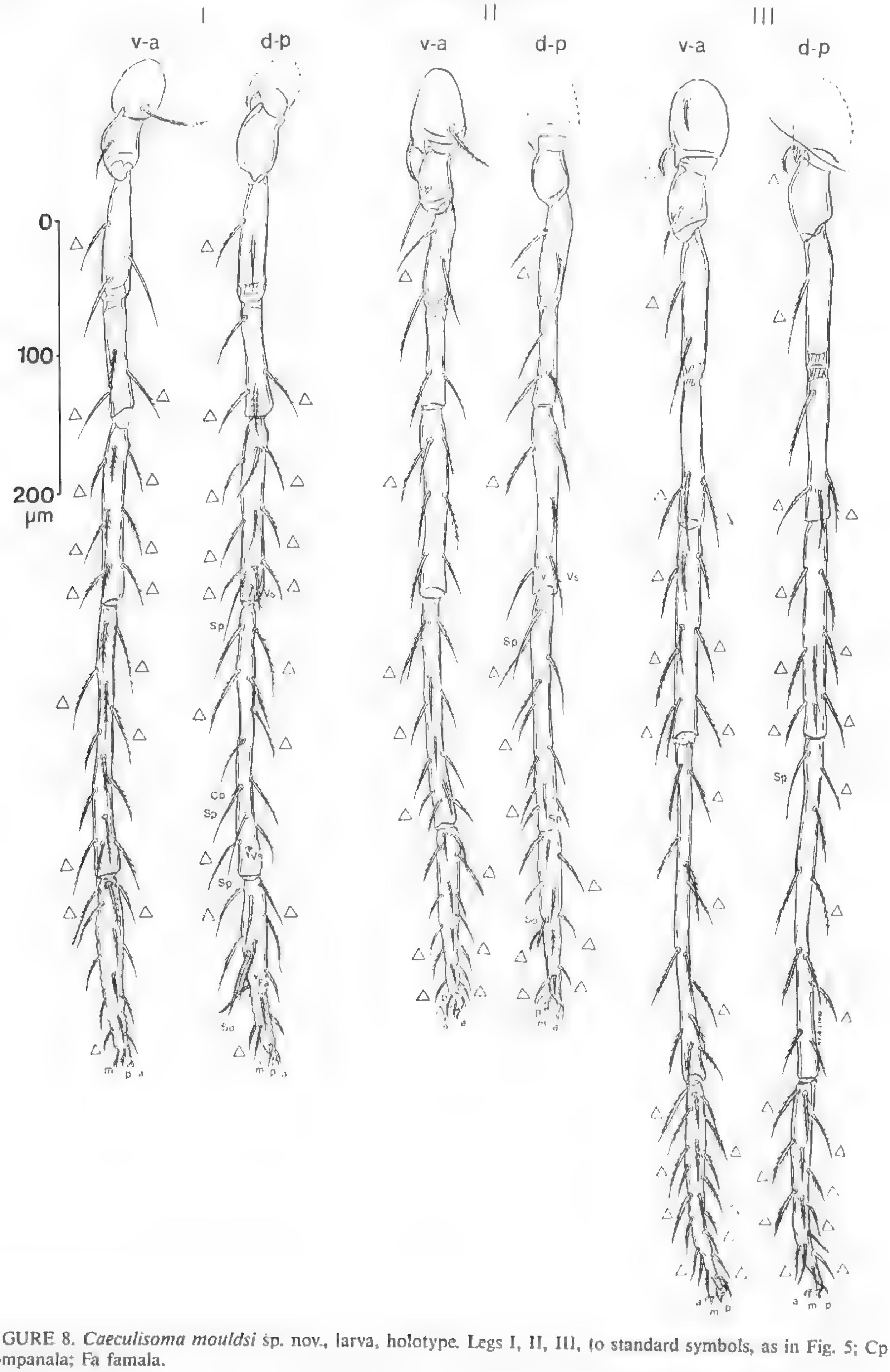

FIGURE 8. *Caeculisoma mouldsi* sp. nov., larva, holotype. Legs I, II, III, to standard symbols, as in Fig. 5; Cp companala; Fa famala.

Gnathosoma: cheliceral bases pyriform, smooth, 120 long by 93 wide (combined). Galeala smooth, simple, pointed, 27 long. Hypostomala arises anterior to palpal trochanters, 40 long, with several long setules. Palpal setal formula 0, 0, 1, 1, 3, 7. Palpal femorala tapering, pointed, well setulose, *c.* 42 long. Palpal genuala tapering, pointed, 27 long, with a few setules. Palpal tibialae pointed, with a few setules. Palpal tibial claw bifid, the dorsal tine weak. Palpal tarsus as figured. Gnathosomal supracoxala a blunted peg, 4 long.

Material examined

Holotype: Queensland: C.R.E.B. Road, nr Mt Hemmant, N. of Daintree, 2.i.1984, M.S. & B.J. Moulds, in rainforest, on wing of cicada *Venustria superba* G. & F (A2824); larva N1987197 (ACA-2309J).

Paratypes: Same data as holotype, nine larvae N1987198-N1987206 (ACA2309A-D, H, K-N). Mt Hartley, nr Roseville, S. of Cooktown, 1.i.1984, M.S. & B.J. Moulds, on *Venustria superba* G. & F. (A2825), 27 larvae N1987207-N1987233 (ACA-2310A-Z, ZA). Same locality, date and collectors, on cicada A2826 *Tamasa doddi* (G. & F.), two larvae N1987234, N1987235 (ACA2312A, B). Same locality, date and collectors, on cicada A2827 *Mardalana suffusa* Distant, nine larvae N1987236-N1987244 (ACA2313A-I). Same locality, date and collectors, on cicada A2829 *Psaltoda fumipennis* Ashton, three larvae N1987245-N1987247 (ACA2314A-C).

Remarks on distribution and taxonomy

Caeculisoma was founded by Berlese (1888: 186) on two adult mites referred to *C. tuberculatum* Berlese, 1888, one collected under decomposing fungi at Buenos Aires, Argentina, and the other from under tree bark at Asunción, Paraguay. Correlation with the larva was established by Southcott (1961a, b) for the Australian *C. darwiniense* Southcott, 1961. The species are known only from Southern Hemisphere locations, and larvae have been described only from Australia and New Zealand. *C. darwiniense* is known from Northern Territory, Queensland, New South Wales, South Australia and Western Australia, recorded hosts being Acrididae (Orthoptera); *C. cooremani* Southcott, 1972, is known from Western Australia (Acrididae); *C. huxleyi* Southcott, 1972, is recorded from New Zealand, parasitizing *Xanthorhoe* sp. (Lepidoptera: Geometridae). *C. mouldsi* sp. nov. is known only as larvae from a limited area of tropical Australia (Cape York Peninsula), parasitic on cicadas.

For a discussion on the generic classification of the tribe Callidosomatini, see Treat (1985) and Southcott (1988).

In the key to the larvae of *Caeculisoma* (Southcott 1972: 25-26), *C. mouldsi* comes down to caption (3), which may be replaced by:

3 (2) PD setae in range 20–30μm long .... *C. sparnoni* Southcott
PD setae in range 40–90μm long 4
4 (3) PD setae in range 40–60μm long .... *C. mouldsi* sp. nov.
PD setae in range 70–90μm long .... *C. huxleyi* Southcott (New Zealand)

Etymology

The species is named for the collectors.

ACKNOWLEDGMENT

I thank the Australian Biological Resources Study for support.

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REVISION OF AUSTRALASIAN HYDROPHILUS MULLER, 1764 (COLEOPTERA : HYDROPHILIDAE)

BY *C. H. S. WATTS*

Summary

The genus Hydrophilus Muller in Australia, New Guinea and New Caledonia is revised and descriptions given for each of the 11 species recognised, three of which are new (H. novaeguineae, H. viridis and H, infrequens). The following new synonyms are proposed : 1) Hydrophilus picicornis (Chevrolat, 1863) = Hydrophilus gayndahensis Macleay, 1871 = Hydrophilus sabelliferus Fairmaire, 1879 = Stethoxus sabellifer Bedel, 1891: 2) Hydrophilus brevispina Fairmaire, 1879 = H. scissipalpus Blackburn, 1901: 3) Hydrophilus loriai (Regimbart, 1902) = Hydrous gebieni Knisch, 1922a. A key to species is provided.

REVISION OF AUSTRALASIAN *HYDROPHILUS* MULLER, 1764 (COLEOPTERA: HYDROPHILIDAE)

C.H.S. WATTS

WATTS, C.H.S. 1988. Revision of Australian *Hydrophilus* Muller, 1764 (Coleoptera: Hydrophilidae). *Rec. S. Aust. Mus.* 22(2): 117-130.

The genus *Hydrophilus* Muller in Australia, New Guinea and New Caledonia is revised and descriptions given for each of the 11 species recognised, three of which are new (*H. novaeguineae*, *H. viridis* and *H. infrequens*). The following new synonomys are proposed: 1) *Hydrophilus picicornis* (Chevrolat, 1863) = *Hydrophilus gayndahensis* Macleay, 1871 = *Hydrophilus sabelliferus* Fairmaire, 1879 = *Stethoxus sabellifer* Bedel, 1891; 2) *Hydrophilus brevispina* Fairmaire, 1879 = *H. scissipalpus* Blackburn, 1901; 3) *Hydrophilus loriai* (Regimbart, 1902) = *Hydrous gebieni* Knisch, 1922a. A key to species is provided.

C.H.S. Watts, South Australian Museum, North Terrace, Adelaide, South Australia 5000. Manuscript received 8 March 1988.

Among the most prominent of Australian water beetles are the large black species of Hydrophilidae which belong to the world-wide genus *Hydrophilus* Muller 1764 (see Balfour-Browne 1941, and Pope 1985, for discussion of the use of this name for the genus). They are common in collections although they are seldom abundant in any one water body. An exception occasionally occurs in drying inland pools when both adults and larvae of some species can be found in large numbers.

The Australasian species have been revised and keys which include the Australasian species have been produced by Bedel (1891), and Regimbart (1902). But these studies were based on the examination of the relatively few specimens available in Europe at the time with the result that variation within species is underestimated. Conversely the lack of type material in Australia has led to misidentifications being perpetuated. As a result material in Australian collections is usually poorly identified.

My studies have shown that there are seven endemic species in Australia, one in New Caledonia and two in New Guinea. In addition the common Indonesian species, *H. picicornis*, occurs widely in New Guinea and eastern Australia.

Hydrophilus is a world wide genus. Because of this I have made no attempt to think cladistically about the Australasian species. Suffice to say that phenotypically they fall into three groups. The largest group, characterised by a short stout sternal spine and little abdominal pubescence, comprises *H. latipalpus*, *H. pedipalpus*, *H. macronyx*, *H. australis*, *H. novaeguineae*, *H. albipes*, and *H. brevispina*. A second group, comprising *H. picicornis* and *H. loria* and characterised by a very long sternal spine and completely pubescent sternal segments, is part of a large group of Asian species. The final group comprises two new species, *H. viridis* and *H. infrequens*, which have a short sternal spine and the sides of the abdominal sternae broadly pubescent; they are also smaller and stouter than most *Hydrophilus*, resembling *Hydrobiomorpha* Blackburn in general shape.

Both adult and larval *Hydrophilus* are aquatic. The larvae are large, fleshy and carnivorous, living and hunting among the weeds at the edges and bottom of shallow ponds. Although frequently collected, no larvae of Australian species have yet been described.

Diagnostic characters of the genus *Hydrophilus* are; large (21-46 mm), prominent keel on underside produced backwards into a spine of varying length, apical margin of clypeus complete, prosternum deeply sulcate (hood-like) posteriorly to receive apex of sternal keel.

Specimens were examined from the following collections:

AM	Australian Museum, Sydney
ANIC	Australian National Insect Collection, CSIRO, Canberra
BMNH	British Museum (Natural History), London
CW	Private collection of author
MNHP	Museum National d'Histoire Naturelle, Paris
NMV	Museum of Victoria, Melbourne
NTM	Northern Territory Museum and Art Gallery, Darwin
EUQ	Entomology Department, University of Queensland
QDPI	Queensland Department of Primary Industries, Mareeba
QM	Queensland Museum, Brisbane
SAMA	South Australian Museum, Adelaide
WAM	Western Australian Museum, Perth

SYSTEMATICS

KEY TO AUSTRALASIAN *HYDROPHILUS*

1 — Tip of sternal carina reaching beyond 2nd abdominal segment, abdominal segment

entirely pubescent 2
— Tip of sternal carina not reaching beyond 2nd abdominal segment, abdominal segments with at least central portions non-pubescent 3

2(1) — Front portion of sternal carina wide, broadly sulcate (Fig. 4) *loriai* (Regimbart)
— Front portion of sternal carina narrow, narrowly sulcate (Fig. 5) .... *picicornis* (Chevrolat)

3(1) — Abdominal segments with all but central portions pubescent, small (18-25 mm), often olive-greenish 10
— Abdominal segments only pubescent in front angles, usually larger (20-46 mm) 4

4(3) — Tip of elytron distinctly spined, tip of sternal carina reaching to second abdominal segment, groove on front edge of pronotum reaching past level of inner edge of adjacent eye .... *australis* Montrouzier
— Tip of elytron rounded or weakly spined. Tip of sternal carina usually not reaching second abdominal segment, groove on front edge of pronotum variable 5

5(4) — Rugose area on front edge of 1st abdominal segment < ⅓ length of segment, metafemur robust 6
— Rugose area on front edge of 1st abdominal segment ½-⅔ length of segment 8

6(5) — Spine on underside of claw on protarsi of female in middle of claw, labial palpi thickened particularly in male, claws on protarsi of male enlarged, somewhat flattened, outer twice size of inner (Fig. 14)............. *novaeguineae* sp. nov.
— Spine on underside of claw of protarsi of female towards base of claw, labial palpi normal, outer claw on protarsi of male either grossly enlarged or thin and not flattened (Figs 10 & 16) 7

7(6) — Large (34-40 mm), groove along front edge of pronotum usually short, confined to extreme sides, protarsal claws of male greatly enlarged, spade-like, punctures on outer face of protibia sharply impressed .... *macronyz* (Regimbart)
— Small (27-35 mm), groove along front edge of pronotum usually reaching to level of inner border of eye, protarsal claws of male subequal but only slightly enlarged, punctures on outer face of protibia weak .... *brevispina* Fairmaire

8(4) — Smaller (21-30 mm), row of stout setae on outer face of protibia to about ½ length of tibia, male maxillary palpi of male simple .... *albipes* Castelnau
— Larger (30-46 mm), row of stout setae on outer face of protibia more than ⅔ length of tibia, male maxillary palpi of male enlarged 9

9(8) — Elytral striae relatively weak, sternal carina in male deeply grooved in front, flat in female, male antenna with first and second joint greatly expanded, maxillary palpi in male expanded .... *pedipalpus* (Bedel)
— Elytral striae well marked, particularly towards apex, sternal carina of male flat, in female with rounded downward extention at anterior apex, apex of elytron rounded or squared off, male antenna with moderately expanded second segment, maxillary palpi in male normal .... *latipalpus* Castelnau

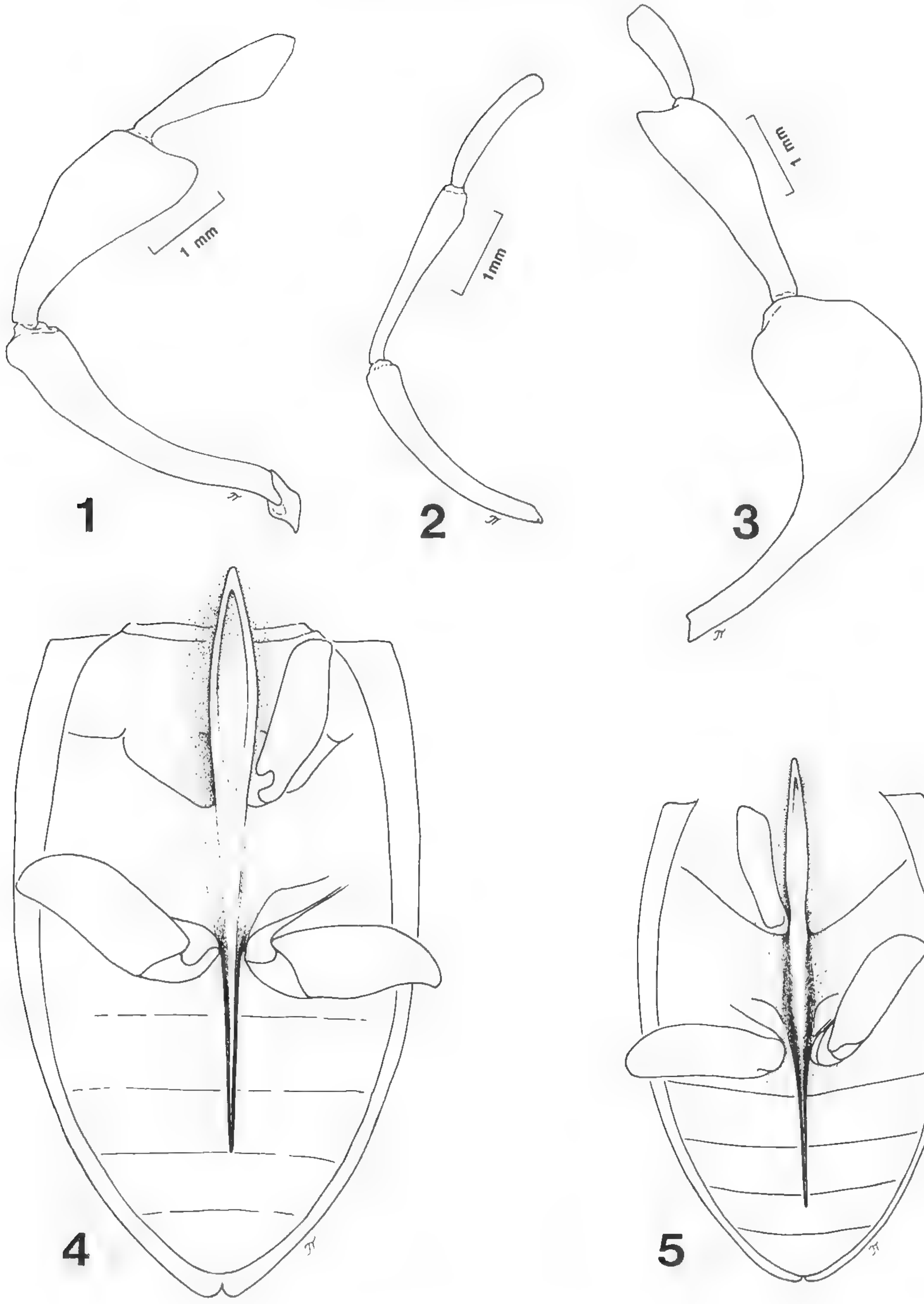
10(3) — Small (18-21 mm), light olive green when dry, inner edges of rugose areas on abdominal segments 2 and 3 not adjacent, giving saw-toothed pattern .... *viridis* sp. nov.
— Large (23-25 mm), dark olive-green or reddish black when dry, inner edges of rugose areas on abdominal segments 2 and 3 approximately adjacent .... *infrequens* sp. nov.

Hydrophilus macronyx (Regimbart)

Stethoxus macronyx Regimbart, 1902, p. 194.
Hydrous macronyx (Regimbart), Knisch, 1924, p. 249.

Description (number examined 11)

Length 34-39 mm. Oval. Dark olive-green to black, appendages lighter, reddish with well marked yellowish spots at side of each abdominal segment. Most of emarginate area on clypeus and membranous area of hind edge of abdominal segments 3-4 yellowish. Head with clypeus widely emarginate, 60-80 large punctures on frons area, densely covered with small punctures of two sizes, the smaller greatly predominating.



FIGURES 1-5. 1, maxillary palpus of male *H. latipalpus*; 2, *H. brevispina*; 3, ditto *H. pedipalpus*; 4, sternal keel of holotype of *H. loriae*; 5, ditto of *H. picicornis* (holotype of *H. sabelliferus*).

Pronotal punctures as on head, with a distinct groove around lateral edge, except near exterior hind angle, extending for only a short distance along front margin, some large punctures towards side. Elytron punctured as on head with four longitudinal rows of scattered large punctures in weak grooves, flanked on each side by row of very small punctures, traceable over whole elytron, a little more developed towards apex where they remain much smaller than punctures in main rows. Apex of elytron smoothly rounded. Sternal carina flat, with narrow grove on hind section, well marked short carina on surface between mesocoxae, spine short, blunt reaching to little more than ½ way across first abdominal segment. Prosternal pillar wide, scoop-like with quite deep groove for reception of sternal carina. Lateral plate of mesosternum short, broad. Metatibia very broad, much larger than width of 2nd abdominal segment. Metacoxal plates not particularly narrow, about same width as 3rd abdominal segment. Pilose portion of 1st abdominal segment reaches about ⅓ way across segment. Pilose portions of sides of other abdominal segments about ⅓ width of segment. Hind edge of 1st abdominal segment with some well marked punctures. Abdominal segment weakly roofed in midline. Groove around edge of apical abdominal segment complete except for small portion at tip.

Female: protarsi not expanded [segment 5>(2>3 - 4 - 1) in length].

Male: protarsi as in Fig. 16. Segment 5 massively expanded especially on bottom front edge, behind this flap is a row of stout setae; segment 4 and to a lesser degree segment 3 with elongate triangular expansion in same plane as segment 5 [5>>(1 - 2 - 3 - 4) in length]. Outer claw massive, flatly expanded, almost as large as segment 5, inner claw greatly expanded, parallel-sided and flattened. 1st segment of lapial palpi a little stouter than in female. Parameres narrow, bent, hooked at tip. Aedeagus short narrow, spermathecal opening very wide, beyond middle.

Type

Stethoxus mucronyz Regimbart. Rockhampton, in MNHP. One of two specimens used by Regimbart but not specifically designated as the Type. Herein designated lectotype.

Distribution (Fig. 17)

Known only from coastal regions of Northern Territory and Cape York.

Remarks

A large species readily recognised from the other large Australian species, *H. pedipalpis* and *H. latipalpus*, by the robust metafemurs and the greatly enlarged spade-like claws on the male protarsi. Separated from *H. novaeguineae* by characters given under that species.

Additional localities

N.T. — Darwin AM, Oenpelli NMV, SAMA, NTM. QLD — Pt Denison AM, Tolga QDPI, Yirrkala AM.

Hydrophilus picicornis Chevrolat

Hydrophilus ruficornis Boisduval, 1835, name preoccupied by *Hydrophilus ruficornis* Klug, 1833). *Hydroporus picicornis* Chevrolat, 1863, p. 204; *Stethoxus picicornis* (Chevrolat), Bedel, 1891, p. 316; Kuwert, 1893, p. 91; Regimbart, 1902, p. 203; Knisch, 1922b, p. 2; Knisch, 1924, p. 256. *Hydrophilus gayndahensis* Macleay, 1871, p. 124, syn. nov.; Blackburn, 1901, p. 129. *Hydrous gayndahensis* (Macleay), Kuwert, 1893, p. 92; Knisch, 1924, p. 248. *Hydrophilus sabelliferus* Fairmaire, 1879, p. 80, syn. nov. *Hydrous sabelliferus* (Fairmaire), Knisch, 1924, p. 248. *Stethoxus sabellifer* Bedel, 1891, p. 316, syn. nov. (unjustified emendation of *sabelliferus* Fairmaire); Regimbart, 1902, p. 204. *Hydrous sabellifer* (Bedel), Knisch, 1924, p. 248.

Description (number examined 233)

Length 21-32 cm. Elongate oval. Dark olive green to black, appendages of head and a diffuse spot laterally on each abdominal segment reddish-brown. Head with clypeus relatively weakly emarginate; 40-60 large punctures in frons area, densely punctured with small punctures of two sizes, the smaller more numerous and minute. Pronotum punctured as on head, with a distinct groove around lateral edge, except for hind angle, and along front to about ¼ width of pronotum on either side; a few very large punctures towards sides. Elytron with very fine reticulation but virtually lacking punctures other than the following except for some very small ones towards apex. Four distinct rows of even punctures, the 1st, 2nd and 4th, to a lesser degree, with punctures close together, the 3rd with only a few sparse punctures. Each row flanked on each side by a row of very small punctures only visible in certain lights. Apex of elytron truncated with or without a small blunt spine on sutural angle. Sternal carina thin, weakly and widely grooved in front portion, hind portion with slight thin groove, spine greatly elongated, sharp, reaching to hind ½ of 3rd segment with tendency to bend downwards towards tip. Prosternal pillar squat, deeply and narrowly grooved for reception of sternal carina. Metacoxal plate a little narrower than metatibia. Metatibia about width of 2nd abdominal segment. Pilose area on underside completely covering abdominal segments, occasionally some thicker golden hairs in midline.

Female: protarsi not expanded [segment 5> = 2> − (1 − 3>4) in length].

Male: protarsi as in Fig. 9. Fifth segment weakly expanded almost equal in length to 2nd. Claws narrow, curved, outer considerably larger than inner [segment 5< <(2> >3>4 = 1) in length]. Parameres elongate, thin, aedeagus thick at base, rapidly tapering at tip. Spermathecal duct opening near tip.

Types

Hydrophilus gayndahensis Macleay. There are two specimens in the ANIC (on permanent loan from the Macleay Museum) from Gayndah labelled as syntypes. One is a male in good condition, the other has lost most of its tarsi. In addition there are two specimens in AM each labelled 'Holotype'. Presumably these are the specimens designated by McKeown 1948. One, without locality and labelled only 'K19395' is a specimen of *H. albipes*, the other with the same number is labelled '*Hydrophilus gayndahensis* Gayndah' and is a specimen of *H. gayndahensis*. I feel reasonably certain that the true holotype is among these specimens and herein designate the specimen labelled '*Hydrophilus gayndahensis* Gayndah' in AM as the lectotype and the Macleay Museum specimens as paralectotypes.

Hydroporus picicornis Chevrolat. Not located. Type locality given as Cuba by Chevrolat but this locality has been discounted by most authors (cf. Bedel 1891; Knisch 1924).

Hydrophilus ruficornis Boisduval. Not located. Type locality, 'Nouvelle Hollande'. It is possible that this is the same insect as *H. picicornis*. It is however an occupied name having been used in 1833 by Klug for a Madagascan species.

Hydrophilus sabelliferus Fairmaire, male, labelled 'Hydrophil sabelliferus Fairm L. Viti-leon' from collection Leon Fairmaire 1906, in MNHP. I herein designate it lectotype since it is unclear whether this is a holotype or a syntype. Synonymy based on examination of types and description of *H. picicornis*.

Remarks

Readily recognisable from all other Australasian *Hydrophilus*, except *H. loriai*, by long sternal carina, which reaches ½ length of abdomen, and by the abdominal segments completely covered by pilosity; separated from *H. loriai* by characters given under that species.

Distribution

Coastal Australia from the Kimberly to northern New South Wales (Fig. 17), New Guinea and other islands to north of Australia.

A widespread species through Indonesia, New Guinea, Pacific Islands and northern Australia. I have not seriously studied the northern or western geographic boundaries of this species but consider specimens seen from Vietnam and the Philippines should be included. There is a north–south trend in size with specimens from Sulawesi and the Philippines averaging considerably larger than those from Australia.

Additional Localities

W.A. — Drysdale R. ANIC, Mitchell Plateau ANIC. QLD — Ayr ANIC, Biggenden ANIC, Brisbane ANIC, BMNH, Bundaberg ANIC, Cairns ANIC, Cooktown QDPI, Edungalba ANIC, Ingham ANIC, Innisfail QDPI, Iron Range ANIC, Lamington Nat. Pk ANIC, Mareeba QDPI, Mt Spec ANIC, Nambour ANIC, Ravenshoe ANIC, Rockhampton ANIC, AM, Samford ANIC, Tolga QDPI, Tully ANIC. N.T. — Adelaide R. NTM, Cobourg Pen. ANIC, Daly River Crossing ANIC, Daly R. SAMA, Darwin ANIC, Gove NMV, Humpty Doo QDPI, Jabiru NTM, Koongarra ANIC, Mt Cahill ANIC, Nabarlek Dam ANIC, Nourlangie ANIC, NMV, 12°34'S 131°18'E NTM. N.S.W. — Bonville ANIC, Iluka AM, Kempsey ANIC, SAMA, Lismore AM, Macleay R. ANIC, Pt Macquarie AM, Repton AM. A.C.T. — Black Mt ANIC. Other — Fiji BMNH, Finesterre Mts (P.N.G.) BMNH, Java SAMA, 90 km W Lae (P.N.G.) BMNH, Mimika R. (P.N.G.) BMNH, Pt Moresby (P.N.G.) BMNH, Pt Yiperres (P.N.G.) BMNH, Sulawesi BMNH.

Hydrophilus loriai (Regimbart)

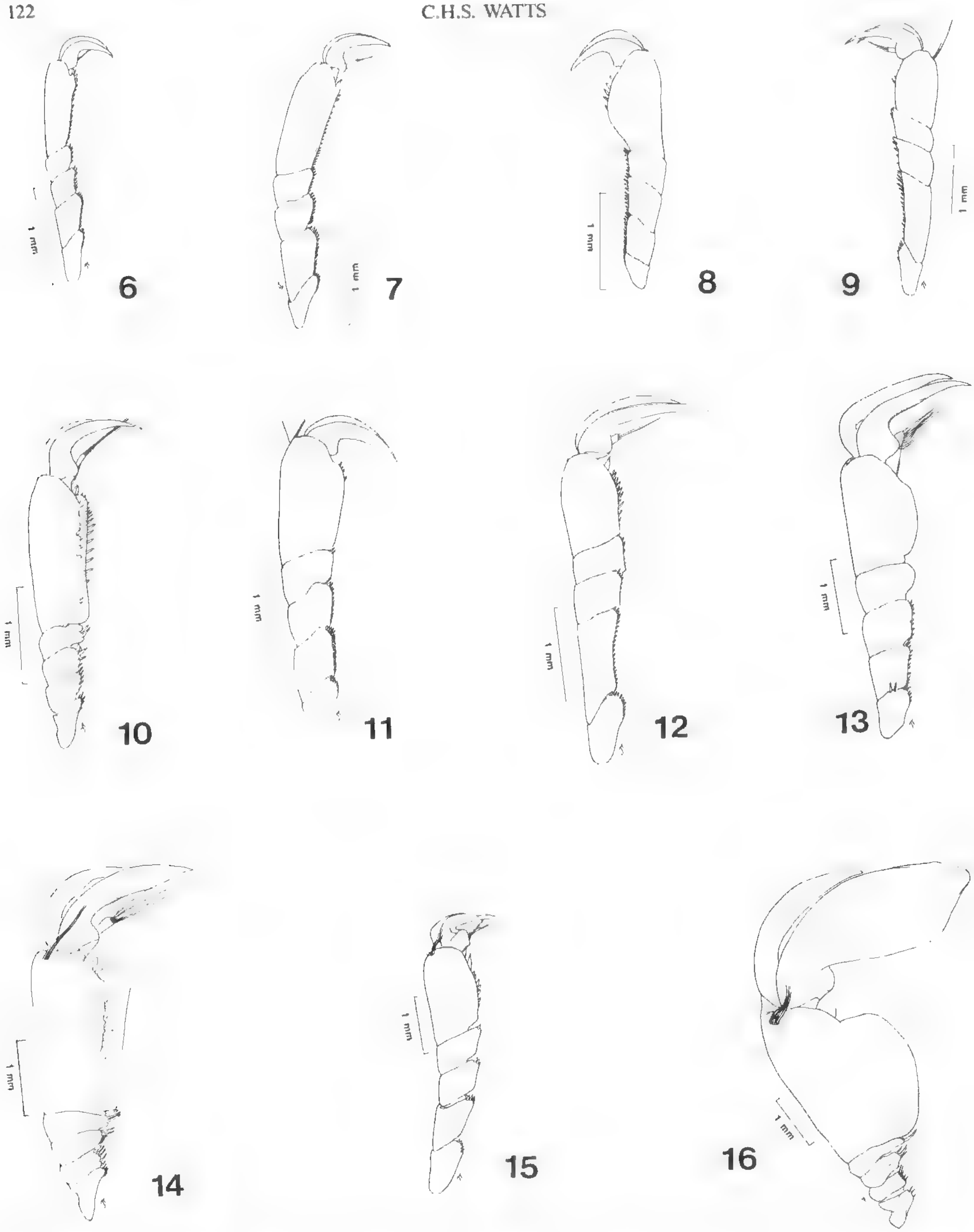
Stethoxus loriai Regimbart, 1902, p. 193.
Hydrous gebieni Knisch, 1922, p. 108, syn. nov.

Description (number examined 9)

Length 31–33 mm. As for *H. picicornis* except as follows. Generally larger. Apex of elytron backcut towards sutural edge which usually has a small but well-marked spine. Sternal carina broad in front, narrowing behind, mesosternal portion broadly and deeply sulcate (Fig. 4) whereas in *H. picicornis* the carina is narrower and has a much weaker groove (Fig. 5). Apical portion of sternal carina tending to bend upwards so as to remain equidistant from abdomen whereas in *H. picicornis* it is almost invariably straight or bent downwards away from the abdomen. The tips of the parameres are more swollen in this species.

Types

Stethoxus loriai Regimbart. Holotype male labelled 'L.Loria/Muso Civ Genova' with handwritten label 'loriai Reg' in MNHP. I herein desig-



FIGURES 6–16. Protarsus of male: 6, *H. viridis*; 7, *H. infrequens*; 8, *H. albipes*; 9, *H. picicornis*; 10, *H. brevispina*; 11, *H. australis*; 12, *H. loriae*; 13, *H. pedipalpus*; 14, *H. novaeguinea*; 15, ditto *H. latipalpus*; 16, *H. macronyz*.

nate it lectotype since it is unclear whether this is a holotype or a syntype.

Hydrous gebieni Knisch. Not located (not in BMNH, MNHP, or Brussels). Synonymy based on examination of type and description of *H. gebieni*.

Distribution

New Guinea; L. Loria, Amboin (ANIC), Lae and Humboldt Bay District, Irian Jaya (in BMNH), Kaiserin Augusta River (type locality of *H. gebieni*). The four specimens from Amboin, New

Guinea, (Col. H. Ohlmus 16/10/74) agree well with the type except that they are noticeably broader.

Remarks

The differences between *H. loriai* and *H. picicornis* are slight and at first I considered the former only a subspecies of *H. picicornis*. However the three Amboin specimens were collected together with typical *H. picicornis* which virtually rules out subspecies. This and the lack of specimens with intermediate characters, particularly the broadly sulcate sternal carina, have persuaded me to treat *H. loriai* as a good species.

Hydrophilus australis Montrouzier

Hydrophilus australis Montrouzier, 1860, p. 248; Fauvel, 1883, p. 351; *Stethoxus australis* (Montrouzier), Fauvel, 1903, p. 351; Bedel, 1891, p. 317; Kuwert, 1893, p. 87; Regimbart, 1902, p. 207. *Hydrous australis* (Montrouzier), Knisch, 1924, p. 247.

Description (number examined 26)

Length 32–36 mm. Oval, dark olive-green to black. Appendages of head, a well marked spot at sides of each abdominal segment, the membraneous hind edge of abdominal segments 2–4 and hind portion of emarginate area on clypeus reddish-yellow. Head with clypeus deeply and widely emarginate, 40–60 large punctures on frons area, densely covered with extremely small punctures with scattered larger ones. Pronotum punctured as on head, with a distinct groove around lateral edge, except for hind angle, and along front margin to about ½ way to centre, some large punctures towards sides. Elytron punctured as on head with a minute reticulation, four longitudinal rows of rather sparse scattered large punctures, each row flanked on either side by a row of small punctures, towards apex these become more noticeable than main rows of punctures, towards front virtually untraceable. Apex of elytron rounded, with well-marked small spine. Sternal carina quite broad particularly towards front where it is deeply and widely grooved, weakly but sharply grooved towards rear, spine sharp, reaching to or just beyond base of 2nd abdominal segment. Posternal pillar pointed, deeply grooved for receiving end of sternal carina. Lateral plate of mesosternum relatively long and narrow. Metatibia relatively narrow, equal to or a little less than width of second abdominal segment. Metacoxal plate narrow, a little narrower than metatibia. Pilose portion of 1st abdominal segment reduced to narrow band along front margin, that on other abdominal segments about ¼ width of segments, both virtually lacking in setae. Abdominal segments 2–5 with broad, rather ill-defined roofing, groove around edge of apical abdominal segment lacking in apical ⅓.

