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Hickmanoxyomma, a new genus of cavernicolous harvestmen from Tasmania (Opiliones: Triaenonychidae)

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ABSTRACT. The monotypic genus *Odontonuncia* Hickman, 1958 is redescribed. A new closely related genus, *Hickmanoxyomma*, is described for the type species, *H. cavaticum* (Hickman, 1958), and six other species. Two new combinations are established: *H. cavaticum* (*Monoxyomma*) and *H. tasmanicum* (Roewer, 1915) (*Monacanthobunus*). One new synonymy is proposed: *Monoxyomma silvaticum* Hickman, 1958 = *H. tasmanicum* (Roewer, 1915). Five new species are described in three species groups: *H. goedei*, *H. clarkei* and *H. eberhardi* (*cavaticum* species group); *H. gibbergunyar* (*tasmanicum* species group); and *H. cristatum* (*cristatum* species group). The distribution of the six cavernicolous and one surface species in *Hickmanoxyomma* and the possible influence of Pleistocene glaciation are discussed. Cavernicolous adaptations, including reductions in lateral branches of claws, are described. Free lateral sclerites are recorded for the first time in the Triaenonychidae and their significance as a family character in the superfamily Travunioidea is discussed.

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Species of *Hickmanoxyomma* n.gen. are the most widely distributed cavernicolous harvestmen in Tasmania (Fig. 1). They occur in almost all karst areas where serious biospeleological studies have occurred (Goede, 1967; Hunt, 1972; Eberhard, 1988; Clarke, 1988). This, together with the varying extent of cave adaptation in different species, means that the group has considerable potential for the study of speciation in isolated cave environments.

Material and Methods

Type material of all nominal species has been examined

and reassessed. The following abbreviations are used to indicate the present location of material examined: AM — Australian Museum, Sydney* (*AM usually denoted simply by the registration number prefix KS), FIS — Forschungsinstitut Senckenberg, Frankfurt am Main, JLH — Dr J.L. Hickman collection, Ferntree, Hobart, QVM — Queen Victoria Museum, Launceston, SAM — South Australian Museum, Adelaide, TMAG — Tasmanian Museum & Art Gallery, Hobart.

Official numbers for caves (e.g. PB3) follow Matthews (1985). Terminology follows Hunt (1985). Tergal areas are abbreviated to TA1, TA2, etc.; coxa of leg I is coxa I, etc.

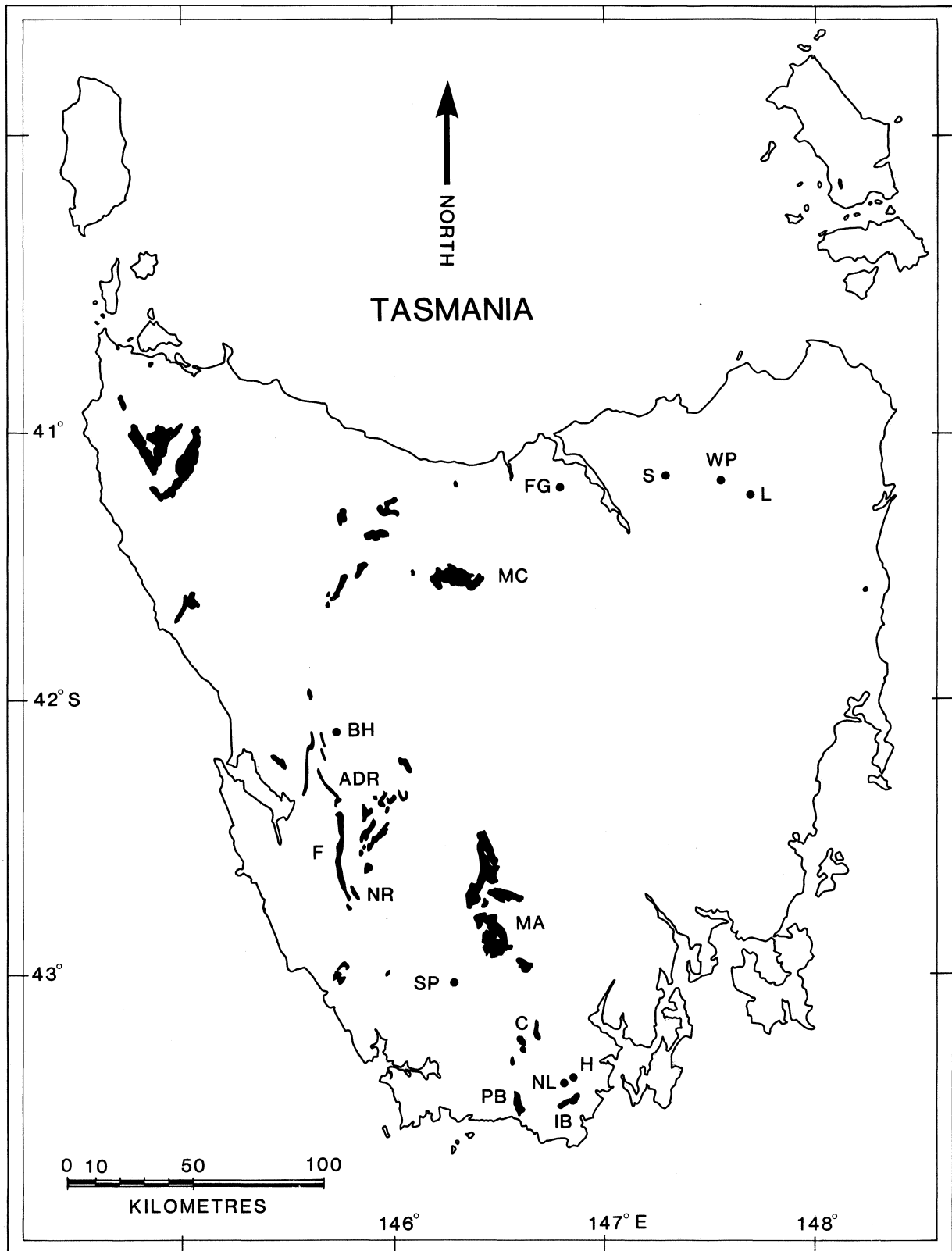


Fig.1. Distribution of cavernicolous and epigeal *Hickmanoxyomma* spp. in Tasmania. Cave localities: ADR = Andrews River; BH = Bubs Hill; C = Cracroft; F = Franklin River; FG = Flowery Gully; H = Hastings; IB = Ida Bay; MA = Mount Anne; MC = Mole Creek; NL = North Lune; NR = Nicholls Range; PB = Precipitous Bluff; SP = Scotts Peak. Surface localities: L = Lottah; S = Scottsdale; WP = Weldborough Pass. Irregular solids = major karst areas. Adapted from Matthews (1985).

GD = Nei's Standard Genetic Distance. Measurements were made according to Fig. 2 using a Hypad Digitiser; appendage measurements were done retrolaterally along the dorsal profile, articular membranes excluded. Abbreviations are: SA = eyemound spine angle, SH = spine height, IOD = interocular distance, SL = scute length, CW = carapace width, PF = pedipalp femur length, AI & AIV = astragalus I & IV lengths, CI & CIV = calcaneus I & IV lengths, FIV = femur IV length, CSL = cheliceral second segment length.

by Forster (1954), Briggs (1971b) and Suzuki (1975b). *Hickmanoxyomma* is placed in the Triaenonychinae on the basis of one pair of short side branches on the claws of legs III and IV and the narrow sternum. Two species have lost the side branches as a result of troglomorphic adaptation, a condition also reported for leg III in one cavernicolous *Cyrtobunus* Banks in North America (Briggs, 1971b). The Triaenonychinae is also defined on the basis of three pairs of side branches in juveniles, so it is interesting to note that all cavernicolous *Hickmanoxyomma* species, where juveniles are known, either possess two pairs or have lost them completely. The only epigeal species has retained the typical number of three pairs.

Although these losses are probable troglomorphies, they point to some plasticity in the form of the tarsal claw. This adds support to the view of Shear (1977) that too much emphasis may have been placed on the form of tarsal claws

Triaenonychidae Soerensen
Triaenonychinae Soerensen

Subfamily taxa in present use have largely been defined

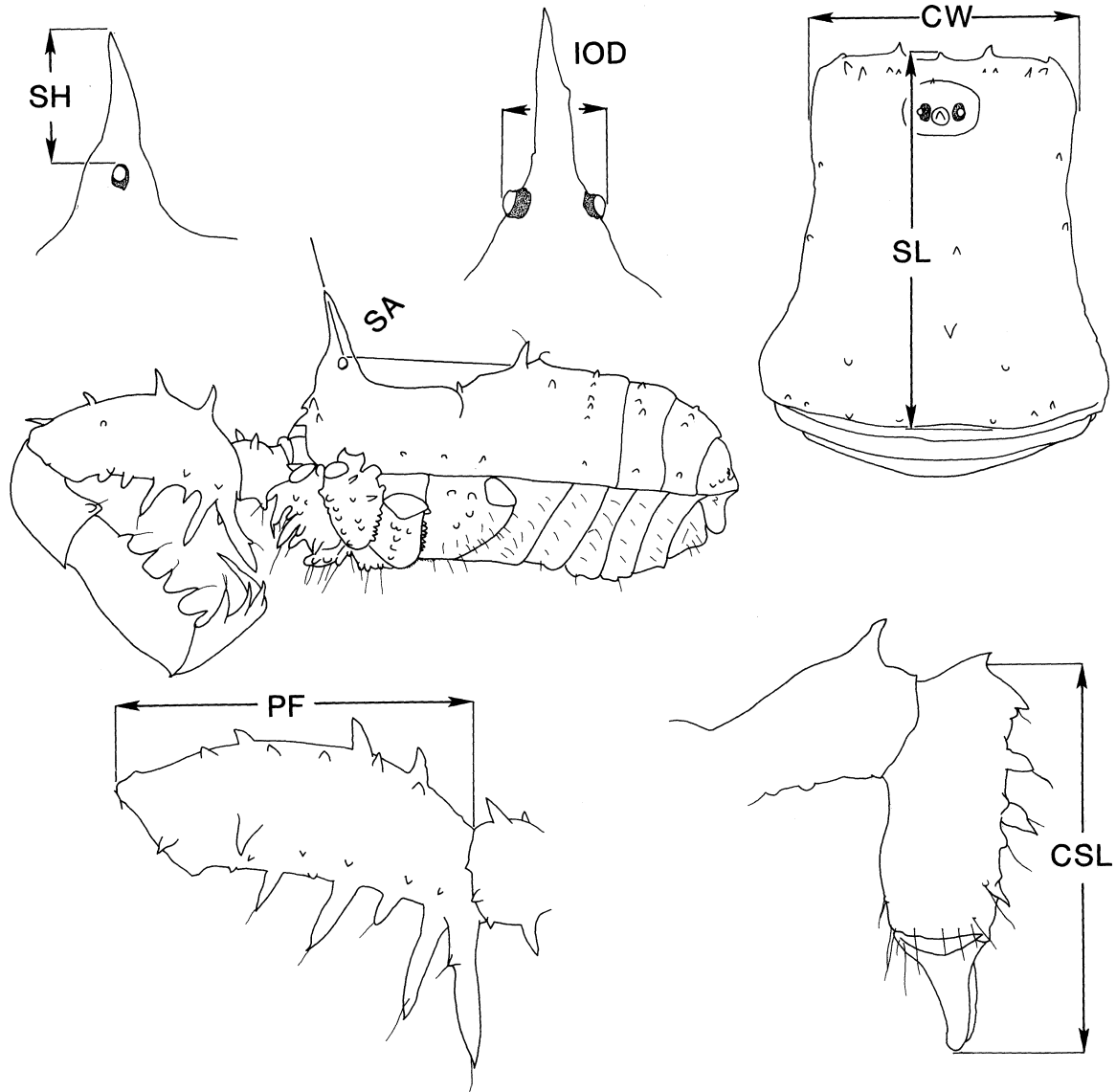


Fig.2. Measurement procedures: SH = eyemound spine height; SA = spine angle; IOD = interocular distance; CW = carapace width; SL = scute length; PF = pedipalp femur length; CSL = cheliceral second segment length.

in defining family level taxa in the Travunioidea, including subfamilies in the Triaenonychidae. Indeed, Maury (1988), while placing his new Argentinian troglobitic species, *Picunchenops spelaeus*, in the Triaenonychidae on the basis of penis morphology, deliberately did not assign it to a subfamily — the hind tarsal claws of this species are in the form of a peltonychium, similar to that in the Travuniidae.

Free lateral sclerites are present in several cavernicolous *Hickmanoxyomma* species and is the first record of these structures in the Triaenonychidae. Briggs (1971a) used their presence in certain North American species as part justification for his new family Pentanychidae, while Briggs (1974) and Suzuki (1975a) reported lateral sclerites in North American and Asian Travuniidae.

Normally, lateral sclerites appear to fuse with the sternites. The five free sclerites in *Hickmanoxyomma* (two to three in the mostly epigeal Pentanychidae and Travuniidae noted above) may be related to possible reduced sclerotisation due to cave adaptation. Interestingly, however, no lateral sclerites have been described in the highly troglomorphic Travuniidae in Europe or in cavernicolous Triaenonychidae, apart from *Hickmanoxyomma* where their presence or absence is significant in defining species groups.

Free lateral sclerites may be a neotenic reversal, as suggested by Rambla (1980). Alternatively, they may be a persistent character which is plesiomorphic for the superfamily Travunioidea. In either case, their presence in the Triaenonychidae supports the view of Rambla (1980) and Shear (1977) that families in the Travunioidea need reassessment, and add support to Martens' (1986) view, based on penis morphology, that pentanychid taxa belong in the Triaenonychidae.

Hickmanoxyomma is very closely related to *Odontonuncia* Hickman and to an undescribed genus from Victoria (including a species from Buchan Caves), both of which also lack a notch in calcaneus I. This group of genera have a penis of similar general form to 3 genera possessing a notch in calcaneus 1, namely *Paranuncia* Roewer, *Holonuncia* Forster and *Equitius* Simon. Together they form a related assemblage inhabiting south-eastern Australia.

Odontonuncia Hickman, 1958

Odontonuncia Hickman, 1958: 47.

Type species. *Odontonuncia saltuensis* Hickman, 1958 by monotypy.

