

Two new Inquiline Silverfish (Zygentoma: Ateluridae, Lepismatidae) From Malaysia

by

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ABSTRACT

Two new species of silverfish are described. Males and females of *Xenolepisma penangi* new species were collected from the nest of the ant *Monomorium pharaonis* (L.). It is the first record of this genus in South East Asia. Females only of *Crypturelloides mindenii* new genus and new species were collected from two separate colonies of the termite *Globitermes sulphureus* Haviland. Video footage of this species in the colony suggests the termite hosts totally ignore the activities of the silverfish.

Key Words: ants, silverfish, inquilines, new species

INTRODUCTION

Several genera and species of inquiline silverfish have been described from Malaysia, all belonging to the family Ateluridae (Silvestri 1916, Uchida 1968, Mendes 1987). This paper describes two new species collected from nests of ants and termites found around Penang. One, collected with a colony of the termite *Globitermes sulphureus* Haviland, is placed in a new Atelurid genus related to others from the Oriental region. The other, collected with a colony of the ant *Monomorium pharaonis* (L.), belongs to the genus *Xenolepisma*, of the Lepismatinae, previously reported from South Africa and southern India.

MATERIALS AND METHODS

Silverfish were found to be present when colonies of their host species were collected from the field and established in the Urban Entomology Laboratory, Vector Control Research Unit, Universiti Sains Malaysia. The silverfish were collected from these colonies and sent to the first author for identification and description.

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Measurement data of whole specimens in 75% ethanol 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. Three Atelurid and three Lepismid specimens were dissected under an Olympus SZ61 stereo microscope (Olympus Co., Tokyo, Japan) and mounted on slides using Tendiero solution. Drawings of specimens in alcohol and on slides were made with the aid of an Olympus CX31 binocular microscope (Olympus Co., Tokyo, Japan) fitted with a U-DA drawing attachment. Abbreviations: Roman numerals are used to number the abdominal segments; H+B, head and body length from the frons to end of urotergite X.

A short video clip recorded using Canon Digital IXUS 120IS (Canon Co., Tokyo, Japan) of the Atelurid species with its termite hosts was examined for indications of the relationship between the silverfish and their hosts.

All specimens are deposited with the Australian Museum, Sydney with accession numbers shown in brackets alongside the material examined.

RESULTS AND DISCUSSION

FAMILY ATELURIDAE

Crypturelloides new genus Smith & Veera Singham (Figs 1-26, Plate 1)

Type species. *Crypturelloides mindeni* new species

Derivation of name. The new genus is so named because of its close proximity to the genus *Crypturella* Silvestri, 1911.

Description. ♀. Small insects tending to oniscoid in shape, not tapering very strongly towards the rear; abdomen merging smoothly with thorax; head quite flattened and not rounded, partially protected under prothorax; antennae short, a little more than one third H+B; cerci less than one tenth H+B; median dorsal appendage almost twice the length of the cerci (Figs. 1 and 2).

Head and body covered with various forms of multi-radiate scales whose rays extend beyond the posterior margin of the scale (Figs 3 and 4). Macrochaetae long and simple, some without apical bifurcation, but others, including the

strong infralateral tergal macrochaetae with a very delicate bifurcation apically and also some exceptionally bifurcated macrochaetae on the pedicel.

Antennae (Figs. 5 - 7) short, robust, 16 articles, all entire; ultimate article shorter and more globular than other articles with single apical papilla.