Female: protarsi not expanded [segment $5<(2>3>=4<1)$ in length].

Male: protarsi as in Fig. 11. Claws thin, curved, subequal [segment $5<(2>3=4<1)$ in length]. Parameres flat, aedeagus relatively short, opening of spermathecal duct beyond middle.

Type

A specimen of unknown sex, labelled 'Hydrophilus Australis Montr, N. Caledonie' in MNHP from Coll. L. Bedel, 1922. The specimen lacks palps and protarsi. Since it is unclear whether this is a holotype or syntype I herein designate it as lectotype.

Distribution

New Caledonia.

Remarks

Separated from the other large *Hydrophilus* of the region by having the tips of the elytra distinctly spined and the spine of the sternal carina reaching at least to the second abdominal segment.

Hydrophilus brevispina Fairmaire

Hydrophilus brevispina Fairmaire, 1879, p. 80; Fauvel, 1883, p. 351. *Stethoxus brevispina* (Fairmaire), Bedel, 1891, p. 317; Regimbart, 1902, p. 208. *Hydrous brevissimus* Kuwert, 1893, p. 87, either a mistake or unjustified emendation of *Hydrous brevispina* Fairmaire, 1879; Blackburn, 1896, p. 225. *Hydrous brevispina* (Fairmaire), Knisch, 1924, p. 247. *Hydrophilus scissipalpis* Blackburn, 1901, p. 128, syn. nov. *Hydrous scissipalpis* (Blackburn), Knisch, 1924, p. 257.

Description (number examined 219)

Length 27–35 mm. Elongate oval. Dark olive-green, appendages reddish, an orange-yellow patch in middle of each ventral abdominal segment at sides. Head with clypeus deeply and widely elongate, exposed portion yellowish, 60–80 large punctures in frons area, densely covered with much smaller punctures of two sizes, smallest very small but well-marked. Pronotum punctured on head, with distinct groove around lateral edge and for about ¼ way along front margin, some large punctures inwards of this groove in front angles. Elytron punctured as on head with four longitudinal rows of scattered punctures in weak depressions, flanked on either side by a row of extremely small punctures only noticeable in some lights; apex of elytron bluntly rounded, not truncated. Sternal carina narrow, flat in front, weakly but sharply grooved in hind quarter, a short sharp ridge in midline at rear of mesosternal portion in some, spine short, blunt reaching to about ½ way across first abdominal sternite. Prosternal pillar thin, pointed, open with little or no hood over groove for sternal carina. Lateral plate of mesosternum relatively short and broad. Metatibia relatively broad, a little larger than width of 2nd abdominal segment. Pilose portion of 1st abdominal segment to about ⅓ width. Rugose portions of other abdominal segments reduced to small patches in front angles at sides about ⅓ width of segment. Abdominal segments weakly roofed in midline. Groove around edge of apical abdominal segment complete or only broken for short distance at apex. Metacoxal lobe narrow, narrower than width of metatibia.

Female: protarsi not expanded [segment 5 - (2>3>4>1) in length], claws subequal with large subbasal tooth.

Male: protarsi as in Fig. 10. Segment 5 expanded with membrane like flap on bottom front margin [segment 5> >(1 - 2 - 3 - 4) in length]. Claws elongate, outer larger and thinner than inner. Second joint of maxillary palpi expanded slightly triangularly inwards near apex. Aedeagus thin, weakly expanded at tip. Parameres weakly hooked on outside of tip. Opening of spermathecal duct midway along aedeagus.

Types

Hydrophilus brevispina Fairmaire. Not located. Type locality, Brisbane.

Hydrophilus scissipalpis Blackburn. Holotype, '697] Central Australia', BMNH. Synonym based on description and examination of type.

Distribution (Fig. 17)

Widespread throughout Australia except for the south-east and Tasmania and possibly also the south-west.

H. brevispina is often confused with *H. albipes* but is readily separated from that species by its much more robust metafemora as well as characters given in the key. Both species are relatively common and are widely sympatric. However *H. brevispina* occurs much further north than *H. albipes*. *H. albipes* is common in south-eastern Australia, Tasmania and the south-west where *H. brevispina* is absent.

Remarks

H. brevispina is moderate-sized, stout, dark olive-green species readily recognized by the complete groove on the apical abdominal segment, small amount of pilosity on abdominal segments, stout metafemur, narrow posternal pillar and relatively large marginal groove along front edge of pronotum.

Additional Localities

VIC. — Ouyen ANIC, Wyperfeld ANIC, 73 km W N.S.W. — Armidale ANIC, 32 km SSW Bourke SAMA, Byrock ANIC, Deniliquin NMV, Dubbo NMV, Glen Innes AM, Grafton ANIC, Milparinka SAMA, Mitchell AM, Mootwingee ANIC NMV, Moree AM, Mt Hope ANIC, Paroo R. BMNH, Parkes AM, Singleton ANIC, Tamworth ANIC, Tibooburra ANIC, Tooraweenah ANIC, Trangie ANIC, Wanaaring ANIC, Willandra Bridge ANIC, Wyvern Bringagee AM. QLD. — Alexandria Stn AM, 49 km SW Arrilalah ANIC, Ayr QDPI, Bedourie ANIC, 138 km NW Bedourie AM, Biggenden ANIC, Bowen SAMA, Burnett R. ANIC, Calliope R. ANIC, Camooweal ANIC, Chillagoe ANIC, Coopers Creek BMNH, Cunnamulla ANIC AM SAMA, Durham Downs ANIC, Eidsvold AM, Emerald ANIC, Funnel Ck ANIC, Glenormiston ANIC, Goondiwindi ANIC, 48 km ESE Hungerford ANIC, 35 km SE Ilfracombe ANIC, Lake Dynevor ANIC, Lawn Hill ANIC, Longreach ANIC, Mackay AM, Mareeba QDPI, Mitchell SAMA, Mt Spec ANIC, Noccundra ANIC, Nockatunga ANIC, Normanton SAMA, Rockhampton ANIC SAMA, 40 mile Scrub ANIC, Silver Plains ANIC, Somerset Dam ANIC, Tanbar ANIC, Taroom ANIC, Thylungra ANIC, 10 km E Tjabulka AM, Townsville ANIC BMNH QDPI, 90 m S Urandangie ANIC, Warwick AM, Wilson R. ANIC, Yeppoon ANIC (BMNH). S.A. — Anna Ck Stn SAMA, 26 km NW Alberga RS SAMA, Blinman SAMA, Cadelga O.S. SAMA, Callabonna SAMA, Cameron Corner SAMA, Coward Spr. 40 km E Frome Downs SAMA, Hay R. Simpson Desert SAMA, Iron Duke SAMA, Kalamurina Stn SAMA, Lake George ANIC, Mabel Ck Stn SAMA, 28 km SSW Mabel Ck Stn SAMA, Marree SAMA, Mt Serle SAMA, Oodnadatta NMV SAMA, Strathearn HS SAMA, Stuart Ck Stn SAMA. N.T. — Alexandria BMNH, Alice Springs SAMA NTM, 1 km N Barrow Ck NTM, Borroloola ANIC, Glenormiston Stn SAMA, Hermannsburg BMNH, Kings Canyon NTM, McArthur R. ANIC, 19 km SW Mt Cahill ANIC, Simpson Gap NTM SAMA, 41° S 133° 25′E NTM, 24° 05′S 134° 00′E NTM, Yuendumu ANIC. W.A. — Ashburton R. WAM, Barradale ANIC, Cane River HS ANIC, Cape Bertholet ANIC, Carnarvon-Exmouth Rd BMNH, Kununurra ANIC, Minilya R. ANIC, Prairie Down Stn SAMA, Wuranga ANIC.

Hydrophilus albipes Castelnau

Hydrophilus albipes Castelnau, 1840, p. 51. *Stethoxus albipes* (Castelnau), Bedel, 1891, p. 317; Regimbart, 1902, p. 207. *Hydrophilus albipes* Castelnau, Blackburn, 1896, p. 255. *Hydrous albipes* (Castelnau), Kuwert, 1893, p. 87; Knisch, 1924, p. 245.

Description (number examined 487)

Length 20-31 mm. Narrowly oval. Black, appendages reddish, diffuse reddish patches at sides of abdominal segments. Head with clypeus quite deeply and widely emarginate, exposed portion yellow only in hind half, 60-80 large punctures on frons, densely covered with small but well-marked punctures of two main sizes, the large less numerous than the smaller. Pronotum punctured as on head, with distinct groove around lateral sides and a short distance along front margin; some large punctures inward of this groove in front angles. Elytral punctures as on head, with four longitudinal rows of scattered punctures, flanked on either side by a row of extremely small punctures only visible anteriorly in certain lights but well-marked at apex. Apex of elytron rounded, with very small spine in extreme apex. Sternal carina thin, a little broader in area of mesosternum, flat except for weak sharp groove towards rear, spine short blunt reaching to about ⅓ width of first abdominal segment. Prosternal pillar broad, bluntly pointed, groove for sternal carina reaching only about ½ depth of pillar. Lateral plate of mesosternum relatively narrow. Metatibia relatively narrow, a little narrower than 2nd abdominal segment. Rugose portion of first abdominal segment covering all but narrow area along hind edge, hind angles and midline of segment, lateral portions on other abdominal segments about ⅓ width of segment. Anterior abdominal segment quite strongly roofed in midline. Groove around edge of apical abdominal segment lacking in apical ¼. Coxal lobe narrow, narrower than metatibia.

Female: protarsi not expanded [segment $5<(2>3>4>1)$ in length], claws with a large basal tooth.

Male: protarsi as in Fig. 8 [segment 5 expanded, particularly on bottom front margin [segment $5<(2=3>4>1)$ in length]. Claws stout, inner a bit stouter and a little shorter than outer. Palpi normal. Aedeagus and paramere long and thin. Opening of spermathecal duct ⅓ way along aedeagus.

Type

Hydrophilus albipes Castelnau. Not located. Type locality given as New Holland.

Distribution (Fig. 17)

A widespread southern species.

Remarks

H. albipes is a small, narrow, black species separated from other *Hydrophilus* by its small size, short sternal carina, incomplete groove around edge of apical abdominal segment, slim metafemur, and with row of setae on outer face of protibia only about ½ length of tibia.

Additional Localities

N.S.W. — Balranald ANIC, Bathurst AM, Binnaway AM, Broken Hill SAMA, Canberra ANIC, Corowa ANIC, Deniliquin ANIC, Girilambone ANIC, Gundaroo ANIC, Hay ANIC, Louth AM, Marrabui BMNH, 24 km ENE Broken Hill AM, 5 m S Mendooran AM, Mitchell AM, Moree MM, Mt Moodie ANIC, Mudgee ANIC, Rylstone SAMA, Silverton ANIC, Singleton ANIC, Trangie ANIC, Uralla ANIC, Wagga Wagga ANIC, Willandra Bend ANIC, Yagobie ANIC, Yanco AM. VIC. — Benambra AM, Bendigo ANIC, Bundoo Rng. AM, Euroa NMV, Gelibrand NMV, Grampians ANIC AM, Halls Gap SAMA, Hattah lakes ANIC SAMA, Kerang AM, Kulkyne Forest ANIC, Lady Julia Percy I. AM, Little Desert ANIC, Melbourne BMNH, Frankston AM, Melbourne NMV BMNH SAMA, Moe ANIC, Moyston ANIC, Otways SAMA, Sealake ANIC, Terang ANIC, Warragul ANIC, Warranabool NMV, Wyperfield Nat. Pk ANIC, Yanac ANIC. S.A. — Adelaide BMNH SAMA, Beachport SAMA, 23 m NE Billa Kalina HS SAMA, Bool Lagoon SAMA, Coward Sp. SAMA, Etadunna WAM, Fairview Park Con. Res. SAMA, 40 km E Frome Downs SAMA, Frome R. Crossing SAMA, Kangaroo I. AM, Koonamore Stn SAMA, Lake Callabonna AM SAMA, Lake Eyre SAMA, Monarto SAMA, Mungerannie Stn SAMA, Mylor SAMA, Nangwarry SAMA, Naracoorte SAMA, Parachilna SAMA, Penola SAMA, Taratap Stn SAMA, Waitpinga SAMA, Whyalla NMV, Yunta SAMA. TAS. — Carlton ANIC, Hobart SAMA, Launceston NMV SAMA, Longford ANIC. W.A. — Albany WAM, Armadale WAM, Boxwood Hill ANIC, Bullsbrook WAM, Cape Arid ANIC, Cervantes ANIC, Claremont ANIC, Culcurdool WAM, Darling Rng. AM, Esperance ANIC, 63 km E Esperance ANIC, Forrestdale WAM, Geraldton ANIC, Guilderton ANIC, Helena R. WAM, Hopetown ANIC, Kalbarri Nat. Pk ANIC, Mt Arid ANIC, Point Peron WAM, Preston R. ANIC, Thomas R. ANIC, 10 m SW Three Springs SAMA, Wanneroo WAM, Wilga ANIC.

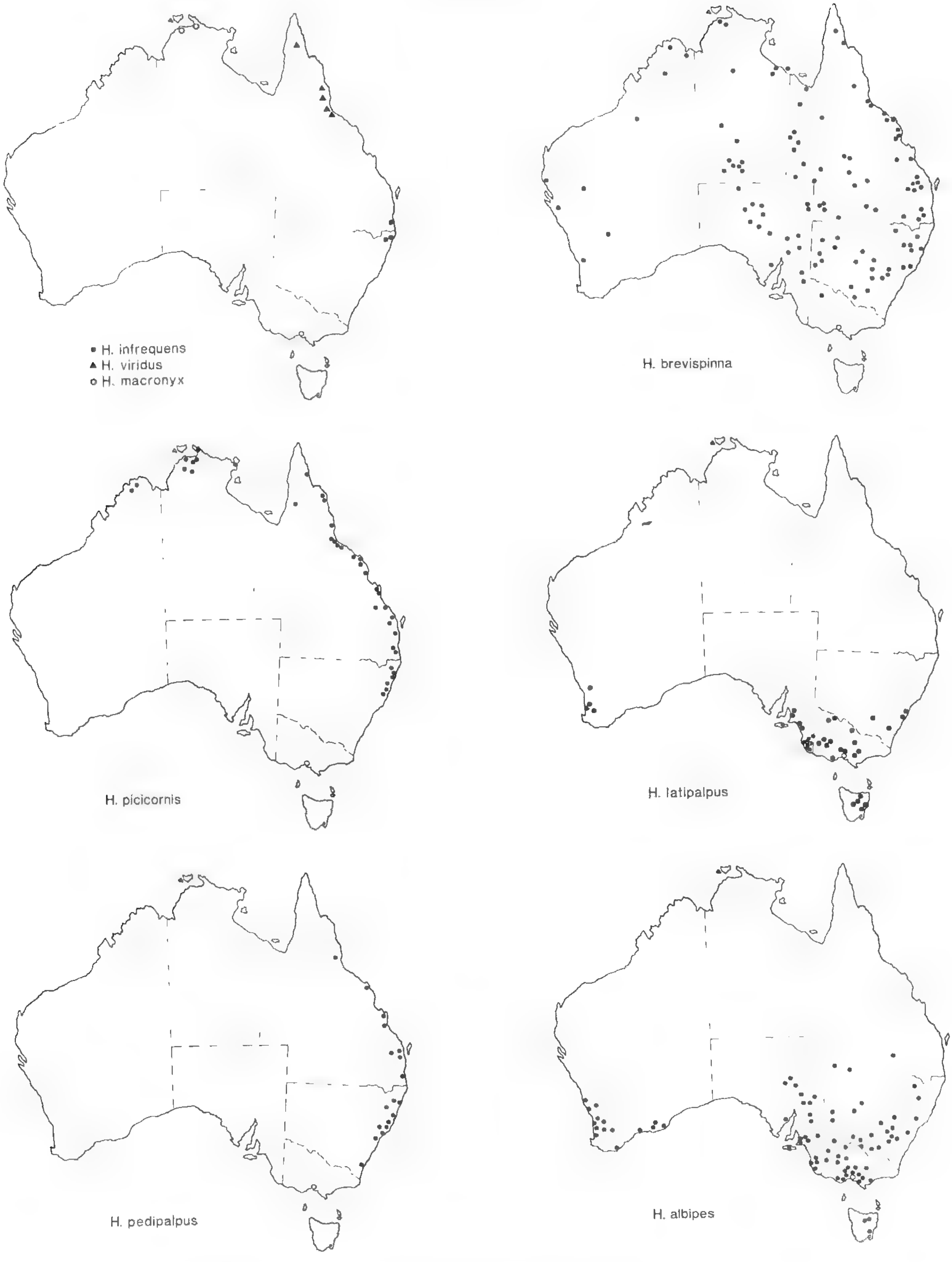


FIGURE 17. Distribution maps of Australian *Hydrophilus* species.

Hydrophilus infrequens sp. nov.

Description (number examined 3)

Length 24–25 mm. Oval. Upper surface, when dry, varying from dark with olive-green tinges to dark with reddish tinges, elytra with vague dark strips in serial puncture lines, at higher magnification elytra covered with thin black interdigitating lines more noticeable in greenish individuals. Ventral surface black, appendages of head and lateral patches on abdominal segments reddish. Head shallowly emarginate for about half width of frons, basal half of exposed portion yellowish, front portion black. About 60 large punctures lying in two V-shaped weak grooves on frons, which is densely covered with small but well-marked punctures predominantly of two sizes with the smaller more numerous. A well-separated pair of pits bearing long setae in middle of frons. Pronotum punctured as on head, with a distinct groove along lateral edges and along front edge for a very short distance, a few groups of 2 large punctures towards sides. Elytron with lightly impressed line reticulation and scattered very small punctures of variable sizes, also four loose rows of large punctures flanked on each side by a row of punctures which are subobsolete towards front but as large as serial punctures at apex. Band of closely placed but scattered punctures along lateral edge of elytron. Apex of elytron rounded. Sternal carina, flat, broad, particularly mesosternal portion, constricted between mesocoxae and narrowing at both front and rear end, spine blunt reaching a little over ½ width of first abdominal segment. Prosternal pillar pointed, groove to receive sternal carina narrow about ½ width of pillar in depth. Lateral plate of mesosternum narrow, relatively long, metacoxal plate narrow, both narrower than width of metafemur which is about same width as second abdominal segment. Pilose area on underside covers all abdominal segments except for approximately the central half of segments 2–5.

Female: protarsi not expanded, protarsal claw with small spine on underside about middle [segment 5<=(2>3>4=1) in length].

Male: protarsi as in Fig. 7. Segments a little thicker than in female and slightly expanded on front bottom edge. Claws simple, evenly curved along outer edge. Segment 5=(2>3=4=1) in length. Parameres short, broad. Aedeagus with spermathecal duct opening near tip.

Types

Holotype: ♂ '28°52'S 153°03'E Casino, N.S.W, 12.XII.1971, Key and Balderson', 'at light' in ANIC. Paratypes: 1, ♂ 'Brisbane 1/30' 'J.G. Brooks Bequest 1976'; 1, ♂, '1 ml N of Brunswick Heads N.S.W. 1 Jan 1973 R.J. Kohout', in ANIC.

Distribution (Fig. 17)

Known only from the type localities on the east coast near the New South Wales/Queensland border.

Remarks

This and *H. viridus* are closely related and separated from other Australasian *Hydrophilus* by the extensive lateral pilosity on the abdominal segments and the presence of a pair of setae bearing pits or a tight group of large punctures on the front of the frons. *H. infrequens* is separated from *H. viridis* by its generally larger, darker and more rounded shape, stronger punctation on upper surfaces, slight difference in pilose area on underside, broader tip to the parameres, spermathecal duct opening at end of adeagus rather than further down, and slightly more robust male protarsi.

Hydrophilus viridis sp. nov.

Description (number examined 4)

Length 18–21 mm. Elongate oval, Olive-green, extreme edges of elytron, pronotum and scutellum black, two small black spots at rear of pronotum. Underside black, legs reddish, appendages on head yellow-brown. Head deeply but rather narrowly emarginated, basal half of exposed portion yellow-brown, front portion black, 70–90 large punctures lying in two V-shaped weak grooves on frons, a well-separated pair of small pits in middle of frons with large setae emerging from them, densely covered with small but well-marked punctures of varying sizes. Pronotum punctured as on head, with distinct groove around lateral edge and along front edge for a short distance, a few groups of large punctures towards sides. Elytron with fine reticulation and scattered minute punctures, also four loose rows of large punctures flanked on each side by a row of very small punctures more distinct towards apex. Apex of elytron rounded. Sternal carina wide, constricted between mesocoxae and narrowing at both front and rear, spine blunt, reaching to beginning of second abdominal segment. Prosternal pillar pointed, narrowly but not deeply grooved for reception of sternal carina. Lateral plate of mesosternum narrow, relatively long, metacoxal plate narrow, both narrower than metafemur which is about width of 2nd abdominal segment. Pilose area of underside covers all abdominal segments except for central ½ of segments 2–5.

Male: protarsi as in Fig. 6. Segments not expanded, claws simple, sharply bent near base [segment 5>=(2>3=4=1) in length]. Parameres short, broad. Aedeagus with spermathecal duct opening around middle.

Distribution (Fig. 17)
Known only from the type localities in coastal northern Queensland.

Types
Holotype: ♂ '14m. S. Coen.N.Q. 780' 18.5.72. J.G. Brooks' 'At light' 'B 73 of 82' in ANIC. Paratypes: 1, ♂ 'Ingham Qld 24.2.1960 K.L. Harley' in ANIC; 1, ♂ 'Townsville Qld. 19.4.63 C.W.' in CW; 1, ♀ 'Atherton 14.XII.58. G. Ettershank' in QM.

Remarks
A rare species with a pronounced olive-green colour when dry. Separated from the closely related *H. infrequens* by characters given under that species.

Hydrophilus novaeguineae sp. nov.

Description (number examined 6)
Length 32-43 mm. Elongate oval. Black, appendages of head and small round patches at sides of abdominal segments dark-reddish. Head with clypeus deeply emarginate for about half width of clypeus, exposed portion dark reddish in front half, 60-80 large punctures on frons in addition to a dense patch inwards from each eye, moderately densely covered by small but variably-sized punctures. Pronotum punctured as on head, with a distinct groove around lateral edge and a short distance along front edge, scattered large punctures towards sides. Elytron punctured as on head with four longitudinal rows of scattered well-impressed setae-bearing punctures each flanked by a row of very small punctures, virtually untraceable towards front, and a single line of close punctures adjacent to lateral edge. Apex of elytron rounded without spine. Sternal carina slightly swollen, sharply but weakly grooved in final section, widely but very shallowly grooved in front section, hind portion of front section with distinct midline carina, hind end of front section slightly above front end of rear section; spine blunt and short, reaching a little more than halfway across first abdominal segment. Prosternal pillar sharply pointed only shallowly grooved to take sternal carina. Lateral plate of mesosternum short, relatively broad. Metatibia stout, noticeably wider than 2nd abdominal segment, metacoxal plate narrower than metafemur. Pilose portion of 1st abdominal segment covering about ⅓ of width of segment, that on sides of other segments about ⅓ of width of segments. Abdominal segments 1-4 weakly roofed in midline. Groove around edge of apical abdominal segment absent in apical portion.

Female: protarsi, segment 5 > > (2 = 3 = 4 > 1) in length, claw with strongly developed spine underneath in about middle. Front section of sternal carina flat. Groove on prosternal pillar deeper than in male. Labial palpi stout.

Male: protarsi as in Fig. 14, segments 1-4 same length, short, progressively more expanded, segment 5 twice length of other segments combined and with thin projection along front edge about half width of rest of segment (segment 5 > > (1 = 2 = 3 = 4) in length). Claws considerably enlarged, outer about ⅓ again length of inner. Maxillary palpi with apex of second segment weakly expanded and flat, labial palpi expanded, much stouter than in female. Genitalia broad, tip of paramere curved, terminating in small sharp spines, aedeagus relatively thick and short, spermathecal duct opening a little below tip.

Types
Holotype: ♂ 'Papua 9 ml. NE. by N. of Port Moresby. 9°22'S 147°13'E, 23 viii. 1970, Key and Balderson. (Key's field notes; Trip 167, stop 21050.8). At light', in ANIC. Paratypes: 2, ♀ 'New Guinea, Port Moresby (Mt. Lawes, 1300 ft.), 5.3-12.5.1963. W.W. Brandt.' in ANIC.

Distribution
New Guinea; known only from the type localities and Amboin (in ANIC and CW).

Remarks
The large size, relatively short, broad male genitalia with hooked tips to parameres, robust metafemur, and small amount of pilosity on first abdominal segment, ally *H. novaeguineae* to *H. macronyx*. It is separated from that species by the much less elaborate male protarsi, thickened labial palpi and the spine on the underside of the protarsal claws in the female being towards the middle of the claw rather than at the base.

Hydrophilus pedipalpus (Bedel 1891) comb. nov.

Stethoxus pedipalpus Bedel, 1891, p. 317; Kuwert, 1893, p. 87; Regimbart, 1902, p. 210. *Hydrous pedipalpus* (Bedel), Knisch, 1924, p. 250.

Description (number examined 72)
Length 35-46 mm. Elongate oval. Black, appendages of head, and round patches at sides of abdominal segments dark-reddish. Head with clypeus deeply emarginate but for a relatively short distance (deepest point ½ width of clypeus). Exposed portion dark reddish in hind half, 60-80 large punctures on frons, densely covered with very small but variably sized punctures. Pronotum punctured as on head, with a distinct groove around lateral

edge, except hind ⅓th, virtually absent from front margin, with scattered large punctures towards sides. Elytron punctured as on head with four longitudinal rows of scattered weakly-impressed large punctures, these are flanked on each side by a row of very small punctures, distinct towards extreme apex but over much of elytron virtually lacking and only visible in certain lights, not lying in grooves except extremely weak ones at extreme apex. Apex of elytron weakly truncated with small blunt spine. Sternal carina swollen, constricted between mesocoxae, weakly grooved in hind portion, broadly and quite deeply grooved in front portion. Spine short, blunt, reaching to about halfway across 1st abdominal segment. Posternal pillar sharply pointed, groove for reception of sternal carina relatively shallow, reaching less than halfway into pillar on top edge. Lateral plate of mesosternum short, relatively broad. Metafemur quite broad, a little wider than 2nd abdominal segment. Metocoxal plate narrow, narrower than metafemur. Pilose portion of 1st abdominal segment covering well over ½ width that segment, that on sides of other abdominal segments about ⅓ width of segment. Abdominal segments 1-4 roofed in midline. Groove around edge of apical abdominal segment lacking in apical ⅙-⅕.

Female: protarsi not expanded [segment 5< <(2>3>4>1) in length]. Front portion of sternal groove flat, groove on prosternal pillar deeper than in male.

Male: protarsi as in Fig. 13. Segments 5 and 4 and portion of 3 enlarged, particularly on outer bottom edge [segment 5< <(2<3=4>1 in length], claws elongate, strongly curved at base, subequal in length, inner stouter than outer. Maxillary palpi with first segment expanded particularly in apical ⅓ where it is deeply excavated below, apical segment short and stout. Labial palpi with first segment expanded. Genitalia with paramere tips broad and flat, aedeagus relatively thick, spermathecal duct opening below middle.

Type

A male labelled 'Australia E. Deipolle/Pedipalpus Bed', in MNHP. Since it is unclear whether this is a holotype or syntype, I hereby designate it lectotype.

Distribution (Fig. 21)

Coastal eastern Australia from Victoria northwards. A more northern species than the quite similar *H. latipalpus*. These species occur sympatrically on the south coast of New South Wales. *H. pedipalpus* differs from *H. latipalpus* by the weaker development of elytral striae, by the flat anterior portion of the sternal keel in both sexes and the strongly expanded maxillary and labial palps in the male.

Additional Localities

QLD. — Atherton, Biggenden ANIC, Brisbane AM, Edungalba ANIC, Julatten AM, Proserpine ANIC WAM, Rockhampton BMNH, Surfers Paradise ANIC QDPI, Yeppoon ANIC. N.S.W. — Alstonville AM, Armidale ANIC, Casino ANIC, Cessnock AM, Clarence R. BMNH, Evans Head ANIC, Fairfield BMNH, Kempsey SAMA, Macleay R. ANIC, Maitland ANIC, Pt Macquarie AM, Roseville AM, Tamarong AM, Terrigal ANIC, Tyndock AM, Wang Wauk AM, Wauchope AM.

Hydrophilus latipalpus Castelnau

Hydrophilus latipalpus Castelnau, 1840, p. 51. *Stethoxus latipalpus* (Castelnau), Bedel, 1891, p. 317; Regimbart, 1902, p. 209. *Hydrous latipalpus* (Castelnau), Kuwert, 1893, p. 87; Knisch, 1924, p. 249.

Description (number examined 121)

Length 30-41 mm. Oval. Black, patches at sides of abdominal segments and appendages of head lighter. Head with clypeus deeply emarginate, 100-120 large punctures in frons area, densely covered with small punctures of two sizes, the smaller sizes predominating. Pronotum punctured as on head, with a distinct groove around lateral edge except hind ⅛, and for a short distance along front margin, with numerous large punctures inwards of groove in front angles. Elytron punctured as on head with four longitudinal rows of scattered large punctures, these are flanked on each side by well marked rows of scattered small punctures which, except on disc, and particularly towards apex, lie in shallow grooves. Apex of elytron bluntly rounded. Sternal carina thin, flat except for well-marked groove in midline toward rear, spine short, sharply pointed, reaching to about base of 2nd abdominal segment. Prosternal pillar sharply pointed, groove for sternal carina deep. Lateral plate of mesosternum short, relatively broad. Metatibia quite broad, about as wide as 2nd abdominal segment. Metacoxal plate narrow, narrower than metatibia. Pilose portion of 1st abdominal segment covering a bit more than half of segment, that on sides of other abdominal segments reaching a little under half way across segment. Abdominal segments 1-4 quite strongly ridged in midline. Groove around edge of apical abdominal segment lacking from apical ⅓.

Female: protarsi not expanded [segment 5<<(2>3>=4>1) in length], claws elongate each with a basal tooth. Front edge of sternal carina projecting downwards to a variable degree.

Male: protarsi as in Fig. 15, moderately expanded, claws subequal, bent, flattened with small expanded lobe at base [segment 5<<(2>3=4=1) in length]. Maxillary palpi with apical half of second segment greatly expanded, hollow beneath, apical segment a little expanded below apex.

Type

Not located. Type locality given as New-Holland.

Distribution (Fig. 17)

South-eastern and south-western Australia and Tasmania.

Remarks

The commonest of the large *Hydrophilus* in Australia, readily separated from *H. pedipalpus* (and *H. australis* from New Caledonia) by the downward lump at the front of the sternal carina in the female, and the moderately expanded male maxillary palpi and by the stronger development of the elytral striae.

Additional Localities

N.S.W. — Araluen ANIC, Leeton AM, Paroo R. BMNH, Nowra BMNH, Strathfield AM, Sydney AM. VIC. — ANIC, Dimboola SAMA, Grampians SAMA, Hattah Lakes ANIC, Hazelwood ANIC, Latrobe Valley NMV, Little Desert ANIC, Melbourne BMNH, Morwell NMV, Otway Ra. SAMA, Ouyen ANIC, Strathfield NMV, Stawell NMV, Swan Hill ANIC, Wyperfield Nat. Pk ANIC. S.A. — Adelaide SAMA, Bool Lagoon SAMA, Cape Jaffa SAMA, Coorong SAMA, Furner SAMA, Glencoe SAMA, Kingscote (K.I.) AM, Kingston SAMA, Mt Scott SAMA, Naracoorte AM, Penola SAMA, Taratap Stn SAMA. W.A. — Midland WAM, Morgers Lake WAM, Mt Arid ANIC, Perth WAM, Swan R. SAMA, Wilga ANIC. TAS. — Freycinet Nat. Pk ANIC, Launceston SAMA, Longford ANIC, Swansea ANIC, Tasmania SAMA.

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DIAMONDS FROM THE ECHUNGA GOLDFIELD, SOUTH AUSTRALIA

BY F. L. GOMMERS

Summary

Small gem quality diamond crystals have been found by miners working the alluvial gold deposits on the Old Echunga Diggings west of Chapmans Gully near Echunga, 30 km south-east of Adelaide. The first diamonds were recovered in 1859, and in the next fifty years at least 20 and perhaps as many as 50 more were found. The largest stone weighed 5 5/16 ct. Only five of the diamonds found at Echunga last century can be traced; three are in the collection of the South Australian Museum, and two in the collection of the South Australian Department of Mines and Energy. This paper traces the history of the diamond occurrence and establishes the authenticity of stones in the Museum collection.

DIAMONDS FROM THE ECHUNGA GOLDFIELD, SOUTH AUSTRALIA

F.L. GOMMERS

GOMMERS, F.L. 1988. Diamonds from the Echunga Goldfield, South Australia. *Rec. S. Aust. Mus.* 22(2): 131-138.

Small gem quality diamond crystals have been found by miners working the alluvial gold deposits on the Old Echunga Diggings west of Chapmans Gully near Echunga, 30 km south-east of Adelaide. The first diamonds were recovered in 1859, and in the next fifty years at least 20 and perhaps as many as 50 more were found. The largest stone weighed 5 5/16 ct. Only five of the diamonds found at Echunga last century can be traced; three are in the collection of the South Australian Museum, and two in the collection of the South Australian Department of Mines and Energy. This paper traces the history of the diamond occurrence and establishes the authenticity of stones in the Museum collection.

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Manuscript received 9 November 1987.

The South Australian Museum collection contains three diamonds which are purported to have come from the Echunga Goldfield, 30 km south-east of Adelaide (Fig. 1). These specimens are amongst the most frequently examined and studied specimens in the Museum's mineral collection. However, there has long been uncertainty and scepticism over authenticity of the locality data for these stones. The diamonds were reputed to occur with alluvial gold, but no kimberlitic source or indicator minerals were found by early investigators.

Geological units in the Goldfield comprise Holocene and Tertiary sediments, predominantly ferruginous alluvial gravel and sand, unconformally overlying kaolinised slate and schist of Torrensian age. The alluvial gold is thought to have been derived from quartz reefs in the older rocks (Ludbrook 1980).

Background

The discovery of gold in Victoria in 1851 and the ensuing rush to the fields from all parts of Australia prompted the government in South Australia to offer a reward of £1 000 for the discovery of payable gold in the colony.

W. Chapman Snr, R. Hardiman and H. Hampton were first to claim the reward for the discovery of gold, near Echunga in the Mount Lofty Ranges. They were eventually paid £500 by the Government. In 1852 Chapman's son William, who had recently returned from the Victorian goldfields, found alluvial gold near Warland's Wheatsheaf Inn, now known as 'Warrakilla', on the Onkaparinga River. William Chapman and his father traced the gold back to its source in a gully, later to become known as Chapman's Gully (Whimpress 1975). The initial rush here lasted only a few months but, at its height, 600 people were living on the diggings and about 5 000 oz. of gold were found. From 1853 to 1868, further discoveries were made in an area west of Chapman's Gully, notably at Long Gully, Christmas Rush and Poor Man's Hill, and further afield at Donkey Gully and Hahndorf Gully.

