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The Tasmanian Mountain Shrimps, *Anaspides* Thomson, 1894 (Crustacea, Syncarida, Anaspididae)

by

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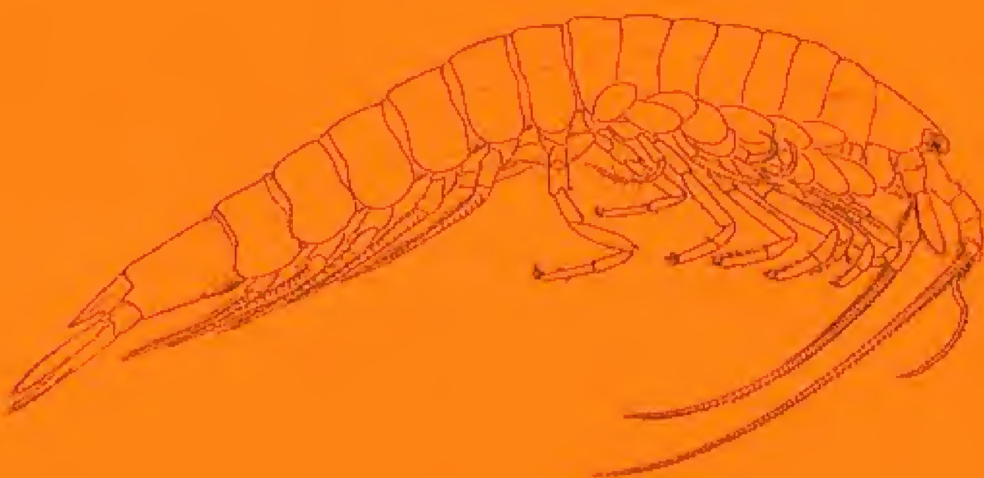

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Cover image—The Tasmanian mountain shrimps of the genus *Anaspides* Thomson, 1894 (Syncarida: Anaspididae), are endemic to Tasmania and often regarded as "living fossils" owing to the the fact they have changed little since the Triassic. All live in cold, usually high altitude fresh-waters. Until recently, only two species were recognized. Australian Museum carcinologist Dr Shane Ahyong has discovered that the fauna comprises at least seven species, among which *Anaspides swaini* Ahyong, 2015 (cover image and pages 352–361) is frequently encountered in the Weld River, Snowy Mountains region (Tasmania), Mt Field and Mt Wellington (North West Bay River catchment) to the Western Arthurs, throughout the Franklin-Gordon drainages, north to Lake Rhona and Frenchmans Cap, Mt Rufus and the vicinity of Lake St Clair; 300–1440 m asl (epigean), 30–1000 m asl (subterranean).

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The Tasmanian Mountain Shrimps, *Anaspides* Thomson, 1894 (Crustacea, Syncarida, Anaspididae)

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ABSTRACT. The Tasmanian mountain shrimps of the genus *Anaspides* Thomson, 1894 (Syncarida: Anaspididae), are endemic to Tasmania and often regarded as "living fossils" owing to the retention of numerous putatively plesiomorphic eumalacostracan traits and minimal morphological change since the Triassic. All live in cold, usually high altitude fresh-waters. Until recently, only two species were recognised: the presumed widespread *A. tasmaniae* (Thomson, 1893) (type species) and *A. spinulae* Williams, 1965a, from Lake St Clair, whose validity was frequently questioned. Independent morphological and molecular studies revealed previously unrecognized taxonomic diversity, resulting in preliminary descriptions of three new species in 2015. *Anaspides* is revised based on extensive collections from throughout Tasmania. Telson structure and male secondary sexual characters proved taxonomically instrumental. Seven species are recognized of which two are new to science; all are fully figured and morphological variation is discussed in detail. Rather than being widespread, *Anaspides tasmaniae* is restricted to Mount Wellington; *A. spinulae* is a valid species known only from Lake St Clair. Two species, *A. clarkei* Ahyong, 2015, and *A. eberhardi* sp. nov. occur only in caves of the Ida Bay-Hastings karst systems and Junee-Florentine systems, respectively. The three widest ranging species (*A. jarmani* Ahyong, 2015, *A. swaini* Ahyong, 2015, and *A. richardsoni* sp. nov.) are primarily epigean and each contains several morphological forms that might warrant further taxonomic subdivision. Distributions of species of *Anaspides* are largely discrete and broadly correspond to the biogeographical discontinuity known as Tyler's Line, dividing the drier eastern from the wetter western parts of Tasmania. Caves are believed to have acted as oligothermal refuges for *Anaspides* in the past, and it is notable that the specimens from the lowest altitudes today are all from caves, including the northernmost record of *Anaspides* (*A. richardsoni*, Great Western Cave, Gunns Plain, 109 m asl). Given the revised taxonomy of *Anaspides*, with significantly altered species distributions, the conservation status of all species of the genus requires review.

KEYWORDS. Crustacea; Anaspidacea; *Anaspides*; Tasmania; freshwater; shrimp.

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When G. M. Thomson (1893) described *Anaspides tasmaniae* (as *Anaspis*) from Mt Wellington, Tasmania, he was not aware of the significance of his discovery, placing his new find in the now defunct Schizopoda, alongside mysidacean and euphausiacean shrimps. It was Calman (1897), however, who recognized the affinities of the living *Anaspides* with the Palaeozoic fossil syncarids, and would later recognize a separate eumalacostracan order, Anaspidacea Calman, 1904 (Brooks, 1962; Schram, 1984). *Anaspides* is remarkable because it retains many putatively plesiomorphic eumalacostracan traits, such as minimal tagmatisation, a relatively complete suite of thoracopodal rami, and an elementary cardioid escape reaction (Schram & Hessler, 1984). As a result, *Anaspides* has attracted considerable scientific interest as a potential "living fossil" closely resembling its Triassic forbears and possibly reflecting the eumalacostracan stem condition (Coineau & Camacho, 2013).

Until 2015, only two species of *Anaspides* were recognised, with *A. tasmaniae* (Thomson, 1893) (type locality: Mt Wellington) accorded a wide range throughout most of central, western and southern Tasmania from both epigean and subterranean habitats, and *A. spinulae* Williams, 1965a, believed to be restricted to central Tasmania from Lake St Clair (type locality) and immediate environs. Additionally, *Anaspides* occurs in subterranean habitats throughout Tasmania, with some having troglobitic adaptations such as eye and pigment reduction and unusual telson morphology in which the posterior telson spines are few, stout and widely spaced, rather than finely spaced and slender—the "cave type" telson (Eberhard *et al.*, 1991; Clarke, 2006). Until recently, taxonomic questions surrounding *Anaspides* focussed on whether *A. spinulae* was distinct from the presumably widespread *A. tasmaniae*, and whether subterranean *Anaspides* with the "cave-type" telson constituted a separate species (O'Brien, 1990). Preliminary molecular investigations (Jarman & Elliot, 2000; Andrew, 2005), although not decisive with regards to previous taxonomic questions, nevertheless identified multiple divergent lineages within *Anaspides*. Independent, parallel morphological and molecular investigations also recognized significant heterogeneity within the genus, not only among epigean, but also subterranean forms, leading to preliminary accounts of three new species of *Anaspides* (Ahyong, 2015) in advance of a full taxonomic revision of the genus. The present study revises *Anaspides*, restricting *A. tasmaniae* to Mt Wellington, recognizes as valid *A. spinulae*, and five other species of which two are described as new.

Materials and methods

Measurements of specimens are of total body length, measured from the apex of the rostrum to the tip of the telson. Abbreviations: above sea-level *(asl)*; indeterminate *(indet)*; juvenile *(juv.)*; Mount *(Mt)*; station *(stn)*. Almost 3600 specimens were examined, deposited in the collections of the Australian Museum, Sydney *(AM)*; Haswell Museum, University of Sydney *(HMUS)*; Museum of Zoology, University of São Paolo, Brazil *(MZUSP)*; Museum of Comparative Zoology, Harvard University *(MCZ)*; Museum Victoria, Melbourne *(NMV)*; Otago Museum, Dunedin *(OM)*; Queen Victoria Museum and Art Gallery, Launceston *(QVM)*; South Australian Museum, Adelaide *(SAMA)*; Tasmanian Museum and Art Gallery, Hobart *(TMAG)*; Lee Kong Chian Natural History Museum, National University of Singapore *(ZRC)*; National Museum of Natural History, Smithsonian Institution, Washington D.C. *(USNM)*; Universidade Federal de Minas Gerais, Brazil *(UFMG)*; Zoological Collection, Universität Rostock *(ZRSO)*; and Yale Peabody Museum, Connecticut *(YPM)*. Material examined is listed in approximately north–south and east–west order and grouped according to regions or localities. In the case of "spinose" *A. spinulae*-like forms of *A. richardsoni*, which occur in the Walls of Jerusalem area and Western Lakes, they are grouped separately or indicated as such within each entry to distinguish them from the typical non-spinose forms. Similarly, the three morphological forms of *A. richardsoni* from the Mole Creek Karst area are also grouped for convenience.

Taxonomic characters in *Anaspides*

Species of *Anaspides* are morphologically conservative, exhibiting few differences in major structures. Pleonal spination, considered diagnostic of *A. spinulae* by Williams (1965a), is more variable than previously thought, but when considered in combination with other characters, remains taxonomically useful. Several new taxonomic features are recognized here and given primacy in separating species—the shape and spination of the telson, and secondary sexual characters of adult males.

The shape and armature of the posterior margin of the telson, whether evenly rounded or angular, and whether armed with stout, well-spaced spines (Figs 8, 12) or lined with numerous finely-set spines (Figs 21, 22), is diagnostic. These features are taxonomically effective across a wide size range, noting that the posterior margin of the telson in the earliest post-hatching juveniles has relatively few spines and a median cleft or emargination (Figs 33P, 34T), which rapidly closes with increasing size to form a rounded or angular spinose margin (Fig. 23B,C).

Two sexually dimorphic features of males have proven especially useful: the modified inner antennular flagellum and pleopod 1 endopod. In adult males, the inner (= accessory) flagellum of the antennule is modified to form a clasping structure used to hold females, presumably during courtship (Hickman, 1937). Rather than being straight and flexible as in females and juvenile males, the proximal portion of the adult male inner flagellum (articles 1–8) is semi-rigid and double-bent into an S-shape, being strongly curled downwardly and then turning upwards and horizontally in the vicinity of the sixth and seventh articles (Figs 1, 2D). Each of the proximal eight articles of the modified inner antennular flagellum has several short, curled setae on the dorsal and lateral surfaces, herein called "finger setae". The proximal 5 articles are as long as or shorter than wide, articles 6 and 7 are more elongated, with an obtusely angled inner margin of which the article 7 bears 1–5 slender, prominent, stiff, conical protrusions on the inner margin, herein called clasping spines (Fig. 2D). The number of clasping spines is diagnostic and should always be examined when making identifications. Both left and right antennules should always be examined in case of damage or regeneration from damage to these delicate structures. Note also that the clasping spines usually arise sequentially and increase in size with successive moults, so juveniles of *A. swaini*, for instance, in which only one of the two clasping spines have appeared, could be mistaken for *A. richardsoni*, which has only one clasping spine in adults. Thus, it is also important to confirm the maturity of male specimens by examining the differentiation of the proximal articles of the inner antennular flagellum and presence of finger setae.

As in many other malacostracans, the adult male pleopods 1 and 2 are modified as copulatory organs and act together to facilitate sperm transfer: the petasma. In *Anaspides*, male pleopod 1 is broadened and expanded distally, with a small medial lobe bearing a short row of retinaculae that link the left and right pleopods to form a functional unit (Fig. 2M). In lateral view of pleopod 1, whether or not the retinacular lobe is visible (Fig. 3 I) or obscured (Fig. 7 I) by the lateral fold of the pleopod is diagnostic.

In identifying *Anaspides*, careful consideration should be given to the sex and maturity of specimens. Adult males, having a full suite of diagnostic characters, are best considered first and can be recognized by the fully modified antennules with well-developed clasping spines, finger setae and fully curled proximal portion of the inner antennular flagellum, in addition to the modified pleopod 1–2 endopods. Adult females can be recognized by the well-developed gonopore on pereonite 8, and the development of distinctly setose endites on the inner margins of the pereopod 1–7 coxae, which meet medially. Individuals of most species are mature by 18–21 mm, but some populations of *A. swaini* do not show fully developed secondary sexual characteristics until 24–33 mm. Several features change allometrically including the rostrum (becoming more slender with size), eyes (proportionally larger in smaller specimens), scaphocerite (more slender in small juveniles), telson proportions (slightly wider with increasing size), pleonal setation (shorter with increasing body size), and to a lesser degree, the proportional width of the uropod rami (wider with increasing size).

The presence or absence of the pleopodal endopods in adults is taxonomically important (pleopods 3–5 in *A. clarkei*; pleopod 5 in other species). Pleopodal endopod development is anamorphic in *Anaspides*. Endopods first appear on the anterior pleopods early in development and progress to the posterior pleopods over successive moults. In species with a full complement of pleopod endopods in adults, such as *A. richardsoni* and *A. spinulae*, the pleopod 5 endopod may appear at an early or late juvenile stage, and this may vary between localities.

Systematics

Syncarida Packard, 1885

Anaspidacea Calman, 1904

Anaspididae Thomson, 1893

Anaspides Thomson, 1894

Anaspis Thomson, 1893: 7 (preoccupied, *Anaspis* Geoffroy, 1762 [Coleoptera]; type species: *Anaspis tasmaniae* Thomson, 1893).

Anaspides Thomson, 1894: 285, 286 (replacement name for *Anaspis* Thomson, 1893, preoccupied).

Diagnosis. Rostrum prominent, well-developed. Cephalothorax without *fenestra dorsalis*. Body subcylindrical, straight or evenly curved, without prominent "bump-like" flexure at pleonite 1. Free pereonites length subequal, shorter than pleonites. Pleonite 6 shorter than twice length of pleonite 5; surface of integument with few setae but no spines. Telson dorsoventrally compressed; posterior margin rounded or angular, with spine row. Antennular and antennal peduncles unarmed. Scaphocerite with small lateral spine. Thoracopod 1 (maxilliped) with epipods. Thoracopod 7 with exopod. Uropodal endopod more than three-fourths length of exopod; exopod with small group of movable spines near position of diaraesis.

Description. Body subcylindrical, straight or evenly curved, without prominent "bump-like" flexure at pleonite 1. Rostrum prominent, apex blunt, rounded, slightly deflected ventrally; few distal setae, arising submarginally. Head (cephalothorax) comprised of fused cephalon and pereonite 1; cervical groove distinct; dorsal organ present on dorsal midline anterior to cervical groove; mid-lateral surface posterior to cervical groove with shallow diagonal groove. Pereonites 2–8 length subequal, subparallel, shorter than pleonites. Pleonites 1–5 length subequal; subparallel; pleura well-developed, rounded. Pleonite 6 shorter than twice length of pleonite 5; surface of integument with few setae but no spines. Telson dorsoventrally compressed, with low, broad median ridge; posterior margin rounded or angular, with spine row; surface with low, broad median crest, few scattered setae. Female gonopore (spermatheca) on pereonite 8 sternum between coxae; bulbous, directed anteriorly, anterior surface with genital orifice as narrow transverse slit. Pleonal sternites 3–5 with low median processes between pleopod bases.

Eyes pedunculate; cornea usually well-developed.

Antennular peduncle 3-articulate, unarmed; article 1 with statocyst; biflagellate, inner (= accessory) flagellum shorter than outer; adult males with proximal portion of inner flagellum modified to form clasping structure, with proximal 8 articles bearing dorsal finger setae and together semi-rigid, S-shaped, curled, strongly curved downward, then turning upwards and horizontally in vicinity of articles 5 and 6, with slender clasping spines on obtusely angled inner margin of article 7.

Antenna uniflagellate; protopod 3-articulate, unarmed; exopod (scaphocerite) laminar, broadly ovate, small lateral spine, mesial and distal margin setose to base of lateral spine; endopod peduncle 2-articlulate, unarmed.

Labrum with shallow proximal constriction, anterior proximal surface with blunt median ridge; distal margin convex to slightly concave, finely setose.

Mandibular corpus (apophysis) robust; molar process and incisor process well-developed; molar with elongate, ovate, triturating surface, surrounded by spiniform setae; incisor process diagonal to axis of mandibular corpus; left incisor process with 7 triangular teeth in sinuous row, proximally with spine row between proximal incisor tooth and molar process; right incisor process similar to left except with 6 triangular teeth, proximal tooth usually apically divided; palp 3-articulate, setose, article 1 short, subquadrate, article 2 slender, almost twice length of article 3.

Paragnaths widely separated by deep V-shaped incision, without lobes, distal half finely setose, especially mesially.

Maxillule with 2 endites; proximal endite distally setose; distal endite spinose distally, lateral surface with small rounded palp.

Maxilla with 4 endites, proximal 2 endites with plumose setae, distal 2 endites densely arrayed with serrulate setae.

Thoracopods 1–8 protopod with coxa, basis, preischium, ischium, merus, carpus, propodus and dactylus; flexure at carpus-merus articulation.

Thoracopod 1 (maxilliped) coxa inner margin with setose coxal endites, outer margin with 2 slender, lamellar epipods, proximal wider than distal; basis with slender, flattened, strap-like exopod; coxa-basis demarcation often ill-defined; preischium rectangular, more than twice length of quadrate ischium; merus as long as preischium, slightly tapering distally; carpus triangular, longer than high, half length of merus; propodus slender, slightly shorter than merus; dactylus short, terminating in slender claw, with 2 slender movable spines on lateral side, 3 on mesial side.

Thoracopods 2–8 (pereopods) as ambulatory legs. Thoracopods 2–6 structurally similar, distal 4 articles with tufts of setae, primarily along flexor margins, dactylus strongly setose; thoracopods 4–5 longest; coxa outer margin with 2 ovate, lamelliform epipods, inner margin in adult females with setose endite; basis short, partially fused with preischium; exopod articulating with outer margin of basis, with elongate basal article and setose multi-annulate flagellum (< 30); ischium about as long as basis-preischium; merus elongate, slightly tapering distally, about twice length of ischium; carpus triangular, longer than high, about half length of merus or slightly less; propodus elongate, slender, shorter than merus; dactylus short, terminating in long, slender claw, with slender movable spine on lateral side, 2 movable spines on mesial side. Thoracopod 7 similar to thoracopods 2–6 except epipods proportionally more slender; exopod a single narrow lamella. Thoracopod 8 structurally similar to preceding thoracopods but lacking epipods or exopod; basis and preischium indistinguishably fused; longer than thoracopod 7.

Pleopods 1–5 exopod long, slender, setose, 25–30-annulate. Pleopods 1–2 endopod always present, unmodified endopod ovate, lamellar, length subequal to first exopod article, variously present on pleopods 3–5 in females and juvenile males; adult male pleopods 1–2 endopod modified as copulatory structures (petasma). Adult male pleopod 1 elongate, directed anteriorly, reaching beyond thoracopod 8 coxa; slender proximally, expanded distally forming cannulate, scoop-like structure, hollowed mesially; distally rounded, lateral margin thin, lamellate; inner margin with short row of retinaculae near distal one-third, forming small rounded lobe; inner proximal surface with scattered setae and spinules. Male pleopod 2 endopod of 2 articles, longer than that of pleopod 1, directed anteriorly, reaching to thoracopod 8 coxa; proximal article twice length of distal article, mesial proximal margin with row of retinaculae; distal article broadly curved, mesially hollowed, apex blunt.

Telson and uropods forming tail-fan. Uropodal exopod lateral margin with indistinct, partial diaeresis near distal one-third; movable spines near position of diaeresis, flanked by tufts of setae; inner margin and outer margin distal to diaeresis setose. Uropodal endopod slightly shorter than exopod, margins setose.

Species composition. *Anaspides clarkei* Ahyong, 2015, *A. eberhardi* sp. nov., *A. jarmani* Ahyong, 2015, *A. richardsoni* sp. nov., *A. spinulae* Williams, 1965a, *A. swaini* Ahyong, 2015, *A. tasmaniae* (Thomson, 1893) (type species).

Remarks. *Anaspides* is one of three anaspidid genera endemic to Tasmania, others being *Paranaspides* Smith, 1908 (with only the type species, *Paranaspides lacustris* Smith, 1908), and *Allanaspides* Swain, Wilson, Hickman & Ong, 1970 (with the type species *A. helonomus* Swain, Wilson, Hickman & Ong, 1970, and *A. hickmani* Swain, Wilson & Ong, 1971) (Lake *et al*., 2002). *Allanaspides,* which uniquely has a *fenestra dorsalis* on the cephalothorax, lacks maxillipedal epipods and lacks the exopod on thoracopod 7, is believed to be sister to other anaspidids (Jarman & Elliott, 2000). *Paranaspides* is most closely related to *Anaspides*, being sister to, or possibly nested within, the latter (Jarman & Elliott, 2000). Few major features separate the two genera, however. *Paranaspides*, with a pelagic rather than benthic habit, is considerably more spinose than *Anaspides* but the most important distinguishing feature is the distinct pleonal flexure of the former as a result of the wedge-shaped pleonite 1.

Phylogenetic relationships inferred from mitochondrial 16S sequences from selected *Anaspides* populations (Jarman & Elliott, 2000; Andrew, 2005), although with low resolution, recognized three broad clades: a southern group corresponding to *A. jarmani* and *A. clarkei,* which diverged from other *Anaspides* approximately 25 ma; a southwestern group (*A. swaini*); and a northern-eastern group corresponding here to *A. tasmaniae*, *A. spinulae, A.richardsoni* and *A. eberhardi*).

The phylogenetic significance of *Anaspides* for Malacostraca has prompted numerous morphological, ultrastructural and physiological studies, all under the name *A. tasmaniae*. Those applicable to *A. tasmaniae* sensu stricto are as follows: embryology (Hickman, 1937); giant lateral neurone (Silvey & Wilson, 1979); organ of Bellonci (Kauri & Lake, 1972); locomotory function (Macmillan *et al*., 1981); spermogenesis (Jespersen, 1983); foregut morphology (Wallis & Macmillan, 1998); and ommatidial structure (Richter, 1999); and cuticular sclerites (Kutschera *et al*., 2015). Manton's (1930) study of habits and feeding are based on *A. tasmaniae* and *A. swaini*. Studies of functional morphology and excretion (Cannon & Manton, 1927; Manton, 1929, 1931) are probably based on *A. swaini* given the photograph by Sidnie Manton, presented by William Calman to the Royal Zoological Society of London depicting what appears to be *A. swaini* (MacBride, 1930). Analyses of ecology and life history (Swain & Reid, 1983) and mandibular morphology (Richter *et al*., 2002) are based on *A. richardsoni* from Mt Field. Serov (1988) examined ecology of populations from Browns River near Silver Falls, which are thus referable to *A. tasmaniae*. Specimens studied by Tjønneland *et al*. (1984) for heart ultrastructure, from Myrtle Forest Creek, are referrable to *A. swaini*. Smith's (1908, 1909b) studies of general morphology may be based several species given that he accessed material from Mt Wellington (North West Bay River), Mt Field and the Hartz Mountains, localities at which *A. swaini*, *A. richardsoni* and *A. jarmani* occur, respectively. Internal anatomy (gonads and alimentary canal) reported by Nicholls & Spargo (1932) is probably based on *A. richardsoni* given that Nicholls collected widely in the Great Lake area, many specimens of which are still extant in the collections of the Western Australian Museum and Tasmanian Museum. Specimens of *Anaspides* collected by Smith were the source material for a parasitic protozoan, *Ganymedes anaspidis* described by Huxley (1910). Given the uncertainty over the identity of Smith's *Anaspides* specimens, however, the host species of the type material of *G. anaspidis* likewise remains unclear.

Anaspides tasmaniae was originally described as the type species of *Anaspis* Thomson, 1893. *Anaspis* Thomson, 1893, however, being preoccupied by *Anaspis* Geoffroy, 1762 (Coleoptera), was replaced by *Anaspides* Thomson, 1894. Seven species of *Anaspides* are recognized here of which two are new to science.

Key to species of *Anaspides*

1 Telson posterior margin with 4–10 (rarely 15), stout, well-spaced spines 2

—— Telson posterior margin lined with more than 17 (usually > 20), slender, finely-spaced spines 3

2 Telson about as long as wide, posterior marginal spines limited to posterior one-fourth. Pleonite 6 posterior margin and pleura 4–5 unarmed. Adult male with 4 (rarely 5) antennular clasping spines. Pleopods 4–5 (usually 3–5) without endopod .... *A. clarkei* Ahyong, 2015

—— Telson distinctly longer than wide, posterior marginal spines limited to posterior one-third. Pleonite 6 posterior margin denticulate; pleura usually with 1 or more small spines. Adult male with 1 antennular clasping spine. Pleopods 3–4 with endopod .... *A. eberhardi* sp. nov.

3 Adult males with 1 antennular clasping spine .... *A. richardsoni* sp. nov.

—— Adult males with 2 or more antennular clasping spines 5

4 Telson linguiform, elongate, lateral margins seamlessly grading into evenly rounded, posterior margin .... *A. tasmaniae* (Thomson, 1893)

—— Telson polygonal, transition between lateral and posterior margins obtusely angular, blunt; posterior margin angular to rounded 5

5 Adult males with 2 antennular clasping spines. Male pleopod 1 endopod with retinacular lobe visible in lateral view 6

—— Adult males with 3–5 (usually 4) antennular clasping spines. Male pleopod 1 endopod with retinacular lobe obscured, not visible in lateral view .... *A. jarmani* Ahyong, 2015

6 Pleonite 6 posterolateral margins blunt, rounded, at most with a minute spinule. Pleonites 5–6 with or without short spines on posterior tergal margins, usually absent on tergite 5; pleura 3–5 with or without small spines, usually absent or at most 1 or 2 small spines on pleura 4–5 .... *A. swaini* Ahyong, 2015

—— Pleonite 6 posterolateral margins produced to prominent spine. Pleonites 5–6 with prominent spination on posterior tergal margins, spines distinctly longer than wide; pleura 3–5 prominently spinose .... *A. spinulae* Williams, 1965a

Anaspides tasmaniae (Thomson, 1893)

Figs 1–4, 35A, 36

Anaspis tasmaniae Thomson, 1893: 7–10 (type locality: near The Springs, Mt Wellington).

Anaspides tasmaniae. —Calman, 1897: 787–794, pl. 1, 2, fig. 12–14. —Thomson, 1897: 580; 1926: 161. —Manton, 1930: pl. 4. —Hickman, 1937: 2, tab. 1–3, pl. 1–13. —Hewer, 1967: 1–2. —Kauri & Lake, 1972: 432, figs. 1–17. —Williams, 1974: 80, fig. 4.6, tab. 4.1. —Silvey & Wilson, 1979: 122. —Jarman & Elliot, 2000: 624, tab. 1 (Mt Wellington). —Jarman, 2001: 201, tab. 1. —Jarman *et al*. 2000: 27, tab. 1 —Lake *et al*., 2002: 11–12. —Serov, 2002: 8, 15. —Camacho, 2006: 4.

Type material. Lectotype: AM G2130, male (23 mm), Mt Wellington, "4000 ft", per G.M. Thomson. Paralectotypes: AM P99315, 1 female (24 mm), 1 juv. ♀ (19 mm), collected with lectotype; OM Iv.1396, 1♀ (22 mm), Mt Wellington, "4000 ft" [1200 m], coll. G.M. Thomson.

Other material examined. TMAG 14370/G114, 7♂♂ (14–26 mm), 1♀ (29 mm), New Town Rivulet, Mt Wellington, 42°52.5'S 147°15.8'E, 1000 ft asl [300 m], coll. J. Pearson, 20 Jun 1937; QVM 10:8079, 1♂ (damaged, c. 27 mm), 2♀♀ (26–27 mm), New Town Creek, Mt Wellington, 42°52'S 147°16'E, coll. E. Guiler, 1956; TMAG G6433, 2♂♂ (22–24 mm), 6♀♀ (22–26 mm), Lenah Valley, Newtown Rivulet, 42°51.6'S 147°16.9'E, 150 m asl, coll. R. Swain, Jul 1969; NMV J42438, 1♂ (28 mm), 2♀♀ (21–25 mm), 2 juv. ♀♀ (13–14 mm), Organ Pipes, Mt Wellington, 42°53.8'S 147°14.5'S coll. 12 May 1912, pres J. Searle, Feb 1936; TMAG G6383, 5♀♀ (27–32 mm), Picnic Hut, Mt Wellington, 42°53.9'S 147°14.2'E, 1250 m asl, coll. R. Swain, 4 Nov 1969; TMAG G6404, 3♂♂ (22–24 mm), 10 ♀♀ (22–27 mm), Picnic Hut, Mt Wellington, 42°53.9'S 147°14.2'E, 1250 m asl, coll. R. Swain, Apr 1969; TMAG G6365, 2♂♂ (21–24 mm), 7♀♀ (24–30 mm), Picnic Hut, Mt Wellington, 42°53.9'S 147°14.2'E, 1250 m asl, coll. R. Swain, 14 Sep 1969; AM P14157, 2 specimens (slide preparations), Picnic Point, Mt Wellington, 42°54.9'S 147°14.7'E, stream, 800 m asl, coll. W.D. Williams 29 Jan 1963; AM P99314, 1♀ (28 mm), The Chalet, Mt Wellington, 42°53.43'S 147°14.04'E, stream, 970 m asl, coll. S. Jarman, Nov 1997; TMAG G6414, 4♂♂ (27–33 mm), 7♀♀ (27–35 mm), Fern Tree, Mt Wellington, 42°55.5'S 147°15.6'E, 420 m asl, coll. R. Swain, 14 Feb 1971; AM P97847, 1 juv. ♀ (12 mm, Silver Falls, Mt Wellington, 42°55.3'S 147°14.9'E, 1500 ft asl [450 m], 28 Feb 1935; TMAG G6431, 2♂♂ (26 mm), 3 juv. ♂♂ (19–21 mm), 5♀♀ (19–28 mm), Browns River, above Silver Falls, 42°55.1'S 147°14.7'E, 620 m asl, coll. I. Wilson & B. Knott, 20 Jan 1971; AM P98089, 1♂ (24 mm), 4 juv. ♂♂ (14–16 mm), 2♀♀ (23–28 mm), 4♀♀ (10–16 mm), Mt Wellington, creeks, coll. R. Swain & A. Richardson, Jul 1990; MZUSP 33665, 1 juv. ♀ (16 mm), Mt Wellington, coll. R. Swain & A. Richardson, Jul 1990; UFMG, 1♀ (19 mm), Mt Wellington, coll. R. Swain & A. Richardson, Jul 1990; USNM 60111, 1♂ (25 mm), 1 juv. ♂ (15 mm), 1♀ (23 mm), Silver Falls, Mt Wellington, coll. W.M. Tattersall, 1914; HMUS Cr(M) 11/11/1–1(i), 18♂♂ (14–24 mm), 16♀♀ (14–28 mm), from creeks on Mt Wellington, 26 Aug 1965; USNM 291481, 1♂ (24 mm), Mt Wellington, coll. F.R. Schram, 25 May 1980; NMV J42440, 1♀ (28 mm), Mt Wellington, 4000 ft asl [1200 m], coll. A. Neboiss, 22 Feb 1967; TMAG, 5♂♂ (24–26 mm), no data; USNM 30578, 2 juv. ♂♂ (13–14 mm), 1♀ (22 mm), 2 juv. ♀♀ (13–14 mm), from G.M. Thomson, no data.