Diagnosis. Eyemound slightly behind anterior margin, armed with a short spine or tubercle. Anterior margin with a few tubercles on each side. TA3 with mesial pair of spines; free lateral sclerites apparently absent (or possibly one present in some specimens). Chelicera without a proximal boss. Pedipalp femur with a proximal compound spine. Calcaneus of leg I without notch. Ventral plate of penis with

3 inferior and 2 superior setae; dorsal plate narrower than glans, short, weakly bifid, with terminal bifurcations not strongly curved and not supporting the glans laterally.

Redescription. Eyemound slightly behind anterior margin, armed with a short simple spine or tubercle. Anterior margin below with 5 inter-appendage projections; above with a few small tubercles on each side. Scutal groove distinct mesially; the 5 tergal areas marked by faint tergal grooves and by tubercles or rows of same, mesial pair on TA3 largest. Ninth abdominal tergite fused with anal plate; free lateral sclerites apparently absent. Sternum long and narrow; genital operculum rounded; spiracle abutting coxa IV but only slightly obscured by granules. First segment of chelicera without a proximal boss, with prodistal spine; second segment with upwardly directed proximodorsal swelling. Pedipalp much larger in male; femur with bases of proximoventral trifid spine and proximal retrolateral spine strongly fused to form a compound spine; trifid spine with main shaft and 2 weak accessory denticles; femur spination includes 2 prodistal spines; patella with 2 prodistal spines; tibia and tarsus each with 3 large pro- and retroventral spines; claw movable. Proximal fusion of coxae II & III marked by suture; coxa II with labial process; coxa I with distal proventral compound, but not clavate, spine. Leg femora armed only with small tubercles/granules; calcaneus I without notch, much shorter than astragalus, latter with pseudosegmentation. Male tarsus I with 4 segments, female 3–4; distitarsi I and II with 2 and 3 segments; adult claw of legs III & IV with one pair of short lateral branches (juveniles not seen). Ventral plate of penis with 3 inferior and 2 superior setae on each side, notch shallow; dorsal plate narrower than glans, terminating at level of ventral plate, weakly bifid, with terminal bifurcations not strongly curved and not supporting the glans laterally.

Comments. *Odontonuncia* is very closely related to *Hickmanoxyomma* but lacks the synapomorphy of long curved terminations on the dorsal plate which functionally appear to support the glans laterally. *Odontonuncia* apomorphies are the waisted form of the dorsal plate and the form of the proximoventral compound spine on the pedipalp femur.

Distribution. North-east Tasmania.

Odontonuncia saltuensis Hickman, 1958

Fig. 3

Odontonuncia saltuensis Hickman, 1958: 48–50.

Type material. North-east Tasmania: HOLOTYPE male: KS6958, Goulds Country, J.L. Hickman, 16 Aug. 1953. ALLOTYPE female: KS17556, same data.

Additional material examined. North-east Tasmania: JLH, Myrtle Creek, north of Mathinna, J.L.

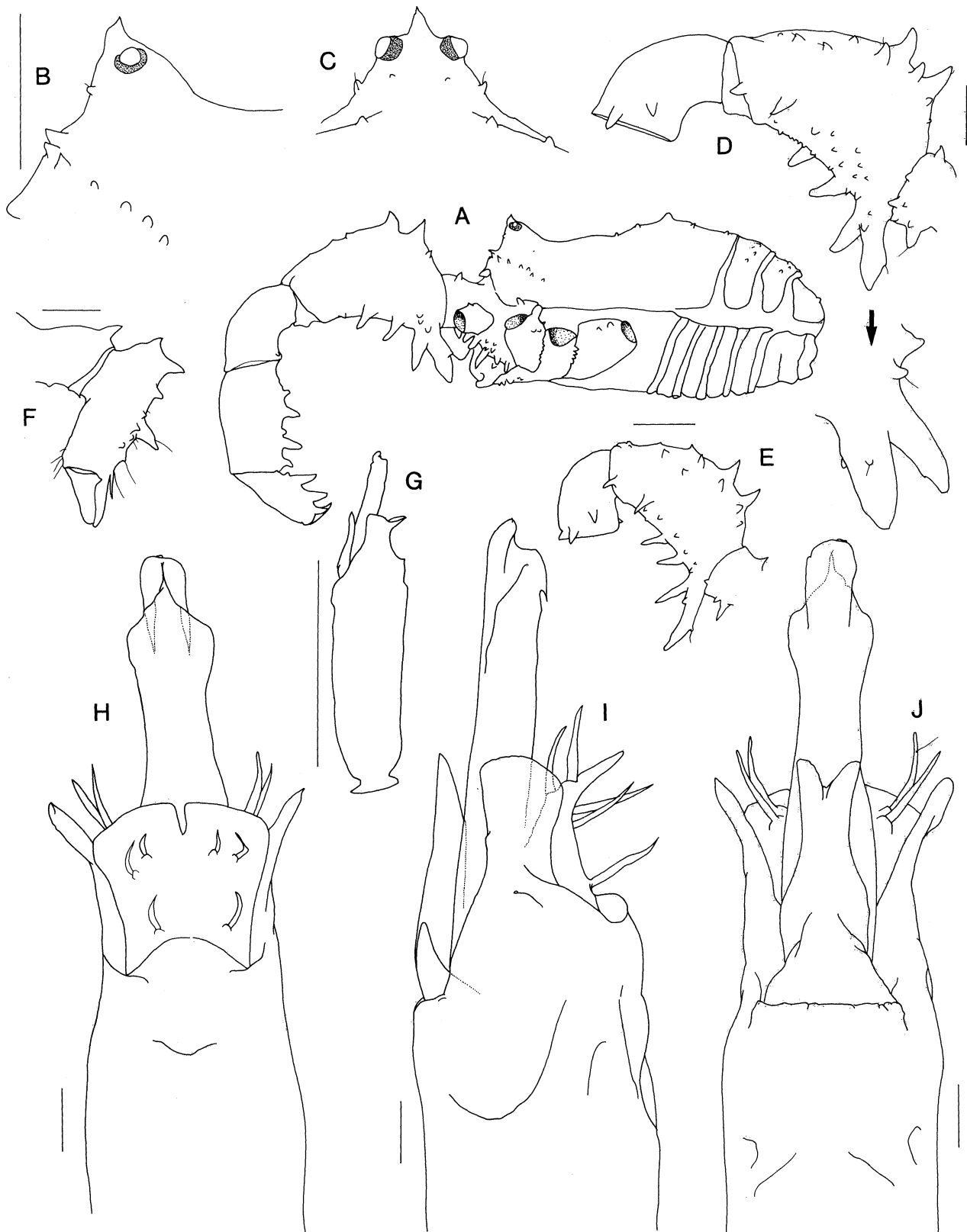


Fig.3. *Odontonuncia saltuensis* Hickman. A-D, F-J = Holotype male; E = allotype female. A = body & pedipalp, lateral; B, C = eyemound, lateral & frontal; D, E = pedipalp femur & patella, prolateral, male with posterior enlargement of ventroproximal spines; F = chelicera, retrolateral; G = entire penis; H-J = distal part of penis, ventral, lateral and dorsal. Scale bars: A-G = 1.0 mm; H-J = 0.1 mm.

Hickman, sample 296, 29 May 1973, 14 males, 12 females; JLH, beside creek a few miles south of Myrtle Creek, J.L. Hickman, 15 July 1973, 3 males, 1 female; JLH, Avoca, R. Maubey, 30 Oct. 1972, 1 female.

Redescription. MALE. Hickman (1958) gave a detailed non-genitalic description of the species to which can be added: lateral and posterior flanks of eyemound sloping gradually immediately below eyes. TA2 with a larger mesial pair of tubercles than TA1. Spines on TA3 small and blunt. No lateral sclerites unambiguously present in partially distended specimens. Genital operculum wider than long; spiracle barely obscured by tubercles on coxa IV. Chelicera second segment with strong upwardly directed mound on proximodorsal surface. Hickman's "bifid median proximal tooth" is formed from a basal fusion of the proximoventral trifold spine and proximal retrolateral spine of *H. cavaticum*. Accessory denticles on trifold spine weakly developed. Ratio PF: CW 0.90, FIV: CW 1.05, CI: AI 0.18. Lateral branches on claw of legs III & IV small. Tarsal formula: 4(2), 8-13(3), 4, 4.

Genitalia. Ventral plate with superior setae set very distally; about as long a wide, widest subdistally and narrowing towards base. Notch very shallow, about 0.2 plate length and not reaching distal inferior setae. Lateral plate very narrow basally and broadening distally, not obscuring bases of inferior and distal superior setae. Dorsal plate narrow subdistally and shortly bifurcate. In lateral view glans terminally concave but not deeply cleft.

FEMALE. As in Hickman (1958). Tarsal formula: 3-4(2), 9-11(3), 4, 4.

Measurements (Myrtle Creek sample, n = 3 males, 3 females).

	SL	CW	PF	AI	CI	AIV	CIV	FIV	CSL
Range	5.95-6.51	3.92-4.13	3.42-3.84	2.28-3.02	0.51-0.54	4.56-5.39	0.50-0.54	3.98-4.54	2.95-3.40
	5.43-5.62	3.40-3.68	2.73-2.81	2.20-2.67	0.44-0.46	4.43-5.03	0.42-0.53	3.89-4.12	2.45-2.58
Mean	6.27	4.05	3.66	2.82	0.52	5.03	0.52	4.25	3.21
	5.52	3.50	2.76	2.51	0.45	4.75	0.46	3.98	2.52
Standard Deviation	0.23	0.09	0.18	0.18	0.01	0.35	0.02	0.23	0.19
	0.08	0.12	0.03	0.16	0.01	0.25	0.05	0.10	0.05

Variation. The height of the eyemound spine varies from a small granule (Avoca specimen) to slightly higher than that of the holotype.

Distribution. North-east Tasmania.

Hickmanoxyomma n.gen.

Type species. *Monoxyomma cavaticum* Hickman, 1958 by original designation.

Diagnosis. Eyemound slightly behind anterior margin, armed with a long spine. Anterior margin with 2 or more tubercles on each side. TA3 with mesial pair of spines; lateral sclerites present in some species. Chelicera without a proximal boss. Calcaneus of leg I without notch. Ventral plate of penis with 3 inferior and 1 or 2 superior setae; dorsal plate as wide as or wider than glans, long, terminal bifurcations long, strongly curved and support the glans laterally.

Description. Eyemound slightly behind anterior margin, armed with a long spine. Anterior margin below with 5 inter-appendage projections; above with 2 or more tubercles on each side. Scutal groove distinct mesially; the 5 tergal areas marked by faint tergal grooves and by tubercles or rows of same, mesial pair on TA3 usually enlarged into spines. Ninth abdominal tergite fused with anal plate; free lateral sclerites present in some species. Sternum long and narrow; genital operculum rounded; spiracle abutting coxa IV but only slightly obscured by granules. First segment of chelicera without a proximal boss, with prodistal spine; second segment with or without upwardly directed proximodorsal swelling. Pedipalp much larger in male; femur with bases of proximoventral trifold spine and proximal retrolateral spine at most weakly fused; trifold spine with main shaft and 2 usually weak accessory denticles; femur spination includes 2 prodistal spines; patella with 2 prodistal spines; tibia with 3 pro- and 5 retroventral spines, tarsus with 3 & 3; claw movable. Proximal fusion of coxae II & III marked by suture; coxa II with labial process; coxa I with distal proventral compound, but not clavate, spine. Leg femora armed only with tubercles/granules; calcaneus I without notch, much shorter than astragalus, latter with pseudosegmentation. Male tarsus I with 4-7 segments, female 3-5; distitarsi I and II with 2 and 3-4 segments; adult claw of legs III & IV with one pair of short lateral branches or branches lacking; juveniles with 2 pairs of lateral branches or lacking. Ventral plate of penis with 3 inferior and 1-2 superior setae on each side, notch shallow; dorsal plate as wide or wider than glans, terminating immediately below terminal expansion of glans, strongly bifid, with terminal bifurcations strongly curved ventrad and supporting the glans laterally.

Species groups. Rather than describing formal subgenera, three species groups are defined, namely the *cavaticum*, *tasmanicum* and *crisatum* species groups. Taxonomic treatment follows this order.

Comments. *Hickmanoxyomma* is very closely related to *Odontonuncia* and to an undescribed genus from Victoria which includes cavernicoles. It differs from both in two apomorphies: a long spine on the eyemound and long, curved terminal bifurcations to the penis dorsal plate which functionally appear to support the glans laterally. The Victorian genus has a characteristically broad and flattened glans (Hunt, in preparation).

Monoxyomma Pocock and *Monacanthobunus* Roewer in which the two described species of *Hickmanoxyomma* were formerly placed are junior synonyms of *Equitius* and

are not available (Hunt, 1985).

Etymology. The generic name acknowledges the great contribution of Professor V.V. Hickman to the study of Tasmanian Opiliones, and retains the “*oxyomma*”

(“spined eye”) fragment of *Monoxyomma* in which Hickman originally placed the type species. Gender is neuter.

Distribution. Tasmania.

Key to Species of *Hickmanoxyomma*

- 1. Calcaneus of leg 1 greater than 0.4 astragalus length, penis with broad crest-like termination *H. cristatum* n.sp.
- Calcaneus less than 0.4 astragalus length, penis without broad crest-like termination 2
- 2. Calcaneus usually less than 0.24 astragalus length, ventral plate of penis widest basally and with 1 superior seta 3
- Calcaneus usually greater than 0.24 astragalus length, ventral plate of penis widest subdistally and with 2 superior setae 4
- 3. Mesial pair of tubercles on posterior margin of dorsal scute and on free tergites strong and rounded *H. tasmanicum* (Roewer), n.comb.
- Posterior margin of scute and free tergites with only small tubercles or granules *H. gibbergunyar* n.sp.
- 4. Mesial spines on TA3 reduced to small tubercles, lateral prongs on the claws legs III and IV lacking *H. eberhardi* n.sp.
- Mesial spines of TA3 quite large, lateral claw prongs present 5
- 5. Eyemound sloping steeply below eyes, mesial spines on anterior margin quite strong, distal 2 pairs of inferior setae inserted at subequal level on ventral plate of penis *H. goedei* n.sp.
- Eyemound sloping gradually below eyes, mesial spines on anterior margin weak, distal 2 pairs of inferior setae inserted at different levels on ventral plate of penis 6
- 6. Ventral plate of penis much longer than wide, its notch depth about 0.3 plate length *H. clarkei* n.sp.
- Ventral plate of penis about as long as wide, its notch depth about 0.5 plate length *H. cavaticum* (Hickman) n.comb.

