

## The marine Haloveliinae (Hemiptera: Veliidae) of Australia, New Caledonia and southern New Guinea

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### Abstract

Water striders (Hemiptera, Gerromorpha) are common inhabitants of aquatic habitats throughout the world. More than 150 species representing five families have colonised the marine environment, chiefly coastal areas of tropical seas in habitats with a strong tidal influence. The Australian fauna of marine water striders is particularly diverse and species-rich, comprising about 30 species. The present paper deals with the marine Haloveliinae (Veliidae) of Australia, New Caledonia and southern New Guinea. They are classified in two genera, *Xenobates* Esaki and *Halovelia* Bergroth. *Xenobates mangrove*, *ovatus*, *major* and *spinoides* (Queensland), *X. lansburyi* and *chinai* (Northern Territory), and *X. caudatus* (southern Papua New Guinea) are described as new. *X. myorensis* (Lansbury), *X. angulatus* (Polhemus) and *X. loyaltiensis* (China) comb. nov. are redescribed. Descriptive notes are presented for the five species of *Halovelia* recorded from Australia. Keys to adults of all species are provided and their distributions mapped. Finally, we discuss the zoogeography and ecology of the marine Haloveliinae of Australia.

### Introduction

More than 150 species of semiaquatic bugs (Hemiptera, Gerromorpha), representing five families, nine subfamilies, and 25 genera, inhabit the marine environment, chiefly coastal areas of tropical seas in habitats with a strong tidal influence (Andersen and Polhemus 1976; Andersen 1982). The Australian fauna of marine water striders is particularly diverse and species-rich. Previously, we have revised the Australian species of sea skaters, genus *Halobates* Eschscholtz (Andersen and Weir 1994), and of the marine genera *Stenobates* Esaki and *Rheumatometroides* Hungerford & Matsuda (Andersen and Weir 1998), all belonging to the family Gerridae. Here, we present a taxonomic revision of the Australian species of marine Haloveliinae (Veliidae) which are classified in two genera, *Xenobates* Esaki and *Halovelia* Bergroth.

The first species of haloveliine water striders recorded from Australian waters was *Halovelia maritima* described by the Finnish hemipterist E. Bergroth (1893) from specimens collected by the British naturalist J. J. Walker on the small Cartier Island in the Timor Sea, about 250 km north-west of Australia. Additional species were described by China (1957), Polhemus (1982), Andersen (1989a), and Lansbury (1989) while Marks (1971) and Polhemus (1982) reported on the biology of Australian species.

In the present paper, we define the genus *Xenobates*, redescribe three species and describe seven new species from Australia, New Caledonia and southern New Guinea. *Halovelia* was revised by Andersen (1989a, 1989b) and we, therefore, restrict ourselves to an illustrated key and descriptive notes for the five Australian species.

### Material and methods

The present study is based upon material borrowed from the institutions listed as repositories below. The identification of new material has been greatly facilitated by reference to specimens deposited in the Zoological Museum, University of Copenhagen. Other major collections, in particular those of the Natural History Museum, London, and the John T. Polhemus collection, Englewood, Colorado (now belonging to the National Museum of Natural History, Washington, D.C.), have been studied by the first author.

Haloveliine water striders can be collected in nearshore, marine habitats (estuaries, mangroves, intertidal coral reefs) by using a lightweight fishing net with a fine-meshed nylon or other rapid-drying bag. Specimens can be stored permanently in 70% alcohol although specimens often become discoloured (bleached) after a lengthy period of storage. In addition, the vestiture of silvery pubescence found in species of *Xenobates* is obscured in liquid-preserved specimens. Dry mounting of synoptic series is therefore advisable. Methods for dissecting and examining the male genitalia of *Halovelia* are described by Andersen (1989a). The terminology used for the male terminalia is explained in that paper and below. All measurements are given in millimetres. Total length and body width are given as ranges for all individuals examined. Other measurements are given for a single specimen: either holotype, lectotype, representative paratype, or other specimen (if no type material is available). The length of the femur is measured along the dorsal side of the limb, not including the trochanter. All adult specimens examined were apterous (wingless).

In the taxonomy section, complete descriptions are given for all Australian species of marine Haloveliinae. We also include descriptions of a few species from southern Papua New Guinea and New Caledonia. The first author has examined holotypes or other type material for all nominal species covered in this paper. The synonymical bibliographies under the taxonomic headings include synonyms and any additional papers dealing with Australian species.

#### Abbreviations for repositories

AMS	Australian Museum, Sydney, Australia.
ANIC	Australian National Insect Collection, CSIRO, Canberra, Australia.
BMNH	Natural History Museum (formerly British Museum, Natural History), London, U.K.
BPBM	Bernice P. Bishop Museum, Honolulu, U.S.A.
JTPC	John T. Polhemus Collection, Englewood, Colorado, now belonging to the U.S. National Museum, Washington, D.C., U.S.A.
MHNP	Museum National d'Histoire Naturelle, Paris, France.
MTKD	Museum für Tierkunde, Dresden, Germany.
NTMD	Northern Territory Museum, Darwin, Australia.
QMB	Queensland Museum, Brisbane, Australia.
RNHL	Rijksmuseum van Natuurlijke Historie, Leiden, The Netherlands
SAMA	South Australian Museum, Adelaide, Australia.
UMO	Hope Department of Entomology, Oxford University, Oxford, U.K.
UQIC	University of Queensland Insect Collection, Brisbane, Australia.
ZMUC	Zoological Museum, University of Copenhagen, Denmark.

#### Taxonomy

The subfamily Haloveliinae is currently classified in the Veliidae, which is the largest of the families of the hemipterous infraorder Gerromorpha, with more than 600 described species (Andersen 1982). When describing *Halovelia*, Bergroth (1893) placed this genus in the Veliidae. Hale (1926) supported this classification by pointing out the presence of a specialised grasping comb on the male fore tibia of *Halovelia*, a feature shared with the Australian species of *Microvelia* Westwood (Veliidae). Despite this, Esaki (1924, 1926) transferred *Halovelia* to the family Gerridae because of superficial similarities among species belonging to these two groups, e.g. points of insertion of the middle and hind legs distinctly removed from that of the fore legs, long and slender middle femora. Esaki (1930) erected a separate subfamily, the Haloveliinae, for the genera *Halovelia*, *Xenobates* Esaki, *Entomovelina* Esaki and *Strongylovelia* Esaki. The two last-mentioned genera contain only freshwater species distributed in the Oriental region, including New Guinea, and are not represented in the Australian fauna. China (1957) and Andersen (1982, 1989a) extensively discussed the relationships of the haloveliine water striders, confirming their classification in the family Veliidae.

#### Key to subfamilies and genera of Australian Veliidae (adults)

1. All tarsi with three segments. Middle tarsi deeply cleft, with leaf-like claws and plumose swimming fans arising from base of the cleft (Rhagoveliinae) ..... *Rhagovelia* Mayr
- Tarsi at most with two segments. Middle tarsi not deeply cleft, without plumose swimming fan ..... 2
2. Fore tarsi with only one segment, middle and hind tarsi two-segmented. Middle femora subequal or shorter than hind femora. Middle tarsi rarely more than twice as long as hind tarsi (Microveliinae) ..... *Microvelia* Westwood

- All tarsi two-segmented (basal segment of fore tarsi short). Middle femora distinctly longer than hind femora. Middle tarsi more than twice as long as hind tarsi (Haloveliinae) ..... 3
- 3. Head with extensive pale markings. Pronotum with pale transverse mark or paired spots. Male fore tibia without grasping comb (Fig. 3); genital segments distinctly protruding from abdominal end (Fig. 2). ..... *Xenobates* Esaki
- Head and pronotum with very limited pale markings. Male fore tibia with grasping comb (Fig. 58); genital segments withdrawn into pregenital abdomen, largely concealed from dorsal view (Figs 66, 71) ..... *Halovelina* Bergroth

### Genus *Xenobates* Esaki

*Microbates* Esaki, 1926: 153 (junior homonym of *Microbates* Sclater & Salvin, 1873 [Aves]).

*Xenobates* Esaki, 1927: 184 (nom. nov. for *Microbates* Esaki, 1926). – Cassis & Gross, 1995: 443.

*Colpovelina* Polhemus, 1982: 7 (as subgenus of *Halovelina* Bergroth, 1893). – Lansbury, 1989: 94; Andersen, 1989a: 85 (synonymised with *Xenobates* Esaki, 1927).

Type species: *Xenobates: Microbates* (= *Xenobates*) *seminulum* Esaki, 1926, by original designation and monotypy; *Colpovelina: Halovelina* (*Colpovelina*) *angulana* Polhemus, 1982, by original designation.

### Description

Small or very small water striders; adults always apterous (wingless). Body fusiform to ovate (Figs 2, 6), length 1.3–2.3 ♂ or 1.5–2.8 ♀, 1.8–2.2× greatest width across mesothorax. Body chiefly dark coloured, covered by a thick pilosity. Head largely pale between eyes. Pronotum with transverse pale marking(s) in middle. Thoracic and abdominal dorsum usually with definite spots of greyish or silvery hairs. *Head* (Fig. 7, he) shorter than wide, moderately deflected in front of eyes; dorsal surface with indistinct, shiny impression in middle but no pseudocellar pits. Eyes relatively large, globular, width of each eye 0.3–0.5× interocular width. Antennae slender, 0.5–0.7× total length of insect; segment 1 always shorter than head, subequal in length to segment 4; segment 3 slightly longer than segment 2. *Thorax*. Pronotum (Fig. 7, pn) very short, suture between pro- and mesonotum (mn) distinct in middle, turned obliquely backwards laterally, terminating far from lateral margins of thorax; sutures between pro- and mesopleura lost. Dorsal boundaries between meso- and metathorax and between metathorax and abdominal terga indistinct. Ventral sutures of thorax and abdomen distinct (Fig. 5); metathoracic scent channels extending laterally and obliquely backward from median scent orifice (so), distinctly separated from hind margin of metasternum; small evaporative areas (Fig. 8, ev) on metacetabula. *Legs*. Fore trochanter of male not modified. Fore tibia of male without grasping comb (Fig. 3), but usually with a row of scattered, spine-like hairs along inner surface before apex. Mesotrochanters prolonged (Fig. 5, tr). Middle femur very long, 0.7–0.9× total length of insect, distinctly thickened in proximal part; femur usually with a row of bristle-like hairs along anterior margin (Fig. 4), continuing on tibia and tarsus; middle tibia and tarsus prolonged, tarsus 0.7–0.8× length of tibia; first tarsal segment 1.2–1.5× second segment; claws very small, falcate. Hind femur relatively short, more or less thickened proximally, especially in male; second tarsal segment much longer than first segment. *Abdomen* relatively short and tapering in width posteriorly in both sexes, sides almost straight (♂) or more or less rounded (♀); connexiva obliquely raised, sometimes vertical in posterior parts (♀); abdominal terga 4–7 distinctly separated by intersegmental sutures. Abdominal venter of male simple or modified (with basal tumescence and median ridge); male genital segments conspicuous and distinctly protruding from pregenital abdomen (Figs 2, 5, 8); segment 8 (Fig. 9, s8) simple or depressed ventrally; pygophore (pg) subovate, not modified distally; parameres (pa) large, symmetrically developed, and usually falciform. Vesica (Figs 11–12) with 3–4 asymmetrical, dark sclerites. Hind margin of sternum 7 of female usually straight; female proctiger (Fig. 13, pr) variable in shape, protruding from segment 8 or more or less deflected. *Egg* (*X. mangrove*, sp. nov., Fig. 16) elongate ovate, 0.6–0.7 mm long, 0.2–0.25 mm wide, with a small tubercle at the anterior pole, traversed by one micropyle (Fig. 17, mi). *Nymphs*. Probably five nymphal instars. Fifth instar (*X. mangrove*, sp. nov., Fig. 15) largely pale, with some brownish sclerotisations dorsally; head without distinct ecdysial line; thoracic nota brownish with pale markings; abdomen with paired

sclerites. Antennal segments 2 and 3 with short pilosity and a few longer hairs. Middle femora and tibia with short but distinct row of hairs along anterior margin.

#### *Biology and ecology*

Species belonging to the genus *Xenobates* are typical inhabitants of mangrove swamps where they occur singly or in groups amongst mangrove shoots and in tidal streams. We, therefore, suggest the trivial name *mangrove bugs* for these marine water striders. Very little is known about the biology of these insects. The present records for Australian *Xenobates* indicate that species may breed throughout most of the year. Adults and nymphs belonging to various instars are usually collected together and samples often contain more than one species (see below). Lansbury (1996) used mercury vapour light to attract *X. solomonensis* Lansbury and *X. pilosellus* Lansbury in Papua New Guinea, and often found these species in habitats where saline water and freshwater mingle.

#### *Comments*

Esaki (1926) described this genus under the name '*Microbates*', which was preoccupied (in Aves) and subsequently changed to *Xenobates* (Esaki 1927). The genus was monotypic and the type species, *X. seminulum* (Esaki), from New Guinea is peculiar in some characters, e.g. its tiny size, very distinct row of mesofemoral bristles, and trough-shaped female abdomen. This probably impeded later classifications of haloveliine water striders. Polhemus (1982: 7) described the subgenus *Colpovelina* stating that it was 'similar to *Halovelina* s.s., but without definite sclerotised comb on fore tibia'. Lansbury (1989) described several new species of haloveliines, placing some of these in the genus *Halovelina* (including *H. myorensis*; see below), others in the genus *Xenobates*. Based upon a preliminary study of all described and many undescribed species, Andersen (1989a; 1992) pointed out that the few salient characters previously used to identify *Xenobates* were highly transitional and that a redefinition of the genus was needed.

*Xenobates* can be separated from *Halovelina* on the characters given in the key (above). The absence of a grasping comb on the male fore tibia and the protruding male genital segments are diagnostic characters for *Xenobates*. In addition, most species of *Xenobates* have extensive pale markings on the head and pronotum, and more or less extensive silvery pubescence which often forms definite spots on the mesonotum and the abdominal dorsum. The mesotibial hair fringe originally used (Esaki 1926) to define the genus has turned out to be quite variable among species, both in the relative length and colour of hairs.

At present, *Xenobates* contains 6 described species. In addition, the senior author has knowledge of about 20 undescribed species from India, Sri Lanka, Thailand, West Malaysia, Singapore, Borneo, the Philippines, Sulawesi, the Moluccas, and New Guinea. In the present study we treat 10 species from Australia, New Caledonia and southern New Guinea, seven of which are described as new.

#### **Key to the species of *Xenobates* in Australia, New Caledonia and southern New Guinea**

1. Male fore and hind femora distinctly more incrassate than middle femora (Figs 52–53). Length 1.6–1.9 ♂ or 2.3–2.5 ♀. New Caledonia, Loyalty Is ..... *X. loyaltiensis* (China) 2
- Male fore and hind femora not distinctly more incrassate than middle femora ..... 2
2. Large species, length more than 1.9 mm ♂ or 2.4 mm ♀ ..... 3
- Small species, length less than 1.8 mm ♂ or 1.9 mm ♀ ..... 4
3. Basal tumescence of male abdominal venter forming a spine before the depressed sterna 6–7 (Fig. 34). Female abdomen relatively long, with distinct lateral hair tufts anteriorly (Fig. 37). Length 2.1–2.3 mm ♂, 2.6–2.9 mm ♀. Queensland ..... *X. major*, sp. nov. 4
- Basal tumescence of male abdominal venter forming a steep angle, but no spine, before depressed sterna 6–7 (Fig. 41). Female abdomen relatively short, without distinct hair tufts (Fig. 43). Length 2.2–2.4 mm ♂, 2.4–2.6 mm ♀. Northern Territory ..... *X. angulanus* (Polhemus) 5
4. Abdominal end of female with distinctly protruding, button-like proctiger (Figs 47–48). Male abdominal venter with narrow basal tumescence ..... 5
- Abdominal end of female not modified as above, proctiger cone-shaped and more or less deflected. Male abdominal venter without basal tumescence ..... 6

5. Basal tumescence of male abdominal venter forming a more or less distinct tubercle (Fig. 45). Paramere in dorso-lateral view (Fig. 46), distinctly flattened with apical part obliquely cut off, pointed. Length 1.6–1.8 mm ♂, 1.9–2.0 mm ♀. Queensland ..... *X. spinoides*, sp. nov.
- Basal tumescence of male abdominal venter forming an almost vertical edge (Fig. 49). Paramere in dorso-lateral view (Fig. 50) with distal part tapering, pointed. Length 1.7–1.8 mm ♂, 1.9–2.1 mm ♀. Papua New Guinea ..... *X. caudatus*, sp. nov.
6. Female abdomen broad, trough-shaped (Fig. 6), proctiger widened and strongly deflected (Figs 13–14, pr). Male abdominal venter distinctly depressed on sterna 6–7 (Fig. 8). Length 1.6–1.7 mm ♂, 1.7–1.8 mm ♀. Queensland ..... *X. mangrove*, sp. nov.
- Female abdomen not trough-shaped, proctiger cone-shaped and only slightly deflected (Figs 20–21, pr). Male abdominal venter simple ..... 7
7. Large species, length more than 1.6 mm ♂ or 1.7 mm ♀ ..... 8
- Small species, length 1.3–1.6 mm ♂, 1.5–1.7 mm ♀ ..... 9
8. Female hind femora slender, not as thick as middle femora (Fig. 19). Paramere as in Fig. 22. Length 1.6–1.8 mm ♂, 1.7–1.9 mm ♀. Queensland ..... *X. myorensis* (Lansbury)
- Female hind femora distinctly thickened, as thick as middle femora. Paramere as in Fig. 29. Length 1.6 mm ♂, 1.7–1.8 mm ♀. Northern Territory ..... *X. lansburyi*, sp. nov.
9. Chiefly dark brownish or black above, antenna, legs, and connexiva dark. Paramere as in Fig. 27. Length 1.4–1.6 mm ♂, 1.5–1.7 mm ♀. Queensland ..... *X. ovatus*, sp. nov.
- Chiefly brownish above, antenna, legs, and connexiva yellowish (Fig. 30). Paramere as in Fig. 31. Length 1.3–1.4 mm ♂, 1.5–1.6 mm ♀. Northern Territory ..... *X. chinai*, sp. nov.

*Xenobates mangrove*, sp. nov.

(Figs 1–18)

*Material examined*

*Holotype*. ♂, 'AUSTRALIA: Queensland, Townsville, 3-mile Creek, at light, 20.VII.1976, Lanna Cheng' (ANIC).

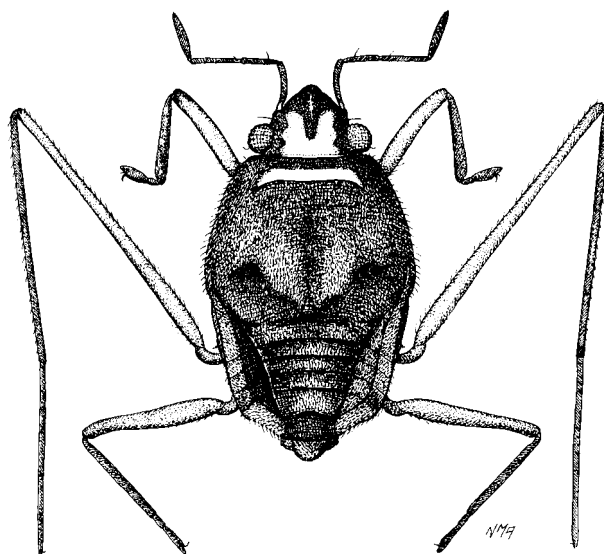
*Paratypes*. **Queensland**: 31 ♂, 44 ♀, same label data as holotype (ANIC, JTPC, ZMUC); 23 ♂, 32 ♀, Horn Island, intertidal creek, CL1767, 30.viii.1983, J.T. & D.A. Polhemus (JTPC); 1 ♀, mouth of Jardine River, CL1768, 30.viii.1983, J.T. & D.A. Polhemus (JTPC); 1 ♀, MacMillan R., mouth of river, water sweep amongst mangroves, 22.v.1994, P. Zborowski (ANIC); 2 ♂, 20 ♀, Annan River estuary, 10 km W of Cooktown, CL1738, 20.viii.1983, J.T. & D.A. Polhemus (JTPC); 6 ♂, 14 ♀, 4 nymphs, Cooper Creek, 18 mls [= 28 km] N of Daintree River, 21–22.vi.1969, G.B. Monteith (ANIC); 11 ♂, 21 ♀, Coopers Creek estuary near Cape Tribulation, CL1734, 17.viii.1983, J.T. & D.A. Polhemus (JTPC); 2 ♀, Daintree Ferry, N. of Mossman, CL1731, 17.viii.1983, J.T. & D.A. Polhemus (JTPC); 41 ♀, Daintree River, 13.xi.1969, T. Weir (ANIC); 13 ♂, 7 ♀, Deeral Landing, Lower Mulgrave River, CL1724, 15.viii.1983, J.T. & D.A. Polhemus (JTPC); 32 ♂, 33 ♀, Saunders Beach near Townsville, mangrove stream, 23.vii.1976, L. Cheng (JTPC, ZMUC); 8 ♂, 18 ♀, Townsville estuary, CL1713, 12.viii.1983, J.T. & D.A. Polhemus (JTPC).

