

# TWO NEW SPECIES OF *HETEROLEPISMA* (ZYGENTOMA: LEPISMATIDAE) FROM EASTERN NEW SOUTH WALES

Graeme Smith

Australian Museum, 6 College Street, Sydney, New South Wales 2010, Australia.

Email: [le\\_gbsmith@optusnet.com.au](mailto:le_gbsmith@optusnet.com.au)

## Summary

Two new species of silverfish from the genus *Heterolepisma* are described from eastern New South Wales and compared with the nearest species.

**Keywords.** Thysanura, taxonomy, new species

## INTRODUCTION

The silverfish genus *Heterolepisma* Escherich, 1905 is well represented in Australia although it also occurs in Central and South America, Africa, on several Caribbean, Indian and Pacific Ocean islands as far north as the southern islands of Japan (Uchida, 1944 and 1968). It is not common in Africa but records exist from Angola and Mozambique (Mendes, 1993), Somalia (Mendes, 1995) and *H. exacta* (Silvestri 1918) was described from Tanzania. In total some 20 species are described, mostly inadequately.

Most of the described Australian species (Silvestri, 1908) were collected by the 1905 Michaelsen-Hartmeyer Expedition to south-western Western Australia. A further species was described by Womersley (1942) from Lord Howe Island and Smith (2013) recently described an additional species from Barrow Island. A review of specimens in various museum collections as well as collection efforts by the current author indicates that there are many undescribed species of the genus in the eastern half of Australia and that the earlier descriptions are no longer adequate for confident determination. This paper describes two species, according to current criteria, which were collected in the eastern half of New South Wales.

## MATERIALS AND METHODS

Both type series consist of specimens collected at the same site or at least within a short distance (<200m) of each other. All other material is excluded from the type series. All specimens are stored in 75-80% ethanol unless noted as slide mounted. A leg was removed from some specimens and placed in 100% ethanol to be stored at 4°C should the possibility arise to conduct DNA sequencing. All specimens referred to in the description are deposited in the entomological collection of the Australian Museum in Sydney (both on slides and in alcohol) and have been

allocated museum data base numbers starting with a "K" in the specimen list.

Locality co-ordinates for specimens collected by the author, were made using a hand held Garmin eTrex®10 GPS with a claimed accuracy usually under 5 metres.

Measurement data of whole specimens in alcohol were taken using a 10/100 scale in the 10x ocular of an Olympus CHT stage microscope. Specimens were placed in a Petri dish one third filled with black sand so that the part to be measured could be oriented close to horizontal. Measurement data was collected on at least ten, mostly mature specimens. Head width was measured between the outer edges of the eyes not from the margins of the mouthparts. Head and body length measured from the front of head to posterior margin of urotergite X. Thorax length measured between anterior and posterior margins along the mid-line and its width at widest point of each notum. Abdominal segment width was measured between the widest points. Antennae were measured from the base of the scape to surviving tip. Articles of maxillary and labial palps measured along their midline from the articulation with adjacent articles or to apex and their width at widest point. Cerci and median dorsal appendage were measured from base to surviving tip. Tibia and tarsus length was measured between articulations with adjacent articles along midline of view and their width at their widest point; the claws of the pretarsus were not included in the length. Stylets were measured from base to tip (excluding any apical spines) and the ovipositor from posterior margin of urosternite VII to the apex. The length of the prothoracic sternum was measured in whole specimens from a line projected across the thorax from the notches at the proximal end of the external margin just before the macrochaetae commence, to the apex of the sternum and the end of the internal margin of the coxa. The length and width of the

**Plate 1.** *Heterolepisma sclerophylla* n.sp. Broulee, NSW



**Plate 2.** *Heterolepisma highlandi* n.sp. Wee Jasper, NSW



processes of urosternite IX were measured only from slide material to ensure that curved surfaces had more or less flattened out before measurement.

Selected specimens were dissected under an Olympus SZ61 stereomicroscope and mounted on slides using Tendeiro solution. In general the head and thorax were mounted on one slide and the abdomen on a second slide. Efforts were made to line up the urosternites and urotergites in two lines from front to back however movement of the sclerites within the mounting fluid results in this ordering only being approximate. Drawings were made with the aid of an Olympus CX31 binocular microscope fitted with a U-DA drawing attachment.

Roman numerals are used to indicate abdominal segment number. In addition the following abbreviations are used: AM: Australian Museum, 6 College St, Sydney 2010 Australia; asl: above sea level (in metres); HW: head width (in millimetres); H+B: head and body length (in millimetres); L/W: length to width (ratio); NSW: New South Wales; PI, PII, PIII: legs of prothorax, mesothorax and metathorax respectively. The term macrochaetae refers to the larger stronger bristles (always apically bifurcated), setae refers to smaller thinner bristles (bifurcated or simple), setulae to the very small, usually straight, setae associated with the combs and cilia to the curly thin hairs, often associated with the combs, setal collar or notal margins.

## SYSTEMATICS

Family **Lepismatidae** Latreille, 1802

Subfamily **Heterolepismatinae** Mendes, 1991

***Heterolepisma*** Escherich, 1905

*Heterolepisma* Escherich, 1905: 63.

*Isolepisma* Escherich, 1905: 61.

*Notolepisma* Tillyard, 1924: 241.

Type species: *Lepisma pampeana* Silvestri, 1902 by subsequent designation.

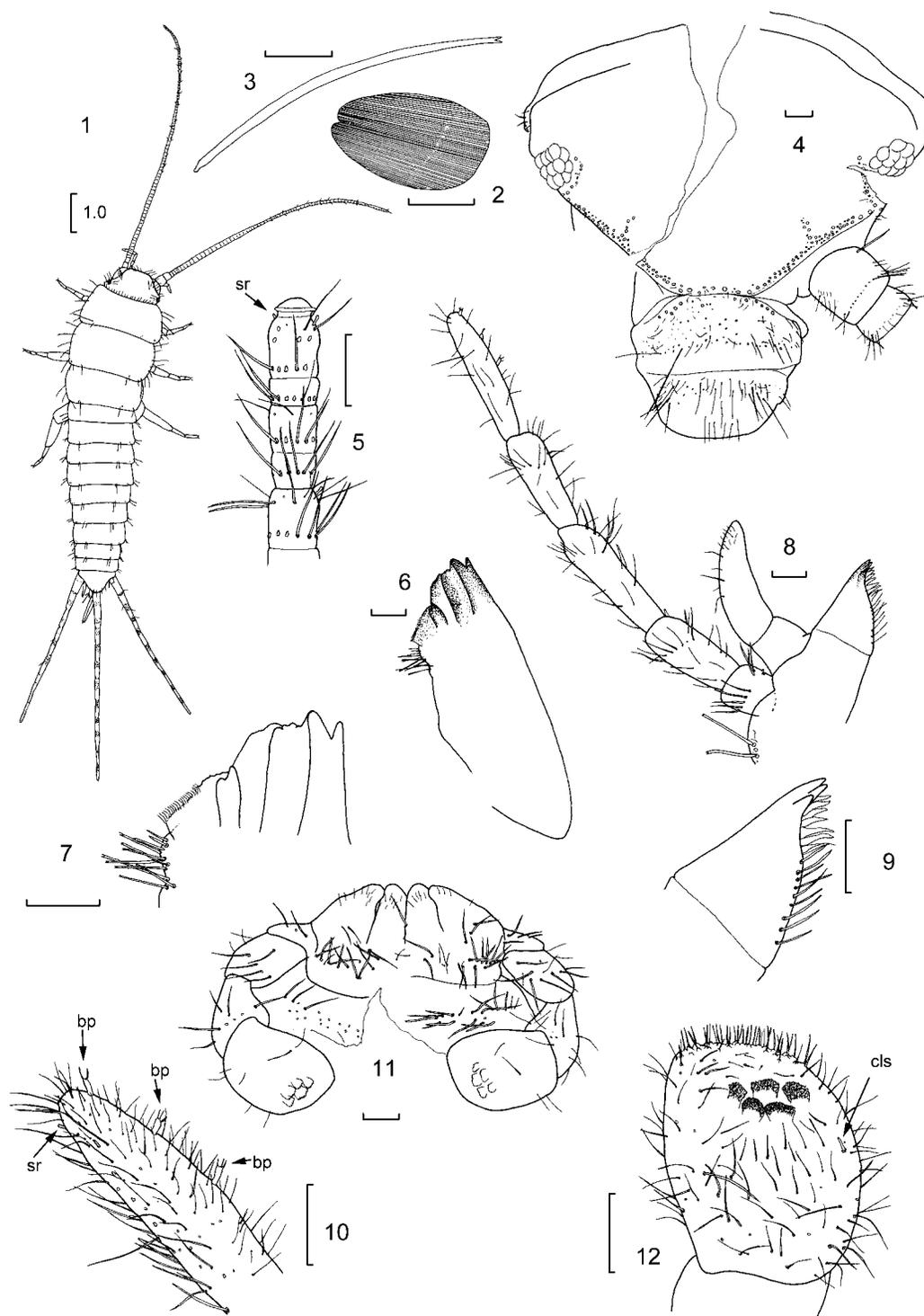
***Heterolepisma sclerophylla*** sp. n.