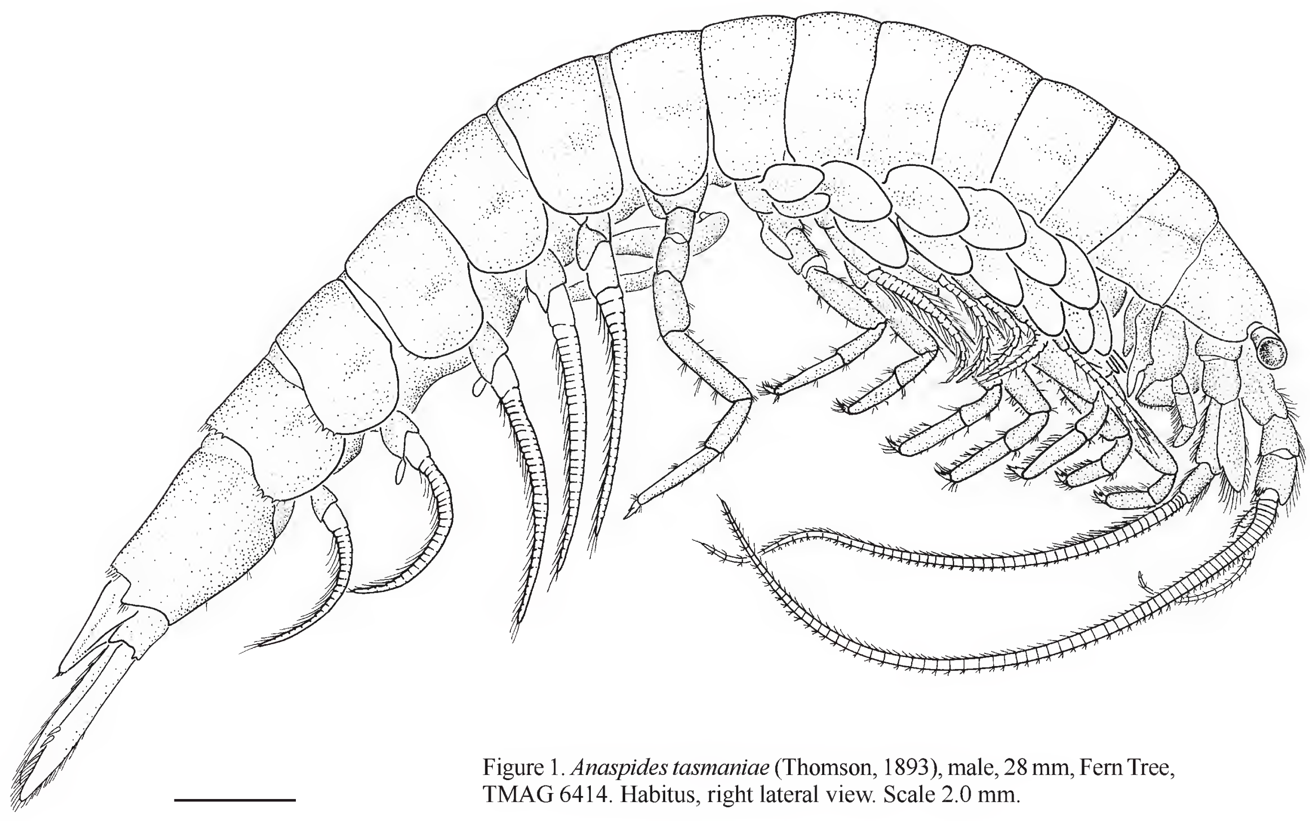

Figure 1. *Anaspides tasmaniae* (Thomson, 1893), male, 28 mm, Fern Tree, TMAG 6414. Habitus, right lateral view. Scale 2.0 mm.

Description. Eyes with well-developed cornea, pigmented, subglobular, longer than half length and slightly wider than stalk, stalk with subparallel margins. Rostrum narrow in adults, apex blunt.

Pleonites with sparsely setose pleural margins, rounded; pleuron 1 unarmed; pleura 2–3 with 0–2 small spines; pleuron 4 with 1–4 small spines and scattered setae. Pleonite 5 pleuron with 1–4 spines and scattered setae; posterior tergal margin with 3–5 spines either side of midline, setose. Pleonite 6 posterior margin spinose, setose; posterolateral margin setose, rounded. Pleonal sternites 3–5 with low, weakly bilobed median processes between pleopod bases, widest on sternite 3, narrowest on sternite 5.

Telson longer than wide, linguiform, widest proximally; lateral margins sinuous in dorsal outline, distally convergent; transition from lateral to rounded posterior margin evenly curved, seamless; posterior spine row with 19–37 short, evenly graded, slender, closely spaced spines, generally longest medially.

Antennule inner flagellum about 0.2 × body length (19–20 articles in figured 28 mm male); article 7 inner margin obtusely angled in adult males, with 2 long, slender clasping spines proximally; outer flagellum 0.4–0.5 × body length (69 articles in figured 28 mm male). Antennal flagellum 0.3–0.4 × body length (47 articles in figured 28 mm male); scaphocerite elongate, ovate, lateral spine slightly distal to midlength; apex reaching almost to midlength of distal peduncular article.

Right mandibular incisor process with proximal tooth distally undivided to trifurcate, usually bifid.

Pleopods 1–4 with endopod in adults (rarely on one side on pleopod 5). Adult male pleopod 1 distally widened, scoop-like, lateral margins weakly expanded, not obscuring retinacular lobe in lateral view.

Uropodal protopod dorsally unarmed or with 1 or 2 small spines; exopod with 2–4 movable spines on outer margin near position of partial diaeresis; exopod length about 2.5–3 times width, as wide as endopod, apex rounded, relatively broad.

Measurements. Male (n = 55) 14–33 mm; female (n = 96) 10–35 mm.

Remarks. *Anaspides tasmaniae* is readily distinguished from other species of the genus by the combination of well-developed eyes, the presence of two antennular clasping spines in adult males (Fig. 2D), the elongated telson with an evenly rounded posterior margin lined with closely set spinules (Fig. 2B), and a male pleopod 1 in which the retinacular lobe is visible in lateral view (Fig. 3I). *Anaspides tasmaniae* shares the presence of two male antennular clasping spines with *A. swaini* and *A. spinulae*, but differs by the rounded versus triangular posterior margin of the telson. Although some specimens of *A. swaini* may also have a slightly rounded posterior margin of the telson (Fig. 33L), the transition between the lateral and posterior margins, marked by the beginning of the spine row, is seamless in *A. tasmaniae* rather than bluntly and obtusely angular.

Morphological variation in *A. tasmaniae* is not marked. The pleonite 4–5 pleura (sometimes also 2–3) are multidenticulate, with 1–4 (usually 2 or 3) small pleural spines on pleonites 4 and 5 (Fig. 4). The posterior tergal margin of pleonite 5 is spinose (usually 2–4 small spines on either side of the midline) and that of pleonite 6 is spinose along the entire posterior margin. The extent of pleonal spination of *A. tasmaniae*, like *A. swaini*, may approach that of *A. spinulae*. In *A. spinulae*, however, the pleonal spines are always considerably more prominent, even in juveniles (Fig. 28B,E), and the posterolateral angle of somite 6 is produced to a prominent spine (Fig. 25C), rather than forming a blunt lobe (Fig.

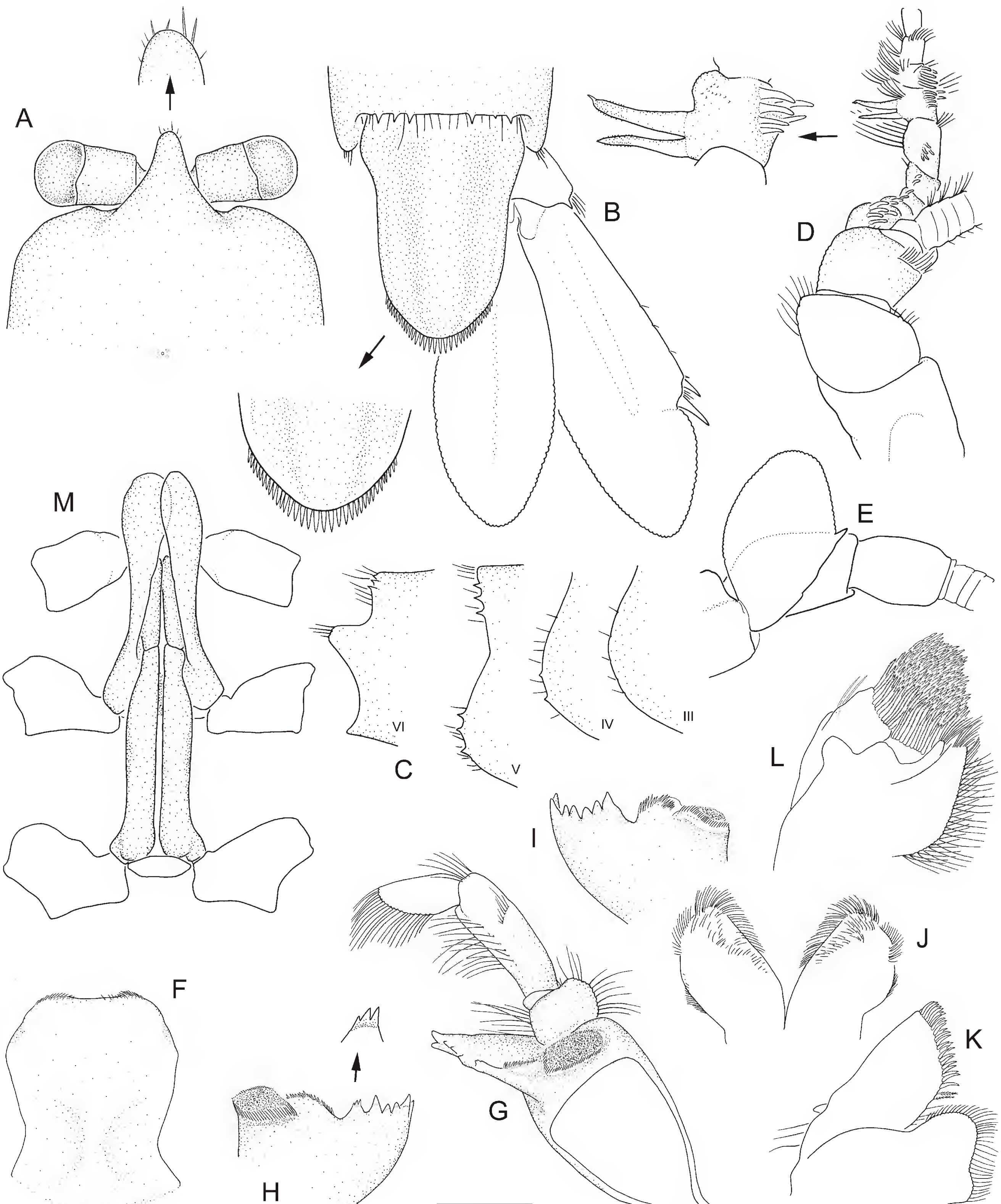

Figure 2. *Anaspides tasmaniae* (Thomson, 1893), male, 28 mm, Fern Tree, TMAG 6414. *(A)* cephalothorax, dorsal view; *(B)* pleonite 6, telson and right uropod; *(C)* pleonites 3–6 pleura, right lateral view; *(D)* right antennule; *(E)* right antenna; *(F)* labrum, anterior view; *(G)* right mandible; *(H)* right mandible incisor process; *(I)* left mandible incisor process; *(J)* paragnaths, anterior view; *(K)* right maxillule; *(L)* right maxilla; *(M)* pleopods 1–2, in-situ, ventral view. Scale: A–E, M = 1.0 mm; F–L = 0.7 mm.

2B,C). The proximal incisor tooth on the right mandible of *A. tasmaniae* is usually distally bifid or trifid (occasionally undivided) (Fig. 2H). As in other congeners, the rostrum of *A. tasmaniae* is proportionally broadest in juveniles, becoming proportionally narrower with increasing body size, and the proportional length of setae on the pleonal pleura and posterior margins decreases with increasing body size. The pleopod 5 endopod is absent in all specimens except for a male from Lenah Valley (24 mm; TMAG G6433) in which an endopod is present on the right side. Both sexes exhibit

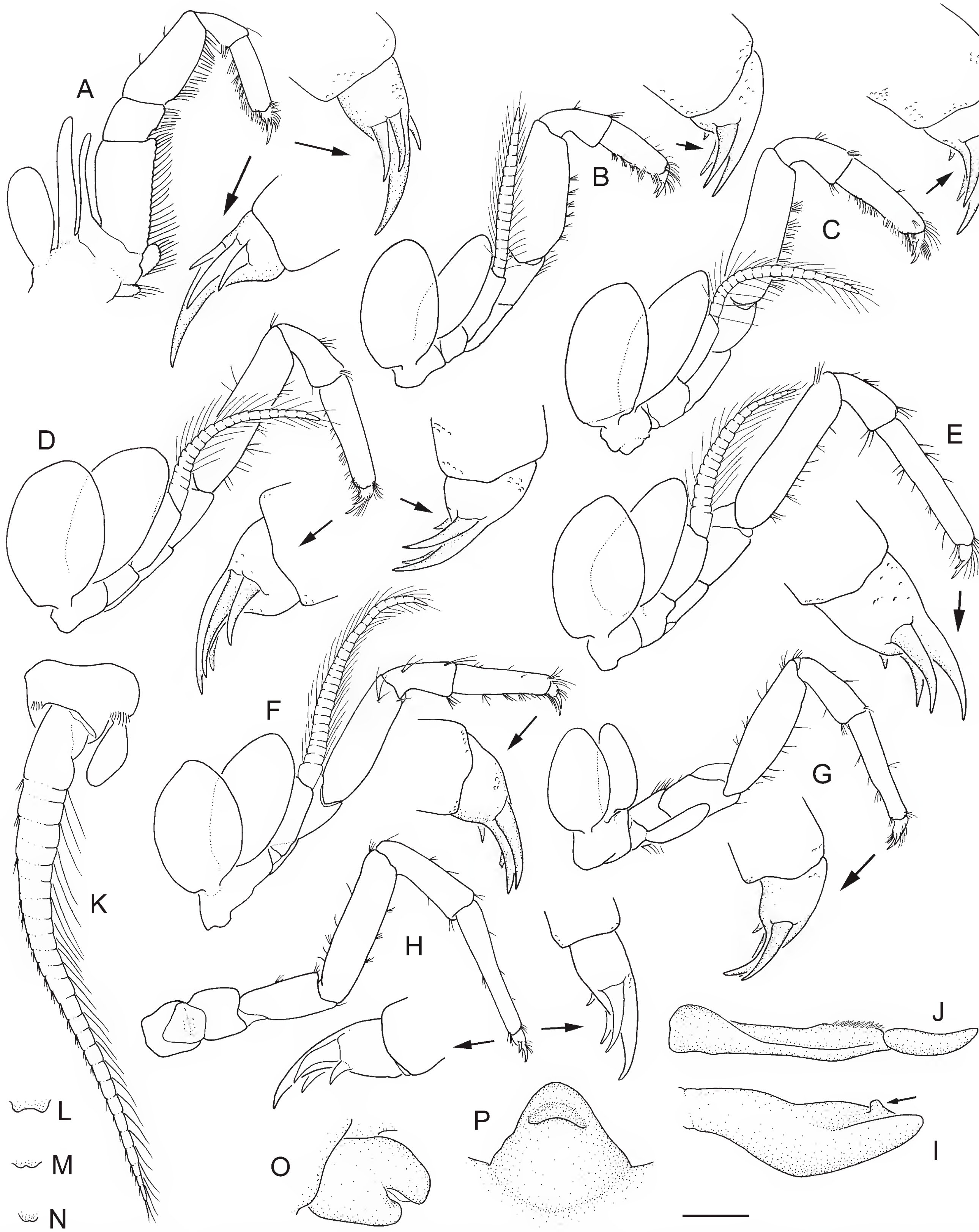

Figure 3. *Anaspides tasmaniae* (Thomson, 1893), Fern Tree, TMAG 6414, male 28 mm *(A–N)*, female 30 mm *(O–P)*. *(A)* right thoracopod 1 (maxilliped); *(B–H)* right thoracopods 2–8; *(I)* right pleopod 1 endopod, lateral view (retinacular lobe indicated by arrow); *(J)* right pleopod 2 endopod, lateral view; *(K)* right pleopod 4, anterior view; *(L–N)* pleonites 3–5 median sternal processes; *(O–P)* female gonopore, right lateral and ventral views. Scale A–H = 1.0 mm; I–P = 0.7 mm.

full secondary sexual characters by 20–21 mm body length.

Anaspides tasmaniae was previously accorded a wide distribution throughout Tasmania, but is here restricted to southeastern Tasmania from surface localities on the eastern and southeastern face of Mt Wellington at altitudes of 150–1250 m above sea-level; it is not yet known from caves. *Anaspides* from elsewhere in Tasmania are referrable to other species (Ahyong, 2015). The locality data accompanying a

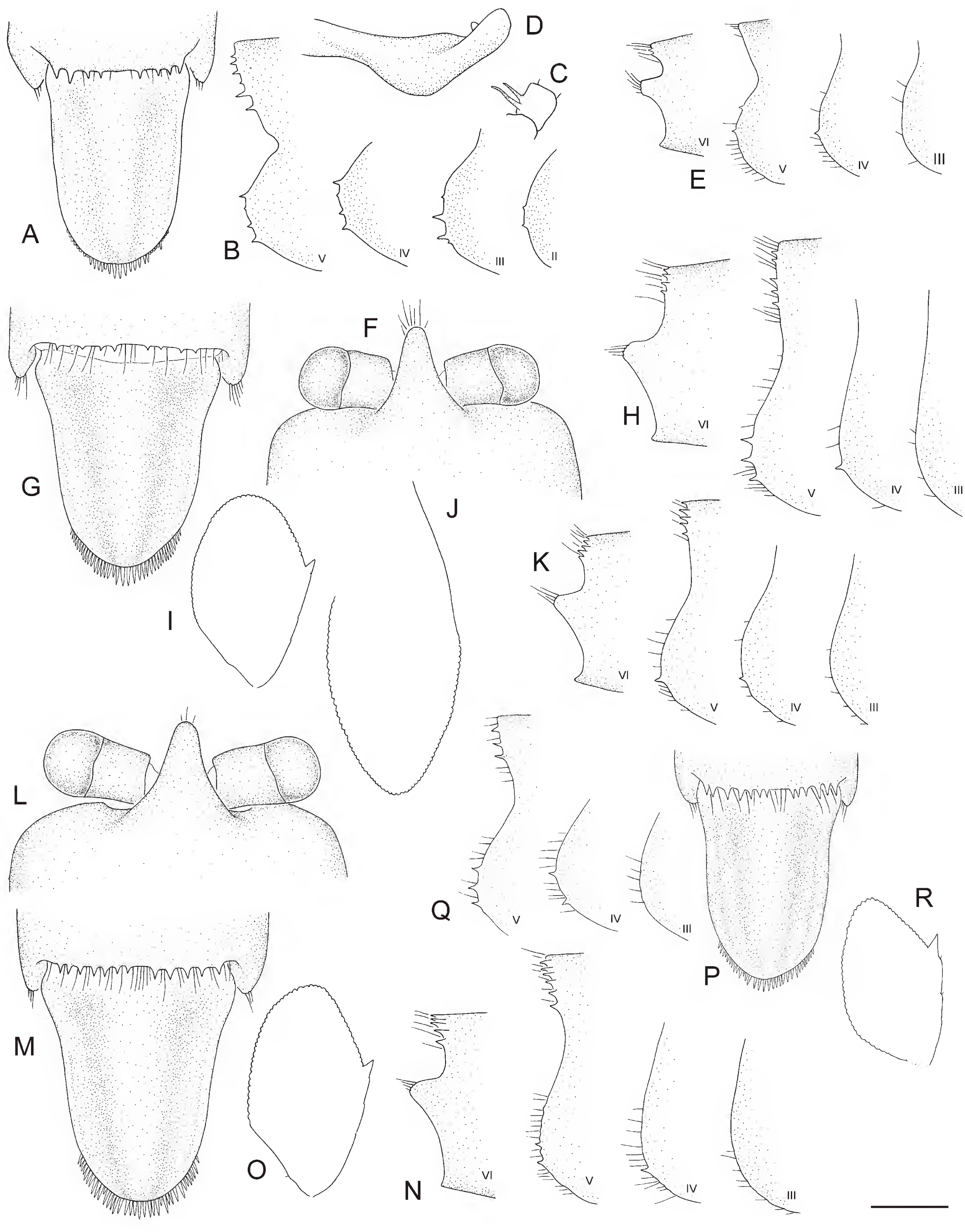

Figure 4. *Anaspides tasmaniae* (Thomson, 1893). *(A–D)* lectotype male, 23 mm, AM G2130, Mt Wellington. *(E)* juv. male, 20 mm, Silver Falls, Browns River, TMAG G6431. *(F–J)* female, 28 mm, Silver Falls, Browns River, TMAG G6431. *(K)* female, 27 mm, Silver Falls, Browns River, TMAG G6431. *(L–O)* female, 32 mm, Picnic Hut, Mt Wellington, TMAG G6383. *(P–R)* female, 23 mm, Mt Wellington, AM P98089. *A, G, M, P,* telson. *B, E, H, K, Q, N,* right pleonal pleura. *C,* right antennular clasping spines. *D,* right pleopod 1 endopod, right lateral view. *F, L,* anterior cephalothorax. *I, R, O,* right scaphocerite. *J,* right uropodal endopod. Scale 1.0 mm.

number of specimens of *A. tasmaniae* sensu stricto from Mt Wellington do not indicate the drainage or precise location, but those with more specific locality data are all from eastern drainages on Mt Wellington between the catchments of New Town Rivulet and Browns River. Previous records of *A. tasmaniae* from northern and western localities around Mt Wellington, such as Myrtle Forest (Collinsvale) and the catchment of the North West Bay River (O'Brien, 1990) are referrable to *A. swaini*, having an angular rather than evenly rounded posterior margin of the telson and minimal pleonal spination (at most with scattered denticles on pleonite 6 and occasionally one or two denticles on the pleonite 5 pleuron) (Fig. 33A–J). A series from the Huonville area slightly west of Mt Wellington (presumably from the catchment of the Mountain River) is also referable to *A. swaini*. Specimens corresponding to *A. swaini*, but labelled only as coming from Mt Wellington, were presumably collected from a westerly locality in the North West Bay River catchment. Two anomalous lots with specific locality data, however, were collected in 1928 from Fern Tree Glen and Wishing Well on the southeastern face of Mt Wellington (AM P9217, 9218). The location of Wishing Well is well known but "Fern Tree Glen" is probably an error for Fern Tree Bower on the lower Browns River, well downstream of Silver Falls. Either way, the presence of *A. swaini* in the Browns River catchment, an eastern locale, is unexpected. Other specimens from the Browns River catchment (Silver Falls and Fern Tree) represent *A. tasmaniae* sensu stricto but those from "Fern Tree Glen" and Wishing Well agree with those from St Crispins Well (Fig. 33A–F), in the catchment of the North West Bay River. The North West Bay and Browns rivers, however, do not share catchments, making natural dispersal between these drainages unlikely. Fern Tree Bower and Wishing Well, however, are notable as two key points along the aqueduct that drew water from the western side of Mt Wellington (starting at St Crispins Well) to Hobart since at least 1881. As a result, the records of *A. swaini* in the lower Browns River from 1928 could be the result of accidental translocation from the western side of Mt Wellington; it remains to be determined whether *A. swaini* is still present there. The western and northern Mt Wellington specimens here referred to *A. swaini* differ slightly from topotypic material (see Remarks under account of *A. swaini*).

Anaspides was previously recorded from the plateau near the summit of Mt Wellington in tarns and creeks, most of which drain into the North West Bay River (Manton, 1930). It apparently no longer occurs there, however, probably as a result of major bushfires that swept across the top of Mt Wellington in 1930s (Swain pers. com. in O'Brien, 1990). *Anaspides* populations are now restricted to catchment creeks to the periphery of the summit—*A. tasmaniae* to the east and south-east, and *A. swaini* to the west and northwest. Material from the uppermost parts of Mt Wellington collected during or before the early decades of the 20th century includes both *A. swaini* and *A. tasmaniae*, so it is possible they were sympatric or lived in close proximity atop Mt Wellington prior to the 1930s bushfires. Manton (1930) observed two colour forms in *Anaspides* on Mt Wellington: a dark brown to olive-green form found on the Mt Wellington plateau, and a light brown form occurring on the slopes. Notwithstanding likely habitat related colour variation, the distribution of *Anaspides* on Mt Wellington as determined herein suggests that Manton's dark form is referrable to *A. swaini*, and the light brown form, to *A. tasmaniae* (Manton, 1930: pl. 2–3, 4). Nicholls' (1947) remark that the "dark coloration prevails almost everywhere the species is taken (many quite remote from Mt Wellington)" is consistent with the much wider range of *A. swaini* relative to *A. tasmaniae*.

The type series of *A. tasmaniae* was collected from Mt Wellington on two occasions in 1892. Specimens were first collected in January 1892 by G.M. Thomson during a visit to Hobart for the Congress of the Australasian Association for the Advancement of Science (Morton, 1893; Thomson, 1926) and by Leonard Rodway (Tasmanian Government botanist) on 24 May 1892 from the original locality (Thomson, 1893, 1894). Thomson's (1893, 1894) early accounts suggest that the specimens were collected near the summit of Mt Wellington at an elevation of "over 4,000 ft" (= 1200 m). Thomson's (1926: 161) more detailed account of events, however, indicates the specimens were collected "about three-fourths of the way to the summit, where the water issues from a few deep pools among the rocks" near "The Springs". Thus, rather than the summit, the type series would have originated from the eastern face of Mt Wellington, nearer to 700 m asl. These specimens of *A. tasmaniae* are now in poor condition, having at one time been dried, but clearly preserve the primary diagnostic features —an elongated telson with rounded posterior margin, two male antennular clasping spines, spinose pleural margins of pleonites 2–5, spinose tergal margins of pleonites 5–6, and absence of the pleopod 5 endopod. The male (Fig. 4A–D) is herein designated as the lectotype to fix the identity of the species. Other type specimens become paralectotypes. The female paralectotype in the Otago Museum (OM Iv.1396) was collected by Thomson, corresponding to a January 1892 collection date.

Being confined to catchments on the eastern face of Mt Wellington, *Anaspides tasmaniae* as currently understood has a considerably narrower distribution than previously thought. Although *A. tasmaniae* resides within the relative protection of the Wellington Park reserve its conservation status requires reassessment along with detailed delimitation surveys to precisely determine its current distribution.

Distribution. Eastern Mt Wellington, from the catchments of the Newtown Rivulet to the Browns River; 150–1250 m asl.

Anaspides clarkei Ahyong, 2015

Figs 5–8, 35B–C, 36

Anaspides tasmaniae. —Lake & Coleman, 1977: 12–13, pl. 2. —Jarman & Elliot, 2000: fig. 4 (Wolf Hole), tab. 1 (part, Wolf Hole). —Clarke, 2000: 30; 2006, fig. 5.13–15. —Eberhard, 2001: 97. —Boulton *et al*., 2003: 48.

Anaspides sp. (telson 'cave' type). —Eberhard *et al*., 1991: 48 (Hastings and Ida Bay systems only).

Anaspides. —Gooderham & Tsyrlin, 2002: 73, unnumbered colour figure (Exit Cave).

Anaspides clarkei Ahyong, 2015: 596–597, fig. 1A–D (type locality: Exit Cave, Ida Bay).

Type material. HOLOTYPE: SAMA C6301,♂ (29 mm), Exit Cave, Ida Bay, 70 m asl, BS1848, coll. E. Hamilton Smith, 24 May 1969. PARATYPES: SAMA C6302, 1♀ (32 mm), Exit Cave, Ida Bay, 70 m asl, BS1848, coll. E. Hamilton Smith, 24 May 1969; AM P73045, 1 juv. ♀ (18 mm), Base Camp Tributary, Exit Cave, Ida Bay, 43°28.2'S 146°51'E, coll. S. Gersbach (#64631); TMAG G6033, 1♀ (38 mm), Exit Cave (IB-120), Ida Bay Karst, rock pool in Skeleton Creek, coll. A. Clarke, 20 Jan 1998.

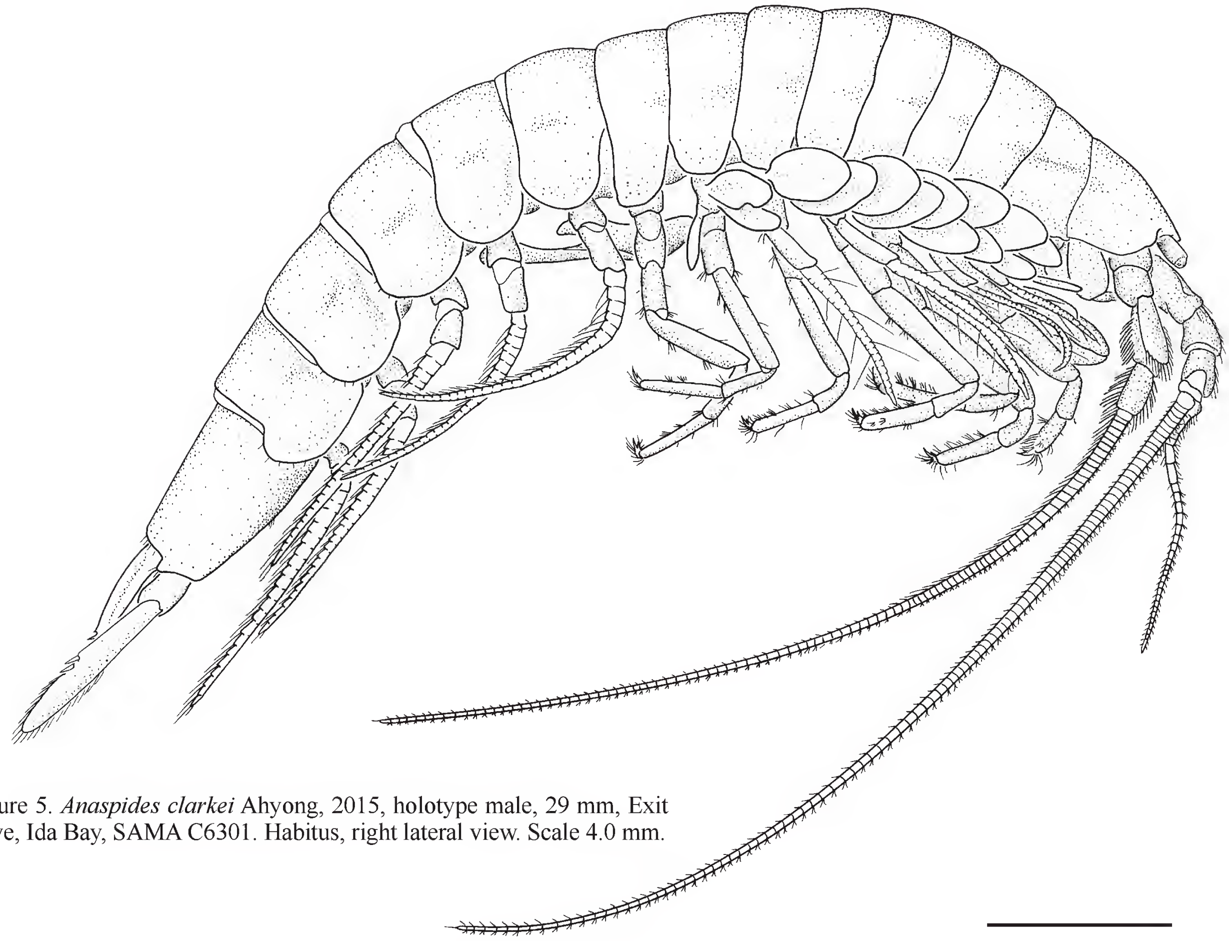

Figure 5. *Anaspides clarkei* Ahyong, 2015, holotype male, 29 mm, Exit Cave, Ida Bay, SAMA C6301. Habitus, right lateral view. Scale 4.0 mm.