***cavaticum* species group**

Four species, southern Tasmania, cavernicolous. Ventral plate widest subdistally, 2 superior setae; 5 free latéral sclerites; penis lateral plate broad basally; end of

glans deeply cleft in lateral view; chelicera second segment without strong upwardly directed proximodorsal swelling; SA usually greater than 65 deg.; CI:AI usually greater than 0.23 less than 0.40.

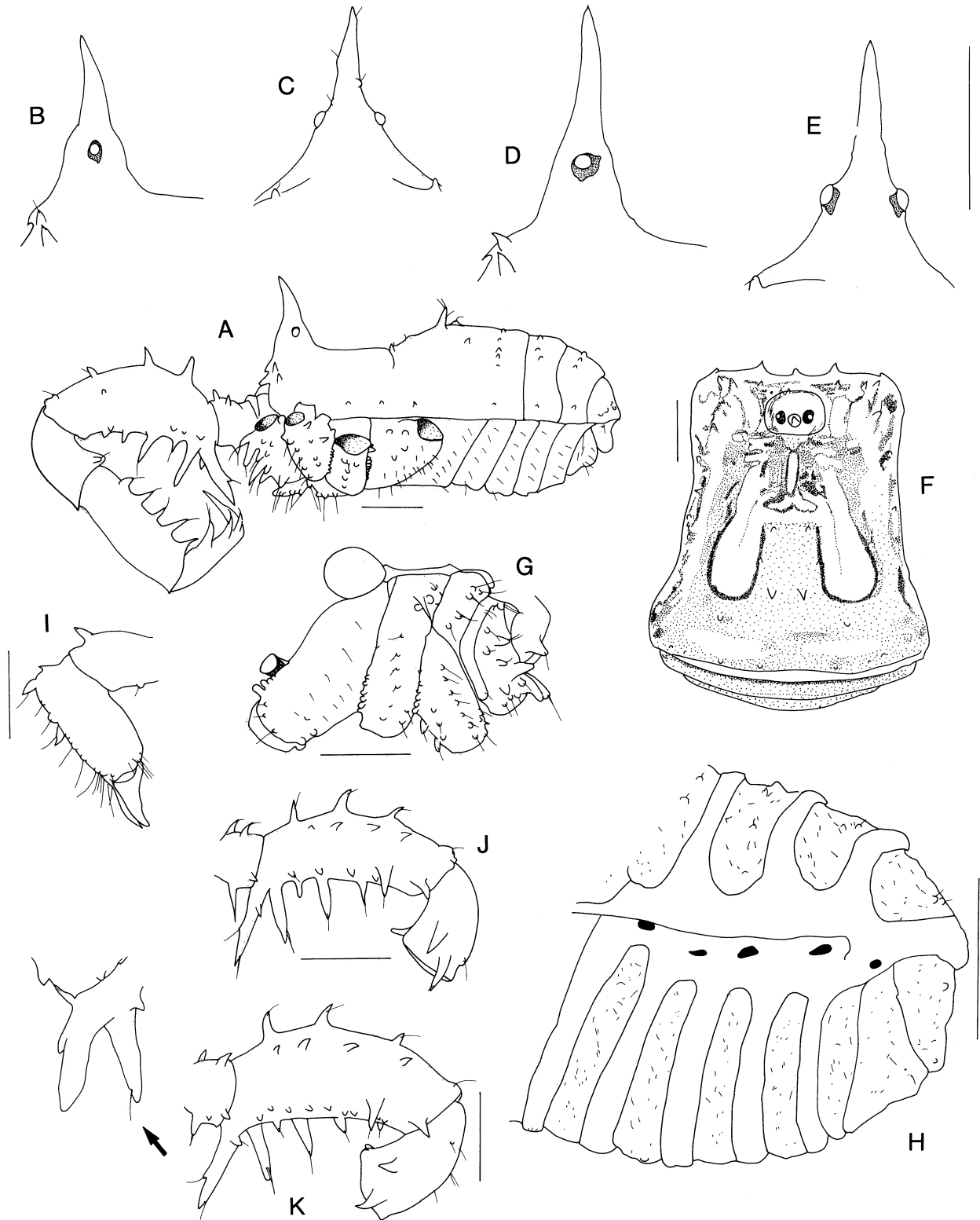


Fig.4. *Hickmanoxyomma cavaticum* (Hickman). A-C, F-G, I, K = Holotype male; H, J = allotype female. A = body & pedipalp, lateral; B, C = eyemound, lateral and frontal (Ida Bay population); D, E = eyemound, lateral and frontal (male, Hastings population); F = body, dorsal; G = coxosternal region, left side; H = posterior of abdomen showing lateral sclerites (solid); I = chelicera, retrolateral; J, K = pedipalp femur & patella, prolateral, male with posterior enlargement of ventroproximal spines. Scale bars = 1.0 mm

Hickmanoxyomma cavaticum
(Hickman, 1958), n.comb.

Figs 4,5

Monoxyomma cavaticum Hickman, 1958: 66–68.

Type material. South-east Tasmania: HOLOTYPE male, AM KS6924, Ida Bay Caves, V.V. Hickman, 22 Nov. 1939. ALLOTYPE female, AM KS17864, same data.

Additional material examined. South-east Tasmania, Ida Bay, 43°30'S, 146°50'E: Ida Bay Caves (probably Mystery Creek Cave): TMAG, J2858, same data as types, 2 males, 2 females, 2 immature; TMAG, J2859, D.M. Alcock, 12 June 1949, 2 females, 3 immature; TMAG, A. Goede, 22 Dec. 1964, 1 male, 1 female; SAM, A.M. Lea, no date, 1 female. Mystery Creek (Entrance) Cave (IB10): KS20061, A.M. Richards, 10 Nov. 1966, 3 males, 3 females; KS20062, A. Goede, 27 Oct. 1967, 1 male, 2 females; KS20095, A. Goede, 27 Oct. 1967, 1 immature; KS20063, A. Goede, 25 July 1971, 1 female; KS20064, A. Goede, 29 June 1974, 1 female; KS20026, same data, 1 male, 6 females; KS20027, same data, 1 male; KS20065, T. Goede, 15 Nov. 1975, 4 immature; KS20066, A. Goede, 29 Feb. 1976, 1 immature; KS20092, same data, 4 females; KS20106, S. Eberhard, 20 Jan. 1985, 1 female; KS20096, S. Eberhard, 11 Nov. 1986, 1 immature. Exit Cave: KS20067, A. Goede, 2 Mar. 1967, 1 female; KS20068, A. Goede, 27 Feb. 1968, 1 female; KS20069, A. Goede, 3 Nov. 1968, 1 female; KS20070, A. Goede, 3 Nov. 1969, 1 male; KS20071, A. Goede, 23 Mar. 1969, immature; KS20072, Kellers Squeeze, A. Goede, 29 Mar. 1969, 1 male, 1 female; SAM, BS1844, E. Hamilton-Smith, 24 May 1969, 1 male; KS20073, A. Goede, 22 Nov. 1970, 1 male, immature; KS20074, A. Goede, 25 July 1971, 1 male, 1 female; KS20021, Colonnades Chamber, W. Lehmann, 21 Apr. 1971, 1 male; KS20075, A. Goede, 5 Nov. 1972, 1 male, 1 female, immature; KS20076, N. Poulter, 22 Jan. 1973, 1 immature; KS19764, A. Goede, 19 Aug. 1974, 2 males, 1 females; KS20077, A. Goede, 15

Jan. 1975, 2 males; KS20078, in talus, dark zone, A. Goede, 19 May 1974, 1 male; KS20079, A. Goede, 21 Dec. 1974, 1 male, 4 females; KS20093, A. Goede, 1976, 1 male, 1 female; KS20094, Kellers Squeeze, Southern Passage end, A. Clarke, 31 Oct. 1987, 1 male. Loons Cave: KS20097, A. Goede, 13 Jan. 1968, 1 immature; KS20098, A. Goede, 18 Jan. 1969, 2 females. March Fly Pot Cave (IB46): KS20099, A. Clarke & N. Poulter, 23 Jan. 1988, 1 female, 1 immature. Little Grunt Cave (IB23): KS20100, S. Eberhard, 1 Dec. 1984, 1 male. Cyclops Cave (IB57): KS20101, S. Eberhard, 26 Oct. 1985, 1 immature. Hobbit Hole Cave (IB15): KS10102, S. Eberhard, Apr. 1984, Arthurs Folly Cave, KS20103, 300-400m from entrance, S. Eberhard, 21 Nov. 1986, 1 male. KS20146, Revelation Cave (IB1), A. Clarke, 24 Mar. 1989, 1 male; Cave IB97: KS20104, A. Clarke, 21 June 1987, 1 female. Unnamed cave, KS20105, S. Eberhard, 7 Feb. 1986, immature.

Hastings Caves, 43°23'S, 146°51'E: King George V Cave: SAM BS0440, E. Hamilton-Smith, 14 Nov. 1963, 1 male; KS20107, A. and T. Goede, 13 Mar. 1968, 1 male; KS20108, T. Goede, 5 Oct. 1968, 1 male; KS20030, twilight zone, T. Goede, 8 Oct. 1968, 1 male; KS20109, A. Goede, 17 Nov. 1968, immature; KS20110, A. and T. Goede, 24 Mar. 1969, immature; KS20111, same data, 1 male, 1 female; KS20112, T. Goede, 17 July 1971, 1 female, 1 immature; KS20028, T. Goede, 21 Oct. 1971, 1 male; KS20029, same data, 2 immature; KS20113, T. Goede, 28 Nov. 1971, 3 immature; KS20114, A. Goede, 8 Jan. 1973, 1 male, 4 females, 3 immature; KS20115, A. Goede, 30 June 1974, 3 males, 2 females; KS20116, T. Goede, 2 Nov. 1975, 2 females; KS20117, A. Goede, 28 Feb. 1976, immature; KS20118, same data, 4 males, 3 females; KS20119, A. and T. Goede, 20 Dec. 1976, 2 females; KS20120, S. Eberhard, 16 Dec. 1984. Trafalgar Cave: KS20121, S. Eberhard, 17 June 1984, 1 immature. Waterloo Swallett Cave: TMAG, R. Eberhard, 31 May 1980, 1 female. Surface collection, side road near King George V Cave, under logs: KS20122, T. Goede, 28 Nov. 1971, 1 male, 1 immature.

North Lune karst area, 43°24'S, 146°50'E: Spiders Den Cave (NL3): KS20123, A. Clarke, 5 Feb. 1988, 1 female.

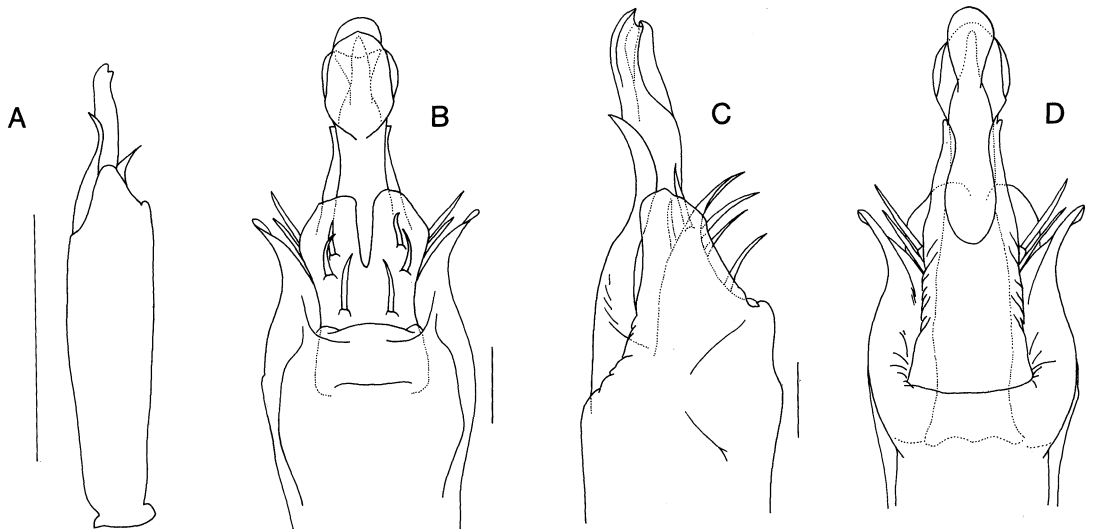


Fig.5. *Hickmanoxyomma cavaticum* (Hickman). Holotype penis: A = entire; B-D = distal part, ventral, lateral and dorsal. Scale bars: A = 1.0 mm; B-D = 0.15 mm.

Diagnosis. Lateral flanks of eyemound sloping gradually immediately below eyes; genital operculum longer than wide; 4–5 retroventral spines (size order 1,3,4,2,5); calcaneus I about 0.30–0.35 astragalus; ventral plate about as long as wide, notch deep, about 0.5 plate length and reaching beyond distal inferior setae. Lateral plate long, obscuring all or virtually all of proximal superior seta.

Redescription. MALE. *Body.* Dorsal colour yellow-brown; pigmentation pattern as figured, faint. Eyemound rising just behind anterior margin; spine suberect, SA about 70°, SH about 1.5 IOD; lateral flanks sloping gradually immediately below eyes. Anterior margin with 2–3 tubercles on each side. TA3 with pair of gracile suberect spines; TA1 with pair small tubercles; TA2 with pair of small granules or lacking, TA4 with more widely spaced pair of tubercles; distribution of other granules as figured. Five lateral sclerites easily seen in distended specimens. Coxosternal region as figured; genital operculum longer than wide; spiracle barely obscured by tubercles on coxa IV.

Chelicerae. Prodistal spine on first segment moderately large; second segment without strong upwardly directed mound on proximodorsal surface, dorsal surface with strong proximal spine and another towards the middle.

Pedipalps. Gracile; ratio PF: CW 0.93. Femur with row of 3 mediadorsal spines (size order 1,2,3), 4 smaller prodorsal spines, and 4–5 retroventral spines (size order 1,3,4,2,5). Accessory denticles on proximoventral trifold spine weakly developed. Trifold spine and proximal retroventral spine barely joined at base. Tibia with 5 retroventral spines.

Legs. Ratio FIV: CW 2.84; calcaneus long, ratio CI: AI 0.35. Lateral branches on claw of legs III & IV small; juveniles with 2 pairs of branches. Tarsal formula: 6–7(2), 18–22,4,4.

Genitalia. Ventral plate with 2 superior setae on each side, about as long as wide, widest subdistally and narrowing towards base. Notch deep, about 0.5 plate length and reaching beyond distal inferior setae. Lateral plate broad basally, obscuring all setal bases on ventral plate, and long, obscuring all or virtually all of proximal superior seta. Glans terminally cleft in lateral view.