Figures 1-42, Plate 1

Material examined: Holotype: ♀ (HW 1.28) on two slides, Broulee, NSW 35°51.468'S 150°09.724'E 15m asl, 17.xi.2010, (K260990 K260991).

Paratypes: 8♀♀, 3♂♂, 1juv. same data as holotype, includes 1♂ (HW 1.25) on two slides (K260992 K260993), 1♀ (HW 1.10) on two slides (K261074 K261075), 1♀ (HW 1.20) (K377561), 1♀ (HW 1.40) (K377562), 1♀ HW (1.23) (K377563), 1♀ (HW 1.25) (K377564), 1♂ (HW 1.23) (K377565), 1♂ (HW 1.13)

(K377566), 1♀ (HW 1.15) (K377567), 1juv.♀ (HW 0.84) (K377568), 1♂ (HW 1.15) (K377569), 1♀ (HW 1.08) (K377570). Note: the holotype was about to moult so had almost fully formed sclerites under the old cuticle; in some cases for example, two pronota appear on the slide, one old missing most of the macrochaetae and the other new with all macrochaetae lying together in a bunch. Other material examined: Glenbrook, NSW, S33°48.116' E150°37.160' 131m asl, 19.vi.2010, 1♂ (HW 0.95) (K377579), 1♂ (HW 1.0) (K377580); Glenbrook, NSW S33°48.078' E150°37.164' 115m asl, 19.vi.2010, 1♂ (HW 1.13) on 2 slides (K261048 K261049) and 1♂, 3♀♀, 1 juvenile in single tube (K377581); Guerilla Bay, NSW, 35°49.929'S 150°13.877'E 87m asl, 17.xi.2010, 1♂ (HW 1.18) on two slides (K260994 K260995) and 4 juveniles in single tube (K377571-74); Lower Portland, NSW, S33°25.320' E150°53.671' 39m asl, 26.iii.2011, 1♀ (HW 1.25) on two slides (K261050, K261051), 1♂ (HW 1.21) on two slides (K261052, K261053), 1♀ (HW 1.33) (K377575) and 4♂♂, 4 juveniles in single tube (K377576); Lower Portland, NSW, S33°25.317' E150°53.631' 66m asl, 26.iii.2011, 1♂ (HW 1.08) (K377577) and 5♂♂, 1♀, 4 juveniles in single tube (K377578); Megalong Valley, NSW, S33°47' E150°18', 18.vi.2011, 2 juveniles in single tube (K377582); Megalong Valley, NSW, S33°47.436' E150°13.882' 640m asl, 19.vi.2011, 1♂ (HW 1.03) (K377583), 1 juvenile ♀ (HW 0.93) (K377584); Megalong Valley, NSW, S33°47.586' E150°14.119' 736m asl, 19.vi.2011, 1 juvenile ♀ (HW 0.91) on two slides (K261046 K261047) and 3♂♂ in single tube (K377585); Burrellow campsite (near Bilpin), NSW, S33.55542° E150.60543° 354m asl, 21.xi.2011, 1♀ (HW 1.40) on two slides (K261076 K261077) and 1♂, 1♀, 1 juvenile in single tube (K377592); Burrellow campsite, NSW, S33.55235° E150.59624° 352m asl, 21.xi.2011, 1♂, 2♀♀ in single tube (K377593); Clandella State Forest, NSW, S32.92990° E149.91534° 722m asl, 10.iii.2013, 1♀ on two slides (K261082 K261083) and 1♂ 1♀ 1 juvenile in single tube (K377590); Clandella State Forest, S32.92981° E149.91542° 730m asl, 10.iii.2013, 1♂ on two slides (K261092 K261093); Clandella State Forest S32.92977° E149.91551° 734m asl, 10.iii.2013, 1♀ 1 juvenile (K377590); Hawkesbury Heights, NSW, S33.66624° E151.64792° 244m, 17-18.xi.2012, 1♂ (HW 1.1) on two slides (K261078 K261079) and 1♀ (HW 1.18) (K377596); Ku-ring-gai, NSW, S33.61817° E151.25851° 239m, 6.viii.2011, 1♂ (K261080 K261081); Ku-ring-gai, S33.62070° E151.26887° 210m asl, 6.viii.2011, 2♀♀ in single tube (K377597); Nattai, NSW, above Middle Flat,



Figures 1-12. *Heterolepisma sclerophylla* sp.n. 1. habitus, 2. scale from urotergite, 3. macrochaeta from urotergite, 4. head (K260992), 5. antenna, most distal remaining article (near apex) showing sensory rods (sr), 6. mandible (K260992), with external macrochaetae omitted, 7. idem, enlargement of distal end, 8. Maxilla, 9. idem, enlargement of lacinia, 10. idem, enlargement of apex of palp showing sensory rods (sr) and branched papillae (bp), 11. labium, larger setae only, 12. idem, enlargement of distal article of labial palp with five papillae and curved, club-like sensilla (cls). All figures of ♀ holotype unless otherwise indicated. Scale bar = 0.1 mm unless otherwise indicated.

S34.24075° E150.35414° 201m asl, 30.iii.2013, 1♀ 2 juveniles in single tube (K377588) and 1♂ 1♀ in single tube (K377589); Nattai, plateau above Lady Amanda Creek, S34.26911° E150.39124° 623m asl, 30.iii.2013, 1♀ (HW 1.21) on two slides (K261084 K261085) and 1♂ 1 juvenile in single tube (K377587); Wellington, NSW, Mt. Arthur Reserve, S32.54791° E148.90897°, 450m asl, 10.iii.2012, 1♀ (HW 1.08) on two slides (K261086 K261087) and 1♀ (HW 0.84) (K377594); Wellington, Mt. Arthur Reserve, S32.54772° E148.90914°, 450m asl, 10.iii.2012, 1♂ 1♀ 1 juvenile in single tube (K377595). All specimens collected by the author.

Description: Appearance in life, mottled grey with lighter brownish appendages, nota with lighter lateral margins, terminal filaments distinctly banded (Plate 1).

Body length up to 8.75mm (♂) 8.63 (♀), no obvious size difference between sexes; maximum head width 1.40mm; thorax: length up to 2.95mm (or 0.29-0.34 times H+B); width up to 2.35mm, widest at mesothorax; maximum preserved length of antenna 5.38mm (or 0.71 x H+B); terminal filaments damaged in all specimens, maximum preserved length of cerci 4.55mm (or 0.68 x H+B); maximum preserved length of median dorsal appendage 4.80mm or 0.71 x H+B. Body neither elongate nor broad (Figure 1) with thorax slightly wider than abdominal segment I, the following abdominal segments become slightly wider until the fourth or fifth. Pigment brown or perhaps slightly purple in alcohol preserved specimens but fades in slide mounted material. Pigment laterally on head especially behind the antennae and surrounding the eyes, an extremely faint band across the frons between the antennae as well as a light band crossing distal half of clypeus. Pigment present on distal half of the pedicel and scape but lacking on ends of articles, rest of flagellum uniformly lightly pigmented although lighter at distal end of each article. Maxillary palp with denser pigmentation in articles two and three but less in the ultimate article especially apically. Labial palp with slight pigmentation in proximal half of ultimate article and moderate pigmentation in penultimate article, following article only slightly pigmented; thoracic tergites with slight pigmentation postero-laterally. Legs with light pigmentation on posterior margin of femur and stronger pigmentation on the anterior margin only distally and little or no pigment on trochanter. Tibia strongly pigmented but pigment largely missing from both ends. Basal tarsal article strongly pigmented except at each end, the following articles with some pigment especially dorsally but much reduced. Stylets IX moderately pigmented