*Description*

*Size*. ♂, length 1.60–1.65, width 0.84–0.86; ♀, length 1.68–1.80, body width 0.90–0.96.

*Colour*. Chiefly dark brown or black above (Fig. 1). A large V-shaped spot on head and posterior half of pronotum in middle, yellowish brown. Thoracic and abdominal dorsum with fine, silvery pubescence which do not form definite spots. Antennae and legs light brown above; basal part of antennal segment 1, most of fore femur, all coxae and trochanters, and femora beneath, yellowish. Ventral surface chiefly dark brown; head and acetabula, abdominal venter in middle and genital segments of male usually light brownish, posterior abdominal venter and genital segments of female usually yellowish.

*Male structure*. Body fusiform (Fig. 2), length 1.9× greatest width across thorax (1.60: 0.85). *Head*. Length 0.6× width across eyes (0.34: 0.53); eye width 0.3× width of head between eyes (0.10: 0.33). Antennae about 0.55× total length of insect (0.90: 1.60); relative lengths of antennal segments 1–4: 0.25: 0.18: 0.23: 0.25; segment 2 shorter than segment 3; segment 4 as thick as segment 1 (0.04); antennal segments with short pilosity and a few longer hairs. *Legs*. Relative lengths of leg segments (femur: tibia: tarsus): fore leg: 0.53: 0.43: 0.19; middle leg:



**Fig. 1.** *Xenobates mangrove*, habitus of apterous ♀ paratype (length 1.75 mm) from Townsville, Queensland.

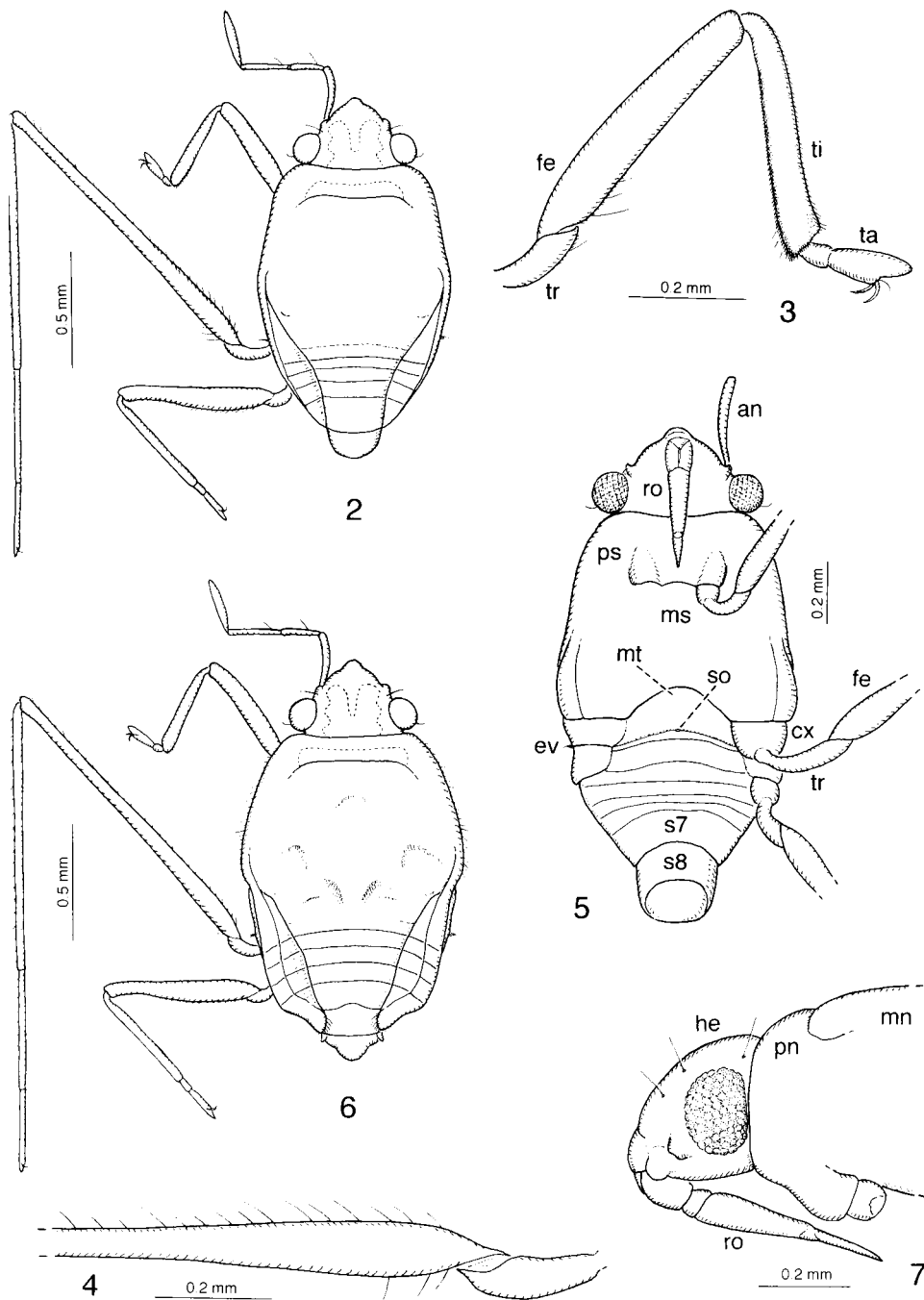
1.39: 1.14: 0.80; and hind leg: 0.71: 0.51: 0.21; fore femur width 0.08; fore tibia with a row of short spinous hairs on inner margin before apex (Fig. 3); middle femur almost 0.9x total length of insect, proximally thickened and with a row of long, bristle-like hairs along anterior margin (Fig. 4), each hair being slightly shorter than greatest width of femur (0.09); a similar row of shorter hairs on middle tibia and tarsus; relative lengths of middle tarsal segments 1–2: 0.50: 0.33; hind femur (0.10) slightly thicker than middle femur. *Abdomen.* Broad at base, tapering posteriorly; abdominal sterna 6–7 distinctly depressed on each side (Fig. 8), forming a more or less distinct median tumescence. Genital segments large (Fig. 9), segment 8 produced on dorsal hind margin; parameres falciform and relatively long, crossing each other dorsal to genital segments; blade of each paramere (Fig. 10) slightly curved in lateral view, distal part curved mesad; apex faintly hook-shaped, pointed. Vesical armature as illustrated (Figs 11–12).

*Female structure.* Body broadly oval (Fig. 6), length about 1.8x greatest width across thorax (1.75: 0.95). *Head.* As in male; antennae about 0.5x total length of insect (0.90: 1.75), with the same kind of pilosity as in male; length of antennal segments (1–4): 0.26: 0.18: 0.21: 0.25. *Thorax.* Convex above; posterior mesonotum and metanotum strongly depressed except in middle, with short pubescence. *Legs.* Relative lengths of segments (femur: tibia: tarsus): fore leg: 0.56: 0.43: 0.20; middle leg: 1.49: 1.19: 0.88; hind leg: 0.70: 0.52: 0.24; middle femur 0.85x total length; hind femur more slender than in male. *Abdomen.* Very broad, only slightly tapering in width to shortly before apex; abdominal tergum distinctly depressed, almost trough-shaped; connexiva broad, almost vertically raised; each with a well marked edge which is abruptly turned mesad and distinctly raised at the level of tergum 7; abdominal end furnished with long hairs; sternum 7 distinctly produced in middle. Tergum 8 relatively long; proctiger very broad and strongly deflected (Fig. 13), almost completely covering gonocoxae (Fig. 14).

*Variation.* Measurements, see Table 1. The colouration seems to vary between localities. Specimens from Horn Island have darker legs than those from the more southern localities, and the female abdominal venter and genital segments are dark brownish instead of yellowish.

#### *Distribution and habitat*

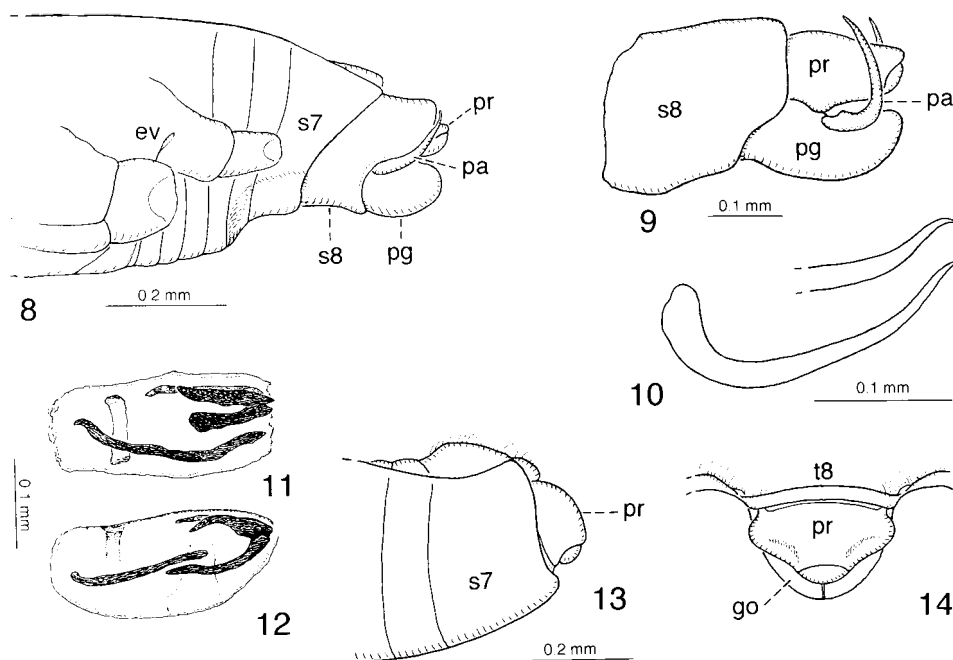
Distributed along the coast of Queensland, from Townsville in the south to Horn Island in the north (see map, Fig. 18). Adults collected in May–August and November, nymphs in June. Inhabits mangroves and mangrove streams.



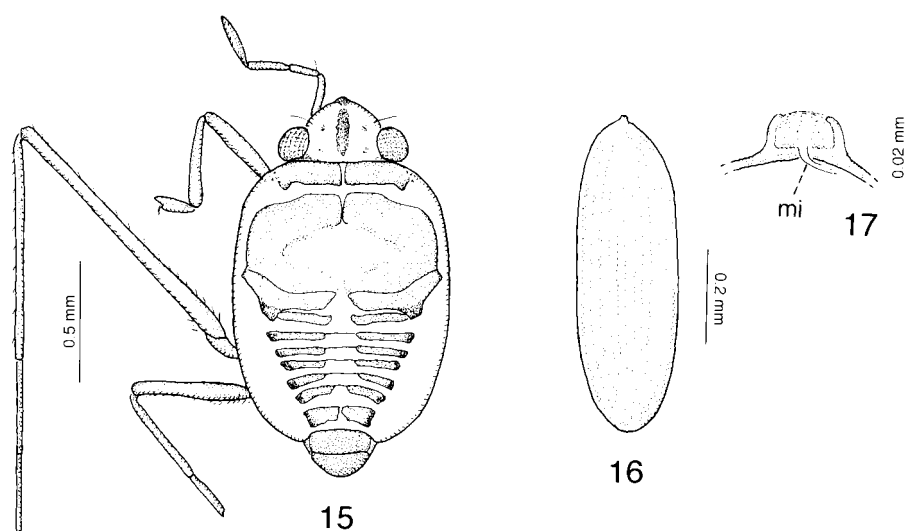
**Figs 2–5.** *Xenobates mangrove*, structure of apterous ♂: 2, dorsal structure; appendages of right side omitted; 3, left fore leg; 4, base of left middle femur; 5, ventral structure; appendages of right side omitted. an, antenna; cx, coxa; ev, evaporative groove; fe, femur; ms, mesosternum; mt, metasternum; ps, prosternum; ro, rostrum; s7, s8, sternum 7 and 8; so, scent orifice; ta, tarsus; ti, tibia. **Figs 6–7.** *Xenobates mangrove*, structure of apterous ♀: 6, dorsal structure; appendages of right side omitted; 7, lateral view of head; antenna removed. he, head; mn, mesonotum; pn, pronotum; ro, rostrum.

### Comments

The specific name is a noun in apposition, indicating the preferred type of habitat of the species. *X. mangrove*, sp. nov. is recognised by the dark colouration of both sexes, the male



**Figs 8–12.** *Xenobates mangrove*, structure of apterous ♂: 8, lateral view of abdominal end; 9, lateral view of genital segments; 10, left paramere; different aspect of blade above; 11, dorsal view of vesica; 12, lateral view of vesica. ev, evaporative groove; pa, paramere; pg, pygophore (segment 9); pr, proctiger; s7, s8, sternum 7 and 8. **Figs 13–14.** *Xenobates mangrove*, abdominal end of apterous ♀: 13, lateral view; 14, caudal view. go, gonocoxa; pr, proctiger; s7, sternum 7; t8, tergum 8.



**Fig. 15.** *Xenobates mangrove*, fifth instar nymph ♀; appendages of right side omitted. **Figs 16–17.** *Xenobates mangrove*, egg structure: 16, ripe ovarian egg; 17, anterior end of egg. mi, micropyle.



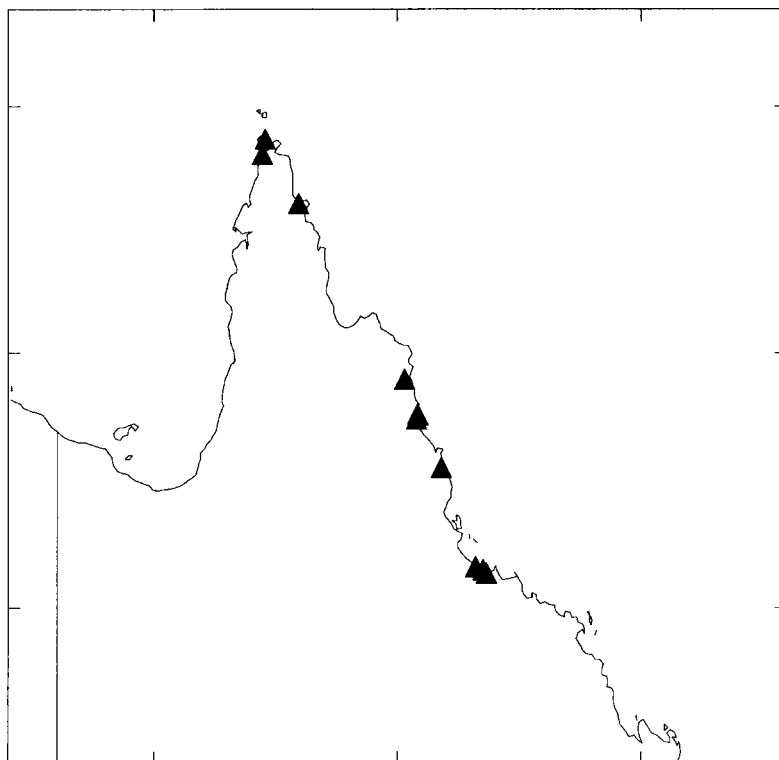


Fig. 18. Distribution of *Xenobates mangrove* ▲.

abdominal venter being distinctly depressed on sterna 6–7, the very broad, trough-shaped female abdomen, and the greatly widened and strongly deflected proctiger of female.

***Xenobates myorensis* (Lansbury)**

(Figs 19–23)

*Halovelia myorensis* Lansbury, 1989: 97–100.

*Xenobates myorensis* (Lansbury). – Cassis & Gross, 1995: 444.

*Material examined*

*Holotype*. ♂, 'Queensland, Stradbroke I., Myora Swamp, 8–9.vi.1979, I. Lansbury' (UMO).

*Paratypes*. **Queensland**: 4♂, 10♀ (incl. allotype), same label data as holotype (MTKD, UMO).

*Other material examined*. **Queensland**: 16♂, 14♀, mouth of Jardine River, CL1768, 30.viii.1983, J.T. & D.A. Polhemus (JTPC); 1♂, 3♀, Deeral Landing, Lower Mulgrave River, CL1724, 15.viii.1983, J.T. & D.A. Polhemus (JTPC); 2♂, 15♀, 20 miles [= 32 km] S of Cardwell, mangrove swamps, 8.xi.1969, T. Weir (ANIC); 6♂, 7♀, Townsville [as Townesville], estuary, CL1713, 12.viii.1983, J.T. & D.A. Polhemus (JTPC); 5♂, 4♀, Townsville, 3-mile Creek, Nite lite, 16.vii.1976, L. Cheng (JTPC); 3♀, Townsville, 3-mile Creek, at light, 20.vii.1976, L. Cheng (ZMUC); numerous adults and nymphs, Fraser Island, Wanggoolba Creek mouth, amongst mangroves, 25.xi.1993, G. Cassis & P. Stys (AMS); 26♂, 25♀, Gladstone, Auckland Creek, mangrove stream, 13 & 18.v.1976, Lanna Cheng (JTPC); 16♂, 36♀, Myora, North Stradbroke Islands, ex mangroves, 28.ii.1969, T. Weir (UQIC).

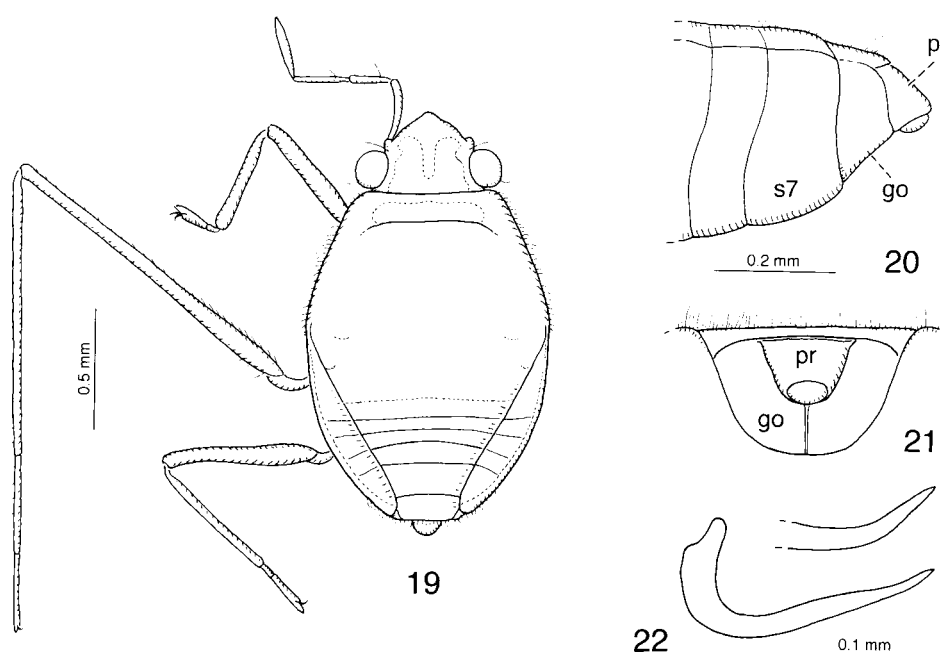
*Description*

*Size*. ♂, length 1.61–1.80, width 0.79–0.90; ♀, length 1.75–1.92, width 0.94–1.01.

**Colour.** Chiefly dark brown or black above. A large U-shaped spot on head and posterior half or two thirds of pronotum in middle, yellowish brown. Thoracic and abdominal dorsum with fine, silvery pubescence which is more dense behind eyes on basal abdominal terga. Antennae and legs brownish above; basal part of antennal segment 1, most of fore femur, all coxae and trochanters, and femora beneath, yellowish. Ventral surface chiefly dark brown or black; head and acetabula yellowish; genital segments of both male and female usually light brown.

**Male structure.** Body fusiform, length about  $2.0\times$  greatest width across thorax (1.62: 0.80). **Head.** Length about  $0.6\times$  width across eyes (0.33: 0.52); eye width  $0.3\times$  width of head between eyes (0.10: 0.31). Antennae about  $0.55\times$  total length of insect (0.88: 1.61); relative lengths of antennal segments (1–4): 0.25: 0.16: 0.21: 0.25; segment 1 shorter than head length; segment 2 shorter than segment 3; segment 4 slightly thicker than segment 1 (0.05: 0.04); antennal segments with short pilosity and a few longer hairs. **Legs.** Relative lengths of segments (femur: tibia: tarsus): fore leg: 0.50: 0.41: 0.20; middle leg: 1.23: 1.01: 0.66; and hind leg: 0.63: 0.50: 0.21; fore femur width 0.09; fore tibia with a short row of short spinous hairs on inner margin before apex; middle femur about  $0.75\times$  total length of insect, proximally thickened and with a row of long, bristle-like hairs along anterior margin, each hair being slightly shorter than greatest width of femur; a similar row of shorter hairs on middle tibia and tarsus; relative lengths of middle tarsal segments (1–2): 0.36: 0.30; hind femur as thick as middle femur (0.09). **Abdomen.** Broad at base, tapering posteriorly; abdominal venter not modified except that sternum 7 is slightly depressed. Genital segments relatively large, segment 8 produced on dorsal hind margin; parameres falciform, crossing each other dorsal to genital segments; blade of each paramere (Fig. 22) almost straight in lateral view, distal part curved mesad, apex pointed; vesical sclerites as in *X. mangrove*, but less sclerotised.