In 1868, Thomas Plane and Henry Saunders found a rich field at Jupiter Creek, 3 km south of Chapman's Gully; they received £300 and £200, respectively, from the South Australian Government in reward for their discovery. Jupiter Creek was worked in several phases between 1868 and 1907. Up to 1 500 diggers were working the field at the height of the rush between 1868 and 1871.

The Echunga Goldfield now covered three areas, the Old Echunga diggings (including Chapmans Gully), Jupiter Creek, and the Hahndorf to Mylor area which included Donkey Gully and Biggs Flat (Fig. 1). By 1900, about 400 000 oz. of gold had been recovered and the area had become the state's most productive field. Drew (1984) gives a more complete outline of the geology and history of the workings.

Miners working the Echunga alluvials occasionally found small gem quality diamonds in their pans and cradles. Over the fifty-year period in which the goldfield was active, approximately 50 diamonds were reported to have been recovered (Brown 1908). These appear to have come mainly from the older part of the Echunga diggings west of Chapmans Gully, the principal localities being 'Long Gully', 'International Dam', 'Poor Man's Hill', 'Christmas Rush' and 'New Rush Hill'.

Doubts have been expressed about the occurrence and even the authenticity of these stones.

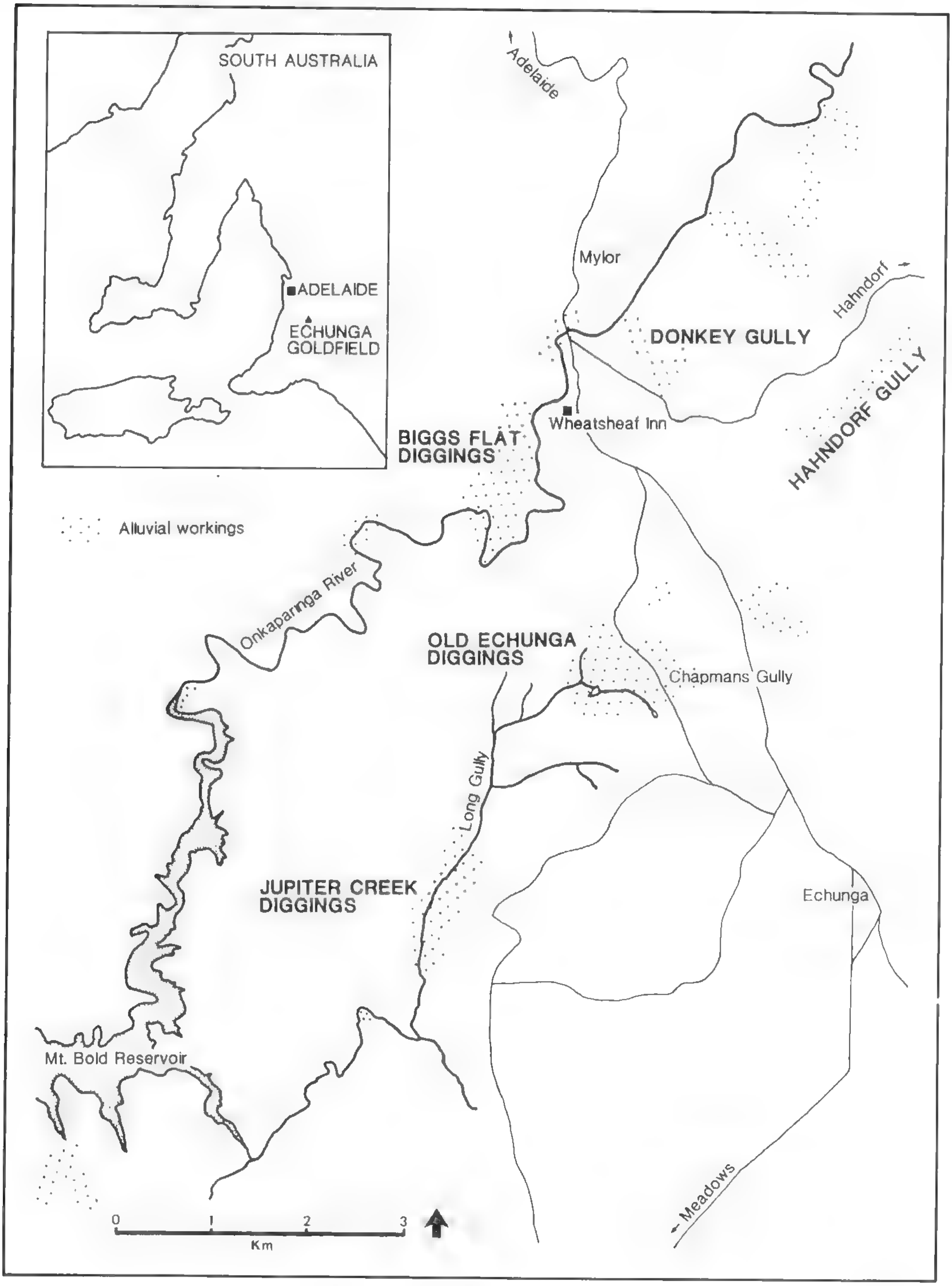


FIGURE 1. Map showing main areas of the Echunga goldfields. Diamonds were found on the Old Echunga Diggings west of Chapmans Gully.

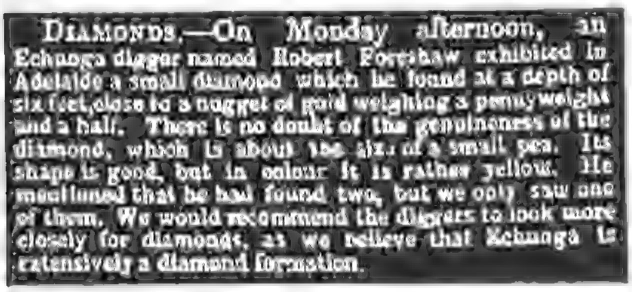
Suggestions were made that diggers returning from the South African fields had been 'salting' the area with diamonds, or that the stones were Brazilian or Indian (Duffield 1909). It is highly unlikely that the stones are South African, however, as the Kimberley field was not discovered until 1866, seven years after the first diamonds were recovered at Echunga.

History of the Diamond Finds

First discoveries

Uncertainty exists as to when and by whom the first diamond was found. The *Adelaide Observer*, a newspaper of the day, reported that Robert Foreshaw found a diamond near Echunga in March 1859 (Fig. 2). The yellow coloured stone was said to be about the size of a small pea, and was found at a depth of 2 m next to a small gold nugget. This seems to be the earliest recorded find.

Tom Hall and his brother Robert also claimed to have found the first diamond, at New Rush Hill. This stone was sold to Mr. E.R. Simpson of the South Australian Company (Hales 1909). No date for this find was given, however.



DIAMONDS.—On Monday afternoon, an Echunga digger named Robert Foreshaw exhibited in Adelaide a small diamond which he found at a depth of six feet, close to a nugget of gold weighing a pennyweight and a half. There is no doubt of the genuineness of the diamond, which is about the size of a small pea. Its shape is good, but in colour it is rather yellow. He mentioned that he had found two, but we only saw one of them. We would recommend the diggers to look more closely for diamonds, as we believe that Echunga is extensively a diamond formation.

FIGURE 2. Report of first diamond find at Echunga from *The Observer*, 26 March 1859.

The *Adelaide Observer* of 21 January 1860 reported:

> A digger named William Hall who had been at work at the new diggings at Echunga, has brought down three supposed diamonds, which he recently discovered there while searching for gold. One is of large dimensions and weighs about an ounce; and the other two are about the size of peas. (*Adelaide Observer*, 21 Jan. 1860)

It seems highly unlikely that the one ounce stone was a diamond, as diamonds of this size (over 140 ct) are extremely rare and valuable. Had a 140 ct diamond been recovered then more extensive reporting of such a find would have been expected; the stone was more probably clear quartz.

By December of 1860, Mr Simpson had purchased 11 diamonds from miners at Echunga; two or three of these were said to be very pure in colour and the size of large peas (*Adelaide Observer*, 15 December 1860). In 1864, Mr Simpson offered two diamonds to the South Australian Institute for £12, which he said were '. . . if not the first found, which I believe, they are by far the most perfect of any yet discovered'. These may have been purchased by the South Australian Government and could be the stones mentioned in Brown (1908) as having been purchased by the Museum authorities. These are not, however, the two uncut stones currently held in the Museum collection.

Largest stone

The largest authenticated diamond found on the field appears to be the 5 5/16 (5 1/2?) ct stone discovered by a digger, John Glover, in August 1877 at Long Gully (Warden of Goldfields, 10 August 1877). Hales (1909) gives the weight as about 14 grains (4.5 ct) and places the find at Poor Man's Hill, but this account was compiled from reminiscences in 1909 and the weight conflicts with catalogue entries. Brown (1908) reports a 9 1/4 ct stone but no other mention of this gem was made in early records; the weight is probably a misprint of carats for grains, with the true weight being about 3 ct.

'Rennells Vision' diamond, found at Poor Man's Hill, was valued at £90 in the rough. Rennells, a prospector, known as the miner's prophet '. . . dreamt that he saw an angel pointing to the spot at the foot of Poor Man's Hill and heard a voice telling him to dig' (The *Advertiser*, 16 June 1909). His mate, not believing him, threatened to throw Rennells into the dam if he did not continue with their usual gold prospecting. A struggle took place near the edge of the water, but the ground gave way and his mate fell in, putting an end to his objections. Rennells continued searching and soon found his diamond. Unfortunately, the weight of this stone was not recorded.

A diamond weighing 3 1/2 ct was found in Long Gully by John Brown while gold washing in December 1867 (Warden of Goldfields, 8 December 1867).

The Dodd and Bean Reports

In the late 1870s, the diamond occurrence at Echunga was of considerable interest, with newspapers urging miners to be on the lookout for these gems and giving regular accounts of new finds. In 1878 and 1879, the Government commissioned two reports[1] on the diamond occurrence.

At the Paris Universal International Exhibition in 1878, two rough diamonds found by gold diggers John Brown and John Glover were exhibited in the South Australian Court (Fig. 3). Mr Boothby, Special Executive Commissioner for the South Australian Court, thinking the occurrence of diamonds in South Australia might be of great importance, submitted the gems to an expert, Mr Arthur Dodd of P.G. Dodd & Sons, diamond merchants, London, for an appraisal. The gems, of 5 5/16 ct and 3 1/2 ct, were cut on Dodd's recommendation. His report expressed the opinion that:

> A diamond field must exist near where these diamonds were found, for two reasons — First that the elevation of Echunga is about the highest point in the range of mountains forming a backbone of the country, therefore these stones could not have been washed down to that place; and secondly, by the evidence of the stones themselves showing no signs of travelling by worn surfaces or broken points. I am therefore of the opinion that the diggers for gold, who for years past have worked and washed the ground in this place, have passed unheeded hundreds of diamonds, not knowing them for worthless crystals or other stones of no value.

His report concluded:

> We do not suppose that Echunga is another South Africa, but at all events there is every reason to believe that the district is rich in diamonds, and it will pay a few enterprising men to give it a trial. If anything like success is attained there will of course be a rush. In that case the Government will have to make some arrangements for the proper regulation of claims, and companies no doubt will be organized to carry on a systematic search for the beautiful crystals (*Southern Argus*, 24 July 1879).

Following recommendations of the Dodd report, the Commissioner of Crown Lands in 1879 appointed Mr G.T. Bean, an experienced gem digger, to examine the potential of the Echunga Goldfield for diamonds and to recommend a course of action for their recovery. Bean reported that the field was similar to those in South Africa and recommended that a systematic search be made. He suggested that four or five men led by an experienced diamond digger should search the area. Bean also recommended that claims be 50 feet by 30 feet, with every digger entitled to two claims. The discoverer of a new find would be entitled to select five claims, and a company able to hold a block of up to 10 claims. He concluded that the best method was to wash all soil and gravel in a cradle and screen, and sort the screenings on a table. Bean nominated Mr A. von Doussa of Hahndorf, a diamond digger from Kimberley in South Africa, as leader of the search party (*Adelaide Observer*, 23 August 1879).

When the report was published others offered their services. One such offer was 'a gentleman . . . who was willing to organise a party and make a search for two or three months for a payment of £5 per week, which would not be claimed if their efforts were successful' (*Adelaide Observer*, 23 August 1879).

In 1880, to further help gold diggers on the fields to recognise diamonds, a collection of 11 rough Brazilian diamonds was displayed at the South Australian Institute, the forerunner of the South Australian Museum. These were obtained through Mr J. Boothby in London at a cost of £20. Unfortunately, they were stolen from the Museum in December 1881.[2]

Few additional diamonds appear to have to have been found after 1880; the only known report was of a diamond obtained by Mr Bertram of Echunga in 1886 (*The South Australian Register*, 22 May 1886).

The recommendations of the Bean Report were raised in South Australian Parliament in August 1879 by Mr Bray (Member for East Adelaide). At this time the Commissioner of Crown Lands reported the matter under consideration (South Australia, Parliament, 1879) but no further action appears to have been taken by the Government and the matter was dropped.

It has not been possible to accurately establish the number of diamonds found on the field between 1859 and 1900. Brown (1908) estimated that 50 stones had been found but an extensive search of newspaper reports and reports by the Warden of Goldfields at Echunga gave definite reference to only about 20 stones (Table 1). Hales (1909) lists a number of miners as having found gems on the field but no details of the stones are given.

CLASS 39.—JEWELLERY AND PRECIOUS STONES.

Steiner, Henry; Jeweller; *Rundle Street, Adelaide.*
Collection of Gold and Silver Jewellery, consisting of Brooches, Earrings, Crosses, Necklaces, Lockets, &c.

Brown, John; Gold Digger; *Echunga, South Australia.*
Diamond, rough as found on the Echunga Gold Field.

Glover, John; Gold Digger; *Echunga, South Australia.*
Diamond, rough as found on the Echunga Gold Field.

FIGURE 3. Catalogue entry for Echunga diamonds exhibited at the Paris International Exhibition, 1878.

Recent exploration

Little interest was expressed this century in the Echunga diamond occurrence until the mining boom of the 1970s enticed several companies to explore the area. The most extensive studies were made by Kimberely Diamond Quest NL and Nickel & Mineral Search NL who contracted Pacific Exploration Consultants to process over 75 tonnes of tailings from the Old Echunga Diggings, but these revealed only one microdiamond. CRA Exploration Pty Ltd also undertook extensive geophysical exploration in the area and located several magnetic

TABLE 1. Records of diamond finds at Echunga.

NAME OF FINDER	LOCATION	DATE	DETAILS	REFERENCE
Robert Foreshaw	New Rush Hill	1859	2 — first found	*Adelaide Observer*, 26 March 1859
William Hall	Echunga	1860	3 — a 1 ounce stone (prob. quartz), 2 the size of peas	*Adelaide Observer*, 21 January 1860
E.R. Simpson, South Australian Company, Adelaide	Echunga	1860	11 diamonds purchased from miners in the last twelve months	*Adelaide Observer*, 15 December 1860
John Brown	Long Gully	1867	1 weighing 3½ cts (exhibited in Paris)	Mem. of Proc. by Warden of Goldfields, 8 December 1867
H. Heuzenroeder, Chemist, Rundle St, Adelaide	Echunga	Before 1869	Acquired 2 diamonds, 1½ and 1 cts (exhibited in Melbourne and Sydney). In South Australian Museum collection.	*Adelaide Observer*, 17 July 1869
James Warland	Echunga diggings	1877	2 diamonds	*The Lantern*, 7 April 1877
A digger (prob. John Glover)	Long Gully	1877	2 diamonds — 1 weighing 5½ cts	Mem. of Proc. by Warden of Goldfields, 10 August 1877
Davis	Echunga diggings	1877	1 small diamond	Mem. of Proc. by Warden of Goldfields, 24 February 1877
Col. Biggs	Echunga	1877	1 weighing 3½ cts	*The Lantern*, 21 April 1877
?	Echunga	?	9¼ cts (prob. a misprint — 9¼ grs = 3 cts)	Brown 1908
John Glover	Poor Man's Hill	?	2 diamonds. One about 14 grs plus smaller one. 5¼ cts exhibited in Paris. Now in S.A.M. collection.	Hales 1909
Alfred Rennells	Poor Man's Hill	?	1 — 'Rennells Vision' diamond	*Advertiser*, 16 June 1909
Tom and Robert Hall	New Rush Hill	?	Claim to have found the first stone	Hales 1909
John Whillis	Poor Man's Hill	?	1 small diamond	Hales 1909
Tom Hall	Poor Man's Hill	?	1 between 2 and 3 grs	Hales 1909
Loveland, Goodliffe, Longman, Jimmy Gibbs, Sam Ewen, Harry Pitcher	New Rush Hill	?	Diamonds were found by these diggers	Hales 1909

anomalies of possible kimberlitic nature on the Old Echunga Diggings, Jupiter Creek Diggings and Biggs Flat area. Samples from these anomalous zones contained zircon, chromite and corundum which may be of kimberlitic origin, but no kimberlites were located (Gerdes 1987).

Western Queen (South Australia) Pty Ltd explored for diamonds in the Lobethal area of the Mount Lofty Ranges, 20 km north of Echunga, and found fresh picroilmenite indicator minerals suggesting possible kimberlites (Gerdes 1987).

In January 1987, John Popeskul, a fossicker, found a 0.91 ct diamond while panning for gold near National Dam on the Old Echunga Diggings.

Diamond Specimens from Echunga

Only five of the diamonds found at Echunga last century can be traced. The collection of the South Australia Department of Mines and Energy contains two small diamond crystals, and three stones (two uncut and one cut) are in the South Australian Museum collection.

The largest of these is a fine brilliant-cut yellow diamond of 2.84 ct (Fig. 4). The gem was said to have originally been pale red in colour (Cloud 1883; Brown 1908), but to have changed colour in the 1950s as a result of being stored with radioactive minerals. This stone was probably the one cut from the 5 5/16 ct crystal found by John Glover in 1877 and displayed, together with another uncut stone, at the Paris Universal International Exhibition of 1878. Both were cut in London in 1879. The cut diamonds were returned to Australia and displayed at the International Exhibitions held in Sydney in 1879 and Melbourne in 1880 (Sydney International Exhibition 1879, Melbourne International Exhibition 1880) (Fig. 5). The South Australian Museum Curator's Monthly report of December

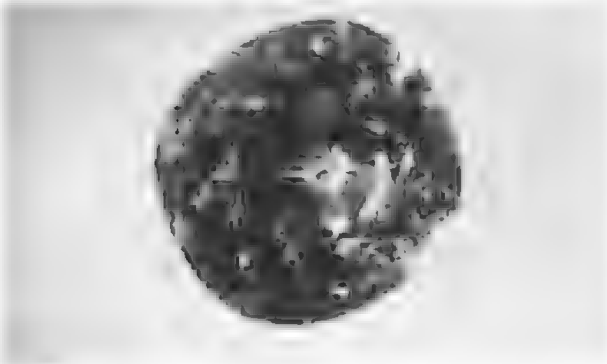


FIGURE 4. Brilliant cut diamond (2.84 ct and 9 mm across) from the collection of the South Australian Museum (G6500); this was cut in London in 1879 from a rough weighing 5 5/16 ct (photo: J.A. Forrest).

286 Commissioners for South Australia.

Collection of South Australian Minerals, prepared for the Commission by T. C. Cloud, A.R.S.M., F.C.S., F.I.C.

DIAMOND.

1 Brilliant cut diamond, from Echunga Gold Fields—weight in the rough, [illegible] carats; present weight, [illegible] carats. S.A. Government.
2 Brilliant cut diamond, from Echunga Gold Fields weight in the rough, [illegible] carats; present weight, [illegible] carats.
3 Diamond, natural crystal, exhibiting the planes of the triakis octahedron—weight, [illegible] carats; Echunga Gold Fields. H. Heuzenroeder.
4 Diamond, natural crystal, hexakis octahedron—weight, [illegible] carats; Echunga Gold Fields. H. Heuzenroeder.

FIGURE 5. Catalogue of the Melbourne International Exhibition, 1880, giving details of four diamonds from Echunga. Three of these stones are now in the collection of the South Australian Museum.

1881 notes the purchase of a diamond, presumably the large cut stone in the Museum collection; the fate of the smaller cut stone could not be traced.

The two small uncut diamonds displayed at the Sydney and Melbourne Exhibitions are also in the South Australian Museum collection; these were acquired in 1949. The stones, a sharp trisoctahedron of 1.5 ct (Fig. 6a) and a distorted octahedron of 1 ct (Fig. 6b), were the property of Mr H.Y. Heuzenroeder, a Rundle Street chemist and coin collector, when exhibited. They were purchased by the Museum from Mr T.W. Hastings, Heuzenroeder's grandson in 1949 for £45. In a letter to Herbert M. Hale, the Museum Director at the time of the purchase, Hastings claimed that the two stones were exhibited in Paris in 1878, but these gems were cut in London after the exhibition. The *Adelaide Observer* of 17 July 1869 states that 'Mr Heuzenroeder of Rundle Street brought to our office on Tuesday two fine rough diamonds, weighing 1 1/2 carats and 1 carat, both of which were found at Echunga some time ago' (*Adelaide Observer*, 17 July 1869). Mr Heuzenroeder may have bought the stones from Mr Simpson of North Adelaide, who earlier offered two diamonds to the Museum in 1864 . The two diamonds are certainly some of the earliest found on the Echunga goldfields.

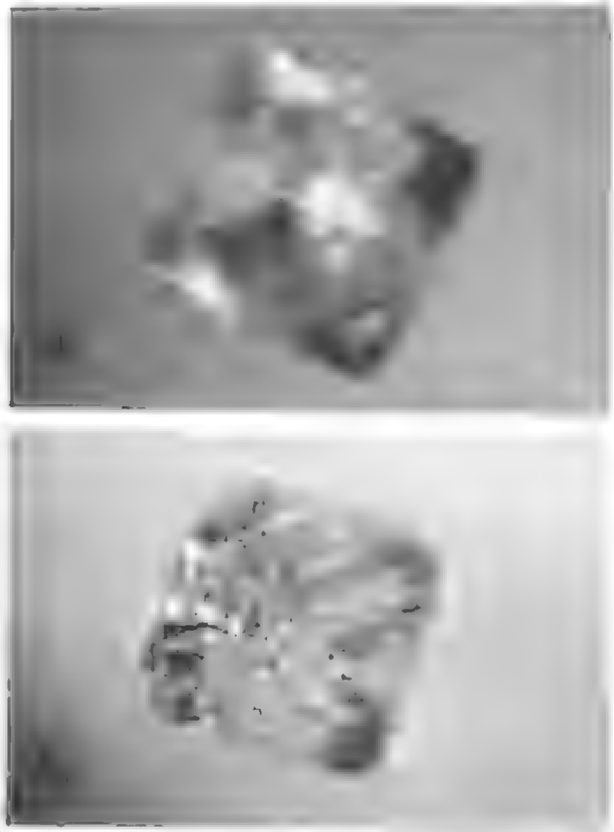


FIGURE 6. Uncut diamonds in South Australian Museum collection (G6505). These stones, exhibited by the South Australian Government at the Sydney and Melbourne International Exhibitions of 1879 and 1880, were purchased from Mr Hastings in 1945. (a) 1.5 ct sharp trisoctahedron, 6 mm across (photo: J.A. Forrest); (b) 1 ct distorted octahedron, 4 mm across (photo: J.A. Forrest).

The two diamonds held by the South Australian Department of Mines and Energy weigh 0.836 and 0.462 ct. Unfortunately, their history cannot been traced, but they may be the two stones offered to the Museum by Mr Simpson in 1864.[3] The gems are of good crystal shape and strongly yellow in colour (Fig. 7). The larger stone is a combination octahedral-dodecahedral crystal, and the smaller is a flattened dodecahedron (Hall & Smith 1983).

FIGURE 7. Two diamonds from the collection of the South Australian Department of Mines and Energy. The larger stone weighs 0.836 ct and is 5 mm across. The smaller stone, a flattened dodecahedron, weighs 0.462 ct and is 3 mm across (photo: J.A. Forrest).

The 0.91 ct diamond found on the Old Echunga Diggings in January 1987 is still in the possession of the finder. The stone has a slightly elongate, almost oval shape showing what appears to be a combination of octahedral and dodecahedral forms; it is pale straw yellow in colour (Fig. 8).

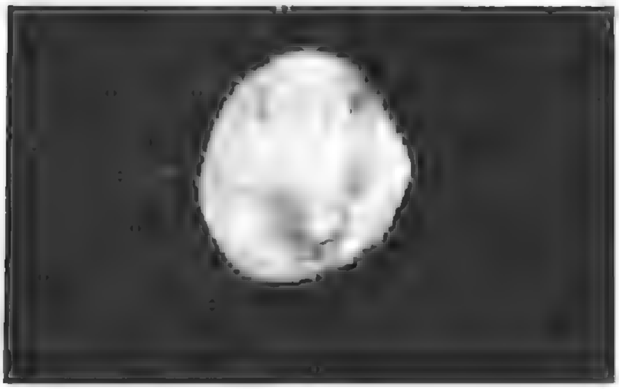


FIGURE 8. Diamond, weighing 0.91 ct (4 × 6 × 3 mm), found near National Dam on the Old Echunga diggings by J. Popeskul in January 1987 (photo: J.A. Forrest).

Other Diamond Localities in South Australia

Numerous kimberlite pipes and dykes have been found in county Kimberley, 250 km north of Adelaide. Microdiamonds were recovered from several of these, including the pipes at Pine Creek, Ketchowal, and Franklyn (Colchester, 1972).

A total of 140 microdiamonds were recovered during exploration of kimberlites near Eurelia, 20 km north of Orroroo, by Stockdale Prospecting in the early 1980s (Scott Smith *et al.* 1984). No larger diamonds have been found in either county Kimberley or the Orroroo kimberlites, and neither appear have of economic significance.

Brown (1908) reports recovery of a 1 ct diamond from auriferous gravel at Algebuckina, 900 km north-north-west of Adelaide, but no further details, including current location of this stone, could be traced. Little exploration appears to have taken place near this occurrence.

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Endnotes

1. Attempts to locate copies of the Dodd and Bean Reports were unsuccessful and information on their content is drawn from newspaper reports.

2. Reports by the Museum Curator on the progress of the Museum, November 1863 to 1882. *See* reports dated March 1880 and December 1881. Public Records office GRG19/168, Adelaide.

3. Letters and Memoranda received by the General Secretary concerning evaluations, donations and purchases of Museum specimens and apparatus, 8 December 1857–10 March 1865. *See* letters dated 26 February 1864 and 11 March 1864. Public Records Office GRG19/167.

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EARLY HUMAN OCCUPATION OF THE FLINDERS RANGES

BY R. J. LAMPERT & P. J. HUGHES

Summary

The climatic amelioration that followed the last glacial maximum (17-15 000 yBP) prompted more widespread human occupation of the Australian arid zone. Whereas the better watered Flinders Ranges were a focus of human activity as early as 15 000 yBP, the shores of Lake Frome became popular during generally moister conditions of 9.5-4 000 y BP, and the widespread occupation of the Strzelecki Desert, with its highly epheremal surface water, took place mainly within the last five thousand years. Technological change accompanied these movements. The Kartan industry, dating to 15 000 yBP, is present at early sites in the Ranges, while small tools characterise the widespread recent sites. Lying temporarily between these is an industry of core tools, shaped differently from those of the Kartan, found on the early Holocene Lake Frome sites, On the evidence of this and earlier investigations, the Kartan has an upland distribution, ranging from hills of Kangaroo Island to the desert highlands of the north.

EARLY HUMAN OCCUPATION OF THE FLINDERS RANGES

R.J. LAMPERT & P.J. HUGHES

LAMPERT, R.J. & HUGHES, P.J. 1988. Early human occupation of the Flinders Ranges. *Rec S. Aust. Mus.* 22: 139-168.

The climatic amelioration that followed the last glacial maximum (17-15 000 yBP) prompted more widespread human occupation of the Australian arid zone. Whereas the better watered Flinders Ranges were a focus of human activity as early as 15 000 yBP, the shores of Lake Frome became popular during generally moister conditions of 9.5-4 000 yBP, and the widespread occupation of the Strzelecki Desert, with its highly ephemeral surface water, took place mainly within the last five thousand years. Technological change accompanied these movements. The Kartan industry, dating to 15 000 yBP, is present at early sites in the Ranges, while small tools characterise the widespread recent sites. Lying temporally between these is an industry of core tools, shaped differently from those of the Kartan, found on the early Holocene Lake Frome sites. On the evidence of this and earlier investigations, the Kartan has an upland distribution, ranging from the hills of Kangaroo Island to the desert highlands of the north.

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Manuscript received 23 December 1987.

Our research on early Aboriginal occupation of the Flinders Ranges, and adjoining areas of the arid zone of south-eastern Australia, began on temperate Kangaroo Island, several hundred kilometres to the south (Lampert 1981). There, attempts to date the Kartan industry, present only on surface sites, had met with limited success. The presence of this industry also on parts of the mainland close to Kangaroo Island, together with evidence for the separation of the island from the mainland by post glacial sea rise some 9 500 yBP (years Before Present), suggested a late Pleistocene age for the industry. This view received support from the absence of large core tools, which are the hallmark of the Kartan, from a number of sites on the island with ages ranging between 11 000 and 4 300 yBP. These sites have securely stratified occupation horizons containing acceptably large samples of an industry characterised by small adzes and scrapers made on stone flakes.

Lampert concluded from his Kangaroo Island research that the Kartan was a regional variant of the core tool and scraper tradition, the earliest Australian stone-working tradition yet recognised; that it dated back to the late Pleistocene; that it preceded an industry of smaller tools, made on flakes rather than cores, this succession being part of a trend towards smaller tool types throughout Australia; and that the later industry was essentially part of the mainland small tool tradition despite the absence from Kangaroo Island of later and more characteristic tool forms (Lampert 1981). Other more tentative hypotheses were raised, notably one concerning the differences between the Kartan and more widespread examples of the core tool and scraper tradition. Whereas large core tools predominate in the Kartan, such tools are smaller and fewer in other industries of the tradition, the much more common tool being a flake scraper. However, large core tools predominate in some early sites in South East Asia, lands from which Australia must have received its early human population. The similarity of these tools to those of the Kartan had been noted earlier (Tindale 1937; McCarthy 1940, 1941, 1943), although later research (Matthews 1966) showed that this relationship was not particularly close. This evidence raised the possibility that the Kartan was different from other industries of the Australian core tool and scraper tradition because it had retained tool forms earlier in origin. If this is the case, some Kartan sites should have ages in excess of 30 000 years.

To address such questions, there was clearly a need to locate the Kartan in stratified contexts that would allow its age and cultural associations to be determined more accurately. The discovery of suitable sites on Kangaroo Island and nearby peninsulas of the mainland seemed unlikely given the number of lengthy reconnaissances that had already failed in this attempt. Attention was turned to the Flinders Ranges where Cooper (1943) had reported the discovery of Kartan tools.

The northern sector of the Ranges seemed the more promising because, lying within the arid zone, it was subject to a cycle of deposition and erosion that could cover archaeological materials and expose them again to allow discovery.

In the event, investigations there illuminated not only the problem of the Kartan but also general questions about the antiquity and nature of human occupation in the arid zone of south-eastern Australia (cf. Gould 1971, Bowdler 1976, Horton 1981, Ross 1981).

The Setting

Present environment

Landforms

Structurally, by far the larger part of the Flinders Ranges (*see* Fig. 1) has developed from sedimentary rocks laid down between 500 and 1 000 million years ago. These rocks were compressed, buckled and fractured; they were uplifted slowly and eroded. In the arid northern Ranges, where vegetation is sparse, the intricate folding and faulting, and the effects of erosion, can be best appreciated. The landforms here are spectacular, the Ranges as a whole rising abruptly from the surrounding plains, and containing deep gorges, jagged ridges and enclosed synclinal basins or 'pounds', the best known of which is Wilpena Pound. Predominant among rock types is quartzite which grades out into sandstone and siltstone. Limestone is fairly extensive, some igneous rocks are present in the Mt Painter region, and there are a few small outcrops of silcrete. To the north, the Ranges become more subdued and eventually terminate in the dunefields and stony plains of the Strzelecki Desert.

Sandy plains some 30 km in width separate the northern Ranges from Lake Frome to the east and Lake Torrens to the west. These lakes are huge saline playas that rarely contain water. Streams flowing from the Ranges soon peter out, reaching the lakes only rarely. Under this regime, the streams drop their bedload of sediments within a short distance, causing alluvial fans to form on the piedmont.

Climate and vegetation

The northern Ranges receive an annual rainfall slightly less than 300 mm which decreases from south to north, the northern limits falling below the 250 mm isohyet. These average figures are deceptive because of considerable variation in rainfall from year to year. Rainfall is 50% greater in the Ranges than on the surrounding plains which receive only 200 mm, a figure that diminishes to a mere 125 mm in the heart of the Strzelecki Desert and at Lake Frome. As well as having a higher rainfall, the Ranges have deep shady chasms with a rocky substrate that allows the retention of surface water in pools.

The plains, by contrast, have only highly ephemeral streams and salt pans, plus a few widely spaced artesian springs with water that is not always drinkable. The northern Ranges are thus a reasonably well-watered strip within an arid region.

Vegetation communities in the Ranges vary mainly in accordance with soil types which in turn reflect the kinds of parent rock and weathering processes to which they have been subjected. Soils range from skeletal soils, found mainly at higher latitudes, through red brown soils and podsols, to the deep alluvial soils found in valley bottoms (Kuchel 1980: 69).

Shrubland dominated by various species of *Acacia*, *Cassia* and *Eremophila* is common, particularly on the stony soils of upper hill slopes. Native pine (*Callitris columellaris*) and sheoak (*Casuarina stricta*) are found on lower slopes and flats. Calcareous podsols developed on a sandy base are colonised mainly by mallee (*Eucalyptus* spp.) with spinifex (*Triodia irritans*) occurring on more mobile sands. Plants of the family Chenopodiaceae, including salt bush (*Atriplex* spp.) and blue bush (*Maireana* spp.) are found on stony flats and hill slopes, notably at the northern end of the Ranges and on the Lake Frome plain. Valley bottoms and stream courses support the lofty river red gum (*Eucalyptus camaldulensis*), specimens of which in the better watered gorges reach an enormous size.

Past events

Before 45 000 yBP

Evidence from this early period is sparse, but thermo-luminescence (TL) dates for the onset of dune building in the northern Strzelecki Desert at least 250 000 yBP (Gardner *et al.* 1987), indicate that desert conditions were in place well before human occupation of the continent. In the Willandra Lakes, just outside the present arid zone, well-developed soils below lake bed deposits give evidence for dry conditions from 120 000–45 000 yBP (Bowler & Wasson 1984).

40 000–25 000 yBP

Significantly wetter conditions throughout southern Australia are shown by a variety of evidence. Lakes filled in the Willandra system and in south-eastern South Australia (Bowler 1971). Rivers of the Murray-Darling system were up to four times their present width (Pels 1964, Bowler *et al.* 1976). Lake Eyre covered three times its present area and was up to 17 m deep (Twidale 1980: 30).

Lake Frome experienced a high water phase minimally dated by C-14 to 36 800 ± 1 700 yBP from Coxiella shells in a beach ridge, while a dune thought to be associated with rising lake levels has a TL date of 48 000 ± 8 900 yBP (Gardner *et al.* 1987).

During this moist phase, high rates of runoff and erosion in the Ranges produced the immense

FIGURE 1. Places mentioned in text.

alluvial fans that form the pediments of hill slopes and extend outward across valley bottoms. Collectively, these sediments are known as the Pooraka Formation (Williams 1973). They are up to 10 m thick where cut through by Hookina Creek, just north of Hawker township. Radiocarbon dates indicate that this formation had begun to build up before 38 000 yBP and was completed by 30 000 yBP, after which the absence of sedimentation allowed a soil profile, known as the Wilkatana Palaeosol, to develop on its surface. Bones of Pleistocene fauna, including *Diprotodon*, have been recovered from deep sediments of this formation along Hookina Creek.