FEMALE. Similar to male except: body smaller, pedipalps more gracile and relatively shorter, trifold spine more slender, its proximal accessory denticle weaker. Tarsal formula: 4–5(2), 16–21(3), 4,4.

Measurements (Exit Cave sample, n = 6 males, 6 females).

	SL	CW	PF	AI	CI	AIV	CIV	FIV	CSL
Range	4.78–5.52	3.33–3.81	2.93–3.70	4.54–5.14	1.61–1.78	10.28–12.01	1.49–1.70	9.63–10.51	2.47–3.02
	4.15–5.25	2.93–3.35	2.51–2.78	4.39–4.62	1.51–1.77	9.94–11.59	1.35–1.74	9.21–9.76	2.19–2.52
Mean	5.09	3.49	3.24	4.87	1.69	11.10	1.63	9.91	2.64
	4.76	3.14	2.64	4.55	1.62	10.59	1.52	9.53	2.41
Standard Deviation	0.26	0.17	0.27	0.21	0.06	0.52	0.08	0.31	0.15
	0.36	0.16	0.09	0.13	0.08	0.54	0.13	0.19	0.11

Variation. The Ida Bay and Hastings populations appear to be very similar morphologically except that the latter tends to have a steeper anterior slope and more convex posterior slope to the eyemound (Fig. 4D), FIV: CW 2.73 and CI: AI only 0.28. Tarsal formula: males 6–7(2), 18–20(3), 4,4; females 4–6(2), 16–17(3), 4,4. Electrophoretically, there are one fixed and two frequency differences in 13 enzymes assessed, GD = 0.167 (n = 4 & 5 respectively) (D. Coglean, personal communication). The North Lune sample (n = 1) shows two fixed differences from both Hastings and Ida Bay, GD = 0.192 and 0.275 respectively. The results suggest the three populations may well be reproductively isolated. Means for the Hastings population sample (n = 6 males, 5 females):

SL	CW	PF	AI	CI	AIV	CIV	FIV	CSL
5.00	3.37	3.18	4.85	1.37	10.36	1.32	9.20	2.61
4.54	2.97	2.51	4.38	1.25	9.63	1.15	8.55	2.26

Comments. *H. cavaticum* appears to be very closely related to *H. goedei* and *H. clarkei* but is more troglomorphic. Further electrophoretic work should clarify these relationships and the status of the populations currently regarded as *H. cavaticum*.

Natural history. The collection of a teneral adult and juvenile under logs over 100 m from the nearest known cave suggests that the species is capable of moving from cave to cave across the surface. The fact that young specimens were collected suggests that the species may sometimes breed in non-cave habitats or may disperse in the juvenile stage.

Distribution. South-east Tasmania: Hastings-Ida Bay karst areas.

Hickmanoxyomma goedei n.sp.

Fig. 6

Type material. South Tasmania, Scotts Peak, near Lake Pedder, 43°03'S, 146°18'E. HOLOTYPE male: KS19749, Huon Cave (SP 1,2), A. and T. Goede, 23 Mar. 1974. PARATYPES, KS19765, same data, 1 female; KS19748, same data, 2 males, 2 immature; KS19747, same cave, S. Eberhard, 29 Oct. 1988, 1 male.

Additional material examined. South-west Tasmania, Nicholls Range, 42°40'S, 145°50'E: KS20023, cave, in twilight zone, S. Eberhard, 19 Feb. 1987, 1 male; KS20024, same data, 2 females. Bill Nielson (Rotuli) Cave (NR1): KS20060, in dark and twilight zone, S. Eberhard, 19 Feb. 1987, 1 male; KS20025, same data, 4 females.

Diagnosis. Lateral flanks of eyemound sloping steeply immediately below eyes. Anterior margin with 2 tubercles on each side, mesial pair close to eyemound and large; TA2 lacking granules; genital operculum longer than wide; dorsal surface of cheliceral second segment with 2 spines towards middle; pedipalp femur with 4–5 retroventral spines

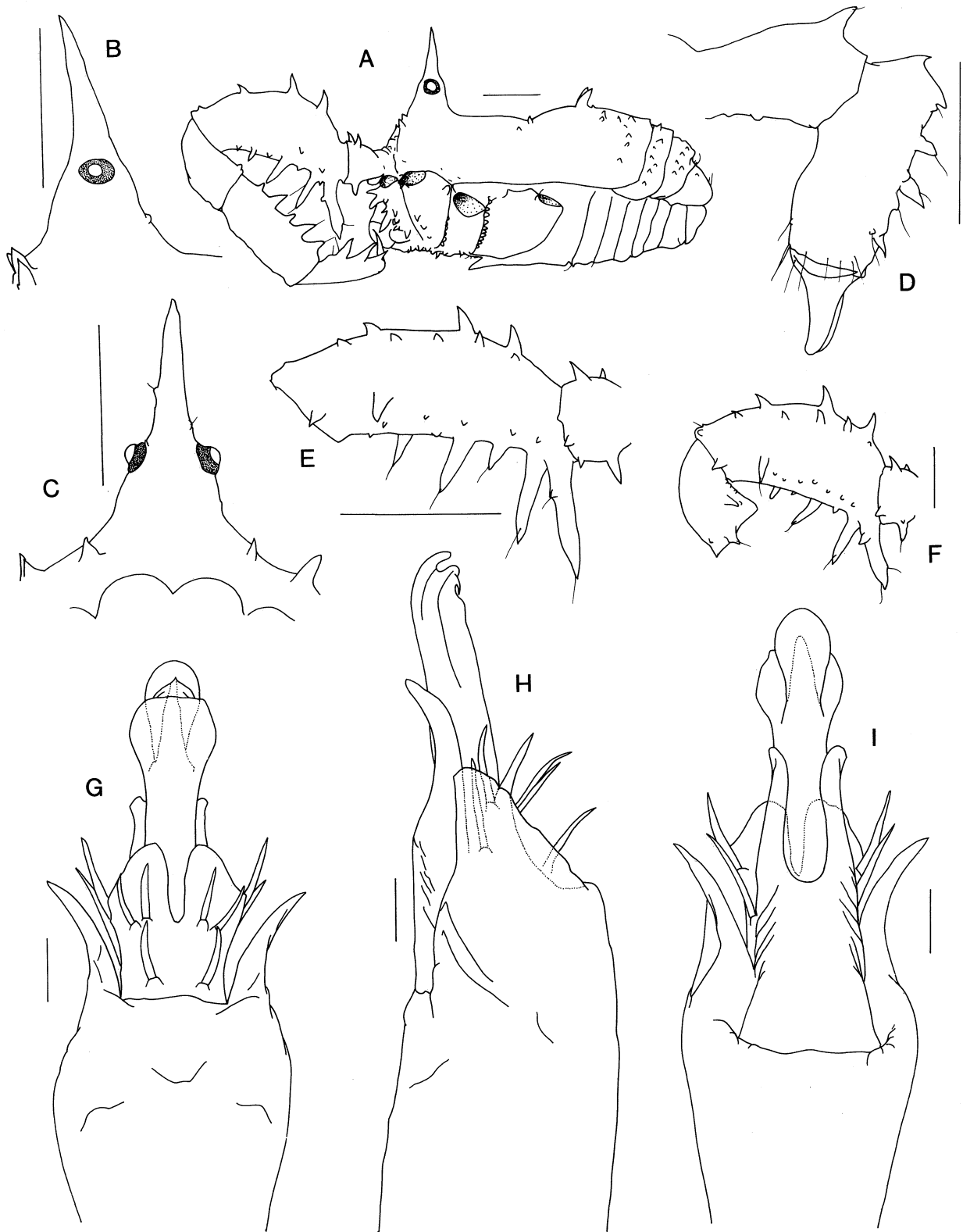


Fig.6. *Hickmanoxyomma goedei* n.sp. A = Holotype male; D, F-I = male KS19747 ; E = female KS19765. A = body and pedipalp, lateral; B, C = eyemound, lateral and frontal; D = chelicera, retrolateral, E-F = pedipalp femur, prolateral (male at reduced scale); G-I = distal part of penis, ventral, lateral & dorsal. Scale bars: A-F = 1.0 mm; G-I = 0.1 mm.

(size order 1,3,4,2,5); calcaneus I about 0.25 astragalus; ventral plate about as long as wide, middle inferior setae close to and lateral to distal pair, notch deep, about 0.5 plate length and reaching beyond distal pair of inferior setae.

Description. MALE. *Body.* Dorsal colour yellow-dark brown; pigmentation pattern as figured, well developed. Eyemound rising just behind anterior margin; spine quite erect, SA about 80°, SH about 1.5 IOD; lateral flanks sloping steeply immediately below eyes. Anterior margin with 2 tubercles on each side, the mesial pair closer to the eyemound and larger than in *H. cavaticum*. TA3 with pair of gracile suberect spines; TA1 with pair small tubercles; TA2 lacking granules, TA4 with more widely spaced pair of tubercles; distribution of other granules as figured. At least 4 lateral sclerites seen in partially distended female. Genital operculum longer than wide; spiracle slightly obscured by tubercles on coxa IV.

Chelicerae. Prodorsal spine on first segment moderately large; second segment without strong upwardly directed mound on proximodorsal surface, dorsal surface with strong proximal spine, 1 at about 0.3 and another at about 0.5.

Pedipalps. Long and gracile; ratio PF: CW 0.86. Femur with row of 3 mediadorsal spines (size order 2,1,3), 3–4 smaller prodorsal spines, and 4–5 retroventral spines (size order 1,3,4,2,5). Accessory denticles on proximoventral trifid spine weakly developed. Trifid spine and proximal retroventral spine only weakly joined at base. Tibia with 5 retroventral spines.

Legs. Ratio FIV: CW 2.48; CI: AI 0.24. Lateral branches on claw of legs III & IV small; juveniles with 2 pairs of branches. Tarsal formula: 5–6(2), 15–18(2–3), 4, 4.

Genitalia. Ventral plate with 2 superior setae on each side, about as long as wide, widest subdistally and narrowing towards base. Middle inferior setae placed more distally and laterally than in *H. cavaticum*. Notch deep, about 0.5 plate length and reaching beyond distal pair of inferior setae. Lateral plate broad basally, obscuring bases of superior and proximal inferior setae, but relatively shorter than in *H. cavaticum*, terminating well below tips of superior setae. Glans terminally bifurcate in lateral view.

FEMALE. Differs from male as in *H. cavaticum*. Tarsal formula: 4(2)15–16(3), 4, 4.

Measurements (Scotts Peak sample, n = 3 males, 1 female).

SL	CW	PF	AI	CI	AIV	CIV	FIV	CSL
4.59	3.13	2.54	4.36	1.05	9.71	0.76	8.42	2.40
5.12	3.33	3.13	4.67	1.10	10.10	0.91	8.52	2.61
Mean								
4.91	3.25	2.81	4.56	1.08	9.90	0.85	8.47	2.52
4.54	3.02	2.69	4.35	1.06	9.69	0.87	8.07	2.40
Standard Deviation								
0.23	0.09	0.24	0.14	0.02	0.16	0.07	0.04	0.09

Variation. Nicholls Range KS 20023 penis with supernumerary inferior seta on left side, its eyemound SH 1.66 IOD, and the spine at about 0.3 on the cheliceral

second segment is smaller than in the Scotts Peak population. PF: CW 0.88, FIV: CW 2.80, CI: AI 0.27. Tarsal formulae: males 5–6(2), 16–20(3), 4, 4; females 4–5(2), 16–18(3), 4, 4. Measurements for a Nicholls Range male:

SL	CW	PF	AI	CI	AIV	CIV	FIV	CSL
4.43	3.13	2.74	4.59	1.22	10.13	1.11	8.75	2.33

Comments. *Hickmanoxyomma goedei* is most closely related to *H. cavaticum* and *H. clarkei*. Electrophoretic work is planned to assess differences between the Scotts Peak and Nicholls Range populations.

Etymology. The specific epithet acknowledges the extensive cave fauna collecting program of cave geomorphologist Dr Albert Goede, University of Tasmania, including the first specimens of this species taken at Scotts Peak.

Natural history. At Nicholls Range most specimens were found in small fissure caves in the twilight zone (S. Eberhard, personal communication) whereas *Hickmanoxyomma* in general is more common in the dark zone (A. Goede, personal communication). It may be more likely to find Nicholls Range specimens on the surface. *Hickmanoxyomma goedei* is more strongly pigmented than *H. cavaticum* and may be a troglophile.

Distribution. Southern Tasmania: Scotts Peak and Nicholls Range cave regions.

Hickmanoxyomma clarkei n.sp.

Figs 7, 8

Type material. Southern Tasmania, Cracroft area, South Picton Range, Judds Cavern (King Billy Cave) (C1): HOLOTYPE male, TMAG, J1559, R. Eberhard, 2 June 1980. PARATYPES: TMAG, J2857, same data, 1 female; KS20128, A. Goede, 30 Jan. 1975, 1 female; KS20129, same data, 1 immature; KS20130, on wall beside stream, S. Eberhard, 5 Apr. 1988. Matchlight Cavern (C2): KS20131, A. Goede, 17 Jan. 1978, 1 female. Cave C6: TMAG, J1560, R. Eberhard, 3 June 1980, 1 male, 1 female.

Additional material examined. Southern Tasmania, Precipitous Bluff, Bauhaus Cave (PB6): KS20058, A. Clarke, 24 Dec. 1988, 2 males, 1 female; KS20059, same data, 1 female; KS20148, same data, 1 male, 1 female, 1 immature; KS20149, same data, 1 male.

Diagnosis. Eyemound spine very long, SH about 1.8 IOD; lateral flanks sloping steeply immediately below eyes. TA2 with a larger pair of tubercles than TAI; genital operculum longer than wide; pedipalp femur with 4–5 retroventral spines (size order 1,3,4,2,5). Proximal accessory denticle on proximoventral trifid spine moderately developed; calcaneus about 0.3 astragalus; ventral plate much longer than wide; notch about 0.3 plate

length and reaching only to distal inferior setae. Lateral plate broad basally and long, obscuring all setal bases and obscuring all or virtually all of proximal superior seta.

Description. MALE. Body. Dorsal colour yellow-dark brown; pigmentation pattern as figured, well developed. Eyemound rising just behind anterior margin; spine very erect, SA about 80°, spine very long, SH about 1.8 IOD; lateral flanks sloping steeply immediately below eyes. Anterior margin with 4 tubercles on each side. TA3 with pair of strong spines; TA1 with pair small tubercles; TA2 with a larger pair of tubercles, TA4 with more widely spaced pair; distribution of other granules as figured. 5

lateral sclerites easily seen in distended specimen. Genital operculum longer than wide; spiracle barely obscured by tubercles on coxa IV.