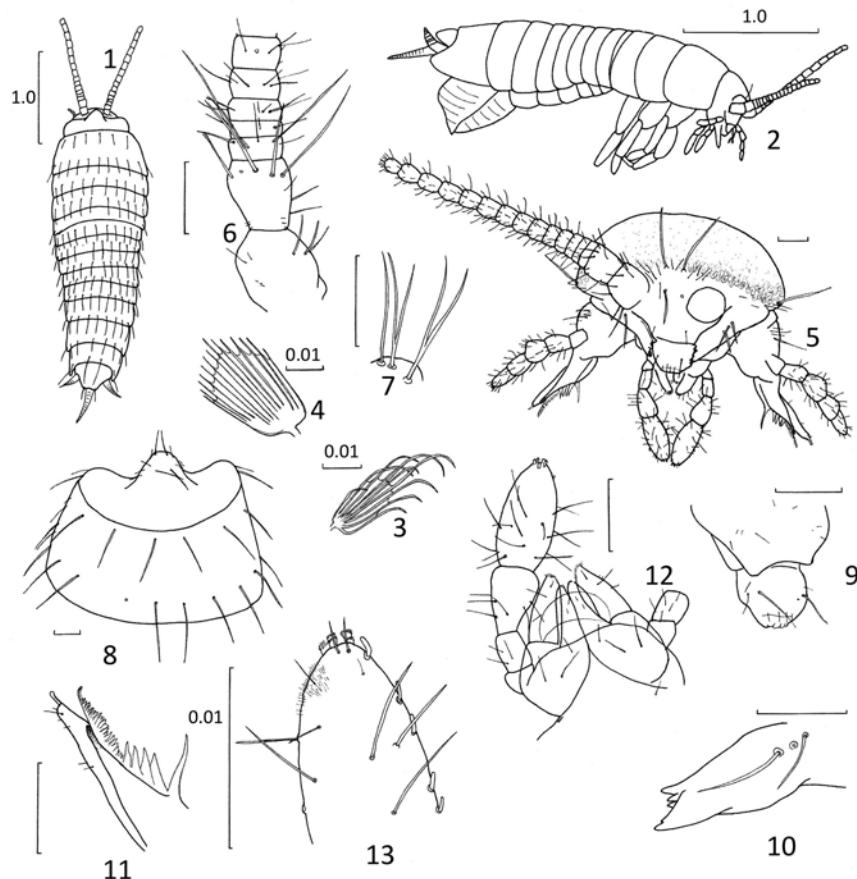
Head partially concealed, hypognathous, flattened anterior to posterior with lateral regions bulging somewhat forward (Fig. 8); vertex behind antennae covered in small dense scales, with very few setae, one pair of large submedial macrochaetae behind the antennae and a smaller pair between the antennae, some finer setae just above insertion of antennae, single strong macrochaetae and smaller setae laterally on each side near the prothorax (Figs. 5 and 8).

Labrum, rounded (Fig. 9). Mandibles (Fig. 10) quite small and slender, lacking molar region. Maxilla (Figs. 5 and 11) very large, projecting like tusks well beyond head; narrow, sharp lacinia, pectinate process much longer than tooth; galea with a single, very long, apical conule; palp short, not much longer than galea. Labium (Fig. 12) with short palp, apical article subovate



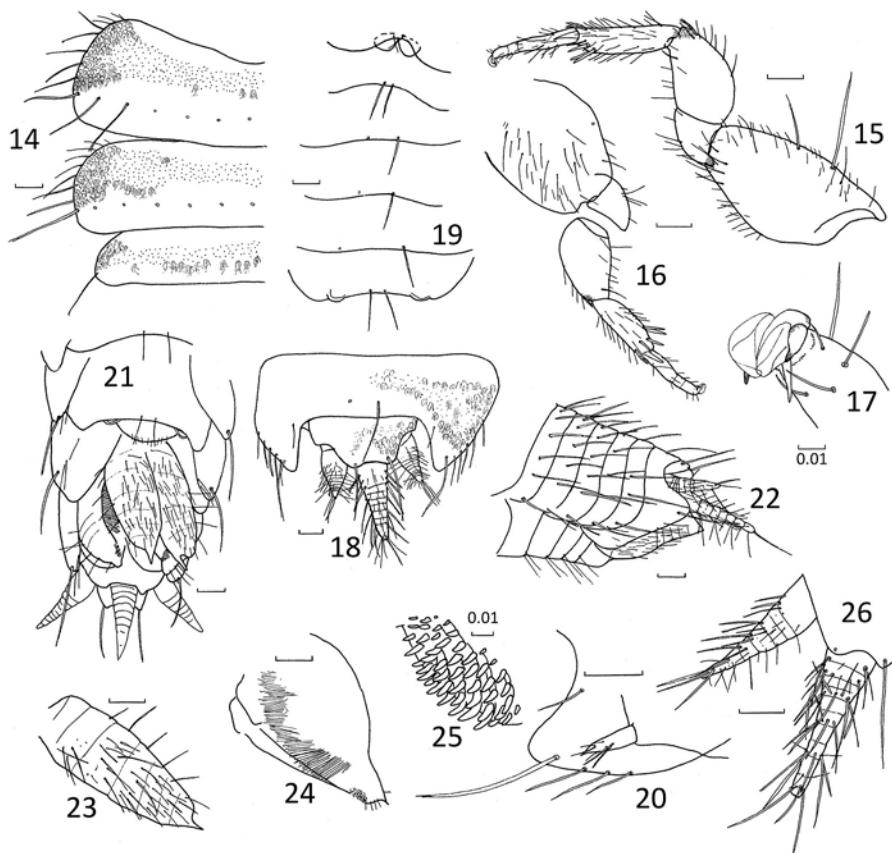
Plate 1. *Crypturelloides mindeni* new genus and species