Other material examined. *Hastings Karst*: AM P73047, 1♂ (28 mm), far end of Lake Pluto, Wolf Hole, above mud, 43°23.3'S 146°51.4'E, 998-23, coll. A. Clarke, 20 Sep 1998; AM P73046, 1♀ (31 mm), Lake Pluto, Wolf Hole, 43°23.3'S 146°51.4'E, above muddy substrate, 200 m asl, 998-22, coll. A. Clarke, 20 Sep 1998; QVM:10:47694, 1♀ (28 mm), Lake Pluto, Wolf Hole, 43°23.3'S 146°51.4'E, above muddy substrate, 200 m asl, 998-22, coll. A. Clarke, 20 Sep 1998; AM P99289, 1♂ (22 mm), 1♀ (23 mm), 1 juvenile♀ (12 mm), Newdegate Cave (H-X7), Hastings Karst, 43°23.0'S 146°50.5'E, from pools in Mystery Creek streamway beyond Binney Chamber, 1298-02, coll. A. Clarke, 1 Dec 1998; AM P99290, 1 indeterminate juvenile (shrivelled, poor condition, >8 mm), Hell's Half Acre streamway, 1.6 km into Newdegate Cave (H-X7), Hastings Karst, 43°23.0'S 146°50.5'E, from pools in Mystery Creek streamway beyond Binney Chamber, 1298-07, coll. A. Clarke, 1 Dec 1998.

Ida Bay Karst: QVM 10:49168, 3♀♀ (21–24 mm), Eastern Passage streamway of Little Grunt Cave and Exit Cave, 43°28.3'S 146°51.7'E, coll. S. Eberhard, Aug 1993; QVM 10:13261, 3♀♀ (c. 19–31 mm), Little Grunt Cave (IB29), 43°28.3'S 146°51.7'E, coll. S. Eberhard, 17 Feb 1992; QVM 10:13254, 1♀ (19 mm), 1 juvenile♀ (14 mm), Exit Cave, Eastern Passage, 43°28.3'S 146°51.3'E, coll. S. Eberhard, 15 Feb 1992; QVM 10:12248, 3 juvenile ♂♂ (9–19 mm), Loons Cave (IB2-7), Ida Bay Karst, 43°27.4'S 146°52.1'E, deep stream, 80 m asl, coll. S. M. Eberhard & J. Jackson, 10 May 1989; QVM 10:12177, 2♀♀ (23–25 mm), 1 indet juv. (10 mm), Milkrun Cave (IB38-5), 43°28.3'S 146°51.3'E, 360 m asl, about 200 m from entrance, coll. S. Eberhard, 22 August 1985; TMAG G6487, 1♀ (24 mm), Arthurs Folly (IB10), 43°27.3'S 146°52.3'E, stream, dark zone, 690-05, coll. A. Clarke, 24 Jun 1990; TMAG G6488, 1♂ (23 mm), Cyclops Pot (IB57), pool at bottom of lower pitch, 190 m depth, 290-01, coll. D. Morgan & J. Butt for A. Clarke, 18 Feb 1990; TMAG G6486, 1 juvenile♂ (18 mm), 1♀ (21 mm), Revelation Cave (IB1), 43°27.8'S 146°50.3'E, from deep pool, base of underground shaft, 240 m asl, CV49, coll. A. Goede, 14 Jun 1969; QVM 10:13230, 1♂ (24 mm), 2♀♀ (22–23 mm), Exit Cave, 43°24'S 146°52'E, tributary, coll. S. Eberhard, 15 Feb 1992; AM P82857, 1 juvenile♀ (14 mm), Exit Cave, 43°28.2'S 146°51.0'E, trickle at side entrance from IB161, Bobs Hole, in twilight zone, JHB T0701, coll. J.H. Bradbury, 7 Mar 1997; AM P99291, 1♀ (21 mm), Exit Cave (IB-14), pool near Ballroom passage, 700 m into cave, 43°28.6'S 146°51.3'E, 202-11, 14 Feb 2002; AM P99292, 1♂ (20 mm), 1 juv. ♀ (21 mm), Exit Cave, riffle zone near Ballroom Passage junction, 43°28.6'S 146°51.3'E, dark zone, 397-63, coll. A. Clarke, 7 Mar 1997; AM P99293, 1 juvenile♂ (18 mm), 2 juvenile ♀♀ (18–19 mm), Exit Cave (IB-120), Lost Squeeze Passage, pools, 194-04, coll. A. Clarke, 20 Jan 1998; AM P99294, 2♀♀ (24 mm), Exit Cave (IB14), Base Camp Tributary, c. 1.75 km into Exit Cave, 202-19, coll. A. Clarke, 14 Feb 2002; TMAG G6489, 3 juvenile ♂♂ (15–22 mm), 1♀ (21 mm), Base Camp Tributary, c. 1.75 km into Exit Cave (IB-14), 193-112, coll. A. Clarke, 29 Jan 1993; TMAG G6485, 2♂♂ (21–24 mm), 3♀♀ (20–29 mm), Exit Cave, Devil's Stovepipe, pool at bottom of shaft, dribble system, at rock base with pools, "no pigment regeneration after 4 weeks in lab", coll. A. Goede & B. Collins, 2 Mar 1969; TMAG G6484, 1♀ (32 mm), Exit Cave, 50 m downstream of "Waddle 'n' Splosh", coll. Laimonis Kavalieris, 23 January 1973; TMAG G6494, 3 juvenile ♂♂ (22–25 mm), 5♀♀ (23–32 mm), Exit Cave, pool at base of shaft near Keller's Squeeze, 43°28.1'S 146°50.7'E, CV42, coll. A. Goede & A. Keller, 29 Mar 1969; TMAG G6490, 1♀ (20 mm), Exit Cave (IB14), 20 m upstream from site of monitoring probe, dark zone, 996-05, coll. L. Gardner & J. Hammond for A. Clarke, 7 Sep 1996; TMAG G1287, 2♀♀ (20–23 mm), Exit Cave, coll. W.D. Williams, 1 Jun 1968; ZSRO 385, 1 juvenile♀ (15 mm), Bradley-Chesterman Cave (IB6), c. 75 m upstream from entrance, 43°27.7'S 146°51.8'E, coll. A. Clarke, 5 Mar 2006.

Description. Eyes with cornea pigmented or unpigmented, strongly reduced, narrower than stalk, shorter than one-fourth length of stalk; stalk with subparallel or slightly convergent margins.

Rostrum broadly triangular, almost equilateral, apex blunt.

Pleonites 1–5 unarmed, with sparsely setose pleural margins, rounded. Pleonite 6 posterior and posterolateral margins unarmed, setose. Pleonal sternites 3–5 with low, median processes between pleopod bases, bilobed and widest on sternite 3, bilobed on sternite 4, unilobate on sternite 5.

Telson length and width subequal to slightly longer than wide, widest proximally; lateral margins sinuous in dorsal outline, distally convergent; transition from lateral to posterior margin obtusely and bluntly angular to rounded; posterior margin bluntly angular to broadly rounded; posterior spine row with 4–15 (usually 6–8) stout, well-spaced spines, directed posteriorly, arrangement usually subsymmetrical, though frequently distinctly asymmetrical; proximalmost spines near posterior 0.25 of telson length.

Antennule inner flagellum about 0.2 × body length (26–28 articles in holotype); article 7 inner margin obtusely angled in adult males, with 4 (rarely 5) relatively short, slender,

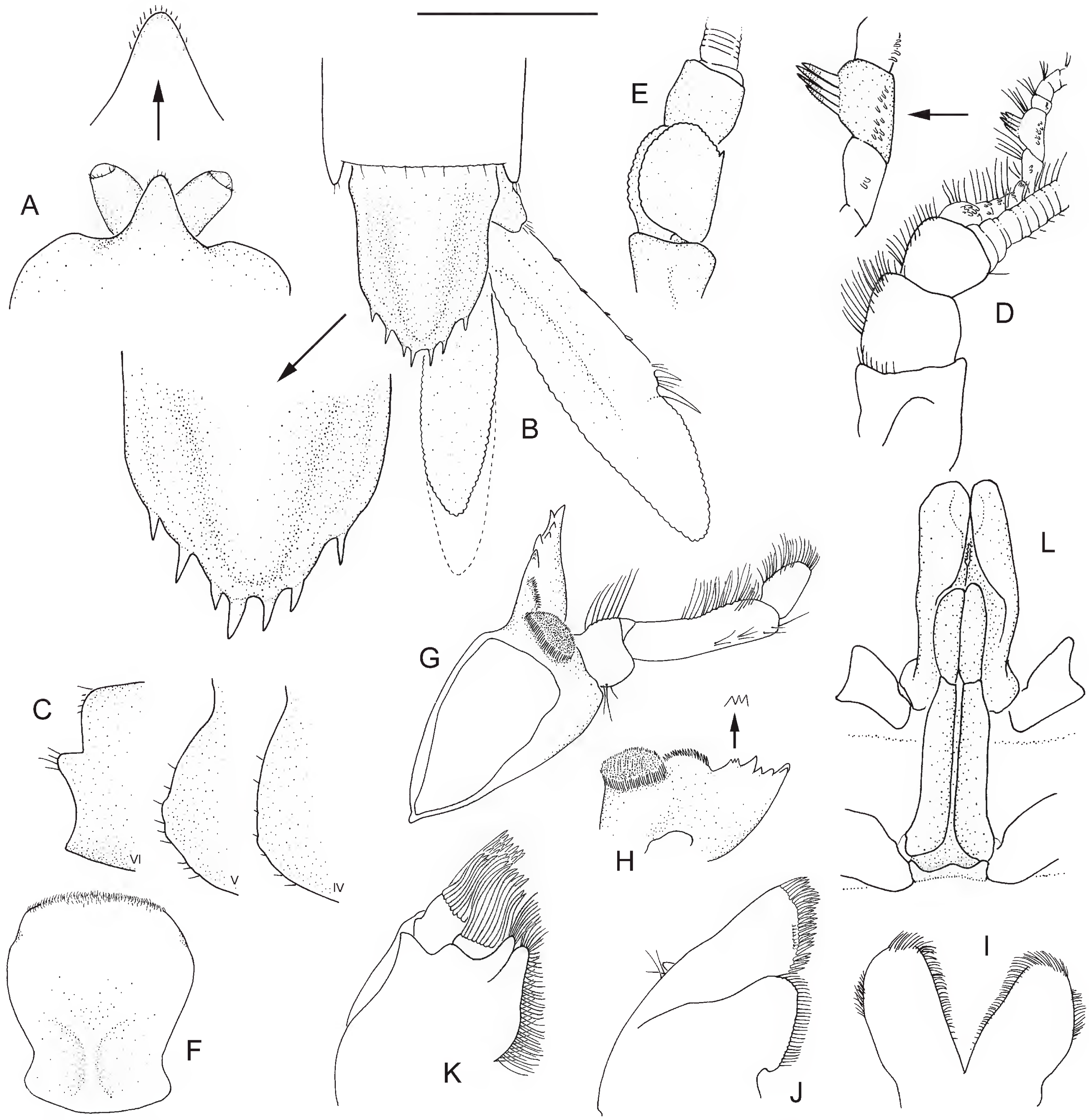

Figure 6. *Anaspides clarkei* Ahyong, 2015, holotype male, 29 mm, Exit Cave, Ida Bay, SAMA C6301. *(A)* cephalothorax, dorsal view; *(B)* pleonite 6, telson and right uropod; *(C)* pleonites 4–6 pleura, right lateral view; *(D)* right antennule; *(E)* right antenna; *(F)* labrum, anterior view; *(G)* right mandible; *(H)* right mandible incisor process; *(I)* paragnaths, anterior view; *(J)* right maxillule; *(K)* right maxilla; *(L)* pleopods 1–2, in-situ, ventral view. Scale: A–E, L = 2.0 mm; F–K = 0.7 mm.

closely spaced clasping spines; outer flagellum 0.6–0.8 × body length (103–108 articles in holotype). Antennal flagellum 0.4–0.6 × body length (98 articles in holotype); scaphocerite ovate, lateral spine near distal one-fourth; apex slightly overreaching penultimate peduncular article.

Right mandibular incisor process with proximal tooth distally trifurcate.

Pleopods 1–2 (usually) or 3 with endopod in adults (occasionally with pleopod 3 endopod present on one side only). Adult male pleopod 1 distally widened, scoop-like, lateral margins expanded, obscuring retinacular lobe in lateral view.

Uropodal protopod dorsally unarmed; exopod with 2 or 3 movable spines on outer margin near position of partial diaeresis; exopod length about 3.5–4 times width, slightly wider than endopod, apex rounded, relatively narrow.

Measurements. Male (n = 20) 15–29 mm, female (n = 47) 9–38 mm, sex indeterminate (n = 2) 8–10 mm.

Remarks. The cave dwelling *Anaspides clarkei* is highly distinctive in having the posterior margin of the telson armed with few (4–15, usually 6–8) stout, well-spaced spines (versus a row of fine, closely-spaced spines), the strongly reduced cornea, and long outer antennular flagella that

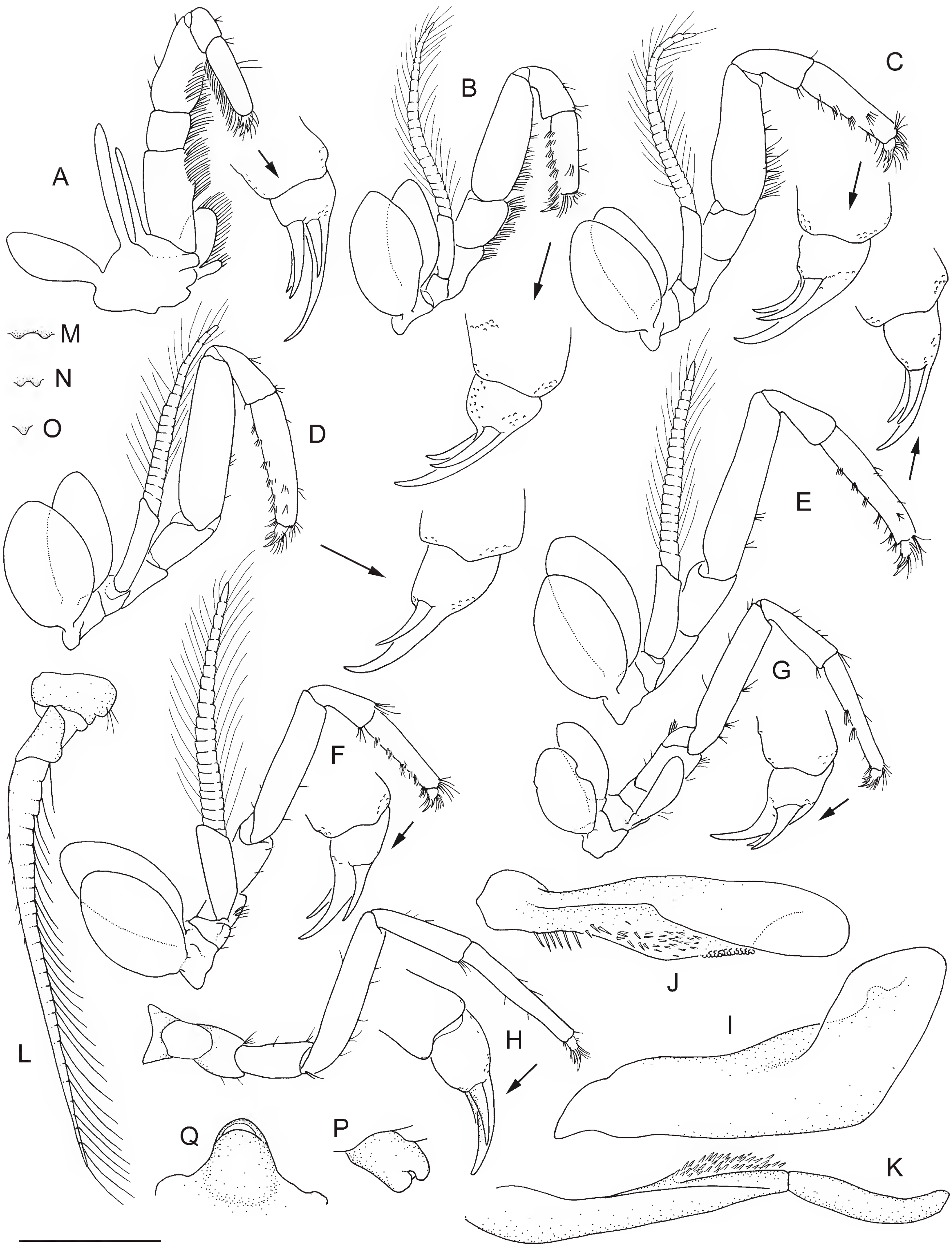

Figure 7. *Anaspides clarkei* Ahyong, 2015. *(A–O)* Holotype male, 29 mm, Exit Cave, Ida Bay, SAMA C6301; *(P–Q)* paratype female, 32 mm, Exit Cave, SAMA C6302. *(A)* right thoracopod 1 (maxilliped); *(B–H)* right thoracopods 2–8; *(I–J)* right pleopod 1 endopod, lateral and ventral views; *(K)* right pleopod 2 endopod, lateral view; *(L)* right pleopod 3, anterior view; *(M–O)* pleonites 3–5 median sternal processes; *(P–Q)* female gonopore, right lateral and ventral views. Scale A–H, L–O = 2.0 mm; I–K = 1.0 mm.

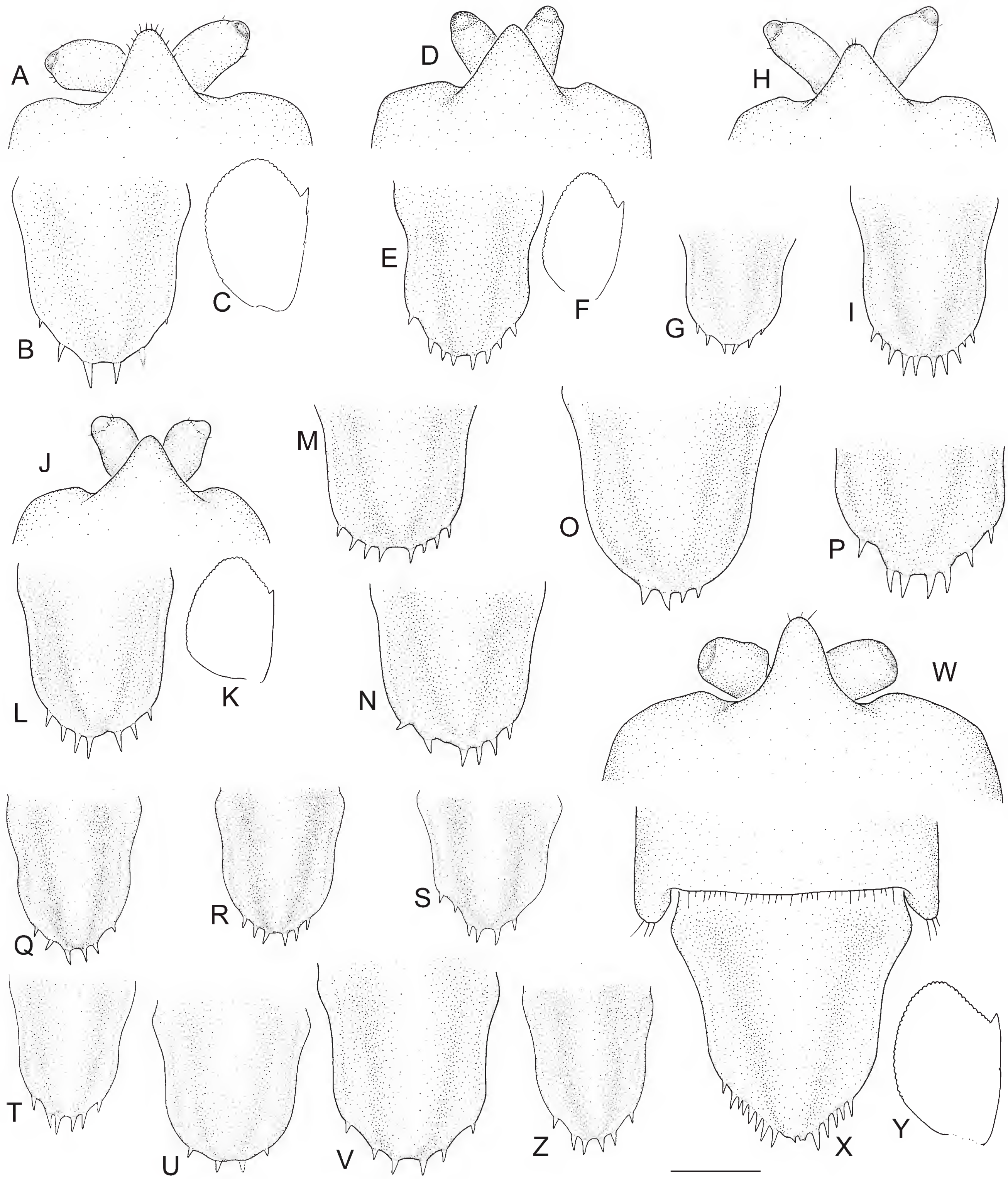

Figure 8. *Anaspides clarkei* Ahyong, 2015. *(A–C)* juv. female, 15 mm, Bradley Chesterman Cave, Ida Bay, ZSRO; *(D–F)* female, 24 mm, Arthur's Folly, Ida Bay, TMAG G6487; *(G)* female, 18 mm, Exit Cave, Ida Bay, AM P73045; *(H–I)* juv. female, 14 mm, Exit Cave, AM P82857; *(J–L)* male, 28 mm, Wolf Hole, Hastings, AM P73047; *(M)* female, 28 mm, Wolf Hole, QVM 10:47694; *(N)* female, 31 mm, Wolf Hole, AM P73046; *(O)* paratype female, 32 mm, Exit Cave, SAMA C6302; *(P)* paratype female, 38 mm, Exit Cave, TMAG G6033; *(Q)* female, 23 mm, Newdegate Cave, Hastings, AM P99289; *(R)* male, 22 mm, Newdegate Cave, AM P99289; *(S)* female, 19 mm, Revelation Cave, Ida Bay, TMAG G6486; *(T–U)* indet juv. (10 mm), female (25 mm), Milkrun Cave, Ida Bay, QVM 10:12177; *(V)* female, 31 mm, Little Grunt Cave, Ida Bay, QVM 10:13261; *(W–Y)* female, 32 mm, "Waddle 'n splosh", Exit Cave, TMAG G6484; *(Z)* female, 24 mm, Exit Cave, AM P99294. *A, D, H, J, W,* anterior cephalothorax; *B, E, G, I, L, M–V, X, Z,* telson; *C, F, K, Y,* scaphocerite. Scale: A–C, H–I, T = 0.5 mm; D–G, J–S, U–Z = 1.0 mm.

are distinctly longer than half the body length (Figs 5, 6). *Anaspides clarkei* also differs from adults of other congeners in lacking the endopod on pleopods 4 and 5, usually also pleopod 3. The endopod of pleopods 1–4, and usually also on pleopod 5, is present in adults of all other species of *Anaspides*. Although pleopodal endopod development is anamorphic in *Anaspides*, but in *A. clarkei*, the endopods do not develop beyond pleonite 3, usually pleonite 2. Similarly, the rostrum of other species of *Anaspides* becomes increasingly slender with age, but the rostrum of *A. clarkei* remains broad into maturity. Thus, the reduction in pleopodal endopods and broad rostrum in adults suggests that *A. clarkei* is, in some respects, paedomorphic.

The "cave-type" telson of *A. clarkei*, with few, stout well-spaced spines, superficially resembles that of *A. eberhardi* from caves in the Junee-Florentine karst system. Distinctions between the two species are outlined under the account of *A. eberhardi*. Despite the superficially similar telson spination to *A. eberhardi*, *A. clarkei* is most closely related to *A. jarmani* from the neighbouring surface localities, uniquely sharing similar male pleopod 1 morphology in which the retinacular lobe is obscured in lateral view, the presence of 4 (rarely 5) antennular clasping spines in adult males, and in the absence of pleonal spines. *Anaspides clarkei* and *A. jarmani* differ chiefly in the well-developed eyes in the latter, different telson spination (spines widely spaced in *A. clarkei*), and absence of endopods on pleopods 4–5 (usually also absent on 3) in *A. clarkei*. Other distinctions between the two species are outlined under the account of *A. jarmani*. As in other species of the genus, the uropodal endopod in *A. clarkei* exceeds three-fourths the length of the exopod. The right uropodal endopod of the holotype of *A. clarkei*, however, is abnormally shortened (Fig. 6B), possibly as a result of damage or moult irregularities.

The arrangement of posterior telson spines of *A. clarkei* is usually only approximately symmetrical, contrasting with the highly degree of symmetry seen in *A. eberhardi*. Several specimens of *A. clarkei* have aberrant, distinctly asymmetrical telson spination, probably as a result of injury or moult irregularities (e.g., Fig. 8N,P,S). A specimen (female, 32 mm, TMAG G6484; Fig. 8W–Y) from "Waddle 'n Splosh", Exit Cave, is aberrant in having more numerous, somewhat asymmetrically developed, less widely spaced telson spines, and much more strongly reduced, almost flattened corneas; in other respects, including pleopodal endopod reduction, the specimen agrees with typical *A. clarkei*. Development of the male antennular clasping spines is sequential, with two or three present in juveniles, reaching the full complement of four spines in adults. Both sexes of *A. clarkei* appear to be mature by 19–25 mm.

Anaspides clarkei is known only from the Ida Bay and Hastings karst systems, exhibiting troglobitic adaptations in the significantly reduced cornea with degenerate ommatidial facets, reduction or absence of corneal and body pigmentation, and proportionally much longer antennular and antennal flagella, measuring distinctly more than half body length. General setal development in *A. clarkei* is uniform and resembles that of epigean forms, but body pigmentation differs between localities. Those from Ida Bay and Newdegate Cave (Hastings) are unpigmented or significantly de-pigmented, at most with diffuse body pigmentation; all have corneal pigmentation (Fig. 35B). As observed by Goede (1972) and Lake & Coleman (1977), however, specimens from Wolf Hole lack all body and corneal pigmentation (Fig. 35C). In addition to the complete loss of pigmentation, adults from Wolf Hole also differ slightly from Newdegate Cave and most Ida Bay specimens in the noticeably blunter, broader and more flattened posterior margin of the telson (Fig. 8L–N); additional material from Wolf Hole is required to determine the stability of this feature. The telson in Ida Bay and Newdegate specimens generally tapers more strongly and is more rounded distally, although some specimens from Milkrun Cave and Little Grunt Cave (Fig. 8U,V) approach those from Wolf Hole. In other respects, the Wolf Hole specimens agree well with those from other localities. The 28 mm male from Wolf Hole (AM P73047; Fig. 8J–L) has five clasping spines on the left antennule, four on the right; other adult males have four clasping spines on both antennules. Wolf Hole is the most isolated locality at which *A. clarkei* occurs, being hydrologically separated from the Ida Bay system and neighbouring Newdegate Cave, as well as from epigean *Anaspides*. Some degree of subspecific or possibly even specific differentiation is plausible between Hastings and Ida Bay populations given the isolation of the respective karst systems. *Anaspides* listed from the Hastings and Ida Bay systems as "telson 'cave' type" by Eberhard *et al*. (1991) are referrable to *A. clarkei*.

In both Hastings and Ida Bay systems, the closely related *A. jarmani* has entered subterranean waters (Newdegate Cave and Mystery Creek Cave, respectively). Both *A. clarkei* and *A. jarmani* are present in Newdegate Cave, but it is not presently known whether they are sympatric there or occur in different parts of the system.

Quarrying at Ida Bay since the Second World War, with attendant severe sedimentation and degraded water quality led to extinction of *Anaspides* from Bradley-Chesterman Cave. Closure of the quarry in 1992, however, followed by catchment rehabilitation saw *Anaspides* recolonize Bradley-Chesterman by December 1998 (Eberhard, 1999, 2001), presumably from populations in other parts of the drainage such as Loon's, Little Grunt, Arthurs Folly caves. The re-appearance of *A. clarkei* in Bradley-Chesterman Cave corroborates the supposition of subterranean continuity between Ida Bay cave subsystems (Kiernan, 1993).

Distribution. Presently known only from Ida Bay and Hastings karst systems; 70–360 m asl.

Anaspides eberhardi sp. nov.

Figs 9–12, 36

Anaspides sp. (telson 'cave' type). —Eberhard *et al*., 1991: 48 (Junee-Florentine records only).

Type material. Holotype: QVM 10:49169,♂ (32 mm), Niggly Cave (JF-2), near Maydena, Junee-Florentine Karst, 42°42'S 146°31'E, coll. S. Eberhard, Aug 1993. Paratypes: QVM:2016:10:0001, 1♂ (30 mm), Niggly Cave (JF-2), collected with holotype; QVM:2016:10:0002, 1♀ (32 mm), Niggly Cave (JF-2), collected with holotype; TMAG G6479, 1♂ (32 mm), 2♀♀ (28–34 mm), Niggly Cave (JF2-1), 42°42'S 146°31'E; QVM 10:12917, 1♂ (31 mm), 2♀♀ (c. 25–33 mm), Cauldron Pot (JF-2), Maydena, Junee-Florentine Karst, 42°42.9'S 146°34.4'E, 720 m asl, Brew Ch, E series streamway, coll. S.M. Eberhard, 28 Jan 1990; TMAG G6492, 1♀ (30 mm), Cauldron Pot (JF-2), Maydena, Junee-Florentine Karst, 42°42.9'S 146°34.4'E, 720 m asl, coll. R. Eberhard, 1 Feb 1985.