**Female structure.** Body oval (Fig. 19), length about  $1.9\times$  greatest width across thorax (1.80: 0.94). **Head.** As in male; antennae about  $0.45\times$  total length of insect (0.84: 1.80), with the same kind of pilosity as in male; length of antennal segments (1–4): 0.24: 0.15: 0.20: 0.25. **Thorax.** Only slightly convex above, not depressed, and with short pubescence. **Legs.** Relative



**Figs 19–22.** *Xenobates myorensis*: 19, dorsal structure of apterous ♀; appendages of right side omitted; 20, lateral view of ♀ abdominal end; 21, caudal view of ♀ abdominal end; 22, left paramere; different aspect of blade above. go, gonocoxa; pr, proctiger; s7, sternum 7.

lengths of segments (femur: tibia: tarsus): fore leg: 0.54: 0.41: 0.23; middle leg: 1.26: 1.01: 0.69; hind leg: 0.60: 0.53: 0.24; middle femur  $0.7 \times$  total length; hind femur more slender than in male. *Abdomen*. Broad at base, tapering in width towards apex; abdominal tergum depressed beyond tergum 4; connexiva broad, obliquely raised; abdominal end furnished with long hairs; sternum 7 not produced in middle. Tergum 8 relatively long; proctiger not widened, slightly deflected (Fig. 20), gonocoxae exposed (Fig. 21).

*Variation*. Measurements, see Table 1. Specimens from the mouth of Jardine River and Stradbroke Islands are slightly larger ( $\delta$ , length 1.68–1.80;  $\varphi$ , length 1.78–1.92) and more robust than specimens from Gladstone and Townsville ( $\delta$ , length 1.61–1.68;  $\varphi$ , length 1.75–1.80).

#### *Distribution and habitat*

Distributed along the coast of Queensland, from Stradbroke Islands near Brisbane in the South to Jardine River in the North (see map, Fig. 23). Adults collected in February, May, June–August, and November, nymphs in May and November. Lansbury (1989: 99) characterises the habitat of *X. myorensis* as follows: ‘Collected from mangrove swamp, water shallow about 1–2 cms deep. The bugs occurring singly amongst mangrove shoots, their cryptic coloration making them difficult to see on the greyish-black ooze of the swamp’.

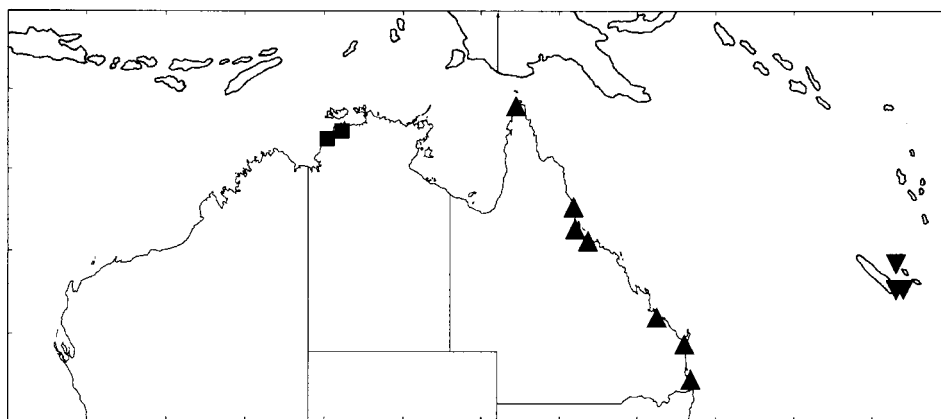


Fig. 23. Distribution of *Xenobates myorensis* ▲, *X. lansburyi* ■, and *X. loyaltiensi* ▼.

#### *Comments*

*Xenobates myorensis* was described by Lansbury (1989) from Myora, Stradbroke Islands, near Brisbane. The original description is excellent and well illustrated and constitutes together with our examination of the types (in UMO) the basis for recognising this species. It is easily separated from *X. mangrove*, sp. nov. by the unmodified male abdominal venter, the different shape of the male parameres, the unmodified female thoracic and abdominal dorsum, and the narrow and only slightly deflected proctiger of female.

#### *Xenobates ovatus*, sp. nov.

(Figs 24–27, 32)

#### *Material examined*

*Holotype*.  $\delta$ , ‘Queensland, Bizant R., Lakefield National Park, amongst mangroves in tidal river, 14.39S 144.07E, 29.x.1992, T. Weir, P. Zborowski’ (ANIC).

*Paratypes*. **Queensland**: 8 $\delta$ , 10 $\varphi$ , 2 nymphs, same label data as holotype (ANIC, ZMUC); 13 $\delta$ , 16 $\varphi$ , mouth of Jardine River, CL1768, 30.viii.1983, J.T. & D.A. Polhemus (JTPC, ZMUC).

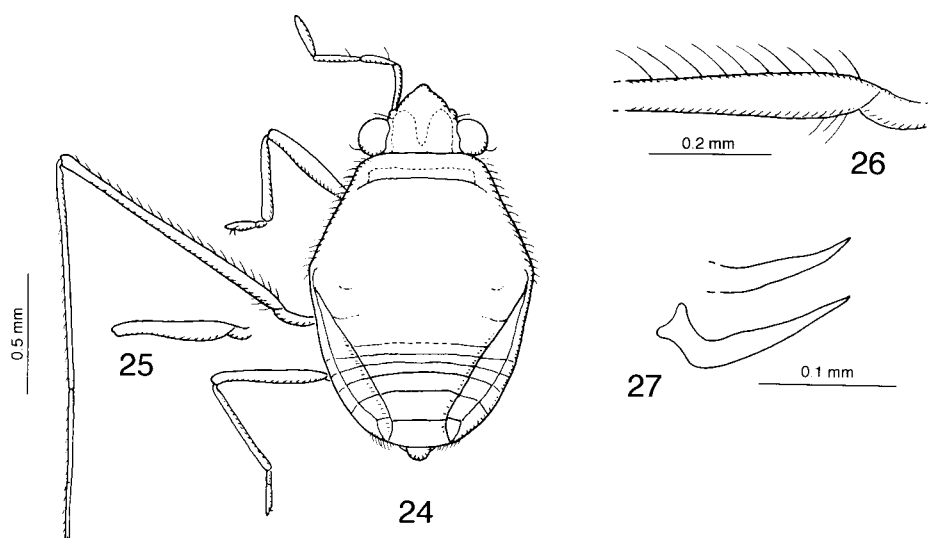
### Description

*Size.* ♂, length 1.40–1.56, width 0.70–0.83; ♀, length 1.53–1.68, width 0.88–0.94.

*Colour.* Chiefly dark brown or black above. A large U-shaped spot on head and posterior half or one third of pronotum in middle, brownish yellow. Thoracic and abdominal dorsum with fine, silvery pubescence which is slightly more dense on abdominal terga. Antennae and legs pale brownish; basal part of antennal segment 1, most of fore femur, all coxae and trochanters, and middle and hind femora beneath, yellowish. Ventral surface chiefly brownish; head, prosternum, and acetabula yellowish; genital segments of both male and female usually light brown.

*Male structure.* Body fusiform, length  $1.9\times$  greatest width across thorax (1.57: 0.83). *Head.* Length about  $0.6\times$  width across eyes (0.31: 0.53); eye width about  $0.5\times$  width of head between eyes (0.13: 0.28). Antennae about  $0.6\times$  total length of insect (0.90: 1.57); relative lengths of antennal segments (1–4): 0.28: 0.15: 0.23: 0.25; segment 2 shorter than segment 3; segment 4 as thick as segment 1 (0.05); antennal segments with short pilosity and a few longer hairs. *Legs.* Relative lengths of segments (femur: tibia: tarsus): fore leg: 0.50: 0.45: 0.20; middle leg: 1.28: 1.05: 0.68; and hind leg: 0.65: 0.55: 0.20; fore femur width 0.09; fore tibia with a row of short spinous hairs on inner margin before apex; middle femur about  $0.8\times$  total length of insect, proximally thickened and with a row of bristle-like, brown hairs along anterior margin (Fig. 26), each hair being slightly longer than greatest width of femur (0.10); a similar row of much shorter hairs on middle tibia and tarsus; relative lengths of middle tarsal segments 1–2: 0.38: 0.30; hind femur proximally thickened (Fig. 25), as thick as middle femur (0.10). *Abdomen.* Broad at base, tapering posteriorly; abdominal venter not modified except that sternum 7 is slightly depressed. Genital segments relatively small, segment 8 produced on dorsal hind margin; parameres falciform and relatively short; blade of each paramere (Fig. 27) stout and almost straight in lateral view, distal part curved mesad, apex pointed.

*Female structure.* Body oval (Fig. 24), length about  $1.75\times$  greatest width across thorax (1.65: 0.94). *Head.* As in male; antennae about  $0.5\times$  total length of insect (0.89: 1.65), with the same kind of pilosity as in male; length of antennal segments (1–4): 0.25: 0.16: 0.23: 0.25. *Thorax.* Slightly convex above, with relatively short pilosity. *Legs.* Relative lengths of segments (femur: tibia: tarsus): fore leg: 0.50: 0.43: 0.20; middle leg: 1.25: 1.01: 0.68; hind leg: 0.65: 0.53: 0.24; middle femur  $0.75\times$  total length; hind femur more slender than in male. *Abdomen.* Broad and relatively short, sides broadly rounded; abdominal tergum depressed beyond tergum



**Figs 24–27.** *Xenobates ovatus*: 24, dorsal structure of apterous ♀; appendages of right side omitted; 25, left hind femur of ♂; 26, base of left middle femur of ♂; 27, left paramere; different aspect of blade above.

4; connexiva broad, obliquely raised; abdominal end furnished with long hairs; sternum 7 not produced in middle. Tergum 8 relatively long; proctiger not widened, slightly deflected, gonocoxae partly exposed.

*Variation.* Measurements, see Table 1.

#### *Distribution and habitat*

Only known from a few localities in northern Queensland (see map, Fig. 32) where the species was collected amongst mangroves in tidal rivers.

#### *Comments*

*Xenobates ovatus*, sp. nov. is one of the smallest of the Australian *Xenobates* species. Named for the shape of the female (*ovatus*, egg-shaped) which, apart from its size, also separates the species from its closest relatives, *X. myorensis* and the following two new species (see below).

#### *Xenobates lansburyi*, sp. nov.

(Figs 23, 28–29)

#### *Material examined*

*Holotype.* ♂, 'N.T., Darwin Harbour, 12°19.6S 131°17.6E, P. Alderslade, 13.x.1987' (NTMD).

*Paratypes.* **Northern Territory:** 6♂, 5♀, same label data as holotype, *Xenobates seminulum* (Esaki), det. M.B. Malipatil, 1987 (NTMD); 19♂, 37♀, 3 mls [= 4.8 km] N mouth of Finnis River, 27.vii.1971, T. Weir & A. Allwood (ANIC, ZMUC).

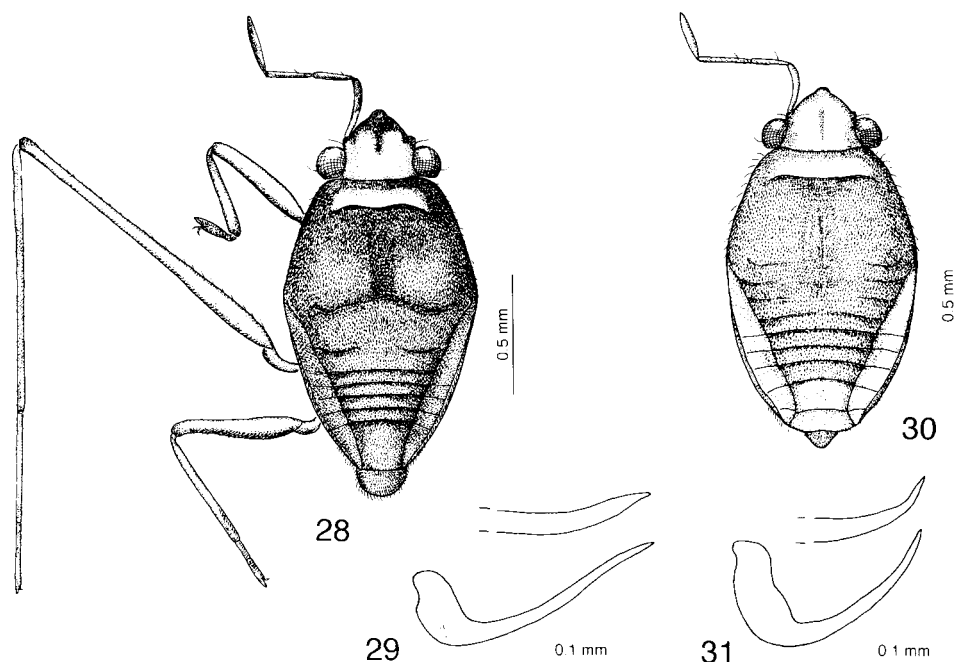
#### *Description*

*Size.* ♂, length 1.55–1.63, width 0.75–0.80; ♀, length 1.73–1.83, width 0.93–1.00.

*Colour.* Chiefly dark brown or black above (Fig. 28). A large U-shaped spot on head and posterior two thirds of pronotum in middle, brownish yellow. Thoracic and abdominal dorsum with fine, silvery pubescence which is more dense on abdominal terga. Antennae and legs brownish yellow; basal part of antennal segment 1 and all coxae and trochanters, yellowish; femora darker beneath. Ventral surface chiefly dark brownish; head, prosternum, and acetabula yellowish; genital segments of both male and female usually light brown.

*Male structure.* Body fusiform (Fig. 28), length 2.0× greatest width across thorax (1.60: 0.80). *Head.* Length about 0.7× width across eyes (0.35: 0.51); eye width about 0.4× width of head between eyes (0.11: 0.29). Antennae about 0.5× total length of insect (0.80: 1.60); relative lengths of antennal segments 1–4: 0.23: 0.15: 0.20: 0.23; segment 2 shorter than segment 3; segment 4 as thick as segment 1 (0.04); antennal segments with short pilosity and a few longer hairs. *Legs.* Relative lengths of segments (femur: tibia: tarsus): fore leg: 0.55: 0.43: 0.18; middle leg: 1.40: 1.10: 0.81; and hind leg: 0.70: 0.53: 0.24; fore femur width 0.09; fore tibia with a row of short spinous hairs on inner margin before apex; middle femur about 0.9× total length of insect, proximally thickened and with a row of bristle-like, pale hairs along anterior margin, each hair being slightly shorter than greatest width of femur (0.11); a similar row of much shorter hairs on middle tibia and tarsus; relative lengths of middle tarsal segments 1–2: 0.48: 0.34; hind femur thickened, as thick as middle femur (0.10), distinctly narrower towards apex. *Abdomen.* Broad at base, tapering posteriorly; abdominal venter not modified. Genital segments relatively small, segment 8 produced on dorsal hind margin; parameres falciform and long, crossing each other above genital segments; blade of each paramere (Fig. 29) slender and almost straight in lateral view, flattened in dorsal view, distal part curved mesad, apex pointed.

*Female structure.* Body oval, length about 1.8× greatest width across thorax (1.83: 1.00). *Head.* As in male; antennae slightly less than 0.5× total length of insect (0.86: 1.83), with the same kind of pilosity as in male; length of antennal segments 1–4: 0.24: 0.16: 0.21: 0.25. *Thorax.* Slightly convex above, with short pilosity which is longer on posterior mesonotum. *Legs.* Relative lengths of segments (femur: tibia: tarsus): fore leg: 0.58: 0.45: 0.21; middle leg: 1.48: 1.25: 0.96; hind leg: 0.70: 0.58: 0.25; middle femur 0.8× total length; shape of hind femur as in male. *Abdomen.* Broad and relatively short, sides broadly rounded; abdominal tergum



**Figs 28–29.** *Xenobates lansburyi*: 28, dorsal view of apterous ♂; appendages of right side omitted; 29, left paramere; different aspect of blade above. **Figs 30–31.** *Xenobates chinai*: 30, dorsal view of apterous ♀; legs omitted; 31, left paramere; different aspect of blade above.

depressed beyond tergum 4; connexiva broad, obliquely raised; abdominal end furnished with long hairs; sternum 7 not produced in middle. Tergum 8 relatively long; proctiger not widened, slightly deflected, gonocoxae partly exposed.

*Variation.* Measurements, see Table 1. The relative length of the middle femur is slightly less in specimens from mouth of Finnis River than from Darwin Harbour.

#### *Distribution*

Only known from a few localities in the Northern Territory (see map, Fig. 23).

#### *Comments*

Named for Mr. Ivor Lansbury, Oxford, in recognition of his life-long contribution to the knowledge of the aquatic and semiaquatic Hemiptera of Australia. *X. lansburyi*, sp. nov. is slightly larger than *Xenobates ovatus*, sp. nov., but otherwise very similar to this species. The different shape of the parameres and the distinctly incrassate hind femora of the female separates the two species. Specimens belonging to the type series were identified by M.B. Malipatil as *X. seminulum* (Esaki), the type species of the genus. This species, however, is confined to northern Papua New Guinea and recognised by the small size of both sexes (length 1.2–1.4 mm), the conspicuous hair fringe along the anterior margin of the middle femora, and the broadly ovate female body with convex abdominal dorsum.

#### *Xenobates chinai*, sp. nov.

(Figs 30–32)

#### *Material examined*

*Holotype.* ♂, 'AUSTRALIA, N.T., 3 ml. N mouth of Finnis R., 27.vii.1971, T. Weir & A. Allwood' (ANIC).

*Paratypes.* **Northern Territory:** 48♂, 39♀, same label data as holotype (ANIC, ZMUC).

#### *Description*

*Size.* ♂, length 1.28–1.35, width 0.64–0.68; ♀, length 1.51–1.63, width 0.78–0.83.

*Colour.* Chiefly brownish above (Fig. 30). Head and pronotum chiefly yellowish with median line of head and anterior margin of pronotum brownish. Thoracic and abdominal dorsum with fine, silvery pubescence which is more dense on abdominal terga. Connexiva yellowish brown. Antennae and legs chiefly yellowish. Ventral surface brownish; head, prosternum, and acetabula yellowish; genital segments of both male and female usually light brown.

*Male structure.* Body fusiform, length 2.0× greatest width across thorax (1.30: 0.65). *Head.* Length 0.65× width across eyes (0.30: 0.46); eye width 0.45× width of head between eyes (0.11: 0.24). Antennae about 0.6× total length of insect (0.81: 1.30); relative lengths of antennal segments 1–4: 0.20: 0.15: 0.23: 0.24; segment 2 distinctly shorter than segment 3; segment 4 as thick as segment 1 (0.04); antennal segments with short pilosity and a few longer hairs. *Legs.* Relative lengths of segments (femur: tibia: tarsus): fore leg: 0.40: 0.35: 0.15; middle leg: 0.89: 0.73: 0.48; and hind leg: 0.50: 0.43: 0.19; fore femur width 0.08; fore tibia with short spinous hairs on inner margin before apex; middle femur about 0.7× total length of insect, proximally thickened and with a row pale, bristle-like, pale hairs along anterior margin, each hair being distinctly shorter than greatest width of femur (0.06); a similar row of much shorter hairs on middle tibia and tarsus; relative lengths of middle tarsal segments 1–2: 0.25: 0.23; hind femur thickened, as thick as middle femur (0.09), distinctly narrower towards apex. *Abdomen.* Broad at base, tapering posteriorly; abdominal venter not modified. Genital segments relatively small; parameres falciform and long, meeting each other above genital segments; blade of each paramere (Fig. 31) slender and almost straight in lateral view, distal part curved mesad, apex pointed.

*Female structure.* Body oval (Fig. 30), length about 1.8× greatest width across thorax (1.53: 0.80). *Head.* As in male; antennae about 0.5× total length of insect (0.79: 1.53), with the same kind of pilosity as in male; length of antennal segments 1–4: 0.20: 0.15: 0.21: 0.23. *Thorax.* Slightly convex above, with short pilosity which is longer on posterior mesonotum. Meso- and metanotum with an elongate oval, shiny area in middle (most distinct in alcohol-preserved specimens). *Legs.* Relative lengths of segments (femur: tibia: tarsus): fore leg: 0.40: 0.35: 0.15; middle leg: 0.93: 0.79: 0.46; hind leg: 0.51: 0.46: 0.16; middle femur 0.6× total length; hind femur distinctly more slender than in male. *Abdomen.* Broad and relatively short, sides broadly rounded; abdominal tergum depressed beyond tergum 4; connexiva broad, obliquely raised; abdominal end furnished with long hairs; sternum 7 not produced in middle. Tergum 8 relatively long; proctiger not widened, slightly deflected, gonocoxae partly exposed.

*Variation.* Measurements, see Table 1.

#### *Distribution and habitat*

Only known from the type series from mouth of Finnis River, N.T. (see map, Fig. 32).