25 000–20 000 yBP

Conditions became cooler and drier throughout southern Australia. The Willandra lake levels were low and fluctuating; at Lake Frome there was a change from lake deposits to dune building; in the Strzelecki Desert extensive sandy clay dunes began to form (Bowler & Wasson 1984).

20 000–15 000 yBP

This was the coldest and most arid phase, with lakes drying up and aeolian activity at its most intense. The Willandra system became almost completely dry; dunes were formed around Lakes Torrens and Frome, and continued to be built in the Strzelecki Desert. Near Edeowie Creek in the northern Ranges, dunes were formed on top of sediments of the Pooraka Formation. Dissection, by irregular stream action, of fan and valley fill sediments of the Pooraka Formation began at this time, and continues today (Williams 1973).

15 000–10 000 yBP

This period was one of transition between earlier intense aridity and later, moister and warmer conditions. Dune building ceased in the Strzelecki Desert.

These conditions allowed the formation of such soils as the Motpena Palaeosol, dated to *c.* 12 000 yBP, and present in the northern Ranges on Edeowie and other dunes (Williams 1973)

10 000–5 000 yBP

More frequent high water levels at Hawker Lagoon in the Flinders Ranges (this report) and at Lake Frome, associated with greater vegetation cover (Singh 1981), indicate moister and warmer conditions, at least in the south-eastern sector of the arid zone, for any time during the past 30 000 years. Lakes near the south-eastern coast of South Australia and on Kangaroo Island provide evidence for similar wetter conditions at much the same time (Dodson 1974a, 1974b, 1975; Dodson & Wilson 1975; Lampert 1981).

After 5 000 yBP

Drier conditions began to return reaching a maximum around 2 000 yBP when the climate was slightly more arid than it is today (Bowler *et al.* 1976).

Reconnaissance of the region

A major aim of field research in the Ranges was to locate subsurface Kartan sites which could be excavated to provide the sort of information unavailable from the surface sites encountered previously. This information included the age of the Kartan; the nature of the 'complete' industry e.g. whether it was as dominated by large core tools as surface sites had suggested; and the stratigraphic relationship of the Kartan with small tools. Another interest developed during research lay in the geographical spread of Kartan *vis-a-vis* small tool sites over a broader region than the Ranges alone since differences might reflect the pace of human colonisation of the arid zone.

North of the Ranges

In 1979, we reconnoitred transects through the Cooper Basin and Strzelecki Desert as well as the northern Flinders Ranges (Hughes & Lampert 1980; Lampert & Hughes 1980). In the desert regions north of the Ranges we examined approximately 100 sites, all of which are of late Holocene age judging from the ubiquitous presence of tools typical of the small tool tradition, the almost total absence of core tools and large scrapers, and the stratigraphic position of these in the unconsolidated surface sands of dunes. No artefact was seen in the consolidated sediments that form the dune cores, and date back 15 000 to 18 000 years, despite numerous deep exposures through them. At Lake Murteree, stone tools protruding from the eroded slope of a dune core appeared to be *in situ*, but later excavation showed the tools lie in a slope washed skin, consisting of more recent sands, covering the eroded face of the dune. In deeper excavation at this site, no artefact predating the dunefield was found. This had seemed a particularly promising site for early occupation, being adjacent to a waterhole and near an outcrop of high quality silcrete from which tools at the site had been flaked. The absence of evidence at such a favourable location suggested that human presence before the late Holocene was sparse enough to be generally below the threshold of archaeological visibility. However, people were not totally absent, as the JSN site shows (Wasson 1983). This site, some 50 km west of Lake Murteree consists of a lens of charred wood together with mussel shell, dated to *c.* 13 500 yBP and presumed to be an Aboriginal fireplace.

Mound springs

These stretch in a broad arc that follows the south-western edge of the Great Artesian Basin from Lake Frome, across the northern margin of the Flinders Ranges, along the south-western shore of Lake Eyre, to Dalhousie on the western edge of the Simpson Desert. The springs are natural outlets for artesian water containing a number of soluble salts which solidify to form mounds as the water evaporates.

The water from these varies considerably in quality. A few springs have excellent drinking water, most are brackish but still potable, while some are biologically inert because of massive quantities of salts in solution. Except for the last, the springs support small areas of lush vegetation, as well as molluscs, amphipods and small fish. They attract such mammals as the red kangaroo, and birds that include ducks, the brolga and stilts. Although their output of water is low, the springs appear as oases in a region where the annual rainfall averages only 125 mm.

Every major spring complex has at least one large Aboriginal surface site adjacent to it (Hughes & Lampert 1985, Lampert 1985). Variations between sites in types of tools, kinds of raw materials, and core reduction techniques, are currently under investigation by S. Florek (University of Sydney). Like those in the Cooper Basin, these sites appear to have been occupied mainly in the late Holocene, judging from the presence of such small tools as pirris, tulas and microliths. Only occasionally are there a few artefacts in carbonate–solidified lower sand horizons to give a hint of sparse earlier occupation.

Sites in the Ranges

We examined a number of sites in the Ranges during our 1979 survey. Chambers Gorge and nearby Moorowie Well we assume to be Kartan judging from the presence of heavy core tools and the rarity of smaller flaked artefacts lying on the surface. However, the sparseness of artefacts generally, and the unlikelihood of finding stratified material in the skeletal soils of the rocky slopes on which the sites are situated, did not prompt any closer research. Only Hawker Lagoon, where stone tools of many types, including large core tools, seemed to be eroding from stratified dune horizons, offered the chance of finding dated sequences.

In the 30 000 to 38 000 years old sediments of the Pooraka Formation along Hookina Creek a quartzite core was found well embedded in the eroded slope of a gully. We accepted this as being *in situ* at the time (Lampert & Hughes 1980), but on a return visit after heavy rain Lampert noted how fluid the deposit became when wet. Whole blocks of sediment slumping downward and becoming embedded in hollows within lower levels, carrying with them material from the present surface, force us to revise our opinion of the stratigraphic provenance of this artefact. Despite the examination of many kilometres of exposures through the Pooraka Formation along the water courses, no sign was seen of human activity in these sediments.

LAKE FROME

Lying about 30 km east of the northern Ranges, Lake Frome is a saline playa some 100 km long and 45 km wide. With an annual rainfall ranging between 100 and 125 mm, and an evaporation rate exceeding 2 200 mm, it is one of Australia's driest places. Because Lake Frome lies at the end of a long chain of ephemeral lakes and watercourses, substantial amounts of water reach it only rarely. Cooper Creek, which drains from south-western Queensland, must have sufficient discharge to flood Strzelecki Creek, then Lakes Blanche and Callabonna before water can reach Lake Frome.

On the western side of the lake a gravel beach 20 m higher than the present lake bed denotes a high stand of fresh water more than 30 000 years ago. Since then, apart from moist phases 9 500–8 000 and 7 000–4 000 years ago (Singh 1981), the lake bed has been almost continuously dry.

A survey of the western and southern shores revealed that artefacts are very rare around Lake Frome. A few sparse scatters of flaked stone, varying in density between one flake per 5 m^2 and one per 50 m^2 being found along the banks of Passmore River (Wilpena Creek), Balcoracana Creek and the channel joining Lake Frome with Lake Callabonna to the north. These sites are all within one kilometre of the lake shore. Except for one tula slug and a few core tools, the artefacts are all undiagnostic small flaked pieces.

Actual sites, that is, places where artefacts are concentrated within a definable area, are similarly rare; they are also small and have a low density of artefacts compared with sites in the Ranges. A report follows on detailed research at one of these, Balcoracana Creek, and comments on a second, Big John Creek.

BALCORACANA CREEK

The site is on the southern bank of Balcoracana Creek, about one kilometre upstream from the outlet of the creek into Lake Frome. Only on very rare occasions does the creek bed contain water. The nearby dunefield is interpreted by Dr R. Wasson (pers. comm., Gardner *et al.* 1987) as being source bordering rather than continental in origin.

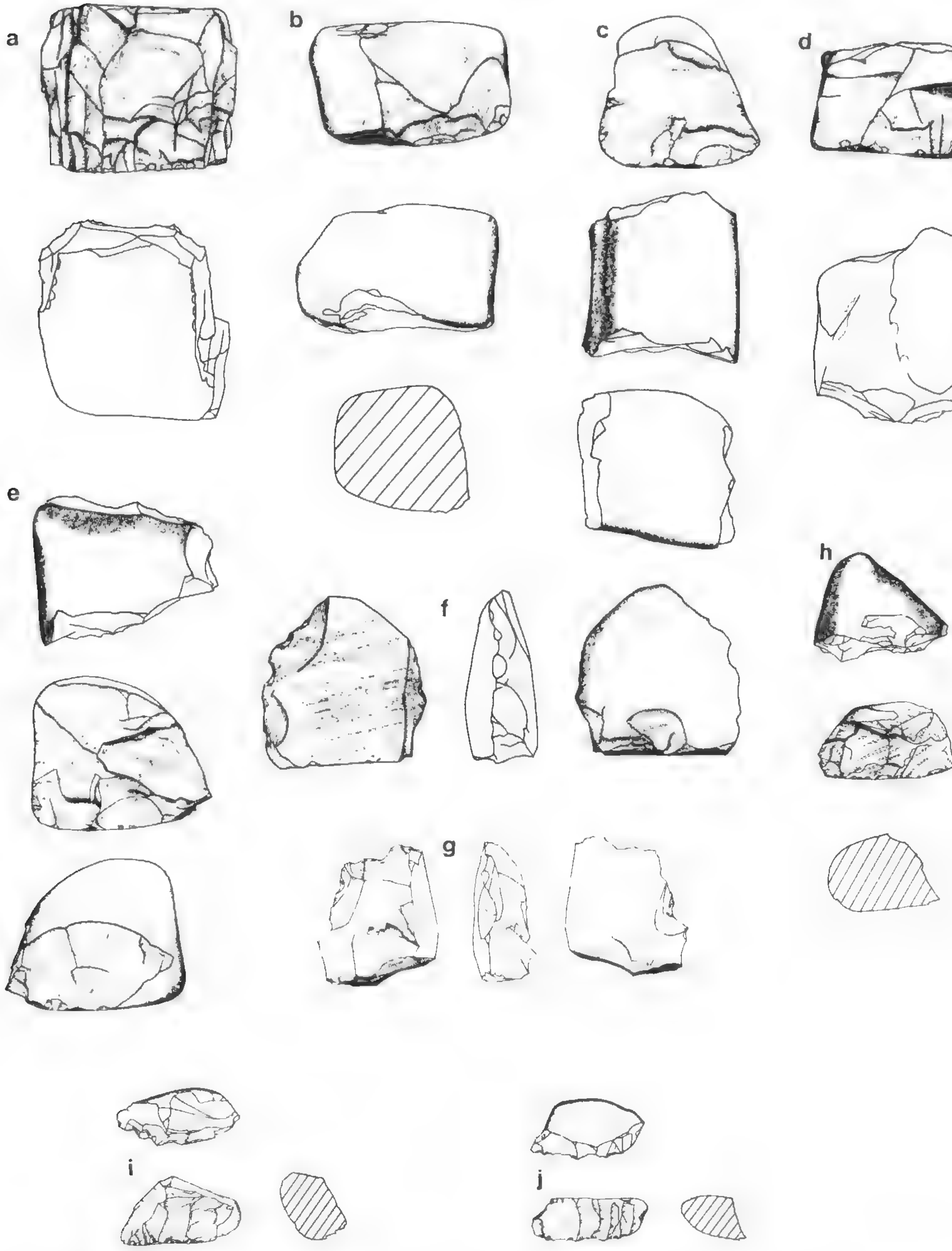

FIGURE 2. Artefacts from Balcoracana Creek: b, f and g are core tools from the carbonate palaeosol; a, c, e and h from the overlying sand; i and j are adzes from the overlying sand.

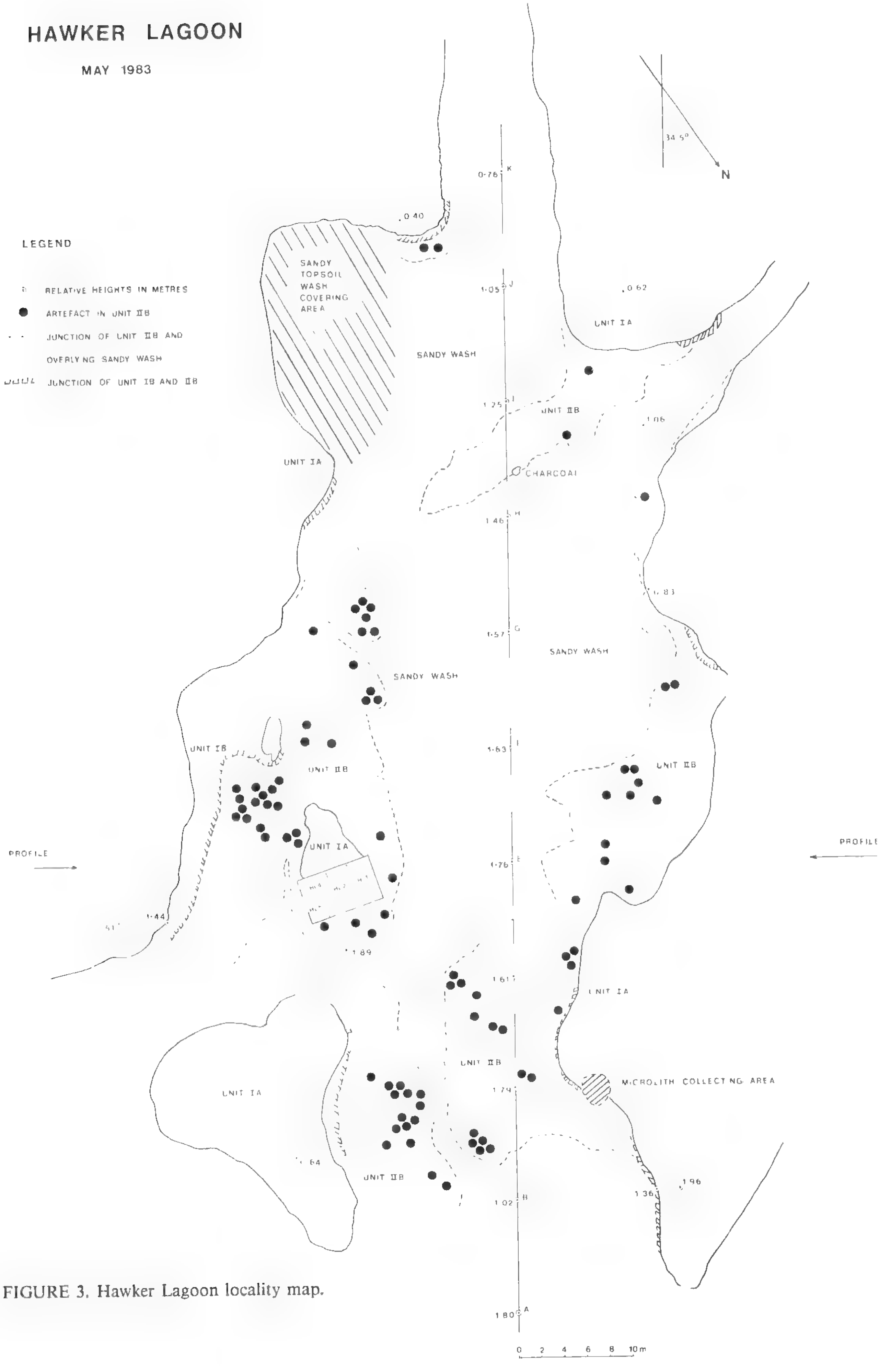

FIGURE 3. Hawker Lagoon locality map.

The site is in a dune blow-out, deflation having exposed the horizontally bedded carbonate horizon of a palaeosol. At the time of our investigation, artefacts lay scattered both on the surface of the carbonate and on the lower slopes of dunes surrounding the blow-out. During our initial appraisal (Lampert & Hughes 1980) we noted that artefacts lying on the sand appeared to be different from those on the carbonate, both in type and in whether or not the artefact was coated with carbonate. This suggested to us the possibility of identifying two industrial phases at the site through more careful scrutiny. In 1981, we revisited the site and collected, for closer examination, all stone artefacts, noting whether each lay on sand or on carbonate. We were accompanied by Drs R. Wasson and J. Ash who investigated the age and origin of the dune sands from which the artefacts had eroded.

The stone industry

The stone industry consists of 1 451 pieces of worked stone found within the blow-out. Two sorts of stone were used: silcrete that is variable both in texture and in colour, and a reef quartz that is somewhat granular in texture. A high frequency of rounded cortical surfaces on the artefacts shows that the raw materials were pebbles, possibly from pebble beds in the Eurinalla formation, exposures through which are located within two kilometres of the site.

A list of the various types of artefact is given below and in Table 1 but for some types (Fig. 2) a more detailed description follows in another section of this report.

Core tools

All of these are made on silcrete pebbles that vary widely in both texture and colour. Because some of the pebbles are water-rounded, sub-angular blocks rather than smoothly curved pebbles we have chosen to call the group core tools rather than pebble tools.

Flake scrapers

These are made on both quartz and silcrete, and include typical steep-edged forms at the heavier end of the range, while lighter specimens merge with adzes.

Non-tula adzes

All of these are made on silcrete. They are recognized by the characteristics listed by Lampert (1981: 134-142), and include one typical burren adze, but not all could readily be distinguished from some of the lighter scrapers.

Tula adze

Made on silcrete, this is a typical tula slug as described by McCarthy (1976: 31).

Hammers

Made on silcrete, they display the pitting that characterises percussion stones generally (McCarthy 1976: 55-9).

TABLE 1. Balcoracana Creek: artefact types and their contexts.

	On palaeosol	On sand	TOTAL	
			Number	Weight in grams
Core tool	5	10	15	5 510
Flake scraper				
silcrete	1	5	6	192
quartz	3	8	11	347
Non-tula adze		11	11	163
Tula adze (slug)		1	1	5
Hammer	2		2	2 277
Trimming flake	1	3	4	162
Silcrete core	14	15	29	4 867
Silcrete flake	76	147	223	1 145
Quartz piece	327	822	1 149	10 665
Total number	429	1 022	1 451	
Total weight	9 349	15 984		25 333

Trimming flakes

All are of silcrete. The small flake scars along the platform suggests that these flakes result from the resharpening of core tools. They are similar to those found at Kartan core tool sites on Kangaroo Island (Lampert 1981: 44).

Silcrete cores

Unlike core tools, these are recognised by the multi-directional removal of primary flakes, and the absence of a working edge along which smaller flakes have been removed.

Silcrete flakes

Quartz pieces

Because of the coarseness of the raw material not many pieces could be recognised either as cores or as flakes, and hence are simply termed quartz pieces. Unlike the quartz component of the industries from most of the early to mid-Holocene sites on Kangaroo Island, no bipolar cores were found at Balcoracana Creek, but whether this is due to a real absence of bipolar flaking or to our inability to recognise it among the course material is unknown.

Time differences within the stone industry

Scattered over the surface of the palaeosol and on loose sand remaining from overlying dunes, the stone industry presented the usual problems of age and association that make surface sites difficult to assess. To look for temporal divisions within the material we examined two lines of evidence.

One was the presence or absence of a carbonate coating on each stone artefact, our assumption being that tools coated with carbonate had lain formerly *in situ*, near the carbonate rich palaeosol, and are therefore relatively old; while tools from which carbonate is absent had been provenanced in higher dune levels, which contain much less ground carbonate, and are therefore younger (cf. Bowler *et al.* 1970: 48). Such a strategy had occurred to us during our first visit to the site in 1979, when initial counts of tool types showed carbonate to be present on all except one of the 14 core tools but absent from the three adzes then located (Lampert & Hughes 1980). Following a complete collection of artefacts in the blow out during our 1980 field season, these relationships were examined more rigorously.

Table 2 shows frequencies for the occurrence of carbonate on various types of artefact, while Table 3 lists the statistically significant relationships using X^2. The results confirm our initial observation that more core tools than adzes are encrusted with carbonate. The same difference occurs between core tools and flake scrapers, while another interesting result is the much greater rarity of carbonate on quartz pieces than on silcrete flakes.

Before deducing from these differences an historical progression of artefact types, it is worth looking at another possible cause. Observations of sections naturally eroded through several alluvial fans in the region show, beyond doubt, that carbonate coating is removed from pebbles following their exposure, presumably by wind and rain. From this evidence it is possible that more core tools are carbonate-coated because they were exposed only recently, while adzes have lain for longer on the surface. However, this would again suggest a greater depth below the surface for the provenance of the core tools.

Of the two mechanisms considered so far for differences in carbonate coating, both suggest that core tools generally lay buried deeper than adzes and are therefore older. We see no other likely cause for the pattern of carbonate encrustation. The silcretes used for both tool types are broadly identical. Although core tools have more cortical surfaces than flake tools, carbonate coats the flaked surfaces of core tools as much as it does the cortex. There is no obvious lateral variation in the distribution of the two tool types. We therefore tentatively accept this evidence as support for the greater antiquity of core tools at the site.

TABLE 2. Balcoracana Creek: carbonate coating on artefacts.

	Carbonate coated	Not carbonate coated
Core tool	14	1
Flake scraper	3	14
Non-tula adze	3	8
Tula adze (slug)		1
Silcrete core	18	11
Silcrete flake	52	171
Quartz piece	7	1 142

A second method for seeking temporal divisions within the assemblage was to record during collection whether each artefact lay on the palaeosol or on the overlying sand. We reasoned that, by natural means at least, artefacts would have moved downward, but could not have moved upward, as the blowout developed. Artefacts found on the palaeosol would thus include a larger number originally from lower levels, while a greater number of those from the dune flanks would be from upper levels. Initially we divided the dune flanks into two stratigraphic levels, consolidated lower and loose upper sand, but because the samples were too small to allow us to make use of this separation, we combined them and simply compared palaeosol with sand.

Table 4 shows the distribution of artefact types on palaeosol and sand (Table 3 listed the differences that can be supported statistically). Adzes are more likely to be found on the sand than are core tools, but this difference is at the 'probably significant' level, as is the increase in quartz pieces over silcrete flakes on the sand.

Like carbonate coating, this is not firm evidence for historical changes in the stone industry. However, the two lines of evidence do support each other. Compared with core tools, fewer adzes are carbonate-coated and fewer are from the palaeosol. Similarly, fewer quartz pieces than silcrete flakes are either carbonate-coated or from the palaeosol. Further, there is a strong positive correlation between carbonate coating, and palaeosol as a context, for all artefacts (Tables 3 and 4). We conclude tentatively that, within an industry containing core tools and flake scrapers, adzes became popular later, and the use of quartz increased.

Dating

Several radiocarbon (C-14) and TL dates (Gardner *et al.* 1987) provide a time framework for the build-up of the dune series from which the artefacts have eroded (Table 5). Dates for the palaeosol, both from carbonates formed within it, and from land snails (*Sinumelon* sp.) embedded in its exposed surface, show that the antiquity of the earliest tools must be less than 13 000 yBP. It is presumed that the carbonate-coated artefacts were eroded out of carbonate rich sands, dated by TL to *c.* 10 000 yBP, lying immediately above the palaeosol. Other artefacts, without carbonate on their surfaces, came from more recent sands, which continued to accumulate until after 5 000 yBP.

As demonstrated later (Tables 5–7), the industry as a whole is typologically akin to that from the Kangaroo Island site of Pigs Water Hole, for which an early Holocene date is favoured (Lampert 1981: 88), while the scrapers and non-tula adzes are like those from several Kangaroo Island sites dated between *c.* 11 000 yBP and *c.* 4 300 yBP (Lampert 1981). Dated tulas from elsewhere in south-eastern Australia indicate that the tula found at this site dates to within the past 5 000 years, while evidence already discussed suggests that this specimen was deposited during the latter part of the site's occupation. Assemblages of late Holocene age found in the lower Murray Valley (Hale & Tindale 1930, Mulvaney 1960) and the Flinders Ranges (this report) contain a much higher proportion of typical small tools (pirris, tulas and backed blades) than does Balcoracana Creek with its single specimen, again suggesting that the site was occupied for some time before such tools became popular.

To accommodate all of the above evidence, much of the occupation of Balcoracana Creek must have occurred during the first half of the Holocene, the site being occupied less intensively after 5 000 yBP. Looking beyond the site itself, such a sequence of events would explain also the pattern of other, smaller, surface sites along the creek bank towards the shore of Lake Frome. These are visible only in deep blow-outs; no artefacts can be seen in higher sands that form the general land surface. Core tools and flake scrapers, but no typical small tools, were seen during our reconnaissance of these sites.

Specific typological relationships

To compare core tools with those found at South Australian sites further south, we measured the same attributes used by Lampert (1981). Tables 5, 6 and 7 set out the mean and standard deviation values for attributes measured on the interval scale, and compares these values with those derived from pebble tool samples from sites on Kangaroo Island. As significance levels for the *t*-tests show, the Balcoracana Creek tools are similar to those from Pigs Water Hole, but unlike pebble tools from Kartan sites on Kangaroo Island (Lampert 1981). Using a discriminant function classification procedure on the same data, 60% of the sample was grouped with Pigs Water Hole and 31% with Kartan.

TABLE 3. Balcoracana Creek: results of hypothesis tests.

Hypothesis tested	Significance level		
	.05	.01	.001
1. Carbonate coating			
On more core tools than adzes			+
On more core tools than scrapers			+
On more core tools than cores	+		
On more silcrete flakes than quartz pieces			+
2. Context			
More adzes than core tools on sand	+		
More adzes than other flaked tools (core tools and scrapers) on sand			
More quartz pieces than silcrete flakes on sand	−		
3. Carbonate coating related to context			
Fewer carbonate-coated artefacts on sand			

TABLE 4. Balcoracana Creek: distribution of artefacts with carbonate coating.

	Carbonate coated	Not carbonate coated
On palaeosol	35	394
On sand	68	954

Turning to attributes measured on the nominal and ordinal scales, there are no significant differences between the same three samples in the characteristics of edge damage and edge shape specified by Lampert (1981). But in the orientation of the worked edge, most of the Balcoracana Creek tools are end-worked, while most of those from Kangaroo Island are side-worked, these differences (using X^2) being significant for Kartan and probably significant for Pigs Water Hole. Because end-worked tools should, almost by definition, have a shorter working edge than those that are side-worked, these results are consistent with the differences in 'percentage of retouch' (Tables 5, 6 and 7) between Balcoracana Creek and the Kangaroo Island sites.

To compare the Balcoracana Creek scrapers and non-tula adzes with 'scraper/adzes' from Kangaroo Island, we combined the two categories, and measured the same attributes recorded by Lampert (1981). Table 7 sets out the mean and standard deviation values and compares these with the values for Pigs Water Hole scraper/adzes. The Balcoracana Creek tools are somewhat larger and are less steeply

TABLE 5. Core tools from Balcoracana Creek (BC) compared with Kartan pebble tools (Lampert 1981) by univariate *t*-tests. S.D. = standard deviation, N = sample size.

Attribute	Significance Level NS	.05	.01	.001	Mean (S.D.) BC (N = 15)	Mean (S.D.) Kartan (N=116)
					15	116
Length				+	74.6 (14.0)	106.6 (20.0)
Breadth				+	64.5 (13.3)	74.6 (12.1)
Height	+				53.3 (14.7)	55.4 (9.9)
Breadth/length	+				115.6 (11.7)	145.2 (29.9)
Height/breadth		+			129.5 (43.5)	137.8 (28.8)
Retouch length				+	80.5 (36.5)	155.3 (57.3)
Retouch percent				+	36.1 (13.6)	51.9 (16.5)
Angle edge				+	87.6 (2.4)	80.6 (8.9)
Weight				+	344.4 (221.2)	520.6 (199.4)

TABLE 6. Core tools from Balcoracana Creek (BC) and Pigs Water Hole (PWH) compared by univariate *t*-tests. S.D. = standard deviation, N = sample size.

Attribute	Significance Level NS	.05	.01	.001	Mean (S.D.) BC (N = 15)	Mean (S.D.) PWH (N = 12)
Length	+				74.6 (14.0)	71.7 (12.3)
Breadth	+				64.5 (13.3)	55.6 (8.0)
Height	+				53.3 (14.7)	46.7 (12.3)
Breadth/length	+				115.6 (11.7)	113.4 (29.9)
Height/breadth	+				129.5 (43.5)	131.4 (46.5)
Retouch length	+				80.5 (36.5)	103.2 (32.8)
Retouch percent				+	36.1 (13.6)	82.7 (5.2)
Angle edge	+				87.6 (2.4)	82.8 (5.2)
Weight	+				344.4 (221.2)	236.7 (137.6)

TABLE 7. Scrapers/adzes from Balcoracana Creek (BC) and Pigs Water Hole (PWH) (Lampert 1981) compared by univariate t-tests. S.D. = standard deviation, N = sample size.

Attribute	Significance Level NS	.05	.01	.001	Mean (S.D.) BC (N = 28)	Mean (S.D.) PWH (N = 24)
Length				•	38.0 (6.7)	30.5 (7.4)
Breadth			•		28.4 (6.3)	23.6 (5.6)
Height		•			15.3 (5.0)	12.3 (4.7)
Breadth/length	•				137 (27.2)	130.8 (22.4)
Height/breadth	•				206 (92.2)	207 (87.9)
Retouch length				•	38.2 (14.4)	27.7 (7.8)
Retouch percent	•				35.5 (13.3.)	31.5 (8.5)
Angle edge		•			63.8 (7.0)	69.3 (8.0)
Weight		•			17.8 (13.4)	11.3 (8.8)

retouched, but have the same general shape of the Pigs Water Hole tools. Also, the proportion of tools that are side-worked does not differ significantly between the sites. Scanning the data for other Kangaroo Island sites, the same relationships appear to be true also between these sites and Balcoracana Creek, even though there is noticeable variation between Kangaroo Island sites in scraper/adze typology (Lampert 1981: 136–137).

Further, the proportion of core to flake tools does not differ significantly between Balcoracana Creek and Pigs Water Hole. The two sites exhibit a fairly close relationship in their stone industries, perhaps partly a reflection of their broad similarity in geographical region and antiquity. However, before these industries can be looked upon as useful regional or chronological markers, a wider sample of dated sites must be examined. Such research is currently under way.

Big John Creek

This site was investigated by Lampert on the advice of geomorphologist, Dr J. Bowler (Museum of Victoria), who had reported the presence of large, carbonate encrusted artefacts lying on the surface of the 20 m beach fringing the western shore of Lake Frome. The artefacts lay on a sector of the beach that had been cut through by Big John Creek, an intermittent channel carrying runoff from the Ranges towards, but rarely reaching the lake. Their presence there invited speculation that they may be associated with high lake levels over 30 000 years ago.

In the event, the artefacts were found to lie, as a lag deposit, not only on the ancient shoreline but also on the stratigraphically more recent Coonarbine Formation, a broad series of sediments ranging in age between 26 000 yBP and present (Callen 1975, Callen & Tedford 1976, Wasson 1983). The distribution of the artefacts followed the creek banks, not the beach.

Within an area of some 400 m^2, on the part of the beach that is also the south bank of the creek, the industry was examined in more detail, but not collected. The only formal tool type recognised was a core tool, most of which are end- rather than side-worked (8 end, 4 side, 6 side-end), and similar therefore to those from Balcoracana Creek, only some 30 km to the south. On this evidence, as well as that of stratigraphy, the industry is likely to be early Holocene in age.

Summing up at Lake Frome

The main phase of human occupation of the Lake Frome shoreline occurred during early Holocene times, the principal evidence being provided by sites on the lower courses of creeks a kilometre or two upstream from the lake shore itself. The rarity of typical small tools, given the fact that these are usually abundant on late Holocene sites, indicates only sporadic visits by people within the last 5 000 years. This pattern of occupation fits well with the palynological evidence which shows a moister phase with more luxuriant local vegetation 7 000–4 000 yBP, after which conditions became as arid as they are today (Singh 1981). The popularity of creeks flowing from the Ranges as camping places suggests that these watercourses had a more reliable discharge, and the Ranges, a higher rainfall, than that of today.

Hawker Lagoon

The setting

Hawker Lagoon (Fig. 3) lies towards the northern end of a synclinal valley, known as Wilson Pound, just 8 km west of Hawker township. The valley is between steep quartzite ridges, Yourambulla Range to the east and Yappala Range to the west, which converge to a narrow gorge at the northern end. At Hawker Lagoon the valley floor is about 2 km in width.

The Lagoon itself is a canegrass swamp slightly less than 1 km wide which a local resident, Mr F. Teague, has seen full of water only three times in the last 40 years. It contains small amounts of water more frequently than this, but most of the time is a completely dry depression that supports a thicket of cane grass.

On the southern shore of the swamp is a lunette rising to some 10 m above the lowest point in the swamp bed. The position of a lunette on the southern rather than the, more usual, eastern shore (e.g. Bowler 1971) is explained by the north–south alignment of the valley which protects the swamp from prevailing westerly winds but exposes it to parching winds from the north.

Being near the head of the valley, the catchment of the swamp is small, consisting only of the slopes of the eastern and western ridges, and the short stretch of valley to the north as far as the watershed less than 2 km distant. The swamp has two outlets, one on each side of the lunette, from which water flows southward, eventually forming a well-defined water course (Wilson Creek).

Dunefields extend along the lower hill slopes and, in places, encroach, upon the valley floor. The source of sand, both for these dunes and the lunette, is ultimately the quartzite ridges. Sand, washed downslope into the depression, was transported by northerly winds to form the lunette. Because the largest dunefields are immediately south of the lunette, deflation of the lunette has probably contributed sand to dune formation down wind.

Sites

In many places sand has been stripped away, by deflation or gullying, to expose stone artefacts, the densest concentrations being beside the two outlet channels. Artefacts along the eastern channel are emerging from the lunette itself and extend southward only as far as the outer rim of the lunette, while those beside the western channel are eroding from a dunefield and extend from the south-western shore of the swamp to a point some 300 m south of the lunette. Sites on the western side of the valley are even more extensive than this, reasonably dense concentrations of artefacts being found in exposures through the dunefield some 800 m south of the swamp. Smaller sites are present for a greater distance, and occur sporadically along the banks of the creek until at least the southern end of the valley, some 3 km from the swamp.

The concentration of artefacts around the western outlet channel is not only large but also very dense, reaching 400 pieces of flaked stone per square metre in places, and having an average density between 100 per m^2 and 150 per m^2. There is great variety too, both in artefact types and in raw materials: large cores, core tools and flakes made of local quartzite, grindstones of sandstone, and such small tools as pirris, microliths and tulas, made of a wide variety of imported, fine-grained silcretes and cherts.

During our initial inspection of Hawker Lagoon, we discovered a large core tool apparently *in situ* in a compact lower horizon of the dunefield along the western side of the valley about 300 m south of the swamp. We also noticed that microlithic material was eroding from the uppermost sands, suggesting the presence of a two phase industrial sequence. To test this hypothesis, Lampert returned to the site for several seasons of excavations while Hughes visited less frequently to investigate the sedimentary history.

Site stratigraphy

The north-western sector

The main excavation trench called HL1 (an abbreviation of HL1-5 shown on Fig. 4) was opened up in the richest part of the concentration of artefacts in the dunefield, just beyond the western end of the lunette. Examination of stratigraphy exposed in the side of a gully (Fig. 4) at this point had revealed four superimposed layers of sand:

1. Unit IA, the top unit, of loose orange sand (Fig. 5: 1), from which microlithic material was emerging;

2. Unit IB, the middle unit, of grey brown compact sand (Fig. 5: 3), in which no artefact was seen;

3. Unit IIA, not present in this part of the site.

4. Unit IIB, the bottom unit, of tightly bonded, almost rock hard, red sand (Fig. 5: 5), from which core tools, cores and large flakes appeared to be eroding.