Other material examined. (Junee-Florentine Karst). TMAG G6467, 1 juv. ♂ (19 mm), 1♀ (43 mm), cave JF-104, at foot of Tiger Range, Florentine Valley, 42°33'S 146°25'E, underground stream, A. Goede, 9 Oct 1976; AM P99295, 1 juv. ♂ (shrivelled, poor condition, c. 13 mm), Welcome Stranger Cave (JF-229), 42°37.8'S

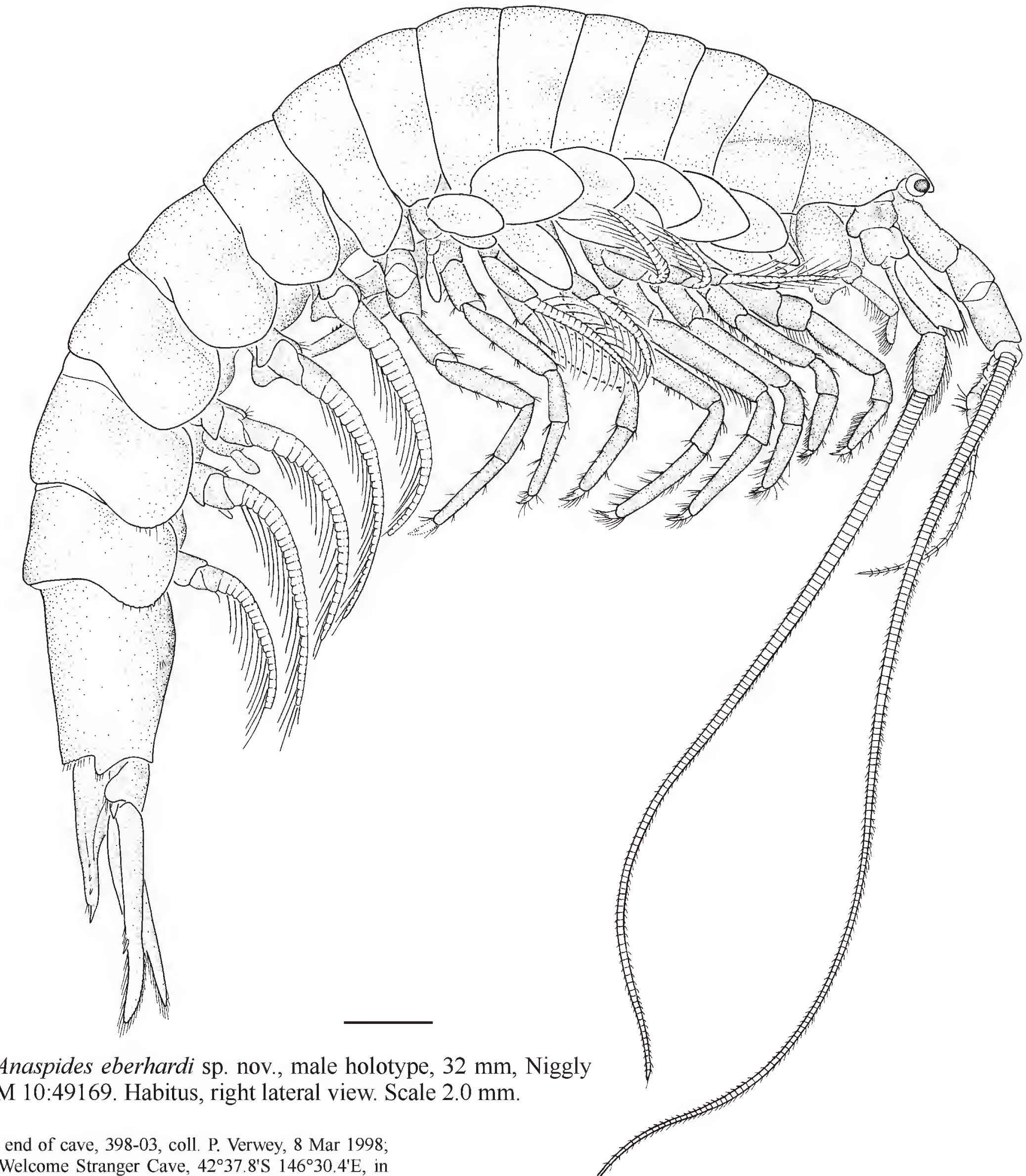

Figure 9. *Anaspides eberhardi* sp. nov., male holotype, 32 mm, Niggly Cave, QVM 10:49169. Habitus, right lateral view. Scale 2.0 mm.

146°30.4'E, from sump pool at end of cave, 398-03, coll. P. Verwey, 8 Mar 1998; TMAG G6469, 1♀ (22 mm), Welcome Stranger Cave, 42°37.8'S 146°30.4'E, in stream, CV50, coll. D. Maloney, 3 Apr 1971; TMAG G6470, 1♂ (24 mm), 1 juv. ♂ (18 mm), Welcome Stranger Cave, 42°37.8'S 146°30.4'E, in stream, CV39, coll. S. Eberhard, A. Richardson & R. Swain, 28 Oct 1984; TMAG G6471, 2♀♀ (21–27 mm), Welcome Stranger Cave, 42°37.8'S 146°30.4'E, coll. R. Eberhard, 6 Aug 1990; TMAG G6482, 1♀ (35 mm), Porcupine Pot (JF387), Florentine Valley, 42°40.9'S 146°30.2'E, 640 m asl, CV1, coll. S. Eberhard, 10 Nov 1985; TMAG G6480, 2♂♂ (29–32 mm), 2♀♀ (31–37 mm), Gormenghast Cave (JF35-8), Florentine Valley, 42°41'S 146°30'E; TMAG G6483, 1♀ (c. 26 mm), Pendant Pot (JF37), Florentine Valley, 42°41.4'S 146°30.0'E, 550 m asl, CV36, coll. R. Eberhard, Apr 1984; TMAG G6472, 1♀ (24 mm), Growling Swallet (JF-36), 42°41.4'S 146°30.0'E, 570 m asl, CV25, coll. S. Eberhard, 29 Sep 1985; TMAG G6474, 1 juv. ♀ (10 mm), Growling Swallet (JF-36), 42°41.4'S 146°30.0'E, at least 400 m depth, in stream, 590 m asl, coll. S. Eberhard, 11 Dec 1983; TMAG G6475, 5♀♀ (27–47 mm), Junee Cave, Florentine Valley, 42°44.3'S 146°35.7'E, 340 m asl, coll. S. Eberhard, 3 Jan 1985; TMAG G6468, 1♀ (31 mm), Settlement Cave, Florentine Valley, CV45, coll. D. Maloney, 17 Apr 1971; TMAG G6477, 1♀ (45 mm), Florentine Valley, cave, no other data, CV48, Jun 1972; TMAG G6476, 1♀ (c. 20 mm, very poor condition), Florentine Valley, cave, no other data, CV47, Jun 1972; TMAG G6478, 2♂♂ (17–18 mm), 2♀♀ (17–20 mm), Florentine Valley, unnamed cave, found in pool of standing water in cave passage which acts as a flood overflow, CV43, coll. A. Goede, 2 Nov 1969.

Description. Eyes with cornea pigmented, reduced, narrower than stalk, shorter than half length of stalk; stalk with subparallel or slightly convergent margins. Rostrum triangular, apex narrow, blunt.

Pleonites with sparsely setose pleural margins, rounded; Pleonites 1–3 unarmed. Pleonite 4–5 posterior tergal margins unarmed; pleura rounded, with 0–3 (usually 1) small spines and scattered setae. Pleonite 6 posterior margin with row of small spines, setose; posterolateral margin setose, rounded. Pleonal sternites 3–5 with low, median processes between pleopod bases, bilobed and widest on sternite 3, bilobed on sternite 4, unilobate on sternite 5.

Telson longer than wide, slender, triangular, widest proximally, lateral margins slightly sinuous in dorsal outline, distally strongly convergent on narrow apex; normally with 4 pairs of stout, graded, symmetrically arranged, well-spaced spines, anterior 3 pairs directed posterolaterally, distal pair directed posteriorly; occasionally with abnormal asymmetrical spination (3/4, 3/5 or 4/5 spines on either side); proximalmost spines near posterior 0.3–0.4 of telson length; occasionally with stout posteromedian spine and small dorsal median spine above posterior margin.

Antennule inner flagellum about 0.2 × body length (24–29 articles in holotype); article 7 inner margin obtusely angled in adult males, with 1 long, slender, clasping spine at proximal corner; outer flagellum 0.6–1.1 (usually 0.7–0.8) × body length (139 articles in holotype). Antennal flagellum 0.5–0.6 × body length (111 articles in holotype); scaphocerite elongate, ovate, lateral spine at distal one-third; apex not reaching midlength of distal peduncular article.

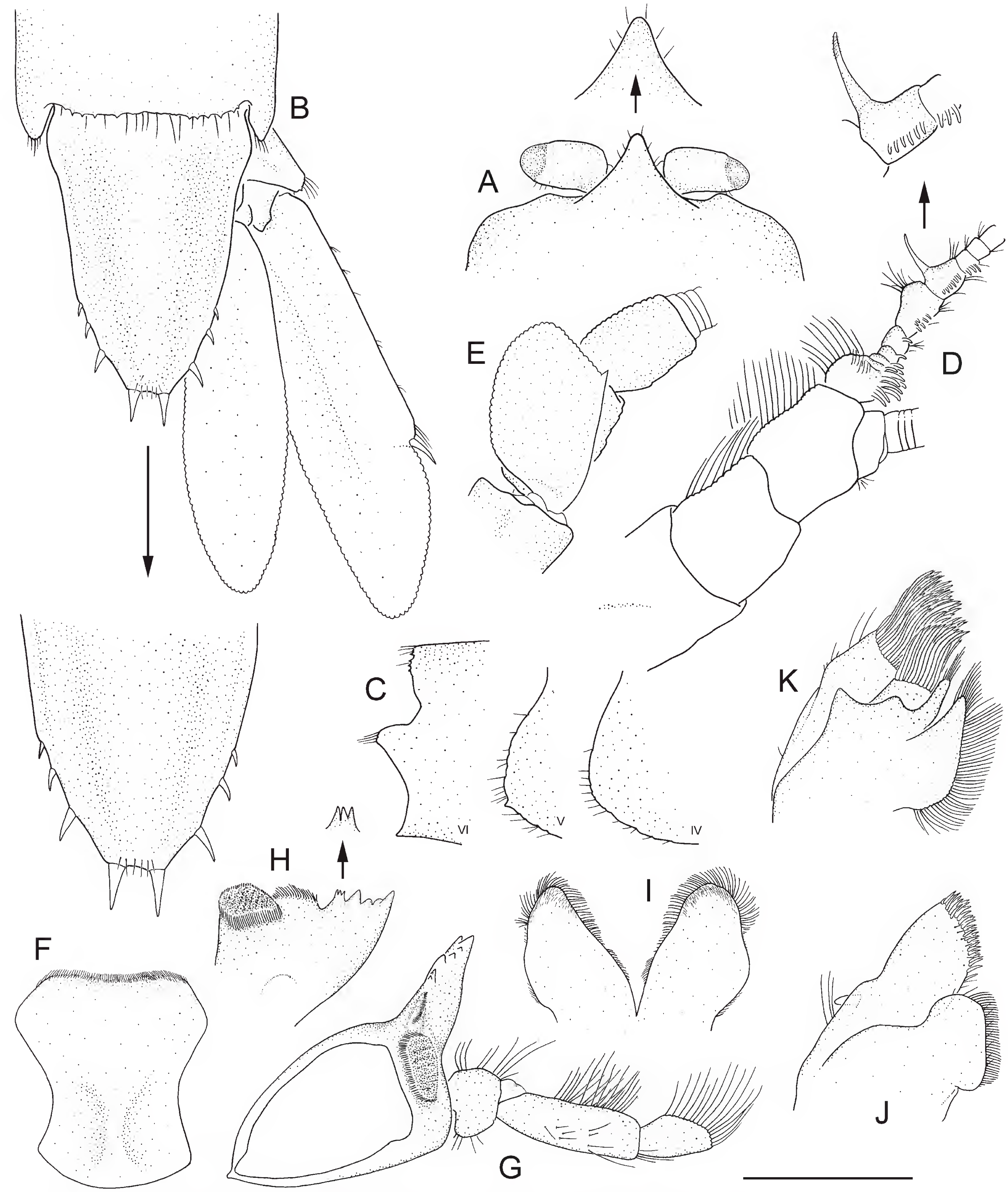

Figure 10. *Anaspides eberhardi* sp. nov., male holotype, 32 mm, Niggly Cave, QVM 10:49169. (*A*) cephalothorax, dorsal view; *(B)* pleonite 6, telson and right uropod; *(C)* pleonites 4–6 pleura, right lateral view; *(D)* right antennule; *(E)* right antenna; *(F)* labrum, anterior view; *(G)* right mandible; *(H)* right mandible incisor process; *(I)* paragnaths, anterior view; *(J)* right maxillule; *(K)* right maxilla. Scale: A–E = 2.0 mm; F–K = 1.3 mm.

Right mandibular incisor process with proximal tooth distally trifurcate.

Pleopods 1–4 with endopod. Adult male pleopod 1 distally widened, scoop-like, lateral margins weakly expanded, not obscuring retinacular lobe in lateral view.

Uropodal protopod with 1–3 small dorsal spines; exopod with 1–3 movable spines on outer margin near position of partial diaeresis; exopod length 3.5–4 times width, slightly wider than endopod, apex rounded, relatively narrow.

Etymology. Named in honour of Stefan Eberhard, who collected the majority of specimens of this new species.

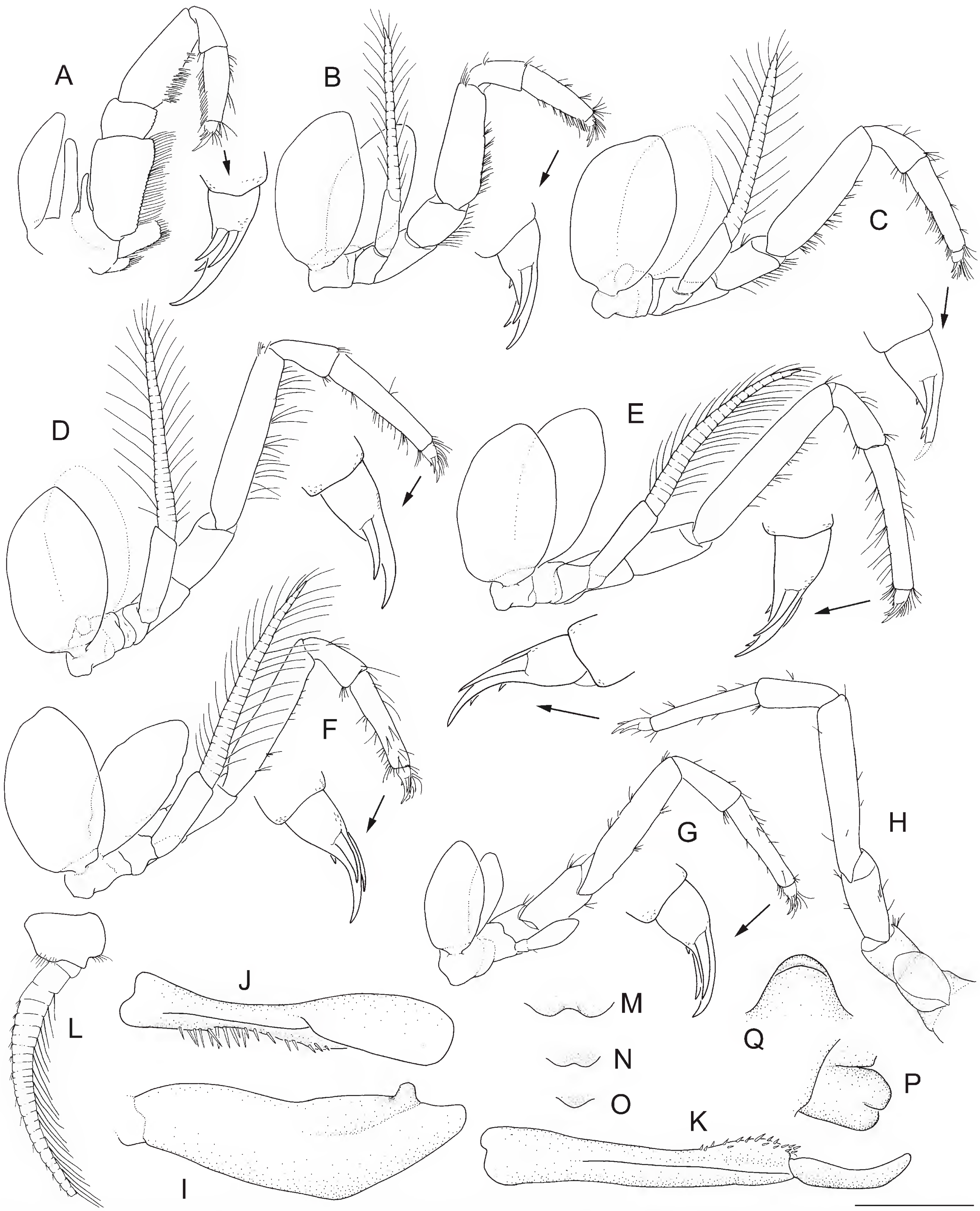

Figure 11. *Anaspides eberhardi* sp. nov. *(A–O)* male holotype, 32 mm, Niggly Cave, QVM 10:49169; *(P–Q)* paratype female, 32 mm, QVM:2016:10:0002; *(A)* right thoracopod 1 (maxilliped); *(B–G)* right thoracopods 2–7; *(H)* left thoracopod 8; *(I–J)* right pleopod 1 endopod, lateral and ventral views; *(K)* right pleopod 2 endopod, lateral view; *(L)* right pleopod 5, anterior view; *(M–O)* pleonites 3–5 median sternal processes; *(P–Q)* female gonopore, right lateral and ventral views. Scale A–H, L = 2.0 mm; I–K, M–O = 1.0 mm; P–Q = 1.4 mm.

Measurements. Male (n = 12) 13–32 mm, female (n = 26) 10–47 mm.

Remarks. *Anaspides eberhardi* sp. nov., the second species of the genus with a "cave-type" telson, is most closely related to *A. richardsoni*, uniquely sharing the single antennular clasping spine in adult males (Fig. 9D). The two species are readily separated by the armature of the telson, with

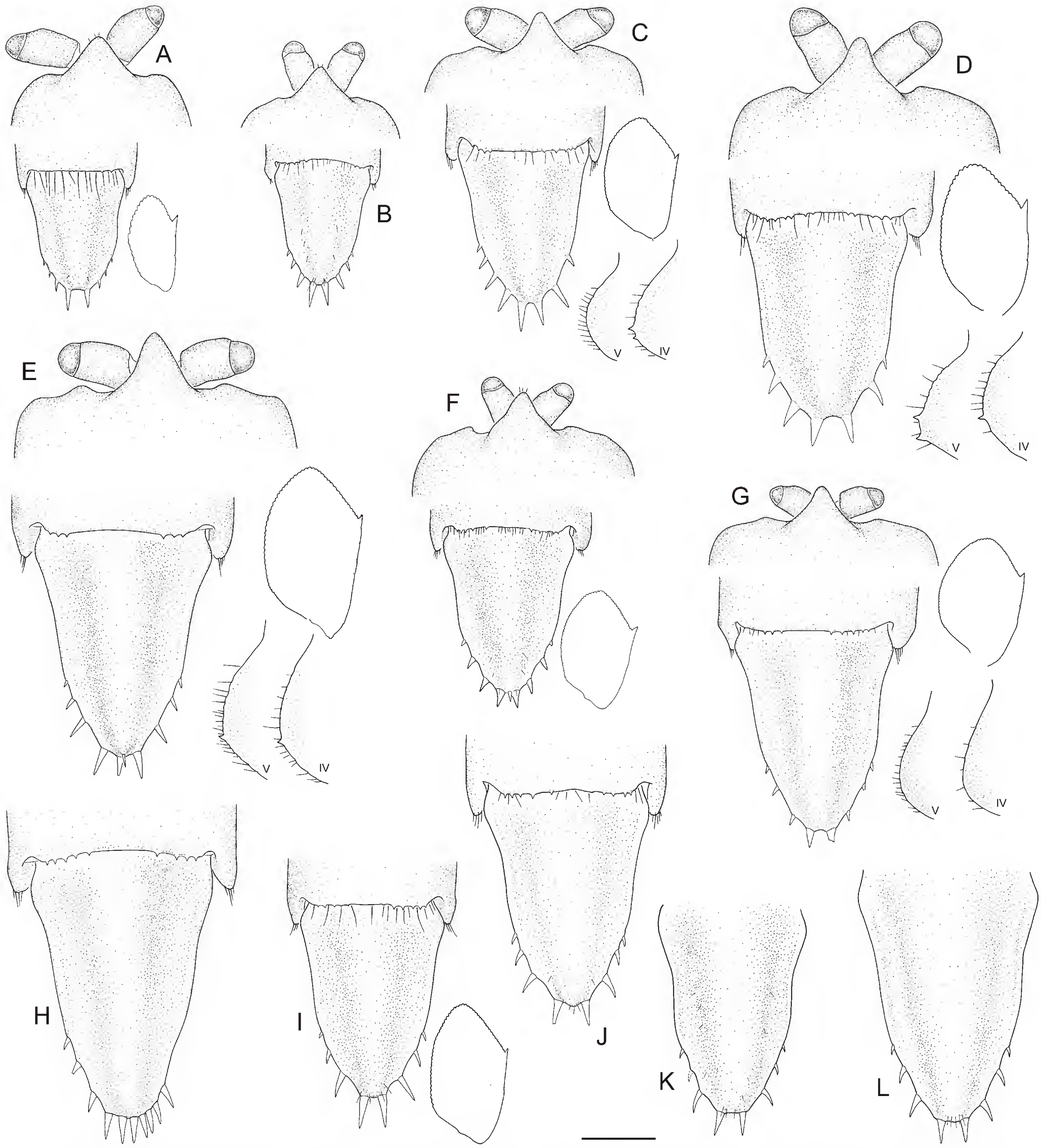

Figure 12. *Anaspides eberhardi* sp. nov., selected features. (*A)* juv. female, 10 mm, Growling Swallet, TMAG G6474; *(B)* juv. male, 18 mm, foot of Tiger Range, TMAG G6467; *(C)* female, 20 mm, unnamed cave CV43, TMAG G6478; *(D)* female, 31 mm, Settlement Cave, TMAG G6468; *(E)* paratype female, 30 mm, Cauldron Pot, TMAG G6492; *(F)* female, 42 mm, foot of Tiger Range, TMAG G6467; *(G)* female, 47 mm, Junee Cave, TMAG G6475; *(H)* female, 33 mm, Junee Cave, TMAG G6475; *(I)* male, 24 mm, Welcome Stranger, TMAG G6470; *(J)* paratype male, 31 mm, Cauldron Pot, QVM 10:12917; *(K)* paratype male, 30 mm, Niggly Cave, QVM:2016:10:0001; *(L)* paratype female, 32 mm, Niggly Cave, QVM:2016:10:0001. Scale A = 0.5 mm; B–D = 2.0 mm, F–G = 2.0 mm; H–L = 1.0 mm.

few, well-spaced spines in the new species (compared to the closely packed posterior spine row in *A. richardsoni*), and absence of the pleopod 5 endopod in adults of *A. eberhardi* (rarely absent in *A. richardsoni*). Moreover, the telson of *A. eberhardi* is distinctly more elongate and posteriorly tapering than any other species of the genus. *Anaspides eberhardi* also shows cave adaptations in corneal reduction, more elongate antennular flagella and body depigmentation. The eyes, however, remain pigmented and the corneas, although reduced compared to epigean forms, are comparatively larger than in the other obligate troglobite, *A. clarkei*. The telson of *A. eberhardi* is like that of *A. clarkei*, however, in having few, stout, widely spaced spines, rather than the fine, closely packed spine row of epigean forms. *Anaspides eberhardi* is readily distinguished from *A. clarkei* by the presence of one instead four (rarely five) antennular clasping spines in adult males, posterior denticles on pleonal pleura 5–6 (unarmed in *A. clarkei*), a distinctly more elongate and more distally tapering telson in which the posterior spines extend anteriorly to the posterior one-third of the telson, rather than posterior one-fourth in *A. clarkei*; and presence of the pleopod 4–5 endopod (absent in *A. clarkei*).

Variation in the *A. eberhardi* is slight. The posterior tergal margin of pleonite 6 always has a series of small denticles, and 1–3 small denticles usually on pleuron 5, often also on pleuron 4 (Fig. 12). The outer margin of the uropodal exopod has 1–3 movable spines, and the uropodal protopod bears 1–3 small dorsal spines. The outer antennular flagellum ranges in length from 0.6–1.1 times body length, generally being proportionally longer in smaller specimens. The arrangement of telson spines is highly consistent in the present series with four pairs of well-spaced marginal spines present from the smallest through largest specimen examined (10–46 mm). Only six specimens differ from the typical pattern of spination. Two specimens (paratype female, 30 mm, TMAG G6492; female, 43 mm, TMAG G6467) have, in addition to the four pairs of marginal spines, a short median spine above the posterior margin, the smaller of which also has an additional marginal median spine (Fig. 12E,F). The telsons of the other four specimens have asymmetrical arrangements, with unequal numbers of spines on either side of the midline (3/4, 3/4, 3/5) (Fig. 12C,D), or distinctly irregularly arranged spines (Fig. 12H). Although normally remarkably consistent in arrangement, the length of the telson spines varies allometrically, becoming proportionally shorter with increasing body size.

Anaspides listed from the Junee-Florentine system by Eberhard *et al*. (1991) as "telson 'cave' type" are referrable to *A. eberhardi*. Several specimens appear to have clusters of fungal hyphae on various parts of the body including the cephalothorax, pleon, uropods and bases of the pereopods.

Given the secondary sexual features of adult males, particularly the single antennular clasping spine and similar pleopod 1, a close relationship between *A. eberhardi* and *A. richardsoni* is likely. The caves occupied by *A. eberhardi* are at the southern end of the wide geographic range of *A. richardsoni*. *Anaspides richardsoni* occurs throughout the caves in the Mole Creek area, but in caves around Mt Field, it has been recorded only from Rift and Growling Swallet caves, the latter of which is also occupied by *A. eberhardi*.

Distribution. Presently known only from caves in the Junee-Florentine Karst area: base of the Tiger Range to Cauldron Pot Cave, Niggly Cave and Welcome Stranger; 340–720 m asl.

Anaspides jarmani Ahyong, 2015

Figs 13–17, 36

Anaspides tasmaniae. —Smith, 1909a: 64, 70 (Harz [sic] Mountains). Thomson, 1926: 161 (Hartz Lake only). —Knott *et al*., 1978: 703, 705, tab. 5. —Eberhard *et al*., 1992: tab. 2. —Jarman & Elliot, 2000: fig. 4 (clade D, part), tab. 1 (part, Adamsons Peak, Hartz Mtns).

Anaspides sp. —Eberhard *et al*., 1992: tab. 2.

Anaspides sp. (telson 'normal' type). —Eberhard *et al*., 1991: 48 (Judds Cavern, Newdegate Cave).

Anaspides sp. (telson type intermediate). —Eberhard *et al*., 1991: 48 (Mystery Creek Cave).

Anaspides jarmani Ahyong, 2015: 598: fig. 1E–H (type locality: Adamsons Peak).

Type material. HOLOTYPE: AM P73039,♂ (24 mm), Adamsons Peak, 43°20.94'S 146°49.94'E, stream, 1200 m asl, coll. S. Jarman. PARATYPES: AM P73040, 1♂ (26 mm), 1 juv. ♂ (18 mm), 3♀♀ (27–30 mm), 5 juv. ♀♀ (7–19 mm), type locality.

Other material examined. *Adamsons Peak*: TMAG G6395, 5 juv. ♂♂ (6–12 mm), 11 juv. ♀♀ (7–11 mm), Adamsons Peak, 50 yards from track signposted "water", 43°21.2'S 146°49.3'E, coll. R. Swain & J. Ong, 8 Feb 1970.

Hartz Mountains: AM P73041, 3♂♂ (20–23 mm), 1 juv. ♂ (18 mm), 3♀♀ (19–24 mm), 6 juv. ♀♀ (8–18 mm), Ladies Tarn, 43°14.83'S 146°46.18'E, 955 m asl, coll. S. Jarman; ZSRO 375, 3♂♂ (19–24 mm), 1 juv. ♂ (20 mm), 4♀♀ (22–24 mm), Ladies Tarn, 43°14.83'S 146°46.18'E, 24 Feb 2006; QVM 10:49055, 1♂ (19 mm), 1 juv. ♂ (16 mm), 1 juv. ♀ (18 mm), 2 indet juv. (5 mm), Ladies Tarn, 43°14.34'S 146°46.03'E, 980 m, rock fauna, coll. S. Chilcott, Inland Fisheries Commission, 14 Jan 1988; QVM 10:49056, 1 juv. ♂ (21 mm), 6 juv. ♀♀ (12–16 mm), Hartz Lake, 43°14.55'S 146°45.15'E, rock fauna, 940 m asl, coll. S. Chilcott, Inland Fisheries Commission, 14 Jan 1988; TMAG G6399, 3 juv. ♂♂ (16–25 mm), 7 juv. ♀♀ (16–25 mm), Hartz Lake, 43°14.55'S 146°45.15'E, 940 m asl, coll. D. Coleman, 9 Jan 1974.

Ida Bay Karst: AM P99299, 3 juv. ♀♀ (c. 18–25 mm, poor condition), Mystery Creek Cave (IB10), Cephalopod Creek side passage, Ida Bay karst, 43°27.8'S 146°50.9'E, 1196-14, coll. A. Clarke, 2 Nov 1996; AM P99300, 3 damaged juveniles (c. 12–13 mm), Mystery Creek Cave (IB10), Ida Bay Karst, 43°27.8'S 146°50.9'E, 1196-15, coll. A. Clarke, 2 Nov 1996; AM P99301, 1 juv. ♂ (18 mm), Mystery Creek Cave (IB10), Ida Bay karst, 43°27.8'S 146°50.9'E, 105-04, coll. A. Clarke & T. Murakami, 5 Jan 2005; AM P99302, 1 juv. ♀ (c. 16 mm, shrivelled, poor condition), Mystery Creek Cave (IB10), Cephalopod Creek passage, Ida Bay Karst, 43°27.8'S 146°50.9'E, pool, 998-28, coll. A. Clarke, 21 Sep 1998; AM P99303, 2 juv. ♂♂ (12–16 mm), Mystery Creek Cave (IB10), Cephalopod Creek side passage, 43°27.8'S 146°50.9'E, plunge pool & streamlet, 1004-04, coll. A. Clarke, 21 Oct 2004; AM P99304, 1 juv. ♂ (shrivelled, poor condition, c. 17 mm), 1 juv. ♀ (shrivelled, poor condition, c. 16 mm), Mystery Creek Cave (IB10), 43°27.8'S 146°50.9'E, pool on side of main streamway, 400 m into cave, dark, 1196-09, coll. A. Clarke, 2 Nov 1996; QVM 10:12175, 1 juv. ♀ (10 mm), Entrance Cave [= Mystery Creek Cave] (IB10-4), Ida Bay, 43°27.8'S 146°50.9'E, cave stream, coll. S. Eberhard, 11 Nov 1986; USNM 1277680, 2♂♂ (20–23 mm), 1♀ (24 mm), 1 juv. ♀ (14 mm), 1 indet juv. (6 mm), Mystery Creek Cave, Ida Bay, 43°27.7'S 146°50.8'E, 0–0.2 m, stn 87-254, coll. T. Iliffe, 29 Dec 1987.