Chelicerae. Prodistan spine on first segment moderately large; second segment without strong upwardly directed mound on proximodorsal surface, dorsal surface with strong proximal spine and another towards middle.

Pedipalps. Long and gracile; ratio PF: CW 0.86. Femur with row of 3 mediodorsal spines (size order 1=2,3), 3 smaller prodorsal spines, and 4-5 retroventral spines (size order 1,3,4,2,5). Proximal accessory denticle on proximoventral trifold spine moderately developed. Trifold spine and proximal retroventral spine only slightly joined at

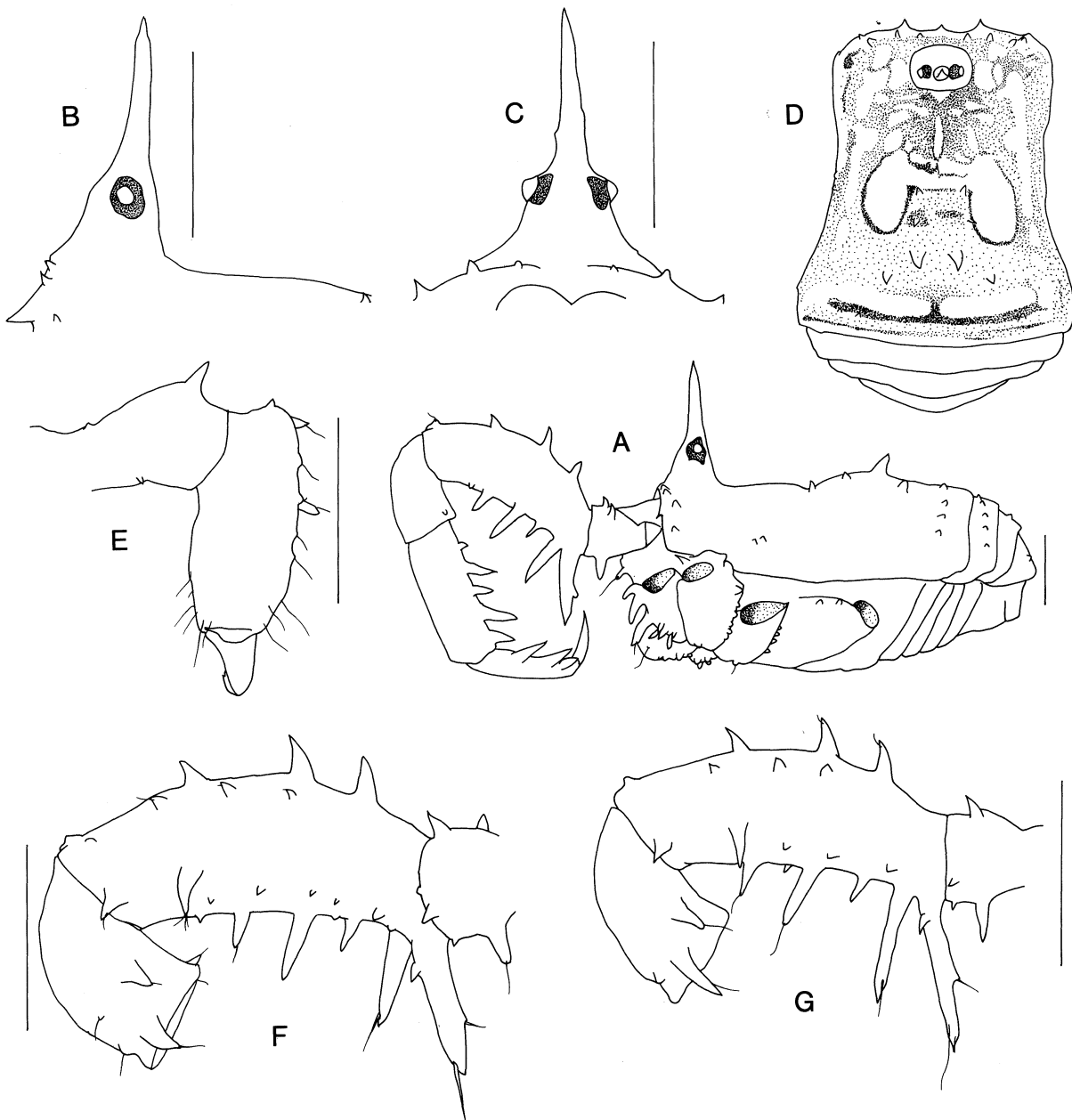


Fig.7. *Hickmanoxyomma clarkei* n.sp. A-F = Holotype male; G = female J2857. A = body and pedipalp, lateral; B, C = eyemound, lateral & frontal; D = body, dorsal; E = chelicera, retrolateral; F, G = pedipalp femur and patella, prolateral. Scale bars = 1.0 mm.

base. Tibia with 5 retroventral spines.

Legs. Ratio FIV: CW 2.82; ratio CI: AI 0.31. Lateral branches on claw of legs III & IV small; juveniles with 2 pairs of branches. Tarsal formula: 5-6(2), 20-21(3), 4, 4.

Genitalia. Ventral plate with 2 superior setae on each side, much longer than wide, widest subdistally and narrowing towards base. Notch shallower than in *H. cavaticum*, about 0.3 plate length and reaching only to distal inferior setae. Lateral plate broad basally and long, when erect obscuring all setal bases and obscuring all or virtually all of proximal superior seta. Glans terminally cleft in lateral view.

FEMALE. Similar to male except: pedipalps more gracile, proximal accessory denticle on trifid spine weaker. Tarsal formula: 5(2), 18-20(3), 4, 4.

Measurements (Cracroft sample, n = 2 males, 4 females).

SL	CW	PF	AI	CI	AIV	CIV	FIV	CSL
4.56-3.16	2.63-	4.53-	1.40-	10.34-	1.21-	8.83-	2.26-	M
4.60	3.19	2.83	4.66	1.42	10.74	1.30	9.11	2.28

3.96-2.97-2.46-	4.40-1.31-9.75-	1.24-	8.47-	2.28-	F					
5.56	3.47	2.94	4.74	1.46	10.76	1.32	9.28	2.40		
Mean	4.58	3.18	2.73	4.60	1.41	10.54	1.26	8.97	2.27	M
4.79	3.18	2.70	4.55	1.38	10.41	1.26	8.98	2.32	F	
Standard Deviation	0.53	0.18	0.17	0.12	0.06	0.35	0.04	0.28	0.05	F

Variation. Precipitous Bluff animals: bigger, PF: CW 1.03, FIV: CW 2.32, CI: AI 0.29, lack tubercle on TA2 though granule may be present, only 3 tubercles on anterior margin, retrolateral spine 4 on pedipalp femur poorly developed and pedipalp more granular. Tarsal formula: 6(2), 16-17(3), 4, 4. Means for 2 males:

SL	CW	PF	AI	CI	AIV	CIV	FIV	CSL
5.77	3.82	3.93	4.78	1.38	10.39	1.29	8.85	3.01

Comments. *Hickmanoxymma clarkei* is similar to *H. eberhardi* in penis structure. The latter species, however, has apomorphic reductions in tergal spines and has lost the claw branches from legs III and IV. Electrophoresis will be used to assess differences in the

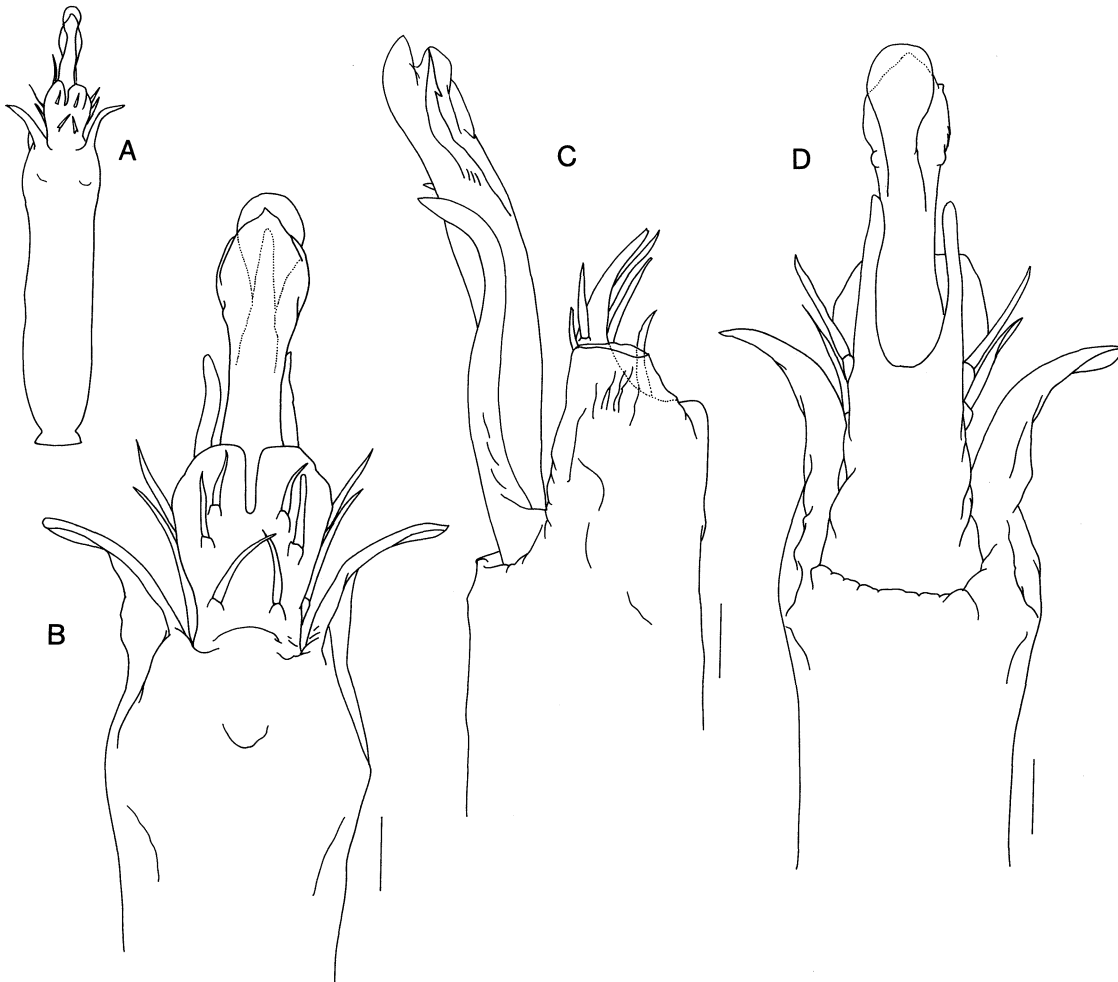


Fig. 8. *Hickmanoxymma clarkei* n.sp. Holotype penis: A = entire; B-D = distal part, ventral, lateral and dorsal. Scale bars: A = 1.0 mm; B-D = 0.1 mm.

Cracroft and Precipitous Bluff populations of *H. clarkei*.

Etymology. The specific epithet acknowledges the contribution made by Mr Arthur Clarke, Chairman of the Tasmanian Karst and Cave Research Group, to Tasmanian biospeleology, including collection of the first specimens of this species from Precipitous Bluff.

Distribution. Southern Tasmania, Cracroft and Precipitous Bluff karst areas.

Hickmanoxyomma eberhardi n.sp.

Fig.9

Type material. South-west Tasmania, Mount Anne, Col-In-Cavern Cave (MA1): HOLOTYPE male: KS19450, dark zone, S. Eberhard, 24 Jan. 1987. PARATYPES: KS20040, same data, 1 female; KS19449, S. Eberhard, 29 Jan. 1987, 1 male. MA14 Cave: KS20038, on walls below pitch 1, G. Smith, 20 Jan. 1987, 1 male; KS20039, same data, 1 female. Deep Thought Cave (MA10): KS20124, in crevice between pitches 1 & 2, G. Smith, 18 Jan. 1987, 1 male; KS20125, dark zone, 160 m depth, S. Eberhard, 13 Jan. 1987, 2 males, 1 female. Anne-A-Kananda Cave (MA9): KS20126, on walls below entrance chamber, L. Whaler and G. Smith, 19 Jan. 1987, 1 male, 1 female. Meltwater Pot Cave (MA20): KS20127, on wall, 60 m depth, S. Eberhard, 25 Jan. 1987, 2 females.

Diagnosis. Lateral flanks sloping gradually immediately below eyes; TA3 only with pair of very small mesial tubercles; genital operculum broader than long; 5 retroventral spines (size order 1,4,2,5,3); calcaneus I about 0.25 astragalus, claw on legs III & IV without lateral prongs; ventral plate about 1.25 as long as wide, notch about 0.4 plate length and not reaching most distal pair of inferior setae.

Description. MALE. *Body.* Dorsal colour straw yellow to very light brown; pigmentation pattern very faint. Eyes small, eye pigment reduced; eyemound rising just behind anterior margin; spine suberect, SA about 70°, SH about 1.45 IOD; lateral flanks sloping gradually immediately below eyes. Anterior margin with 2–3 tubercles on each side. TA3 and TA1 each with pair of very small tubercles; TA2 lacking even granules, TA4 with more widely spaced pair of tubercles; distribution of other granules as figured. 4–5 lateral sclerites easily seen in distended specimens. Genital operculum broader than long. Spiracle not obscured by bridging tubercles on coxa IV.

Chelicerae. Proximal spine on first segment moderately large, smaller denticles more proximally; second segment without strong upwardly directed mound on proximodorsal surface, dorsal (anteriad) surface with strong proximal spine and another towards the middle.

Pedipalps. Long and gracile, more slender than in *H. cavaticum*; PF: CW 0.89. Femur with row of 3 mediodorsal spines (size order 2 = 3,1), 4–6 smaller prodorsal spines, and 5 retroventral spines (size order

1,4,2,5,3). Proximal accessory denticle on proximoventral trifold spine moderately developed. Trifold spine and proximal retroventral spine joined at base. Tibia with 5 retroventral spines.

Legs. Slender. Ratio FIV: CW 2.87; ratio CI: AI 0.25. Claw on legs III and IV without lateral branches in adult (juveniles not seen). First tarsal article long. Tarsal formula: 4–5(2), 14–16(3), 4, 4.