5. Unit III, mottled yellow and grey clayey sand without artefacts.

In this gully and along the edge of the dunefield facing the swamp units IA and IB, and the top few centimetres of Unit IIB had been stripped by erosion. The exposed surface was of the hard unit IIB material, on which some artefacts lay and others seemed to be still *in situ*. After our experiences at Lake Murteree and at Hookina Creek (this report), there were obvious dangers in accepting artefacts as being *in situ* without thorough investigation. Therefore, in a residual in the gully, where all three strata were superimposed, a trench 4 × 2 m was opened up. Artefacts were found in all three units but not in sufficient quantity in Unit IIB to allow the bottom industry to be characterized, nor was charred wood suitable for dating found. Also, the hardness of this unit made excavation difficult and very slow. Three more seasons were needed, and the trench was extended to a total of 4 × 6 m, before a reasonable sample of artefacts, and a carbon sample of acceptable quality for dating were obtained.

Having established through excavation that artefacts are unquestionably embedded in Unit IIB, we increased the sample by removing those emerging from IIB sediments exposed in the gully floor. Before removal, the matrix around each artefact was half sectioned to a depth of 20 cm to make sure it was in undisturbed unit IIB sand and not a slope washed skin. In all cases the matrix remained consistent, through depth, with the stratified unit IIB sands in the main excavation. Therefore, artefacts were judged to be *in situ*.

Dating of HL1

Radiocarbon dates from Trench HL1 are shown in Table 8. The single soil carbonate date (Unit III) provides only a minimum age for the sediments themselves. Judging from its wide divergence from the consistent series of charcoal dates above, the carbonate formed much later than Unit II sediments. Also worthy of comment is the modern date for Unit IA, a horizon that must have suffered post-occupational wind disturbance, lying disconformably on Unit IB.

HL 30 and HL 32: the lagoon bed and lunette

Trenches HL 30 and HL 32 were excavated by Professor R.V.S. Wright (Dept of Anthropology, University of Sydney), who visited Hawker Lagoon during our 1982 fieldwork season in search of faunal remains and other environmental evidence in the swamp sediments. Trench HL 30 is a 1 m^2 test pit in approximately the centre of the lagoon bed, excavated to a depth of 1.6 m and from there augered to a total depth of 3.9 m below the surface of the swamp bed. Throughout this depth the sediments were found to be hard clayey sand, grey in colour and devoid of stratigraphic differences. Other than an occasional fleck of charcoal, no organic substance was seen, nor was pollen found in samples submitted to Dr J. Dodson (University of NSW).

A line of auger holes extending from the swamp bed southward across the eastern end of the lunette helped to locate where lacustrine and terrestrial sediments intersected at the shoreline. At this point, Trench HL 32, a 1 m^2 test pit, was opened up to investigate possible stratigraphic relationships between artefacts and the lunette.

The trench was excavated to a depth of 1.0 m, then a small sondage was dug for a further 40 cm. The strata encountered were:

A	0–45 cm	loose orange sand becoming compact with depth — backed blade at 45 cm
B	45–65 cm	light grey sand containing a small flake at 65 cm
C	65–115 cm	hard red clayey sand — tiny carbonate flecks in top 4 cm — no artefact recovered
D	130+ cm	mottled yellow and grey clayey sand, intersecting with the grey clayey sand found in the swamp

From the outset, several of the strata seemed like those of HL1; stratum A corresponding to Unit IA, C to IIB, D to III, but B having no counterpart in HL1. Stratum B is interpreted as beach sand, partly because of its loose, coarse texture, but mainly because it is present only at the swamp margin, where sediments found while augering the swamp bed meet with Unit III. It diminishes in thickness

TABLE 8. HL1 radiocarbon dates.

Unit no.	Unit depth (cm)	Sample depth (cm)	Description	Age
IA	0-20	15-20	Scattered charcoal in loose sand	60 ± 50 (SUA: 2254)
IB	20-32	18-32	Scattered charcoal	5 100 ± 100 (SUA: 2253)
IIB	32-112	104-112	Fireplace in pit	14 770 ± 270 (SUA: 2131)
III	112+	112-120	Calcium Carbonate	2 950 ± 70 (ANU: 3353)

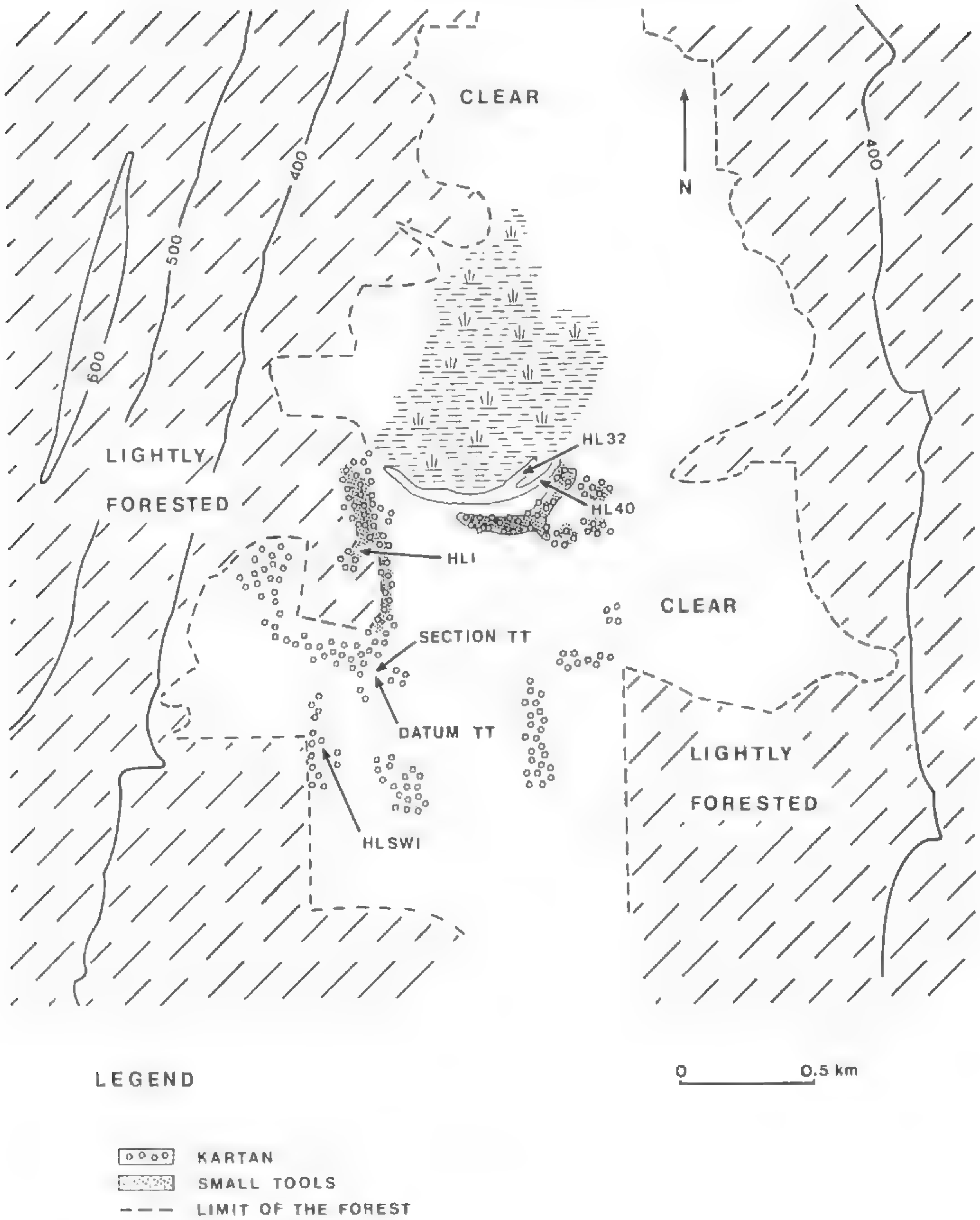

FIGURE 4. Plan of main excavation area of Hawker Lagoon.

and peters out, southward from the swamp, as auger holes revealed.

HL 40 and the north-western sector

Further to examine these putative relationships, HL 40, another 1 m^2 test pit was opened up on the lunette some 100 m SW of HL 32. At this point, deflation had not only unearthed a large number of artefacts but also revealed stratigraphy like that seen in HL1. Three strata were revealed:

0–12 cm	grey-brown compact sand containing flakes

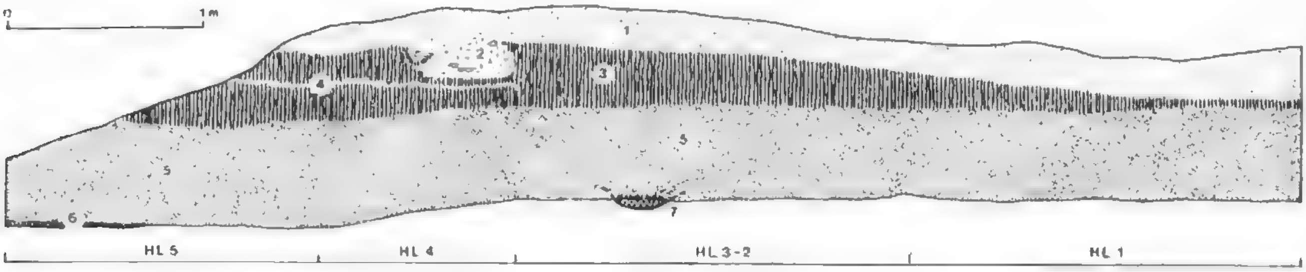

FIGURE 5. Stratigraphy of Trench HL1-5, Hawker Lagoon: 1. Loose orange sand (IA), 2. Disturbance (animal burrow), 3. Compact, grey-brown sand (IB), 4. Grey-brown clay band, 5. Hard red clayey sand (IIB), 6. Scattered charcoal, 7. Hearth in pit, dated by SUA: 2131.

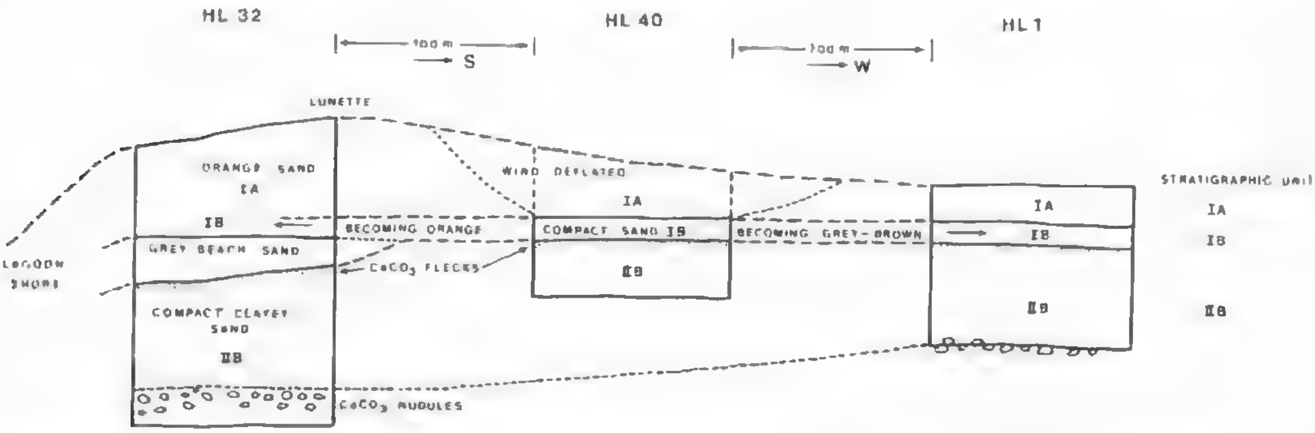

FIGURE 6. Composite section showing stratigraphic relationship between the three excavation trenches at Hawker Lagoon.

12–62 cm	hard red clayey sand with tiny carbonate flecks in top 4 cm and containing core tools
62+ cm	carbonate zone in mottled yellow and grey clayey sand

These are unmistakably the same strata as Units IB, IIB and III in trench HL1 some 700 m westward (Fig. 6). At HL40, Unit IA has been stripped away by deflation but is present just a few metres away on the surface of the lunette.

Having established this relationship, a line of closely spaced holes was augered between HL40 and HL32. These show that the top stratum (A) in HL32 is continuous with both Unit IA and Unit IB, even though no clear division can be seen in the HL32 section, while stratum C is continuous with Unit IIB in HL40 (Fig. 5).

HL TT and the south-western sector

HL TT is a section, exposed in a creek bank, 500 m south of HL1, showing the dune stratigraphy at this part of the site.

Unit No.	Unit depth (cm)	Description	Age
IA	0–22	Loose orange sand lying disconformably on IIA	Modern
IIA	22–57	Fairly compact red sand with large carbonate nodules in top 15 cm, lying disconformably on IIB	>8 380 ± 110 yBP (on carbonate)
IIB	57–76	Hard red clayey sand	
III	76+	Mottled yellow and grey clay with carbonate horizon	>13 930 ± 140 yBP (SUA-1 751) (on carbonate)

Because the eroded sediments above Unit II were discontinuous between HLTT and HL1, a complete stratigraphic section between the sites could not be examined. However, Units IA, IIB and III are common to both sites, and are clearly identical in terms of appearance, hardness, stratigraphic position and age. Unit IB is absent from HLTT, its stratigraphic position between IA and IIB being taken by IIA, a compact red sand with massive carbonate blocks in the top third of its thickness.

Regional stratigraphy and palaeoenvironments

From the morphology of the valley, it is apparent that all wind blown deposits overlie the tails of alluvial fans which mantle the middle and lower hill slopes. According to Williams (1973) such fans are part of the Pooraka Formation deposited between 40 000 and 30 000 years ago. However, there is no evidence for human occupation in the region at this time.

The earliest aeolian sedimentary unit encountered, Unit III, is also devoid of evidence for human presence. Lying between Unit IIB and the Pooraka Formation, Unit III must have been laid down some time between 30 000 and 15 000 years ago. Lying conformably below Unit IIB it appears to have still been accumulating at the end of this period. Thus, the upper sediments of Unit III may be part of widespread dune building of the arid phase which lasted altogether from 22 000 to 13 000 yBP (Bowler & Wasson 1983).

Unit IIB sands which contain the earliest evidence for human occupation, accumulated around 15 000 yBP, towards the end of the arid phase. Red in colour, IIB sands resemble those of the Edeowie dunes, some 45 km to the north, which also built up during the arid phase (Williams 1973). This was overlain by IIA, also a red sand but not cemented as tightly together as IIB. Towards the top of IIB a layer of massive tabular blocks of soil carbonate developed (Section HLTT) dated to older than *c.* 8 400 yBP, but possibly a local expression of the Motpena Palaeosol dated to *c.* 12 000 yBP (Williams 1973).

A phase of erosion followed, Unit IIA being stripped away completely in some areas (e.g. at HL1) and stripped down to the top the blocky carbonate palaeosol in others (e.g. at HLTT). In places where IIA had been stripped away the surface of IIB was weathered, then disconformably overlain by IB. We see no obvious reasons for this in the climatic models available. According to Williams (1973), from 16 000 to 12 000 yBP in the Flinders Range the climate was temperate with sufficient moisture to allow soil formation, while from 12 000 to 5 000 yBP conditions were generally more arid but rainfall was of great intensity causing high stream discharge rates. However, the broader climatic model of Bowler & Wasson (1983) shows the arid phase diminishing after 15 000 yBP but persisting until at least 13 000 yBP, after which conditions continued to improve as the moist phase of the Early Holocene was reached. Neither of these models offers an explanation for the weathering of Units IIA and IIB, which might result from peculiar local conditions caused perhaps by the site location in a narrow valley through which wind is channelled either from the north or the south.

The stratigraphy revealed in HLTT can be traced over most of the south-western sector of the Hawker swamp site complex. Because this sector had been cleared of its original woodland cover (mallee and native pine) much of it has been eroded deeply, usually to a level within the Unit IIB clayey sand. However enough remnants of overlying deposits are present to show the consistency of the stratigraphy across the sector.

Core tools, cores and largish flakes were found on and eroding from the exposed horizontal surface of Unit IIB but typical small tools are extremely rare in the south-western sector. Two core tools were found *in situ* within IIA while a number were found, as a lag deposit, on remnants of the exposed horizontal surface of IIA. Wind erosion seems to have ceased on reaching the horizon of massive carbonate nodules, which are harder than the sandy matrix of IIA. Later, the deposits were dissected deeply by numerous small streams carrying runoff to the valley floor, leaving flat topped columns of sediment capped by carbonate. While the nature of the sediments that have blown away cannot be ascertained beyond doubt, sections at the edge of the cleared land where upper deposits are still protected by mallee woodland, show that the IIA red sands continue for some 20 cm above the carbonate horizon. Because carbonate horizons form within, rather than on, a sedimentary unit, it seems likely that IIA red sand once lay above the carbonate horizon throughout this sector of the site.

Summing up the stratigraphic evidence

Table 9 brings together stratigraphic evidence from the various excavations and natural exposures discussed above. While not all strata are present in any one section, three (IA, IIB and III) are present throughout, and two others (IB and IIA) are closely dated enough to allow them to be placed in sequence.

The stone industries (Figs 7–10)

Surface evidence

The seemingly patchy distribution of artefacts shown on the site map (Fig. 3) results partly from lack of visibility where erosion has not occurred. This map shows also that while the Kartan industry is widespread, the small tool industry is confined almost entirely to areas where the two outflow channels emerge from the lagoon, where its distribution overlaps that of the Kartan.

Two controlled surface collections, designated HLA2 and HLSW1, were made in the cleared rectangular areas where the industry appeared to be purely Kartan i.e. large core tools dominant but small tools entirely absent, while a third (HL7) was made at the western end of the lunette in a purely small tool area on recent sand (Unit IA) on the top of a dune.

Surface collection HL A2

This was collected near HL TT, in the SW sector of the site. Here the landscape is deeply etched with erosion channels, leaving less deeply eroded pedestals of sediment. Large core tools, cores and flakes were found both lying on the surface of these pedestals and partly embedded in the IIA red sand, some exposed in vertical sections being unquestionably *in situ*. All the exposed material was collected, and the following artefact types were identified:—

	N	%
Flake scraper	4	3.9
Core tool	20	19.6
Trimming flake	8	7.8
Core	19	18.6
Flake	51	50.0

Surface collection HL SW1

This was made in the extreme south-western corner of the site, where the eroded area finishes abruptly at an old fence line, beyond which the dunefield is well stabilised by its original thick cover of mallee. Along the eastern side of the fence line, where the site lies, the sediments have been eroded down uniformly to Unit III material, on which the artefacts now lie. This surfce is devoid both of vegetation and of naturally occurring stone. From the outset this area looked like a typical Kartan site on Kangaroo Island, with its predominance of large core tools among artefacts. However, it was seen to have an important advantage in that the industry is fully exposed on a clay base, unlike the Kangaroo Island sites where both vegetation and naturally shattered stone aroused suspicion of a bias in sampling (Lampert 1981).

A strip, 150 × 30 m, parallel to the fence was marked out and all stone collected. The following artefact types were identified:

TABLE 9. Correlation of dune stratigraphy at Hawker Lagoon.

Depositional Unit	Geological activity	Relationship with swamp	Age	Archaeological evidence
IA: loose, orange wind-blown sand	Depositional	Both units lie above beach of former high water level; water level now low	Late Holocene; present day land surface. Modern carbon date from bottom of unit shows post-depositional wind disturbance	Small tools including geometric microliths concentrated in small areas
IB: compact, grey-brown sand; present only in and near lunette	Depositional		Mid-to late Holocene; date of *c.* 5 100 yBP from bottom of unit	One small thumbnail scraper of microlithic character
Beach sand at swamp margin	Depositional	Water level high	Early-mid-Holocene	Microlith lying on, but not in, beach
None recognised	Erosional: weathering of IIB and IIA		Terminal Pleistocene?	None recognised; no lag of artefacts on IIB surface
IIA: red wind-blown sand present only in SW sector of site	Depositional		Greater than *c.* 8 400 yBP on carbonate horizon which could be Motpena Palaeosol (*c.* 12 000 yBP)	Kartan tools
IIB: hard, red wind-blown clayey sand	Depositional	Both units continue below beach of high water level	Pleistocene; date of *c.* 14 800 yBP from pit in unit	Kartan tools
III: mottled yellow and grey clayey sand with carbonate horizon	Depositional		Greater than *c.* 13 900 yBP on carbonate date, but must be older than IIB	None

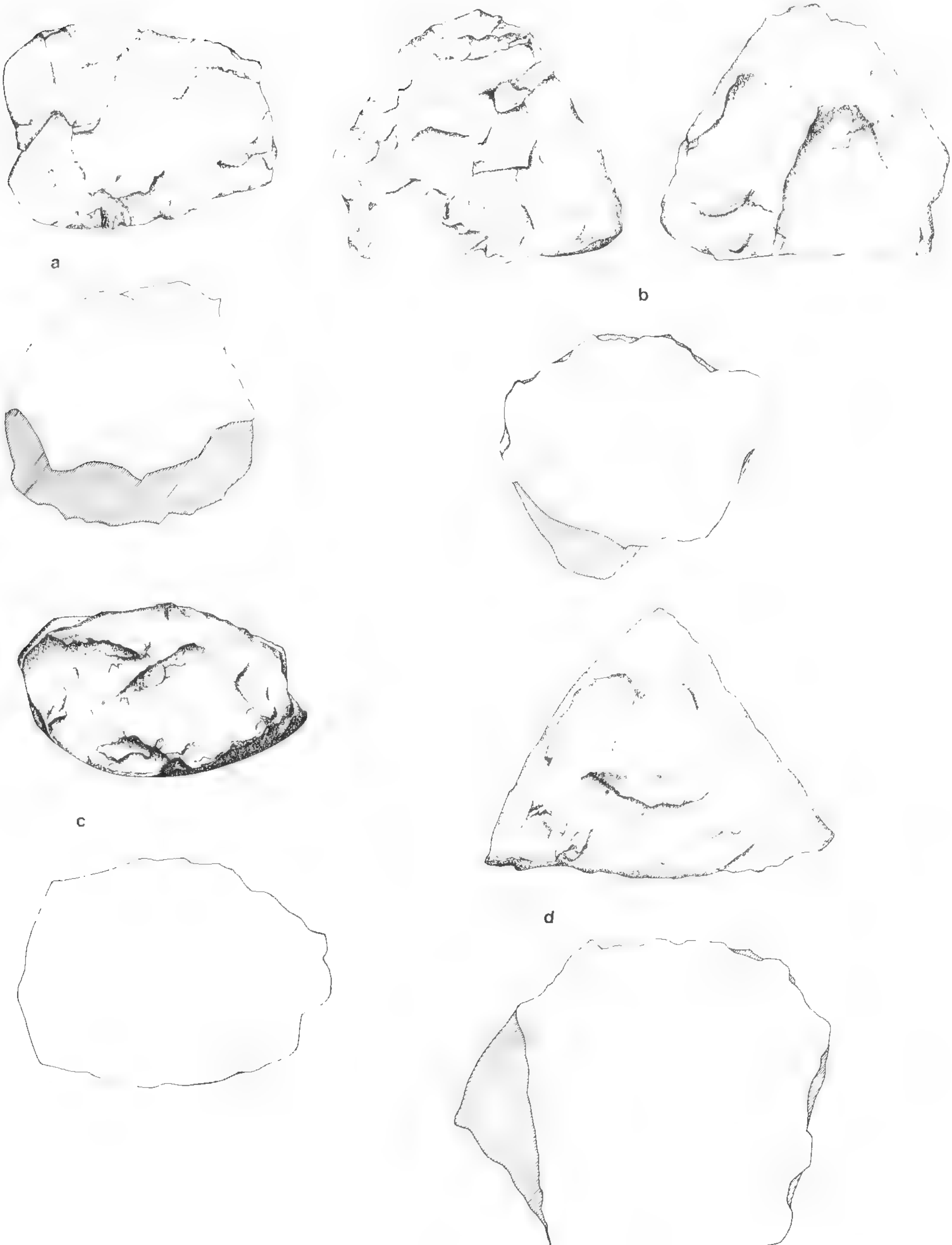

FIGURE 7. Core tools from Hawker Lagoon surface collections: a and b from HL2; c and d from SW1.

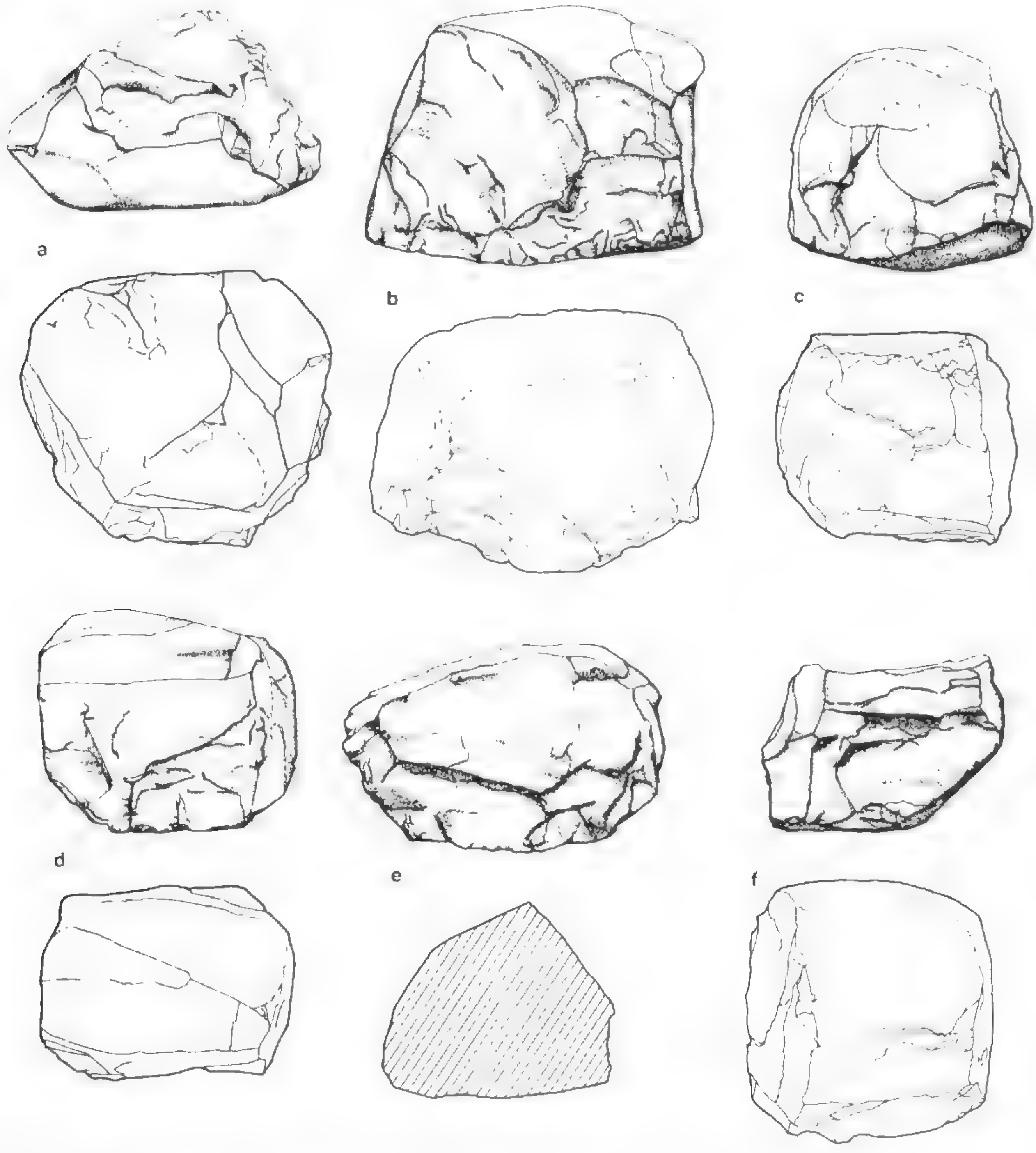

FIGURE 8. Core tools from Hawker Lagoon Unit IIB: a–f excavated from exposed surface (HLZ).

	N	%
Flake scraper	6	4.5
Core tool	31	23.5
Trimming flake	10	7.6
Core	19	14.4
Flake	66	50.0

Surface collection HL 7

This was made in a small (3 × 4 m) patch of IA sand some 40 m N. of the main excavation trench HL1. Wind had exposed a heavy concentration of small artefacts over a larger area, of which HL7 was seen as typical. The following artefacts were collected:

	N	%
Geometric microlith	6	0.2
Tumbnail scraper	3	0.1
Miscellaneous retouch	9	0.3
Bipolar core	1	0.1
Core	5	0.2
Flake	2570	99.1

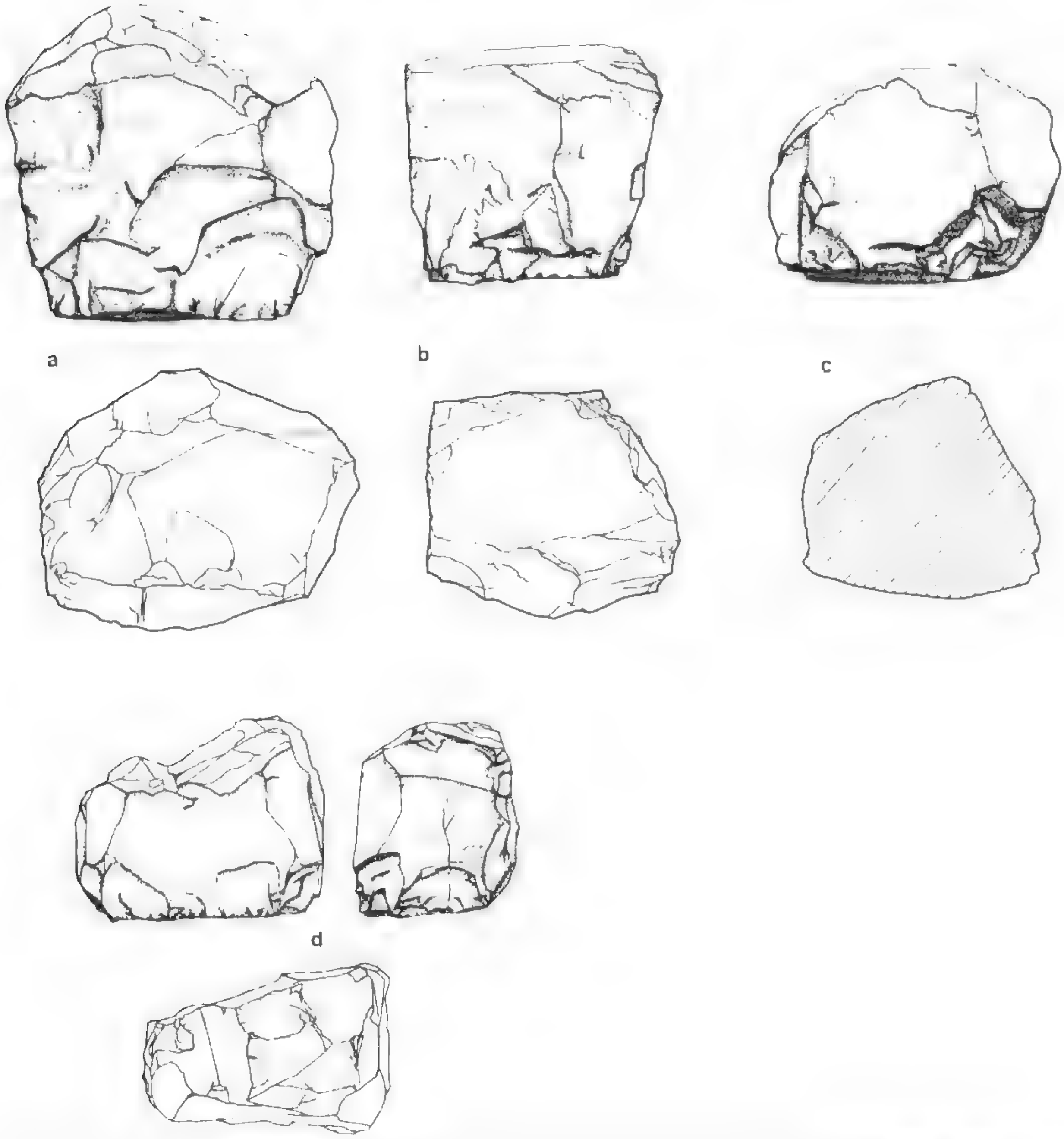

FIGURE 9. Core tools from Hawker Lagoon Unit IIB: a and b from HLZ; c and d from Trench HL1.

The preponderance of flakes over other artefacts is noteworthy, as is the small size of the material, most of which is 1-2 cm^2 and the largest piece, a flake, has a length of 5 cm. The 2 594 artefacts have a total weight of only 1 860 g.

Also of interest is the high density of artefacts: more than 200 m^2 at this one stage in the process of deflation. A year later, further erosion of IA sand had exposed a similar density of artefacts in this same small patch. This is typical of eroded patches in the north-west sector of the site suggesting that an immense amount of flaked stone lies buried within the nearby dunes.

Excavated samples from HL1 and HLZ

Table 10 shows the distribution of artefact types through the three sedimentary units in HL1, the main excavation trench. Unit IIB has been divided into three levels of equal depth to demonstrate that artefacts are embedded deeply enough in it to have been deposited during the unit's sedimentation. Also shown are the artefact types excavated from HLZ, the eroded surface of IIB sediments adjacent to HL1. The HLZ artefacts provide a larger sample from IIB than that given by HL1 alone.

The excavation of trench HL1 confirms that the two industrial traditions, recognised from surface

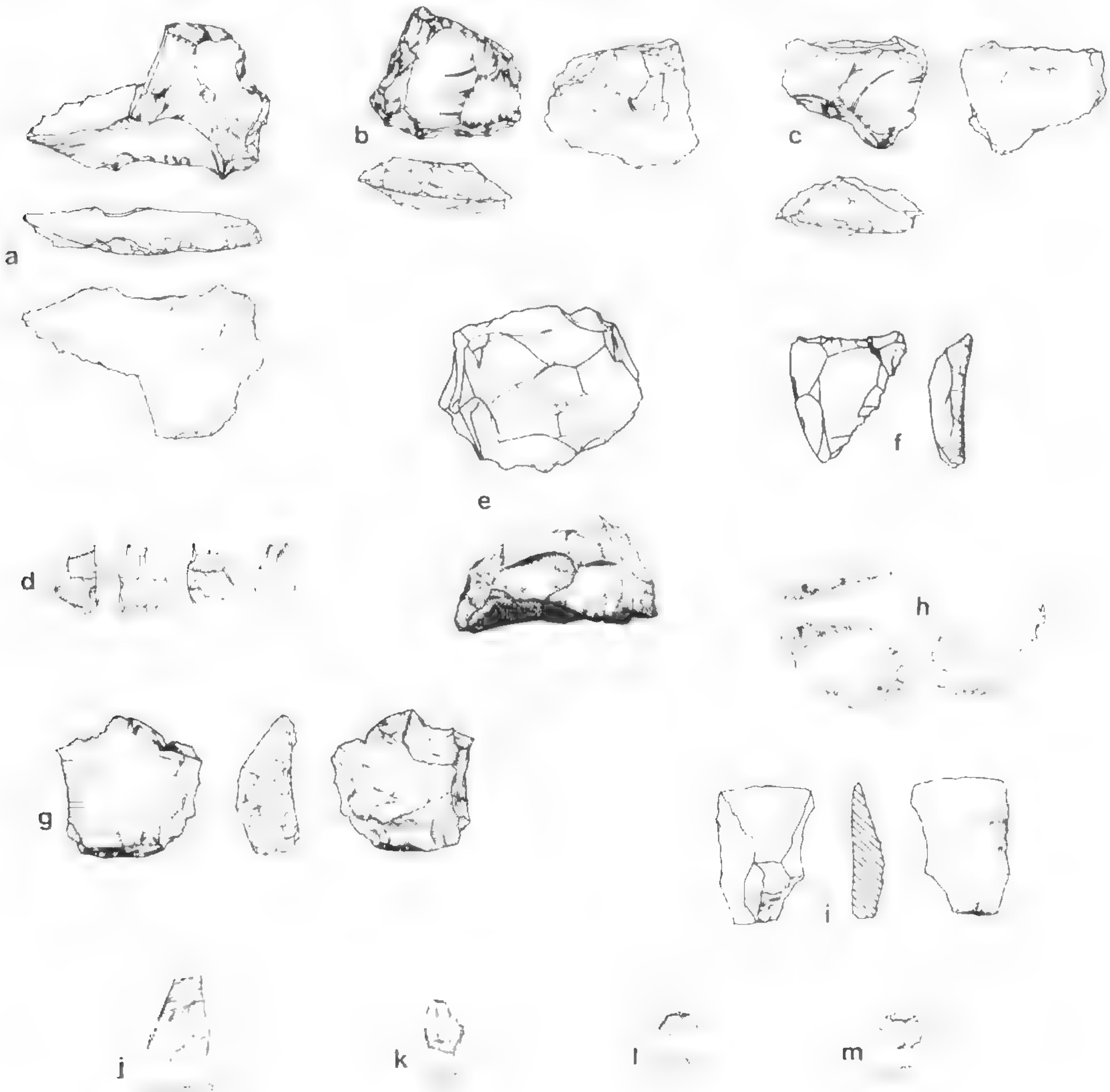

FIGURE 10. Artefacts from Hawker Lagoon Trench HL1: a to i, flake scrapers from Unit IIB; j, piece of reniform slate scraper from IA; k and l, microliths from IA; m, thumbnail scraper from IB.

evidence, were popular at different times. The earlier, dated to around 15 000 yBP, is characterised by core tools, trimming flakes and a high core to flake ratio (1:23). The later, dated from about 5 000 yBP, onward, is characterised by such typical small tools as geometric microliths, a pirri, thumbnail scrapers, a fragment of a reniform slate scraper and a low core to flake ratio (1:616).