Hastings Karst: TMAG G6493, 1♀ (21 mm), Hell's Half Acre, Newdegate Cave, 43°23.0'S 146°50.5'E, small creek, coll. A. Goede, 1 Nov 1970.

Vanishing Falls karst, Salisbury River: QVM 10:13005, 1♂ (26 mm), Salisbury River Cave, 43°22.8'S 146°37.5'E, VF-X2, coll. S. Eberhard, 25 Apr 1992; QVM 10:13014, 2♂♂ (21–22 mm), 2♀♀ (c. 24–27 mm), Salisbury River Cave, 43°22.8'S 146°37.5'E, VF6, flood overflow passage, coll. S.M. Eberhard & V. Wong, 21 Apr 1992.

Cracroft: QVM 10:12326, 1♂ (28 mm), Wargata Mina, Judds Cavern, in main stream, 1.5 km from entrance, 43°15.3'S 146°35.0'E, 380 m asl, C1-8, coll. S. Eberhard, 4 Apr 1989; QVM 10:12327, 1♀ (22 mm), Wargata Mina (C-001), Judds Cavern, main stream, 43°15.3'S 146°35.0'E, C1-19, 380 m asl, coll. J. Jackson, 25 Nov 1989; TMAG G6495, 1♀ (31 mm), Judds Cavern, 43°15.3'S 146°35.0'E, C1-28, route 66, 2 Mar 1990.

Precipitous Bluff: QVM 10:13279, 1♂ (26 mm), 1♀ (27 mm), Bauhaus Cave (PB6), Persephone Stream, Precipitous Bluff, 43°29.0'S 146°37.0'E, Screaming Stals streamway, stn 4, coll. S. Eberhard, 23 Dec 1991; QVM 10:12322, 1 indet juv. (7 mm), Persephone Cave, Precipitous Bluff, 43°28.9'S 146°35.2'E, deep stream, PB17-6, coll. S.M. Eberhard, 3 Jan 1990.

Southern Ranges: TMAG G6366, 4♀♀ (23–28 mm), Ooze Lake, 43°30.2'S 146°42.0'E, 900 m asl, coll. P. Davies, Oct 1985.

Description. Eyes with well-developed cornea, pigmented, wider than and longer than half length of stalk (epigean specimens) to narrower than stalk, strongly reduced, shorter than half length of stalk (in some subterranean forms); stalk with subparallel margins.

Rostrum narrow in adults, apex blunt.

Pleonites 1–5 unarmed, with sparsely setose pleural margins, rounded. Pleonite 6 posterior and posterolateral margins unarmed, setose. Pleonal sternites 3–5 with low, median processes between pleopod bases, bilobed and widest on sternite 3, bilobed on sternite 4, unilobate on sternite 5. Pleonal sternites 3–4 with distinctly bilobed median processes between pleopod bases, widest on sternite 3; sternite 5 with narrow rounded lobe.

Telson length and width subequal or slightly longer than wide, pentagonal, widest proximally; lateral margins sinuous in dorsal outline, distally subparallel to convergent; transition from lateral to posterior margin obtusely angular; posterior margin acutely to obtusely angular, blunt medially; posterior spine row with 17–37 slender, evenly graded, closely spaced spines, longest medially.

Antennule inner flagellum about 0.2 × body length (20

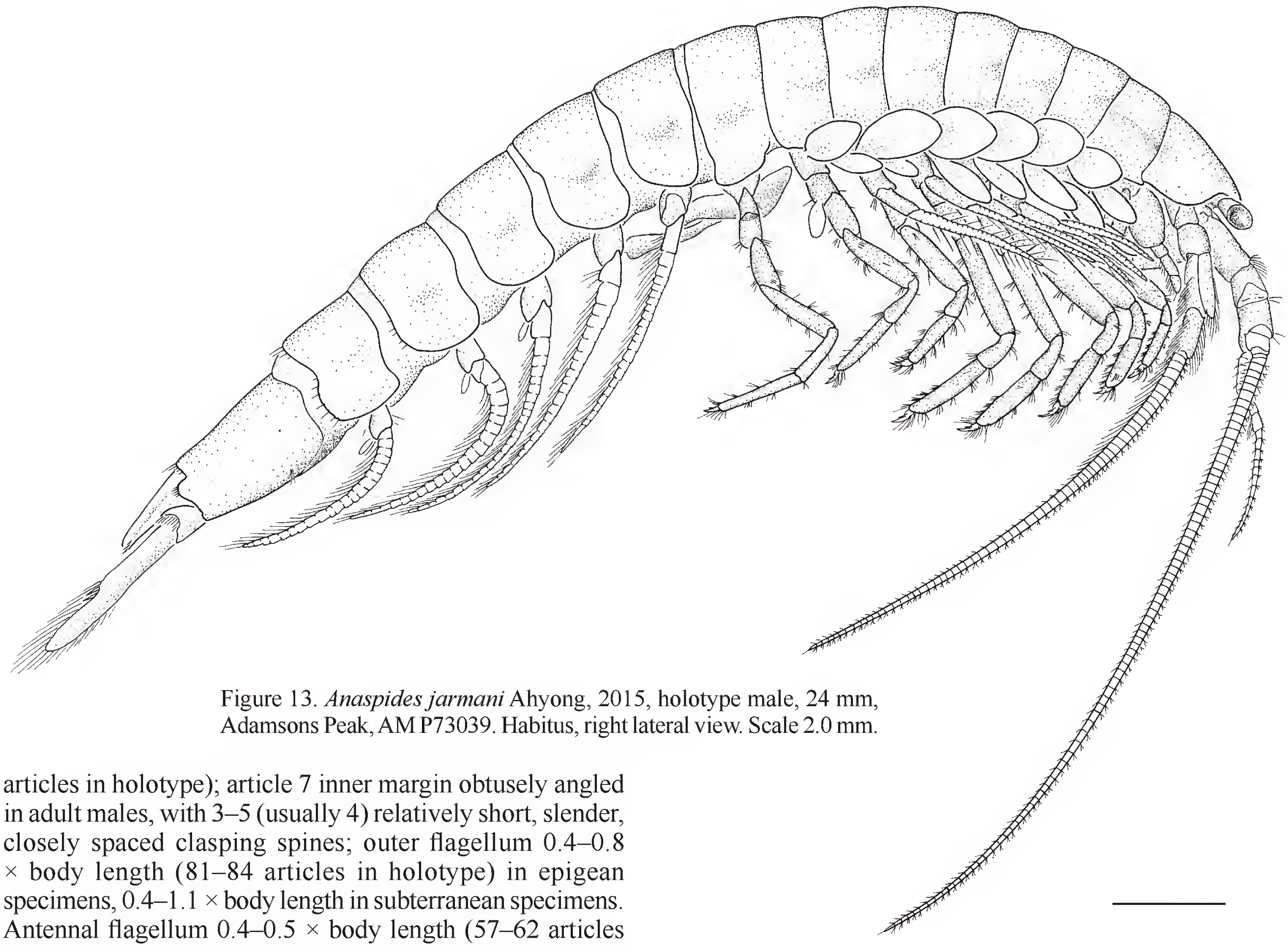

Figure 13. *Anaspides jarmani* Ahyong, 2015, holotype male, 24 mm, Adamsons Peak, AM P73039. Habitus, right lateral view. Scale 2.0 mm.

articles in holotype); article 7 inner margin obtusely angled in adult males, with 3–5 (usually 4) relatively short, slender, closely spaced clasping spines; outer flagellum 0.4–0.8 × body length (81–84 articles in holotype) in epigean specimens, 0.4–1.1 × body length in subterranean specimens. Antennal flagellum 0.4–0.5 × body length (57–62 articles in holotype) in epigean specimens, 0.5–0.8 × body length in subterranean specimens; scaphocerite ovate, lateral spine usually near distal one-fourth, slightly distal to midlength in specimens from Hartz Mountains; apex slightly overreaching penultimate peduncular article. Right mandibular incisor process with proximal tooth distally bifid to quadrifid.

Pleopods 1–4 or 5 with endopod in adults. Adult male pleopod 1 distally widened, scoop-like, lateral margins expanded, obscuring retinacular lobe in lateral view.

Uropodal protopod dorsally unarmed; exopod with 2 or 3 movable spines on outer margin near position of partial diaeresis; exopod length 3–4 times width, slightly wider than endopod, apex rounded, relatively narrow.

Measurements. Male (n = 32) 16–28 mm, female (n = 66) 7–31 mm, indet (n = 4) 5–7 mm.

Remarks. *Anaspides jarmani* and *A. clarkei* are unique in the genus in their male pleopod 1 morphology in which the lateral margins obscure the retinacular lobe in lateral view (Fig. 15I), the presence of 3–5 (usually 4) closely set antennular clasping spines (Fig. 14D) and complete absence of spines or denticles on the pleonites, unlike other species of the genus in which one or more pleonites have some degree of spination. *Anaspides jarmani* differs from *A. clarkei* in the spination of the posterior margin of the telson (lined with numerous, fine, closely set spines rather than stout, well-spaced spines), in having well-developed or only slightly reduced eyes (rather than strongly reduced), and in the presence in adults of endopods on pleopods 3–4 or 3–5 depending on locality. In adult *A. clarkei*, the endopod of pleopod 4–5 (usually 3–5) is absent. Note that in the smallest juveniles (7–10 mm) of *A. jarmani* from all localities as well as larger juveniles from Mystery Creek Cave (Ida Bay), the endopods of pleopods 4–5 are as yet undeveloped. In *A. jarmani*, the posterior margin of the telson becomes angular by 8 mm body length, more or less attaining its adult shape by about 17 mm. Maturity is reached by 19–25 mm. The angle of the posterior margin of the telson in adults is slightly acute to approximately right angled in eastern specimens (Adamsons Peak, Ida Bay, Hartz and Hastings), and obtuse in westerly specimens, most of which are from caves (Cracroft, Vanishing Falls, Precipitous Bluff, Southern Ranges).

Anaspides jarmani has a narrow distribution in southern Tasmania, constrained in the northeast by the Hartz Mountains, the southeast by Ida Bay and in the west by the New River. Adult *A. jarmani* from the southeastern part of its range (Adamson's Peak and Newdegate cave, Hastings) differ from those from other localities in the presence of the endopod on pleopod 5 and a proportionally broader scaphocerite in adults (noting that the scaphocerite is typically more slender in juveniles than adults). Adults of *A. jarmani* from other localities lack the pleopod 5 endopod except for three specimens from the Hartz Mountains (18 mm female, AM P73041; 16 mm juvenile female, QVM 10:49056; 21 mm juvenile female, TMAG G6399) in which the endopod is present on the right side, absent on the left. These differences in pleopod 5 endopod condition and subtle proportional differences in the scaphocerite might reflect significant population differences, but all are presently considered to represent a single species, *A. jarmani*, pending further study.

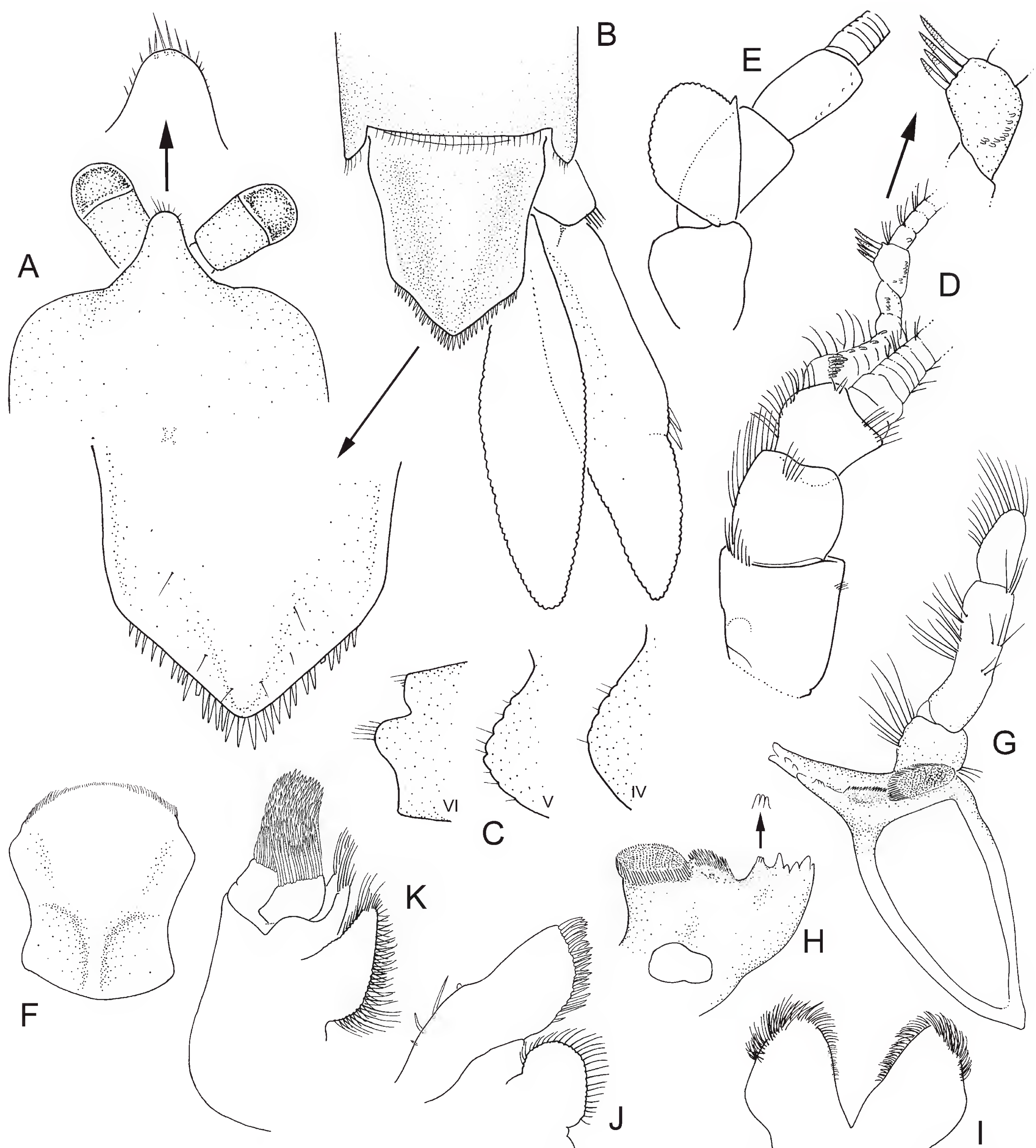

Figure 14. *Anaspides jarmani* Ahyong, 2015, holotype male, 24 mm, Adamsons Peak, AM P73039. (*A)* cephalothorax, dorsal view; *(B)* pleonite 6, telson and right uropod; *(C)* pleonites 4–6 pleura, right lateral view; *(D)* right antennule; *(E)* right antenna; *(F)* labrum, anterior view; *(G)* right mandible; *(H)* right mandible incisor process; *(I)* paragnaths, anterior view; *(J)* right maxillule; *(K)* right maxilla. Scale: A–E = 1.0 mm; F–K = 0.7 mm.

Although normally epigean, *Anaspides jarmani* has entered caves throughout its range: Hastings (Newdegate Cave), Ida Bay (Mystery Creek Cave), Cracroft (Judds Cavern), Vanishing Falls Karst (Salisbury River Cave) and Precipitous Bluff (Bauhaus Cave, Persephone) (Fig. 17). Specimens from Newdegate Cave (Fig. 17E) agree well with epigean forms, including pigmented eyes, differing only in body depigmentation and longer antennular flagella; they are readily distinguished from *A. clarkei* by the much better developed cornea, telson spination and presence of the pleopod 5 endopod. Distinct corneal reduction is evident in unpigmented specimens from Judds Cavern and some specimens from Salisbury River Cave (Fig. 17A,B) as in cave forms of *A. richardsoni* from the Honeycomb and Wet Caves, Mole Creek. In addition to the cave-adapted form in Salisbury River Cave (Fig. 17B), pigmented epigean forms (Fig. 17C) are also present, the former from streamways and the latter from seeps (Eberhard *et al*., 1991, 1992). Specimens

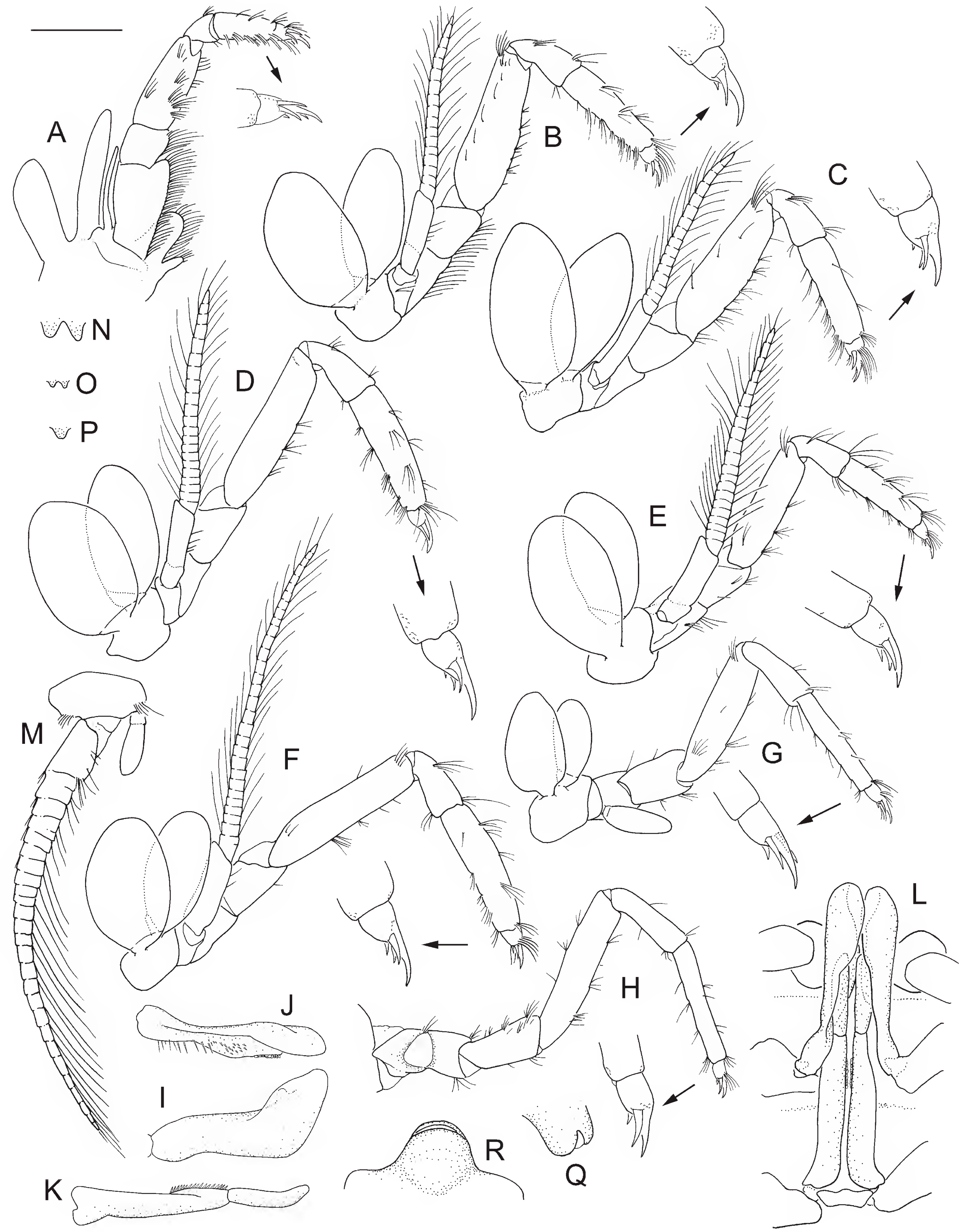

Figure 15. *Anaspides jarmani* Ahyong, 2015. *(A–P)* holotype male, 24 mm, Adamsons Peak, AM P73039; *(Q–R)* paratype female 27 mm, Adamson's Peak, AM P73040; *(A)* right thoracopod 1 (maxilliped); *(B–H)* right thoracopods 2–8; *(I–J)* right pleopod 1 endopod, lateral and ventral views; *(K)* right pleopod 2 endopod, lateral view; *(L)* pleopods 1–2, in-situ, ventral view; *(M)* right pleopod 3, anterior view; *(N–P)* pleonites 3–5 median sternal processes; *(Q–R)* female gonopore, right lateral and ventral views. Scale = 1.0 mm.

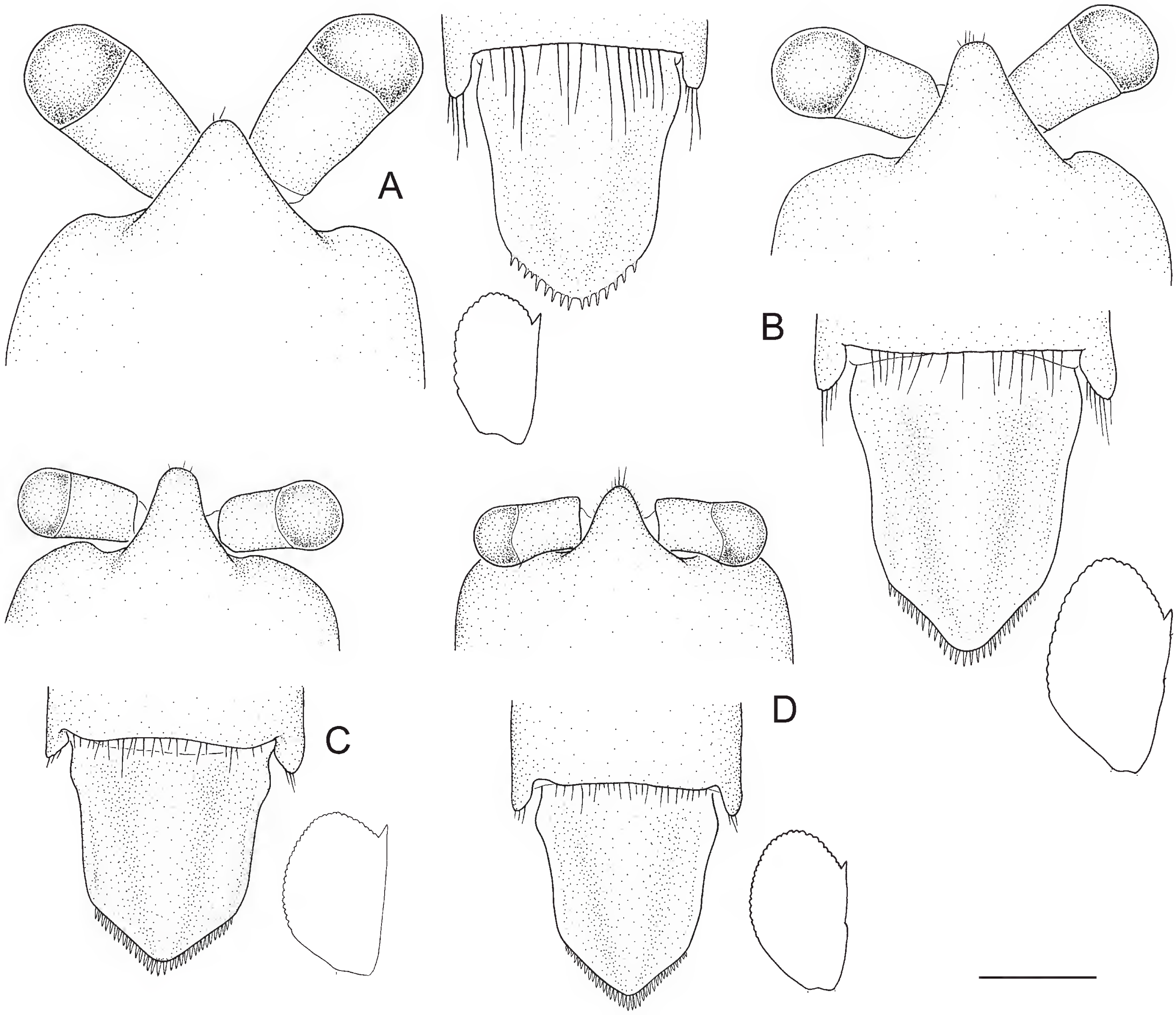

Figure 16. *Anaspides jarmani* Ahyong, 2015, anterior cephalothorax, telson and scaphocerite. *(A)* paratype juv. female, 8 mm, Adamsons Peak, AM P73043; *(B)* paratype juv. male, 18 mm, Adamsons Peak, AM P73043; *(C)* female, 25 mm, Ooze Lake, TMAG G6366; *(D)* male, 23 mm, Ladies Tarn, Hartz Mountains, AM P73041. Scale: A = 0.25 mm; B = 0.5 mm; C–D = 1.0 mm.

from Precipitous Bluff (Fig. 17D) are unusual, with the seemingly mature male from Bauhaus Cave having two antennular clasping spines, but a typical pleopod 1 endopod; they may represent a separate species but tentatively assigned to *A. jarmani* pending further study. As in epigean specimens from Ooze Lake (Fig. 16C) and the Hartz Mountains (Fig. 16D), cave specimens from Cracroft, Salisbury and Precipitous Bluff lack the endopod on pleopod 5, whereas the endopod is present in the Newdegate Cave specimen as in the adjacent epigean specimens from Adamsons Peak. Specimens of *A. jarmani* from Mystery Creek Cave, Ida Bay, are juveniles and apart from depigmentation and an incomplete complement of pleopod endopods, agree well with surface forms.

Distribution. Southern Tasmania in epigean habitats from the Hartz Mountains to Adamson's Peak and Ooze Lake, and from caves in the Hastings, Ida Bay, Cracroft, Salisbury karst systems and Precipitous Bluff; 160–380 m asl (subterranean), 900–1340 m asl (epigean).

Anaspides richardsoni sp. nov.

Figs 18–23, 35D–F, 36

Anaspides tasmaniae. —Calman, 1897: 802 ["Lake Field" (= Mt Field) specimens only (OM Iv.1394, below)]. —Smith, 1909a: 64, 70 (Mt Read, Mt Field). —Williams, 1965b: 333–334, fig. 1, 2; 1965a: 106, tab. 6. —Swain & Reid, 1983: 163–171. —Richardson & Swain, 1989: 277, tab. 1, app. 1. —Jarman & Elliot, 2000: fig. 4 (clade E, part), tab. 1 (part, Central Plateau). —Gooderham & Tsyrlin, 2002: 73 (unnumbered colour figure). —Richter *et al*., 2002: 341, 347, fig. 31–33.

Anaspides spinulae. —O'Brien, 1990: frontispiece, pl. 1.

Anaspides sp. (telson 'normal' type). —Eberhard *et al*., 1991: 48 (Mole Creek caves).

Type material. (Mt Field). HOLOTYPE: AM P72839,♂ (33 mm), between Newdegate Pass and Mawson Plateau, coll. J. Kunze, 27 Feb 1974. PARATYPES: AM P72840, 1♀ (TL 32 mm), between Newdegate Pass and Mawson Plateau, 42°40.2'S 146°33.6'E, coll. J. Kunze, 27 Feb 1974; AM P72841, 4♂♂ (23–27 mm), 5 juv. ♂♂ (17–21 mm), 4♀♀ (24–31 mm), 5 juv. ♀♀ (14–20 mm), between Newdegate Pass and Mawson Plateau, 42°40.2'S 146°33.6'E, coll. J. Kunze, 27 Feb 1974; ZRC 2016.0491, 1♂ (30 mm), 1♀ (31 mm), between Newdegate Pass and Mawson Plateau, 42°40.2'S

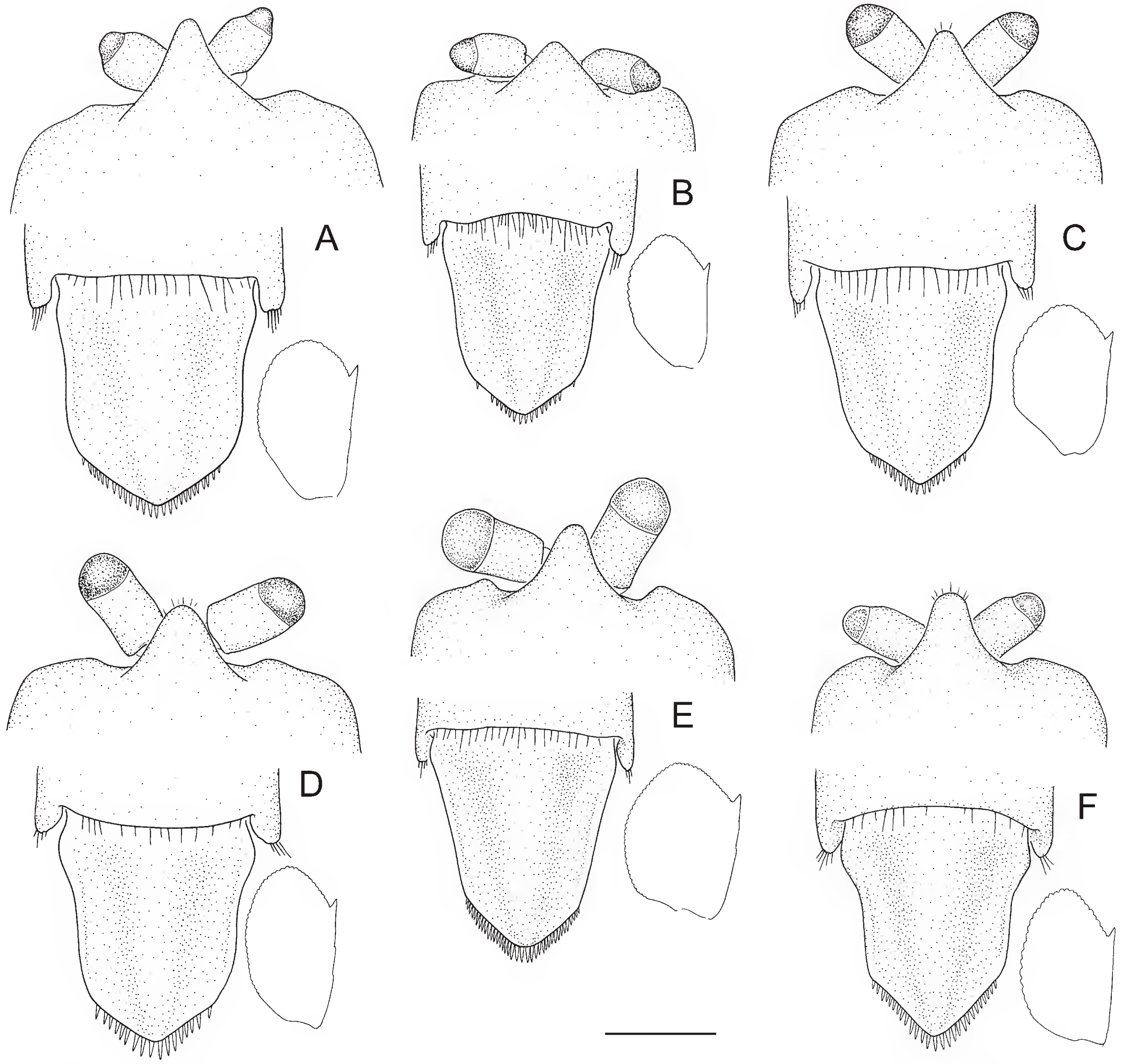

Figure 17. *Anaspides jarmani* Ahyong, 2015, anterior cephalothorax, telson and scaphocerite. (*A)* male, 28 mm, Judds Cavern, QVM 10:12326; *(B)* female, c. 24 mm, Salisbury River Cave, QVM 10:13014; *(C)* male, 26 mm, Salisbury River Cave, QVM 10:13005; *(D)* female, 27 mm, Bauhaus Cave, Precipitous Bluff, QVM 10:13279; *(E)* female, 21 mm, Hell's Half Acre, Newdegate Cave, TMAG G6493; *(F)* male, 23 mm, Mystery Creek Cave, USNM 1277680. Scale = 1.0 mm.