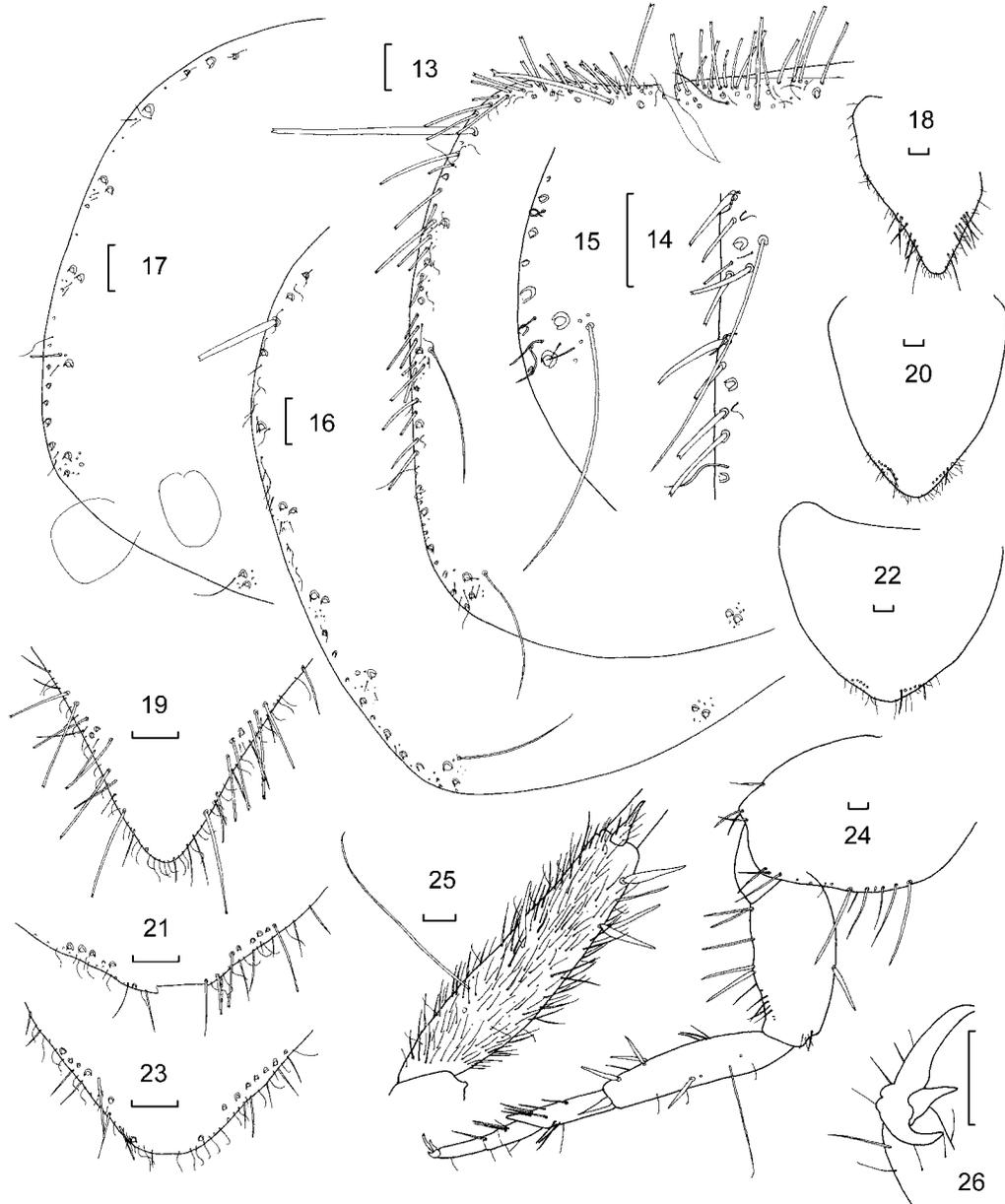
except distally, very light pigment on other stylets. Coxites IX with light pigmentation. Ovipositor with yellowish hue. Cerci and median dorsal appendage with rings of pigmentation, the darker areas getting increasingly longer distally. Some individuals show greater or lesser levels of pigmentation, especially noticeable on the apical article of the labial palp, where it can extend to the apex.

Scales (Figure 2) in alcohol dorsally dark brown (much more so in their apical half) or clear ventrally, rounded or ovoid, with numerous parallel rays, that do not extend beyond the margin. Lanceolate scales have not been observed. Macrochaetae bifid or trifid apically or simple, hyaline or brown (Figure 3).

Head wider than long and with chaetotaxy typical of the genus (Figure 4) i.e. marginal rows of macrochaetae along the sides of the vertex, including a complete anterior row and extending back along the margin to and above the eyes, as well as a small group extending sub-perpendicular to the margin at the level of the antennae; clypeus with numerous setae, some long and thin, and 1+1 combs of 3-5 macrochaetae proximally at the lateral ends of the suture with the frons; labrum with many long thin setae. Scales on top of head only. Eyes dark, composed of about twelve ommatidia. Antennae long, reaching about  $\frac{2}{3}$  H+B; the more apical articles with at least one rod-like basiconic sensilla near the apex of each article (Figure 5) as well as a trichobothria in each apical subarticle. Mandibles (Figures 6-7) typical with well-developed molar and incisor areas; a group of about 12 setae distally adjacent to the pectinate molar area and a bush of 30+ setae and macrochaetae externally. Maxilla (Figures 8-10) without special characters, the lacinia with three strong teeth, seven lamellate processes and a row of nine setae, apical article of maxillary palp (Figure 10) 3.5 - 5.5 times longer than wide and 1.1-2 times longer than penultimate article, the ultimate article in both sexes with three "branched" papillae along the margin in the apical half. Labium (Figure 11) short and broad with rows of setae on prementum; labial palp short, apical article subrectangular (Figure 12), about as long as wide (0.9-1.2) with 2+3 papillae of compact type and at least one curved club-like sensilla.

Pronotum (Figure 13) with wide setal collar of shorter and longer, mostly apically bifurcated setae and macrochaetae, and cilia, not arranged in distinct rows but about 3-4 macrochaetae wide with 1+1 long (almost twice that of other macrochaetae) thin simple macrochaetae well medially to the level of the eyes among the more posterior "row" of bifurcated

Figures 13-26. *Heterolepisma sclerophylla* sp.n. 13. pronotum, left margin, 14. idem, anterior trichobothrial area, 15. idem, posterior trichobothrial area, 16. mesonotum, left margin, 17. metanotum, left margin, with outline of two scales, 18. prosternum, 19. idem, enlargement of apex, 20. mesosternum, 21. idem, enlargement of apex, 22. metasternum, 23. idem, enlargement of apex, 24. metathoracic leg, major setae only, 25. idem, chaetotaxy of tibia, 26. pretarsus (K377562). All figures of ♀ holotype unless otherwise indicated. Scale bar = 0.1 mm.



macrochaetae. Lateral margins with numerous shorter and longer setae as well as numerous cilia slightly mediad to the marginal setae, each side with 6-7 larger submarginal macrochaetae. Trichobothrial areas open and in contact with the lateral margins, the anterior one about half way along the margin with none or just one macrochaeta (Figure 14) and two to four setulae, and the trichobothria located mediad to the macrochaeta. Posterior trichobothrial area in posterior lateral corner with two macrochaetae

(Figure 15) oriented obliquely (i.e. one smaller insertion close to the margin and the larger one more anterior and mediad) as well as a few setulae and a cilia, the trichobothria located in the most mediad position. Posterior margin slightly concave with 1+1 combs of two macrochaetae associated with three cilia and a setula, but otherwise glabrous. Mesonotum (Figure 16) and metanotum (Figure 17) lacking anterior notal collar; lateral chaetotaxy differing from pronotum in that the two submarginal macrochaetae

anterior to (or rarely also those in) the trichobothrial areas arranged in combs of two macrochaetae and the anterior trichobothrial areas located more posteriorly at about  $\frac{3}{4}$  of the distance along the margin, with the trichobothria located between the macrochaeta and the margin and slightly anterior to the macrochaeta. The number of combs of two macrochaetae can vary from the left to the right hand side of the same specimen (e.g. anterior trichobothria area of *Clandella* specimen (K261092 K261093) has two macrochaetae on both sides of the metanotum but only one on the right side of the mesonotum).