#### *Comments*

Named for the late Dr W. E. China, former curator of Hemiptera, BMNH, in recognition of his important contribution to the knowledge of the marine water striders of Australia. *X. chinai*, sp. nov. is an even smaller species than *X. ovatus*, sp. nov. (especially males), but otherwise very similar to this species. The colouration and shape of the parameres separate the two species. In mixed samples of *X. chinai* and *X. lansburyi*, females can be recognised by the shiny, oval area of the meso-metanotum and slender hind femora in the first species.

#### *Xenobates major*, sp. nov.

(Figs 33–39)

#### *Material examined*

*Holotype.* ♂, '10.45S 132.35E, Qld., Somerset, 15 Oct. 1992, T. Weir, P. Zborowski, amongst mangroves on beach' (ANIC).

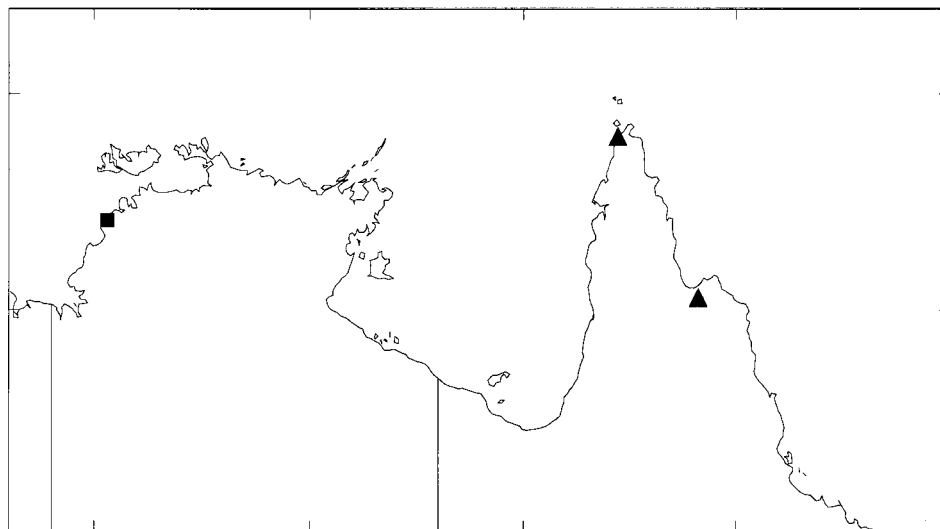


Fig. 32. Distribution of *Xenobates ovatus* ▲ and *X. chinai* ■.

*Paratypes.* **Queensland:** 16♂, 26♀, many nymphs, same label data as holotype (ANIC, ZMUC); 16♀, 79♂, Somerset Bay, mangroves, CL 1763, 28.viii.1983, J.T. & D.A. Polhemus (JTPC, ZMUC); 2♂, 3♀, Portland Roads, CL1751, 24.viii.1983, J.T. & D.A. Polhemus (JTPC).

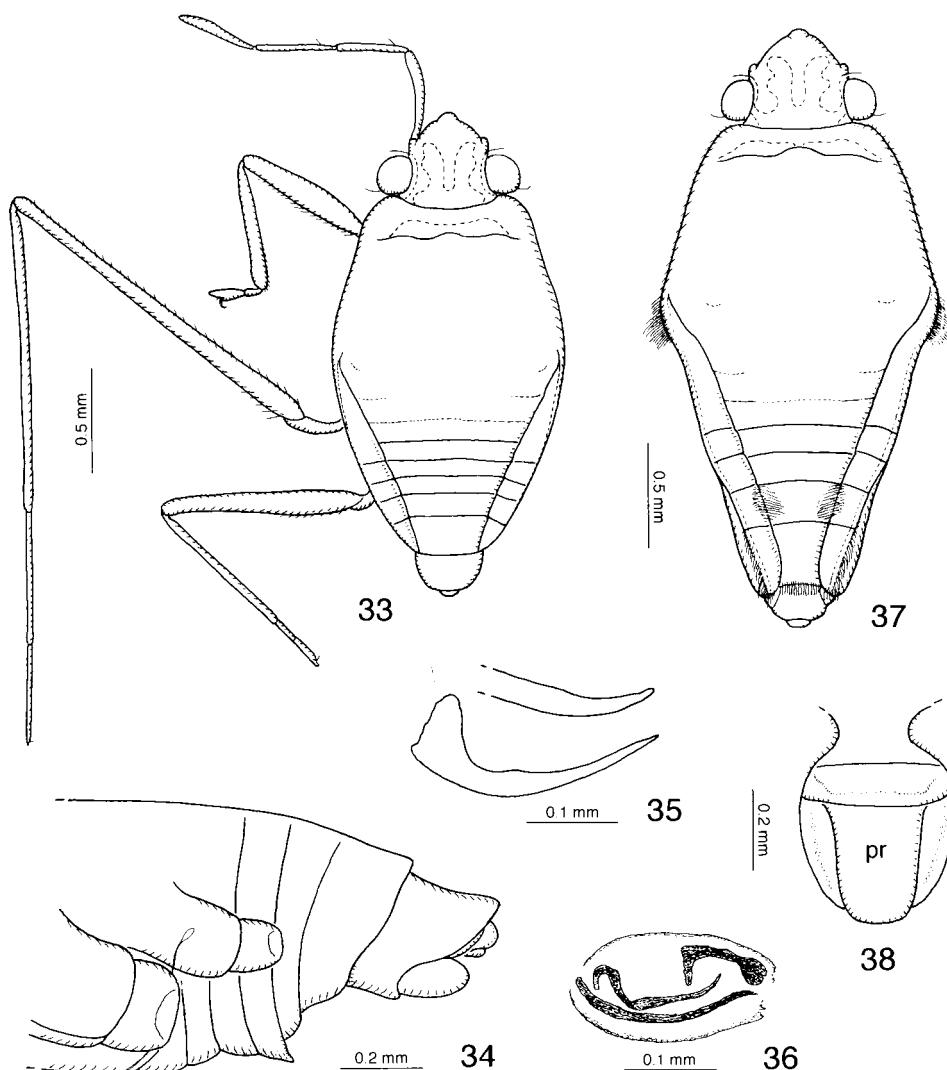
#### Description

*Size.* ♂, length 2.10–2.33, width 0.98–1.15; ♀, length 2.63–2.93, width 1.23–1.33.

*Colour.* Chiefly blackish above. A large U-shaped, spot on head and two transverse stripes along posterior margin of pronotum, brownish yellow; pronotal markings usually distinctly separated in middle. Thoracic and abdominal dorsum with fine, greyish or silverish pubescence which form definite spots on pronotum, lateral parts of basal abdominal terga, and on posterior abdominal dorsum. Antennae and legs chiefly blackish; extreme base of antennal segment 1 and all coxae and trochanters, yellowish; femora with dorsal, longitudinal yellowish brown stripe. Ventral surface blackish or dark brown; head, prosternum, and acetabula yellowish; most of abdominal venter of ♂, sternum 7 of ♀, and genital segments of both sexes usually brownish.

*Male structure.* Body fusiform (Fig. 33), length  $2.0\times$  greatest width across thorax (2.30: 1.15). Body and legs covered by short, dense pilosity. *Head.* Length about  $0.75\times$  width across eyes (0.50: 0.68); eye width about  $0.4\times$  width of head between eyes (0.15: 0.38). Antennae about  $0.7\times$  total length of insect (1.63: 2.30); relative lengths of antennal segments 1–4: 0.48: 0.35: 0.40: 0.40; segment 2 slightly shorter than segment 3; segment 4 slightly thicker than segment 1 (0.07: 0.06); antennal segments with dense, short pilosity. *Legs.* Relative lengths of segments (femur: tibia: tarsus): fore leg: 0.75: 0.68: 0.28; middle leg: 1.88: 1.53: 1.18; and hind leg: 1.00: 0.78: 0.38; fore femur slightly thickened (0.13); fore tibia with rows of short, spinous hairs on inner margin before apex; middle femur about  $0.8\times$  total length of insect, proximally thickened (0.15), with a row of very short hairs along anterior margin (obscured by the overall dense pilosity of the legs); relative lengths of middle tarsal segments 1–2: 0.68: 0.50; hind femur proximally thickened, almost as thick as middle femur. *Abdomen.* Abdomen broad at base, distinctly tapering posteriorly; abdominal venter with a narrow, basal tumescence which ends with a steep edge towards the depressed sterna 6–7 (Fig. 34); posterior part of tumescence forming a more or less distinct spine. Genital segments very conspicuous; parameres long, falciform, meeting each other dorsal to genital segments; blade of each paramere (Fig. 35) slender, almost straight in lateral view, distinctly flattened in dorsal view, apical part curved mesad and narrowed before pointed apex. Vesical armature (Fig. 36) composed of 4 slender, dark sclerites.





**Figs 33–36.** *Xenobates major*, structure of apterous ♂: 33, dorsal structure; appendages of right side omitted; 34, lateral view of abdominal end; 35, left paramere; different aspect of blade above; 36, lateral view of vesica. **Figs 37–38.** *Xenobates major*, structure of apterous ♀: 37, dorsal structure; appendages omitted; 38; caudal view of abdominal end. pr, proctiger.

*Female structure.* Body elongate oval (Fig. 37), length about  $2.2\times$  greatest width across thorax (2.83: 1.30). *Head.* As in male; antennae about  $0.55\times$  total length of insect (1.55: 2.83), with the same kind of pilosity as in male; length of antennal segments 1–4: 0.48: 0.33: 0.38: 0.38. *Thorax.* Mesonotum slightly convex above, with mostly short, dense pilosity; a tuft of long, erect hairs on each side at the point where the abdominal connexiva originate. *Legs.* Relative lengths of leg segments (femur: tibia: tarsus): fore leg: 0.80: 0.68: 0.35; middle leg: 1.95: 1.58: 1.25; hind leg: 1.10: 0.88: 0.40; middle femur about  $0.7\times$  total length; middle and hind femora more slender than in male. *Abdomen.* Relatively long, sides distinctly converging posteriorly; abdominal tergum strongly depressed; connexiva broad, almost vertically raised; laterotergite 6 with tuft of long hairs; abdominal end furnished with long hairs; hind margin of sternum 7 slightly produced in middle. Tergum 8 relatively short; proctiger relatively narrow, distinctly deflected to cover gonocoxae (Fig. 38).

*Variation.* Measurements, see Table 1. Specimens from Portland Roads are slightly smaller ( $\delta$ , length 2.1,  $\varnothing$  length 2.6) and the hair tufts on the thorax of  $\varnothing$  less conspicuous than in specimens from Somerset Bay.

*Distribution and habitat*

Only known from a few localities in northern Queensland (see map, Fig. 39).

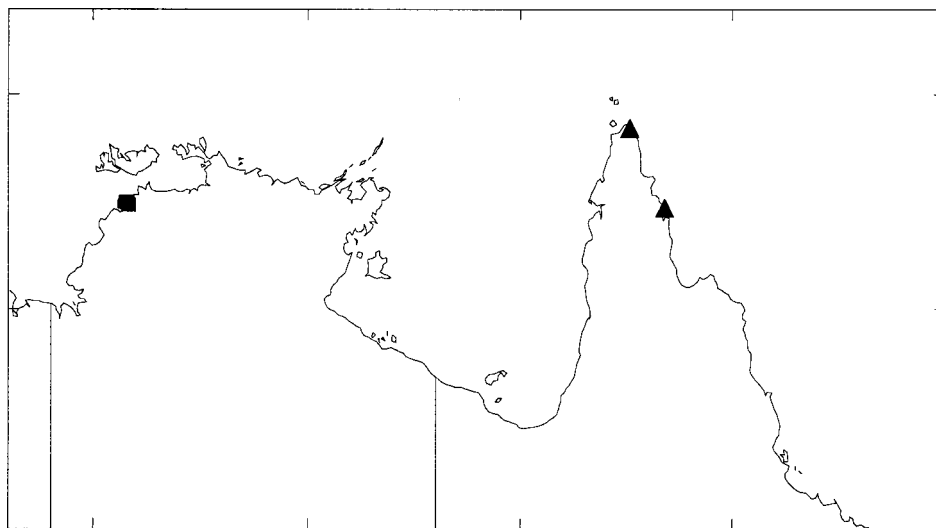


Fig. 39. Distribution of *Xenobates major* ▲ and *X. angulanus* ■.

*Comments*

This is the largest species of *Xenobates* known so far which is reflected in the specific name (*major*, meaning bigger). *X. major*, sp. nov. is most closely related to *X. angulanus*, but separated from this species by the relatively long female abdomen and basal tumescence of male abdominal venter ending as a spine.

*Xenobates angulanus* (Polhemus)

(Figs 39–44)

*Halovelgia (Colpovelgia) angulana* Polhemus 1982: 7–9. – Andersen, 1989a: 85; Lansbury, 1989: 94.

*Xenobates angulana* (Polhemus). – Cassis and Gross, 1995: 444.

*Material examined*

*Holotype.* ♂, 'AUST., NT. Darwin, Frances Bay, CL914, XII-13-77, J.T. Polhemus' (ANIC).

*Paratypes.* **Northern Territory:** 46♂, 33♀, same label data as holotype (ANIC, UQIC, JTPC, ZMUC).

*Other material examined.* **Northern Territory:** 4♂, 2♀, Darwin, East Point Reserve, amongst mangroves/incoming tides, 9–10 July 1994, T. Weir & A. Roach (ANIC); 2♂, Ludmilla, Darwin, In brackish seepage water among mangroves, 22.iii.1982, M.B. Malipatil (NTMD).

*Description*

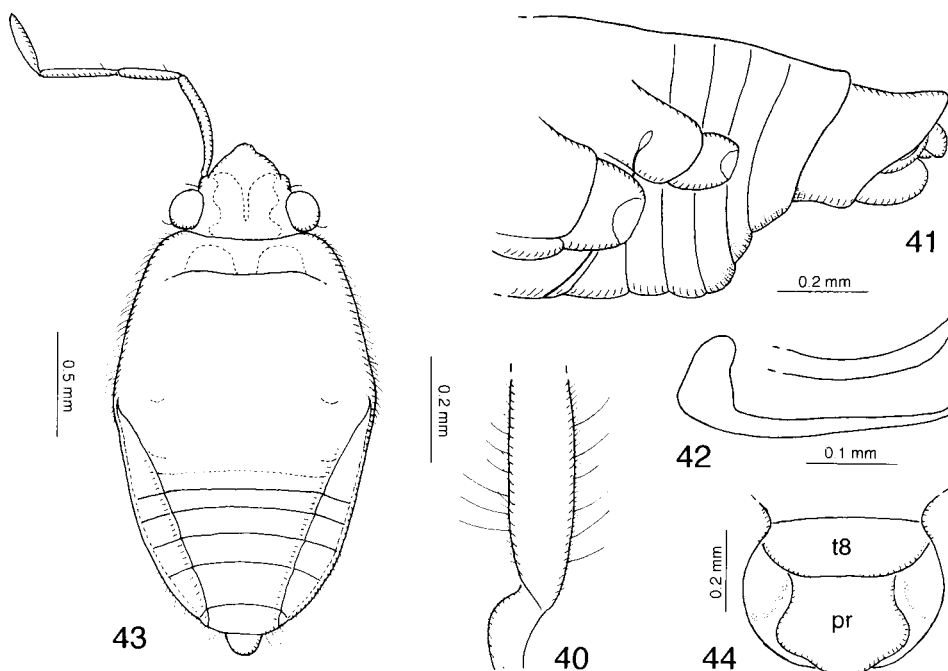
*Size.* ♂, length 2.20–2.35, width 1.10–1.15; ♀, length 2.43–2.55, width 1.28–1.40.

*Colour.* Chiefly dark brown or blackish above. Head brownish yellow, anterior part, a faint median stripe, and stripes along inner margins of eyes, dark. Pronotum with two transverse, brownish yellow stripes or spots along posterior margin. Thoracic and abdominal dorsum with

fine silverish pubescence which form definite markings on pronotum, lateral parts of basal abdominal terga, and on posterior abdominal dorsum. Antennae and legs chiefly brownish; base of antennal segment 1, all coxae and trochanters, and dorsal stripes on femora, yellowish. Ventral surface dark brown; head, prosternum, and acetabula yellowish; most of abdominal venter of ♂, sternum 7 of ♀, and genital segments of both sexes, brownish.

**Male structure.** Body fusiform, length  $2.15\times$  greatest width across thorax (2.43: 1.13). Body and legs covered by short, dense pilosity. **Head.** Length about  $0.7\times$  width across eyes (0.48: 0.68); eye width  $0.35\times$  width of head between eyes (0.14: 0.40). Antennae about  $0.6\times$  total length of insect (1.50: 2.43); relative lengths of antennal segments 1–4: 0.45: 0.30: 0.38: 0.38; segment 2 slightly shorter than segment 3; segment 4 as thick as segment 1 (0.06); antennal segments with dense, short pilosity and a few longer hairs. **Legs.** Relative lengths of segments (femur: tibia: tarsus): fore leg: 0.80: 0.68: 0.30; middle leg: 1.88: 1.48: 1.15; and hind leg: 1.03: 0.80: 0.33; fore femur width 0.14; fore tibia with rows of short, spinous hairs on inner margin before apex; middle femur slightly less than  $0.8\times$  total length of insect, proximally thickened (0.15), with a row of pale hairs along anterior margin (Fig. 40), each hair slightly shorter than greatest width of femur (0.08); relative lengths of middle tarsal segments 1–2: 0.65: 0.50; hind femur proximally thickened, slightly thicker than middle femur. **Abdomen.** Abdomen broad at base, distinctly tapering posteriorly; abdominal venter with a narrow, basal tumescence which ends with a steep edge towards the depressed sterna 6–7 (Fig. 41). Genital segments very conspicuous; parameres long, falciform, meeting each other dorsal to genital segments; blade of each paramere (Fig. 42) slender, almost straight in lateral view, distinctly flattened in dorsal view, apical part curved mesad, pointed.

**Female structure.** Body oval (Fig. 43), length about  $1.9\times$  greatest width across thorax (2.50: 1.30). **Head.** As in male; antennae  $0.6\times$  total length of insect (1.48: 2.50), with the same kind of pilosity as in male; length of antennal segments 1–4: 0.45: 0.31: 0.35: 0.36. **Thorax.** Mesonotum slightly convex above, with dense pilosity of short hairs which becomes longer



**Figs 40–44.** *Xenobates angulanus*: 40, base of middle leg of ♂; 41, lateral view of abdominal end of ♂; 42, left paramere; different aspect of blade above; 43, dorsal structure of apterous ♀; appendages except antenna of left side omitted; 44, caudal view of abdominal end of ♀. pr, proctiger; t8 abdominal tergum 8.

posteriorly. *Legs*. Relative lengths of leg segments (femur: tibia: tarsus): fore leg: 0.83: 0.68: 0.30; middle leg: 2.00: 1.60: 1.20; hind leg: 0.98: 0.83: 0.39; middle femur about 0.8× total length; middle and hind femora more slender than in male. *Abdomen*. About as long as thorax, sides distinctly converging posteriorly; abdominal tergum depressed; connexiva broad, obliquely raised throughout; abdominal end furnished with long hairs; hind margin of sternum 7 almost straight. Tergum 8 relatively short; proctiger relatively broad, distinctly deflected to cover gonocoxae (Fig. 44).

*Variation*. Measurements, see Table 1.

#### *Distribution and habitat*

Only known from a few localities around Darwin, N.T. (see map, Fig. 39). Polhemus (1982: 8) found this species 'skating amongst mangroves bordering the east side of Frances Bay some miles south of the city of Darwin'. It was collected together with *Halobates darwini* Herring.

#### *Comments*

Polhemus (1982: 7–9) placed *X. angulanus* in the genus *Halovelina* and erected a new subgenus, *Colpovelina*, for his new species where he also placed *Halovelina loyaltiensis* China. Both *angulanus* and *loyaltiensis* (endemic to New Caledonia and Loyalty Islands) clearly belong to the genus *Xenobates* as defined by Andersen (1992) and in the present work.

*X. angulanus* is larger than other Australian species of *Xenobates* except for the previous species, *X. major*, sp. nov. These two species share the basal tumescence of the male abdominal venter which in *angulanus* ends at a steep angle (without a spinous process) before sterna 6–7. The female abdomen is much shorter in *angulanus*, without distinct hair tufts.

### *Xenobates spinoides*, sp. nov.

(Figs 45–48, 51)

#### *Material examined*

*Holotype*. ♂, 'Australia, Queensland, Portland Roads, CL1751, 24.viii.1983, J.T. & D.A. Polhemus' (ANIC).

*Paratypes*. **Queensland**: 11♂, 20♀, same label data as holotype (ANIC, JTPC, ZMUC); 3♂, 4♀, many nymphs, Cape York, amongst mangroves on beach, 16.x.1992, T. Weir, P. Zborowski (ANIC); 2♀, Somerset Bay, mangroves, CL1763, 28.viii.1983, J.T. & D.A. Polhemus (ANIC, JTPC).

#### *Description*

*Size*. ♂, length 1.60–1.78, width 0.85–0.89; ♀, length 1.88–1.95, width 0.94–1.00.