146°33.6'E, coll. J. Kunze, 27 Feb 1974; TMAG G6174, 1♂ (27 mm), 2 juv. ♂♂ (14–16 mm), 1♀ (34 mm), Mt Field, small tarn above University ski lodge, 42°40.134'S 146°34.152'E, tarn in herbfield with dolerite rocky outcrops, dipnet, 1240 m asl, coll. R. Mollison, 27 Apr 2011; TMAG G6363, 1♀ (45 mm), midway between Newdegate Pass and Newdegate Tarn, 42°39.6'S 146°33.6'E, in small tarn, 1200 m asl, coll. I. Wilson & J. Ong, 25 Jan 1970; TMAG G6419, 2♂♂ (25–27 mm), 21 juv. ♂♂ (11–21 mm), 1♀ (22 mm), 37 juv. ♀♀ (11–21 mm), Newdegate Pass, 42°39.6'S 146°33.0'E, sample 2, coll. I. Wilson & J. Ong, 25 Jan 1970; TMAG G6445, 5♂♂ (20–21 mm), 6 juv. ♂♂ (13–19 mm), 2♀♀ (24–29 mm), 5 juv. ♀♀ (13–15 mm), Newdegate Pass, 42°39.6'S 146°33.0'E, sample 1, coll. I. Wilson & J. Ong, 25 Jan 1970; TMAG G6429, 11 ♂♂ (22–32 mm), 3 juv. ♂♂ (18–21 mm), 25♀♀ (22–34 mm), 5 juv. ♀♀ (14–21 mm), near Sitzmark Lodge, Mt Field, 42°40.8'S 146°34.8'E, tarn, coll. C. Reid, 15–18 Oct 1974; USNM 1277685, 1♂ (26 mm), 1 juv. ♂ (17 mm), 3♀♀ (25–30 mm), near Sitzmark Lodge, Mt Field, 42°40.8'S 146°34.8'E, tarn, coll. C. Reid, 15–18 Oct 1974.

Other material examined. *Gunns Plain to Black Bluff*: AM P99296, 1 juv. ♂ (12 mm), Great Western Cave (GP27), Gunns Plains karst area, NW Tasmania, 41°17.8'S 146°00.3'E, from riffle pool 250 m upstream, 1296-24, 109 m asl, coll. A. Clarke, 29 Dec 1996; QVM 10:13975, 1♀ (23 mm), Paddy's Lake, below Black Bluff, near Loongana, Nietta South, 41°27.2'S 145°57.6'E, 1070 m asl, coll. T. Hume, 5 May 1972; TMAG G6398, 14♂♂ (20–24 mm), 1 juv. ♂ (16 mm), 32♀♀ (19–30 mm), 3 juv. ♀♀ (16–17 mm), Paddy's Lake, Black Bluff, 41°27.2'S 145°57.6'E, 1070 m asl, coll. C. Binks, 25 Apr 1979; TMAG G6169, 1 juv. ♂ (13 mm), 6 juv. ♀♀ (10–17 mm), Vale of Belvoir, 41°32.95'S 145°53.54'E, coll. R. Mollison, 16 Mar 2010.

Deloraine: TMAG 14391/G135, 2♂♂ (22–24 mm), Deloraine, coll. C. King, Nov 1937.

Mole Creek (Form 1): SAMA C8481, 2 immature ♂♂ (16–21 mm), 2♀♀ (30–39 mm), 1 indet juv. (9 mm), about 200 m from cave entrance, Marakoopa Cave, 41°34.9'S 146°17.3'E, 490 m asl, small stream, BS0464, coll. E. Hamilton Smith, 19 Nov 1963; USNM 1277682, 3♂♂ (29–34 mm), 3 juv. ♂♂ (12–16 mm), 3♀♀ (21–30 mm), 2 juv. ♀♀ (16–17 mm), Marakoopa Cave, 0.3 m, stn 87-253, coll. T. Iliffe, 27 Dec 1987; TMAG G646, 1♂ (34 mm), 1♀ (45 mm), Long Creek, Marakoopa Cave (MC120), 4 Dec 1991; QVM 10:13973, 1♀ (33 mm), Marakoopa Cave II (MC-015), 41°34.9'S 146°17.3'E, coll. K. Crocker, 1 Jul 1981; TMAG G6458, 2♂♂ (31–32 mm), 2♀♀ (32–33 mm), Lake Passage, Marakoopa Cave II (MC15-1), 41°34.9'S 146°17.3'E, 490 m asl, coll. A. Goede, 21 Aug 1982; TMAG G6459, 2♂♂ (26–28 mm), 3♀♀ (21–32 mm), Lake Passage, Marakoopa Cave II (MC15-1), 41°34.9'S 146°17.3'E, 490 m asl, coll. A. Goede, 21 Aug 1982; TMAG G6462, 2♀♀ (36–41 mm), Prohibition Cave, 41°35.6'S 146°19.5'E, coll. R. Eberhard, 19 Apr 1991.

Mole Creek (Form 2): AM P73038, 1♂ (37 mm), Honeycomb Cave (MC107), lower pool, dark zone, 41°36.0'S 146°24.4'E, 1096.03, coll. S. Bunton, 27 Oct 1996; ZSRO 863a, 1♀ (44 mm), Honeycomb Cave, KS34, Ana16 A011, 27 Feb 2013; ZSRO 863b, 1♀ (46 mm), Honeycomb Cave, KS34, Ana17 A011, 27 Feb 2013; USNM 1277681, 1♂ (33 mm), 1 juv. ♂ (22 mm), 7♀♀ (32–55 mm), Honeycomb Cave, 0–0.5 m,

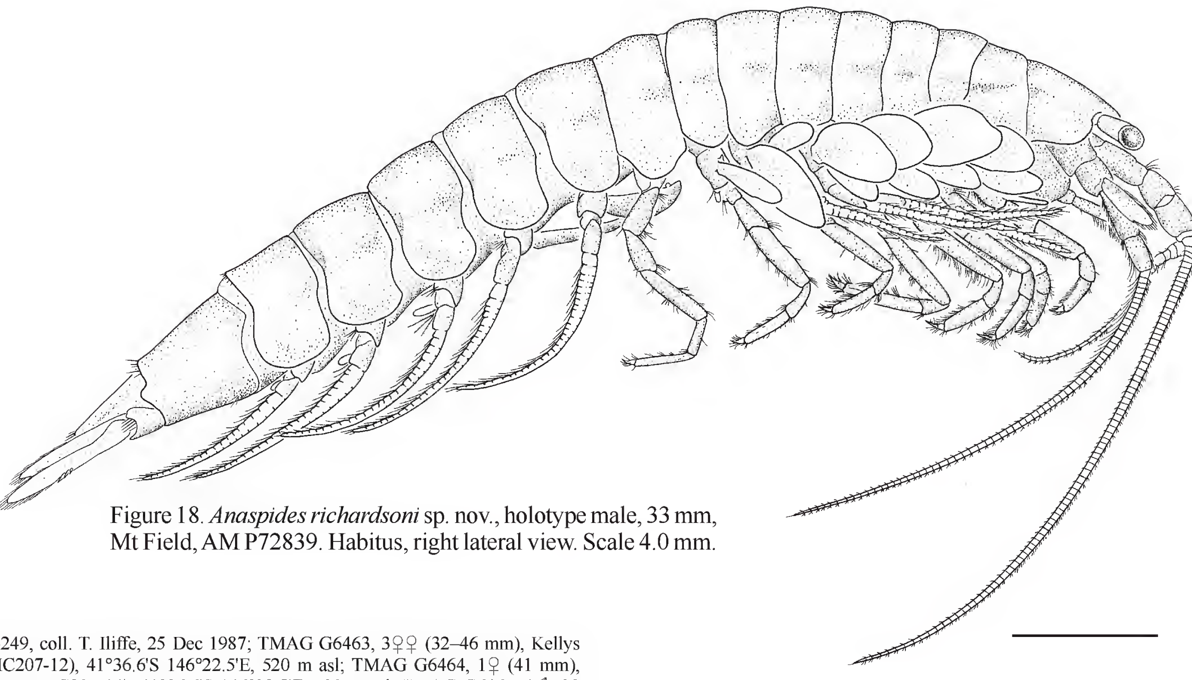

Figure 18. *Anaspides richardsoni* sp. nov., holotype male, 33 mm, Mt Field, AM P72839. Habitus, right lateral view. Scale 4.0 mm.

stn 87-249, coll. T. Iliffe, 25 Dec 1987; TMAG G6463, 3♀♀ (32–46 mm), Kellys Pot (MC207-12), 41°36.6'S 146°22.5'E, 520 m asl; TMAG G6464, 1♀ (41 mm), Kellys Pot (MC207-14), 41°36.6'S 146°22.5'E, 520 m asl; TMAG G6465, 1♂ (29 mm), 2♀♀ (30–37 mm), Kellys Pot (MC207-13), 41°36.6'S 146°22.5'E, 520 m asl; TMAG G6460, 1♀ (37 mm), Mole Creek caves, in water pool, coll. R.A. Rafferty, 28 Apr 1938; TMAG G6457, 1♂ (36 mm), 2♀♀ (37–46 mm), Herbert's Pot (MC202), 41°36.9'S 146°23.3'E, 500 m asl, CV40, coll. S. Eberhard, 6 Apr 1985; AM P56373, 1♂ (TL 35 mm), 1♀ (TL 35 mm), Wet Cave near Caveside, 41°36'S 146°25'E, C.92T, moderate flowing stream, disappears before cave entrance, cave with few pools, coll. W. Ponder *et al*., 18 Jan 1982.

Mole Creek (Form 3): SAMA C8482, 1♀ (24 mm), 2 juv. (7–9 mm), unnamed cave, Sassafras Creek, about 50 m from entrance, 41°33.7'S 146°21.9'E, 270 m asl, clear pool, mud bottom, BS0457, 18 Nov 1963; TMAG G6454, 3♂♂ (23–32) mm), 1♀ (23 mm), 5 juv. ♀♀ (13–20 mm), Kubla Khan Cave, 41°33.2'S 146°17.6'E, coll. S. Eberhard, R. Swain & A. Richardson, 23 Sep 1981; TMAG G6455, 1♂ (26 mm), 1 juv. ♂ (20 mm), 2♀♀ (26–28 mm), 3 juv. ♀♀ (10–21 mm), Kubla Khan Cave, 41°33.2'S 146°17.6'E, coll. S. Eberhard, A. Richardson & R. Swain, 25 May 1986; TMAG G6456, 1♂ (29 mm), 2♀♀ (23–39 mm), Kubla Khan Cave, 41°33.2'S 146°17.6'E, in river, c. 500 m into cave, 320 m asl, coll. S. Eberhard, 12 Nov 1983; TMAG G6466, 3♂♂ (25–30 mm), 3♀♀ (23–28 mm), Kubla Khan Cave (MC1-30), 41°33.2'S 146°17.6'E; USNM 1277679, 1♂ (25 mm), Kubla Khan Cave, 0–0.5 m, stn 87-250, coll. T. Iliffe, 26 Dec 1987; USNM 1277683, 3♂♂ (23–26 mm), 5♀♀ (28–40 mm), Mayberry area, Mole Creek, water cave, from sinkhole near farmhouse, baited traps, 0.2m, stn 87-251, coll. T. Iliffe, 27 Dec 1987.

West Coast Range: TMAG G6411, 1♂ (26 mm), 3 juv. ♂♂ (16–20 mm), 2 juv. ♀♀ (20–21 mm), tarn II, S of Lake Tyndall, 41°57.1'S 145°35.2'E, 980 m asl, coll. C.J. Binks & B. Knott, 16 Jan 1973; TMAG G6312, 8♂♂ (23–25 mm), 3 juv. ♂♂ (16–21 mm), 8♀♀ (23–30 mm), 3 juv. ♀♀ (15–18 mm), tarn S of Lake Tyndall, 41°57.1'S 145°35.2, 980 m asl, coll. C.J. Binks & B. Knott, 16 Jan 1973; TMAG G6362, 1 juv. ♂ (18 mm), 2 juv. ♀♀ (16–17 mm), Lake Sandra, Mt Murchison, 41°49.9'S 145°35.8'E, 940 m asl, 10 Dec 1973; TMAG G6385, 1♀ (damaged, c. 26 mm), Lake Sandra, Mt Murchison, 41°49.9'S 145°35.8'E, 940 m asl, coll. W. Fulton, Nov 1983; TMAG G6392, 1♀ (27 mm), N of Geikie, Tyndall Range, alpine plateau above climbing route and camp, 41°57.4'S 145°35.0'E, 1000 m asl, coll. C.J. Binks & B. Knott, 16 Jan 1973.

Cradle Mountain Lake St Clair National Park: TMAG G6352, 1♂ (21 mm), 1♀ (23 mm), Twisted Lake, Cradle Mountain, 41°40.22'S 145°58.09'E, 1116 m asl, coll. D. O'Brien, 8 Mar 1990; SAMA C6303, 1 juv. ♂ (18 mm), top of Cradle Mountain, 41°40.8'S 145°57.0'E, small pool in creek, 4850 ft asl [1455 m], coll. A. Kowanko, Dec 1967; SAM C6304, 2♀♀ (21–32 mm), top of Cradle Mountain, 41°40.8'S 145°57.0'E, small pool in creek, 4850 ft asl [1455 m], coll. A. Kowanko, Dec 1967; QVM 10:13835, 1♂ (20 mm), Sutton's Tarn, Cradle Mountain, 41°41.01'S 145°55.98'E, 1089 m asl, coll. Kingston, 1991; TMAG G6350, 1♂ (26 mm), 1♀ (24 mm), Sutton's Tarn, near Kitchen Hut, Cradle Mountain, 41°41.0'S 145°56.0'E, 1089 m asl, coll. D. O'Brien, 8 Mar 1990; TMAG G6351, 2♀♀ (30–31 mm), Sutton's Tarn, near Kitchen Hut, Cradle Mountain, 41°41.0'S 145°56.0'E, 1089 m asl, coll. D. O'Brien, 8 Mar 1990; TMAG G6381, 2♂♂ (27–31 mm), 12♀♀ (21–32 mm), Mt Doris, tarn on S side, 41°52.6'S 146°02.7'E, 1170 m asl, coll. B. Knott, 12 May 1970; AM P72843, 1 juv. ♂ (21 mm), 1♀ (23 mm), Mt Ossa–Mt Doris Ridge, Mt Ossa, 41°52.2'S 146°04.8'E, 1255 m asl, coll. C. Sands; AM P82858, 2♂♂ (23–24 mm), 4 juv. ♀♀ (14–21 mm), 8♀♀ (23–30 mm), 5 juv. ♀♀ (13–18 mm), S of Mt Doris, runnel crossing Mt Ossa track, 41°52.2'S 146°01.8'E, deep runnel in grassy lawn in alpine shrubbery, FW18, coll. A. Richardson & P.A. Serov, 28 Jan 1990; TMAG G6413, 6♂♂ (24–29 mm), 6♀♀ (26–34 mm), 1 juv. ♀ (16 mm), near summit of Cathedral (NE of summit), 41°53.4'S 146°07.2'E, c. 1350 m asl, tarn, small, clear & with rocky bottom, sample 6, coll. C.J. Binks & B. Knott, 31 Jan 1972; WAM C11772, 1♂ (21 mm), 3♀♀ (21–23 mm), Cradle Mountain district, coll. A. Connell, 1939; WAM C58160, 1 juv. ♂ (16 mm), 4♀♀ (25–39 mm), Cradle Mountain-Lake St Clair, National Park, 16 Oct 1947.

Walls of Jerusalem National Park (non-"spinulae" form): TMAG G6448, 28 juv. ♂♂ (13–18 mm), 49 juv. ♀♀ (12–19 mm), 1 indet juv. (5 mm), Jaffa Vale, at Dixon's Hut, Walls of Jerusalem, 41°40.77'S 146°06.37'E, 1250 m asl, coll. ?R. Swain, 1969; TMAG G6449, 2♂♂ (25–28 mm), 2 juv. ♂♂ (18–19 mm), 4 juv. ♀♀ (15–17 mm), Jaffa Vale, at Dixon's Hut, Walls of Jerusalem, 41°40.77'S 146°06.37'E, 1250 m asl, coll. ?R. Swain, 1969; TMAG G6319, 2♂♂ (23–29 mm), 1♀ (20 mm), 1 juv. ♀ (13 mm), pool 50 m W of Herod's Gate Pool, 41°48.7'S 146°16.8'E, 1220 m asl, coll. S. Smith, 16 Apr 1990; TMAG G6380, 6 juv. ♂♂ (13–16 mm), 8 juv. ♀♀ (12–19 mm), Lake Adelaide track between Fish Rock and Herod's Gate, Walls of Jerusalem, 41°48.7'S 146°16.8'E, runnel, 1200 m asl, coll. B. Knott, 18 Nov 1971; TMAG G6368, 5♂♂ (24–26 mm), 10 juv. ♂♂ (14–21 mm), 8♀♀ (25–35 mm), 9 juv. ♀♀ (11–20 mm), near Herod's Gate, Walls of Jerusalem, 41°48.7'S 146°17.4'E, small creek, 1200 m asl, coll. B. Knott, 17 Nov 1971; TMAG G6446, 2♂♂ (25–27 mm), 1 juv. ♂ (17 mm), 2♀♀ (26–30 mm), 10 juv. ♀♀ (14–18 mm), Zion Gate west, Walls of Jerusalem, 41°48.9'S 146°19.6'E, 1280 m asl, coll. ?R. Swain, 1969; TMAG G6393, 1♂ (24 mm), 10 juv. ♂♂ (11–18 mm), 2♀♀ (24–33 mm), 13 juv. ♀♀ (15–18 mm), Saddle through to east wall, Walls of Jerusalem, 41°48.9'S 146°19.2'E, 1230 m asl, coll. J. Bludhorn, 18 Nov 1971; TMAG G6418, 4♂♂ (29–32 mm), 4 juv. ♂♂ (16–23 mm), 2♀♀ (26–29 mm), 2 juv. ♀♀ (13–18 mm), E side of Zion Gate, Walls of Jerusalem, 41°49.0'S 146°19.6'E, 1240 m asl, coll. ?R. Swain, 1969; TMAG G6345, 3♂♂ (21–22 mm), 1♀ (25 mm), 20 m below Gate of Chain, Walls of Jerusalem, 41°49.12'S 146°18.39'E, pool in pencil pines, 1300 m asl, coll. S. Smith, 16 Apr 1990; TMAG G6346, 1♂ (21 mm), 3♀♀ (20–22 mm), 1 juv. ♀ (14 mm), Gate of Chain, 50 m below ridge, Walls of Jerusalem, 41°49.13'S 146°18.53'E, 1280 m asl, coll. S. Smith, 16 Apr 1990; TMAG G6318, 2♂♂ (24–27 mm), 1 juv. ♂ (13 mm), 2♀♀ (26–30 mm), 100 m E of ridge, Gate of Chains, Walls of Jerusalem, 41°49.13'S 146°18.60'E, 1260 m asl, coll. S. Smith, 16 Apr 1990; TMAG G6440, 1♂ (23 mm), 1 juv. ♂ (16 mm), 1♀ (23 mm), 6 juv. ♀♀ (12–16 mm), near Lake Ball, Walls of Jerusalem, 41°49.23'S 146°17.95'E, 1240 m asl, coll. V. Thorp, 3 Apr 1972; TMAG G6320,♂ (26 mm), 1 juv. ♂ (15 mm), 2♀♀ (25–29 mm), 1 juv. ♀ (16 mm), 200 m below Pool of Bethesda, Walls of Jerusalem, 41°49.34'S 146°17.81'E, runnel, #1, 1260 m asl, coll. S. Smith, 14 Apr 1990; TMAG G6348, 6♂♂ (25–32 mm), 1♀ (32 mm), 50 m SE of Damascus Gate, 41°49.61'S 146°17.59'E, pool in grassland, coll. R. Smith, 1350 m asl, 15 Apr 1990; TMAG G6376, 3 juv. ♂♂ (15–16 mm), 11 juv. ♀♀ (12–17 mm), Damascus Gate, 41°49.61'S 146°17.95'E, coll. R. Swain, 1969; TMAG G6422, 1♂ (29 mm), 1 juv. ♂ (18 mm), 2♀♀ (26–28 mm), 6 juv. ♀♀ (12–15 mm), Damascus Gate, Walls of Jerusalem, runnel draining into Lake Calvine, 41°49.99'S 146°18.16'E, 1340 m asl, coll. ?R. Swain, 1969; TMAG G6394, 9 juv. ♂♂ (15–20 mm), 1♀ (24 mm), 8 juv. ♀♀ (13–18 mm), near Junction Lake immediately under Moraine retaining Lake Meston, Walls of Jerusalem, 41°55.35'S 146°11.52'E, bog drainage pool (chiefly *Gleichenia*), "sample 2", 950 m asl, coll. C. Binks & B. Knott, 31 Jan 1972; TMAG G6397, 7 juv. ♂♂ (10–22 mm), 1♀ (29 mm), 5 juv. ♀♀ (17–21 mm), creek draining into Junction Lake, second of four or five drainage systems on broad plain from Lake Meston, Walls of Jerusalem, 41°55.35'S 146°11.52'E, clear pools under *Nothofagus* lined creek, "sample 3", 950 m asl, coll. C. Binks & B. Knott, 31 Jan 1972.

Walls of Jerusalem National Park (mixed "spinulae" and non-"spinulae" forms): TMAG G6396, 4♂♂ (21–22 mm), 6 juv. ♂♂ (15–18 mm), 1♀ (24 mm), 2 juv. ♀♀ (17–20 mm), Zion Vale, Walls of Jerusalem, 41°48.64'S 146°18.83'E, pool, 1200 m asl, coll. R. Swain, 1969; TMAG G6379, 1♂ (25 mm), 2 juv. ♂♂ (18–22 mm), 2♀♀ (24–25 mm), Maximal Creek, W of Herod's Gate, Walls of Jerusalem, 41°48.62'S 146°15.94'E, 1150 m asl, coll. B. Knott, 16 Nov 1971.

Walls of Jerusalem National Park ("spinulae" form): WAM C11771, 4 juv. ♂♂ (shrivelled, c. 13–16 mm), 1♀ (shrivelled, c. 19 mm), Jones Tarn, at foot of Western Wall, Walls of Jerusalem, 41°49.02'S 146°18.46'E, approx. 4200 feet [1260 m], 26

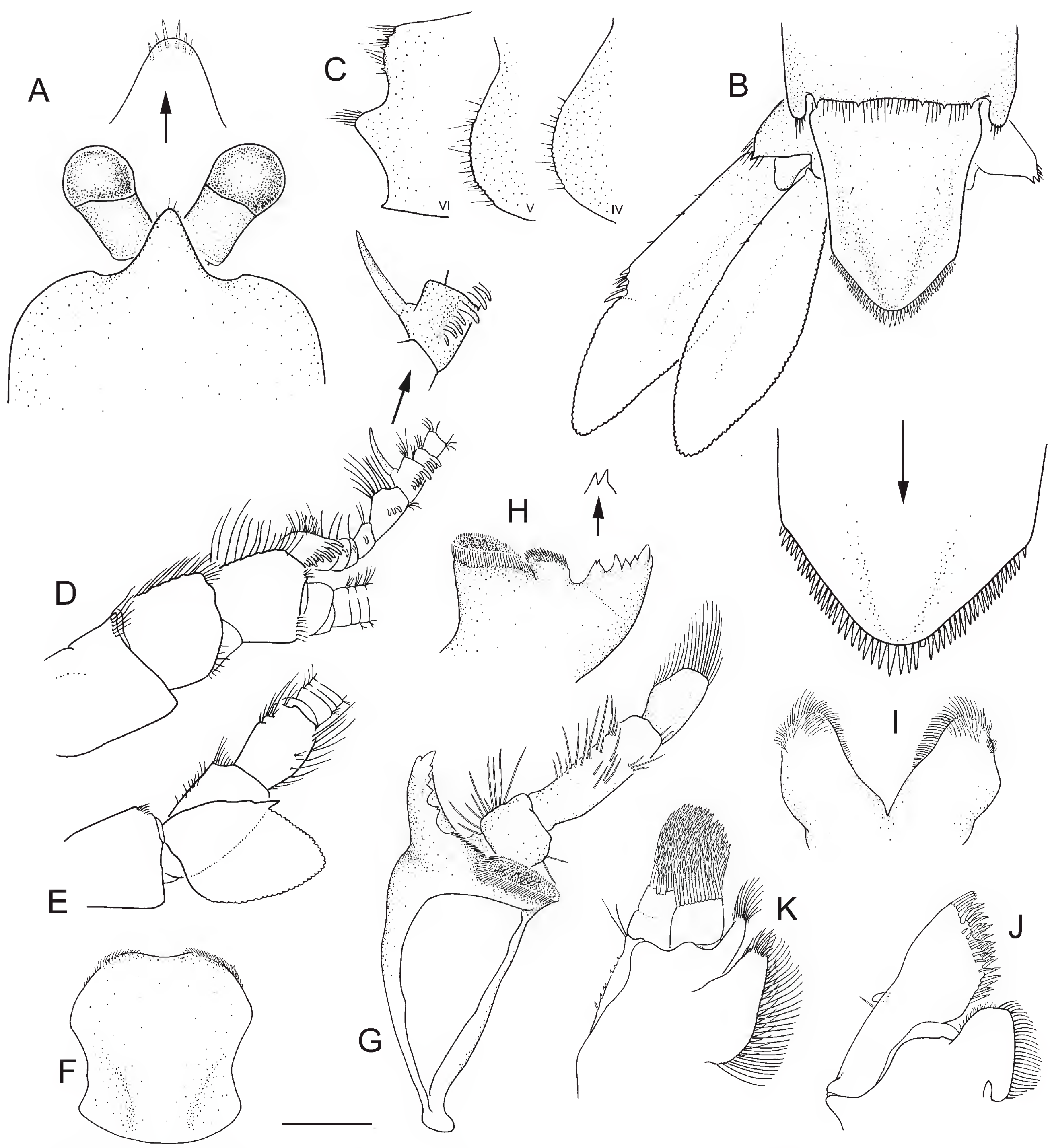

Figure 19. *Anaspides richardsoni* sp. nov., holotype male, 33 mm, Mt Field, AM P72839. (*A*) cephalothorax, dorsal view; *(B)* pleonite 6, telson and left uropod; *(C)* pleonites 4–6 pleura, right lateral view; *(D)* right antennule; *(E)* left antenna; *(F)* labrum, anterior view; *(G)* right mandible; *(H)* right mandible incisor process; *(I)* paragnaths, anterior view; *(J)* right maxillule; *(K)* right maxilla. Scale: A–E = 1.0 mm; F–K = 0.7 mm.

Apr 1935; TMAG G6347, 4 juv. ♂♂ (9–12 mm), 7 juv. ♀♀ (11–15 mm), 100 m E of ridge, Gate of Chain, Walls of Jerusalem, 41°49.13'S 146°18.53'E, 16 Apr 1990; TMAG G6391, 9 juv. ♂♂ (14–18 mm), 1♀ (27 mm), 11 juv. ♀♀ (13–17 mm), SE end Cloister Lagoon, 41°54.26'S 146°10.66'E, from small drainage pools in predominantly *Gleichenia* covered bog, sample 4, 1100 m asl, coll. C.J. Binks & B. Knott, 31 Jan 1972; TMAG G6434, 7♂♂ (23–30 mm, 5♀♀ (24–31 mm), Pool of Bethesda, Walls of Jerusalem, 41°49.28'S 146°17.95'E, 1270 m asl, coll. R. Swain, 1969; TMAG G6349, 2♂♂ (21–23 mm), 1 juv. ♂ (15 mm), 3♀♀ (26–27 mm), E edge Pool of Bethesda, 41°49.28'S 146°17.88'E, 1270 m asl, coll. S. Smith, 16 Apr 1990; TMAG G6427, 1♂ (24 mm), 19 juv. ♂♂ (12–18 mm), 11 juv. ♀♀ (12–20 mm), 6 indet juv. (6–7 mm), 41°53.01'S 146°09.23'E, from dirty, deep pool system draining through pineapple grass into Lake Chalice, 1020 m asl, "sample 5", coll. C. Binks & B. Knott, 31 Jan 1972; TMAG G6330, 3♂♂ (22–23 mm), 1♀ (24 mm), [no label] Lake Chalice, 41°52.84'S 146°08.87'E, coll. W. Fulton, 2 Feb 1988.

Western Lakes—Great Western Tiers: AM P57906, 1♀ (21 mm), Western Bluff, 41°37'S 146°17'E, 26 Jan 1964; QVM 10:13977, 1♀ (36 mm), 1 juv. ♀ (18 mm), Jacks Lagoon, 5 km SW of Lake Mackenzie, 41°42.1'S 146°20.6'E, "abundant", "no fish", 1260 m asl, coll. E.V. Terry, 7 Apr 1989; WAM C58161, 3♂♂ (26–29 mm), 2♀♀ (25–26 mm), Ironstone Mountain, Northwestern Tiers, 41°42.8'S 146°28.5'E, from temporary creek, 100 m asl, coll. I. Gooch, 1946; QVM 10:13978, 1♂ (23 mm), 2♀♀ (23–31 mm), Meander Falls, 41°44.1'S 146°30.3'E, coll. S. Merry, 1957; QVM 10:49162 ("spinulae" form), 1♂ (23 mm), 5♀♀ (23–28 mm), Lake Johnny, 41°43.6'S 146°25.2'E, 1210 m asl, coll. W. Fulton, 9 Dec 1987; QVM 10:49163 ("spinulae" form), 2♂♂ (18–20 mm), 5♀♀ (23–26 mm), Lake Halkyard, 41°44.2'S 146°18.9'E, 1210 m asl, coll. W. Fulton, 9 Dec 1987; QVM 10:49164 ("spinulae" form), 2♂♂ (22–23 mm), 5♀♀ (20–30 mm), Lake Fox, 41°43.9'S 146°24.8'E, 1230 m asl, coll. W. Fulton, 9 Dec 1987; QVM 10:49165, 3♂♂ (28–31 mm), 8♀♀ (24–29 mm), 3 juv. ♂♂ (20–21 mm), 15 juv. ♀♀ (11–19 mm), 300 m W of Lake Fox, 41°43.9'S 146°24.00'E, pool, 1210 m asl, coll. W.