Presternum narrow, with transverse row of strong setae. Prosternum subtriangular, about as long as wide at base, narrow to very narrow apically (Figures 18 and 19), sometimes with subapical constriction, reaching only to about 0.70 to 0.85 times the length of the coxa, distal third with about four to seven setae on each side forming a weak comb almost parallel to the margin and 1+1 setae subdistally (on some specimens the setae of the combs are positioned slightly more widely spaced and the gap between the comb and the subdistal seta indistinct), as well as a fringe of small straight or curved setae on the distal lateral two thirds. Mesosternum (Figures 20 and 21) longer than broad with two to seven setae forming submarginal combs near the distal margin on each side. Metasternum (Figures 22 and 23) more rounded but still with a distinct apex (sometimes straight), slightly wider than long with 1+1 distal combs of five to seven setae, the distance between the combs 1.2-3.3 times the length of each comb. Margins of all thoracic sternites with small setae and cilia as well as a few setulae between the combs and the margin.

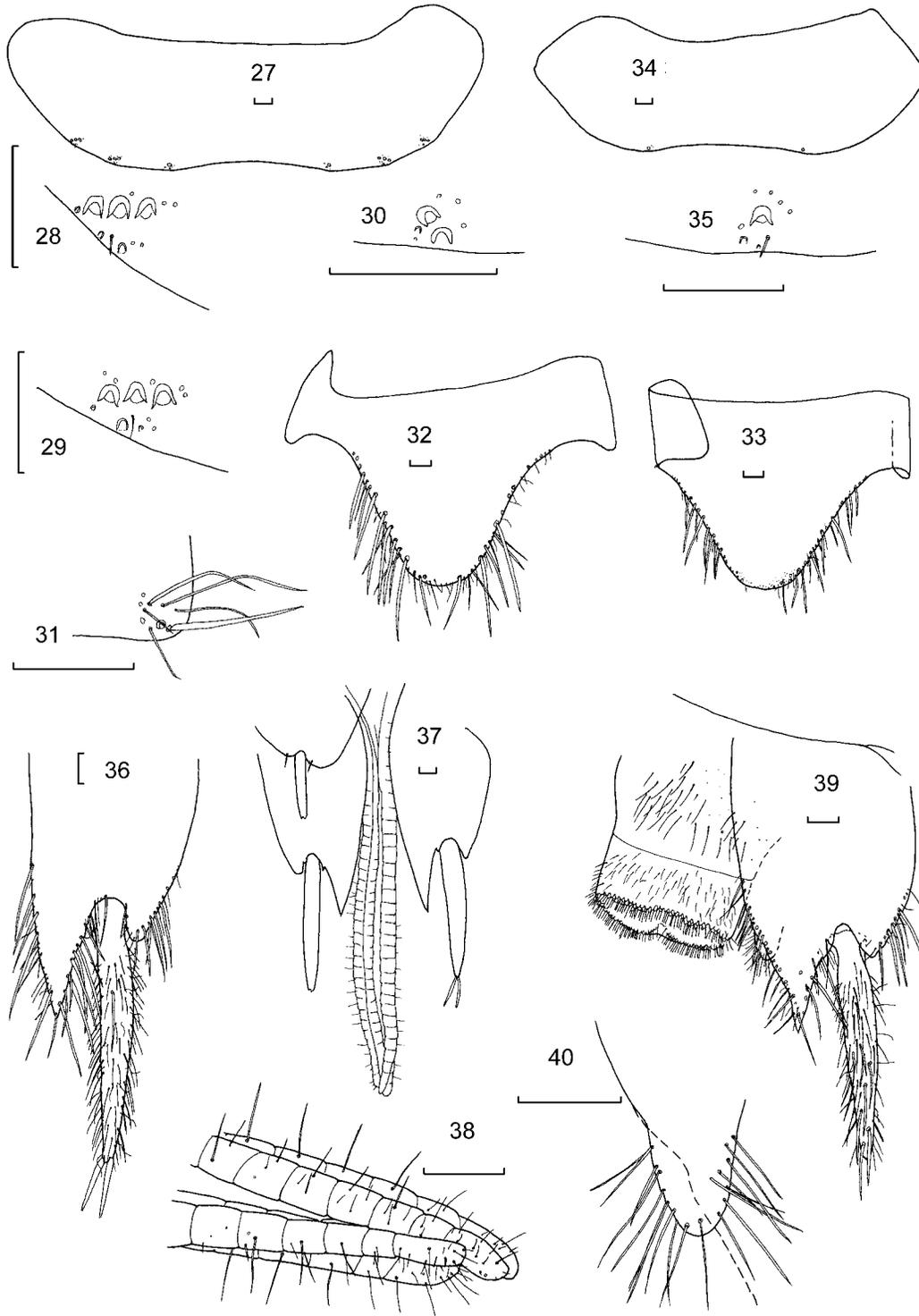
Legs fairly long (Figure 24), tibia L/W ratio of legs PI 2.3-3.9, PII 2.9-3.9, PIII 3.4-4.6; tarsi L/W ratio PI

4.8-7.0, PII 6.2-7.4, PIII 6.8-9.8. Transverse comb of about seven macrochaetae laterally on small article between prothoracic presternum and coxa. Coxa well scaled with numerous strong macrochaetae along the external margin, a stout macrochaeta on the inner margin subapically and group of about four stout curved macrochaetae at the apex over the articulation. Femur lacking scales, with several strong spines ventrally and dorsally two or three smaller setae subdistally and one about  $\frac{2}{3}$  of the way along the margin, in addition to the fine setae over the surfaces. All tibia with three pairs of strong macrochaetae ventrally and another stout macrochaeta on face subapically; tibia of PI and PII with three stout macrochaetae near the outer margin. Tibia of P III (Figure 25) with three pairs of stout macrochaetae ventrally but only two macrochaetae near the dorsal margin (more distal macrochaeta absent), as well as a long laterally projecting thin seta, which is almost as long as the length of the tibia, located near the more proximal macrochaeta. Tarsus with four articles although joints between distal three articles quite indistinct. Pretarsus with long curved lateral claws and a strong and a shorter medial claw (Figure 26).

Urotergite I with lateral combs of two or three macrochaetae plus two small setae located posterior to the combs almost on the margin, two or three cilia around the macrochaetae and some setulae and sublateral combs also of two or three macrochaetae with one to two marginal setae, one or two cilia and some setulae. Urotergites II-VII (Figure 27) with three pairs of combs, the lateral comb (Figure 28) with three to four, the sublateral (Figure 29) with two to three macrochaetae, the submedial comb (Figure 30) with two long macrochaetae of almost the same

**Table 1.** Number of macrochaetae per bristle comb in specimens of *Heterolepisma sclerophylla*

Segment	Urotergite			Urosternites
	Lateral	Sublateral	Submedial	
I	2-3	2-3	-	-
II	3-4	2-3	2	1
III	3-4	2-3	2	1
IV	4	3-4	2	1
V	4	3-4	2	1
VI	4-5	3-4	2	1
VII	3-5	3-4	2	1
VIII	3	-	1-2	1
IX	1-2 (infralateral setae)	-	-	-



Figures 27 – 40. *Heterolepisma sclerophylla* sp.n. 27. urotergite III? (K260993), 28. idem, lateral comb, 29. idem, sublateral comb, 30. idem, submedial comb, 31. right infralateral comb of urotergite IX, 32. urotergite X of ♀, 33. urotergite X of ♂ (K260993), 34. urosternite III? (K260993), 35. idem, detail of right sublateral comb, 36. right coxite IX of ♀ with stylet, 37. genital region of ♀, omitting most chaetotaxy, 38. idem, detail of apices of gonapophyses, 39. genital region of ♂ (K260993), showing penis, paramere, left coxite IX and stylet, 40. idem, detail of paramere. All figures of ♀ holotype unless otherwise indicated. Scale bar = 0.1 mm.

length, arranged obliquely with the more mediad and closer to the margin, being thinner and displaying a smaller insertion, plus some cilia and setulae and zero to two marginal setae. Urotergite VIII lacking the sublateral comb. Urotergite IX with one or two infralateral setae (Figure 31), as well as a few long thin sensory hairs. Urotergite X parabolic, similar in both sexes (Figures 32 and 33), L/W at base about 0.5 to 0.7 (generally slightly longer on ♀ than on ♂) with several strong and numerous finer setae on margin, 1+1 submarginal macrochaetae in postero-lateral corners.