*Colour*. Chiefly dark brown or black above. A large U-shaped, spot on head and two transverse spots along posterior margin of pronotum, brownish yellow; pronotal markings usually distinctly separated in middle. Thoracic and abdominal dorsum with fine, greyish pubescence which form definite spots on pronotum, lateral parts of basal abdominal terga, and on posterior abdominal dorsum. Antennae and legs pale brownish; basal part of antennal segment 1, most of fore femur, all coxae and trochanters, and femora beneath, yellowish. Ventral surface chiefly dark brownish; head, prosternum, and acetabula yellowish; sternum 7 of female and genital segments of both male and female usually light brown.

*Male structure*. Body fusiform, length 1.9× greatest width across thorax (1.70: 0.88). *Head*. Length about 0.6× width across eyes (0.35: 0.55); eye width about 0.4× width of head between eyes (0.12: 0.31). Antennae about 0.6× total length of insect (1.04: 1.70); relative lengths of antennal segments (1–4): 0.29: 0.23: 0.25: 0.28; segment 2 shorter than segment 3; segment 4 as thick as segment 1 (0.05); antennal segments with short pilosity and a few longer hairs. *Legs*. Relative lengths of segments (femur: tibia: tarsus): fore leg: 0.53: 0.45: 0.20; middle leg: 1.30: 1.03: 0.76; and hind leg: 0.68: 0.51: 0.23; fore femur width 0.10; fore tibia with a row of short spinous hairs on inner margin before apex; middle femur about 0.75× total length of

**Table 1. *Xenobates* spp. Body dimensions and length of middle femur of adults.**  
Measurements (in mm) given as mean values  $\pm$  standard error. *N* = number of individuals measured.

Species	Sex	<i>N</i>	Body length	Body width	Middle femur
<i>Xenobates</i>					
<i>mangrove</i>	♂	10	1.62 $\pm$ 0.007	0.85 $\pm$ 0.005	1.41 $\pm$ 0.008
<i>mangrove</i>	♀	10	1.77 $\pm$ 0.010	0.98 $\pm$ 0.006	1.47 $\pm$ 0.010
<i>myorensis</i>	♂	10	1.64 $\pm$ 0.006	0.83 $\pm$ 0.007	1.30 $\pm$ 0.013
<i>myorensis</i>	♀	10	1.77 $\pm$ 0.008	0.97 $\pm$ 0.005	1.30 $\pm$ 0.008
<i>ovatus</i>	♂	10	1.47 $\pm$ 0.018	0.75 $\pm$ 0.013	1.14 $\pm$ 0.018
<i>ovatus</i>	♀	10	1.59 $\pm$ 0.015	0.90 $\pm$ 0.007	1.18 $\pm$ 0.032
<i>lansburyi</i>	♂	10	1.60 $\pm$ 0.008	0.78 $\pm$ 0.007	1.29 $\pm$ 0.032
<i>lansburyi</i>	♀	10	1.78 $\pm$ 0.011	0.97 $\pm$ 0.009	1.39 $\pm$ 0.035
<i>chinai</i>	♂	10	1.31 $\pm$ 0.011	0.66 $\pm$ 0.004	0.90 $\pm$ 0.006
<i>chinai</i>	♀	10	1.55 $\pm$ 0.010	0.81 $\pm$ 0.005	0.97 $\pm$ 0.012
<i>major</i>	♂	10	2.26 $\pm$ 0.014	1.11 $\pm$ 0.008	1.83 $\pm$ 0.021
<i>major</i>	♀	10	2.84 $\pm$ 0.015	1.30 $\pm$ 0.007	1.97 $\pm$ 0.013
<i>angulatus</i>	♂	10	2.26 $\pm$ 0.015	1.13 $\pm$ 0.006	1.90 $\pm$ 0.012
<i>angulatus</i>	♀	9	2.49 $\pm$ 0.016	1.33 $\pm$ 0.014	1.94 $\pm$ 0.027
<i>spinoides</i>	♂	10	1.68 $\pm$ 0.016	0.87 $\pm$ 0.004	1.31 $\pm$ 0.007
<i>spinoides</i>	♀	10	1.91 $\pm$ 0.009	0.98 $\pm$ 0.007	1.29 $\pm$ 0.009
<i>caudatus</i>	♂	2	1.75 $\pm$ 0.025	0.89 $\pm$ 0.013	1.39 $\pm$ 0.038
<i>caudatus</i>	♀	10	2.01 $\pm$ 0.011	1.02 $\pm$ 0.008	1.39 $\pm$ 0.007
<i>loyaltiensis</i>	♂	10	1.64 $\pm$ 0.010	0.80 $\pm$ 0.006	1.16 $\pm$ 0.015
<i>loyaltiensis</i>	♀	10	2.35 $\pm$ 0.016	1.20 $\pm$ 0.012	1.81 $\pm$ 0.011

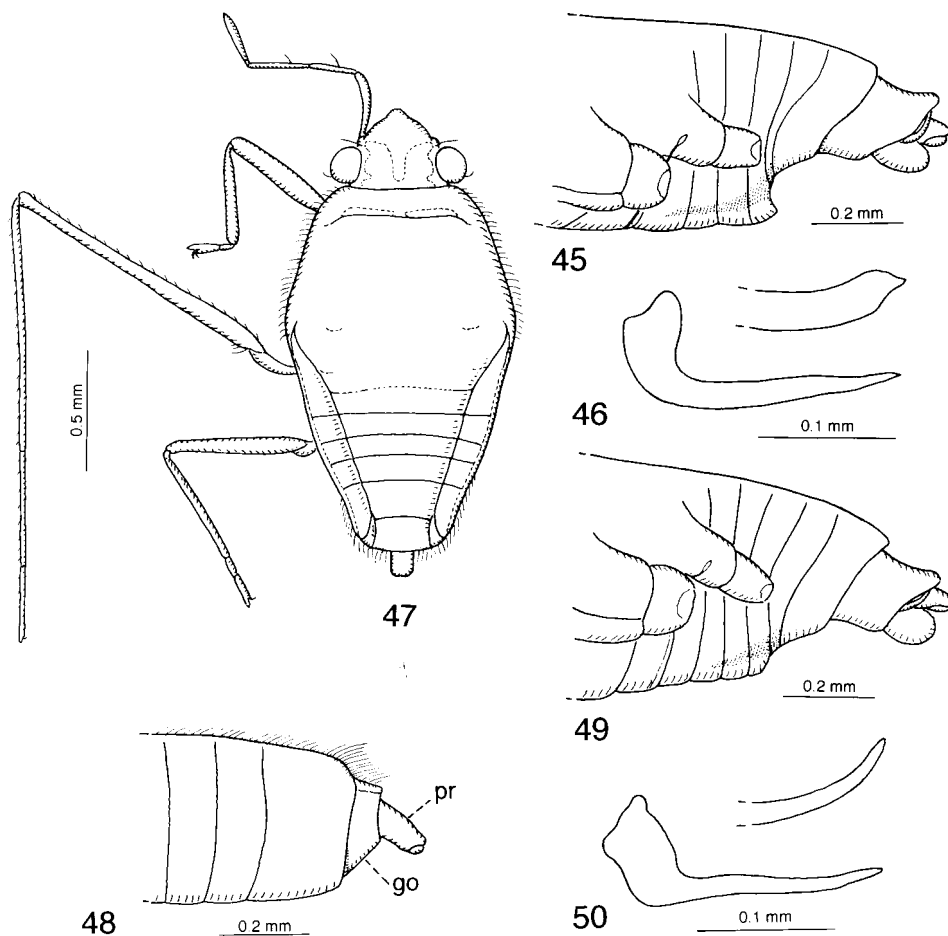
insect, proximally thickened (0.11) and with an indistinct row of short, pale bristle-like hairs along anterior margin, each hair being much shorter than greatest width of femur (0.11); a similar row of hairs on middle tibia and tarsus; relative lengths of middle tarsal segments 1–2: 0.43: 0.34; hind femur proximally thickened (0.11), as thick as middle femur. *Abdomen.* Abdomen broad at base, distinctly tapering posteriorly; abdominal venter with a narrow tumescence (Fig. 45) which ends with a steep edge towards the depressed sterna 6–7; posterior part of tumescence forming a more or less distinct tubercle. Genital segments relatively large, segment 8 with large, ventral depression; parameres falciform and relatively long, meeting each other dorsal to genital segments; blade of each paramere (Fig. 46) slender, almost straight in lateral view, distinctly flattened and slightly curved mesad, apical part obliquely cut off, pointed.

*Female structure.* Body elongate oval (Fig. 47), length about 1.9 $\times$  greatest width across thorax (1.90: 1.00). *Head.* As in male; antennae about 0.5 $\times$  total length of insect (1.01: 1.90), with the same kind of pilosity as in male; length of antennal segments (1–4): 0.28: 0.21: 0.25: 0.28. *Thorax.* mesonotum slightly convex above, with pilosity of dark suberect hairs, depressed towards abdominal dorsum. *Legs.* Relative lengths of leg segments (femur: tibia: tarsus): fore leg: 0.55: 0.45: 0.21; middle leg: 1.31: 1.10: 0.88; hind leg: 0.68: 0.54: 0.25; middle femur about 0.7 $\times$  total length; middle and hind femora more slender than in male. *Abdomen.* Broad and relatively long, sides almost straight, converging posteriorly; abdominal tergum depressed; connexiva broad, obliquely raised anteriorly, almost vertical posteriorly; connexiva and abdominal end furnished with long hairs; sternum 7 not produced in middle; gonocoxae exposed. Tergum 8 relatively long; proctiger narrow (Fig. 48, pr), parallel-sided, distinctly protruding from abdominal end.

*Variation.* Measurements, see Table 1.

#### *Distribution and habitat*

Only known from a few localities along the east coast of Cape York Peninsula, northern Queensland (Fig. 51). Collected amongst mangroves on beach.



**Figs 45–48.** *Xenobates spinoides*: 45, lateral view of abdominal end of ♂; 46, left paramere; different aspect of blade above; 47, dorsal view of apterous ♀; appendages of right side omitted; 48, lateral view of abdominal end of ♀; go, gonocoxa; pr, proctiger. **Figs 49–50.** *Xenobates caudatus*: 49, lateral view of abdominal end of ♂; 50, left paramere; different aspect of blade above.

#### Comments

*Xenobates spinoides*, sp. nov. belongs to the group of small species without a distinct row of long bristle-like hairs on middle femur. This species is easily recognised on the ventral modification of the male abdomen, shape of male parameres, and the narrow and distinctly protruding female proctiger. A closely related species from Motupore Island, Central Province, Papua New Guinea, is described below.

#### *Xenobates caudatus*, sp. nov.

(Figs 49–51)

#### Material examined

**Holotype.** ♂, 'Papua New Guinea, Central Province, Motupore [as Malupore] Is., Marine Reserve Station, CL1839, 21.ix.1983, J.T. & D.A. Polhemus' (JTPC).

**Paratypes.** **Papua New Guinea:** 1 ♂, 32 ♀, same label data as holotype (JTPC, ZMUC).

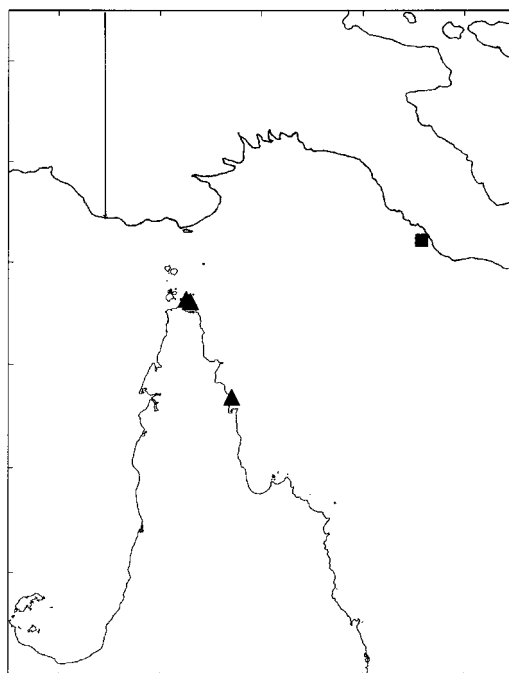


Fig. 51. Distribution of *Xenobates spinoides* ▲ and *X. caudatus* ■.

#### Description

*Size.* ♂, length 1.73–1.78, width 0.88–0.90; ♀, length 1.93–2.05, width 0.98–1.04.

*Colour.* Chiefly dark brown or black above. A large U-shaped spot on head and posterior half or one third of pronotum, brownish yellow; pronotal marking partly divided in middle. Thoracic and abdominal dorsum with fine, greyish pubescence which forms definite spots on pronotum, lateral parts of basal abdominal terga, and on posterior abdominal dorsum. Antennae and legs pale brownish; basal part of antennal segment 1, most of fore femur, all coxae and trochanters, and femora beneath, yellowish. Ventral surface chiefly dark brownish; head, prosternum, and acetabula yellowish; sternum 7 of female and genital segments of both male and female usually light brown.

*Male structure.* Body fusiform, length  $1.9\times$  greatest width across thorax (1.73: 0.90). *Head.* Length about  $0.6\times$  width across eyes (0.33: 0.56); eye width about  $0.4\times$  width of head between eyes (0.13: 0.31). Antennae about  $0.6\times$  total length of insect (0.99: 1.73); relative lengths of antennal segments (1–4): 0.26: 0.20: 0.25: 0.28; segment 1 shorter than head length; segment 2 shorter than segment 3; segment 4 as thick as segment 1 (0.06); antennal segments with short pilosity and a few longer hairs. *Legs.* Relative lengths of segments (femur: tibia: tarsus): fore leg: 0.58: 0.48: 0.21; middle leg: 1.35: 1.05: 0.79; and hind leg: 0.70: 0.58: 0.25; fore femur slender (0.11); fore tibia with a row of short spines on inner margin before apex; middle femur about  $0.8\times$  total length of insect, proximally thickened and with an indistinct row of short, pale bristle-like hairs along anterior margin, each hair being much shorter than greatest width of femur (0.13); a similar row of hairs on middle tibia and tarsus; relative lengths of middle tarsal segments (1–2): 0.45: 0.34; hind femur proximally thickened, as thick as middle femur. *Abdomen.* Abdomen broad at base, distinctly tapering posteriorly; abdominal venter with a narrow tumescence (Fig. 49) which ends with an almost vertical edge towards the depressed sterna 6–7. Genital segments relatively large, segment 8 with large, ventral depression; parameres falciform and relatively long, meeting each other dorsal to genital segments; blade of each paramere (Fig. 50) very slender, almost straight in lateral view, distal part slightly flattened and curved mesad, apex pointed.

*Female structure.* Body elongate oval, length about 1.9× greatest width across thorax (1.95: 1.03). *Head.* As in male; antennae about 0.5× total length of insect (1.04: 1.95), with the same kind of pilosity as in male; length of antennal segments (1–4): 0.30: 0.20: 0.26: 0.28. *Thorax.* Slightly convex above, with pilosity of dark suberect hairs. *Legs.* Relative lengths of leg segments (femur: tibia: tarsus): fore leg: 0.59: 0.48: 0.24; middle leg: 1.43: 1.13: 0.88; hind leg: 0.70: 0.60: 0.28; middle femur about 0.7× total length; hind femur more slender than in male. *Abdomen.* Broad and relatively long, sides broadly rounded; abdominal tergum depressed beyond tergum 4; connexiva broad, obliquely raised anteriorly, almost vertical posteriorly; connexiva and abdominal end furnished with long hairs; sternum 7 not produced in middle; gonocoxae exposed. Tergum 8 relatively long; proctiger narrow, distinctly protruding from abdominal end.

*Variation.* Measurements, see Table 1.

#### *Distribution and habitat*

Only known from the type series from Motupore Island, Central Province, Papua New Guinea (Fig. 51).

#### *Comments*

*Xenobates caudatus* is very closely related to the previous species, sharing the absence of a distinct row of long bristle-like hairs on middle femur and the narrow, distinctly protruding female proctiger. The two species can be separated from the structure of the ventral modification of the male abdomen and the shape of male parameres.

### *Xenobates loyaltiensis* (China), comb. nov.

(Figs 23, 52–56)

*Halovelvia loyaltiensis* China, 1957: 354–355. – Andersen, 1989a: 85.

*Halovelvia (Colpovelvia) loyaltiensis* China. – Polhemus, 1982: 8.

*Halovelvia (Halovelvia) loyaltiensis* China. – Lansbury, 1989: 94.

#### *Material examined*

*Holotype.* ♂ (on slide), 'Loyalty Is., Fayaoye Bay, Uvea, Salt Lake, 23.iii.1953, ♂ . Laird' (BMNH).

*Paratypes.* **New Caledonia (Loyalty Islands):** 1M, 2FF, same label data as holotype (BMNH).

*Other material examined.* **New Caledonia:** 1♂, Hienghene R., 3.ix.1965, F.S. coll. (JTPC); 5♂, 4♀, Kuebeni Isle near Yate, 2–5.x.1940, F.X. Williams (BPBM); 1♂, 1♀, 16 nymphs, Dumbéa River estuary, CL1868, 27.ix.1983, J.T. & D.A. Polhemus (JTPC); 1♂, Noumea, Rocky Beach, CL1867, 27.ix.1983, J.T. & D.A. Polhemus (JTPC); 12♂, 10♀, Tina Bay near Noumea, mangrove estuary, CL1863, 28.ix.1983, J.T. & D.A. Polhemus (JTPC, ZMUC).

#### *Description*

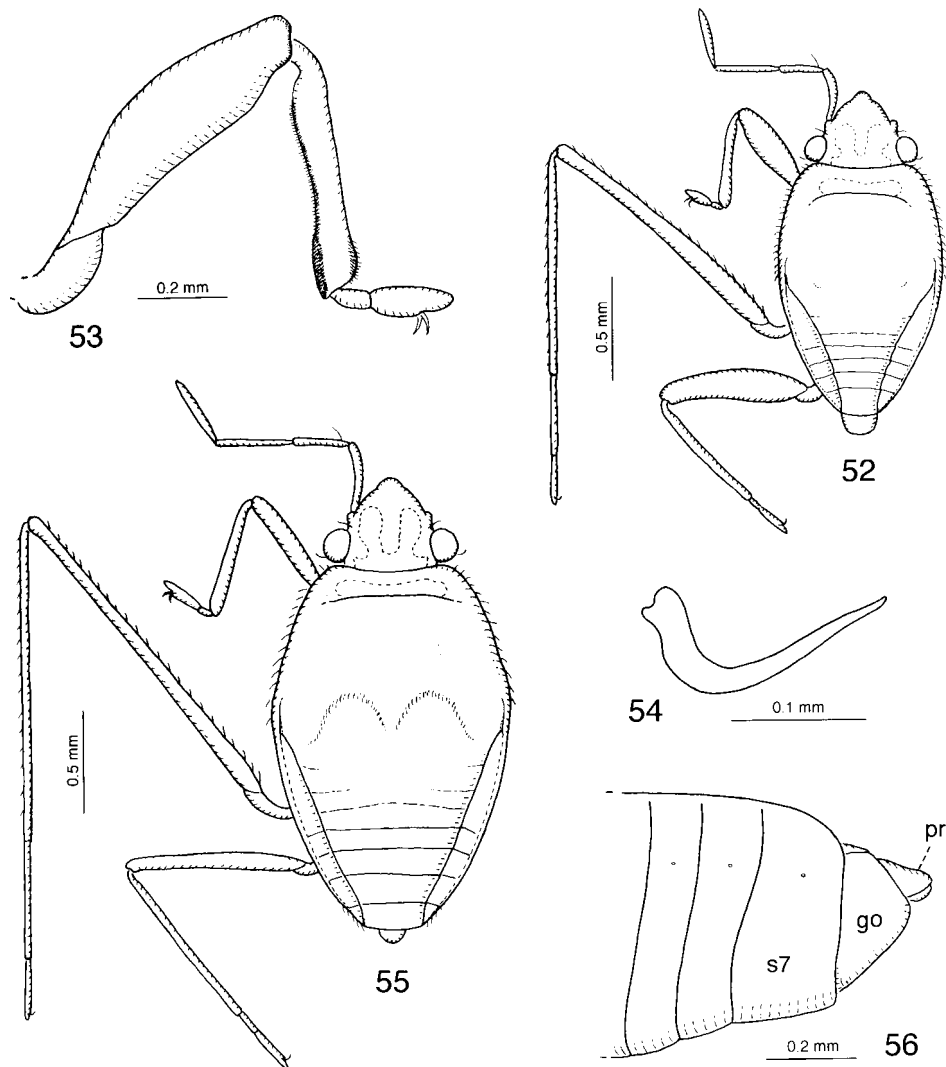
*Size.* ♂, length 1.59–1.90, width 0.76–0.89; ♀, length 2.28–2.54, width 1.15–1.28.

*Colour.* Chiefly dark brownish or black above. Head with brownish yellow markings, either a transverse band or a large U-shaped spot at base. Pronotum with a broad, yellowish band along posterior margin, sometimes interrupted in middle. Thoracic and abdominal dorsum with fine, greyish or silverish pubescence which form definite spots on pronotum, lateral parts of basal abdominal terga, and on posterior abdominal dorsum. Antennae and legs chiefly dark; extreme base of antennal segment 1 and all coxae and trochanters, yellowish; femora with dorsal, longitudinal yellowish brown stripe. Ventral surface dark brown; head, prosternum, and acetabula yellowish; most of abdominal venter (♂), sternum 7 (♀), and genital segments (♂, ♀) brownish.