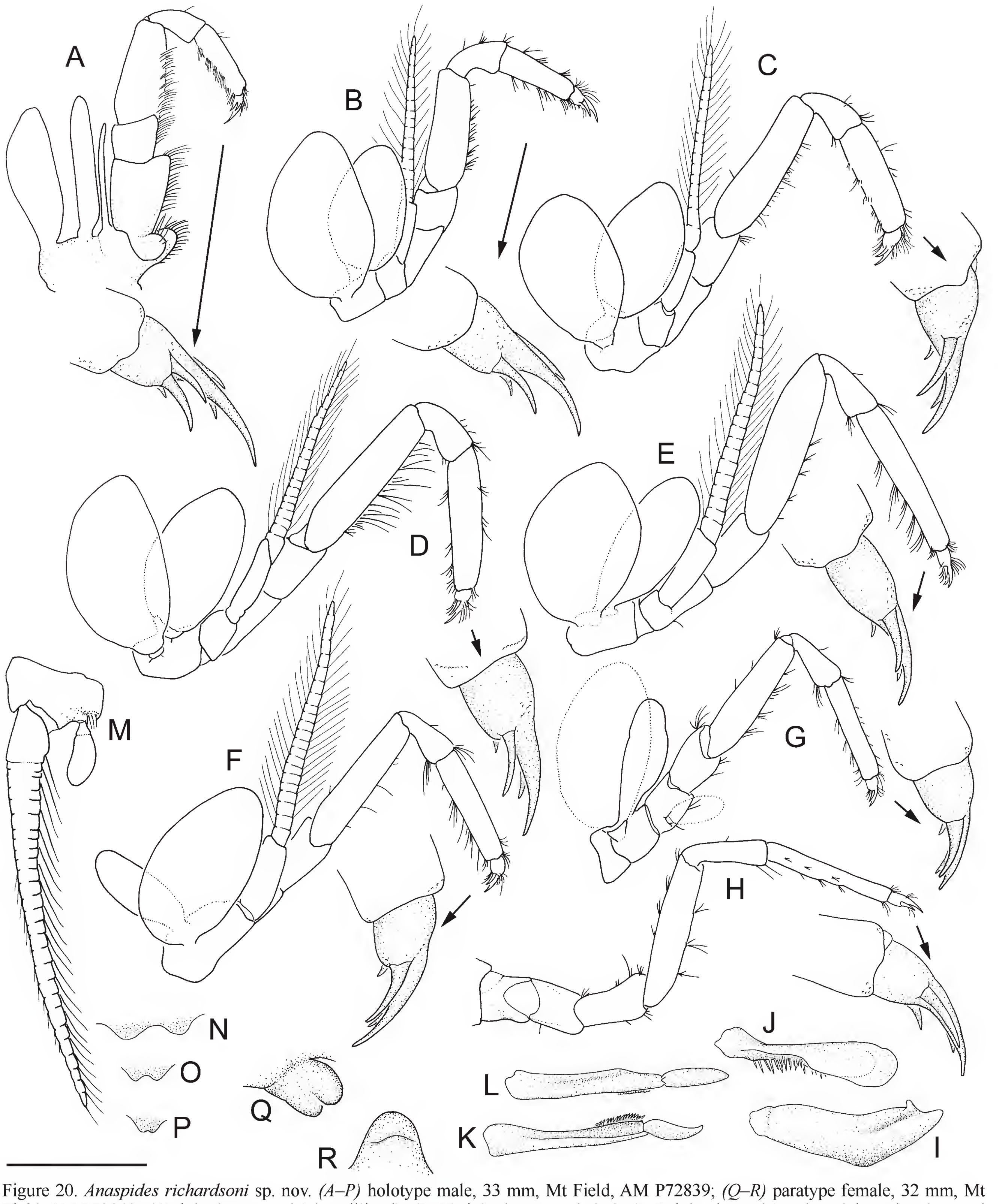

Figure 20. *Anaspides richardsoni* sp. nov. *(A–P)* holotype male, 33 mm, Mt Field, AM P72839; *(Q–R)* paratype female, 32 mm, Mt Field, AM P72840; *(A)* right thoracopod 1 (maxilliped); *(B–H)* right thoracopods 2–8; *(I–J)* right pleopod 1 endopod, lateral and ventral views; *(K–L)* right pleopod 2 endopod, lateral and ventral views; *(M)* right pleopod 5, anterior view; *(N–P)* pleonites 3–5 median sternal processes; *(Q–R)* female gonopore, right lateral and ventral views. Scale A–M = 2.0 mm; N–R = 1.0 mm.

Fulton, 9 Nov 1987; QVM 10:13980, 2 juv. ♂♂ (17–18 mm), 1 juv. ♀ (19 mm), stream on top of Western Tier near Lake Lucy Long, 41°42.2'S 146°26.0'E, 1190 m asl, coll. J. Simmons, 3 Mar 1963; TMAG G6438, 3♂♂ (25–29 mm), 4 juv. ♂♂ (17–22 mm), 1♀ (28 mm), 7 juv. ♀♀ (14–21 mm), edge of Great Western Tiers near Pine Lake, 41°44.7'S 146°43.0'E, runnel draining opposite way, 1220 m asl, coll. B. Knott, 1970; WAM C58166, 1♀ (31 mm), creek north of Pine Lake, coll. G.E. Nicholls, 27 Jan 1947; WAM C58165, 7♂♂ (19–23 mm), 4 juv. ♂♂ (17–17 mm), 7♀♀ (19–27 mm), 4 juv. ♀♀ (16–18 mm), N end of Pine Lake, 41°44.2'S 146°42.2'E, from linked puddle, coll. G.E. Nicholls, 27 Jan 1947; TMAG G6443, 1♂ (21 mm), 16 juv. ♂♂ (16–20 mm), 8♀♀ (19–26 mm), 10 juv. ♀♀ (14–19 mm), Pine Lake, 41°44.6'S 146°42.0'E, 1190 m asl, coll. R. Swain, 22 Nov 1969; TMAG G6420, 19♂♂ (20–24 mm), 9 juv. ♂♂ (9–18 mm), 19♀♀ (18–22 mm), 6 juv. ♀♀ (14–19 mm), creeks entering Pine Lake, 41°44.6'S 146°42.0'E, coll. R. Swain, 3 Feb 1969; AM P97845, 3 juv. ♂♂ (7–12 mm), 15 juv. ♀♀ (6–11 mm), Halfmoon Creek, roadcrossing below Pine Lake, 41°45.01'S 146°42.75'E, from rocky pools, hand sieves, 1159 m asl, TAS-516, coll. G.D.F. Wilson & S.J. Keable, 9 Mar 2001; TMAG 14371/G115, 1♀ (29 mm), stream, 1 mile N of Rainbow Chalet, Great Lake, 41°46.0'S 146°33.7'E, 3000 ft asl [914 m], coll. J. Pearson, Apr 1939; TMAG G1309, numerous juv, Breona, 41°47'S 146°42'E, 1060 m, from well, coll. G.E. Nicholls,

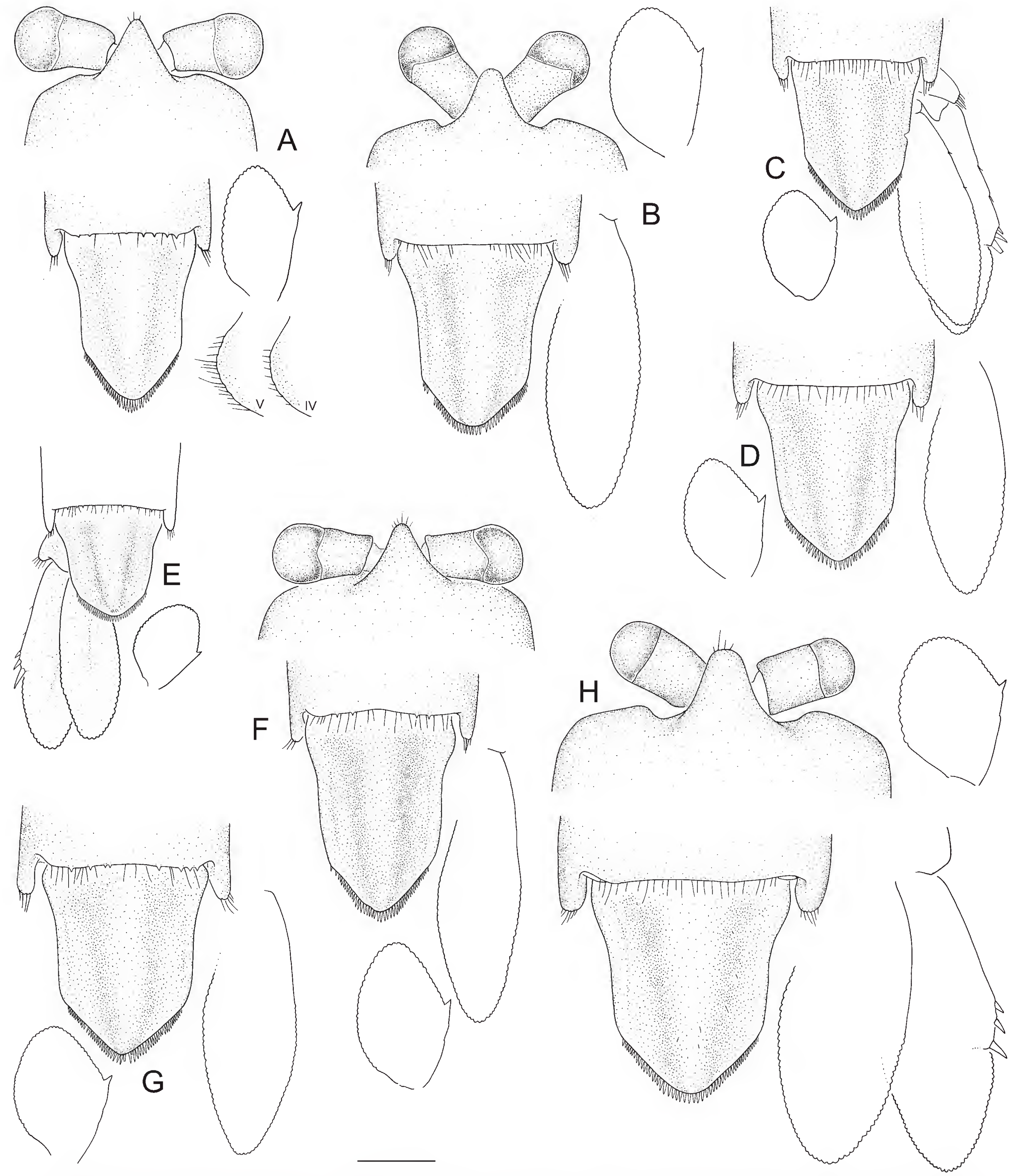

Figure 21. *Anaspides richardsoni* sp. nov., selected features. (*A*) male, 23 mm, S of Lake Tyndall, TMAG G6312; *(B)* female, 23 mm, Loongana, QVM 10:13975; *(C)* male, 22 mm, Deloraine, TMAG G135; *(D)* female, 26 mm, Little Pine Lagoon, QVM 10:13981; *(E)* juv. male, 18 mm, Cradle Mountain, SAM C6303; *(F)* female, 28 mm, W of Lake Fox, QVM 10:49165; *(G)* female, 27 mm, Mt Ossa, AM P82858; *(H)* female, 36 mm, Oatlands, TMAG G6360. Scale = 1.0 mm.

6 Feb 1945; TMAG G1310, 8 mature ♂♂ (18–24 mm), 6♀♀ (21–35 mm), Breona, from well, coll. G.E. Nicholls, 6 Feb 1945; TMAG G1314, 1♂ (28 mm), 3 juv. ♂♂ (12–17 mm), 1♀ (26 mm), 2 juv. ♀♀ (11–15 mm), Breona, Great Lake, north-east, in creek supply hotel, coll. G.E. Nicholls, 23 Dec 1943; TMAG G1311, 1♀ (19 mm) and numerous juv, Breona, from well behind Stewart's house, coll. G.E. Nicholls, 6 Feb 1945; TMAG G1312, 1♂ (20 mm) and numerous juv, Breona, from waterhole draining creek, coll. G.E. Nicholls, 6 Feb 1945; WAM C11773, 1♂ (c. 18 mm), 1 juv. ♂ (c. mm), 1♀ (22 mm), 3 juv. ♀♀ (c. 10–16 mm), Stewarts Water Hole, Breona, coll. G.E. Nicholls, 8 Jan 1946; WAM C58164, 1♂ (18 mm), 3 juv. ♂♂ (12–14 mm), 1♀ (21 mm), 7 juv. ♀♀ (6–15 mm), Breona, log behind (north) Stewart's Cottage, 30 Jan 1947; WAM C11769, 2♂♂ (18–22 mm), 2 juv. ♂♂ (13–16 mm), 1♀ (21 mm), 5 juv. ♀♀ (7–20 mm), creeks at Breona, Great Lake, 41°47'S 146°42'E, coll. Mr Stewart *et al*., 25 Jan 1947; WAM C11774, 2♂♂ (21–23 mm), 1 juv. ♂ (17 mm), 1♀ (18 mm), 2 juv. ♀♀ (9–10 mm), Breona, wells, coll. G.E. Nicholls, 6 Feb 1945; WAM C58158, 27 juv. ♂♂ (11–18 mm), 43 juv. ♀♀ (8–17 mm), indet juv. (6–7 mm), Breona, Great Lake, puddles near haulage, coll. G.E. Nicholls, 28 Jan 1947; WAM C11770, 8♂♂ (24–31 mm), 8♀♀ (27–42 mm), Brandons [=Brandum], Great Lake, 41°49.6'S 146°40.5'E, 1034 m asl, Easter 1946; WAM C11775, 1 juv. ♂ (16 mm, 1 juv. ♀ (16 mm), Reynolds Neck, Great Lake, 41°51.1'S 146°41.4'E, 1034 m asl, coll. A. Pike, 1935; TMAG G1630, 4♂♂ (22–23 mm), 1♀ (23 mm), near Shannon Lagoon, 41°59.6'S 146°44.1'E, pool in swamp, 1040

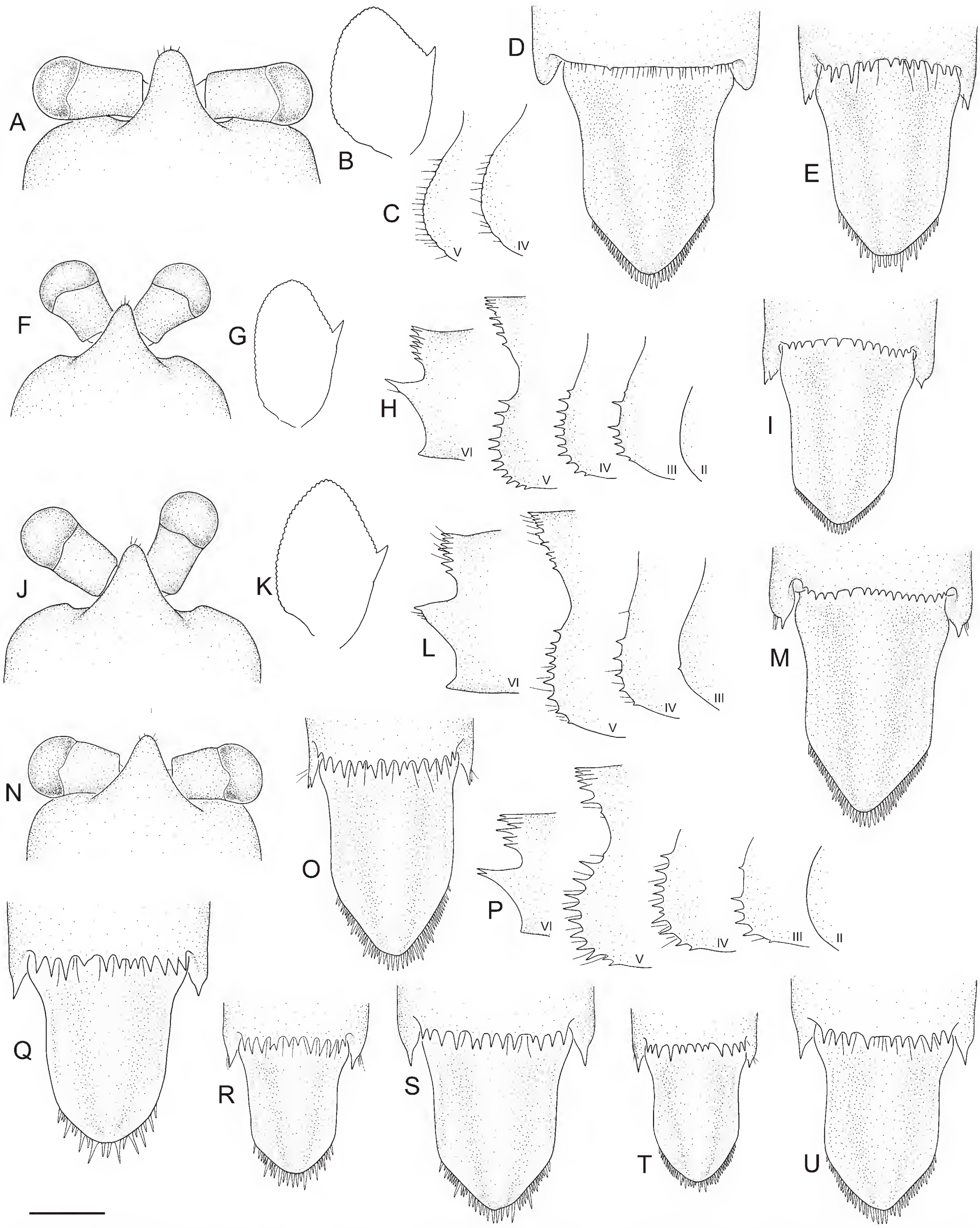

Figure 22. *Anaspides richardsoni* sp. nov., selected features. *(A–D)* female, 30 mm, Clarence Lagoon, TMAG G6359; *(E)* juv. female, 13 mm, Clarence Lagoon, TMAG G6359; *(F–I)* male, 23 mm, Clarence Lagoon, TMAG G6359; *(J–M)* male, 30 mm, Pool of Bethesda, TMAG G6434; *(N–P)* male, 23 mm, Lake Johnny, QVM 10:49162; *(Q–S)* Lake Fox, QVM 10:49164, female (29 mm), female (20 mm), female (30 mm); *(T–U)* Lake Halkyard, QVM 10:49163, male (18 mm), female (27 mm). Scale: A–D, F–U = 1.0 mm; E = 0.5 mm.

m asl, coll. J.W. Evans, 13 Dec 1936; TMAG G131, 2 juv. ♀♀ (15–21 mm), mouth of creek, Great Lake, coll. A.W.G. Powell, 29 Mar 1937; NMV J42435, 2♀♀ (25.0–36.0 mm), Great Lake, coll. F.E. Burbury, 1942; NMV J42443, 1♀ (24.0 mm), Great Lake, coll. F.F. Wilson, Jan 1933; AM P99298, 2 juv. ♂♂ (10–11 mm), 12 juv. ♀♀ (8–14 mm), Sandbanks Tier, 41°50'28.69"S 146°51'10.95"E, 1150 m asl, stream from under boulderfield, coll. S. Jarman; QVM 10:22606, 1♀ (34 mm), Lake River Valley, coll. C. Spencer, 1997; WAM C58156, 33♂♂ (18–31 mm), 48 juv. ♂♂ (12–18 mm), 23♀♀ (19–34 mm), 174 juv. ♀♀ (9–18 mm), 5 miles N of Breona, 41°42.2'S 146°43.4'E, creek, coll. G.E. Nicholls, 7 Feb 1945; NMV J42444, 4 juv. ♀♀ (12.0–16.0 mm), Ouse River, 5 miles W of Miena, coll. A. Neboiss, 28 Feb 1967; USNM 1277684, 1 juv. ♂ (15 mm), Ouse River, 5 miles W of Miena, coll. A. Neboiss, 28 Feb 1967; TMAG G6369 ("spinulae" and non-"spinulae" forms), 8♂♂ (19–22 mm), 4 juv. ♂♂ (15–17 mm), 10

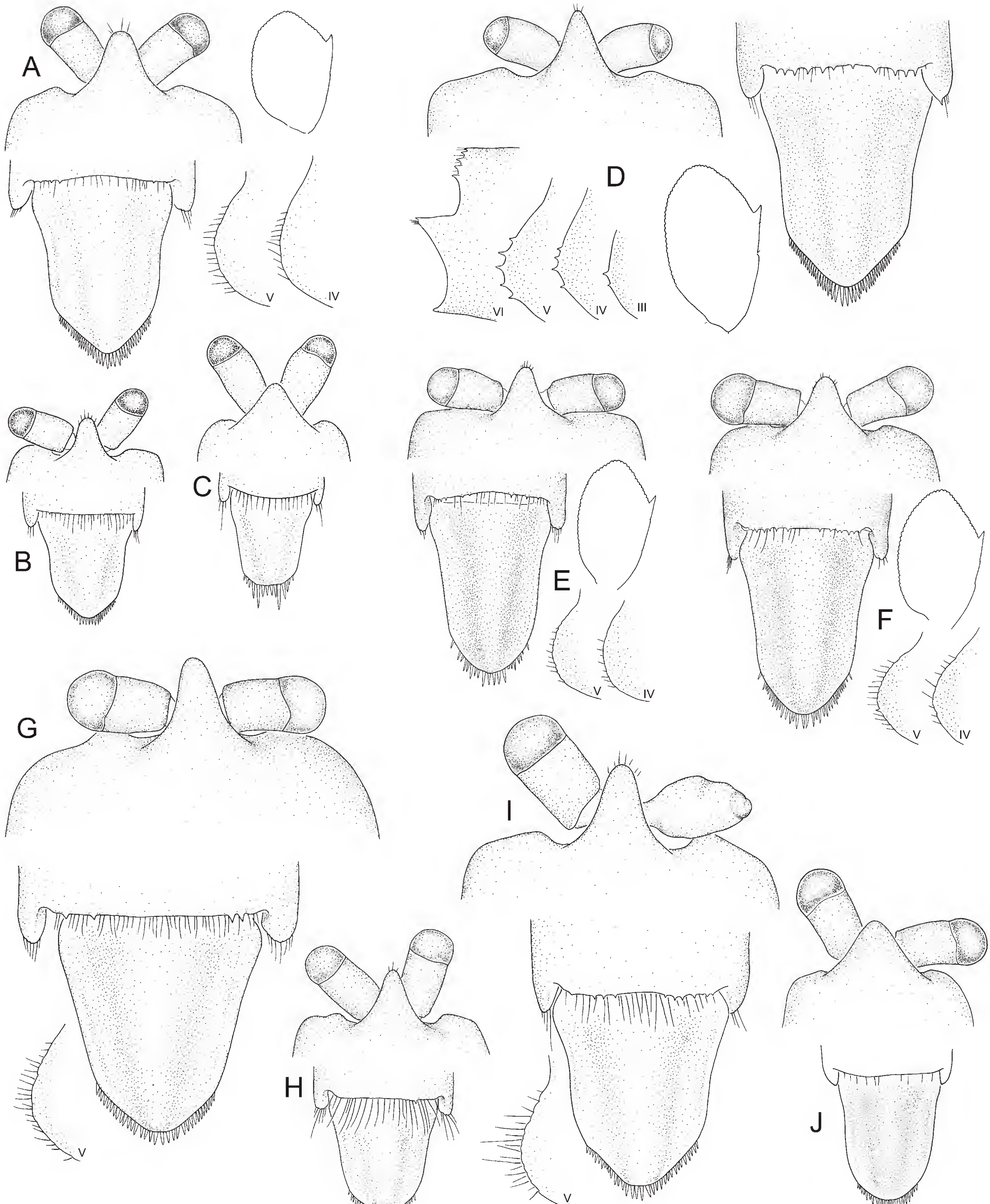

Figure 23. *Anaspides richardsoni* sp. nov., selected features. (*A–C)* Marakoopa Cave, SAM BS0464, female (31 mm), juv. female (21 mm), juv. female (9 mm); *(D)* male, 37 mm, Honeycomb Cave, AM P73038; *(E)* male, 25 mm, Kubla Khan Cave, USNM 1277679; *(F)* female, 28 mm, Mayberry area, sink hole, Mole Creek, USNM 1277683; *(G–H)* Growling Swallet, female 41 mm (TMAG G6473), juv. female 12 mm (TMAG G6481); *(I)* juv. female, 20 mm, Rift Cave, QVM 10:12158; *(J)* juv. female, 12 mm, Great Western Cave, Gunns Plain, AM P99296. Scale: A, B, D–G = 1.0 mm; C, H–J = 0.5 mm.

♀♀ (18–27 mm), 1 juv. ♀ (15 mm), Ouse River, semi creek, 22 Nov 1969; AM P11873, 1♀ (24 mm), 4–4½ miles S of Miena, in spring off road between Miena and Bothwell, about 20 yards to left of road near old notice on tree, marked "water", 41°59.8'S 146°47.2'E, coll. J. Waterhouse, c. 1930; TMAG G6428, 16♂♂ (23–33 mm), 7♀♀ (32–35 mm), small stream running into Ouse River on Lake Auga Road, 41°52.61'S 146°36.28'E, drift sample, 1150 m asl, coll. P. Davies, Nov, 1985; AM P14158, 6 juv. (slide preparations), near Little Pine Lagoon, 42°00.0'S 146°35.7'E, 1000 m asl, stream, coll. W.D. Williams, 5 Feb 1963; QVM 10:13981, 17♂♂ (19–25 mm), 1 juv. ♂ (18 mm), 7♀♀ (22–26 mm), 5 juv. ♀♀ (10–18 mm), about 10 miles from Great Lake on Missing Link Road, between Great Lake and Bronte Park, from little stream on S side of McKenzies Tier leading into Little Pine River, 42°02.2'S 146°33.0'E, coll. Sgt. McIntyre, 1958 via Arthur Fleming; SAMA C8446, 4 juv. ♂♂ (13–18 mm), 2♀♀ (36–41 mm), 9 juv. ♀♀ (9–21 mm), about 10 km N of Bronte Park, 42°04'S 146°29'E, from small stream above Pine Tier Dam, coll. W. Zeidler, 16 Jul 2001; AM P99297, 1♂ (21 mm), Pine Tier Lagoon, near shore, 42°04.38'S 146°29.30'E, coll. S. Richter & C. Wirkner, 28 Feb 2006; ZSRO 372, 1 juv. ♂ (11 mm), 7 juv. ♀♀ (6–12 mm), Pine Tier Lagoon, near shore, 42°04.38'S 146°29.30'E, coll. S. Richter & C. Wirkner, 28 Feb 2006; ZSRO, 1♀ (38 mm), tributary of Travellers Rest River, coll. A. Richardson, 4 Aug 2016; TMAG G6321, 2♀♀ (21–28 mm), Clarence Lagoon, 40–50 m from outflow, 42°05.12'S 146°18.87'E, 980 m asl, coll. D. O'Brien & R. Kirkwood, 30 Mar 1990; TMAG G6439, 2♂♂ (24–29 mm), 5♀♀ (21–36 mm), 6 juv. ♀♀ (11–12 mm), Clarence Lagoon, 42°05.2'S 146°19.2'E, on scuba, 980 m asl, coll. R. Mawbey 11 Jan 1984; TMAG G6442, 3♂♂ (21–23 mm), 2♀♀ (26–29 mm), Clarence Lagoon, 42°05.12'S 146°18.87'E, stomach of brook trout, 980 m asl, coll. P.A. Tyler, 5 Aug 1970; TMAG G6355, 1♀ (32 mm), Clarence Lagoon, 42°05.2'S 146°19.2'E, outflow creek, 980 m asl, in FBA net, coll. R. Mawbey, 13 May 1985; TMAG G6359, 3♂♂ (22–24 mm), 1 juv. ♂ (12 mm), 1♀ (30 mm; non-"spinulae" form), 1 juv. ♀ (13 mm), Clarence Lagoon, near start of Clarence River, 42°05.1'S 146°18.9'E, rocky shoreline, 980 m asl, coll. W. Fulton, 22 May 1976; TMAG G6367(non-"spinulae" form), 4♂♂ (22–26 mm), 6 juv. ♂♂ (18–21 mm), 2♀♀ (23–24 mm), 4 juv. ♀♀ (10–21 mm), 2 indet juv. (7 mm), moorland pools draining into Clarence Lagoon, 42°04.42'S 146°18.80'E, 980 m asl, coll. R. Swain, 21 Dec 1982; TMAG G6353, 15 juv. ♂♂ (12–15 mm), 13 juv. ♀♀ (11–14 mm), Silver Plains Creek, Alma Tier, 42°07.19'S 147°04.57'E, 920 m asl, coll. R. Mawbey, 11 Mar 1979; TMAG G6360, 1♂ (30 mm), 1♀ (36 mm), "The Groves", Oatlands, 2 Mar 1969; AM P14160, 1♂ (slide preparation), 1♀ (slide preparation), near Tarraleah, 42°17.2'S 146°26.3'E, 470 m, stream, coll. W.D. Williams, 7 Feb 1963.