Other changes occurred during the history of occupation. Sixteen of the core tools from IIB (HL1 and HLZ) are made on quartzite and one is on silcrete, whereas the microliths, pirri and thumbnail in IA and B are all made on silcrete. Flake scrapers, however, are made on silcrete and quartzite in roughly equal proportions throughout. This increasing popularity in the use of silcrete can be seen best in 'waste' flakes (Table 11), a change that is statistically significant. The size of artefacts changed, seen not only in the obvious change from core tools to small tools, but also in the decrease in size both of 'waste' flakes (Table 12) and of flake scrapers (Table 13) both changes being statistically highly significant.

Excavated samples from HL40

In this eroded area at the eastern end of the lunette only part of Unit IB and all of IIB were available for excavation, IA having been stripped away entirely. The following artefacts were recovered from Unit IIB:

TABLE 10. Hawker Lagoon: excavated artefacts from HL1 and HLZ.

HL1												HLZ					
Soil unit	Microlith	Pirri	Thumbnail	Bipolar core	Slate scraper	Scraper	Misc. retouch	Core tool	Trimming flake	Core	Flake	Soil unit	Scraper	Core tool	Trimming flake	Core	Flake
IA		1	2	1	1	5	9			1	1101						
IB	2					2	1			1	131						
IIB i						2				1	113						
IIB ii						5	6	2	4	12	259	IIB ii	4	11	5	16	60
IIB iii						11	13	4	10	22	420	IIB iii					

	N	%
Flakes	81	92.0
Cores	1	1.1
Core tools	3	3.4
Scrapers	2	2.3
Trimming flakes	1	1.1

This 1 m^2 test pit confirms that artefacts are *in situ*; that the strata are IIB overlain by IB, as found also at HL1; and that the IIB artefacts, in which core tools and flake scrapers predominate, conform with those from HL1.

Excavated samples from HL 32

A 1 m^2 test pit made to examine the stratigraphy at the lagoon shoreline, HL 32 revealed three strata described earlier. The following artefacts were recovered:

Units IA and IB combined (no stratigraphic division visible)	Flakes 434 Geometric microlith 1
Grey beach sand	Flakes 63 Thumbnail scraper 1
Unit IIB	No artefact found

The microlith was in the bottom 10 cm of units IA–IB and the thumbnail scraper was in the top 10 cm of the grey beach sand. It is possible that more recent material was trodden into the soft sand of the beach, indicating that the beach could have been formed before the advent of small tools. However this could not have been much earlier because the exposed loose sands of the beach would almost certainly have been either stripped away by deflation or a protective soil would have formed in its upper horizon. Given also the fact that the beach lies disconformably over Unit IIB, which shows the same upper zone of weathering here as it does below IB, it seems likely that the beach formed not long before IB i.e. at the mid-Holocene. This interpretation accords with the type of stone artefacts found in the beach. Not only is there a thumbnail scraper made on a section of a silcrete blade but there are many small flakes of silcrete, reminiscent more of the stone from upper levels (IB and IA) in HL1 than the lower level (IIB).

Typological relationships among core tools

To compare Hawker Lagoon core tools with those from Kangaroo Island, the same metrical observations were made (Lampert 1981). Samples provided by surface collections HLA2 and HLSW1, and by excavation of HL1/HLZ, were each compared with a sample of 76 block tools from Kangaroo Island (Fig. 11). As Tables 14 to 16 show, among 27 comparisons there are only two differences significant at the 0.05 level.

There are other similarities between the industries of the two regions:

1. With few exceptions, local stone of indifferent quality was used for core tools.
2. With the exception of HL1, where the sample is small, core tools predominate among formal tool types.
3. Given the number of finished tools, flakes and multidirectional cores are fewer than on non-Kartan sites.
4. Site areas are large with artefacts scattered fairly thinly.

Given this close correspondence with Kangaroo Island, the early industry at Hawker Lagoon must also be Kartan.

Summing up at Hawker Lagoon

Hawker Lagoon is a large open site with stone industries eroding from several strata in a lunette

TABLE 11. HL1 — distribution of unmodified flakes of silcrete and quartzite between upper and lower units.

Level	Silcrete	Quartzite	Total
IA, IB	50	50	100%
IIB	43	57	100%

TABLE 12. HL1 — distribution of unmodified flakes according to size between upper and lower units.

Level	1 cm	1.5-2 cm	2 cm	Total
IA, IB	66	31	3	100%
IIB	23	41	36	100%

and contiguous dunefield. Artefacts of the Kartan industry are present over a wide area, but small tools are confined to two localised patches where the lunette terminates near the sides of the valley and two channels carry overflow from the swamp downstream. The Kartan tools are provenanced to two lower horizons, IIB and IIA, dated to 14 770 ± 270 yBP and older than 8 380 ± 110 yBP, respectively; the small tools to two upper horizons, IB and IA, dating back to 5 100 ± 100 yBP, and possibly to beach sands stratigraphically between IIA and IIB. Further excavation is planned to elucidate the late Holocene stratigraphy, not only at the swamp shore, but also near the location of Trench HL1 where the upper horizons (IA and IB) suffered post-occupational wind disturbance.

Over much of the site, Unit IIA is not present, presumably stripped away by the same climatic event that weathered the surface of IIB. However, no particular reason for this event, between *c.* 15 000 and 5 000 yBP, can be identified in the broad palaeoclimatic history of the region, suggesting it may have local rather than regional causes.

The presence of a beach, stratigraphically between IIA and IB, shows that a stand of high water also occurred in the 15 000-5 000 yBP period. Because the weathered surface of IIB continues below the beach, the phase of erosion preceded that of high water. The wetter local conditions that must have caused the stand of high water are thought to be part of the early Holocene wet period evidenced for southern Australia generally, suggesting a terminal Pleistocene date for the phase of erosion.

The Region in the Context of Australian Prehistory

The Kartan industry

Description of the Kartan industry

Because some of the main conclusions reached in this report depend upon proper recognition of

TABLE 13. HL1, HL2 flake scrapers comparison between upper (IA, IB) and lower (IIB) depositional units. S.D. = standard deviation, N = sample size.

Attribute	Significance Level NS	.05	.01	.001	Mean (S.D.) IA, IB (N = 8)	Mean (S.D.) IIB (N = 16)
Length				+	24.5 (5.2)	58.1 (20.8)
Breadth				+	22.0 (6.2)	47.5 (14.0)
Height				+	8.1 (1.2)	22.6 (10.3)
Breadth/length	+				123.8 (20.1)	128.4 (35.4)
Height/breadth	+				276.9 (76.4)	247.3 (111.3)
Retouch length			+		24.5 (7.5)	77.3 (51.7)
Retouch percent	+				34.3 (14.6)	43.1 (22.0)
Retouch angle	+				64.8 (3.6)	70.0 (13.4)
Weight		+			8.3 (2.1)	87.9 (81.8)

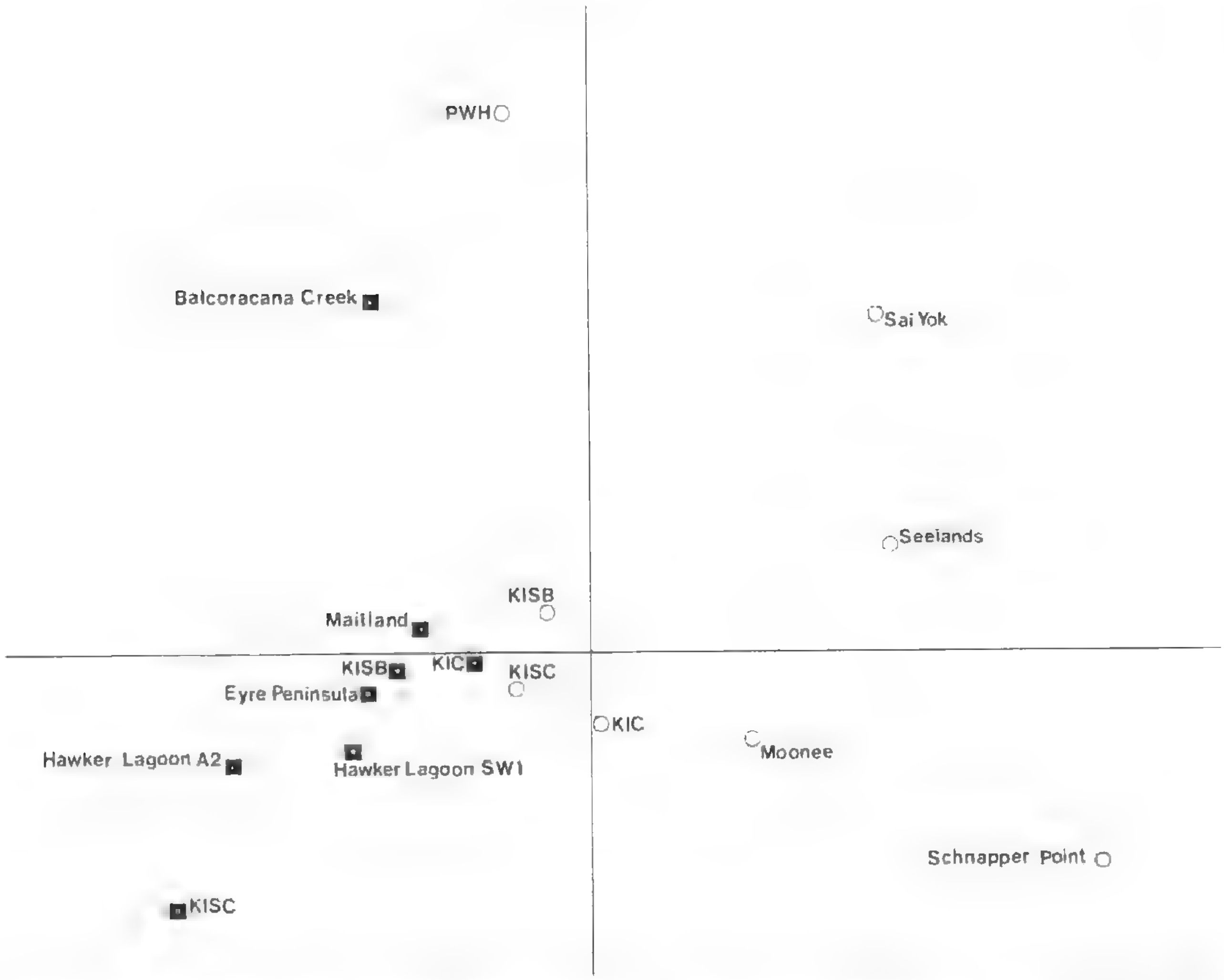

FIGURE 11. Discriminant function analysis comparing Hawker Lagoon and Balcoracana Creek core tools with those from elsewhere (data from all sites outside the Flinders Ranges are mentioned in Lampert 1981: Fig. 36). Note that Hawker Lagoon clusters with other South Australian Kartan sites while Balcoracana Creek is closer to Pigs Water Hole (PWH). KI = Kangaroo Island.

the Kartan we put forward the following criteria, taken from Lampert (1981, 1983):

1. The Kartan is found on Kangaroo Island and in nearby parts of mainland South Australia, mainly on open sites near fresh water.
2. The dominant artefact in Kartan assemblages is a large core tool made on either a pebble or block of quarried stone in accordance with the availability of local stone.
3. Kartan core tools have metrical-statistical characteristics, described by both Matthews (1966) and Lampert (1981), which distinguish them from core tools in all other known industries from the Australian-South East Asian region.
4. Another characteristic that appears unique to Kartan assemblages is the rarity of flakes, flake tools and cores, compared with core tools.
5. Kartan core tools are unifacially flaked from a flattish base, producing a working edge that extends, on average, around half the base perimeter.
6. With use and sharpening, the edge becomes steeper and extends further around the perimeter, leading eventually to the classic horsehoof core on which the edge is too steeply overhung for the artefact to be functional as a tool.

Since this description was published, other information has emerged. From his excavation of a 7 000 year old occupation level at the Cape du Couedic rockshelter on Kangaroo Island, Draper (1987) claims to have recovered Kartan tools, and believes that the Kartan owes much of its character to the use of a particular reduction sequence, suited to the kind of stone. For different raw material, another technology was favoured. At the very least, this view provides an alternative hypothesis to those explored by Lampert (1981) in seeking to explain the spatial separation of Kartan from most other sites on Kangaroo Island. Characterised by 'two large pebble choppers, a couple of small ones (comparable to . . . examples from Pigs Water Hole

TABLE 14. Core tools from surface site HLA2 compared with KI block tools. S.D. = standard deviation, N = sample size.

Attribute	Significance Level NS	.05	.01	.001	Mean (S.D.) HLA2 (N = 20)	Mean (S.D.) KI (N = 76)
Length	+				107.5 (16.7)	106.4 (20.2)
Breadth	+				90.8 (14.7)	85.4 (16.6)
Height	+				73.0 (20.5)	65.0 (17.8)
Breadth/length	+				118.6 (13.4)	126.9 (22.4)
Height/breadth	+				132.4 (30.8)	144.1 (56.0)
Retouch length	+				184.2 (64.3)	156.7 (71.4)
Retouch percent	+				57.2 (16.5)	51.0 (21.8)
Retouch angle	+				84.9 (4.6)	84.0 (8.7)
Weight	+				927.4 (331.7)	881.7 (451.4)

TABLE 15. Core tools from surface site HLSW1 compared with KI block tools. S.D. = standard deviation, N = sample size.

Attribute	Significance Level NS	.05	.01	.001	Mean (S.D.) HL (N = 31)	Mean (S.D.) KI (N = 76)
Length	+				109.6 (13.5)	106.4 (20.2)
Breadth	+				90.3 (15.0)	85.4 (16.6)
Height	+				65.8 (16.0)	65.0 (17.8)
Breadth/length	+				122.8 (16.2)	126.9 (22.4)
Height/breadth	+				145.3 (45.6)	144.1 (56.0)
Retouch length	+				130.0 (49.1)	156.7 (71.4)
Retouch percent		+			40.1 (12.2)	51.0 (21.8)
Retouch angle	+				82.8 (6.3)	84.0 (8.7)
Weight	+				846.9 (350.8)	881.7 (451.4)

TABLE 16. HL excavated sample compared with KI block tools. S.D. = standard deviation, N = sample size.

Attribute	Significance Level				Mean (S.D.)	Mean (S.D.)
	NS	.05	.01	.001	HL (N = 17)	KI (N = 76)
Length	•				97.6 (16.9)	106.4 (20.2)
Breadth	•				80.8 (16.2)	85.4 (16.6)
Height	•				64.4 (14.3)	65.0 (17.8)
Breadth/length	•				122.6 (12.5)	126.9 (22.4)
Height/breadth	•				125.6 (12.0)	144.1 (56.0)
Retouch length	•				149.8 (75.9)	156.7 (71.4)
Retouch percent	•				57.1 (24.5)	51.0 (21.8)
Retouch angle		•			89.1 (2.4)	54.0 (8.7)
Weight	•				714.7 (400.6)	881.7 (451.4)

. . . .)' and 'hundreds of quartzite flakes' (Draper 1987: 5), the Cape du Couedic assemblage appears to have greater similarity with the Pigs Water Hole site (Lampert 1981: 81–96), for which, like Cape du Couedic, an early Holocene age is indicated, than with the more usual range of Kartan sites. However, the presence of large pebble choppers within the assemblage does support Draper's suggestion (1987: 6) that Cape du Couedic is the 'missing link' in site variation, indicating a closer relationship between Pigs Water Hole and Kartan sites than Lampert's research suggests.

Research at the Lime Springs site, in inland northern New South Wales, has revealed an industry featuring horsehoof cores and large flake scrapers, termed Kartan by the authors (Gorecki *et al.* 1984), in the upper levels of a deposit dating back some 19 000 years. Because this industry has not been fully described by the authors its relationship with the Kartan from South Australia cannot be determined. However, a metrical-statistical comparison between core tools from South Australia and coastal northern New South Wales (Lampert 1981) shows no close relationship; instead it reinforces a view of the Kartan as a regional industry confined to South Australia. Other writers question the status of the horsehoof core as a tool. Both Kamminga (1982) from the absence of use wear, and Flenniken & White (1985) from the steepness of edge angle, conclude that most horsehoofs are simply cores rather than core tools, a view not greatly different from that of Lampert (1981: 65) who sees the horsehoof core as 'the worked out remnant of a tool' rather than a functional tool *per se*.

The geographical range of the Kartan

Previous typological studies (Matthews 1965, 1966; Lampert 1981) establish the Kartan as a regional industry within the Australian core tool and scraper tradition, confined to Kangaroo Island and the three nearby mainland peninsulas, Fleurieu, York and Eyre, with the Wakefield River as the most northerly site recognised. That view is changed by the present study which confirms reports by Cooper (1968) of Kartan sites in the northern Flinders Ranges. However, no Kartan site was found while reconnoitring surrounding desert areas, ranging as far north as Innamincka, Birdsville and Oodnadatta (Hughes & Lampert 1980, 1985; Lampert 1985); nor have Kartan sites been reported from coast and hinterland to the west and east of the three peninsulas. On present evidence then, the Kartan extends from a clearly defined sector of the South Australian coast, through the Mount Lofty Range, and the southern and northern Flinders Ranges, but is absent from surrounding regions. As Lampert (1981) shows, Kartan sites are invariably in hilly country, near either a stream or lagoon, and usually placed on the lower slope of a hill, often with a northerly aspect. Sites in the Flinders Ranges conform to this locational pattern, both Mount Chambers and Mooroowie Well being on slopes near streams, while most Hawker Lagoon Kartan tools lie on the lower slopes of the Yappalla Range.

The Kartan industry has an upland distribution, ranging from humid coastline in the south to desert ranges in the north. Such a distribution indicates cultural unity through the long chain of ranges, despite climatic diversity. Recent patterns of Aboriginal culture show unity within drainage basins, but division along watersheds, such as ranges (Peterson 1976). However, the ranges in question are wide enough to have been a cultural province themselves. Indeed, present day Aboriginal inhabitants of the northern ranges, who were interviewed by Lampert, distinguish between 'rock' (or hill) people, such as the Adnyamathanha, and 'salt water' (inland salt lake) people like the Arabana.

Age of the Kartan

From its presence on Kangaroo Island, an antiquity greater than the flooding of the land bridge that had joined the island to the mainland (c. 9 500 yBP) is inferred (Tindale 1957, Cooper 1960, Lampert 1981). While the Hawker Lagoon date of c. 15 000 yBP confirms that the Kartan has Pleistocene origins, recent excavations at Cape du Couedic, Kangaroo Island, suggest that Kartan tools were still in use at some sites as recent as c. 7 000 yBP (Draper 1987). This modifies the view of Lampert (1981), deduced from the absence of the industry at several dated sites, that Kartan tools had gone out of use at least before 11 000 yBP, and possibly before 16 000 yBP.

Later core tool assemblages

The Lake Frome sites at Balcoracana Creek and Big John Creek, the Kangaroo Island site at Pigs Water Hole, and possibly Cape du Couedic, have several features in common, including an early Holocene age. Like Kartan sites, core tools predominate in the assemblages, but the tools are smaller and have working edges of different orientation. These differences, though statistically significant, are not as great as those between either group and local assemblages of the small tool tradition; nor is there a great time difference between the two groups judging from the dates of Hawker Lagoon and Balcoracana Creek. Possibly we are looking at a 'sub-Kartan' industry, which has developed out of the Kartan and retained some of its features.

Movement of people

At Hawker Lagoon the bulk of the archaeological evidence is concentrated within two broad phases: (i) an early phase around 15 000 yBP with Kartan artefacts, (ii) a late phase beginning about 5 000 years ago and continuing possibly until the late 19th century. Stratigraphically these phases are represented by units IIA-IIB and IA-IB, respectively, but in the three excavated areas IIA is not presented. The disconformity between IIB and IA represents a 10 000 year gap in the site's despositional and human history. If the site had been popular during that time artefacts should appear as a lag on the weathered IIB surface, but this is not the case. The possibility of artefacts having shifted by natural means at the site is currently being investigated by taphonomic studies. Conducted by Dr J.P. White (University of Sydney) and the authors, these studies involve annual observation over 10 years. Preliminary results from fieldwork in 1987 indicate that small, flattish flakes are moved easily by strong gusts of wind, some being blown as much as 4 m uphill on an eroded dune face, suggesting that the 'industry' in Unit IA, Trench HL1, which consists almost entirely of flakes of this kind, is in fact a wind sorted component of an industry.

Meanwhile we assume that a whole industry, including its larger elements, could not have been swept away entirely by runoff, wind or other natural force, and this part of the site was not occupied to an archaeologically visible degree during those years. Why this should have occurred during the early Holocene when conditions were moist and the lagoon brimming with fresh water seems paradoxical.

In answer we propose that moister conditions allowed people to spread themselves more widely, occupying regions that had been inhospitably arid. Under this explanation it comes as no surprise to learn that the main phase of occupation of the shores of Lake Frome was the early Holocene. With moist conditions general, the more reliable water sources such as Hawker Lagoon were no longer a focus.

The early occupation of the arid zone

Recent Aborigines in arid and semi-arid regions have a pattern of movement that takes maximum advantage of the availability of water and other resources. During dry times they fall back on reliable sources of water such as streams (Allen 1974) or desert uplands (Peterson & Long 1986), but after rain move out across the landscape exploiting ephemeral water sources such as pans, soaks and streams, and with them a wider range and greater abundance of foods. For the Flinders Ranges, a senior Adnyamathanha man told Lampert that his people were based in the Ranges but sometimes 'in a good season' they made brief forays as far as the shores of Lake Frome. One of the places visited was Eudli Wagloona, on the south-eastern shore of Lake Frome, where Lampert noted an extremely sparse scatter of stone flakes (1 per 50 m^2) around an ephemeral waterhole.

On a much longer timescale, this pattern of movement is the same as that envisaged in the more distant past, people based in the better watered

Ranges within a dry phase moving out to the shores of Lake Frome as conditions became wetter during the early Holocene.

Hawker Lagoon shares a number of similarities with Puritjarra, a rock shelter in the Cleland Hills of central Australia in which occupation dates back to *c.* 22 000 yBP and appears to be continuous through the last glacial maximum until at least 12 000 yBP (Smith 1987). Both sites not only confirm a Pleistocene age for human settlement of the arid interior but are in desert uplands. At both sites the deposits are sandy and devoid of such direct evidence for past environments as pollen or plant and animal remains. However, the desert uplands in which the sites lie fringe the Lake Eyre Basin where stratified sediments spanning much of the Pleistocene and Holocene contain a wide variety of environmental evidence. This enormous basin, draining about one million square kilometres, is the focus of future arid zone prehistoric studies, both by the authors and by other researchers (Lampert in press, Lampert *et al.* in prep.).

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NOTES ON A WOODEN IMPLEMENT TYPE FROM NORTH-EASTERN ARNHEM LAND

BY M. PICKERING & J. DEVITT

Summary

This paper presents data on a wooden implement found at a site in north-eastern Arnhem Land and discusses briefly its significance for archaeological research elsewhere.

NOTES ON A WOODEN IMPLEMENT TYPE FROM NORTH-EASTERN ARNHEM LAND

M. PICKERING & J. DEVITT

Pickering, M. & Devitt, J. 1988. Notes on a wooden implement type from north-eastern Arnhem Land. *Rec. S. Aust. Mus.* 22(2): 169–171.

This paper presents data on a wooden implement found at a site in north-eastern Arnhem Land and discusses briefly its significance for archaeological research elsewhere.

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This paper illustrates, describes, and discusses a particular type of artefact from north-eastern Arnhem Land, northern Australia. Consideration of these artefacts helps illustrate the importance of functional, as opposed to morphological, observations in the typological classification of artefacts.

The implements were collected during fieldwork in the Nhulunbuy area of north-eastern Arnhem Land in late 1986. They were recovered from sites on a small island which is connected to the mainland by a 300 m permanent exposed sandbar. This island is basically a granitic rocky outcrop consolidated by sandy soils and coastal scrub vegetation. It is edged by a rocky boulder shore, often steep in places. The island is a popular visiting spot for Yulngu and white residents of Nhulunbuy.

During a casual walk around the island, easily accomplished in two hours, the authors' attention was drawn to the numerous scatters of rock oyster shells (*Saccostrea cucculata*). These scatters were, characteristically, usually within 20 m of the water and on bare flat rock surfaces. The shells were often burnt and/or associated with charcoal and burnt sticks.

No sites were observed which had any stratigraphic depth or, indeed, potential for formation of deposit. The scatters were usually within the zone subject to wind, wave and rain action, particularly in the summer wet season. Even before we discussed these shell scatters with local informants it was obvious that they were the product of shellfish collecting for food. They reflect single transient occupation, such as a 'dinner camp'. A small permanent Yulngu community resides approximately 2 km away. The island falls within the traditional country of the Rirratjingu clan group.

The Implements

Two of the shell scatters were subjected to closer examination. These contained eight wooden implements in definite association with the shells and charcoal. Figure 1 provides a field map of the site from which these artefacts were collected. This site is typical of the location and condition of these sites. A tyre lever was seen in a crevice. This may have been used for removing the oysters from the rocks.

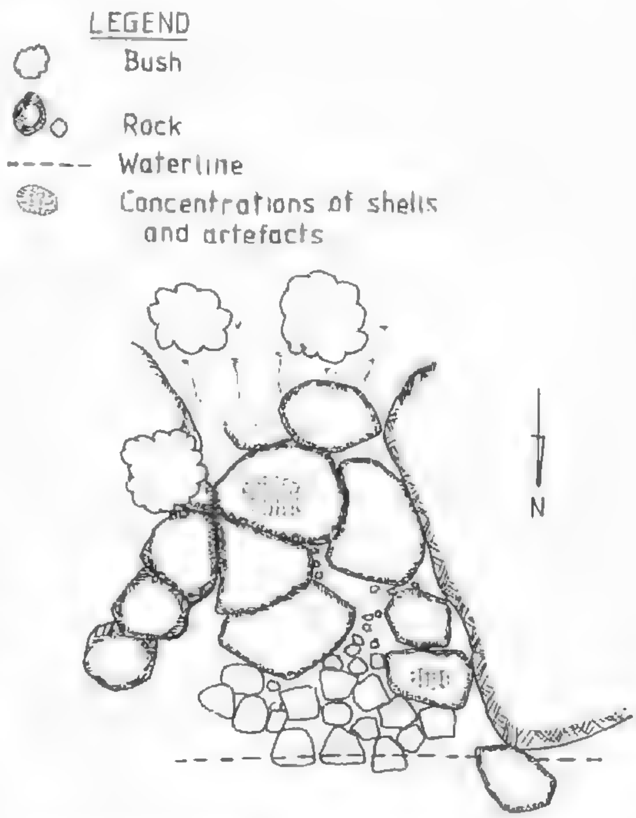

FIGURE 1. Field map of site from which artefacts were obtained. Scale approximately 1 cm = 2 m. Compiled from field sketch.

A Yulngu informant (Warramirri clan) identified these artefacts as **Birngal** and described their functions as being for picking shellfish out of their shells or for the removal and/or cleaning of small skin eruptions (caused by parasitic infection or biological actions e.g. pimples). They could be produced at any time.

Meehan (1982: 101, 102, 110) reports the similar use of wire and bone points to break open the shells and remove the flesh of oysters, (*Crassostrea amasa*) amongst the Anbarra of north-central Arnhem Land.

Also on the site were several tops of soft drink cans, though no cans were found. The informant explained that the cans were sometimes used to carry oysters back to camps, the tops being removed and discarded to make the container.

The implements are illustrated in Fig. 2 and are best described according to their level of modification.

Implement 4 is simply a twig from which the bark has been peeled to make a point which has subsequently been rounded through use. Implement 1 is a split twig, triangular in cross-section, retaining some bark on the outer surface. The tip is modified, possibly through grinding. Implements 5, 6 and 8 are similar to 1 and 4 except the tips have been shaped through cutting. They retain some remnant cut facets.

Artefact 2 is a single-pointed implement with a modified butt. The point is smoothly shaped with some remnant cut marks almost obscured through rounding, probably by use. The shaft appears to have been worked smooth. The butt is abrupt with clear cut marks and facets. Implement 7 is bi-pointed. The shaft shows clear faceting through cutting, though use has rounded the edges. Both points are rounded. The implement has a low sheen, presumably through being held. Implement 3 is a highly modified bi-point. It has remnant facets along its length showing its manufacture by cutting. Use has, however, tended to round and obscure the edges of these facets, which do not show up in the illustration except in cross section.

Discussion

With the exception of implement 4, all implements were made with a steel knife. In some examples the direct evidence of this, the cut marks and faceting, have been obscured through use. Such use-wear is probably quick in forming given the hard abrasive nature of the oysters' homes.

Sites such as the one we have described and their associated artefacts are unlikely to last long in the archaeological record. The action of wind, waves and other activity would quickly disperse all site contents. Even where conditions were more stable, and formation of deposit likely to occur, the wood-

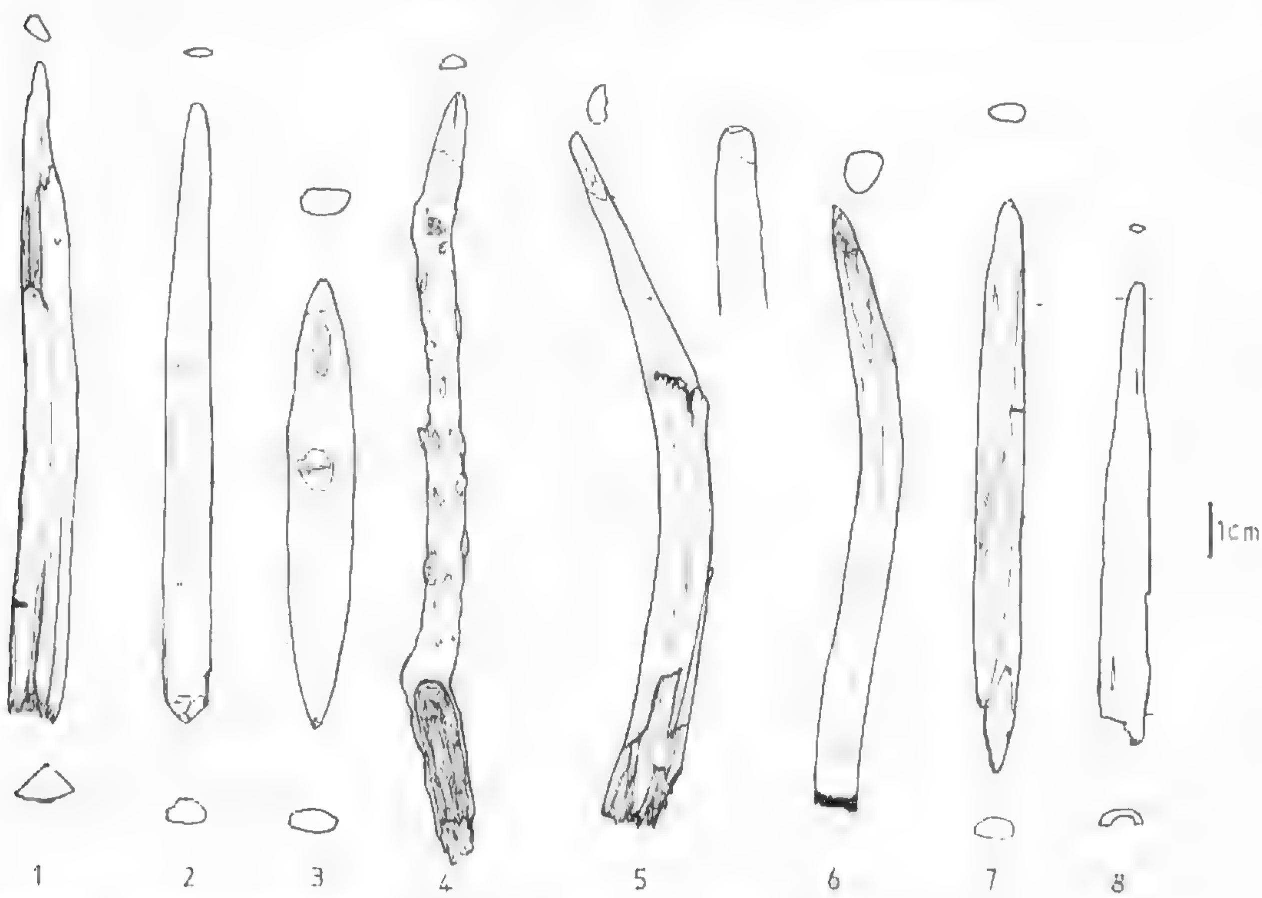

FIGURE 2. Wooden implements found at site near Nhulunbuy, north-eastern Arnhem Land.

en artefacts would rapidly decay, or their technological attributes erode to a degree where status as implements is concealed.

The implements also illustrate a question of typology. Put simply, the artefacts vary greatly in their form but not in their functions. Conventional typologies, based on observation of technological attributes and unsupplemented by ethnographic data, would obscure this functional unity.

The description of these implements also has implications for interpretation of archaeological remains from elsewhere in Australia. One author (Pickering 1979) has suggested that bone artefacts, frequently recovered from south-eastern Australian coastal sites, may have been complemented by a similar range of wooden points which had decayed and so were not represented archaeologically. Fresh wood and fresh bone share similar structural characteristics in the form of high tensile and compressive strength, which makes them sometimes interchangeable. The morphological range of the wooden artefacts described here is analogous to examples of bone points found throughout coastal Australia. It is, therefore, not unreasonable to suggest that similar artefacts would have been utilised by other groups which exploited shellfish.