*Male structure.* Body fusiform (Fig. 52), length 2.2× greatest width across thorax (1.91: 0.88). Body and legs covered by short, dense pilosity. *Head* relatively narrow and long, length about 0.9× width across eyes (0.50: 0.58); eye width 0.35× width of head between eyes (0.12:



0.34). Antennae  $0.65\times$  total length of insect (1.25: 1.91); relative lengths of antennal segments 1–4: 0.29: 0.26: 0.35: 0.35; segment 3 distinctly longer than segment 2; segment 4 as thick as segment 1 (0.05); antennal segments with dense, short pilosity and a few longer hairs. *Thorax* with scattered black bristles dorsally and along lateral edges. *Legs*. Relative lengths of segments (femur: tibia: tarsus): fore leg: 0.63: 0.51: 0.23; middle leg: 1.29: 1.19: 0.68; and hind leg: 0.81: 0.70: 0.28; fore femur (Fig. 53) distinctly incrassate in distal part (0.16); fore tibia with a row of spinous hairs on inner margin and a dense, elongate pad of pegs before apex; middle femur relatively short, about  $0.7\times$  total length of insect, proximally thickened (0.13), with a row of short hairs along anterior margin (obscured by the overall dense pilosity of the legs); relative lengths of middle tarsal segments 1–2: 0.41: 0.26; hind femur incrassate proximally, distinctly thicker than middle femur. *Abdomen*. Abdomen broad at base, distinctly tapering posteriorly; abdominal venter not modified. Genital segments very conspicuous; parameres short, falciform; blade of each paramere (Fig. 54) slender, almost straight in lateral view, apex pointed.



**Figs 52–56.** *Xenobates loyaltiensis*: 52, dorsal structure of apterous M; appendages of right side omitted; 53, left fore leg of ♂; 54, left paramere; 55, dorsal structure of apterous ♀; appendages of right side omitted; 56, lateral view of abdominal end of ♀. go, gonocoxa; pr, proctiger; s7, abdominal sternum 7.

*Female structure.* Body oval (Fig. 55), length about 2.0× greatest width across thorax (2.54: 1.28). *Head* as in male; antennae about 0.6× total length of insect (1.58: 2.54), with the same kind of pilosity as in male; length of antennal segments 1–4: 0.38: 0.33: 0.45: 0.43. *Thorax* slightly convex above, with short, dense pilosity; metanotum distinctly impressed on each side of middle. *Legs.* Relative lengths of leg segments (femur: tibia: tarsus): fore leg: 0.84: 0.70: 0.34; middle leg: 1.96: 1.73: 0.95; hind leg: 1.08: 0.98: 0.38; middle femur about 0.75× total length; middle and hind femora not incrassate. *Abdomen* very broad, sides almost straight, converging posteriorly; abdominal tergum strongly depressed; connexiva broad, almost vertically raised; hind margin of sternum 7 almost straight. Tergum 8 relatively short; proctiger (Fig. 56, pr) cone-shaped, not deflected.

*Variation.* Measurements, see Table 1. Specimens belonging to the type series from Loyalty Islands are larger than specimens from New Caledonia, but very similar in all other characters.

#### *Distribution*

Described from Loyalty Islands (China 1957), but now also recorded from New Caledonia (Fig. 23).

#### *Comments*

*Xenobates loyaltiensis* (China) differs from all other species of *Xenobates* in the distinctly thickened fore and hind femora in male. Since the male is distinctly smaller than the female (female/male size ratio about 1.4), the incrassate male legs probably have a grasping function during the copulation and/or postcopulatory mate guarding.

China (1957: 354) placed this species in the genus *Halovelina*, but also pointed out that it differs from all other species of that genus in the distinctive pubescence forming silvery spots, a feature shared with most species of *Xenobates*. Lansbury (1989: 94) retained this species in *Halovelina*, and furthermore in a species-group characterized by the male having a fore tibial comb. *X. loyaltiensis*, however, does not possess a male grasping comb of the same structure as species of *Halovelina* (compare Figs 53 and 58). As here defined (see generic description above), *X. loyaltiensis* clearly belongs to the genus *Xenobates*.

### *Xenobates* sp.

#### *Notes*

Two specimens (1♂ and 1♀) labelled 'Hermite Id., Monte Bello Islands, 12 November 1953', 'Monte Bello Exped. 1953', and '*Halovelina* sp. nov., Det. W.E. China 1956' (BMNH) may belong to an undescribed species. The specimens clearly belong to the genus *Xenobates* and are very similar to *X. chinai* in colouration and structure (see above). The specimens are, however, slightly larger than this species (♂, length 1.46, width 0.73; ♀, length 2.00, width 1.06). The female has an elongate shiny area in the middle of the meso-metanotum and the basal abdominal terga are slightly depressed on each side. The following measurements are provided for the male specimen: antennal segments 1–2 (segments 3–4 missing): 0.25: 0.19; lengths of leg segments (femur: tibia: tarsus): fore leg: 0.53: 0.46: 0.18; middle leg: 1.10: 0.88: 0.58; hind leg: 0.60: 0.50: 0.20; and for the female specimen: antennal segments 1–2: 0.33: 0.21: 0.35: 0.25; lengths of leg segments (femur: tibia: tarsus): fore leg: 0.68: 0.53: 0.23; middle legs missing; hind leg: 0.73: 0.65: 0.24. We refrain from assigning the Hermite Island specimens to any species pending collection of further material from the Monte Bello Islands or other localities along the coast of Western Australia.

### Genus *Halovelina* Bergroth

*Halovelina* Bergroth, 1893: 277. – Esaki, 1926: 157; Esaki, 1930: 24; China, 1957: 350–351; Andersen, 1989a: 83–84.

Type species: *Halovelina maritima* Bergroth, 1893; designation by monotypy.

### Description

Small or very small water striders; adults always apterous (wingless). Body usually subovate, length  $1.7\text{--}2.0\times$  ♂ or  $2.0\text{--}2.6\times$  ♀ greatest width. Body chiefly dark coloured, covered by a thick pilosity which is more or less greyish, especially on abdomen. Head and pronotum without extensive pale markings. Thoracic and abdominal dorsum without definite spots of silvery hairs. *Head* much shorter than wide, moderately deflected in front of eyes; dorsal surface at most with an indistinct median groove and without pseudocellar pits. Eyes globular but relatively small, width of each eye less than  $0.3\times$  interocular width. Antennae long and slender, usually  $0.6\text{--}0.8\times$  total length of insect; segment 1 usually as long as head, subequal to or slightly shorter than segment 4; segment 3 longer than segment 2. *Thorax*. Pronotum very short (Fig. 61, pn); suture between pro- and mesonotum (mn) usually obscured laterally, rarely distinct throughout, reaching lateral margins of thorax. Dorsal boundaries between meso- and metathorax and between metathorax and abdominal terga indistinct. Ventral sutures of thorax and abdomen distinct; metathoracic scent channels extending laterally and obliquely backward, distinctly separated from hind margin of metasternum. *Legs*. Fore trochanter of male not modified. Fore tibia of male with a grasping comb (Fig. 58, gr) composed of a compact row of short spines along the inner margin. Mesotrochanters prolonged. Middle femur very long, usually more than  $0.6\times$  ♂ or  $0.5\times$  ♀ total length of insect, slightly thickened in proximal part; femur with short pubescence along anterior margin; middle tibia and tarsus very slender and long, tarsus  $0.7\text{--}0.8\times$  length of tibia; first tarsal segment  $1.3\text{--}1.5\times$  second segment; claws very small, falcate. Hind femur relatively short, usually thickened proximally; second tarsal segment much longer than first segment. *Abdomen* short with broadly rounded sides in male, longer and usually with more straight sides in female; connexiva broad and obliquely inclined (♂), sometimes vertically raised or inflexed upon abdominal dorsum (♀); abdominal terga 4–7 distinctly separated by intersegmental sutures. Abdominal venter of male usually simple. Male genital segments relatively large but withdrawn into pregenital abdomen and only slightly protruding from abdominal end (Figs 66, 71, 75); segment 8 and pygophore usually simple; parameres large and symmetrically developed. Phallic conjunctivum with lateral processes; vesica with three asymmetrical, dark sclerites. Hind margin of sternum 7 of female usually produced in middle. Female genital segments clearly visible behind tergum 7; proctiger cone- or button-shaped, usually concealed beneath tergum 8. *Egg*. Elongate oval,  $0.6\text{--}0.7$  mm long,  $0.3$  mm wide, with a small tubercle at the anterior pole, traversed by one micropyle (Andersen 1989b: fig. 72–73). *Nymphs*. Five nymphal instars (illustrated by Kellen 1959: fig. 5 for *H. bergrothi*). Fifth instar with extensive brownish sclerotisations dorsally; head with distinct U-shaped ecdysial line; thoracic nota uniformly brownish; abdomen with large, paired sclerites. Antennal segments 2 and 3 with short pilosity. Middle femora and tibia without distinct row of hairs along anterior margin.

### Biology and ecology

Kellen (1959) and Andersen (1989b) gave comprehensive accounts of the biology of *Halovelia* species which were given the trivial name *coral bugs* because of their association with coral reefs. Most species are found on intertidal reef flats, on the surface of tidal pools among stands of *Porites* and *Acropora* corals on the mid-reef flat, but only rarely on the inner-reef flat or towards the outer reef margin. Species of *Halovelia* have also been recorded from rocky coasts without corals. The coral bugs usually appear when the tide recedes, in particular upon the surface of shallow pools around or beneath blocks of coral or porous rock. When the tide rises, both adults and nymphs retreat to cavities and holes in such blocks and stay submerged during high tide, surrounded by an air bubble. Coral bugs probably deposit their eggs on blocks of dead coral and the ecdysis of nymphs take place in the cavities and holes in such blocks. Occasionally, *Halovelia* species are found in mangrove habitats, especially when these border coasts fringed by coral reefs.

### Comments

The genus *Halovelia* was described by Bergroth (1893) for a single species, *H. maritima*. Esaki (1926), Hale (1926) and China (1957) added useful diagnostic characters. These were

summarized by Andersen (1989a) in his redescription of the genus. *Halovelgia* is separated from *Xenobates* by the characters given in the key (see above). The presence of a grasping comb on the male fore tibia and the concealed male genital segments are good diagnostic characters. In addition, most *Halovelgia*-species have almost uniformly dark head and pronotum, without extensive pale markings. The body is covered by a dense clothing of short pubescence (which may appear greyish in some parts), but never by silvery pubescence forming definite spots. The middle femora and tibiae are covered by short pubescence but only rarely have a hair fringe.

In his monographic revision of the genus *Halovelgia*, Andersen (1989a, 1989b) presented the results of a phylogenetic analysis of relationships between species. A number of monophyletic species-groups can be defined upon apomorphic characters. The Australian species of *Halovelgia* belong to several of these groups. *H. hilli* and *H. heron* belong to the *bergrothi* Esaki group; *H. polhemi* is closely related to *H. esakii* Andersen. Finally, *H. maritima* and *H. corallia* both assume a basal position on the reconstructed phylogeny.

#### Key to the species of *Halovelgia* in Australia, New Caledonia and southern Papua New Guinea

1. Antennal segment 3 subequal to or only slightly longer than segment 2 (ratio less than 1.2). Grasping comb of ♂ fore tibia more than half length of tibia (Fig. 58, gr); parameres slender and very long (length subequal to or more than half width of head across eyes), in resting position distinctly crossing each other above genital segments (Fig. 59). Thoracic dorsum of ♀ distinctly swollen (Figs 62, 63, 69) ..... 2
- Antennal segment 3 distinctly longer than segment 2 (ratio 1.2: 1 or more). Grasping comb of ♂ fore tibia less than half length of tibia; parameres relatively short (length less than half width of head across eyes), in resting position reaching or barely crossing each other above genital segments. Thoracic dorsum of ♀ only moderately swollen (Figs 74, 79, 82) ..... 4
2. Extreme apex of each paramere almost straight (Fig. 67). Length 1.4–1.5 ♂ or 1.9–2.0 ♀; length of ♀ about 1.8× greatest width across thorax. Queensland ..... *H. heron* Andersen
- Extreme apex of each paramere hook-shaped (at least in some angles of view, Figs 59, 60). Length of ♀ about 2.0× greatest width across thorax ..... 3
3. Distal part of paramere smoothly curved (Fig. 60). Greatest height of ♀ thorax located about or slightly before middle of mesonotum (Figs 62, 63). Length 1.4–1.6 ♂ or 1.8–2.2 ♀. Queensland, Northern Territory, West Australia, Papua New Guinea, Timor, New Caledonia ..... *H. hilli* China
- Distal part of paramere rather abruptly turned mesad. Greatest height of ♀ thorax located distinctly before middle of mesonotum. Length 1.4–1.6 ♂ or 2.0–2.7 ♀. Papua New Guinea, New Caledonia, islands of West Pacific Ocean, Philippines, Vietnam ..... *H. bergrothi* Esaki
4. Eyes small, width of an eye distinctly less than one fourth interocular width (Figs 71, 73). Middle femur of ♀ less than half total length. Length 1.7 ♂ or 2.1–2.2 ♀. Cartier Island, Timor Sea ..... *H. maritima* Bergroth
- Eyes larger, width of an eye subequal to or more than one fourth interocular width. Middle femur of ♀ subequal to or longer than half total length ..... 5
5. Abdominal venter of ♂ with basal tumescence furnished with long hairs; paramere relatively short and broad (Fig. 80). Small species, length less than 1.5 ♂ or 1.6 ♀. Northern Territory ..... *H. polhemi* Andersen
- Abdominal venter of ♂ not modified as above; paramere longer and more slender ..... 6
6. Grasping comb of ♂ fore tibia very short, only one sixth length of tibia (Fig. 76). Abdominal venter of ♂ simple; paramere slender, with narrow and pointed distal part (Fig. 77). Mesothorax of ♀ simple. Small species, length 1.6 ♂ or 1.9 ♀. Queensland, Papua New Guinea ..... *H. corallia* Andersen
- Grasping comb of ♂ fore tibia longer, about two fifth length of tibia. Abdominal venter of ♂ deeply depressed in middle; paramere stout, with spatulate distal part. Mesothorax of ♀ with distinct lateral tufts of hairs. Large species, length 1.8–1.9 ♂ or 2.1–2.2 ♀. Papua New Guinea ..... *H. novoguineensis* Andersen

*Halovelia hilli* China

(Figs 57–65)

*Halovelia hilli* China, 1957: 352–354. – Polhemus, 1982: 9; Lansbury, 1989: 95–97; Andersen, 1989a: 99–102; Cassis & Gross, 1995: 442–443.

*Halovelia maritima* Bergroth. – Hale, 1926: 203–206; Hale, 1935: 251.

*Material examined*

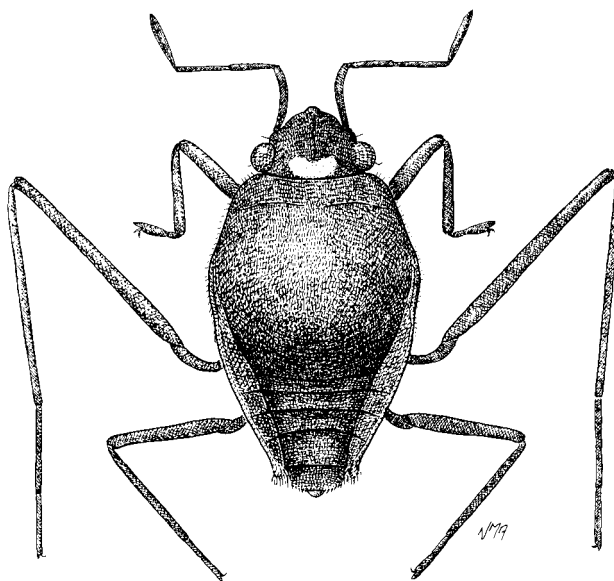
*Holotype*. ♂, 'South Hermite, mangrove swamp, August 1952, G. Wedd' (BMNH).

*Paratypes*. **Western Australia**: 10♂, 8♀, same label data as holotype (BMNH); 8♂, 10♀ (several pairs in copula), Monte Bello Islands, S. Hermite, from mangrove swamp, 21.x.1952, F.L. Hill (BMNH).

*Other material examined*. **Northern Territory**: 60♂, 44♀, 31 nymphs, Rimbija Island, Wessel Islands, amongst pools between rocks at low tide, 3–14.ii.1977, T.A. Weir (ANIC); 2♂, 4♀, Lee Point Beach, large intertidal rock pool, 21.ii.1988, M.B. Malipatil (NTMD); 22♂, 34♀, Darwin, East Point, CL904, 10.xii.1977, J.T. Polhemus (JTPC, UQIC, ZMUC); 3♂, 2♀, Darwin, East Point Reserve, pools in rockshelf, above incoming tide, 9–10.vii.1994, T. Weir & A. Roach (ANIC). **Queensland**: 66♂, 67♀, Prince of Wales Island, intertidal reef, CL1769, 30.viii.1983, J.T. & D.A. Polhemus (JTPC, ZMUC); 78♂, 46♀ (4♂, 4♀, in copula), 2 nymphs, Roonga Point, amongst mangroves and in sea, 17.x.1992, T. Weir, P. Zborowski (ANIC); 2♂, Somerset, Cape York, 16–17.iv.1973, G.B. Monteith (QMB); 24♂, 24♀, Somerset Bay, mangroves, CL1763, 28.viii.1983, J.T. & D.A. Polhemus (JTPC, ZMUC); 1♂, Somerset, amongst mangroves on beach, 15.x.1992, T. Weir, P. Zborowski (ANIC); 2♂, 2♀, Sherrard Island, on reef, low tide, 9.vi.1956, E.N. Marks & M.J. Mackerras (UQIC); 22♂, 27♀, 3 nymphs, Cape Tribulation, N. of Cairns, dead coral reef, at low tide, 8.viii.1990, N.M. Andersen (ZMUC); 2♂, 2♀, Green Island off Cairns, reef pools at low tide, 23.vi.1956, E.N. Marks (UQIC); 1♂, 5♀, Bedarra Island, rock pools, low tide, 1.vi.1973, E.N. Marks (UQIC); 7♂, 7♀, Etty Bay via Innisfail, 24.x.1980, G.B. Monteith (QMB); 9♂, 3♀, Magnetic Island, Geoffroy Bay, 15.vii.1976, Lanna Cheng (JTPC, ZMUC); 6♂, 9♀, Low Isles, Great Barrier Reef, reef & shore pools, low tide, 8–23.viii.1954, E.N. Marks & M.J. Mackerras (UQIC). **Western Australia**: 3♂, 1♀, labelled '*Halovelia maritima* Berg., Id. by H.M. Hale', Pelsart Is. Houtmanns Abrs., W.A. Lea (SAMA). **New Caledonia**: 2♀, Iles Loyalty, 1928, Mme Pruvot (MHNP); 1♂, 4♀, Noumea, rocky coast, CL1867, 27.ix.1983, J.T. & D.A. Polhemus (JTPC). **Papua New Guinea**: 19♂, 26♀, Western Province, Daru Island, CL1771, 1.xi.1983, J.T. & D.A. Polhemus (JTPC).

*Description*

*Size*. ♂, length 1.22–1.50, width 0.75–0.90; ♀, length 1.75–2.25, width 0.95–1.12.

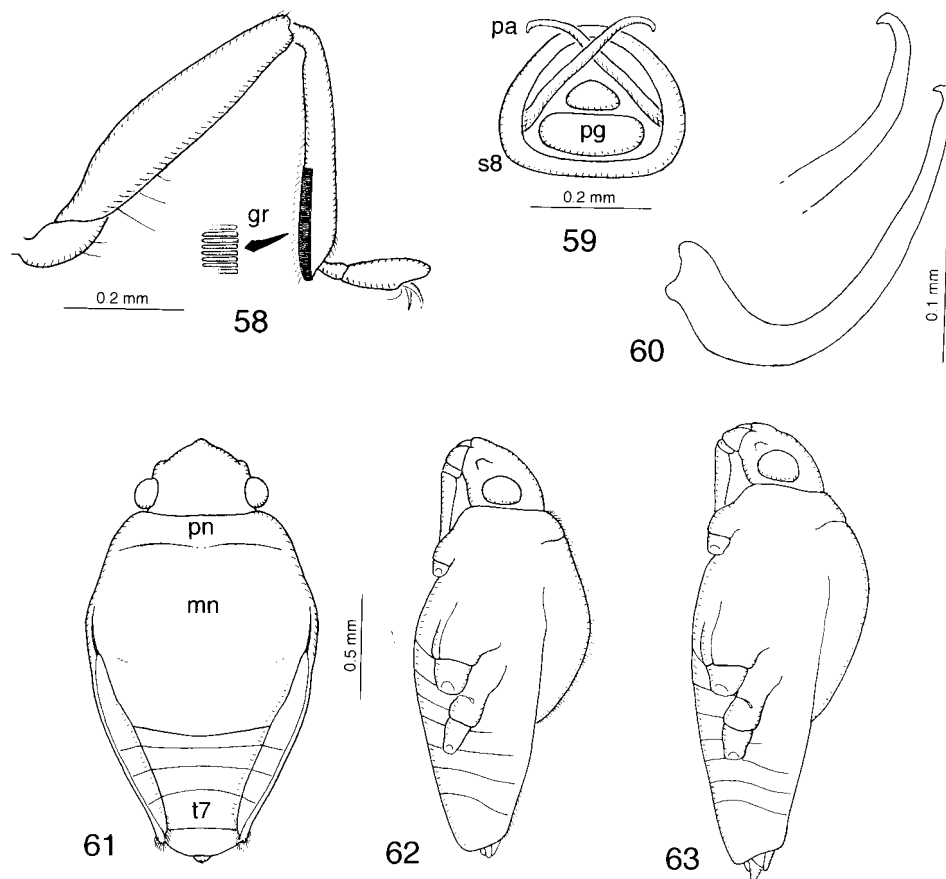


**Fig. 57.** *Halovelia hilli*, habitus of apterous ♀ (length 1.8 mm) from Darwin, Northern Territory.

**Colour.** Black or dark brown (Fig. 57) with greyish pubescence which is longer and more distinctly grey on male abdomen. Female connexiva terminated by short, whitish hairs. A large irregular, yellowish brown spot at base of head.