Genitalia. Ventral plate with 2 superior setae on each side, about 1.25 as long as wide, widest subdistally and narrowing towards base, similar to that of *H. clarkei* in form but narrower. Notch relatively shallow, about 0.4 plate length and not reaching most distal pair of inferior setae. Lateral plate broad basally and obscuring setal bases on ventral plate; not obscuring tip of proximal superior seta. Glans terminally cleft in lateral view.

FEMALE. Differs from male as in *H. cavaticum*. Tarsal formula: 4(2), 12–17(3), 4, 4.

Measurements (n = 5 males, 3 females).

SL	CW	PF	AI	CI	AIV	CIV	FIV	CSL
Range								
3.39-4.13	2.36-2.86	2.01-2.55	3.75-4.32	1.17-1.40	8.05-8.89	1.00-1.24	7.22-8.02	1.69-2.17
3.75-4.19	2.51-2.81	2.07-2.41	3.90-4.33	1.25-1.40	8.29-9.27	1.07-1.28	7.44-7.99	1.97-2.07
Mean								
3.72	2.63	2.33	4.08	1.26	8.53	1.14	7.54	1.96
4.02	2.64	2.21	4.06	1.34	9.00	1.16	7.69	2.01
Standard Deviation								
0.27	0.20	0.20	0.19	0.09	0.30	0.08	0.28	0.18
0.19	0.13	0.15	0.19	0.07	0.20	0.09	0.23	0.04

Comments. This species seems to be most closely related to one or more undescribed species represented only by females from the Bubs Hill, Andrews River and Franklin River karst areas in south-west Tasmania. These show reduction in the spine on TA3 but retain lateral branches on leg claws. *Hickmanoxyomma eberhardi* is the second most cave adapted species after *H. cristatum*, although subdivision of leg tarsi is only moderate. Its similarity to *H. cristatum* in reduction of spines on TA3 and loss of lateral branches on tarsal claws is regarded as convergence.

Etymology. The specific epithet acknowledges the large numbers of harvestmen collected by biospeleologist Mr Stephan Eberhard in Tasmanian caves, including caves in Mount Anne.

Distribution. Caves in Mount Anne, south-west Tasmania.

tasmanicum species group

Two species, northern Tasmania, surface and cave dwelling. Ventral plate widest basally, 1 superior seta; lateral plate narrow basally; end of glans may be slightly concave but not deeply cleft in lateral view; free lateral

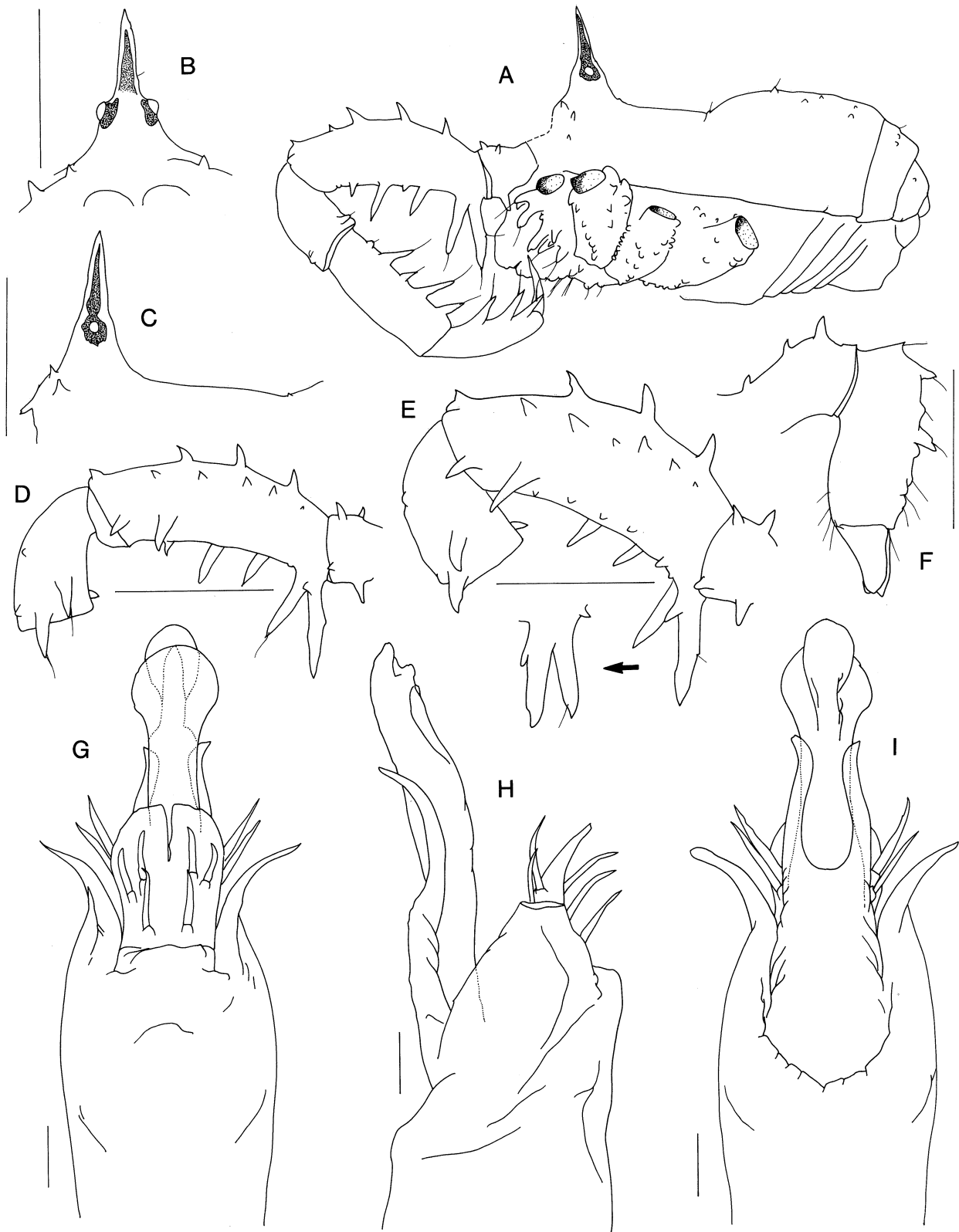


Fig.9. *Hickmanoxyomma eberhardi* n.sp. A = Holotype male; B–C, F = male KS20038; G–I = male KS19449; D = female KS20039. A = body & pedipalp, lateral; B, C = eyemound, lateral and frontal; D, E = pedipalp femur and patella, prolateral, male with posterior enlargement of ventroproximal spines; F = chelicera, retrolateral; G–I = distal part of penis, ventral, lateral and dorsal. Scale bars: A–F = 1.0 mm; G–I = 0.1 mm.

sclerites apparently absent; chelicera second segment with strong upwardly directed proximal mound; SA usually less than 65°, CI:AI usually less than 0.24.

Hickmanoxyomma tasmanicum

(Roewer, 1915) n.comb.

Figs 10, 11

Monacanthobunus tasmanicus Roewer, 1915: 104–105; 1923: 604.

Monoxyomma silvaticum Hickman, 1958: 65–66. n.syn.

Type material. Tasmania: HOLOTYPE female: FIS,

Roewer coll. no. 1034.

Additional material examined. North-east Tasmania: Holotype male and Allotype female (*M. silvaticum*) AM KS6925 & KS17635, Weldborough Pass, V.V. Hickman, 16 Apr. 1954. KS20135, Scottsdale, granite cave, A. Goede, 25 Oct. 1970, 1 immature male. KS20036, Lottah, mine adit on Anchor Lease, T. Goede, 24 Oct. 1970, 1 male, 1 female. KS20037, Flowery Gully Cave (FG201), Flowery Gully, 41°15'S, 146°50'E, R. Eberhard, 28 Feb. 1987, 1 male, 1 female.

Diagnosis. Lateral flanks of eyemound sloping gradually immediately below eyes, SA less than 50°; TA3 with pair of blunt spines with broad bases, mesial tubercles

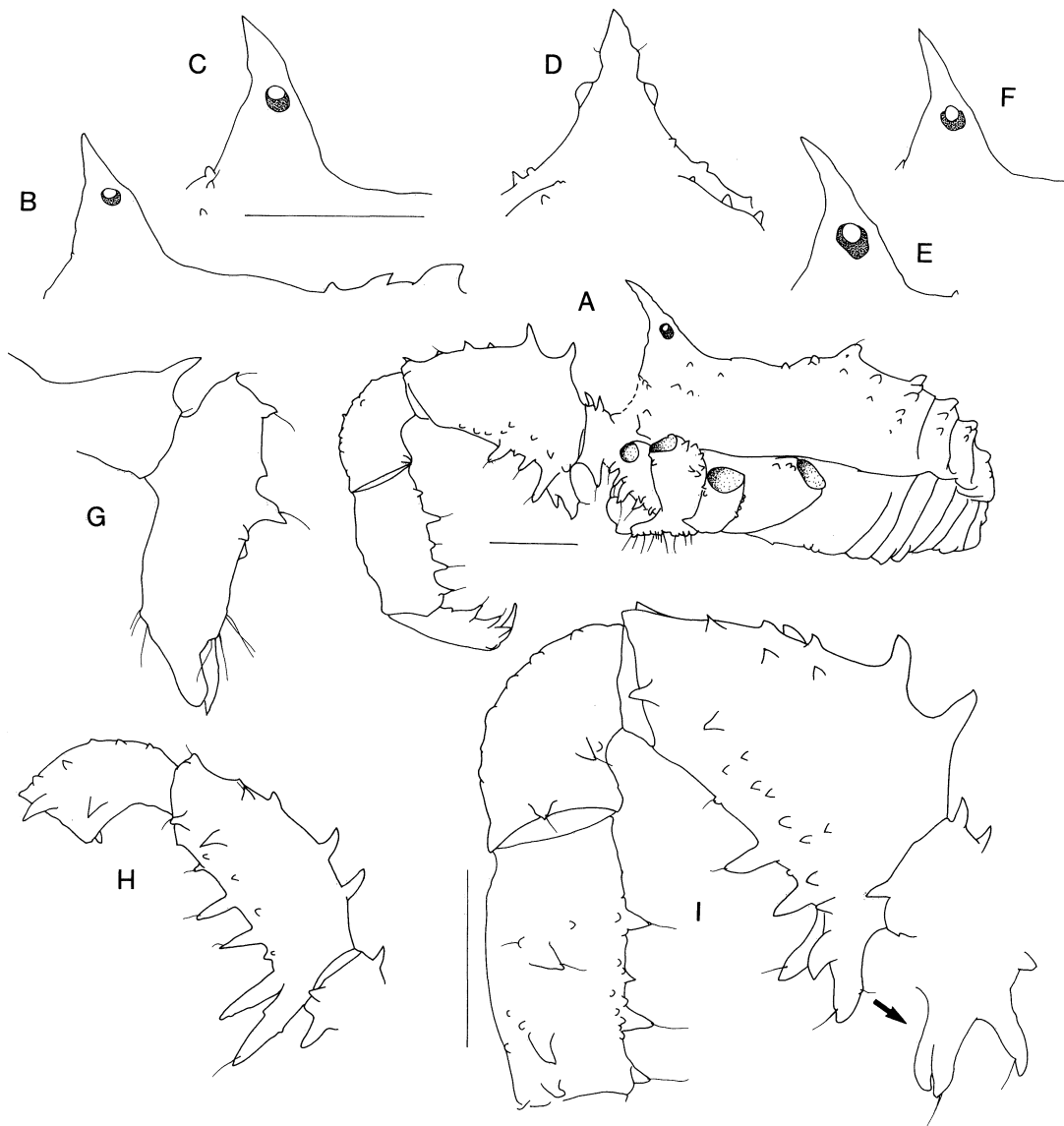


Fig. 10. *Hickmanoxyomma tasmanicum* (Roewer). A, E, G, I = holotype of *M. silvaticum*; B = holotype female, F, H = allotype female of *M. silvaticum*; C–D = Scottsdale male KS20036. A = body and pedipalp, lateral; B = lateral profile; C, E–F = eyemound, lateral; D = eyemound, frontal; G = chelicera, retrolateral; I–H = pedipalp (part), prolateral, male with posterior enlargement of ventroproximal spines. Scale bars = 1.0 mm.

on TA5 and free tergites large and rounded; dorsal surface of cheliceral second segment with proximal spine and a very strong spine towards the middle; pedipalp femur with 4 retroventral spines (size order 1,3,2,4), proximal accessory denticle on proximoventral trifid spine very strong; calcaneus I about 0.23 astragalus, distitarsus 2 with 4 articles; ventral plate about 0.85 as long as wide, notch about 0.5 plate length and reaching distal pair of inferior setae.

Redescription. MALE. *Body.* Dorsal colour reddish brown with dark brown reticulations. Eyemound rising just behind anterior margin; spine directed forwards, SA about 40°, spine relatively short, SH subequal to IOD; lateral flanks sloping gradually immediately below eyes. Anterior margin with 3 small tubercles on each side. TA3 with pair of blunt spines with broad bases, tubercle on TA2 larger than on TA1, TA4 with more widely spaced pair of tubercles, mesial tubercles on TA5 and free tergites large and rounded; distribution of other granules as figured. No lateral sclerites seen in distended specimens. Genital operculum circular. Spiracle not obscured by bridging tubercles but close to coxa IV.

Chelicerae. Prodistal spine on first segment very large; second segment with strong upwardly directed mound on proximodorsal surface, dorsal (anteriad) surface with proximal spine and a very strong spine towards the middle.

Pedipalps. Robust; ratio PF: CW 0.97. Femur with row of 4 mediodorsal spines (size order 1 = 2,3,4), 3 smaller prodorsal spines, and 4 retroventral spines (size order 1,3,2,4). Proximal accessory denticle on proximoventral trifid spine very strong. Trifid spine and proximal retroventral spine barely joined at base. Tibia with 5 retroventral spines (1, 3 and 5 shortest), granulate ventrally.

Legs. Relatively much shorter than in *H. cavaticum*, ratio FIV: CW 1.70; ratio CI: AI 0.23. Claw on legs III and IV with longer lateral branches than in *H. gibbergunyar* n.sp., juveniles with 3 pairs. Tarsal formula: 4-6(2), 15-18(4), 4,4.

Genitalia. Ventral plate with 1 superior seta on each side, about 0.85 as long as wide, widest basally. Notch moderately deep, about 0.5 plate length and reaching distal pair of inferior setae. Lateral plate very narrow basally, not obscuring bases of any setae. In lateral view, glans without terminal concavity and not cleft.