Urosternite I glabrous, urosternites II-VIII with 1+1 isolated macrochaetae (Figures 34-35) and zero to one marginal seta as well as a few cilia and/or setulae. Stylets in three pairs in the ♀ (VII-IX) but only two pairs in the ♂ (VIII-IX); all stylets with at least two significantly quite long stronger setae apically (e.g. Figure 36). Stylets IX more than twice as long as stylets VIII with numerous setae which are quite strong apically, stylets VII of ♀ are only slightly smaller than those on VIII.

Genital region of ♀ as in Figure 37, the internal process of coxite IX about two times longer than wide at its base and three times longer than the external process. Ovipositor on holotype not very long (up to 2.09 HW), exceeding the apex of stylet IX by about half the length of the stylet (excluding terminal macrochaetae), composed of about 34 articles. However the ovipositor in some specimens (e.g. Portland ♀ K261051) is longer, surpassing the apices of stylets IX by more than one and a half times the length of the stylet, with more than 40 articles. Distal area of gonapophyses VIII and IX as in Figure 38 with only short fine setae and setulae. Coxite IX in the ♂ as in Figure 39, the internal process acute apically, about three times longer than the external process and 1 and one third times as long as broad at its base; external margin of coxite IX with several moderately strong setae in the posterior third. Penis typical with numerous glandular setae apically, each set on a protuberance. Parameres small, a bit longer than wide, with about 20 fine setae (Figure 40).

Cerci (Figures 41 and 42) with articles from second small, several times wider than long, gradually becoming longer, equally wide as long by the sixth article, after which they begin to subdivide into subarticles, and after about the tenth article they subdivide again, and yet again by about the thirteenth so that the “individual articles” between the rosettes of very large macrochaetae consist of eight subarticles; all articles with macrochaetae having only a minute apical bifurcation, setae and

trichobothria, the latter especially numerous on the basal articles of median filament; similar subsegmentation occurs slightly more distad to that on the cerci.

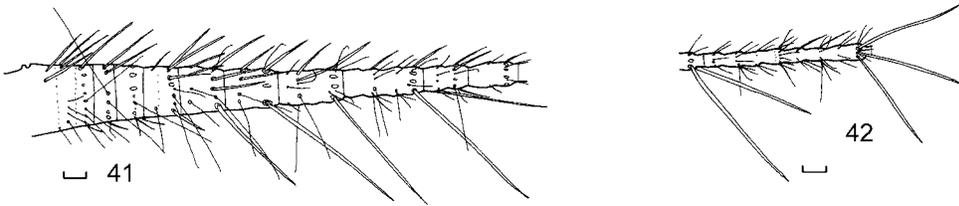
Subadult stages: One female (K377594) with HW 0.84 has stylets VII only represented by small triangular points and the end of the ovipositor is not yet visible between coxites IX.

Derivation of name: The species name is derived from the botanical term “sclerophyll” which describes a type of hard leaved forest. This species commonly occurs in the “moister” sclerophyll forests of eastern New South Wales.

Habitat: The type specimens from Broulee were collected in Eucalypt leaf litter accumulating between the fronds of *Macrozamia* cycads. The silverfish were generally high in the dry leaf litter rather than at soil level. Live specimens held in the same leaf litter for a few weeks always preferred to sit on the leaves well above the soil level. In general this species can be found in places where they can avoid moisture but where leaf litter can accumulate. Such habitats include accumulations of dry leaf litter sheltered under fallen trees or rock overhangs, bark and leaf litter caught in the low forks of trees or on well drained exposed rocks, under bark and within old abandoned tunnels in badly termite-damaged fallen branches.

Discussion: With a glabrous urosternite I, lateral and sublateral combs only on urotergite I and stylets on VII-IX in the female and VIII-IX in the male, this species is closest to *H. kraepelini* Silvestri, 1908 from Western Australia and *H. howensis* Womersley, 1942 from Lord Howe Island. Descriptions of both these species are inadequate, making comparison with the literature unsatisfactory. Both are described as having submedial urotergal combs of one macrochaeta whereas *H. sclerophylla* has two macrochaetae of similar size. However, examination of a single female specimen from Lord Howe Island, collected in 2000, confirms many characters in common. Both species exhibit a short apically narrow prothoracic sternite. Both have a similar chaetotaxy on the thoracic sternites and nota with the exception of the setulae, which are almost absent on the Lord Howe Island specimen (K261088 K261089). Contrary to Womersley (1942), the posterior submedial combs of the tergites in the single specimen examined show two insertions per comb in similar positions to those of *H. sclerophylla*. However the more postero-medial insertion is a lot smaller than the other possibly leading to the interpretation of having only single posterior macrochaeta (and a thinner seta?). The Lord

Figures 41 – 42. *Heterolepisma sclerophylla* sp.n. 41. base of cercus, 42. idem, most distal remaining article. All figures of ♀ holotype. Scale bar = 0.1 mm.



Howe Island specimen exhibits the strikingly truncate urotergite X illustrated by Womersley, which contrasts with the rounded one of *H. sclerophylla*. However, four specimens examined of the latter, a juvenile ♀ from the Megalong Valley (K261046 K 261047), a ♂ and a juvenile ♀ from Nattai (K377588) and a ♂ from Ku-ring-gai (K261081) also show a somewhat straighter (even slightly concave posterior margin on urotergite X and the Megalong Valley specimen has quite small mediad posterior macrochaetae insertions on the tergites (and in one case this is even missing) and therefore approaching the condition in *H. howensis*. These two species may eventually prove to be conspecific. A redescription of the Lord Howe Island species would clearly be beneficial in establishing the consistency of the features mentioned, however DNA sequencing may be required to decide on the significance of these differences.

*H. sclerophylla* also has a long very thin seta on the tibia of PIII in both sexes. This seta is easily broken off and hence overlooked but was illustrated in the original description of *Heterolepisma rouxi* (Silvestri, 1915) from New Caledonia, and reported by Wygodzinsky (1961) as a trichobothria for both *Allacrotelsa dubia* (Menge, 1854) and *Allacrotelsa spinulata* (Packard, 1873) and, also as a trichobothria, by Mendes (1989) for various species of *Acrotelsella* i.e. *A. procedens* Silvestri, 1935, *A. pacifica* Silvestri, 1935 and *A. annamita* Silvestri, 1948.

***Heterolepisma highlandi* sp. n.**

Figures 43- 82, Plate 2

Material examined: Holotype: ♀ (HW 0.93) on two slides, Wee Jasper, NSW, 35°03.535'S 148°38.972'E 555m asl, (K260996 K260997).