**Male structure.** Body ovate, total length about  $1.7\times$  greatest width across thorax. Eyes relatively small, about  $0.25\times$  width of head between eyes. Antennal segment 3 slightly longer than segment 2 (ratio 1.15: 1). Grasping comb of fore tibia relatively long (Fig. 58), almost two fifths of tibial length; middle femur about  $0.65\times$  total length of insect; hind femur as thick as middle femur. Abdominal venter slightly depressed beyond sternum 4. Parameres very long and slender, distinctly crossing each other dorsal to the genital capsule (Fig. 59); blade of each paramere curved dorsad in lateral view, distal part turned mesad, apex faintly hook-shaped (Fig. 60).

**Female structure.** Body fusiform (Fig. 61), length almost  $2.0\times$  greatest width across thorax. Thoracic dorsum distinctly raised, with greatest height about or slightly before middle of mesonotum (Figs 62–63), with erect pubescence which is slightly longer on mesonotum. Middle femur  $0.6\times$  total length of insect. Abdomen broad at base, evenly tapering in width posteriorly; terga depressed from segment 4 and backwards; connexiva more or less obliquely raised



**Figs 58–60.** *Halovelia hilli*, structure of apterous ♂: 58, left fore leg showing enlarged details of tibial grasping comb; 59, caudal view of abdominal end; 60, left paramere; different aspect of blade above. gr, grasping comb; pa, paramere; pg, pygophore; s8, abdominal segment 8. **Figs 61–63.** *Halovelia hilli*, structure of apterous ♀: 61, dorsal structure of ♀ from Hermite Island, Western Australia; appendages omitted; 62, lateral structure of ♀ from same locality; appendages omitted; 63, lateral structure of ♀ from Prince of Wales Islands, Queensland; appendages omitted. mn, mesonotum; pn, pronotum; t7, abdominal tergum 7.

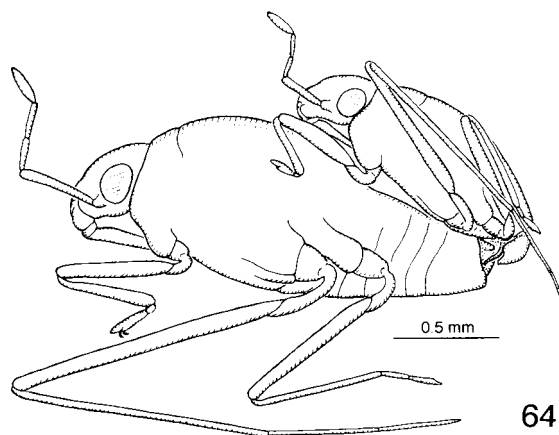
throughout; tergum 8 short and wide, exposing proctiger behind.

**Variation.** Andersen (1989a: table 2) records the size variation in this species. The smallest individuals come from Darwin, N.T. (length: ♂, 1.22–1.30 mm; ♀, 1.75–1.82 mm), the largest from Prince of Wales Islands, Queensland (length: ♂, 1.40–1.50 mm; ♀, 2.05–2.25 mm). Females from the Monte Bello Islands, W.A. (Fig. 62), and from the islands of the Great Barrier Reef (Sherrard Island, Low Isles, Green Island, and Magnetic Island), are more convex dorsally than females from Darwin, N.T., and from Prince of Wales Islands, Cape York Peninsula, Queensland (Fig. 63).

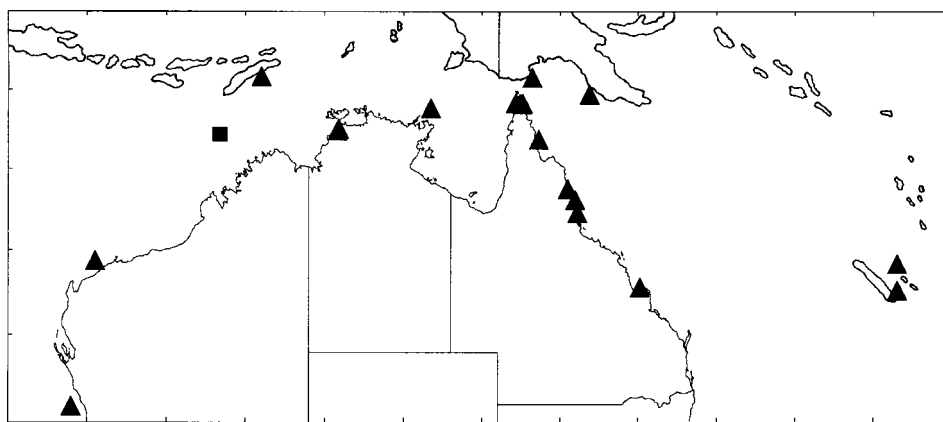
*Distribution and habitat*

Widely distributed along the north, northwest, and west coasts of Australia (Fig. 65). Also recorded from southern Papua New Guinea, New Caledonia and Loyalty Islands (Andersen 1989a). We have also seen a male labelled 'Portuguese Timor, March 1961, G.F. Gross' (SAMA) which belong to this species.

Adults were collected in February, April, June–August, October, and December. Copulating pairs were found in August and October, nymphs in February and August. The male of *H. hilli* is much smaller than the female (♀/♂ size ratio 1.4–1.5) and its very long parameres interlocks



**Fig. 64.** *Halovelia hilli*, lateral view of female with male in postcopulatory position; male paramere interlocks with female genital segments.



**Fig. 65.** Distribution of *Halovelia hilli* ▲ and *H. maritima* ■.

with the genital segments of the female during matings (Fig. 64; illustrated for *H. bergrothi* by Andersen 1989b: SEM, Figs 61–63). Males are so persistent in guarding their mate that they remain seated on the female's back even after being killed.

Polhemus (1982: 9) collected *H. hilli* on East Point Reef near Darwin, N.T., writing: 'This species... was taken from tide pools among the large shoulder-high boulders. The most productive pools were considerably above the tidal level where *Hermatobates haddoni* Carpenter was abundant;...', and 'Certain sheltered localities under overhanging rock, and particular sites along more exposed rock surfaces were favoured by these bugs'. Also abundant on the intertidal reef off Prince of Wales Island, northern Queensland, described as (Polhemus, unpublished field notes): 'reef of dead coral exposed at low tide, rough and blocky with pools and channels at various levels, connected by small streams and falls of salt water'. The first author collected *H. hilli* in similar surroundings at Cape Tribulation, Queensland.

#### Comments

China (1957) described *H. hilli* from South Hermite, Monte Bello Islands, W.A. comparing it with *H. septentrionalis* Esaki from Japan, the Ryukyu Islands and Taiwan. In reality, China's species is more closely related to *H. bergrothi* Esaki, which is widely distributed in the West Pacific, from Indo-China and the Philippines to the Marianna Islands, northern New Guinea, the Solomons and Samoa (Andersen 1989a). Generally, *H. hilli* is a smaller species than *bergrothi*, especially when only males are considered. The dorsal structure of thorax and basal abdomen of females also differs. Females of *hilli* have their dorsal convexity most pronounced at or a little before the middle of mesonotum while in females of *bergrothi*, the dorsal convexity is displaced towards the anterior part of mesonotum. In *H. hilli*, the male grasping comb rarely exceeds one half length of fore tibia, and the male parameres are more slender and the distal part of each is smoothly curved, not abruptly turned mesad as in *bergrothi*.

### *Halovelvia heron* Andersen

(Figs 66–70)

*Halovelvia heron* Andersen, 1989a: 102–103. – Cassis & Gross, 1995: 442.

#### Material examined

*Holotype*. ♂, 'Australia, Queensland, Heron Island, 16-20.xii.1967, S.R. Curtis' (UQIC).

*Paratypes*. **Queensland**: 1 ♂, Bedarra Island, on seawater, 12.viii.1976, D.C. Geijskes (RNHL); 3 ♂, 10 ♀, same label data as holotype (UQIC); 11 ♂, 1 ♀, Heron Island, 15.i.1965, B. Cantrell (UQIC); 1 ♂, 3 ♀, Heron Island, via Gladstone, 10.i.1965, B. Cantrell (UQIC); 1 ♂, 3 ♀, Heron Island, 15.i.1965, T. Weir (UQIC); 17 ♂, 7 ♀, Heron Island, N side of reef, Intertidal rocks, 15-17.v.1976, Lanna Cheng (JTPC, ZMUC).

*Other material examined*. **Queensland**: 2 ♂, 3 ♀, Masthead Island via Gladstone, ex beach rock, 5.xii.1972, J.H. Simmonds (UQIC); 6 ♂, 10 ♀, Heron Island, Great Barrier Reef, on sea surface near high water mark, 26.xi.1968, E.B. Britton & S. Misko (ANIC).

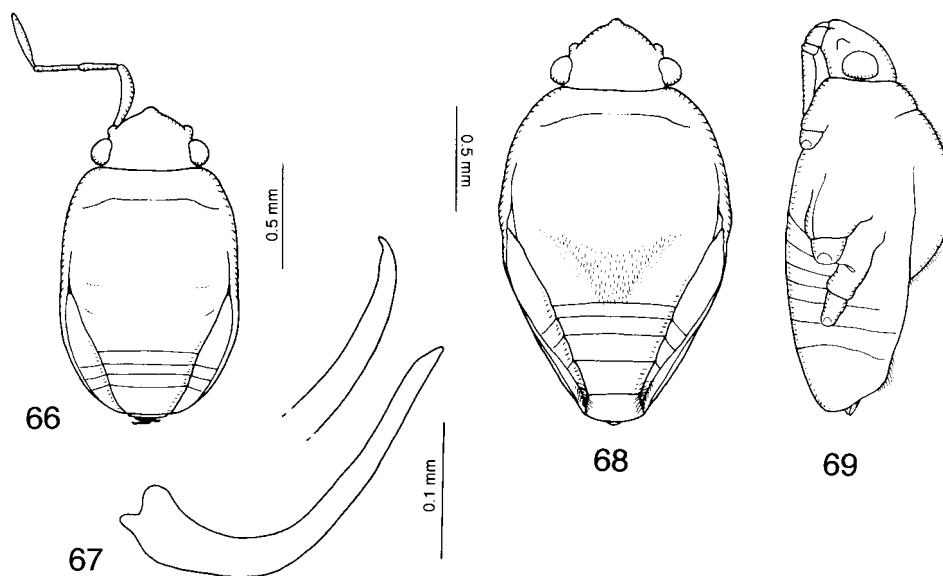
#### Description

*Size*. ♂, length 1.40–1.50, width 0.84–0.89; ♀, length 1.92–2.05, width 1.08–1.12.

*Colour*. Dark brownish with greyish pubescence which is denser and more distinctly grey on male abdomen. Basal abdominal terga of female with a large median patch of pale hairs. Female connexiva terminated by long, whitish hairs. A large yellowish brown spot at base of head.

*Male structure*. Body ovate (Fig. 66), total length a little more than 1.7× greatest width across thorax. Eyes relatively small, about 0.25× width of head between eyes. Antennal segments as in *H. hilli*. Grasping comb of fore tibia about half of tibial length; middle femur slightly more than 0.6× total length of insect. Abdominal venter slightly depressed beyond sternum 4. Parameres very long and slender, distinctly crossing each other dorsal to the genital





**Figs 66–69.** *Halovelia heron*: 66, dorsal structure of apterous ♂; appendages except left antenna omitted; 67, left paramere; different aspect of blade above; 68, dorsal structure of apterous ♀; appendages omitted; 69, lateral structure of apterous ♀; appendages omitted.

capsule (as in Fig. 59); blade of each paramere curved dorsad in lateral view, distal part turned mesad, apex at most slightly curved (Fig. 67).

**Female structure.** Body subovate (Fig. 68), length about  $1.8\times$  greatest width across thorax. Thoracic dorsum distinctly raised in middle of mesonotum (Fig. 69); thoracic and basal abdominal dorsum furnished with long, erect pubescence which is longer in the middle of posterior mesonotum, metanotum, and basal abdominal terga. Middle femur about  $0.6\times$  total length of insect. Abdomen broad at base, subparallel in anterior parts, tapering in width posteriorly; terga slightly depressed basally on each side and from segment 4 and backwards; connexiva more or less obliquely inclined anteriorly, almost vertically raised or slightly overturned posteriorly; tergum 8 short and wide, barely exposing proctiger behind.

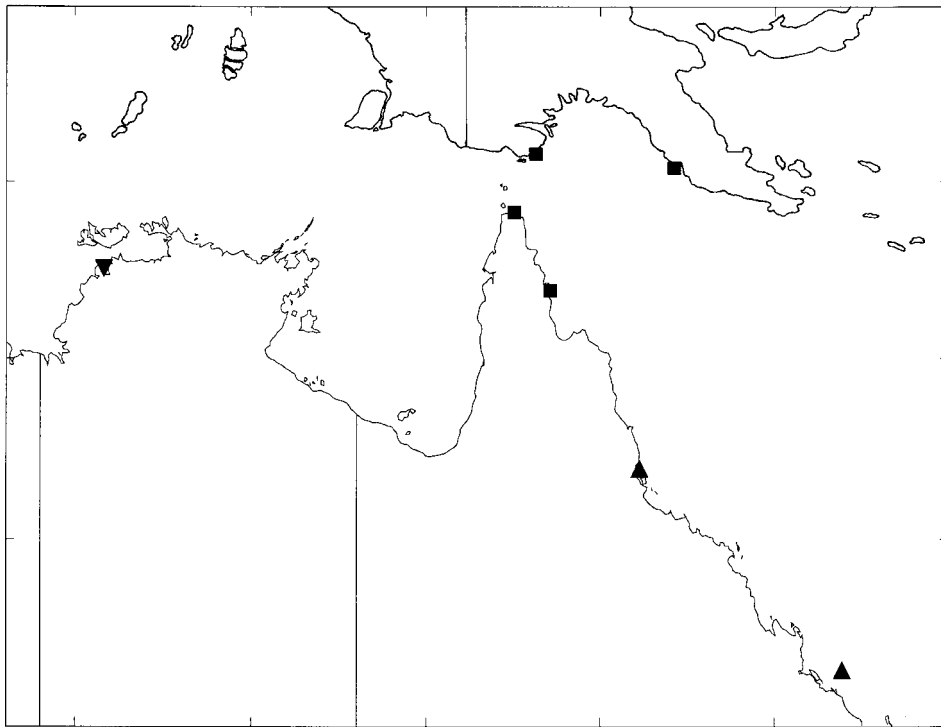
#### *Distribution and habitat*

This species has a very restricted distribution along the coast of Queensland (Fig. 70) and Heron Island is the only locality where it has been collected more than once. Dr Lanna Cheng (personal communication) collected this species among intertidal rocks on the northern side of the fringing reef at Heron Island.

#### *Comments*

*H. heron* is very closely related to, and not significantly different from *hilli* in absolute size, relative lengths of middle femora, etc. It can be recognised on the following characters (Andersen 1989a):

1. Extreme apex of male parameres straight instead of hook-shaped (compare Figs 60 and 67).
2. Females stouter, their length being only  $1.8\times$  instead of  $2.0\times$  greatest width of body.
3. Female abdomen more voluminous, especially in lateral aspect (compare Figs 62–63 and 69).
4. Metanotum and basal abdominal terga of female impressed on each side, forming a medial swelling furnished with long pubescence.



**Fig. 70.** Distribution of *Halovelia heron* ▲, *H. corallia* ■, and *H. polhemi* ▼.

The lack of *Halovelia* specimens with intermediate states of the above mentioned characters was the primary reason for giving the Heron Island population status as a separate species (Andersen 1989a: 103). Although no *Halovelia* has been recorded from localities between Heron Island and Magnetic Island to the north, it is likely that *H. heron* and *hilli* are sympatric somewhere in that area of the Great Barrier Reef. Only further collecting efforts can test that hypothesis.

### ***Halovelia maritima* Bergroth**

(Figs 65, 71–74)

*Halovelia maritima* Bergroth, 1893: 277–278. – China, 1957: 255; Andersen, 1989a: 87; Lansbury, 1989: 94–95; Cassis and Gross, 1995: 443.

#### *Material examined*

**Lectotype** (designated by China 1957: 255). ♂, 'Arafura Sea, 18/5/90, J.J. Walker', 'Type', 'Under blocks of coral below high water mark, Cartier I., Timor Sea, 100 miles from mainland, small island', 'Halovelia maritima Bergr., E.M.M. 1893, p. 277', and 'Champion coll. B.M. 1927-409' (BMNH).

**Paralectotypes.** 2♂♂, 7♀♀ (on same card as lectotype), same label data as lectotype (BMNH); 1♂, 'Halovelia maritima Bergr., ♂ paratype' and 'Arafura Sea, Cartier Is., B.M.1' (BMNH); 2♂♂ 1♀ (on slide), 'Halovelia maritima Bergr., Paratypes 2♂♂ 1♀', and 'Cartier Is., Paratypes 1' (BMNH); 1♂, 1♀, labelled '487 [= Cartier Islet, Arafura Sea, 18.5.90]', 'Paratype', 'N.W. Austr. 90-126 [= Pres. by J.J. Walker esq. Collected during the voyage of H.M.S. 'Penguin' by the donor (BMNH)', 'Under blocks of coral at half tide mark, common. J.J. Walker', and 'Halovelia maritima Bergr., E.E.M. 1993: 277' (BMNH).

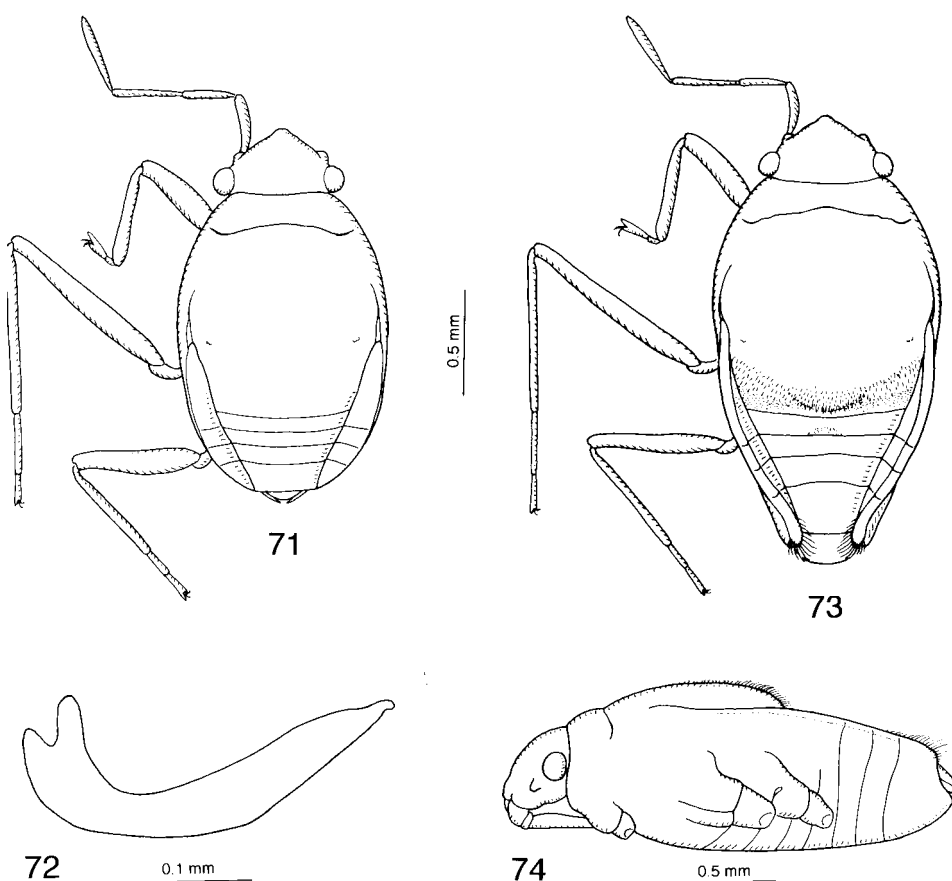
#### *Description*

**Size.** ♂, length 1.68–1.72, width 1.00–1.02; apterous ♀, length 2.12–2.20, width 1.02–1.08.

*Colour.* Black or dark brown with greyish pubescence which is longer and more dense on abdomen. An obscure spot at base of head and hind margin of pronotum, yellowish brown.