and not greatly expanded with five apical feathered papillae as well as several obvious thick walled chemoreceptors (see Slifer & Sekhon 1970) on lateral margins, surface covered in numerous small micro setae (Fig. 13).



Figs. 1-13. ♀ *Crypturelloides mindeni* new genus and species. 1. Body, dorsal; 2. Body, lateral; 3. Tergite scale; 4. Head scale; 5. Head, anterior view, showing the limit of the scales on the vertex, one of the antennae and the very prominent maxillae and small mandibles; 6. Base of antenna; 7. Enlargement of profoundly bifurcated macrochaetae of the pedicel; 8. Head and prothorax (scales not shown), dorsal; 9. Clypeus and labrum; 10. Mandible; 11. Enlargement of apices of galea and lacinia of the maxilla; 12. Labium; 13. Enlargement of apex of ultimate article of labial palp showing various papillae and a small example area of the fine setae covering the surface. Scale bars equal 0.1 mm unless otherwise indicated (in mm).

Prothorax almost as long as meso- and metathorax together, with an anterior submarginal row of about 6 very long, strong, simple macrochaetae and a second row of about 10 macrochaetae about $\frac{1}{4}$ of the width of the pronotum from the posterior margin plus 1+1 macrochaetae in the postero-lateral corners. Scales on tergites arranged in a band only on the anterior $\frac{1}{2}$



Figs. 14-26. ♀ *Crypturelloides mindeni* new genus and species. 14. Meso and metanota and urotergite I, showing areas covered by scales and location of row of macrochaetae or their insertion points; 15. Metathoracic leg; 16. Mesothoracic leg; 17. Enlargement of pretarsus; 18. Urotergites IX and X with paratergites flattened out; 19. Hind margins of urosternites II-VII showing vesicles and macrochaetae; 20. Stylet of urosternite IX and paratergite IX; 21. Genital segments, ventral; 22. Genital segments, lateral, of specimen with non-expanded ovipositor; 23. Anterior valve of ovipositor; 24. Posterior valve of ovipositor, internal, showing field of long setae which form a curtain between the valves; 25. Enlargement of subapical field of modified setae; 26. Cerci and median dorsal appendage. Scale bars equal 0.1 mm unless otherwise indicated (in mm).

of the tergites (e.g. Fig. 14), the remaining surface free of scales; those on the pronotum extending forward to the anterior margin, those on the remaining tergites lacking where the preceding tergite overlaps.

Legs (Figs. 15 and 16) short and robust; tarsi with 4 short articles; pretarsi complex with large folded lamellate pulvilli shrouding the outer claws (Fig. 17) such that only the apices of these claws are visible; medial empodial claw thin and not enclosed by pulvilli.

Urotergite I very short, with only 1+1 large macrochaetae on each posterolateral corner (Fig. 4); urotergites II-VII each with a row of up to 10 very long macrochaetae similar to those on the thorax, well back from the posterior margin, almost midway along the tergites. Urotergites VII - IX longer than the preceding urotergites (Fig. 1); urotergite IX (Fig. 18) with two very long strong submedial macrochaetae that project almost to the end of urotergite X, the posterolateral corners of this urotergite extended ventrally and posteriorly into rounded lobes (paratergites) completely covering stylets, these paratergites with 1+1 strong submarginal macrochaetae near the posterior apices and about 5 smaller macrochaetae along the lateral margins.

Urotergite X subtrapezoidal (Fig. 18) not covered by urotergite IX, apically with moderate concave indentation and rounded apices with 1+1 large subapical macrochaetae.

Urosternite I glabrous, urosternite II (Fig. 19) with pair of medial vesicles and 1+1 small macrochaetae, urosternites II-VII with 1+1 submedial macrochaetae, those on III very close together becoming more widely spaced until urosternite VI; small pseudovesicles on urosternite VII; coxites VIII fairly broad and well separated; coxites IX hidden below paratergites; very short stylets present on coxite IX only (Fig. 20), completely hidden from view in whole specimens; stylets absent from all other urosternites.