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YANYUWA CANOE MAKING

BY R. M. BAKER

Summary

This paper describes the construction of a dugout canoe near Borroloola in the Northern Territory in 1987. The history of canoe making and use in the area is also documented using written and oral records. The taping of information about objects collected by Museums has often been neglected. This paper illustrates the value of collecting such oral accounts both in documenting the process of manufacture and in revealing the wider cultural context of that object. When such information is ignored, there is the danger of viewing the collected object out of its social and historical context.

YANYUWA CANOE MAKING

R.M. BAKER

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This paper describes the construction of a dugout canoe near Borroloola in the Northern Territory in 1987. The history of canoe making and use in the area is also documented using written and oral records. The taping of information about objects collected by Museums has often been neglected. This paper illustrates the value of collecting such oral accounts both in documenting the process of manufacture and in revealing the wider cultural context of that object. When such information is ignored, there is the danger of viewing the collected object out of its social and historical context.

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Canoe Construction

In 1987, as part of research on the contact history of the Yanyuwa who live in the Borroloola area of the Northern Territory (Fig. 1), I documented the construction of a dugout canoe which had been commissioned by the Australian National Maritime Museum in Sydney. This article presents a description of this construction along with background

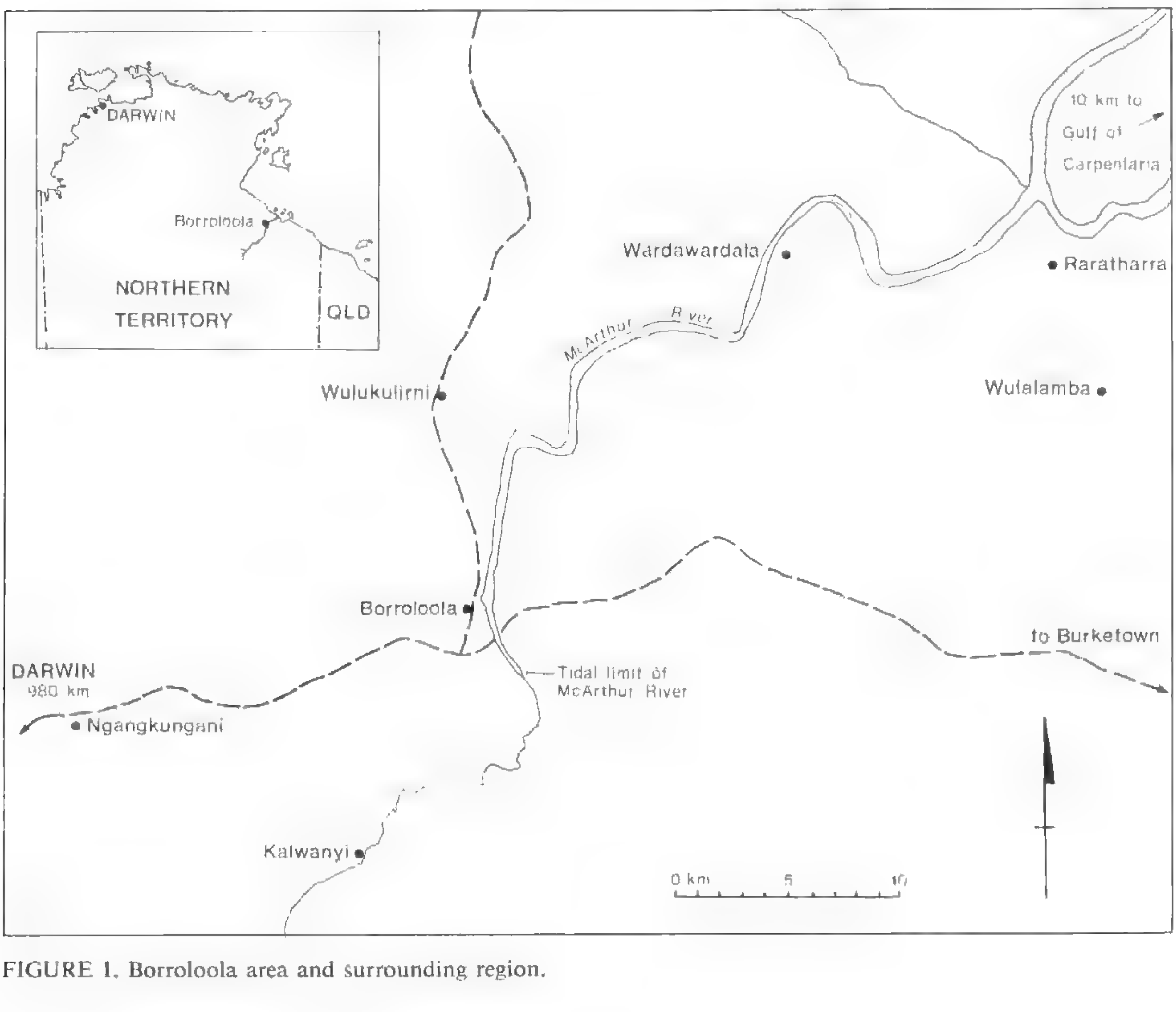

FIGURE 1. Borroloola area and surrounding region.

information on the history of Yanyuwa canoe making and use.[1]

The canoe was constructed by Annie Karrakayn, her husband Isaac Walayungkuma and Ida Ninanga. Karrakayn is approximately 55 years in age, Walayungkuma 65 and Ninanga 70 (see Fig. 2). Ninanga had previously made a dugout canoe which was purchased by the Museum of Australia in 1986. Isaac Walayungkuma is an experienced canoe maker who worked on canoes when they were still constructed for use in the area. He has also made a number of canoes to sell as artefacts. A small canoe which he made is part of the collection of the Museum and Art Galleries of the Northern Territory. Annie Karrakayn had not worked on a canoe before, but like the others she has an intimate knowledge of dugout canoes gained from years of experience using them. She recalls, for instance, literally growing up in one: 'When Tim[2] had that big boat, that canoe, we used to stick in that canoe . . . big mob of kid, right up'.

Walayungkuma and Karrakayn usually live on their outstation Wardawardala, which is about 30 km from Borroloola. Ninganga once lived in this area, but since being widowed usually lives in Borroloola. Ninganga and Karrakayn are Yanyuwa speakers and Walayungkuma is a Garawa speaker. All three spent much of their younger days living on or near the Sir Edward Pellew Islands which are located at the mouth of the McArthur River. All three used dugout canoes regularly to move from island to island or to visit the mainland.

Canoes in the area were usually made by a group of people but it is new for women to help in this process, as Annie Karrakayn notes: 'Someone was helping one another, two or three or four . . . but man used to work before, not woman, woman used to go hunting for food'. A good description of how canoe making was a communal affair comes from Tim Rakuwurlma: 'We doublebank,[3] two fella first time cut him, two fella man, right two fella sit down, another two fella now, long time you know'. On another occasion after a particularly tiring day's work Annie Karrakayn also exclaimed: 'just men [used to make canoes], that's first time lady, me and her, that's the first time for us, and I'm sick of this too . . . yeah! Because I know women didn't work, only man'.

The selection of a suitable tree took four exhausting days of searching along the McArthur River. The main selection criteria were size, straightness and a lack of branches and holes in the bark. Great attention was also paid to checking whether there were any holes beneath the bark extending into the trunk. The canoe was made from a large paper-bark tree *Melaleuca argentea*, known in Yanyuwa as **Binjirri**, which was felled on the banks of the McArthur River about 10 km upstream of Borroloola. There are two tree species in the area which are suitable for canoe construction, this *Melaleuca* and the 'Leichhardt pine', *Nauclea orientalis*; both are common along freshwater streams in the area.

Local Aboriginal people have differing opinions on the relative virtues of making canoes from these two trees. These conflicting views are based on the fact that while the Leichhardt pine is definitely easier to work, the much harder *Melaleuca* makes a canoe which is considerably longer lasting. The advantages of Leichhardt pines are discussed by Tom Wambarirri: 'Leichhardt tree . . . easier to cut him' and by Tim Rakuwurlma: 'Leichhardt tree more soft, good one, you finish quick'. Because of the number of canoes that have been made in the area in the past from Leichhardt pines, there are not any large trees of this species left. Therefore when the canoe makers were asked to make a 'proper big sea going canoe' a *Melaleuca* was the only choice possible. The smaller Leichhardts are only suitable for 'kid canoes'. The Yanyuwa used to construct small canoes known as **a-dubarl** for children to use. A number of people have told me how as children they were given canoes 'for training'.

The spot where the tree was felled and the canoe was constructed is close to a lagoon called Kalwanyi (Fig. 1) which also has the European name of Goose Lagoon. At this spot in the late dry season, the McArthur River is reduced to a trickle and the tidal reaches of the river are some 10 km downstream. In the dry season the river from Kalwanyi to the tidal reaches consists of a series of fresh water billabongs separated by a combination of stony bars and sandy banks. At this time of year a canoe cannot be paddled downstream.

In earlier times canoes were usually made upstream on the McArthur River in the late dry season and then moved downstream when the river levels rose after the first wet season rains. This sometimes involved using ropes to pull canoes across shallow bars. As Eileen Manankurramara recalls: 'They been put him cross stick and pull him . . . push that canoe right up long big river'. Usually however, the local rainmaker is said to have provided rain at the appropriate time to enable the canoe to be floated all the way down the river. Tim describes how one year he had to go downstream to Borroloola to tell the rainmaker to delay the rain as the canoe makers had not quite finished the canoe. He recalls the following exchange between the rainmaker and himself:

> Tim Rakuwurlma: 'Don't make rain yet'.
> Billy Hooker: 'Right you finish him up, all right come back . . . when you finished that canoe, all right . . . I'll send him flood for you, floodwater.'

In keeping with Yanyuwa tradition the canoe is called 'Rra-Kalwanyimara', which can be translated

FIGURE 2. The canoe makers, left to right: Ninanga, Karrakayn and Walayungkuma. Also Kylie Marikbalinya, granddaughter of Karrakayn and Walayungkuma.

literally as 'the female one from Kalwanyi'. As Annie Karrakayn puts it: 'All the canoe got name . . . [from the] country where they come from'. Tim Rakuwurlma called one of his canoes made in the Kalwanyi area, 'Rra-Kudanjimara', because the country around this area belongs to Kudanji people. There are two general Yanyuwa terms for dugout canoes: **rra-muwarda** and **rra-libaliba**. The latter is of Macassan[4] origin and the former is by far the most commonly used term.

The canoe construction camp was only about 30 minutes drive from Borroloola. This proximity enabled me to bring out a number of the elderly former canoe makers who were keen to see how the construction was going. I was told to bring out certain people whose opinions were valued. The comments these former canoe makers made on these visits made it very clear that there was a community standard of what a 'proper olden time canoe' looked like and that the canoe makers had to meet this standard.

As well as the canoe, the following items were made to go with it (see Fig. 3):

1. Paddles were made by Isaac Walayungkuma from a 'Pine tree', **walkuwalku** *(Callitris intratropica)*.

2. A sail and mast were made by Annie Karrakayn and Isaac Walayungkuma respectively. The mast was made from a small messmate tree, **budanja** *(Eucalyptus tetradonta)*, and the sail was made from calico.

3. Jerry Rrawyajinda made a dugong rope which is used when harpooning dugongs (and salt water turtles) from boats. To make the rope the bark of young **ma-kawurrka** *(Acacia torulosa)*, saplings is pulled off in long strips. These strips of bark are called **na-wamara** and are pulled apart into thin threads which in turn are rolled into twine and then made into a two-ply rope. A number of separate trips were made to get the bark necessary for the rope. Most of the bark came from Wulukulirni and Ngangkungani (Fig. 1).

4. Don Manarra made dugong hunting points, **na-malbi**, and a dugong harpoon, **ridiridi**, with 'sugar bag' wax[5] binding. The points were made from the wood of the mangrove, **arndiny**, *Lumnitzera racemosa* and the harpoon was made from the straight trunk of a young messmate tree, **budanja** *(Eucalyptus tetradonta)*.

Construction time

The tree was felled on July 16th. The first work on hollowing out the canoe started on July 19th and

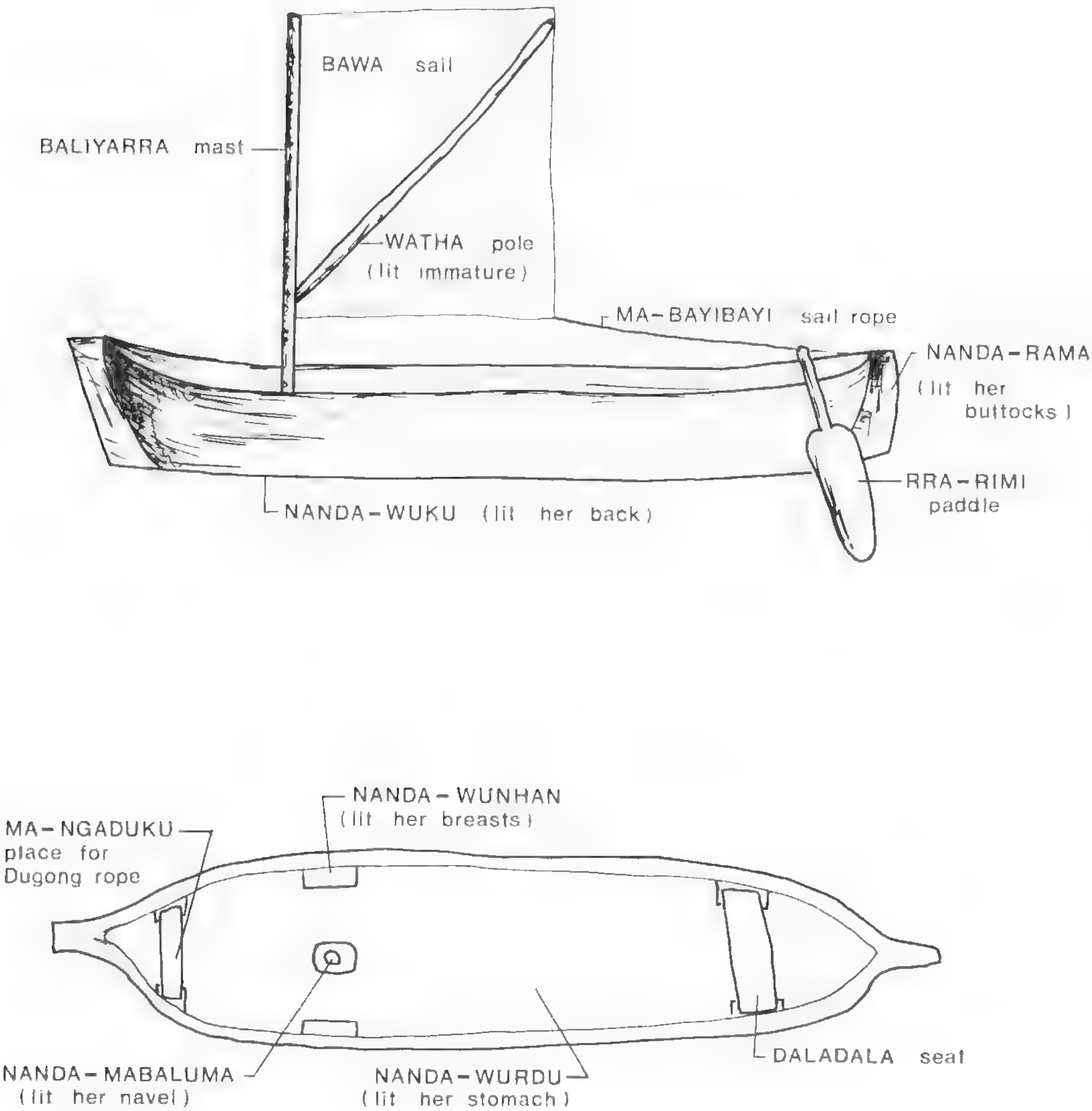

FIGURE 3. Yanyuwa terms for parts of a dugout canoe.

it was exactly a month later that it was moved into Borroloola. Whilst the canoe was *in situ*, work usually proceeded six days a week, with the three canoe makers each averaging eight hours work a day. The canoe was moved into Borroloola before it was completely finished as one canoe maker in particular was keen to return to town. Work on the canoe was much less consistent once it was moved to town. Pressures of town living and the fact that the canoe was locked up inside the Adult Education Workshop and work could only proceed when this building was unlocked, limited the times the canoe makers could work. If we had remained in the bush, I think the canoe would have been finished in about another six working days. A rough estimate for person hours for construction is 720 person hours based on three people working eight hours a day for 30 days.

This figure corresponds approximately to the only piece of historical information I have been able to obtain on the time it took to make a canoe in the old days. This comes from Don McLean.[6] He told me of seeing a canoe made: 'It had taken six of them seven days to hollow this . . . The lump of timber was 15 feet [4.5 m] long but it took them seven days . . . They worked day and night, there'd always be someone [working]'. If one estimates that each man averaged 10 hours a day, this would represent 420 man hours. There are two likely reasons why this figure would be less than that for 'Rra-Kalwanyimara'. First, the canoe McLean saw was about 50 cm smaller if his recollection of 15 feet is correct. Second, it is quite likely that the canoe he observed had been worked on before it was moved to the spot where he saw it. The construction work that he saw occurred near the mouth of the McArthur River. It is likely that at least some work had been done on the log to lighten it and make it easier to move, prior to it being floated to the construction site.

Construction methods

After felling, the tree had its bark stripped and the hollowing out of the log was begun. This involved making a series of cuts[7] with tomahawks and axes[8] at right angles across the log at about 20 cm intervals. This formed a series of blocks which could then be removed when they were hit by a large adze swung parallel to the long axis of the log (*see* Fig. 4). Most of the hollowing out was done in this way. A smaller adze was used to do some chipping out of the insides and then the tomahawks were used to do finer work. Finally, files were used inside to smooth the surface. On the outside of the canoe the same combination of tomahawks and files was used. The hardest work was the construction of the two ends. This was done by Isaac Walayungkuma using a large axe. This was the only example of one of the canoe makers doing all of a specific job. All the rest of the work was shared by the canoe makers. When the series of cross cuts were being put in, it was possible for all three to work at the same time. However, when the blocks were being removed it was safe for only the person doing this to be in the canoe. Walayungkuma did most of this block removing but Karrakayn and Ningana also did some.

Towards the end of the four weeks' work at the canoe camp the canoe was burnt inside and out. Some of the chips of wood that had been chopped off, plus dead leaves and twigs from the felled tree were gathered and placed inside and under the canoe and burnt. The burning material inside the canoe was stoked by long poles. The flames burnt for about five minutes and then the fire smouldered for about another ten minutes. The fire was of low intensity and was carefully monitored to make sure it did not get too hot. This burning was done for two reasons, to aid the smoothing up of the canoe and to allow it to be 'spread'. The spreading was achieved by ramming some cross sticks inside the canoe flush against both sides and then burning the inside of the canoe. As Annie Karrakayn notes, the burning and ramming of cross sticks is to 'make it wide and [to] clean him really, make him smooth . . . that canoe got to burn first, then when it finished flame fire, you can hit him [the stick] then, knock him in, knock, knock, . . . that stick fall, that mean he wider'. When 'Rra-Kalwanyimara' was burnt it spread sufficiently for the cross sticks, previously flush against both sides, to be easily knocked down to the canoe floor. Then, as soon as the fire was cool enough, rasping inside the canoe commenced.

Another good description of burning comes from Steve Johnson:

> They used to fill [the canoe] up with water and let it soak for a while and then put the fire in it, put grass and all the shavings. Not stuff that'd burn a hole in it, but enough to heat it up, then they'd put the sticks in and bash the sticks in to spread it. They'd spread them a bit at a time, spread them about an inch today and then they'd push them back, sink them in the water . . . and in about a weeks time they'd get into them again and do the same thing. They used to do that for months after. Some of them used to go too far and they'd start cracking on the bottom . . . from too much spreading.[9]

Steve goes on to note that the expert canoe makers knew from experience exactly how far a tree could be spread without cracking it. Steve on another occasion gave the following reasons why Mac and George Riley made the best canoes: 'Everything they cut was good because they knew how to line them up and straighten them, they cut them with the timber and they were really good boats they made. If the tree wasn't good enough they wouldn't start on it'.

Initially the canoe construction of 'Rra-Kalwanyimara' occurred on the spot where the tree had fallen. Later, when the canoe was light enough, it was moved further down the bank. This was done by using a number of poles, cut from the trunks of small trees, as levers and also by placing the canoe on rollers made from short sections of tree trunks. It was first placed on a sandy bank and, later, on a rocky bar. The latter site had the advantage that the canoe could be raised on large stones and the fire could, therefore, burn immediately underneath it. As Annie Karrakayn put it, the canoe was moved 'because [the new spot] good place, so

FIGURE 4. 'Rra-Kalwanyimara' in the first stages of construction, July 1987.

we can put bushes underneath, chips'. The 'bushes' and 'chips' Annie refers to were put under the canoe and set alight as part of the burning process described above. Another advantage of moving the canoe onto the stones was that the canoe could now be leant from one side to another so that the under surfaces could be worked on.

When the canoe makers had a day off to go hunting or shopping in town they very carefully covered with strips of paperbark all surfaces that would be exposed to the sun. Annie Karrakayn explained why they did this: 'We go back home now, town, so we covered that canoe, just keep him away sun, he might get crack . . . if it's dry he'll crack but we have got to put paperbark and cover it . . . everyday when we go out'.

On the 14th of August the canoe was 'launched' by moving it the 10 m to the McArthur River. It was taken for a test paddle and the balance of the canoe was carefully assessed to determine where the most weight had to be taken off in the final finishing up work. This balancing work was subsequently done at Borroloola.

On the 19th of August the canoe was towed into Borroloola after winching it up the bank and onto a boat trailer. Work on finishing the canoe then proceeded inside the Adult Education Workshop in Borroloola. The canoe was 'made lighter' with tomahawks and files. Some further shaping of the two ends of the canoe also occurred. At the end of each day's work, the canoe was filled up with water and covered with wet blankets to keep it from drying out too fast.

Finishing the canoe in town fits in with what usually occurred in the past. The canoes were taken down the river to Borroloola before the canoe makers had completely finished them. They then worked on them at their leisure on the banks of the river. In the past, as occurred with 'Rra-Kalwanyimara', the canoes were paddled to see how well they floated. If necessary, the canoe makers would lighten particular areas to improve the balance. During this 'finishing off' period the canoes were often filled up with water and left in the river so that the wood did not dry out too quickly. A number of people remarked that the purpose of bringing the canoe to town and finishing it slowly was to allow the timber to dry out slowly and thus to avoid cracking.

The mast for the sail was fitted into the canoe when it was in Borroloola. This was done by drilling a hole only fractionally larger than the mast in a board that rests firmly between the **nanda-wunhan** (Fig. 3). The mast was then lowered through this hole and lodged firmly in another hole in a mound, **nanda-mabaluma**, left in the base of the canoe for this purpose. The rear seat or **daladala** and the front 'seat', **ma-ngaduku** for the dugong rope to rest on were also made in Borroloola. These were made out of timber from the 'Leichhardt Pine' *(Nauclea orientalis)*. The wood from old packing cases is said to be ideal for these seats and was much used in the past.

History of Aboriginal Watercraft in the Borroloola Area

Logs and rafts

The simplest type of watercraft used by Aboriginal people in the Borroloola area was a swimming log. Tim Rakuwurlma told me how he and two other Yanyuwa men had to 'get a log' to help them swim from island to island in the Sir Edward Pellews after they jumped off a European lugger on which they had been employed. As well as providing extra buoyancy for the swimmer, such logs were felt to provide some safety from crocodiles and sharks. Herbert (n.d.: 155) observed people swimming the Roper River (200 km north-west of Borroloola) using such logs. He notes that: 'It was not clear whether the alligators regarded this apparition as a friendly object, or a deadly enemy charged with possibilities of destruction to themselves, but in either case the log was recognized by the native as a great safeguard'.

Rafts of various types were also constructed in the area. These were typically constructed on site, when groups who were walking needed to cross one of the large salt water rivers in the region. They were constructed in both triangular and rectangular shapes. The triangular rafts were similar to the Mornington Island one illustrated in MacIntyre (1921: 60) and the Bardi ones from Western Australia (Ackerman 1975: Fig. 1).

The Yanyuwa made rafts by lashing together a number of thick logs, using twine made from the bark of the following trees: **karruki** (*Wrightia saligna*), **ma-lhalhaki** or **ma-murndurrarra** (*Brachychiton diversifolius*), **ma-rdardaki** or **ma-yatha** (*Brachychiton paradoxus*) and **ma-kawurrka** (*Acacia torulosa*). Twine was also sometimes made from lily stems. Paperbark was piled on top of the lashed logs to raise the craft above the water. Thomson (1957) and Davidson (1935) note that such rafts were used across the whole of northern Australia.

Bark canoes

Bark canoes, known in Yanyuwa as **na-wulka**, were made by sewing together the bark of the messmate tree *(Eucalyptus tetradonta)*. They were made in the area before dugout canoes were constructed. As Isaac Walayungkuma notes, they were 'olden time, first time canoe . . . that first time they been make them'. The Yanyuwa bark canoes were quite distinct from Garawa ones made to the east, which were smaller and made from a single piece of bark. The Garawa ones were only used in calm waters while the Yanyuwa canoes were suited to the rough conditions that could be encountered in voyages from the mainland to their islands. The Yanyuwa canoes had rounded sterns and had extra height in the bow to stop waves washing in.

The first written account of Yanyuwa bark canoes is contained in Flinders' description of his voyage around the Sir Edward Pellew Group in December 1802. He found on North Island two canoes 'formed of slips of bark, like planks, sewed together, the edge of one slip overlaying another, as in our clincher-built boats' (Flinders 1814, 2: 171). He also notes that 'their construction was much superior to that on any other part of Terra Australis hitherto discovered' (*Ibid*.: 172). On the grounds of this superior construction, he questions whether they were made by Aboriginal people.

Bark canoes of varying types were made across a wide area of northern Australia (*see* Bell 1956, Davidson 1935, Holland 1976, Hornell 1940 and Thomson 1934a, 1934b, 1939, 1949a, 1949b, 1952 and 1957). Bell (1956) describes and illustrates with a series of photographs the steps involved in making a small bark canoe in the Archer River region of Cape York Peninsula. Thomson (1934a) describes the construction and use of bark and dugout canoes in the Batavia River area of Cape York. He concludes that the bark canoe is 'employed chiefly as a river craft, while the wooden outrigger canoe is a sea-going vessel and is used especially in dugong and turtle hunting' (Thomson 1934a: 229). In his 1934b article Thomson gives a detailed description of the dugout canoes and the dugong and turtle hunting carried out from them in the Stewart River area of eastern Cape York. In his 1939 article he documents a localised variation of bark canoes made for hunting geese and collecting eggs in the Arafura Swamp of north central Arnhem Land. Thomson's 1952 article is a review of the distribution of various watercraft across northern Australia. However, on his distributional map he incorrectly excludes the Sir Edward Pellew area from having both dugouts and bark canoes. Davidson (1935: 73), likewise, excludes the Pellew group, citing the eastern limits of dugout canoes as the Roper River.

Hornell (1940) presents a world-wide survey of canoe types and gives an unconvincing argument for an evolutionary transition from bark canoes to dugouts to plank boats. He does, however, give good detailed descriptions of three bark canoes made in the Borroloola area that he saw in the South Australian, Victorian and New South Wales state museums.

One of the best descriptions of a bark canoe being constructed is that of Banfield. He describes how a Cape York man got the bark 'raw from the tree [and how] he would soak the single sheet in water and while sodden, steam it over a smoky fire, and, as it softened, mould it with hand and knee' (1918: 127).

Despite their frailty these bark canoes were used by the Yanyuwa to make lengthy sea trips. Spencer & Gillen, who were in Borroloola in 1901, describe (1912: 484) a bark canoe carrying six men from Vanderlin Island to Borroloola. This is a voyage of about 50 km across the Gulf of Carpentaria then 50 km up the McArthur River. Spencer & Gillen also include a detailed sketch of a bark canoe (*ibid*.: 483) and give a description of their manufacture (*ibid*.: 482-484). Tim Rakuwurlma has told me of a Yanyuwa revenge party that sailed all the way to and from Massacre Inlet in Queensland in bark canoes, a return trip of about 400 km. This trip was made at the turn of the century and as Tim notes, it was made in paperbark canoes: '**nu-wulka** . . . paddle him all the way'. Dinny Nyliba McDinny also recalled in 1986 how, when he was young, his family travelled back and forth in bark canoes along the Gulf of Carpentaria coast between Manangoora and Robinson River, a distance of about 100 km each way.

Spencer in his notebook gives a detailed description of how these bark canoes were constructed:

> The salt water men build very decent canoes. They strip . . . long pieces of bark off the big wattle trees and sew them together at each end and then they have a long thin bough which forms the gunwal on each side . . . [and which] are held tightly stretched by means of sticks which run across from side to side. Some of these canoes are twelve and fifteen feet long and will hold three or four men (Spencer 1901: 98).[10]

Bark canoes remained in use in the area after the Macassans introduced dugout canoes, presumably because of the ease of bark canoe construction. Paradice gives an example of the continuing use of bark canoes, recording a 'very fine canoe — twenty feet long — [that] was made of a large sheet of bark' (Paradice 1924: 7) and includes a photograph of it. Similarly Pyro Dirdiyalma who was born around 1930 and who grew up in Garawa country on the coast to the east of Borroloola, recalls such canoes being used but also notes that bark canoes were becoming rare ('just about finished'), when he was young. Tim Rakuwurlma describes how a bark canoe could be made in only two days: '**Na-wulka**

I been make that kind . . . , not hard work like canoe, him two days that is all . . . mend [sew] him all the way . . . tie him quick, we been mend him with that string now'.

Because of the ease of their construction, the bark canoes could be treated in a fairly 'disposable' manner. Brown, the Northern Territory Government Geologist, for example, visited the Borroloola area in 1907 and described how a bark canoe was paddled out to meet the steamer 'and as the canoe was stove in against the side of the vessel they let it float away and remained on board' (Brown 1908: 6). Brown goes on to also describe (*ibid*: 7) how they 'passed canoes with blacks crossing the river on two or three occasions'.

Whilst bark canoes had the advantage of quick construction they were not nearly as durable or as safe as dugout canoes. Many Yanyuwa people can recount stories of relatives drowning as a result of bark canoe mishaps. Tim Rakuwurlma, for example, describes his older brother drowning in one such incident that Tim managed to survive by holding onto his mother: 'My mother, I been hold [her] shoulder all the way long Wulibirra country [the nearest landfall to the spot where the canoe sank] . . . bark canoe, no good one . . . he been leak, when no canoe yet . . . behind [after], him been make [dugout canoes]'. On another occasion Tim told me, 'no good bugger, plenty men been drown . . . more good one Leichhardt tree, leave that messmate canoe now, leave him altogether'. Isaac Walayungkuma and Annie Karrakayn in the following exchange also stress the dangers of bark canoes and the comparative advantages of dugouts:

> Isaac Walayungkuma — Wulganyi[11] he drowned for good now, he can't float, no further, he sink right down finish.
> Annie Karrakayn — [dugout canoes when full of water] turn him around . . . or sometime just bail him out quickly [indicates doing this by shaking the canoes back and forth].

Another important advantage which dugouts have over bark canoes was that they are sturdy enough to allow the erection of a mast and sail. As well as making the canoes faster and saving much effort in paddling, the sails add to the handling of canoes. The anthropologist Donald Thomson, who made great use of both canoe types in his travels in northern Australia, notes (1957: 19) that sails, 'helped steady the craft in a following sea'. It should be noted, however, that sails of a sort were used in paperbark canoes. A number of people have described to me branches being put up in paperbark canoes as sails. Tim Rakuwurlma should be given the final say on the disadvantages of paperbark canoes with this dramatic comment:

> When something bite him, shark, well he been drown, everybody been drown long middle water . . . sometime blind shark . . . bite him make a hole . . . when you go early fella morning, go along sea now, shark come along you, bite him that canoe, knock him down, early fella morning he'll bite anything.

Introduction of dugout canoes

Spencer & Gillen record both dugout and messmate canoes in use in the Borroloola area in 1901. Aboriginal and historical records right across the 'Top End' of the Northern Territory suggest that production of dugouts did not commence until after the Macassans stopped coming and supplying them. Warner (1969: 459) and Thomson (1937) both quote informants who say dugout canoes were not made until the Macassans stopped bringing them. Thomson (1952: 3) makes the same point but in more general terms and does not mention the informant. Warner goes on to suggest that in the area where he was working (north-eastern Arnhem Land), people reverted to using paperbark canoes for a while until they learned how to construct dugouts from Aboriginal people from the English Company Islands. Worsley (1954: 61–62) from his work on Groote Eylandt, also concludes that dugout canoes were obtained from the Macassans and not made until after they stopped their visits to northern Australia. Heath (1980: 532) presents a Nunggubuyu text (from the Roper River area) that describes how bark canoes were used first and that the dugouts were introduced later as a result of Macassan contact.

Tim Rakuwurlma's account given to me in 1983 supports this suggestion:

> My father, messmate [canoe], him been have first time. By and by, he been think about now, him been find big tree there, Leichhardt tree, along island along him country.
> 'I think I'll cut him'
> I been big boy, I never had corroborree along me yet [he had not been through circumcision initiation ceremony]. That big I been [indicated about 10 years old] and old Banjo [his older brother] was there.
> 'I think I want to cut him canoe along you two fella, we got to make him canoe **libaliba**'. Him been talk.
> 'We've got to make him **libaliba**'.
> 'Go on'.
> 'Yeah I been look that mob from Groote Eylandt, Ingura mob been learn me'.
> Old fella been learn him my father long Groote Eylandt people, blackfella. When them been come along that big boat Malay[13] men, coloured men. That mob been learn him, him cut [the dugout canoe] himself . . . long tomahawk.

The first Yanyuwa-made dugout canoe was constructed well inland and as Tim describes, 'we all been pull him down . . . all the way [to the coast]'. In 1987 Tim told me this story again and after noting that the early canoes were made from a Leichhardt Pine, says 'tea-tree (*Melaleuca* sp.) that one behind [after], we been cut that kind when my father been finished . . . when no more Leichhardt tree there long island, my father been finish them up. We been go along McArthur River higher up'.

Using Tim's mention of his age in the above quote, this first Yanyuwa-made dugout can be dated to about 1910. This corresponds with the information presented by Warner and Thomson that canoes were not constructed until after the Macassans stopped coming. The last voyage made by the Macassans to Australia was in 1906–1907 (Macknight 1976: 126). Further support for this post-Macassan commencement of canoe construction comes from Stretton's (1893) comments on how Aboriginal people on Vanderlin Island obtained their canoes. Writing in the decade before the Macassan visits stopped he notes that 'the Vanderlin tribe are expert canoeists, and are possessed of some very fine canoes, made out of solid trees, which have been left behind by the Malays' (Stretton 1893: 228). He makes no mention of the Yanyuwa building their own dugout canoes.

The rise and decline of Yanyuwa canoe making

Yanyuwa canoe making probably reached a peak in the 1930s and 1940s when, with ready access to European metal tools, a large number were made. Several of the European residents in Borroloola commissioned canoes and these were sometimes used to transport stores up the McArthur River. The canoes carried the supplies upstream from the landing some 30 km downstream where the coastal supply boat unloaded the cargo. The vital part these Europeans provided in the construction of the canoes was the supply, as payment, of preservable food such as flour. As Tim Rakuwurlma observes, canoes took a long time to make and the canoe makers were dependent on others to provide them with food during the period they were working full time: 'Might be three weeks . . . long time no tucker . . . but this time big mob of tucker flour'. Tim goes on to note how he made canoes with food being provided by a European called Havey and compares this food source with that his father lived on when he made canoes. 'Charlie Havey alla [always] send tucker for me . . . get a bag of flour all the way . . . my father been cut a canoe and he been had **munja**[13] . . . cooked by my mother'.