*Male structure.* Body ovate (Fig. 71), total length almost  $1.7\times$  greatest width across thorax. Eyes relatively small, slightly less than  $0.2\times$  width of head between eyes. Antennal segment 3 distinctly longer than segment 2 (ratio 1.3: 1). Hind margin of pronotum distinct throughout. Grasping comb of fore tibia about two fifths of tibial length; middle femur about  $0.5\times$  total length of insect; hind femur slightly thicker than middle femur. Abdominal venter slightly depressed beyond sternum 6, otherwise not modified. Parameres long, barely reaching each other dorsal to the genital capsule; blade of each paramere (Fig. 72) vertically flattened, broad and almost straight, apex blunt.

*Female structure.* Body subovate (Fig. 73), length  $2.0\times$  greatest width across thorax. Head structure as in male except that antennal segment 1 is more slender. Thoracic dorsum moderately raised, with greatest height in middle of mesonotum, with suberect pubescence which is distinctly longer on metanotum and basal abdominal terga. Middle femur  $0.4\times$  total length of insect. Abdomen basally with subparallel sides, tapering in width posteriorly; metanotum and basal terga raised, depressed behind tergum 3; connexiva suberect throughout; hind corner of each connexivum furnished with long hairs; tergum 8 relatively long, deflected and concealing proctiger.



**Figs 71–74.** *Halovelia maritima*: 71, dorsal structure of apterous  $\delta$ ; appendages of right side omitted; 72, left paramere; different aspect of blade above; 73, dorsal structure of apterous  $\text{♀}$ ; appendages of right side omitted; 74, lateral structure of apterous  $\delta$ ; appendages omitted.

*Distribution and habitat*

Known only from the type locality, Cartier Island (Fig. 65), a small coral island located in the Timor Sea, c. 250 km NW of Australia. The records from Pelsart Islands, W.A. (Hale 1926) and Darwin, N.T. (Polhemus 1982) which were repeated by Cassis and Gross (1995), refer to other species (see below). The haloveliines from Papua New Guinea identified as *H. maritima* by Esaki (1926: 162) belong to *Haloveloides browni* (Lansbury) (Andersen 1992: 397). Walker (1891: 235) describes his capture of these marine bugs: 'Cartier is a mere sand bank, less than half a mile in length, and destitute of even the smallest trace of vegetation, but it is surrounded by an extensive coral reef.', and 'There was, of course, nothing to do on the Islet except to look for shells, of which I found a good many, and while looking for these I met with a very curious and interesting little hemipteron (I fancy of the genus *Halobatoidea*), inhabiting the sand beneath stones near low water mark, *à la Aepys*'.

*Comments*

*H. maritima* is recognised by its relatively small eyes, distinct, yellowish brown hind margin of pronotum, distinct greyish patch of hairs on the female metanotum and basal abdomen, relatively short middle legs, and the shape of the parameres of the male.

China (1957) designated a male from the type series (in BMNH) as the lectotype for *H. maritima*. Subsequently, Lansbury (1989: 94) expressed 'a certain amount of confusion as to which is the type' citing Esaki's (1926) suggestion, that Bergroth retained the female type(s) of *maritima* in his own collection (presumably in the Zoological Museum, Helsinki). It is, however, difficult to prove that Bergroth only had females before him when he described this species and the lectotype designation by China (1957) is therefore, in our opinion, valid.

Hale (1926: 203–205) recorded *H. maritima* from Pelsart Islands, Western Australia and gave descriptive notes. Hale's illustration of a male (1926: fig. 84a) shows very long parameres which distinctly cross each other above the genital capsule. This is not the case in the male lectotype of *maritima* (Fig. 72). We have examined 3 ♂ and 1 ♀ from Pelsart Island (borrowed from SAMA) and can confirm that they belong to the widespread Australian species *H. hilli* China as suggested by Andersen (1989a: 88). Finally, the *Halovelina* specimens from Darwin, N.T., identified as *maritima* by Polhemus (1982: 9–10), were classified by Andersen (1989a) as belonging to a new species, *H. polhemi* (see below).

***Halovelina corallia* Andersen**

(Figs 70, 75–79)

*Halovelina corallia* Andersen, 1989a: 92–93. – Cassis & Gross, 1995: 442.*Material examined*

*Holotype*. M, 'Papua N. Guinea, Central Prov., Motupore [as Malupore] Is., Marine res. station, CL1839, IX-21-83, J.T. & D.A. Polhemus' (BPBM).

*Paratypes*. **Papua New Guinea**: 1 ♂, 10 ♀, same label data as holotype (BPBM, JTPC, ZMUC); 2 ♀, Western Province, Daru Island, CL1771, IX-1-83, J.T. & D.A. Polhemus (JTPC). **Queensland**: 3 ♀, Sherrard I., on reef, low tide, 9.vi.1956, E.N. Marks & MacKerras (UQIC).

*Other material examined*. **Queensland**: 1 ♀, Somerset, amongst mangroves on beach, 15.x.1992, T. Weir, P. Zborowski (ANIC).

*Description*

*Size*. ♂, length 1.58–1.63, width 0.89–0.94; ♀, length 1.85–1.96, width 0.92–0.95.

*Colour*. Black or dark brown with greyish pubescence which is longer and more distinctly greyish on abdomen. Base of head yellowish brown.

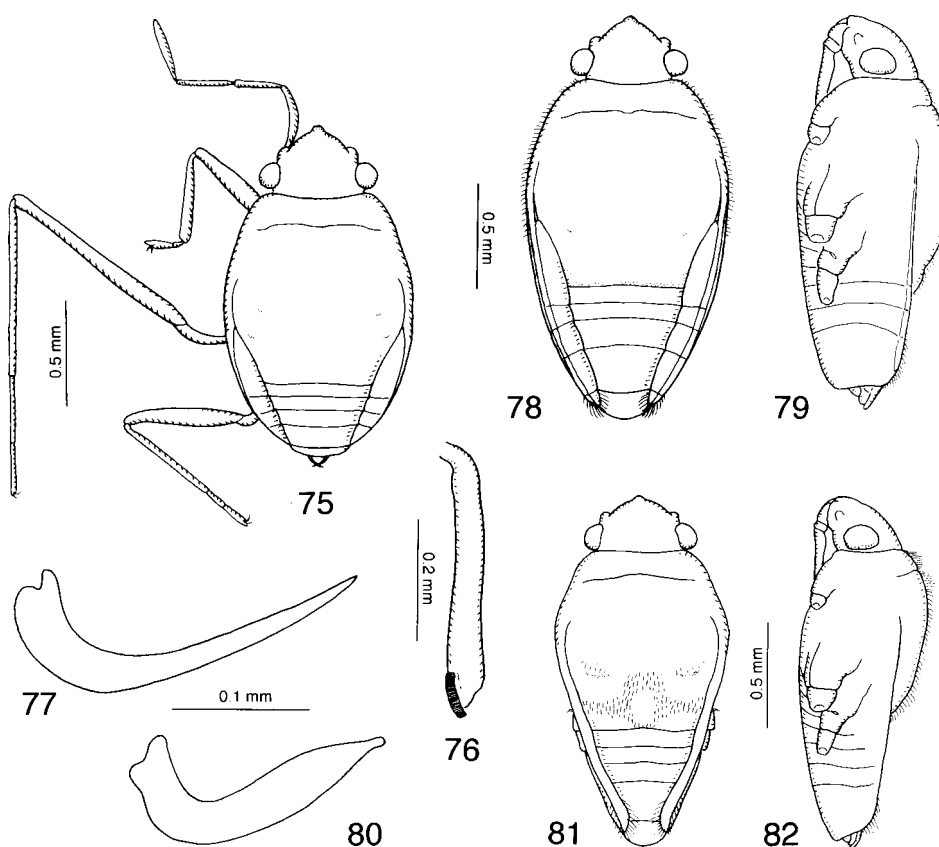
*Male structure*. Body ovate (Fig. 75), total length about 1.75× greatest width across thorax. Width of an eye about 0.25× width of head between eyes. Antennal segment 3 distinctly longer than segment 2 (ratio 1.3: 1). Hind margin of pronotum indistinct laterally. Grasping comb of

fore tibia short (Fig. 76), about one sixth of tibial length; middle femur almost  $0.6\times$  total length of insect; hind femur as thick as middle femur. Abdominal venter not modified. Parameres long, crossing each other dorsal to the genital capsule; blade of each paramere (Fig. 77) slender and straight, apex pointed.

**Female structure.** Body fusiform (Fig. 78), length  $2.0\times$  greatest width across thorax. Thoracic dorsum moderately raised (Fig. 79), with short, suberect pubescence. Middle femur almost  $0.5\times$  total length of insect. Abdomen with broadly rounded sides; abdominal terga depressed from segment 4 and backwards; connexiva erect throughout, their margins furnished with long suberect hairs which become longer towards abdominal end; tergum 8 relatively large, concealing proctiger.

#### *Distribution and habitat*

In Australia only recorded from Sherrard Island and Somerset Bay, northern Queensland (Fig. 70). At Motupore Island Marine Research Station, near Port Moresby, Papua New Guinea, *H. corallia* was found among coral blocks in the high tidal zone (J. Polhemus, unpublished field notes).



**Figs 75–79.** *Halovelia corallia*: 75, dorsal structure of apterous ♂; appendages of right side omitted; 76, left fore tibia of ♂ with grasping comb; 77, left paramere; 78, dorsal structure of apterous ♀; appendages omitted; 79, lateral structure of apterous ♀; appendages omitted. **Figs 80–82.** *Halovelia polhemi*: 80, left paramere; 81, dorsal structure of apterous ♀; appendages omitted; 82, lateral structure of apterous ♀; appendages omitted.

### Comments

*H. corallia* shares the relatively short middle femora and relatively long antennal segment 3 with *H. maritima*, but can be separated from the latter by the very short male grasping comb and the unmodified female thoracic dorsum.

### *Halovelgia polhemi* Andersen

(Figs 70, 80–82)

*Halovelgia polhemi* Andersen, 1989a: 109–110. – Cassis & Gross, 1995: 443.

*Halovelgia maritima* Bergroth. – Polhemus, 1982: 9–10.

### Material examined

*Holotype.* ♂, 'AUST., Darwin, N.T., East Point, CL904, XII-10-77, J.T. Polhemus' (ANIC).

*Paratypes.* **Northern Territory:** 31♂, 22♀, same label data as holotype (ANIC, JTPC, UQIC, ZMUC).

*Other material examined.* **Northern Territory:** 4♂, 1♀, Darwin, East Point Reserve, pools in rockshelf, above incoming tide, 9-10.vii.1994, T. Weir & A. Roach (ANIC).

### Description

*Size.* ♂, length 1.32–1.43, width 0.80–0.83; ♀, length 1.55–1.63, width 0.90–0.83.

*Colour.* Black or dark brown with greyish pubescence on entire abdomen ♂ or forming definite markings on dorsum of thorax and basal abdominal terga ♀. Female connexiva terminated by long, whitish hairs. A large yellowish brown spot at base of head.

*Male structure.* Body subovate, total length about 1.7× greatest width across thorax. Eyes relatively small, a little more than 0.25× width of head between eyes. Antennal segment 3 distinctly longer than segment 2 (ratio 1.25: 1). Grasping comb of fore tibia a little more than two sevenths of tibial length; middle femur about 0.7× total length of insect; hind femur slightly thicker than middle femur. Base of abdominal venter with a broad tumescence furnished with long hairs. Parameres short and stout; blade of each paramere (Fig. 80) broad, slightly widened before pointed apex.

*Female structure.* Body subovate (Fig. 81), length 1.95× greatest width across thorax. Thoracic dorsum moderately raised in middle of mesonotum (Fig. 82), furnished with erect pubescence which is distinctly longer on pronotum, anterior mesonotum, and on metanotum; metanotum with lateral, shallow impressions. Middle femur 0.55× total length of insect. Abdomen tapering in width posteriorly; terga distinctly depressed behind segment 3; connexiva suberect, converging towards abdominal end; tergum 8 prolonged, deflected posteriorly to conceal proctiger.

### Distribution and habitat

Only known from East Point Reef near Darwin, N.T. (Fig. 70), where it was found together with *H. hilli* in reef pools among large shoulder-high boulders, especially in certain sheltered localities under overhanging rock, and particular sites along more exposed rock surfaces (Polhemus 1982: 9).

### Comments

*H. polhemi* is very closely related to *H. esakii* Andersen (1989a), a widely distributed species known from the Solomon Islands, New Guinea, the Moluccas, Sulawesi, West Caroline Islands (Palau Islands), the Lesser Sunda Islands and the Philippines. Polhemus (1982: 9–10) identified this species as *H. maritima*, apparently because of the similarity in the shape of their parameres. *H. polhemi*, however, has relatively larger eyes, longer middle femora, and different structure of the female dorsum than *maritima*. It differs from *H. hilli* in being a smaller species with a much less convex female mesonotum, different shape of parameres, etc.

### Zoogeography

The marine Haloveliinae have a Indo-West Pacific distribution and probably originated somewhere in the Indo-Australian region (Andersen 1991, in press). The sister group of marine haloveliines is a clade composed of two limnic genera, *Entomovelina* Esaki and *Strongylovelina* Esaki, found in India, Indo-China and the Indo-Malayan Archipelago (Andersen 1982). The distribution of the marine genera *Xenobates* and *Haloveloides* (Andersen 1992) covers the same geographical areas, while the present distribution of *Halovelina* includes the whole Indo-West Pacific region, from the Red Sea to Samoa. Most species distributed along the coasts of East Africa, Madagascar, and the islands of the Indian Ocean (Mascarenes, Seychelles, Maldives) belong to the Southeast Asian *H. malaya* group (Andersen 1989b). The disjunct distribution of the most basal clades of *Halovelina* (East Africa, Caroline Islands, Australia) may be relictual of an ancient, much wider distribution of the genus. The record of an extinct species of *Halovelina* from Dominican amber (Andersen and Poinar, in press) supports this hypothesis.

The winged adult form has never been recorded in any species of marine water striders. Thus, marine water striders cannot disperse by flight like most insects, but must rely on other means of dispersal. Most species confined to estuaries and mangroves have relatively limited distributions suggesting that they do not disperse easily between geographically separate but otherwise suitable habitats. Some species of *Halovelina*, however, are so widely distributed that they may have dispersed by 'island-hopping' or by crossing wide stretches of open ocean.

As expected, the Australian fauna of marine Haloveliinae shows strong affinities to adjacent areas, in particular New Guinea and the islands of the West Pacific. Most of the Australian *Xenobates* species, however, seem to form a monophyletic group which may be most closely related to species groups on northern New Guinea, the Moluccas and Sulawesi (Andersen, unpublished). The relationships of the New Caledonian endemic, *X. loyaltiensis*, is at present obscure.

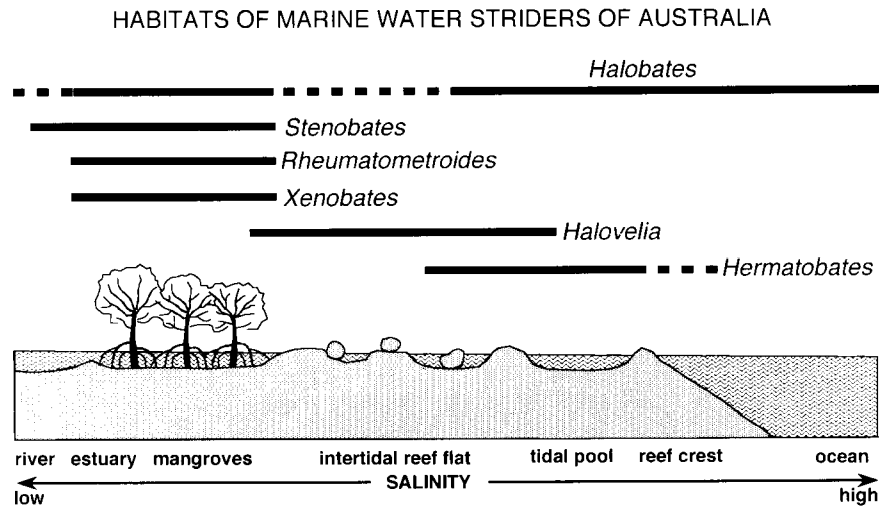
*Halovelina hilli* and *H. heron* belong to the *bergrothi*-group widely distributed in the western Pacific area whereas *H. polhemii* is a close relative of *H. esakii* which has an extensive distribution ranging from the Philippines to New Guinea and the Solomon Islands (Andersen 1989b). *H. maritima* and *H. corallia* belong to the basal clades of the phylogeny of *Halovelina* which include several species with presumable relictual distributions.

### Ecology of marine water striders of Australia

During the course of our project on the semiaquatic bugs of Australia we have examined about 170 samples containing marine water striders. About 100 of these are labelled with some sort of habitat data. Based on variations in salinity, tidal influence, wind exposure, wave action, and exposure to sunlight, the following types of habitats can be recognised:

1. *Rivers and creeks*. Fresh water without significant tidal influence. Shade usually available.
2. *Estuaries and mangrove swamps* with tidal influence. Salinity vary from brackish to euhaline. Shade from mangrove trees usually available.
3. *Saltwater lagoons* with or without fringing mangroves. Salinity usually high. Shade only available when the lagoon is fringed by tall trees.
4. *Intertidal reef flats* with tidal pools, coral rubble, and blocks of coral which are submerged during high tides. Salinity high. Shade only available in holes and cavities of coral blocks or beneath such blocks.
5. *Nearshore sea surface*, from relatively calm to exposed, with moderate wave action except for incoming surf. No shade available.
6. *Open ocean surface*, fully exposed to winds and with strong wave action. No shade available.

An idealised transect through various habitats is shown in Fig. 83 with the distribution of species belonging to the Australian genera of marine water striders. The sea skaters, genus *Halobates* (Gerridae, Halobatinae), show the widest range of habitat use (Andersen and Weir 1994). One species, *H. acherontis* Polhemus, was collected more than 100 km above the mouth of Daly River, Northern Territory (Polhemus 1982). Most Australian *Halobates* species, however, inhabit mangroves in river estuaries, tidal creeks, or protected bays (e.g., *H. mjobergi*



**Fig. 83.** Distribution of marine water striders of Australia on an idealised transect through marine habitats.

Hale, *H. zephyrus* Herring, *H. whiteleggei* Skuse, *H. darwini* Herring, and *H. herringi* Polhemus & Cheng) whereas *H. hayanus* White and *H. princeps* White inhabit tidal pools and lagoons along coral coasts. Finally, the open ocean surface is inhabited by *H. sericeus* Eschscholtz, *H. micans* Eschscholtz, and *H. germanus* White, the last mentioned species usually found closer to land than the two other species.

*Rheumatometroides carpentaria* Polhemus & Polhemus and *Stenobates australicus* Polhemus & Polhemus (Gerridae, Trepobatinae) are both inhabitants of estuaries and mangrove channels (Polhemus and Polhemus 1996; Andersen and Weir 1998).

As already described above, species belonging to the two genera of marine Haloveliinae occupy distinctly different types of habitats. *Xenobates* spp. are confined to estuaries and mangrove swamps with tidal influence, whereas *Halovelia* spp. inhabit intertidal reef flats with coral rubble and blocks of coral. The last mentioned type of habitat also seems to be preferred by coral treaders, genus *Hermatobates* Hermatobatidae) (Polhemus 1982; Foster 1989), although adults and larger nymphs frequently are captured on the nearshore sea surface, irrespective of tidal stage (Polhemus 1990).

Individuals belonging to different genera and species are often caught together in the same type of habitat. In samples from estuaries and mangrove habitats, we found strong associations of *Xenobates mangrove* with *Halobates herringi* (7 samples), with *Stenobates australicus* (5 samples), and with other *Xenobates* spp. (4 samples), but rarely with *Halobates mjobergi*, *darwini*, and *herringi*. On intertidal reef flats *Halovelia hilli* were most often found with *Hermatobates* spp. (5 samples) and with other *Halovelia* spp. (3 samples).

Marine water striders are generally darker than their freshwater relatives, probably as a protection against UV-radiation in fully sun-exposed situations (Cheng et al. 1978). Species of *Halovelia* living on exposed reef flats are generally darker than the mangrove-inhabiting *Xenobates* species. The oceanic species of *Halobates* (including immature stages) are darker than nearshore species which again have more limited pale colouration than mangrove-inhabiting *Halobates* spp.

Marine water striders inhabiting coastal habitats have acquired behavioural adaptations to cope with the tidal cycle of water level changes. Species of *Hermatobates* and *Halovelia* live on reef flats where they can be found on the surface of tidal pools. At high tide they retreat to holes in blocks of coral or other porous rocks where they rest, surrounded by an air bubble, until the next low tide (Andersen 1989b; Foster 1989).



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