Ovipositor (Figs. 2 and 21-25) short but usually very bulbous and open, on other specimens the ovipositor lies much flatter (compare Figs 2 and 22); pseudo-segmented, with numerous simple setae; both anterior and posterior valves with a curtain of closely appressed setae internally covering the gap between the anterior and posterior gonopophyses; anterior gonopophyses VII (Fig. 23) with about 7 divisions and pointed apically; posterior gonopophyses with mediad field of small modified setae sub-apically. Cerci short and conical, consisting of a larger basal article and about 7 smaller articles

narrowing fairly quickly to the apex (Fig. 26). Median dorsal appendage (Fig. 26) about twice as long, with about 10 articles of similar length, large simple macrochaetae on every second article.

♂. Unknown

Discussion. Among the genera of Atelurids that have median vesicles on urosternites II, Mendes (1987) and Mendes & Machida (2003) identify a “*Metriotelura*-group” of genera with reduced mandibular molar areas and the pectinate prostheca clearly longer than the tooth of the lacinia. *Crypturelloides* clearly fits within this group and appears close to two genera (*Comphotriura* Paclt, 1963 and *Gastrotheellus* Silvestri, 1942) that have only one pair of urostylets while a third (*Crypturella* Silvestri, 1911) only has vestiges of stylets on urosternites VII and VIII. All these genera are monotypic.

Crypturelloides shares several characteristics with *Crypturella termitaria* Silvestri, 1911 from Sri Lanka, including the large paratergites of urotergite IX that cover the urostylets, the large ovipositor, the arrangement of tergal scales in anterior rows rather than over the entire tergites, the antennae of 16 entire articles and the large lamellate pulvilli that almost completely covers the outer pretarsal claws. It differs from *C. termitaria* however, in the general body shape, the more exposed head and urotergite X, very different dorsal chaetotaxy and the long thin papillae on the galea. Males are unknown for both species. Silvestri (1911) described his species as having vesicles only on urosternite VII, however it shares so many other features with the other species from the region, which all have additional paired medial vesicles on urosternite II, that this should be reconfirmed by examination of Silvestri's type material.

Comphotriura miranda (Silvestri, 1916), also from Malaysia, differs from *Crypturelloides* in the shape of the head and the body, the absence of chaetotaxy on the abdominal segments, the scales which extend to the posterior margin of the urotergites, the short papilla on the galea and much shorter antennae. A single male only is known for this species.

Crypturelloides also differs from *Gastrotheellus notabilis* Silvestri, 1942 from China and Japan (Mendes & Machida 2003); the latter having well developed macrochaetae on the vertex, a more anteriorly pronounced head which fits somewhat into the pronotum, a short, broad papilla on the galea, a very long subgenital plate, no large paratergites IX nor large lamellate pulvilli covering the claws and it has different dorsal chaetotaxy. Only females are known.

***Crypturelloides mindeni* new species Smith & Veera Singham
(Figs. 1-26, Plate 1)**

Material examined. Holotype ♀ in alcohol, *G. sulphureus* colony, Bayan Lepas, Penang, 11.xii.2009, G. Veera Singham (K281810). Paratypes 15 ♀♀ in alcohol (K281811-K281824), one ♀ as slide preparation on 2 slides (K260960-K260963), same data as holotype (legs of one specimen retained by first author for possible DNA analysis); 1 ♀ in alcohol (K281825) and 1 ♀ as slide preparation on 2 slides (K260958 and K260959), *G. sulphureus* colony, Minden, Penang, 26.vii.2009, G. Veera Singham.

Description. ♀. Small, up to 3.7 mm long. Scales on the thoracic tergites and abdomen with about 9 long rays extending well beyond the margin of the scale and often quite curved, the medial ray and the outer rays shorter than the remaining (Fig 3); scales on the urosternites similar but with mostly straight rays; scales on the head smaller with more rays (about 13), the rays not quite so far extended beyond the margin of the scale and straight not curved (Fig. 4), some scales almost rectilinear in shape.

Generally white in colour but more golden-brown tinge on posterior edge of all tergites, from about the level of insertion of the macrochaetae (Plate 1).