It was not only Europeans who commissioned canoes. Aboriginal people also commissioned canoes from a number of expert canoe makers. The terms of this trade included supplying the maker with food during the construction phase and then giving a proportion of food caught from the canoe for sometime afterwards. Steve Johnson describes Mac Riley making canoes 'for trade' and says he got half the catch for the first six months of the canoe's life as part payment. Tim Rakuwurlma also describes how Mac made him a canoe and sent it down from Mara country (to the north-west) to him and how he kept the Mara name given to this canoe; 'I been buy him long blanket . . . him been make him long his country . . . 'Bayilmalkulma' . . . that mob Mara [named it] . . . I been keep name they been call him that way'. Mac is also mentioned in the Welfare Department files (Australian Archives 1952) as having made (with others) five canoes in 1952.

Tim Rakuwurlma who supplied me with much of my information on Yanyuwa canoes, was a particularly renowned canoe maker. As Ted Egan recounts:

> Old Tim was always working on a canoe . . . float it down . . . half make it and either carry it or float it to a beach and finish it there . . . he was referred to as much by the term the 'canoe man' as 'Old Tim'.[14]

Egan also recalls how a European boat would sometimes tow dugout canoes: 'They had about ten canoes when I was there. Jack Bailey had a wonderful old chug chug boat and Jack would often pull a string of canoes up the river'.

The South Australian film maker, Roy Vyse, visited Borroloola in July 1954 and describes[15] how 'hunting is done from dugout canoes of which there are a large number'. A missionary based in Borroloola describes how in 1958 'a party of sixteen had left' Borroloola to pick up 'about eleven canoes' that had been made at one location that year (Main 1958: 15). Kettle (1967: 95) reports seeing 14 dugout canoes at Borroloola in 1955. An interesting burst of canoe making occurred in 1961 when the Yanyuwa were moved by the Welfare Branch to Dangana on the Robinson River.[16] Musso Harvey recalls how six canoes were made in the seven or eight months people lived there and how 'we all [came] sailing back' to Borroloola.

Yanyuwa people also made canoes when they were away from Borroloola working on cattle stations. Some stations provided ready access to suitable large trees. The residential quarters on many stations in the region are located on springs that are lined with tall trees. Hence there was the opportunity to work on canoes during slack periods of the cattle work. As Jean Kirton[17] recalls, the Yanyuwa would often come back from the cattle stations on trucks with new canoes:

> When they came back there, maybe two or three canoes would come back on the backs of the trucks . . . there were all kind of good things associated with the coming of the wet season, all the relatives coming back and new canoes coming back with them.

Canoe construction began to decrease in the early 1960s as the Yanyuwa began to have the cash to buy European aluminium dinghies. The last canoe built by the Yanyuwa for their own use was made by 'Old Dhulu' in 1977 at Ryan's Bend. This particular canoe was commissioned by Tim Rakuwurlma and stayed in use until 1981. At the end of one day's work on 'Rra-Kalwanyimara' Annie Karrakayn remarked how all the old canoe makers 'been die now' and that no younger canoe makers had replaced them 'because they had the dinghy now, white fella dinghy'.

Use of dugout canoes

It is possible to document long voyages made by the Yanyuwa in dugout canoes. Pyro Dirdiyalma described how a relative used to travel all the way to Burketown in a dugout canoe (a distance of over 400 km each way) 'looking for tobacco'. Don McLean told me of a round trip of over 500 km he made in a dugout canoe with three Yanyuwa men in 1943 to and from Groote Eylandt. People also travelled from Borroloola to Numbulwar (250 km to the north-west), in dugout canoes to attend ceremonies. As Steve Johnson recalls, whenever possible such trips would have involved sailing and not paddling:

> They sailed them when the wind was favourable; they never paddled because they wanted to. Most of them waited for the wind to come the right way before they even start. Probably sit there for a week waiting for favourable weather . . . unless they were in a hurry there is no way they'd paddle against it. But if they were out there and got caught, some of them old fellas could paddle for days without getting off that paddle.

As well as being a means of transport, dugout canoes played an important role in the Yanyuwa economy. This was particularly the case with turtle and dugong hunting. It should be noted, however, that older Yanyuwa individuals are adamant that people did hunt dugong and turtle from bark canoes in the 'old days'. As Tim Rakuwurlma notes: 'They been make him messmate tree, bark [canoe] . . . big mob dugong killer, black fella, right up long Wunubarryi [100 km north-west of Borroloola]'. It is conceded however that the dugout is far superior for hunting due to its greater size and stability. Indeed the dugout is in many ways superior to the aluminium dinghies powered by outboard engines used today. As Mick Pollard recalls, Tyson Walayungkuma told him how dugout canoes were superior for dugong hunting as in 'them aluminium boat, you go out and your toenail touch that floor, them dugong go for one mile'. Dugong are renowned for their acute hearing. In a canoe a hunter could silently glide over herds of turtles and dugongs and literally take his pick. Today, however, hunting in aluminium boats involves a hair raising high speed chase as the hunters attempt to outrun the turtle and dugong. The canoes also obviously have the advantage of not requiring fuel. Today it is quite a logistic effort to carry enough fuel to make the long trip down the McArthur River, go hunting and still have enough fuel to return to Borroloola. Another disadvantage of outboard powered dinghies is the fact that the occupants usually get covered with spray when travelling in them.

The following Yanyuwa terms are given for the crew of a dugout canoe. The person behind, sitting on the **daladala** (Fig. 3) was called **ramangka ngulakari**, the person in the front of the canoe was called **ngurrungu** and the person in the middle was called **a-kuyila wumbiji**. However, when hunting dugong and turtle in the past in dugout canoes or today in aluminium dinghies, different names are used for the person at the front and at the back of the canoe. The dugong hunter in the front armed with the harpoon and looking for dugong is known as **maranja**. This person indicates with hand signals which way the **wungkayi** (who is sitting behind) should paddle.

Dugong hunters took great care of their hunting equipment. When on hunting trips, ropes were carefully coiled so they would not get tangled and the harpoon was mounted on the side of the canoe with nails holding it in place. The harpoon was placed on the right-hand side of the canoe for right-handed hunters and on the left side for left-handed hunters. Dugongs and turtles were often hunted at night, with the hunter following the phosphorescent trails left in the wake of the animals. Such night time hunting trips could be quite long and young children were often taken out and bedded down for a night's sleep in the canoe. On cold dry season nights another advantage of dugout canoes was that a fire could be lit in the canoe. As Steve Johnson told me:

> They used to have a fire going there [on] a big flat rock or sheet of iron and a bit of mud on it clay, have a fire going there all day. They'd be paddling down the river and you'd see smoke in the boat . . . they used to even cook a feed, cook a fish or something like that . . . if they went out for a long trip . . . they'd take a bit of extra wood with them, they'd anchor all day out there waiting for the dugong to come back in from the deeper water, if they had some fish they'd cook that up, they lived like kings out there . . . boil the billy . . . they'd cook a few crabs.

It was the job of the person in the middle of the canoe, the **a-kuyila wumbiji**, to keep the fire burning. These fires served the dual functions of cooking and keeping people warm. Isaac Walayungkuma gives another description of these fires: 'Big canoe, you can put dugong and swag, put flat stone, make a fire there too'. Another good description of these fires is given by Ricket Murnudu in which he makes the point that when paddling the canoe the person behind was kept warm by the smoke drifting back: 'Fella in front he cold, but this one behind [is warm] because he keep smoking long him behind when he paddling'.

However, as Tim Rakuwurlma recalls, the results of not putting a fire out properly were serious. He describes how once, when he lent his canoe to his brother:

> Him been go out night time hunting and he been come back and been leave that boat there, he been wet that fire long salt water, wet him . . . but that fire been alight, canoe been burn him . . . [next morning] Banjo been come out. 'Ah that boat been drown here . . . oh I been burn [it] long fire'.

Tim goes on to describe how a European resident of the area 'been fix that boat now, got copper tack, copper nail and iron'.

As well as being used for hunting and carrying dugong and turtle, dugout canoes were also very useful for carrying loads of people, possessions and food. Annie Karrakayn notes for example how people used to 'fill him up **libaliba** . . . right up' with shell fish gathered from mudflats. Canoes were also filled up with sea bird chicks, gathered by shaking mangrove trees during the wet season. Sometimes these birds were also cooked on fires in the canoe. Large quantities of cycad fruit were also carried in canoes from where they grew to places where there was plenty of water to leach the toxic substances out of the cycad. Annie Karrakayn, for example, describes how people used to go to Manangoora where there are dense stands of cycads *(Cycas angulata)* and 'fill up canoe . . . and take him to . . . spring country, . . . soak it there now for eat'.

Canoes were also used to carry dogs. The last couple to travel regularly around in canoes, for a long time had one canoe each so that all their dogs could fit in. In the 1950s and 1960s when a large number of Yanyuwa people had moved in to Borroloola, dugout canoes were often used to carry fire-

FIGURE 5. Forty-four gallon drums being carried by canoes. Photograph Steve Johnson, circa 1955

wood back to their camp. They were also used to carry strips of paperbark that were collected from trees along the river to roof the shelters people built for themselves in Borroloola.

It is not surprising considering the time people spent in canoes that at least one Yanyuwa person was actually born in one. Also a number of other births were apparently brought on when heavily pregnant women were paddling canoes and just managed to make landfall before giving birth.

Early government officials such as Patrol Officers also made use of dugout canoes to travel around the Borroloola area, as they were the only possible form of transport for much of the wet season. The long time regional head of the Welfare Branch, Les Penhall, described how 'We bought two dugouts off one of the Aborigines out there so we could have transport available'. As well as being used for carrying supplies (Fig. 5) up the river from the deep water jetty downstream, canoes were used by the Welfare Department to get good timber to Borroloola. Annie Karrakayn, for instance, recalls how people used to get pine trees (*Callitris intratropica*) downstream along the McArthur River and brought them back to Borroloola with 'that canoe, pulling behind like a trailer'.

A number of European crocodile shooters in the area also used dugouts, for, as when hunting dugong, the crocodile hunter could silently glide on top of the prey. Considerable use of dugout canoes was also made by the army unit that was based on the Sir Edward Pellew Group during World War II. Don McLean describes how canoes were used to carry supplies and personnel, to patrol for mines, to carry messages and to locate an American airman who once crash landed in the area.

Canoe size

Spencer's diary contains a good indication of how large were the canoes which the Yanyuwa obtained from the Macassans. He notes that:

> A big canoe has come up the river from the coast with about 20 natives in it. It is quite unlike the bark canoe and is simply a great log hollowed out and shaped into a boat. It is quite 30 feet long . . . This particular boat was made by the Malays who come all down the coast every year in their Prahus in quest of toitorse [sic] shell [and] bêche de mer which they barter for with the blacks (Spencer 1901: 110).

The largest canoe made in living memory was measured by Steve Johnson to be 27 feet (8.23 m) long and was called the 'Butterfly'. The Yanyuwa classify canoe size in terms of how many large saltwater turtles they would hold: the 'Butterfly' being a 'four turtle canoe'. Tim Rakuwurlma also comments on a 'four turtle canoe' and goes on to say that it could also carry four 44 gallon drums. 'Sonny' Raggatt, the former manager of a station for which supplies were brought up the river in canoes, recalls one canoe that carried five 44 gallon drums or forty 50 lb bags of flour.

Annie Karrakayn in the conversation quoted above on how all the kids used to 'stick in that canoe', notes that the canoe also carried 'big mob of load' which included swags, billy cans and 44 gallon drums. Another mention of the capacity of dugout canoes is in Griffin's (1941: 32) description of a visit to Borroloola. She records a canoe paddled by Tim Rakuwurlma's brother Banjo carrying 'his lubra, and her sister, two piccaninnies, two dogs, one puppy, two galahs, and coolamons of lily seeds, roots and wild raspberries, not to mention billies and pannikins'.

Canoe life-span

Most dugout canoes appear to have lasted less than three years. Thomson (1934: 244) discusses the short life-span of canoes at Stewart River, Cape York, and comments on one lasting only seven to eight months. The fact that one canoe lasted five years before it sank is noted as being unusual by Johnson Babaramila Timothy: 'Him sunk down . . . might have been too old. One boat from Roper, we had it for long time, for about, might have been more than five years'. The oldest canoe described to me was the last one owned by Tyson Walayungkuma. This canoe, according to Steve Johnson, was a 'good ten years old' when it was finally too rotten to patch up any more.

The spreading of canoes, described above, makes canoes particularly susceptible to cracking. As well, boring water worms tended to eat through the canoes. Canoes were constantly patched, using the reddish bark of **ma-wunjurrwunjurr** (*Terminalia carpentariae*), a tree that grows on the Sir Edward Pellew Islands. As Steve Johnson notes: 'They used to use that, scrape the bark off . . . and they'd pound it up into a putty and then use that to shut the cracks'. When available, however, iron and tacks were considered preferable. As Steve goes on to note, **ma-wunjurrwunjurr** bark was only used 'if they were out bush and didn't have that gear [metal] . . . they even used mud, that hard clay for repairs'. Canoes were often removed from the water and rolled over to dry in the sun in attempts to kill the borers. Also, canoes were painted with a red ochre to protect them from worms. When available, tar, pitch and various boating oils were used as they were more effective.

Jean Kirton gives a good summary of the problems people had maintaining their canoes and illustrates why aluminium dinghies were so readily adopted in preference to dugouts:

> There were two kinds of borer that got into them, a freshwater one and a saltwater one and most of them only lasted two years. They would patch them and they would leak a lot. It got to the stage where they would leak so much they would be under water, [it] gets a bit discouraging bailing something when the entire thing is under water every time you want to use it. So [at] that point it got relegated to being drowned. When you could get an aluminium dinghy that borer did nothing to it.

Conclusion

The Yanyuwa history of canoe making is a good example of Aboriginal culture's quick response to change. Canoes were readily adopted by the Yanyuwa as they were a better version of something they already had. As such they represent cultural change very much on Yanyuwa terms. Use of dugout canoes allowed the Yanyuwa to exploit their environment in new ways. Resources such as bird and turtle eggs on isolated islands could be obtained and previous activities such as turtle and dugong hunting would have been both safer and more productive.

Methods of construction and repair of dugout canoes changed according to supply of natural resources, and to the provision of European tools and food sources. The move to use aluminium boats instead of dugouts occurred for the same reasons that dugouts were originally adopted. The new item had great advantages.

In the case of adoption of aluminium boats however, as has been the case for many aspects of European culture adopted by Aboriginal people, there have been unforeseen ramifications. The decline in canoe making has been but one part of an overall pattern of greater dependency on European resources and services that has led to a great reduction in Yanyuwa independence overall. The decision to adopt European dinghies occurred in the late 1960s when, with the granting of equal wages on cattle stations, there was plenty of cash about to buy dinghies. However, the prosperity of this time was short-lived. Massive lay-offs of Aboriginal people in the cattle industry in the 1970s have resulted in very few Yanyuwa people currently being employed. Today, there is little money to buy dinghies or outboard motors and often not enough mechanical 'know how' to keep those motors going.

Hence Tim Rakuwurlma (Fig. 6) who spent much of the first two-thirds of his 90 years travelling in dugout canoes around his island country, can now lament 'I want to go island, sit down long island, but no boat too much . . . I got no boat too much, I want to sit down long my country'.

FIGURE 6. Tim Rakuwurlma and his canoe, July 1954. From the Les Penhall Collection, Northern Territory State Reference Library. Reproduced with Penhall's permission.

ACKNOWLEDGMENTS

I wish to thank all the Yanyuwa people who shared with me their knowledge of canoes. I am also most grateful to all the non-Aboriginal people with experience in the Borroloola area who helped me with their memories of Yanyuwa canoe use. I thank the Australian National Maritime Museum for giving permission to publish here sections of a report I prepared for them. Research in the Borroloola area has also been supported by the Australian Institute of Aboriginal Studies, the University of Adelaide, the Northern Australian Research Unit of the Australian National University and the Royal Geographic Society of Australasia (South Australian Branch). In addition, I wish to thank Chris Anderson, Michael Bardsley, Fay Gale, Philip Jones, and Beth Slatyer for useful comments on earlier drafts of this paper. I am also particularly indebted to John Bradley for all his logistic and linguistic assistance.

ENDNOTES

1. All the conversations quoted are from recorded interviews, now lodged with the Australian Institute of Aboriginal Studies in Canberra. A copy of this paper footnoted with details of tape number for each quote and the place on the tape where the conversation occurs is lodged with the A.I.A.S. Most quotes are from Aboriginal people from the Borroloola area. Where the quotes are not from Aboriginal people, I give in an endnote, background information on how the individual concerned came to be in the area. A detailed set of photographs documenting the construction is also lodged at the A.I.A.S., as are a number of historic collections of photographs which I have located relating to the area and which include photographs of canoes.

2. She is referring here to Tim Rakuwurlma, an old Yanyuwa man who has supplied me with much of my information on Yanyuwa watercraft. Tim was born some time late last century.

3. This is an Aboriginal English term for helping someone.

4. Macassans are fishermen who came to northern Australia from the port of Macassar in the Celebes (now known as Ujung Pandang and Sulawesi respectively) prior to European settlement of Australia. Their visits stopped in 1907 as a result of South Australian Government legislation. They came to collect, amongst other things, trepang. (*See* Macknight 1969, 1972 and 1976 for further details.)

5. 'Sugar bag' is an Aboriginal English term for the native bee nests that contain wax and honey.

6. A European soldier based on the Sir Edward Pellew Group during part of World War II

7. The photographic recording of the canoe construction illustrates each stage of production it went through. The copy of this article lodged with the A.I.A.S. includes a daily record that details each photograph taken.

8. All tools used were purchased metal ones. In the recent past most work was done with similar tools. Don McLean, however, recalls seeing 'wedges made out of stone and they were on a long handle . . . like an adze' and describes them being used in the same way I observed large steel adzes being used.

9. Steve Johnson has lived all his life on Vanderlin Island. His father was a European trepanger who lived most of his life there with Steve's mother, a Yanyuwa woman. Steve has a detailed knowledge of canoes from the use Aboriginal people made of them around his home, Vanderlin Island.

10. Spencer & Gillen collected one such canoe which is now held by the National Museum of Victoria. The South Australian Museum also holds a canoe collected from Borroloola around the turn of the century and Hornell (1940) also gives a detailed description of another bark canoe made in the Borroloola region, held by the Australian Museum in Sydney.

11. As noted above, Isaac Walayungkuma is a Garawa speaker and hence uses this Garawa term and not the Yanyuwa term **Na-wulka**. Trigger (1987: 80) mentions Garawa watercraft and notes the Garawa use of this term for bark canoes.

12. 'Malay' was the incorrect term Europeans applied for a long time to the Macassan trepangers. Tim would have learned this from Europeans and not from the Macassans themselves. The Groote Eylandt Aboriginal people Tim mentions came down on the Macassan boats.

13. A term for the cycad that grows in abundance in the area. It is processed to leach out toxic substances and is then prepared into preservable dampers.

14. Egan was the relieving Welfare Officer at Borroloola for a number of brief periods in the 1950s.

15. This quote comes from S.A. Museum Archives Acc. No. 1676, which is a notebook of his trip. Vyse made a film of his trip (also held by South Australian Museum) which includes a shot of Tim Rakuwurlma paddling a canoe across the McArthur River. The photograph in Fig. 6 was also taken at this time.

16. The Northern Territory Welfare Branch Annual Report 1960/61: 76 documents the move of 133 Aboriginal people previously resident at Borroloola.

17. Jean Kirton has worked as a linguist at Borroloola since 1963.

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REVIEW

BY P. HORTON

Summary

The dynamic partnership : birds and plants in southern Australia edited by Hugh Ford & David Paton. The Flora and Fauna of South Australia Handbooks Committee, Adelaide, 1986. 199 pp., 8 colour plates, 23 figures, 38 tables. Paperbound, $A19.50.

REVIEW

The Dynamic Partnership: Birds and Plants in Southern Australia edited by Hugh Ford & David Paton. The Flora and Fauna of South Australia Handbooks Committee, Adelaide, 1986. 199 pp., 8 colour plates, 23 figures, 38 tables. Paperbound, $A19.50.

The editors, Hugh Ford (University of New England) and David Paton (University of Adelaide), themselves contributors to the book, are to be commended for bringing together much of the current understanding of bird-plant relationships in southern Australia — as yet a relatively little studied field. The resulting publication is the first broadly-based treatise on this subject for Australia. The title suggests that the book pertains to southern regions of Australia only, but in fact many of the hypotheses and conclusions put forward may be applicable to most of the continent.

The book is divided into sixteen chapters, and each discusses a particular aspect of bird-plant interactions. Some are specific, such as the pollination and seed dispersal of mistletoes (by N. Reid), and others are more generalised, such as lifestyles and food resources of birds in inland environments (by K.S. Shurcliff). Some authors largely restrict their discussions to an analysis of the available data, for example P.A. Paton in her chapter on the use of aquatic plants by birds in the Coorong, South Australia. Others are more speculative, for example D.C. Paton in his chapter on the evolution of bird pollination in Australia. Inevitably with such a diversity of topics, the book is essentially a collection of papers. However, the editors have grouped those with similar themes, except for some that fall into no particular category, and there is some cross-referencing between chapters. This, together with the provision of introductory and concluding chapters, gives a degree of continuity throughout. Despite the diversity of material discussed, there are still several aspects of bird-plant interactions left unexplored, such as the use of plants for nest sites and nesting materials. But as is suggested in the introductory chapter, some subjects are beyond the scope of the book; these may well serve as the basis for future publications.

Most of the book deals with endemic plant and bird communities, but two chapters examine the adaptations to and utilisation of exotic habitats by birds, in comparison with adjacent areas of native habitat. These are studies in suburban gardens (by R.J. Green) and pine forests (by B.C. Gepp). I found A.V. Milewski's chapter, also comparing bird communities in different habitats, particularly interesting. In this case they are both endemic habitats — southern Australia and southern Africa. Despite the presence of many plant and bird families that are the same in both regions, Milewski points out some distinct differences, which he attributes to climatic and soil differences between the continents. Thus in southern Africa there is a diversity of birds that consume fleshy fruits and of plants that produce them, while in southern Australia there is a diversity of honeyeaters and nectar-producing plants.

Much of the book examines bird-plant interactions from the point of view of the use of or dependence on plant species by particular birds, or of the mutualistic relationship between the two groups. Chapter 15 (by H.A. Ford) on birds and eucalypt dieback, however, is taken from the point of view of plants' dependence on birds not just for enhanced dispersal of pollen and seed but more directly for their health and survival. This and several other chapters also address the question of the future for bird and plant communities in Australia, and suggest management strategies for their conservation.

Perhaps the overriding impression gained from the book is that in attempting to answer many questions about bird-plant relationships, it raises many more, as would be expected in such a youthful field of research. The reader is provided with a kaleidoscope of bird-plant interactions yet to be investigated, and is given many suggestions as to the directions that future research may take.

The literary style adopted by most of the thirteen authors is somewhat more expansive and descriptive than would appear in a scientific journal, and the book is liberally illustrated with tables, figures and colour plates, so it should be an informative text for amateur ornithologists, botanists and ecologists as well as for the scientific community. The book has been well-produced, the layout is good, and the printing excellent; a minor criticism is that many of the chapter sub-headings are larger and bolder than is aesthetically necessary. It is priced reasonably, and is a creditable addition to the series of Handbooks of the Flora and Fauna of South Australia. I recommend it to anyone interested in ecology and conservation.

P. HORTON, South Australian Museum, North Terrace, Adelaide, South Australia 5000. *Rec. S. Aust. Mus.* 22(2): 189, 1988

NGURUNDERI : A NGARRININDJERI DREAMING

BY S. J. HEMMING

Summary

The South Australian Museum has for several years been developing an exhibition depicting aspects of the Aboriginal culture of the Lower Murray region of South Australia. Central to the religious beliefs of the people in this region was the Dreaming ancestor Ngurunderi and the story of the creation of the Murray River and many other geographical features in the Lower Murray and Coorong areas. The exhibition incorporates as a central theme the Dreaming of Ngurunderi. As an introduction to the exhibition, the South Australian Museum, in association with the South Australian Film Corporation, Pepper Studios and the Ngarrindjeri Community have produced a short film entitled 'Ngurunderi: A Ngarrindjeri Dreaming'. After several years of planning it was finally completed in 1987 and was launched early in 1988. The film won a silver award in the education/social studies category at the New York World Film and Television Festival. It also won a gold award for camera work from the Australian Society of Cinematographers. Since the launch it has been screened continuously in the introductory area to the planned exhibition. This was the Museum's intended function for the film, with the possibility of its use by the South Australian Education Department. The South Australian Film Corporation, which holds the copyright of the film, are trying to market it as widely as possible and copies are presently available from the Film Corporation or through the South Australian Museum shop.

NGURUNDERI: A NGARRINDJERI DREAMING[1]

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A number of accounts of the Ngurunderi Dreaming were recorded by anthropologists, missionaries and other non-Aboriginal commentators including Cawthorne, Taplin, Meyer, Smith, Berndt, and Tindale. Most relate only to a small segment of the Dreaming, usually focusing upon Ngurunderi's exploits in one particular area. Professor Ronald Berndt's version (1940) is the most detailed published account and it is upon this that the Museum's film is mainly based. Dr Norman Tindale, the other anthropologist to have worked extensively in the area, also collected lengthy accounts, but these are yet to be fully published. His one brief published account (Tindale & Pretty 1978) differs in certain details from that of Berndt. Both these anthropologists worked with Aboriginal people from different groups in the region; Berndt's main source of information was Albert Karloan, an initiated man of the Yaralde people; Tindale's primary source was Clarence Long, an initiated man from the Tangane people. This may be the reason for the variation in the two accounts. The people in each Ngarrindjeri group would have known in most detail the section of the Ngurunderi Dreaming that related to their own region. This phenomenon still exists today and those in the Ngarrindjeri community who have heard about Ngurunderi from the old people usually know something of the section which relates to the areas associated with their families.

In several of the published accounts, Ngurunderi's epic journey appears to have started in the Darling Junction area of the River Murray and continued down the Murray to the Lakes. Some Ngarrindjeri people today see this as providing evidence that Ngarrindjeri territory, before the arrival of the Europeans, stretched as far as the Darling region. In Berndt's version, Ngurunderi chases the giant cod, **ponde**, into Lake Alexandrina and with the help of his brother-in-law Nepele, the cod is speared and cut into many pieces. He changes each piece into one of the present-day species of freshwater fish inhabiting the area. George Trevorrow, a Ngarrindjeri man with a Coorong background, knows another version of this part of the Dreaming. He describes a different location for the cutting up of the cod and includes the creation of saltwater fish such as the mulloway. A combination of this and Berndt's version is used for this incident in the film. Henry Rankine, another Ngarrindjeri man who provided details not available in the Berndt version of the Dreaming, has a connection through his father with the Lower Murray area and the northern shores of Lake Alexandrina. He supplied some detail about Ngurunderi's use of smoke signals and this was also included in the film.

According to Berndt's account, Ngurunderi's journey continued from the Lakes area, down the Coorong to Kingston. During this part of the Dreaming, his runaway wives become a central feature of the events. At Kingston, Ngurunderi fought with an evil sorcerer called Parampari. He killed Parampari and burnt his body, which changed into the Granites near Kingston. Ngurunderi then pursued his wives back towards the Murray mouth, crossed it and travelled around Encounter Bay. Along this coast he created many of the islands, including Granite Island. I have not spoken with any Ngarrindjeri people who know details of the Encounter Bay section of the Ngurunderi Dreaming. This is to be expected, given the rapid occupation of this area by the British and the impact that this had on the culture of the local Ngarrindjeri group, the Ramindjeri. Ngurunderi caught up with his wives, who had broken several Ngarrindjeri laws and drowned them by flooding the land between the mainland and Kangaroo Island — their bodies became 'The Pages'. He crossed

Backstairs Passage to Kangaroo Island where he entered the spirit world. According to Ngarrindjeri belief, Ngurunderi established many laws and when someone dies the spirit follows Ngurunderi to Kangaroo Island and from there into the spirit world. Today Ngarrindjeri people still bury their dead with the head facing towards Kangaroo Island in the west. The association of this practice with Ngurunderi's laws is now only becoming widely known through the greater availability of the published versions of the Ngurunderi Dreaming. It is also due, though, to the activities of the South Australian Museum, its exhibition and the inclusion of this Dreaming story in new courses being developed by the South Australian Education Department.

As previously mentioned, most of the available accounts of the Ngurunderi story are fragmentary. One of the earliest examples is provided by the missionary H.A.E. Meyer (1846). Here 'Nurrunduri' is described as controlling the life of the moon, who was a woman. When she becomes too thin he orders her to be driven away to eat roots and so recuperate. Meyer's version of the cutting up of the cod and the creation of the fish from the pieces varies considerably from Berndt's account. He says Pungngane caught a **ponde** and divided it into pieces, each becoming a cod. Strangely enough he threw them into the sea. The association with saltwater is to be expected here as Meyer's informants were Ramindjeri people and therefore predominantly coastal dwellers. Tindale (1935) says that Pungngane is the equivalent of Nepele. Another early version of the Dreaming story was recorded by W.A. Cawthorne in the early days of British settlement and published in 1926. Here 'Ooroondovil' (Cawthorne's spelling) is described as the 'first great spirit', who made the land, when all that existed was water. This is very different from Berndt's account of the Dreaming story in which Ngurunderi appears in the later phase of the Dreaming, after the land, sea and other basic forms have already been created. However, there are some similarities and interestingly, Cawthorne says that after leaving Kangaroo Island, Ooroondovil '. . . went on westward, where he still lives, though by this time a very old man, and has taught the Europeans the use of firearms, how to make clothes, etc.' (Cawthorne 1926: 26).

During research for the main exhibition and for the film, I worked with a number of Ngarrindjeri people who were at least partly familiar with the Dreaming of Ngurunderi. All knew only fragments of the detailed Dreaming story that must have once existed. One interview I had with a non-Aboriginal, former riverboat captain, Don Ledo, also provided some interesting information. As a child he grew up on the Murray and he spent much of his time with Aboriginal friends. He remembers listening to an old Aboriginal man telling, or rather acting out, the Dreaming story of Ngurunderi. George Taplin, the missionary who established Point McLeay settlement, records in his diary a corroboree he witnessed which incorporated song and dance and, as he discovered, concerned Ngurunderi (Taplin 1873, 1879). There would have been many such corroborees concerning Ngurunderi. When I first asked Don Ledo whether he knew anything about Ngurunderi, it took him a few minutes to recognise my initial crude attempt at pronunciation. However, he soon worked out that I meant, 'Ngoorroonderree' (primary stress on the first syllable, 'oo' as in 'book', and the 'rr' trilled), as he pronounced it. Of the several Ngarrindjeri people whom I have heard use the word Ngurunderi, most employ the same pronunciation as Ledo. The Ngarrindjeri spoke several different dialects and this probably accounts for some of the variations. For instance, some Coorong people pronounce the word with a 'u' sound as in 'but'.

Initially, missionary George Taplin used the word 'Ngurunderi' as a convenient translation for God. He wanted to use the local language and a modified version of the Dreaming as a tool in the conversion of the Ngarrindjeri to Christianity. However, he soon discovered that Ngurunderi was responsible for many customs with which he was loath to associate his God. He subsequently set about dissuading the use of Ngurunderi as the equivalent for his concept of the Christian God. There are a number of historical examples of his lack of success in this endeavour and a few Ngarrindjeri people have continued to equate Ngurunderi with God. For example, this is the philosophy of the Ngarrindjeri church at Meningie, on Lake Albert. When consultations regarding the making of the film were started, I was told by various people including the Chairman of Point McLeay, Henry Rankine, that I would have to speak to Mrs Lola Sumner, as she was one of the most important and knowledgeable old people in the Ngarrindjeri community. She approved of the idea of the Museum making a film of the Ngurunderi Dreaming. She also pointed out that Ngurunderi was the Ngarrindjeri way of saying 'God'. Her pronunciation of the word was the same as Ledo's and it was on her authority that we used it in the film. Mrs Sumner, who is now deceased, was recognised in the Ngarrindjeri community for her excellent knowledge of the language.

The main Ngarrindjeri contributors to the development of the film's script were Henry Rankine, George Trevorrow, and Harvey Karpany. However, most of the detail used was from Berndt's version which was recorded in the late 1920s and early 1930s from information supplied by Ngarrindjeri people such as Albert Karloan. It was decided early during the film's planning that, ideally, a Ngarrindjeri narrator and Ngarrindjeri actors were required. Henry Rankine was selected by the South Australian Film

Corporation to be the narrator and the actors for the film were chosen from the Point McLeay and Meningie Aboriginal communities. The selected locations were as close as possible to the actual places mentioned in the Dreaming. The actors were: Henry Rankine jnr. (Ngurunderi), Maxwell Rankine (Nepele), Fred Sumner (Parampari), Susan Rankine (Wife) and Margaret Rankine (Wife). It was felt necessary and agreed upon by Ngarrindjeri people that the actors be of a dark skin colouring for the authenticity of the film. From the beginning it was also decided that identifiable facial shots should not be used in the film, in an attempt to retain a mystique about the identity of Ngurunderi.

For the film, we paid particular attention to detail in the items of material culture used. We highlighted, as much possible, the differences between the southern Australian Aboriginal cultures and peoples and those of the desert and the north. The baskets and mats used in the film were made by Yvonne Koolmatrie, Ellen Trevorrow and Glenda Rigney. These women have continued the Ngarrindjeri basketry tradition in that the technique and materials they use have not changed since at least 1836.

Prior to the final version of the film being released a seminar was organised for the Ngarrindjeri community during which they could view the film and comment on its development. The progress of the exhibition itself was also discussed. About two hundred Ngarrindjeri people attended this seminar and the response to the film was very encouraging. The film has certainly been successful in its role as an introduction to the Ngarrindjeri exhibition and it will also have applications outside the Museum in areas such as education and tourism. Its production, however, required a complicated series of consultations with members of the Ngarrindjeri community, particularly given the Museum's inexperience in the area of film-making. However, the finished product was worth the effort, due in no small way to the sensitive handling of the subject by Pepper Studios. Many opportunities exist for similar films to be made in the future and perhaps the education system should be seeking funding for their production. In the final analysis, however, the film 'Ngurunderi' illustrates the value for museums, of a close, co-operative, working relationship with the Aboriginal community and the value of film as a medium for effectively educating the wider Australian public about Aboriginal culture.

Endnote

1. When the British first arrived in South Australia, the peoples of the Lower Murray were identified by a large number of local clan and language-group designations. Today most of the local people from this area identify themselves as Ngarrindjeri people. The Ngarrindjeri community numbers several thousand people and is spread throughout the Murray River and south-east region of the state.

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ERRATUM FOR VOLUME 22(1)

WATTS, C.H.S. 1988. *Rec. S. Aust. Mus.* 22 (1):

p. 22 — Lower caption should read:
FIGURES 7-13. 7, lateral view of aedeagus of *H. alastairi;* 8, lateral view of aedeagus and paramere of *H. gibbus;* 10, ditto *H. alastairi;* 11, lateral view of aedeagus and paramere of *H. fuscatus;* 12, dorsal view of aedeagus of *H. fuscatus*

ERRATUM FOR VOLUME 22(1)

WATTS, C.H.S. 1988. *Rec. S. Aust. Mus.* **22** (1): 21–28.

p. 22 — Lower caption should read:
FIGURES 7-13. 7, lateral view of aedeagus of *H. alastairi*; 8, lateral view of aedeagus and paramere of *H. gibbus*; 9, dorsal view of aedeagus of *H. gibbus*; 10, ditto *H. alastairi*; 11, lateral view of aedeagus and paramere of *H. fuscatus*; 12, dorsal view of aedeagus of *H. fuscatus.*

p. 27 — Start of 'Remarks' should read:
Does not appear to be as common as *H. gibbus,* nor as widespread. I have been unable to separate this species from *H. gibbus* except by the male aedeagus, which is narrow and sinuate, but broad in *H. gibbus.*

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