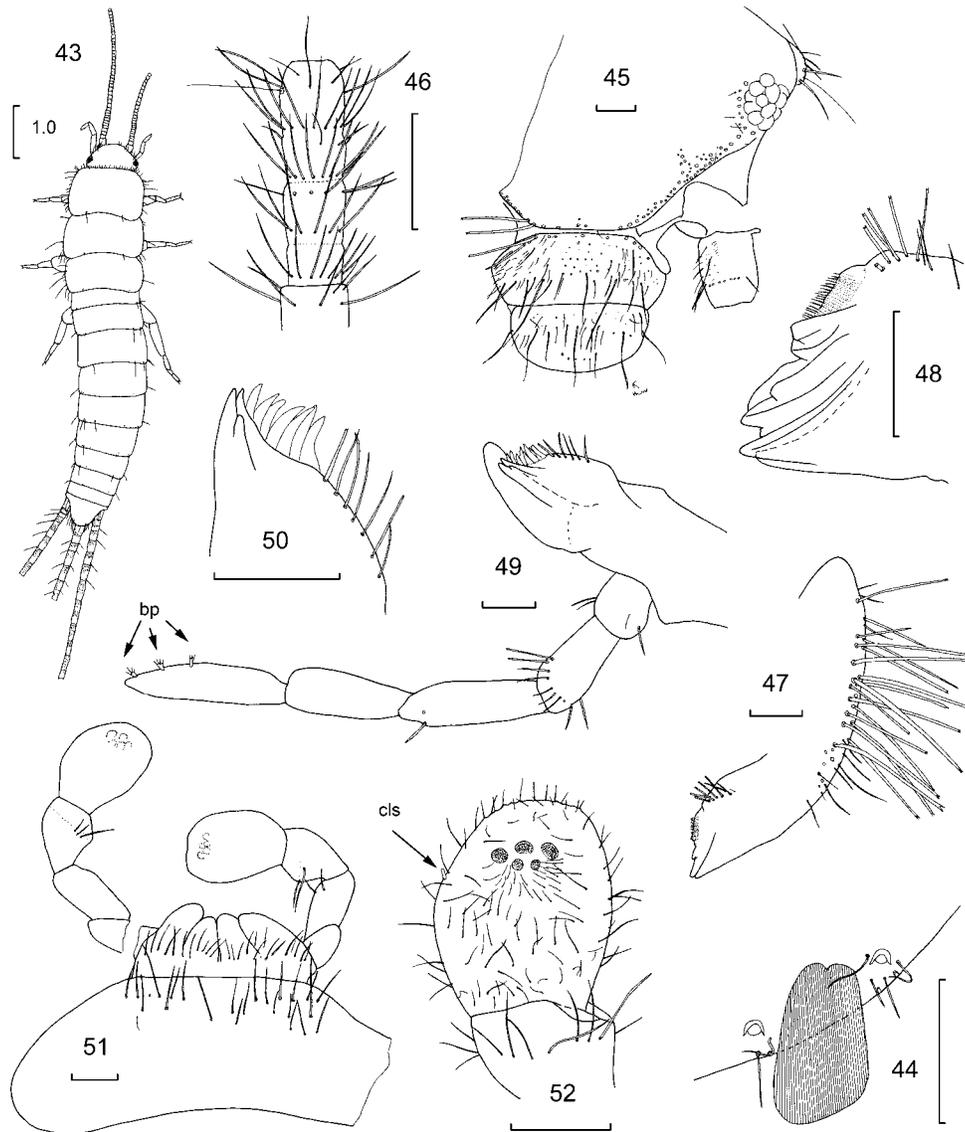
Paratypes: 1♂, 6♀♀, 9 juveniles, same data as holotype, includes 1♀ (HW 1.00) (K377598), 1♂ (HW 0.88) on two slides (K2600998 K260999); 1juvenile♀ (HW 0.55) (K377599); Wee Jasper S35°03.696' E148°39.839' 558m asl, 1♀ (HW 1.03) (K377600), 1♀ (HW 1.03) on two slides (K261000),

5 juveniles (HW 0.50-0.68) in single tube (K377601); Wee Jasper S35°03.523' E148°39.009' 519m asl, 1 juvenile. (HW 0.63) (K377602); Wee Jasper, NSW S35°03.543' E148°38.935' 552m asl; 1♀ (HW 1.25) (K377603), 1 juvenile ♀ (HW 0.88) (K377604); 1♀ (HW 1.00) (K377605); ♀ (HW 1.03) (K377606); 1 juvenile ♂ (HW 0.68) (K377607); 1 juvenile ♀ (HW 0.68) (K377608). All collected by G.B. Smith & P. Fleming, 21.viii.2010.

Description: Appearance in life mottled light silvery above with light lateral margins on nota, appendages light grey purple or slightly brown appearance, terminal appendages distinctly banded (Plate 2).

Body length up to 9.55mm (♀), 6.55mm (♂) but size difference may be due to small sample size (only two mature males); maximum head width 1.25mm; thorax: length up to 2.50mm (or 0.25-0.33 times H+B); width up to 1.80mm; maximum length of antenna 3.43mm (or 0.62 x H+B); maximum cerci 2.85mm (or 0.51 x H+B); median dorsal appendage damaged in all specimens, maximum preserved length 2.33mm or 0.48 x H+B. Body moderately narrow and somewhat elongate (Figure 43) with thorax not much wider than the middle abdominal segments.

Pigment brown, visible in alcohol preserved specimens but fades in slide mounted material. Head with pigment around eyes, along lateral margins especially around the comb behind the antennal insertions and around eyes. Pigment on clypeus and frons especially laterally. Sides of pedicel and scape pigmented, the rest of the flagellum uniformly lightly pigmented. Mandibles with pigment on outer face among the macrochaetae. Ultimate article of maxillary palp with pigmentation only on one side towards the base, penultimate article more densely pigmented on all sides but not at its base, the following two articles most densely pigmented on the sides.



Figures 43 – 52. *Heterolepisma highlandi* sp. n. 43. habitus (K377605), 44. lateral and sublateral combs and scale of urotergite I, 45. head (right side missing), 46. antennae, most distal remaining article (mid antenna), 47. mandible, 48. idem, enlargement of distal end, 49. maxilla showing branched papillae (bp) and larger setae, 50. idem, enlargement of apex of lacinia, 51. labium, larger setae only, 52. idem, enlargement of distal article of labial palp with 5 papillae and curved, club-like sensilla (cls). All figures of ♀ holotype except habitus. Scale bar = 0.1 mm unless otherwise indicated.

Labial palp with clear pigmentation on most of ultimate article; penultimate article also strongly pigmented except around the basal articulation. Thoracic tergites with pigmentation laterally especially anterior corners. Legs with light pigmentation on both inner and outer margins of coxa. Trochanter with light pigment on posterior edge. Femur also with pigmentation on posterior margin with light pigment extending over the surface of the article, strongest on distal apex of the outer margin. Tibia fairly evenly pigmented except for

around distal articulation. Basal tarsal article pigmented but remainder of tarsus free of pigment. Stylets IX pigmented except for small portion at apex and base. Coxites VIII and IX with light pigmentation becoming more obvious posteriorly. Ovipositor without pigment. Urotergite X with pigment especially antero-laterally. Cerci and median dorsal appendage with rings of pigmentation in proximal half of each article. Scales on alcohol preserved specimens appear dark brown or clear, rounded or ovoid, with numerous parallel rays (Figure 44), that

do not extend beyond the margin. Isolated lancet-shaped scale hairs appear to be present on coxa and cerci but are very difficult to discern. Ventral scales hyaline. Macrochaetae bifid or rarely trifid apically or simple, hyaline or brown.