Antennal setae and trichobothria as shown in figure 5. Scape with some medium length macrochaetae as well as some very short "points" arranged in short lines of 3-5. Pedicel (Fig. 6) also with some short lines of very short stout setae, with 3 striking bifurcated macrochaetae ventrally, two of which are bifurcated for over $\frac{3}{4}$ of their length (Fig. 7); very long thin macrochaetae on pedicel and the first segment of the flagellum, dorsally with shorter simple macrochaetae.

Mandibles with three macrochaetae externally. Maxilla palp short, third article broader and more angularly shaped than the rest, apical article only slightly longer than the others with a single apical feathered papilla.

Legs (Figs. 15 and 16); femur not much larger than tibia, a single slender lyriform seta apically; tibia with 2 lyriform setae and a large spur (almost as long as the tibia is wide), 4 strong spines in distal third.

♂. Unknown

Biology. This species was discovered during an excavation of a *G. sulphureus* mound in Universiti Sains Malaysia Minden campus. Five silverfish were found at the mid-section of the mound along with termite workers, soldiers, larvae and eggs. A short (1 min 40 sec) video recorded at the site shows at least three silverfish (about half the size of the host termite workers) running freely among the termites, eggs and larvae. On no occasion did the termites show any aggression towards the silverfish, even when the silverfish pushed their heads under the bodies of the termites. On one occasion a silverfish appeared to use the antennae and maxillae to stimulate a termite worker to raise its abdomen, so that the silverfish could push underneath. In this very short glimpse into their behaviour, it appeared more as if the silverfish were searching the substrate rather than trying to take material from the termites.

All 19 specimens collected were female suggesting a possible parthenogenesis. The variability in the appearance of the ovipositor may be linked to the moulting/reproduction cycle; its very large size suggests that the progeny may be quite large when passing through the highly expandable ovipositor.

LEPISMATIDAE: LEPISMATINAE

Xenolepisma penangi new species Smith & Kuah (Figs 27-59, Plate 2)

Material examined. Holotype ♀ in alcohol, *Monomorium pharaonis* colony, Minden, Penang, 30.xi.2009, M.K. Kuah (K277699). Paratypes 2 ♀♀ on 4 microscope slides, *Monomorium pharaonis* colony, Minden, Penang 28.vii.2009, M.K. Kuah (K260953, K260954, K260956, K260957); 2 ♀♀, ♂ in alcohol (K277700-K277702), 1 ♂ on microscope slide (K260955) and 1 juv. in alcohol, *Monomorium pharaonis* colony, Minden, Penang, 30.xi.2009; M.K. Kuah (K277703).

Distinctive features. This Malaysian species is very close to the description of *X. subnigrina* Silvestri, 1938 but differs in the reduced number of macrochaetae on the posterior margins of the urotergites and the shape of the prosternum.

Description. Medium to small insects, up to 5 mm long; antennae about four tenths H+B or about same as thorax length; cerci short, about one tenth H+B; median dorsal appendage slightly longer exceeding the apex of urotergite X by about the length of this urotergite (Fig. 27).

Integument generally white with brown to slightly purple pigment spots on sides of head (Fig. 28) including mouthparts although much less on ultimate article of maxillary palp, on scape but not pedicel, remainder of flagellum with some pigment, more distally in each article but not creating a banded appearance, on medial anterior prothorax and posterior urotergites, on prothoracic presternum and thoracic sterna especially on the prothorax, meso and meta thoracic sternites have more pigment posteriorly, coxa, especially outer margins, a little distally on the tibia, on underside of nota at margins, posterior lateral margins of more posterior urotergites and urosternite X, urostylets with pigment in basal half.