FEMALE. The holotype female closely resembles males in the specific characters including the characteristic spines on TA3. The eyemound spine is slightly more erect, SA about 50°. Otherwise females differ from males as in *H. cavaticum*. Tarsal formula: 4(2), 13-16(3-4), 4,4.

Measurements (north-east Tasmania excluding Flowery Gully, n = 2 males, 3 females).

SL	CW	PF	AI	CI	AIV	CIV	FIV	CSL	
Range									
4.41-2.84-	2.81-	2.63-0.59-	5.56-	0.54-	4.93-	2.39-	M		
4.59	3.01	2.86	2.68	0.62	5.65	0.70	5.02	2.42	
3.71-2.44-	1.91-	2.13-0.56-	4.55-	0.45-	3.93-	1.79-	F		
4.27	2.76	2.11	2.73	0.63	5.84	0.55	5.23	2.10	
Mean									
4.50	2.92	2.84	2.66	0.60	5.61	0.62	4.97	2.40	M
4.07	2.60	2.02	2.43	0.59	5.13	0.50	4.54	1.96	F
Standard Deviation									
0.25	0.13	0.09	0.25	0.03	0.54	0.04	0.53	0.13	F

Variation. The holotype has relatively shorter legs than other females. There is slight variation in the angle and length of the eyemound spine. The Lottah male KS20036 has a very robust spine.

The ventral plate of the Flowery Gully Cave specimen

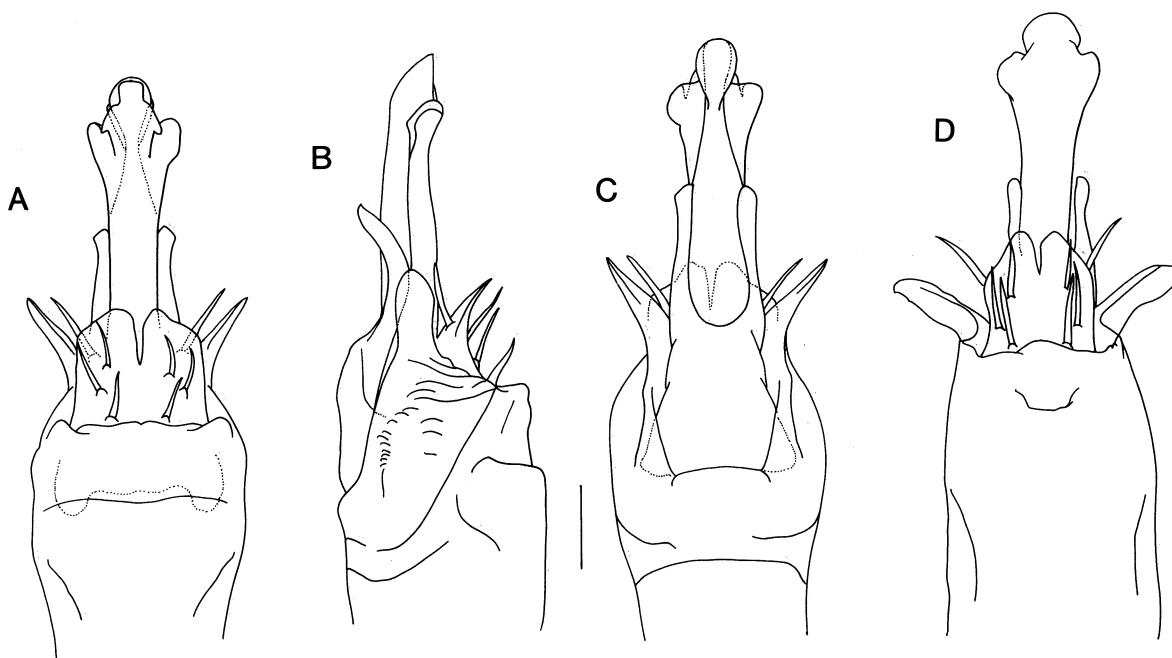


Fig.11. *Hickmanoxyomma tasmanicum* (Roewer). Distal part of penis: A-C, holotype of *M. silvaicum*, ventral, lateral, dorsal; D = Flowery Gully, ventral. Scale bar = 0.1 mm.

is relatively narrow. Measurements of the male and female from Flowery Gully Cave are:

SL	CW	PF	AI	CI	AIV	CIV	FIV	CSL
3.76	2.43	2.08	2.69	0.50	5.30	0.56	4.52	1.73 M
4.13	2.67	2.18	2.77	0.42	5.49	0.52	4.85	1.92 F

The legs are marginally longer than surface individuals from other populations. Tarsal formula: male 5(2), 15–16(4), 4, 4; female 4(2), 15–16(5), 4, 4. The body is heavily pigmented; no troglomorphies are noted.

Comments. Hickman’s types of *M. silvaticum* show close identity to Roewer’s holotype female (precise locality not specified), particularly in possessing the distinctively shaped spines on TA3 and four articles in distitarsus II. Hence *M. silvaticum* is synonymised with *H. tasmanicum*. Electrophoretically, the Flowery Gully Cave sample (n = 1) differs from the Weldborough Pass sample (n = 1) in 6 out of 12 enzymes studied, GD = 0.672 (D. Coglean, personal communication). This is highly suggestive of a specific difference. Until larger samples are available, the Flowery Gully population is provisionally placed in *H. tasmanicum* because of morphological similarities.

Hickmanoxyomma tasmanicum is the only species in the genus which has retained the typical number of three lateral branches on hind claws, emphasising its epigeal status.

Natural history. Though not primarily a cavernicole this species has been collected in a limestone cave, a small granite cave and a mine adit. The legs of surface specimens are relatively longer and have more tarsal articles than the closely related *O. saltuensis* suggesting some degree of “preadaptation” to cave life.

Distribution. North-east Tasmania, east of Tamar River in Scottsdale-Weldborough area, and Flowery Gully Caves immediately west of Tamar River.

***Hickmanoxyomma gibbergunyar* n.sp.**

Fig. 12

Type material. Northern Tasmania, Mole Creek, 41°32’S, 146°20’E: HOLOTYPE male: KS20031, Baldocks Cave (MC32), A. Goede, 20 Feb. 1972. PARATYPES: Baldocks Cave: KS20032, same data, 1 female; KS20132, same data, 2 males; KS20133, A. Goede, 15 Nov. 1969, 1 male. Honeycomb Cave (MC84): QVM, 1989/13/2, Type 442, T. Churchill, 17 Mar. 1988, 1 female. Wet Cave (MC144): QVM, 1989/13/3 Type 444, T. Churchill, 18 Oct. 1987, 1 immature. Herberts Pot cave (MC202): TMAG, J2861, R. J. Cockerill, 9 June 1968, 1 male; Cow Cave-Pyramid Cave link: TMAG, J2860, R.J. Cockerill, 12 Apr. 1968, 1 female. Westmoreland Cave (MC-X64): KS20134, R.J. Cockerill, 27 Jan. 1968, 1 male, 1 female. Caves (unspecified): QVM, 1989/13/3 Type 443, V.L. Fahey, 8 Jan. 1986, 1 male; QVM, 1989/13/1 Type 441, 2 km South Mole Creek, 30 m in cave, K. Crocker, Aug. 1981, 1 male.

Diagnosis. Lateral flanks of eyemound sloping steeply immediately below eyes, SA greater than 50°; TA3 with pair of large sharp spines; dorsal surface of cheliceral second segment with proximal spine and 2 others towards the middle; pedipalp femur with row of 4 mediodorsal spines, 5 retroventral spines (size order 1,5 = 3,4,2), tibia with 4 retroventral spines; calcaneus I about 0.15 astragalus; ventral plate about 1.2 as long as wide, notch not reaching most distal pair of inferior setae.

Description. MALE. *Body.* Dorsal colour light brown with darker brown patterning; pigmentation pattern faint but includes mesial saddle-shaped stripe. Eyemound rising just behind anterior margin; spine suberect, SA about 65°, spine relatively short, SH about 1.15 IOD; lateral flanks sloping steeply immediately below eyes. Anterior margin with 2-3 tubercles on each side. TA3 with pair of large sharp spines, tubercle on TA2 larger than granule on TA1, TA4 with more widely spaced pair of tubercles; distribution of other granules as figured. No lateral sclerites seen in distended specimens. Genital operculum circular. Spiracle not obscured by bridging tubercles but very close to coxa IV.

Chelicerae. Prodistal spine on first segment very large; second segment with strong upwardly directed mound on proximodorsal surface, dorsal (anteriad) surface with proximal spine and 2 others towards the middle.

Pedipalps. Long, ratio PF:CW 0.99. Femur with row of 4 mediodorsal spines (size order 2,1 = 3,4), 5 smaller prodorsal spines, and 5 retroventral spines (size order 1,5 = 3,4,2). Both accessory denticles on proximoventral trifid spine moderately developed. Trifid spine and proximal retroventral spine barely joined at base. Tibia with 5 retroventral spines (3 shortest, 1 and 5 less so).

Legs. Ratio FIV:CW 2.15; calcaneus short, ratio CI:AI 0.15. Femur I very tuberculate, particularly dorsally. Claw on legs III and IV with 1 pair of small lateral branches, juveniles with 2 pairs. Tarsal formula: 4(2), 14–16(3–4), 4, 4.

Genitalia. Ventral plate with 1 superior seta on each side, about 1.20 as long as wide, widest basally. Notch relatively shallow, about 0.3 plate length and not reaching most distal pair of inferior setae. Lateral plate narrow basally, not obscuring bases of inferior setae. In lateral view glans with terminal concavity but not cleft.

FEMALE. Differs from male as in *H. cavaticum*. Tarsal formula: 3(2), 12–14(3), 4, 4.

Measurements (Baldocks Cave sample, n = 4 males, 1 female).

SL	CW	PF	AI	CI	AIV	CIV	FIV	CSL
Range								
5.16-6.43	3.39-3.73	3.33-3.91	4.80-5.08	0.73-0.77	9.44-9.96	0.76-0.84	7.47-8.21	2.90-3.38 M
Mean								
5.86	3.62	3.60	5.00	0.75	9.70	0.79	7.77	3.14 M
5.18	3.30	2.80	4.49	0.70	9.00	0.67	7.35	2.60 F
Standard Deviation								
0.46	0.14	0.21	0.12	0.02	0.23	0.03	0.27	0.17 M

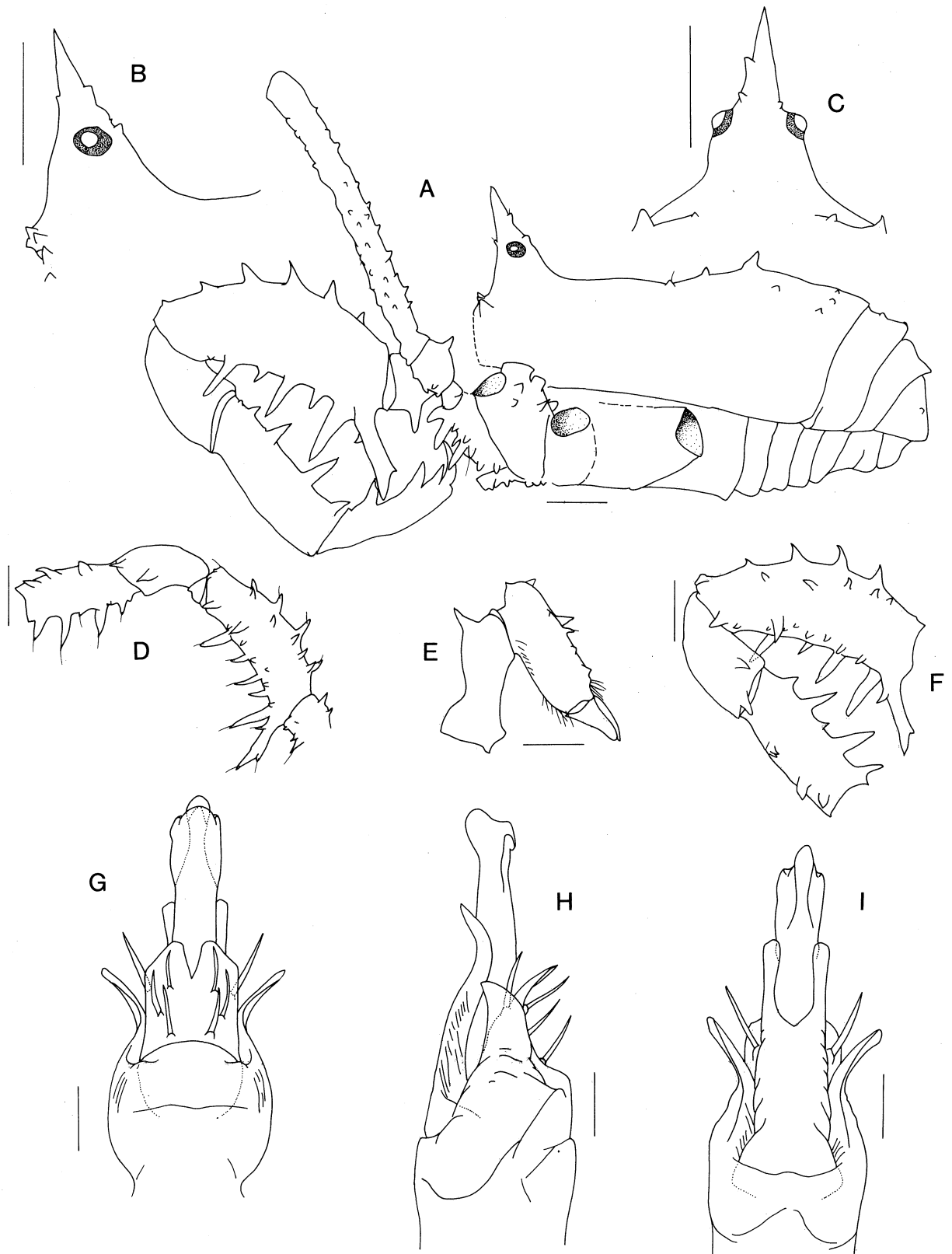


Fig.12. *Hickmanoxyomma gibbergunyar* n.sp. A = Holotype male; C, F-I = male KS20023; D = female KS20032. A = body, pedipalp and femur I, lateral; B, C = eyemound, lateral and frontal; D, F = pedipalp femur and patella, prolateral; E = chelicera, retrolateral; G-H = distal view of penis, ventral, lateral and dorsal. Scale bars: A-F = 1.0 mm; G-I = 0.15 mm.