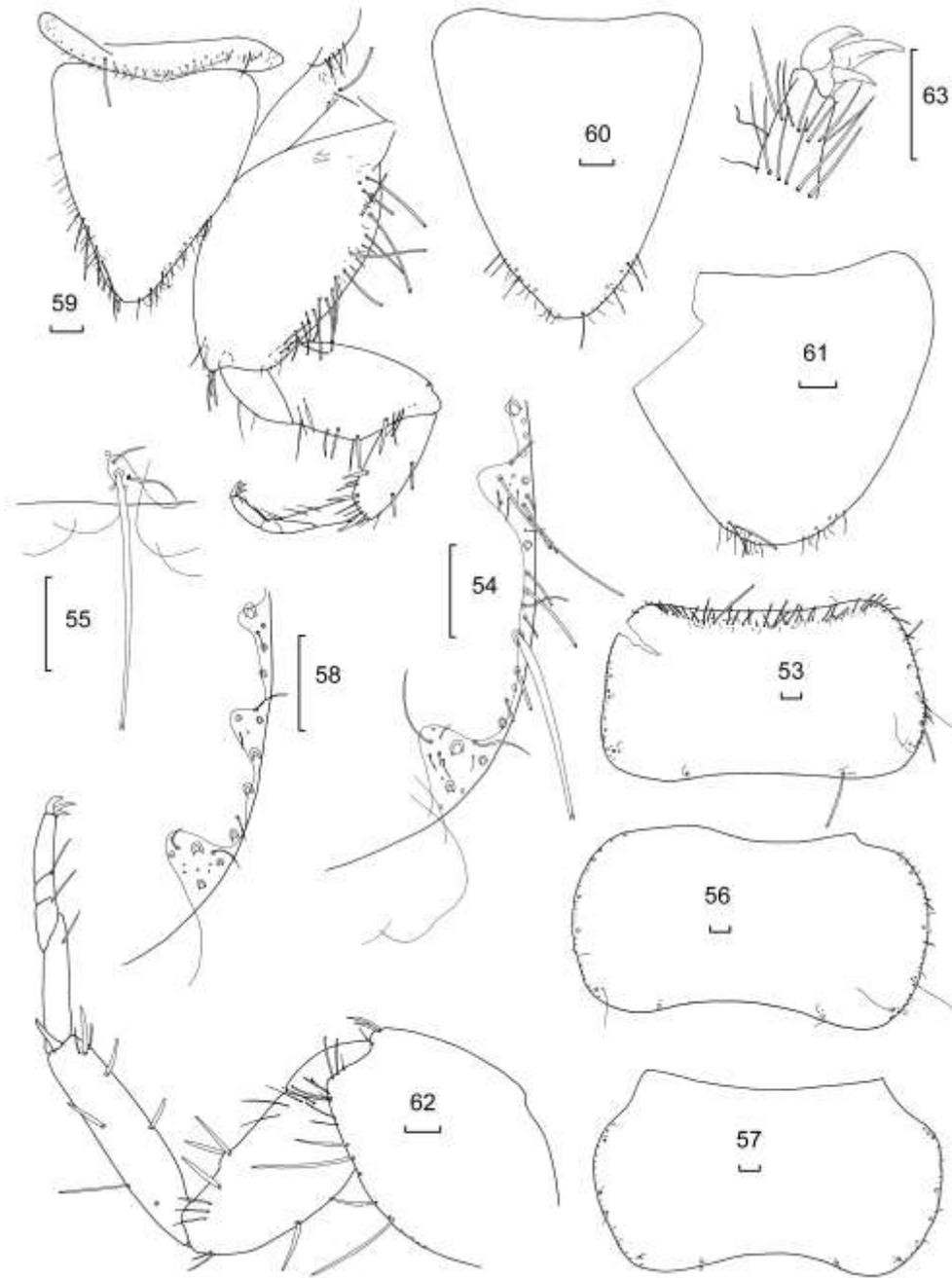
Head wider than long and with chaetotaxy typical of the genus (Figure 45) i.e. marginal rows of macrochaetae around the vertex, extending back in front of the eyes, as well as a small row extending posteriorly above the insertion points of the antennae, the anterior marginal row almost lacking, with only a few macrochaetae medially. Clypeus with long, thin setae and numerous shorter setae and four or five stronger macrochaetae in a dorso-lateral row. Labrum with five long thin setae and several shorter setae. Scales on top of head only. Eyes dark, composed of about twelve ommatidia. Antennae long, reaching to almost  $\frac{2}{3}$  H+B; the most apical surviving articles on slide mounted specimens (about half complete length) divided into subarticles with setae and an apical trichobothria, appear to be without rod-like basiconic sensillae (Figure 46). Mandibles (Figure 47) typical with well-developed molar and incisor areas; a group of five or six stout bifurcated and three smaller setae distally adjacent to molar area (Figure 48) and a bush of more than 40 macrochaetae externally. Maxilla (Figure 49) without special characters, the lacinia (Figure 50) with three strong teeth, seven lamellate processes and a row of six or seven setae. Apical article of maxillary palp 2.73-4.43 times longer than wide and 1.07-1.5 times longer than penultimate article, the ultimate article in both sexes with three "branched" papillae along the margin in the apical half and appear to be without rod-like sensillae. Labium (Figure 51) short and broad with rows of setae on prementum. Labial palp short, apical article subrectangular (Figure 52), slightly longer than wide (1.05-1.31) with 2+3 papillae of compact type in two rows with the posterior two smaller than the others, which arch around them distally, and at least one curved club-like sensilla.

Pronotum (Figure 53) with anterior collar of stout, apically bifurcated setae in a very irregular row about two macrochaetae wide along the anterior margin as well as two much longer but also thick macrochaetae mediad to the eyes in a posterior position, as well as numerous small curly hair-like cilia among and posterior to the setae. Lateral margins with short,

apically bifurcated and also pointed setae and cilia plus four or five single submarginal macrochaetae. Trichobothrial areas open and in contact with the lateral margins, the anterior one slightly behind the mid-point of the margin not associated with a large macrochaeta (Figure 54) with a cilia and three or four setulae. Posterior trichobothrial area in posterior lateral corner with one macrochaeta accompanied by two small cilia and some setulae. Posterior margin slightly concave with 1+1 single macrochaetae each associated with one or two cilia and a setula (Figure 55), but otherwise glabrous. Meso and meta nota (Figures. 56 - 58) with slightly concave posterior margins. Laterally with fringe of short stout setae and cilia as well as three or four stronger submarginal macrochaetae which are usually single and only occasionally present as a pair (e.g. on one side of mesonotum (K377600) and one side of metanotum (K377603)). Anterior trichobothrial areas located more posteriorly at about  $\frac{2}{3}$  of the distance along the margin and lacking larger macrochaetae. Posterior trichobothrial areas located on the postero-lateral corners with a single macrochaeta; 1+1 dorsal posterior macrochaetae with a single apically bifurcated macrochaeta and a few short curly setae.

Presternum narrow with row of macrochaetae along the transverse midline. Prothoracic sternum narrow cordiform, reaching to  $\frac{3}{4}$  the length of the coxae of PI (74-88% the length of the coxa) (Figure 59), only slightly longer than wide at base (ratio about 1.10), margins of posterior  $\frac{2}{3}$  with fringe of fine straight or curved small setae, distal half with about five to seven long setae on each side forming a weak comb almost parallel to and close to the margin, with a few setulae, as well as 1+1 apical setae; on some specimens the setae are positioned close together, on others slightly more widely spaced, especially the most distal and longest setae which may almost be on the margin some distance from the others in some specimens. Mesosternum (Figure 60) longer than broad with three or four setae forming very weak submarginal combs near the distal margin on each side, with fringe of curled setae only in distal third. Metasternum (Figure 61) rounded, wider than long (ratio 1.2), with weak 1+1 distal combs of two to four setae, the distance between them 1.5-2.7 times the length of each comb.

Legs fairly long (Figures 59 and 62), tibia L/W ratio of legs PI 2.57-3.44, PII 2.45-3.93, PIII 2.93-4.63; tarsi L/W ratio PI 5.33-7.76, PII 5.83-8.75, PIII 7.67-



Figures 53 – 63. *Heterolepisma highlandi* sp. n. 53. Pronotum, 54. idem, anterior and posterior trichobothrial areas of right margin (limit of scales shown as fine line), 55. idem, posterior comb and macrochaeta, 56. mesonotum, 57. metanotum, 58 – Idem, anterior and posterior trichobothrial areas of right margin (limit of scales shown as fine line), 59. presternum, prosternum and right prothoracic leg, 60. mesosternum, 61. metasternum, 62. metathoracic leg, major setae only, 63. idem, pretarsus. All figures of holotype. Scale bar = 0.1 mm.

9.75. Transverse comb of about three macrochaetae laterally on small article at base of coxa. Coxa with rounded scales and possibly lancet-shaped scales. Strong setae ventrally in the distal half, and one strong seta/macrochaeta dorsally as well as some

smaller but strong setae subdistally over the articulation. Tibia with three (pairs?) of strong macrochaetae ventrally, two subdistally, one of which is longer than the tibial spur and two on the outer margin

Tibia of leg III (Figure 62) with a third seta which is longer and thinner than the others located between them and closer to the lateral margin, this seta is thicker and more robust than that of *H. sclerophylla* and it is also absent from PI and PII. Tarsus with four articles although joints between distal three articles very indistinct. Pretarsus (Figure 63) with long curved lateral claws and a strong but shorter medial claw.

Urotergite I with lateral and sublateral combs each of only one macrochaeta plus one or two cilia and one to three setulae (Figure 64). Urotergites II-VII (Figure 65) with three pairs of combs, the lateral comb (Figure 66) with two or three macrochaetae, the sublateral with one or two (Figure 67) macrochaetae, the submedial with one macrochaeta (Figure 68). These combs also with one or two smaller straight setae plus one to three very small setulae located between the combs and the margin and a few small curly cilia, (about twice the length of the setulae) between the macrochaetae. Urotergite VIII (Figure 69) with lateral (Figure 70) and submedial (Figure 71) combs only; urotergite IX (Figure 72) with one to three infralateral setae (Figure 73), as well as a setula and two or more(?) cilia. Urotergite X parabolic, similar in both sexes (Figures 74 and 75) but slightly longer in the ♀, with several strong and numerous finer setae on margin, without strongly pronounced macrochaetae in postero-lateral corners.