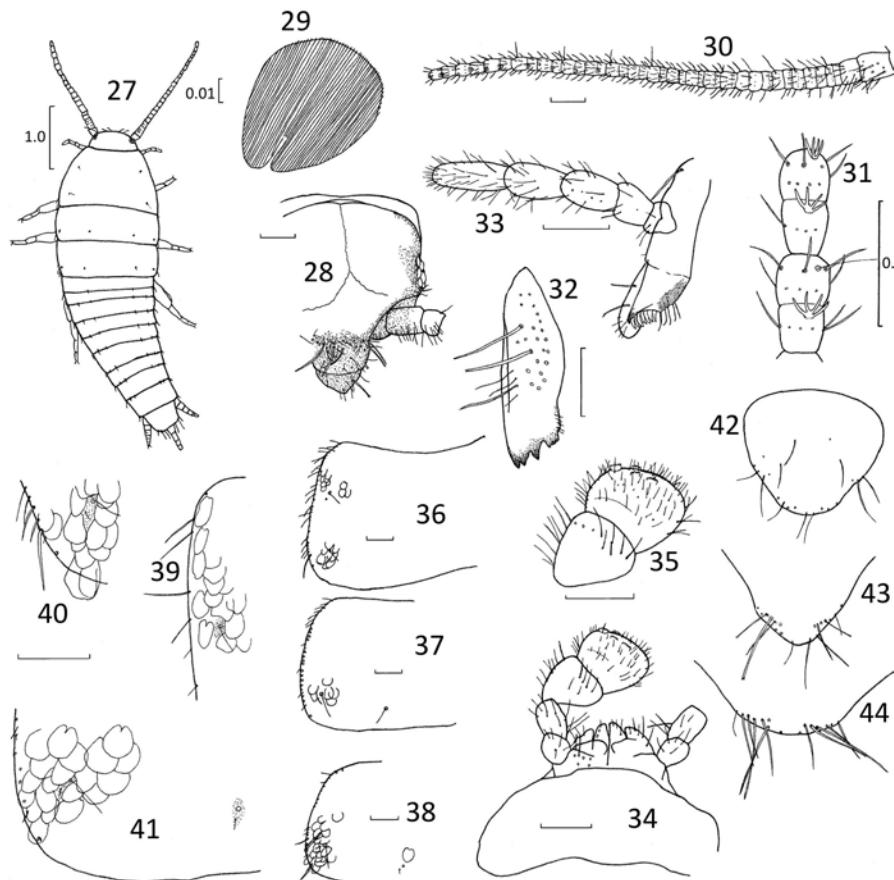
Scales (Fig. 29) with numerous parallel rays; scales mostly dark in colour, appearing almost black but more dark brown under the microscope, scales on top of head but lacking elsewhere on head, mouthparts and antennae, coxa heavily scaled, but scales absent from remaining leg articles. Scale pattern (Plate 2) dorsally uniformly black except for distinct 1+1 large white patches on anterior margin of mesonotum, transversely across the posterior two thirds of urosternite I and 1+1 patches on anterior margin of urosternite VII, some lighter scales medially on anterior margin of pronotum, patches due to very translucent scales which let the white colour of the integument show through. These patches can be difficult to see on specimens where con-



Plate 2. *Xenolepisma penangi* new species showing scale pattern.

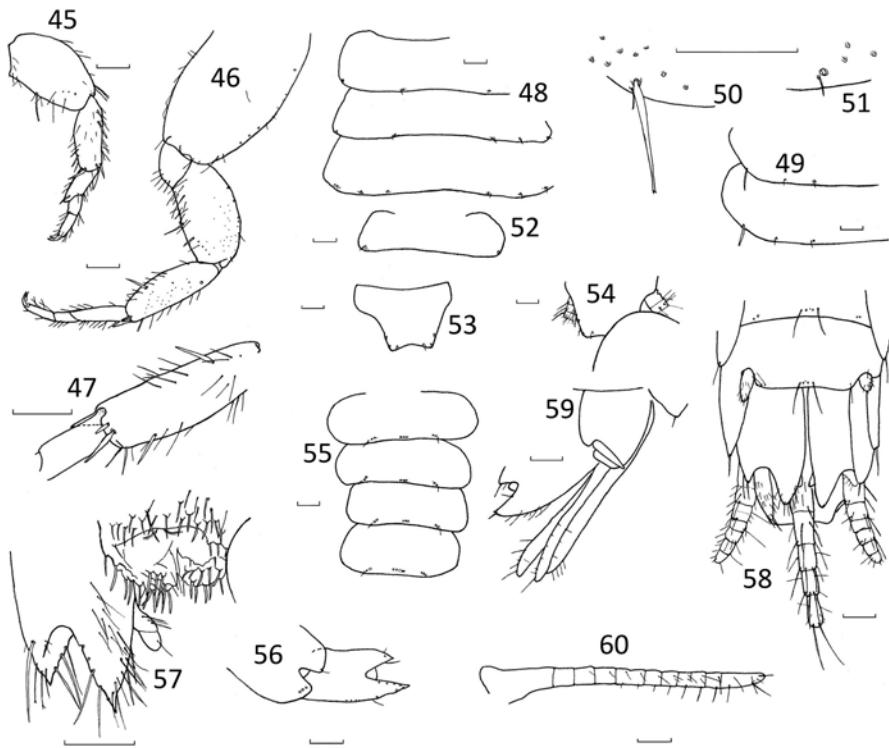
siderable scale damage has occurred; on one recently molted specimen the dark scales did not extend to the lateral and posterior margins of all tergites creating the appearance of light margins to all tergites.