Variation. A male and female from Westmoreland Cave had the following measurements:

SL	CW	PF	AI	CI	AIV	CIV	FIV	CSL	
6.86	4.30	4.28	5.35	0.74	10.08	0.67	7.85	3.68	M
6.24	3.84	3.47	4.64	0.67	8.93	0.65	7.15	3.10	F

Comments. *Hickmanoxyomma gibbergunyar* is most closely related to *H. tasmanicum*. The terminal part of the glans resembles that in *O. saltuensis*.

Etymology. The specific epithet is a noun in apposition from the Australian Aboriginal word "gibber-gunyar" which means "a cave dwelling".

Distribution. Central north Tasmania: Mole Creek Caves.

cristatum species group

One species, southern Tasmania, cavernicolous. Ventral plate widest basally, 1 superior seta; lateral plate narrow basally; glans with broad crestlike termination in lateral view; lateral sclerites apparently lacking; chelicera second segment without upwardly directed proximodorsal swelling; pedipalp tibia with 5 retroventral spines; SA greater than 80°, CI:AI greater than 0.4 less than 0.7.

Hickmanoxyomma cristatum n.sp.

Fig. 13

Type material. Southern Tasmania, Precipitous Bluff, 43°30'S, 146°35'E: HOLOTYPE male: KS19766, Quetzacoatl Conduit Cave (PB3), S. Eberhard, 29 Mar. 1986. PARATYPES: Quetzacoatl Conduit: KS19767, same data, 1 female; KS20022, K. Kiernan, 20 Jan. 1973, 2 immature; KS20057, A. Clarke, Dec. 1988, 1 female. Damper Cave (PB1): KS19769, A. Goede, 24-25 Jan. 1978, 4 females. Cueva del Blance cave: KS19768, S. Eberhard, 31 Mar. 1986, 1 male, 1 immature.

Diagnosis. Lateral flanks of eyemound sloping steeply immediately below eyes; anterior margin with 1 large tubercle on each side; TA1,2,3 each with pair of small granules; lateral sclerites apparently lacking; pedipalp femur with 4 retroventral spines (size order 1,4,2,3); calcaneus I about 0.5-0.6 astragalus, tarsal claw on legs III & IV without lateral prongs in adults and juveniles; ventral plate about 0.7 as long as wide, widest basally, notch not reaching most distal pair of inferior setae; lateral plate narrow basally, not obscuring inferior setal bases; in lateral view glans terminating in complex crestlike structure.

Description. MALE. *Body.* Dorsal colour yellow; pigmentation pattern very faint. Eyes small, eye pigment reduced; eyemound rising just behind anterior margin; spine very long and almost erect, SA about 85°, SH about 1.75 IOD; lateral flanks sloping steeply immediately below

eyes. Anterior margin with 1 large tubercle on each side. TA1,2,3 each with pair of small granules, TA4 with more widely spaced pair; no lateral sclerites seen in 2 semidistended specimens. Genital operculum and base of sternum broader than in *H. cavaticum*, not obscured by the single retrolateral tubercle on coxa IV.

Chelicerae. Prodistal spine on first segment relatively small; second segment without strong upwardly directed mound on proximodorsal surface, dorsal (anterior) surface with proximal spine and a stronger spine towards the middle.

Pedipalps. Long and gracile, similar to *H. eberhardi*, ratio PF:CW 1.25. Femur with row of 3 mediadorsal spines (size order 2,1 = 3), 3 smaller prodorsal spines, and 4 retroventral spines (size order 1,4,2,3). Proximal accessory denticle on proximoventral trifold spine weakly developed. Trifold spine and proximal retroventral spine joined at base though not as strongly as in *Odontonuncia*. Tibia with 5 retroventral spines (1 and 3 very short).

Legs. Very long, ratio FIV:CW 3.24; calcaneus very long, ratio CI:AI 0.58. Tarsal claw on legs III & IV without lateral branches in both adults and juveniles. Tarsal formula: 6(2), 18-19(3), 4, 4.

Genitalia. Ventral plate with 1 superior seta on each side, about 0.7 as long as wide, widest basally. Notch prominent but relatively shallow, about 0.4 plate length and not reaching most distal pair of inferior setae. Lateral plate relatively narrow basally, not obscuring inferior setal bases on ventral plate. In lateral view glans strongly bent and expands terminally into complex crest-like structure.

FEMALE. Larger than male; otherwise differs as in *H. cavaticum*. Tarsal formula: 4-6(2), 17-20(3), 4, 4.

Measurements (n = 2 males, 3 females).

SL	CW	PF	AI	CI	AIV	CIV	FIV	CSL	
Range									
3.63-2.59	2.46-	3.70-2.14	8.29-	2.14-	8.39-	1.92-	M		
3.75	2.77	4.23	3.76	2.23	8.83	2.17	9.00	2.03	
4.00-2.71	2.23-	3.81-2.14	8.81-	2.14-	8.59-	2.16-	F		
4.78	3.29	2.69	4.39	2.19	10.16	2.22	9.54	2.46	
Mean									
3.69	2.68	3.34	3.73	2.18	8.56	2.16	8.70	1.97	M
4.38	2.95	2.45	4.00	2.16	9.14	2.13	8.82	2.27	F
Standard Deviation									
0.32	0.25	0.19	0.28	0.03	0.74	0.08	0.52	0.14	F

Comments. The species appears to be closely related to the *tasmanicum* species group of northern Tasmania. Its similarity with *H. eberhardi* in reduction of spine on TA3 and loss of lateral prongs on tarsal claws is regarded as convergence. The distinctive structure of the glans separates it from its congeners.

Natural history. This is the most troglomorphic species in *Hickmanoxyomma* and is almost certainly a troglobite.

Etymology. The specific epithet refers to the crest-like termination to the penis.

Distribution. Southern Tasmania, known from three

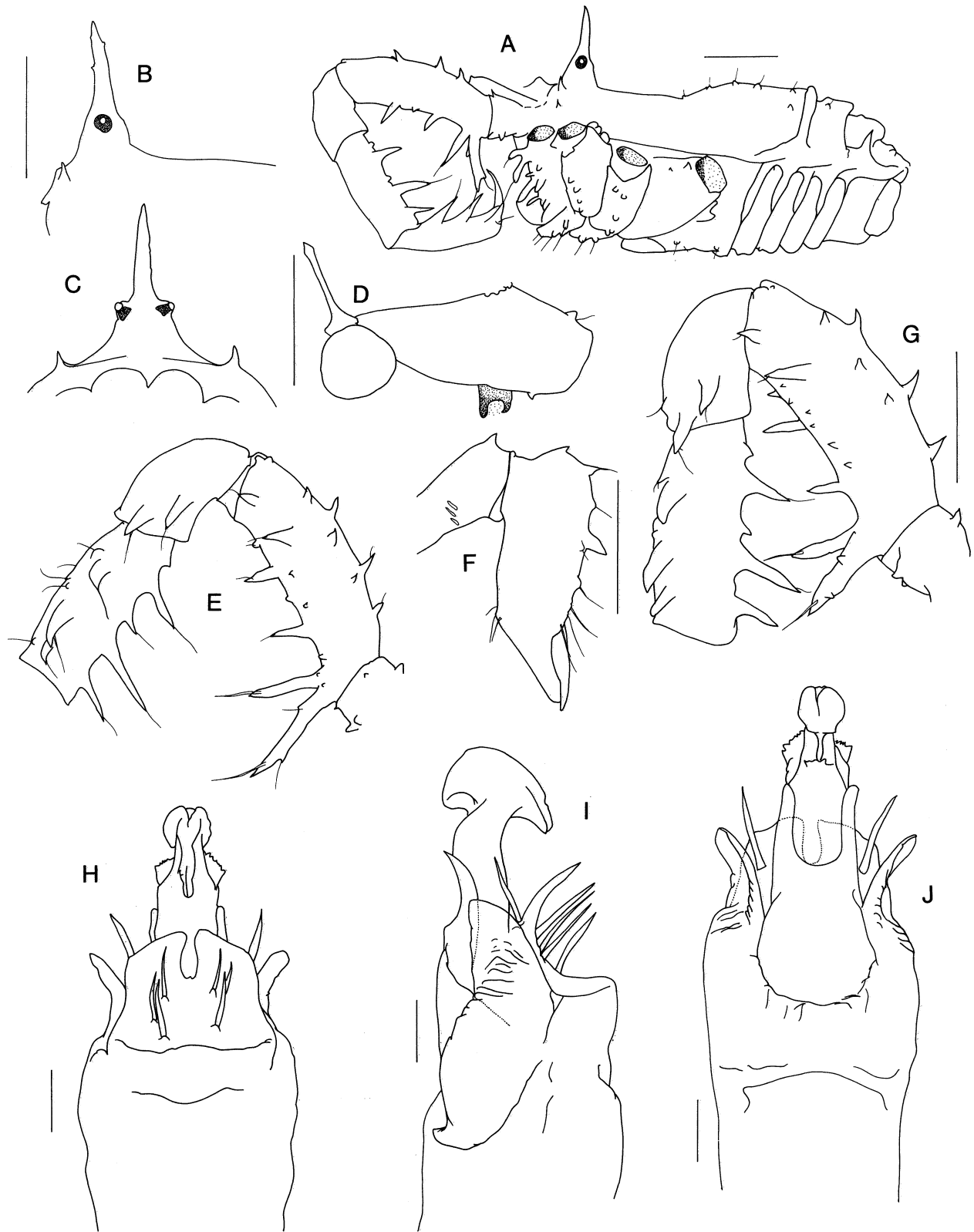


Fig.13. *Hickmanoxyomma cristatum* n.sp. A, D = Holotype male; B-C, F-J = male KS19768; E = female KS19767. A = body and pedipalp, lateral; B, C = eyemound, lateral and frontal; D = sternogenital region with coxa IV, E, G = pedipalp femur and patella, prolateral; F = chelicera, retrolateral; H-J = distal view of penis, ventral, lateral and dorsal. Scale bars: A-G = 1.0 mm; H-J = 0.1 mm.

caves at Precipitous Bluff. Apparently absent from Bauhaus Cave where it is replaced by a population of *H. clarkei*.

Discussion

Cavernicolous species in *Hickmanoxyomma* have been reported from virtually all karst areas in Tasmania subjected to biospeleological examination (Eberhard, 1988; Clarke, 1988). A notable exception is the Junee-Florentine karst in central southern Tasmania where a troglomorphic *Nuncioides* sp. is established (J.L. Hickman, personal communication).

Cavernicolous *Hickmanoxyomma* spp. exhibit, in varying extent, adaptations to the cave environment: depigmentation, attenuation of pedipalps and legs, reduction in eye size (but not loss), reduced sclerotisation, reduction in size of tergal spines, reduction in size or loss of lateral prongs on claws of legs III and IV in adults, reduction in number or loss of lateral prongs in juveniles, an increase of articles in leg tarsi, and elongation of leg tarsal setae and claws.

The most troglomorphic species are *H. eberhardi* and *H. cristatum* which can probably be regarded as obligate cavernicoles, or troglobites. The most notable troglomorphy is the loss of lateral claw prongs from the hind legs of both adults and juveniles.

The balance of evidence suggests other troglomorphic species are also troglobites, though two circumstances leave room for doubt: 1. The Nicholls range population of *H. goedei* is relatively strongly pigmented and individuals frequent the entrance and twilight zones of small fissure caves. A population may live on the surface, e.g. in large logs. 2. Two individuals from the Hastings population of *H. cavaticum* have been collected under logs over 100 m from the nearest known cave entrance. Mesocavities in or under logs of the southern Tasmanian forests virtually reproduce the cave environment on the surface.

Evidence pointing to troglobitic status includes:

1. Gene flow across the surface at Hastings appears limited: preliminary allozyme studies suggest that the Hastings and North Lune populations might well be genetically isolated despite being only 3 km apart, with no major intervening barrier except lack of caves.

2. Within the Precipitous Bluff karst, *H. cristatum* has been recorded from three caves, but not from Bauhaus Cave where a population of *H. clarkei* is established. This suggests at least two separate invasions of the cave environment and little migration between caves. Further work is required to substantiate the allopatry of these species.

3. Despite considerable collecting for harvestmen across southern Tasmania, the *cavaticum* and *cristatum* species groups have not been recorded on the surface outside karst areas, nor from the mine adits where Dr A. Goede has searched.

In northern Tasmania, the *tasmanicum* species group

has been recorded on the surface and in caves. *Hickmanoxyomma tasmanicum* occurs in essentially karst free north-eastern Tasmania where it is typically found under logs. It has also been taken from a small granite cave and a mine adit. To the west of the Tamar River, *H. tasmanicum* has given rise to a population in a limestone cave at Flowery Gully. This population appears to be genetically distinct from surface populations to the east of the river and may well prove to be a separate species. *Hickmanoxyomma gibbergunyar* appears confined to caves at Mole Creek.

Apart from the situation noted in *H. tasmanicum*, the surface progenitors of the cave species are likely to be extinct, or perhaps survive as relicts in a few favourable localities.

Extinction of the surface fauna may have facilitated speciation in cavernicolous *Hickmanoxyomma*. Such a model is favoured by Barr & Holsinger (1985) to explain speciation in many relictual temperate cavernicoles including spiders and predatory beetles, though these authors postulate interglacial warming and drying as the cause of surface extinctions.

In Tasmania, glacial climates of the Pleistocene which were cold, windy and dry may have been more important in causing epigeal extinctions. Over ten areas of high altitude karst, for example Mount Anne where the highly troglomorphic *H. eberhardi* occurs, were at least partly over-ridden by glaciers, while several others including Mole Creek and Cracroft lay marginal to ice (Kiernan, 1982). North-eastern Tasmania had more equable climates and surface populations of *H. tasmanicum* and the closely related *O. saltuensis* survive only there.

The possible role of surface extinctions is less demonstrable for cavernicoles in the related genus *Holonuncia* which inhabits warmer latitudes on the mainland. Epigeal relatives frequently occur in parapatry, or perhaps even sympatry.

It is possible that glaciation and periglacial conditions of central Tasmania facilitated isolation of the *tasmanicum* and *cavaticum* species groups respectively to the north and south. The two groups differ in many features and have been evolving separately for a considerable period, a conclusion supported by multiple fixed allozymic differences between *H. tasmanicum* and *H. cavaticum* (GD range 0.779–1.407, D. Coglean, personal communication). The aberrant *H. cristatum* in the extreme south of Tasmania, however, appears to be more closely related to the *tasmanicum* species group suggesting that the latter was once more widespread. It may have given rise to the *cavaticum* group through evolution of presumed apomorphies including a more elevated eyemound and two superior setae and an invaginated glans on the penis: Continued molecular systematic work will hopefully clarify these relationships.

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