Urosternite I glabrous, urosternites II-VIII with 1+1 isolated macrochaetae (Figures 76 - 77) associated with a submarginal setula and a cilia. Stylets present only on segment IX in both sexes (Figures 78 and 79); stylets with numerous setae which are quite strong apically. The stylets were present on all specimens examined although quite short and lacking

strong setae in the smallest specimen examined (HW 0.50mm, H+B 2.50mm).

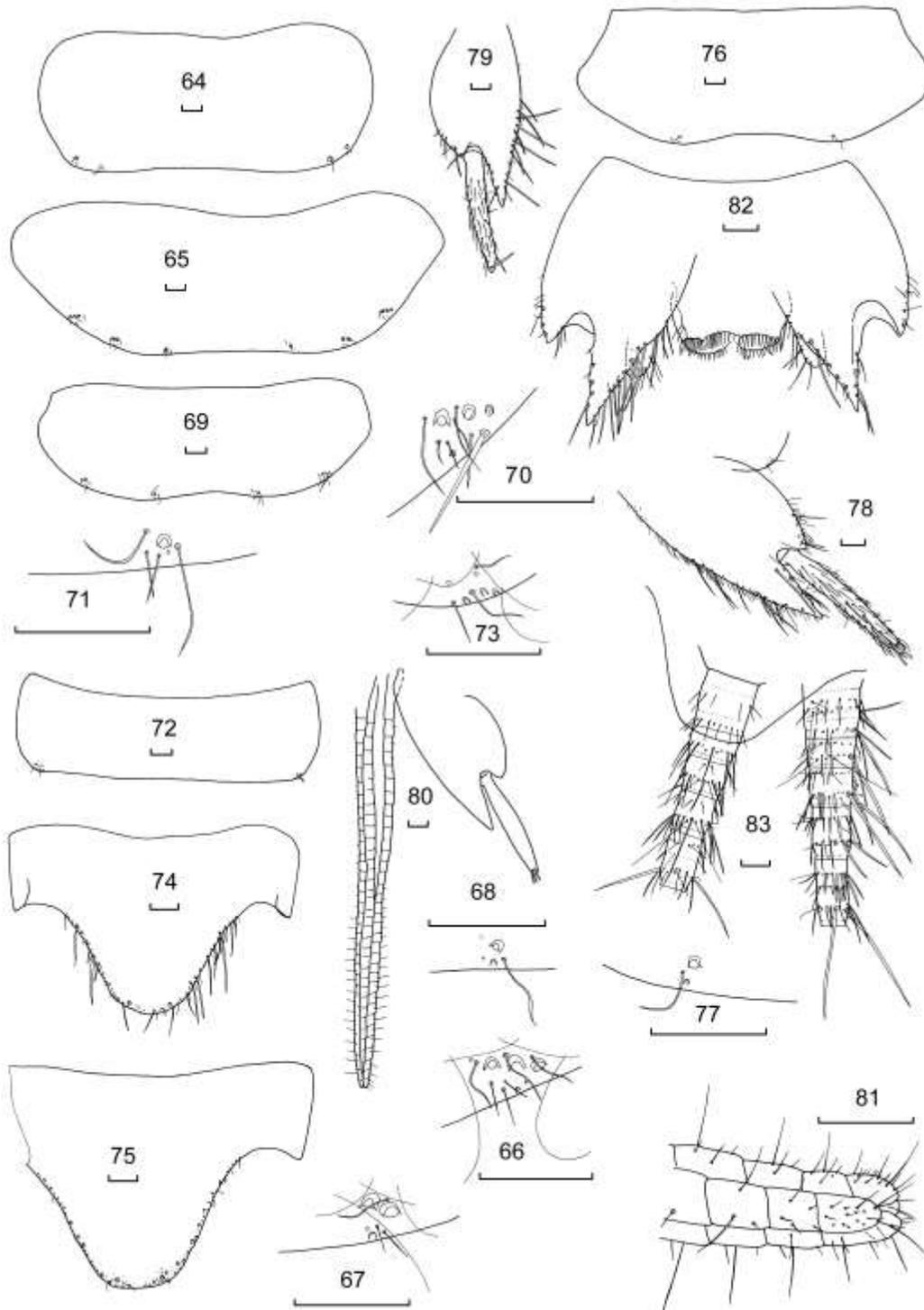
Genital region of ♀ as in figure 80, the internal process of coxite IX acute, about 1.9 times longer than wide at its base and 3½ times longer than the external process. Ovipositor (Figure 80) very slightly yellowish, up to 2.47 times HW, moderately long, exceeding the apex of stylet IX by about 1½ times the length of the stylet (excluding terminal macrochaetae), composed of about 34 articles each slightly longer than wide; distal area of gonapophyses VIII and IX as in figure 81. Coxite IX of ♂ as in figure 82, the internal process acute apically, about 2½ times longer than the external process and 1½ times as long as broad at its base. Penis (Figure 82) typical with numerous glandular setae apically, each set on a protuberance. Parameres small, a bit longer than wide, with about 18 fine setae.

Cerci (Figure 83) with articles from second small, wider than long gradually becoming longer than wide by the fifth to eighth article after which they begin to subdivide into subarticles, and after about the seventh to tenth article they subdivide again, and yet again by about the ninth or eleventh so that the "individual articles" between the rosettes of very large macrochaetae consist of eight subarticles; macrochaetae of all articles with only minute apical bifurcation, setae and trichobothria, the latter especially numerous on the basal articles; lanceolate scales appear to be present on the outer surface of the cerci beyond the sixth article; median filament (Figure 83) similar.

Derivation of name: The species is named for the Highland Caving Group, whose members organised some of the field trips during which specimens were collected and who have assisted the author with collection.

**Table 2** . Number of macrochaetae per bristle comb in specimens of *Heterolepisma highlandi*

Segment	Urotergite			Urosternites
	Lateral	Sublateral	Submedial	
I	1	1	-	-
II	2	2	1	1
III	2-3	2	1	1
IV	3	2	1	1
V	3	1-2	1	1
VI	3	1-2	1	1
VII	2-3	1-2	1	1
VIII	2	-	1	1
IX	1-3 infralateral setae	-	-	-



Figures 64 – 83. *Heterolepisma highlandi* sp. n. 64. urotergite I, 65. urotergite VI?, 66. idem, lateral comb, 67. idem, submedial comb, 68. idem, submedial comb, 69. urotergite VIII, 70. idem, lateral comb, 71. idem, submedial comb, 72. urotergite IX, 73. idem, infralateral comb, 74. urotergite X of ♂ (K260999), 75. urotergite X of ♀, 76. urosternite III?, 77. idem, right submedial comb, 78. apex of left coxite VIII and coxite IX of ♀ with stylet (K261001), 79. left coxite IX of ♀ with stylet, 80. genital region and ovipositor of ♀, omitting most chaetotaxy (K261001), 81. idem, detail of apices of gonapophyses, 82. genital region of ♂ (K260999), showing penis, paramera and coxites IX, 83. base of right cercus and median filament. All figures of ♀ holotype unless otherwise indicated. Scale bar = 0.1 mm.

Habitat: All specimens were collected high up a steep hillside; one specimen was collected in a decaying termite-eaten log, the remainder were collected from dry soil/leaf litter accumulations, sheltered from rainfall by rock overhangs.

Discussion: Only one other species of the genus (*H. horni* Stach, 1933 from Ecuador and the Caribbean islands) is described with stylets restricted to segment IX in both sexes, 2+2 combs on urotergite I and (probably) a glabrous urosternite I but it can be distinguished from *H. highlandi* by the double row of setae on the metasternum and its truncated urotergite X. However, the author has recently collected related material from eastern New South Wales with the same configuration as *H. highlandi*. This material differs, inter alia, in the shape of thoracic sternites and the nature of the long setae on PIII.

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