Head (Fig. 28) wider than long; eyes well forward; vertex lacking chaetotaxy; narrow field of macrochaetae between antennae at top of clypeus, area of weaker setae subdistally on clypeus; labrum with a few stronger macrochaetae.



Figs. 27-44. *Xenolepisma penangi* new species. 27. Body, dorsal; 28. Head, right side from front, showing pigmented areas; 29. Scale; 30. Antenna; 31. Apical articles of antenna; 32. Mandible; 33. Maxilla; 34. Labium; 35. Apical articles of labial palp; 36. Pronotum, left side; 37. Mesonotum, left side; 38. Metanotum, left side; 39. Detail of anterior trichobothrial area of pronotum; 40. Detail of posterior trichobothrial area of pronotum; 41. Detail of trichobothrial areas of mesonotum; 42. Prosternum; 43. Mesosternum; 44. Metasternum. Scale bars equal 0.1 mm unless otherwise indicated (in mm).

Antennae (Fig. 30) with subarticles of distal articles about as long as wide, asteriform sensillae, each with 3-4 arms, on articles in distal two thirds of the flagella (Fig. 31). Trichobothria on every proximal article and every second article from about the 6th article. Mandibles well developed (Fig. 32) with three apical teeth, distinct raised molar region and a field of very strong, apically bifurcate macrochaetae on external surface. Maxillae (Fig. 33) short and stout, lacinia with three small teeth, one shorter than the others, fol-



Figs. 45-59. *Xenolepisma penangi* new species. 45. Prothoracic leg; 46. Metathoracic leg; 47. Tibia of metathoracic leg; 48. Urotergites I-III, left side; 49. Urotergites IV and V, left side; 50. Enlargement of infralateral macrochaeta (scale insertion points also shown); 51. Enlargement of sublateral macrochaeta insertion socket (scale insertion points also shown); 52. Urotergite IX; 53. Enlargement of infralateral macrochaeta insertion socket (scale insertion points also shown); 54. Urotergite X of ♂ (partially hidden by air bubble); 55. Urosternites IV-VII; 56. Coxites VII and IX of ♀; 57. Coxite IX and paramere, left and penis of ♂ (partially hidden by air bubble); 58. Posterior segments of ♂, ventral. 59. Ovipositor and posterior coxites of ♀; 60. Posterior gonopophyses; Scale bars equal 0.1 mm.

lowed by seven lamellate process and five long setae; maxillary palp short, its distal article subcylindrical and about $1\frac{1}{2}$ times longer than the penultimate article, the basal article subapically with rosette of stout, apically bifurcated macrochaetae. Labium (Fig. 34) very broad with short glossal and paraglossal lobes, palp short, apical article as at least as wide as long, with 3+2 compact sensory papillae apically although the two rows are so close together that it appears almost as one undulating row; penultimate segment also quite wide (Fig. 35).

Thorax not much wider than base of abdomen and about $\frac{2}{3}$ its length. Pronotum (Fig. 36), mesonotum (Fig. 37) and metanotum (Fig. 38) with short macrochaetae on lateral margins but glabrous on posterior margins, each nota with two closed trichobothrial areas (isolated from margins by scales), those of the prothorax located anteriorly and sub posteriorly, while those of the meso and -meta nota are both subposterior. Each trichobothrial area provided with a short trichobothria plus a very short, delicate spine (Figs. 39-41); surface of cuticle in trichobothrial areas very slightly more granular in appearance than surrounding cuticle.

Prosternum (Fig. 42) subcordiform, slightly wider at its base than long with some strong marginal macrochaetae, not arranged in groups, as well as two pairs of 1+1 setae submedially; mesosternum (Fig. 43) more acute apically with 1+1 apical macrochaetae as well as 1+1 subapical combs each of 4 macrochaetae plus some other subapical marginal finer macrochaetae; metasternum (Fig. 44) broader apically with 1+1 weak combs each with about 5 macrochaetae, the distance separating them about the same as their length.

Legs (Figs 45-47); femur of prothoracic leg with bifurcated spine apically and a stronger macrochaeta midway along internal margin of all femora; tibia with one stronger macrochaetae proximally near external margin, two apically and another pair in distal third internally, tarsus with three articles, pretarsus with long lateral claws, and shorter medial empodial claw.

Abdomen at its base not much narrower than the thorax and not clearly set apart from this. Urotergites I-IX with 1+1 infralateral macrochaeta about $\frac{1}{3}$ the length of the corresponding tergite, urotergite I with additional 1+1 sublateral and urotergites II – VIII also with smaller 2+2, lateral and sublateral isolated macrochaetae (Fig. 49-51), each associated with small curved seta, the insertion points of these smaller lateral and submedial macrochaetae can

be difficult to see; urotergite IX with only infralateral macrochaetae (Fig. 52), urotergite X of males and females similar (Figs. 53 and 54) trapezoidal, with 3+3 short macrochaetae apically as well as some lateral setae.

Urosternite I without combs, II with a narrow medial comb of two (?) long, thin apically bifurcated macrochaetae and III-VIII (in ♂) or III-VII (in ♀) with 1+1 sublateral combs each of 2-4 macrochaetae and small curved seta (those on III more medial than on more posterior segments) and 1 medial comb of 3-5 long, thin apically bifurcated macrochaetae (Fig. 55); coxites VIII of ♀ with 1+1 combs of about 3 macrochaetae internal to stylets (Fig. 56). Internal process of coxite IX of ♂ (Fig. 57) acute apically, less than 1½ times as long as broad at its base; those of ♀ similar to male. Parameres short (Fig. 57) with some fine setae. Penis with numerous stout spines (Fig. 57). Stylets on urosternites VIII and IX, short and robust (Fig. 58). Ovipositor (Figs. 59 and 60) exceeding apex of internal processes of urosternite IX by about the length of the process. Cerci and median dorsal appendage as in Fig. 58.

Biology. The insects were first found in a colony of *M. pharaonis* that was nesting between a wooden plank and styrofoam in a rack in the Aquaculture Research complex, Universiti Sains Malaysia Minden campus. Subsequently we found the insects moving along with *M. pharaonis* queens and workers carrying brood in an ant trail in another location in the building suggesting a strong inquiline relationship with *M. pharaonis*.

Discussion. The first species of this genus, from South Africa, was described by Escherich (1905) as *Lepisma globosa* and later redescribed in more detail by Wygodzinsky (1955). Mendes (1978) transferred the species to his new genus *Asterolepisma* based on the presence of asteriform sensillae and in 1981 created the subgenus *Xenolepisma* within *Asterolepisma* for *L. globosa*. In 1988 he raised *Xenolepisma* to generic level and augmented the species description. Silvestri (1938) described a second species from southern India as *Lepisma subnigrina*. Mendes (1988) redescribed the species and transferred it to his new genus. The Malaysian material is very close to the description of *X. subnigrina*. While it is here described as a new species, it cannot be excluded that these differences are typical of variations within populations. More material from a wider range of localities and DNA studies would be required.

The key of Mendes (1988) has been amended below to include the new species.

1. Posterior edge of urotergites II-VIII provided with 5 +5 macrochaetae. Median comb of urosternites of 4-5, the laterals with 2-4 setae, the distance separating them 3-4 times greater than the width of the latter. Parameres very small, provided with about 6 thin setae. Internal process of coxite IX of the ♂ a bit longer than wide at its base.....
..... *X. subnigrina* (Silvestri, 1938).
- Posterior edge of urotergites II-VIII with 3 +3 macrochaetae. Internal process of coxites ♂ IX more than 1.5 times longer than wide at base....2
2. Medial comb of urosternites with 6-10 macrochaetae, the sublateral combs with 4 setae, the distance that separates them 2-2.5 times the width of the former. Hypodermal pigment intense in the vertex of head, appendages and part of body. Parameres reduced, devoid of chaetotaxy.....
..... *X. globosa* (Escherich, 1905)
- Median comb of urosternites with 3-5 long, thin macrochateae, the sublateral combs with 2-4, the distance separating them more than 4 times the width of the former. Hypodermal pigment on head only intense on lateral and anterior margins. Parameres small with a few thin setae.....
..... *X. penangi* new species

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