Mt Field National Park: OM Iv.1394, 4♂♂ (21–30 mm), 3♀♀ (21–32 mm), Mt Field, 4000 ft asl [1200 m]; AM P97846, 1♀ (38 mm), 1 juv. ♀ (16 mm), Tarn Shelf, Rodway Range, coll. M.S. Moulds, 3 Feb 1992; AM P14159, 4 specimens (slide preparations c. 16–18 mm), near Lake Dobson, 42°41'S 146°36'E, stream, coll. W.D. Williams, 28 Jan 1963; AM P73058, 1♂ (28 mm), Wombat Moor, Mt Field, spring head of small spring fed sphagnum swamp on hillside, 42°40.98'S 146°36.48'E, TAS-484, coll. G. Wilson & S. Keable, 4 Mar 2001; AM P73059, 1♂ (25 mm), 3♀♀ (19–25 mm), Wombat Moor, Mt Field, spring head of small spring fed sphagnum swamp on hillside, 42°40.98'S 146°36.48'E, TAS-484, coll. G. Wilson & S. Keable, 4 Mar 2001; AM P97844, 1 juv. ♂ (15 mm), 9 juv. ♀♀ (6–15 mm), spring flowing out of hillside near ski lodge at bottom of walking track skirting Lake Dobson and continuing to Mt Field West, 42°41.11'S 146°35.44'E, pool among water mosses, with phreatoicidean isopods, hand sieves, 1037 m asl, TAS-483, coll. G.D.F. Wilson & S.J. Keable, 4 Mar 2001; TMAG G6405, 10♂♂ (25–33 mm), 5♀♀ (28–38 mm), Mawson Plateau, Mt Field, 42°41.4'S 146°35.1'E, 1270 m asl, coll. D. Hamilton, Apr 1970; TMAG G6371, 1 juv. ♂ (18 mm), Mt Field West, 42°39.5'S 146°30.7'E, 1400 m asl, coll. M. Fenton, 20 Jan 1971; TMAG G6401, 2♂♂ (27–29 mm), 5♀♀ (26–38 mm), Newdegate Pass, Mt Field, 42°39.5'S 146°33.3'E, coll. C. Reid, 23 May 1974; TMAG G6441, 6♂♂ (24–29 mm), 2 juv. ♂♂ (9–10 mm), 6♀♀ (24–33 mm), between Mackenzie tarn and James Tarn, 42°40.2'S 146°33.7'E, small tarn, 1180 m asl, coll. T. Walker, Mar 1972; TMAG G133, 1♀ (29 mm), Lake Fenton, 42°40.4'S 146°36.9'E, 1006 m asl, coll. Pott, Apr 1936; TMAG G6375, 3♂♂ (29–31 mm), 2 juv. ♂♂ (15–25 mm), 1♀ (33 mm), Mt Mawson, 42°41.7'S 146°35.8'E, 1280 m asl, coll. D. Hamilton, Apr 1970; TMAG G6444, 5♂♂ (25–29 mm), 1 juv. ♂ (19 mm), 5♀♀ (26–42 mm), 5 juv. ♀♀ (8–22 mm), Mawson Plateau, 42°41.4'S 146°35.1'E, pool with mud bottom, 1267 m asl, coll. T. Walker, Mar 1972; TMAG G6415, 2 juv. ♀♀ (13 mm), Mawson Plateau, 42°41.4'S 146°35.0'E, pool with rocky bottom, coll. T. Walker, Mar 1972; TMAG G6384, 4♂♂ (25–30 mm), 7♀♀ (26–36 mm), 8 juv. ♀♀ (12–20 mm), Mawson Plateau, 42°41.4'S 146°35.0'E, pool with rocky bottom, coll. T. Walker, Mar 1972; TMAG G6432, 1♂ (25 mm), 1 juv. ♂ (20 mm), 1♀ (31 mm), 6 juv. ♀♀ (8–23 mm), 1 indet juv. (7 mm), W side of Rodway Range, 42°40.2'S 146°32.4'E, pool with muddy bottom, coll. T. Walker, Mar 1972; TMAG G6373, 3 indet juv. (7 mm), W side of Rodway Range, 42°40.2'S 146°32.4'E, pool with muddy bottom, coll. T. Walker, Mar 1972; QVM 10:43547, 28♂♂ (20–32 mm), 18♀♀ (20–41 mm), 1 juv. ♀ (13 mm), Mawson Plateau, Mt Field, 42°41.4'S 146°35.1'E, 1270 m asl, coll. C. Reid, 1975; TMAG G6314, 7♀♀ (25–36 mm), Robert Tarn, Tarn Shelf, Mt Field, 42°40.7'S 146°34.2'E, 1200 m asl, coll. T. Walker, Mar 1972; TMAG G6372, 10♂♂ (25–32 mm), 8 juv. ♂♂ (16–21 mm), 9♀♀ (20–32 mm), 11 juv. ♀♀ (10–22 mm), Robert Tarn, Tarn Shelf, Mt Field, 42°40.7'S 146°34.2'E, 1200 m asl, sample 1, tube 1(2), coll. I. Wilson & J. Ong, 25 Jan 1970; TMAG G6408, 1♂ (31 mm), 1♀ (38 mm), Mt Field, midway between Newdegate Pass and Newdegate Tarn, 42°39.6'S 146°33.6'E, in small tarn, 1200 m asl, coll. I. Wilson & J. Ong, 25 Jan 1970; TMAG G6423, 1♂ (27 mm), Tarn Shelf, Mt Field, pool on lodge side, 42°40.1'S 146°33.6'E, 1260 m asl, coll. T. Walker, Mar 1972; TMAG G6386, 3 juv. ♂♂ (15–18 mm), 2♀♀ (20–26 mm), 6 juv. ♀♀ (9–17 mm), Lake Dobson Road, 3 miles before Lake, 42°40.8'S 146°37.7'E, 1000 m asl, coll. R. Swain, 18 Dec 1969; TMAG G6410, 4♂♂ (20–29 mm), 6 juv. ♂♂ (10–17 mm), 12♀♀ (19–28 mm), 10 juv. ♀♀ (11–14 mm), Tarn Shelf, near James Tarn, 42°40.3'S 146°33.8'E, small tarn with stream, sample 4, coll. I. Wilson & J. Ong, 25 Jan 1970; TMAG G6421, 5♂♂ (22–26 mm), 4 juv. ♂♂ (13–17 mm), 3♀♀ (24–30 mm), 5 juv. ♀♀ (12–18 mm), Tarn Shelf, near Backhouse Tarn, 42°40.1'S 146°33.6'E, small tarn, sample 5, coll. I. Wilson & J. Ong, 25 Jan 1970; TMAG G6445, 5♂♂ (20–21 mm), 6 juv. ♂♂ (13–19 mm), 2♀♀ (24–29 mm), 5 juv. ♀♀ (13–15 mm), Newdegate Pass, 42°39.6'S 146°33.0'E, sample 1, coll. I. Wilson & J. Ong, 25 Jan 1970.

Junee-Florentine Karst: QVM 10:12158, 1 juv. ♀ (20 mm), Rift Cave (JF34-5), Junee, Florentine Valley, 42°44.3'S 146°35.6'E, 680 m asl, coll. S.M. Eberhard, 4 Jan 1985; TMAG G6481, 1 juv. ♂ (12 mm), Growling Swallet Cave, Florentine Valley, 42°41.4'S 146°30.0'E, JF36-39, 570 m asl, CV10, coll. S. Eberhard, 2 Jun 1985; TMAG G6473, 1♀ (41 mm), Growling Swallet Cave (JF36), Florentine Valley, 42°41.4'S 146°30.0'E, 550 m asl, CV41, coll. S. Eberhard, 14 Apr 1985.

No data: AM P11897, 2♀♀ (31–39 mm), Tasmania, coll. B. Plomley via J. Waterhouse, pre 1949; QVM 10:13484, 1♂ (24 mm), 2♀♀ (21–24 mm), unidentified cave, coll. S. Eberhard, ?1993; QVM 10:13976, 1♀ (31 mm), coll. E.O.G. Scott; USNM 1277686, 1♀ (31 mm), from G.M. Thomson, no data.

Description. Eyes with well-developed cornea, pigmented, wider than stalk (epigean forms) to narrower than stalk in some subterranean forms, longer than half length of stalk; stalk with subparallel margins (except in some "spinose" specimens). Rostrum narrow in adults, apex blunt.

Pleonites with sparsely setose pleural margins, rounded; posterior margin of tergites 5–6 setose. Pleuron 1 unarmed. Pleonites 2–6 usually with posterior margin of tergite 5 unarmed and pleura 2–5 unarmed or with 1 or 2 small spines on pleuron 5; pleonite 6 posterior margin unarmed or minutely spinose, posterolateral margin rounded, with or without minute denticle. Pleonites 2–6 of "spinose" specimens with pleura 3–5 (sometimes also pleuron 2) strongly spinose; posterior margin of tergites 5–6 strongly spinose; posterolateral margin produced to distinct spine. Pleonal sternites 3–5 with low, median processes between pleopod bases, distinctly bilobed and widest on sternite 3, bilobed on sternite 4, weakly bilobed and narrowest on sternite 5.

Telson slightly wider than long to longer than wide (usually slightly longer than wide), pentagonal (usually) to sub-linguiform, widest proximally; lateral margins sinuous in dorsal outline, distally subparallel to convergent; transition from lateral to posterior margin obtusely angular; posterior margin angular to rounded, blunt medially; posterior spine row with 19–50 slender, closely spaced spines, (usually) short, evenly graded to distinctly uneven in some "spinose" specimens.

Antennule inner flagellum about 0.2 × body length (21 articles in holotype); article 7 inner margin obtusely angled in adult males, with 1 long, slender clasping spine at proximal corner; outer flagellum 0.4–0.6 × body length (83 articles in holotype) in epigean specimens, 0.4–0.9 × body length in subterranean specimens. Antennal flagellum 0.4–0.6 × body length (62–65 articles in holotype), 0.5–0.9 in subterranean specimens; scaphocerite elongate, ovate, lateral spine slightly distal to midlength; apex reaching almost to midlength of distal peduncular article.

Right mandibular incisor process with proximal tooth distally undivided to trifurcate, usually bifid.

Pleopods 1–5 (rarely 1–4) with endopod in adults. Adult male pleopod 1 distally widened, scoop-like, lateral margins weakly expanded, not obscuring retinacular lobe in lateral view.

Uropodal protopod dorsally unarmed or with 1–3 spines; exopod with 2–4 (usually 3) movable spines on outer margin near position of partial diaeresis; exopod length about 2.5–3.5 times width, as wide as endopod, apex rounded, narrow to relatively broad.

Etymology. Named in honour of Alastair Richardson, for his many contributions to Tasmanian carcinology and limnology.

Measurements. Male (n = 756) 7–37, female (n = 1151) 6–55 mm, indet (n = 16) 5–7 mm.

Remarks. *Anaspides richardsoni* sp. nov. is characterized by the combination of a single antennular clasping spine in adult males (Fig. 19D), the telson posterior margin with a close-set spine row (Fig. 19B) and the male pleopod 1 endopod having the retinacular lobe visible in lateral view (Fig. 20I). Additionally, the pleopod 5 endopod is present in adults (except in some cave specimens from parts of the Mole Creek and Junee-Florentine systems; see below). *Anaspides richardsoni* is widespread across central Tasmania (Fig. 36) in a wide arc stretching from the West Coast Range in the northwest, eastwards to Cradle Mountain and as far north as Gunns Plains and Mole Creek, across the Central Plateau, and south to Mt Field. It is primarily an epigean species occurring in springs, creeks and lakes, but also caves.

As presently understood, *Anaspides richardsoni* is the most morphologically variable species of the genus. Through the central-eastern (Mt Field east to Oatlands and north to Deloraine) and north-western part of its distributions (West Coast Range to Cradle Mountain and Mt Ossa to Gunns Plains), however, *A. richardsoni* is relatively uniform morphologically. The pleonites are almost always unarmed (or with few spinules on the posterior margin of pleonite 6), and in specimens from Mount Field to the Great Lake-Deloraine area, the telson is about as long as or little longer than wide, with the posterior margin distinctly angular, approximately right-angled (Fig. 21). The telson in specimens from the far north (Gunns Plains, Loongana, Vale of Belvoir, Mole Creek) and western Central Plateau (Walls of Jerusalem area, Western Lakes) tend to be more elongate and often more acutely angular posteriorly (Figs 21B, F; 22). Specimens from the Mt Field area at the southern extremity of its range generally have more slender uropods than those from the northeast (most evident in large adults), and a usually bifid proximal tooth on the right mandibular incisor process (Fig. 19H) compared to the typically trifid condition found in other areas. Populations of *A. richardsoni* from the peripheries of the main distribution, however, show additional notable variations, particularly those from the far north, the western Central Plateau and the Mole Creek Caves.

Specimens from parts of Cradle Mountain and further north (Black Bluff, Vale of Belvoir, Gunns Plains) have a less angular telson than usual, sometimes being almost rounded. At a relatively small size (18 mm) some Cradle Mountain specimens already have a noticeably shortened telson (slightly wider than long; Fig. 21E), broad uropods and broad scaphocerite compared to size-matched specimens from elsewhere.

Few specimens are known from the West Coast Range (Mt Murchison), and are the most westerly specimens examined (Fig. 21A). All have minimal pleonal spination (at most with few small spines on the posterior margin of pleonite 6). Most known males are juveniles with a single antennular clasping spine, although the largest male has (TMAG G6411) has one antennular clasping spine on the left and two on the right. The right antennule (peduncle and flagellum), however, is shortened overall and appears abnormal, possibly as a result of developmental irregularities. Smith's (1909a) report of *A. tasmaniae* from Mt Read (near Mt Murchison, West Coast Range) is probably referable to *A. richardsoni*.

A number of specimens of *A. richardsoni* from the northwestern Central Plateau encompassing the Walls of Jerusalem and Clarence Lagoon east to the Ouse River have strongly spinose pereonites as in *A. spinulae* from Lake St Clair —the *A. "spinulae"* of O'Brien (1990) (Fig. 22). In these specimens, pleonite 4–5 pleura (usually also pleonite 3) and the posterodorsal margins of pleonites 5 and 6 (5 less often so) are prominently spinose and the posterolateral margin of pleonite 6 is usually produced to a prominent spine. The proximal tooth on the right mandibular incisor process is usually trifid. In addition, the telson is often more elongate than usual, with a sometimes somewhat rounded margin on which the posterior spines vary from evenly graded to distinctly uneven in length. Telson spination differs slightly between sampled lakes and the Walls of Jerusalem. Specimens from Lakes Fox and Johnny (Fig. 22N–S) have relatively uneven telson spination compared to those from Clarence Lagoon (Fig. 22A–I), Lake Halkyard (Fig. 22T,U), Jacks Lagoon and most specimens from the Walls of Jerusalem (Fig. 22J–M), which have more evenly graded telson spines like those of typical epigean forms. It should be noted, however, that most specimens found throughout this area are non-spiny or less-spiny than "*spinulae*" (in which only pleura 4–5 and the dorsal margin of pleonite 6 may be spinose, e.g., Jacks Lagoon, QVM 10:13977). Both spiny and non-spiny forms were found together in tarns and runnels in the Walls of Jerusalem (TMAG G6396, TMAG G6379), the vicinity of Lake Fox (Fig. 21F), the Ouse River (TMAG G6359) and Clarence Lagoon (TMAG G6359) (Fig. 22A–I). The strong similarity in pleonal spination of the most spinose specimens of *A. richardsoni* to *A. spinulae* is remarkable, suggesting similar underlying developmental processes. O'Brien (1990), noting a correlation between spininess and lake habitats, suggested that *A. spinulae* might be a separate lacustrine species or lacustrine ecomorph, given that non-spiny specimens seemed to be from creeks, runnels and tarns. If so, however, it would remain to be explained why *A. richardsoni* from other lakes, such as Pine Tier Lagoon and Pine Lake are non-spiny, and why spiny forms can also be found together with non-spiny forms in tarns, small creeks, and pools. Both non-spiny and spiny forms are recorded from Clarence Lagoon (Fig. 22A–I). Additionally, the "*spinulae*" form of *A. richardsoni* occurs only on the Central Plateau to the east and northeast of the similarly spinose *A. spinulae* from Lake St Clair, but not in other lake populations of *A. richardsoni* (e.g., lakes at Mt Field and the West Coast Range such as Lakes Tyndall and Sandra), let alone lake populations of other species of *Anaspides* such as *A. jarmani* and *A. swaini*. The presence of predatory fish, such as trout and *Galaxias* might be posited to induce a spiny "defensive" phenotype in *Anaspides* as has been observed in *Daphnia* (Adler & Harvell, 1990). Trout are certainly present in Lake St Clair (*A. spinulae* sensu stricto), Clarence Lagoon, Lakes Fox, Halkyard and Johnny, but they are also present in more easterly water bodies such as Pine Tier Lagoon, Little Pine Lagoon and Pine Lake in which *A. richardsoni* shows no such defensive spination. Instead, the distribution of the "*spinulae*" form of *A. richardsoni* correlates more strongly with geography than ecology, and might reflect phylogeographic genotypic variation. In particular, the relationship between these spinose *A. richardsoni* and *A. spinulae* from Lake St Clair warrants further investigation, with *A. spinulae* differing most fundamentally in having two rather than one antennular clasping spines. Curiously, specimens to the immediate south and west of Lake St Clair, all referrable to *A. swaini*, do not have the spinose pleon of *A. spinulae*. Specimens to the immediate east of Lake St Clair from the eastern side of the Traveller Range are non- or minimally spinose as in typical specimens of *A. richardsoni*. In addition, the telsons of both spiny and non-spiny specimens from the Walls of Jerusalem to the northern tiers (as well as Mole Creek) tend to be more elongated than specimens from elsewhere. More detailed population level studies, currently underway in collaboration with S. Richter and colleagues, are required to further understand these morphological patterns.

Anaspides richardsoni has entered subterranean habitats in at least three parts of the periphery of its range (Fig. 23): Mole Creek karsts and Great Western Cave (Gunns Plain) in the north, and the Junee-Florentine system in the south. The single known specimen from Great Western Cave (AM P99296; Fig. 23J) is a juvenile male that agrees well with epigean juveniles (e.g., TMAG G6169); it also represents the northernmost record of *Anaspides*. Aside from loss of body pigmentation, the specimen exhibits no obvious troglobitic adaptations and has well-developed, pigmented eyes. At Mole Creek, three subterranean forms occur, differing between cave systems.

- Form 1 occurs in the Sassafras (Prohibition Cave) and Marakoopa systems (Marakoopa I and Marakoopa II caves) (Figs 23A–C, 35F). Apart from reduced body pigmentation, it closely resembles epigean specimens, having well-developed eyes, the outer antennular flagellum 0.4–0.6 (usually 0.5–0.6) body length, unarmed pleonites except for scattered denticles along the upper posterior margin of pleonite 6, and in having a finely-graded spine row on the posterior margin of the telson.
- Form 2 is found in caves in the Mole-Lobster system (Honeycomb Cave, Wet Cave, Herberts Pot and Kellys Pot) (Figs 23D, 35E). It resembles Form 1 in telson structure, but has reduced eyes, outer antennular flagella 0.5–0.8 (usually 0.6) body length, and more extensive pleonal spination, with denticles on the pleura of pleonites 4–5 as well as the dorsal posterior margin of pleonite 6. Form 2, reaches the greatest size of the three forms (>50 mm), the largest being from Honeycomb Cave.
- Form 3 occurs in the Kubla Khan system (Kubla Khan Cave) and an unnamed cave in the Sassafras system (Fig. 23E,F). It resembles Form 1 in eye development and minimal pleonal spination, but differs from both Forms 1 and 2 in consistently having much more elongate antennular flagella (0.7–0.9, usually 0.8) and a more slender telson with longer, more robust spines, somewhat approaching that of *A. richardsoni* from the Walls of Jerusalem and localities close to Mole Creek such as Western Bluff, and Ironstone Mountain. Additionally, the pleopod 5 endopod is frequently absent in specimens from the Kubla Khan system. One series corresponding to Form 3 (USNM 1277683; Fig. 23F) was collected from a deep, water filled sink hole in the Mayberry area (near Mole creek), believed to be hydrologically connected to the Kubla Khan system (Iliffe, 1988); the specimens differ from the Kubla Khan specimens only in having more extensive body pigmentation typical of epigean forms, and a slightly wider cornea.

Although most common on the surface around Mt Field, *A. richardsoni* is recorded from the Junee-Florentine system (Rift Cave and Growling Swallet; Fig. 23G–I) on the basis of two juveniles and an adult female. These specimens agree well with epigean *A. richardsoni*, including pigmentation (albeit seemingly somewhat reduced) and well-developed eyes, but differ in lacking the pleopod 5 endopod. The right eye of the Rift Cave specimen is deformed, seemingly having been damaged (Fig. 23I). Two other species of *Anaspides* occur in caves in the Mt Field area: *A. eberhardi* (Junee-Florentine karsts including Growling Swallet), which is closely related to *A. richardsoni*, and *A. swaini* (Junee-Florentine and Risby's Basin karsts), which also sometimes occurs on the surface at Mt Field, but is the dominant epigean species to the south and west of the area.

Anaspides richardsoni features well-developed secondary sexual characteristics by 18–25 mm (usually 20–22 mm). The pleopod 5 endopod is the last of the endopods to develop, appearing in juveniles as small as 11 mm to as large as 22 mm, but usually by 15–18 mm. The presence of a single male antennular clasping spine is highly consistent, with, in rare cases, a second spine developing on one side, often associated with possible regeneration after damage. The male from Wet Cave, however, is highly aberrant in having two clasping spines on one side, three on the other. In both cases, the normal single clasping spine is present on the proximomedial corner of flagellar article 7, but the additional abnormally and asymmetrically developed spines arise on the anteromedial corner. The abnormal positions and asymmetrical development of the clasping spines in the Wet Cave male indicate that it is aberrant.

Anaspides richardsoni is the most taxonomically challenging species of the genus given the range of forms encountered, especially those from the peripheries of its range with distinctive morphologies. These may carry the signature of populations from areas untouched by the Pleistocene glaciations, which otherwise dominated the Central Plateau at the time, or may indicate ongoing differentiation (Andrew, 2005). Further sampling is required to better understand these peripheral populations, especially since some localities, such as Gunns Plain, the West Coast Range and Sandbanks Tier are represented by juveniles or only few specimens. Further sampling is also required in the eastern Great Western Tiers in the vicinity of Deloraine, Great Lake, and Lake Sorell down to the Oatlands area to determine the current extent of occurrence. The specimens from the Oatlands area (Fig. 21H) are the easternmost records of the genus, although O'Brien (1990) speculated their provenance to be from surrounding hills slightly to the west. Likewise, specimens from Deloraine were speculated to originate from hills slightly to the south (O'Brien, 1990). The known distribution *A. richardsoni* is discontinuous between the West Coast Range and Cradle Mountain area, and between the Western Lakes and Mt Field. Whether these "gaps" are real or owe to lack of sampling remains to be determined. Despite the wide morphological diversity, *A. richardsoni* is readily diagnosed by the combination of the single antennular clasping spine in adult males and the close-set spine row on the posterior margin of the telson.

Distribution. Wide ranging in central Tasmania, from the West Coast Range and Cradle Mountain in the west to the Central Plateau from Mt Ossa and localities east of Lake St Clair, to Mole Creek and the vicinity of Great Lake, south to Mt Field and as far east as the Oatlands area; 470–1455 m asl (epigean), 109–520 m asl (subterranean).

Anaspides spinulae Williams, 1965

Figs 24–28, 36

Anaspides tasmaniae. —Powell, 1946: 84.

Anaspides spinulae Williams, 1965a: 117–123, fig. 5 (type locality: Lake St Clair, S of pumping station). —Williams, 1974: 84–85, tab. 4.1. —Knott, 1975: 157 (Lake St Clair specimen only), 173. —Michaelis, 1985: tab. 2. —Richardson, 1985: 3. —O'Brien, 1990: 11–18, tab. 2.2, 2.4, pl. 2. —Jarman & Elliot, 2000: fig. 4, tab. 1. —Camacho *et al*., 2002: fig. 1, tab. 1. —Lake *et al*., 2002: 11. —Serov, 2002: 8, 15. —Camacho, 2006: 4.

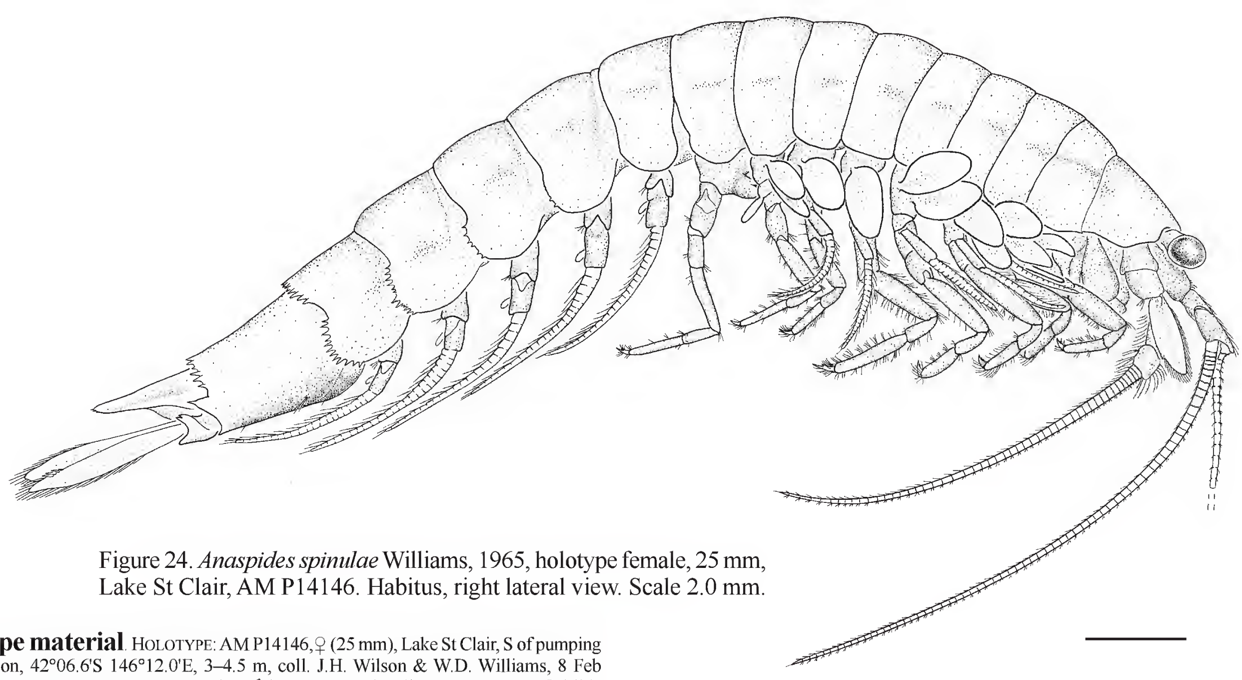

Figure 24. *Anaspides spinulae* Williams, 1965, holotype female, 25 mm, Lake St Clair, AM P14146. Habitus, right lateral view. Scale 2.0 mm.

Type material. HOLOTYPE: AM P14146,♀ (25 mm), Lake St Clair, S of pumping station, 42°06.6'S 146°12.0'E, 3–4.5 m, coll. J.H. Wilson & W.D. Williams, 8 Feb 1963. PARATYPES: AM P14147, 1 juv. ♂ (12 mm), type locality; AM P14148, 1♀ (slide preparation), type locality; AM P14149, 1 specimen (slide preparation), type locality; AM P14150, 1♀ (slide preparation); AM P14151, 1 specimen (slide preparation), type locality; AM P14152, 4 specimens (slide preparation), type locality; AM P14153, 1♀ (slide preparation), type locality; AM P14154, 4 specimens (slide preparation), type locality; AM P14155, 1 juv. ♂ (c. 11 mm), type locality; AM P14156, 1♀ (21 mm), 1 juv. ♂ (c. 11 mm), type locality.

Other material examined. YPM 9194, 2♂♂ (13–14 mm), 1♀ (15 mm), Lake St Clair, coll. J.H. Wilson, Mar 1961; TMAG G124, 2 juv. ♂♂ (11–13 mm), 5♀♀ (9–18 mm), Lake St Clair, bottom drag at midnight, coll. A.W.G. Powell, 24 Jul 1937; TMAG G134, 2 juv. ♂♂ (10–12 mm), Cynthia Bay, Lake St Clair, 42°06.6'S 146°10.1'E, bottom drag, coll. A.W.G. Powell, 26 Aug 1937; AM P99312, 2 juv. ♂♂ (8–9 mm), Lake St Clair, 42°06.75'S 146°11.81'E, 5 m depth, Lake bottom, towed net, 730 m asl, coll. S. Jarman; AM P99313, 16 juv. ♂♂ (7–9 mm), 11 juv. ♀♀ (7–10 mm), Lake St Clair, S of Pumphouse Point, 42°06.38'S 146°12.10'E, 2 m, weed bed, on scuba, 730 m asl, coll. M. Driessen & J. Andrew; MCZ IZ:68029, 1 juv. ♂ (9 mm), 1 juv. ♀ (8 mm), Lake St Clair, S of Pumphouse Point, 42°06.38'S 146°12.10'E, 2 m, weed bed, on scuba, 730 m asl, coll. M. Driessen & J. Andrew, late 1990s to pre 2005; TMAG G6325, 1♂ (23 mm), 1♀ (23 mm), Ida Bay, Lake St Clair, 42°01.7'S 146°08.5'E, 3–7 m, sand & under rocks, stones, plentiful to 7 m, 737 m asl, coll. R. Holmes, 20 Mar 1990; TMAG G6327, 1♀ (22 mm), 2 juv. ♀♀ (10–11 mm), Lake St Clair, 42°01.75'S 146°06.94'E, 6 m, between rocks & stones, "No. 4", coll. D. O'Brien, 20 Mar 1990; TMAG G6328, 1♂ (14 mm), 1♀ (20 mm), 2 juv. ♀♀ (9–11 mm), Lake St Clair, 42°04.63'S 146°10.02'E, under logs, 6–12 m, coll. D. O'Brien & M. Driessen, 20 Mar 1990; TMAG G6326, 1 juv. ♂ (11 mm), Lake St Clair, 42°05.08'S 146°11.76'E, 6 m, pebbles and stone outcrops, coll. R. Holmes, 20 Mar 1990; TMAG G6324, 3 juv. ♂♂ (9–10 mm), 5 juv. ♀♀ (8–9 mm), Lake St Clair, 42°06.70'S 146°11.74'E, 3–4 m, amongst *Isoetes*, under stones, rocks, site 9, coll. D. O'Brien, 20 Mar 1990; TMAG G6323, 2 juv. ♂♂ (10–11 mm), 2 juv. ♀♀ (11–12 mm), Lake St Clair, 42°01.04'S 146°06.74'E, 4–6 m, stones and pebbles, coll. R. Holmes, 20 Mar 1990; TMAG G6329, 1 juv. ♂ (8 mm), 1♀ (20 mm), no locality data.

Description. Eyes with large well-developed cornea, pigmented, distinctly wider than stalk, subglobular, longer than half length of stalk; stalk with divergent margins. Rostrum narrow in adults, apex blunt.

Pleonites with sparsely setose pleural margins, rounded; pleuron 1–2 with 0–3 small spines; pleura 3–5 prominently spinose. Pleonites 5–6 posterior tergal margins prominently spinose, setose. Pleonite 6 posterolateral margin produced to prominent spine, occasionally with secondary spine. Pleonal sternites 3–5 with low, median processes between pleopod bases, distinctly bilobed and widest on sternite 3, bilobed on sternite 4, weakly bilobed and narrowest on sternite 5.

Telson longer than wide, widest proximally; lateral margins sinuous in dorsal outline, distally convergent; transition from lateral to posterior margin obtusely angular; posterior margin angular to slightly rounded, blunt medially; posterior spine row with 17–32 slender, uneven, closely spaced spines, with several longer spines, approximately evenly spaced among shorter spines; rarely with dorsomedian spine above posterior margin.

Antennule inner flagellum about 0.2 × body length (22 articles in holotype); article 7 inner margin obtusely angled in adult males, with 2 long, slender clasping spines proximally; outer flagellum 0.5–0.6 × body length (67–71 articles in holotype). Antennal flagellum 0.3–0.5 × body length (49–50 articles in holotype); scaphocerite elongate, ovate, lateral spine slightly distal to midlength; apex almost reaching or slightly overreaching apex of distal peduncular article.

Right mandibular incisor process with proximal tooth distally bifid or trifid.

Pleopods 1–5 with endopod in adults. Adult male pleopod 1 distally widened, scoop-like, lateral margins weakly expanded, not obscuring retinacular lobe in lateral view.

Uropodal protopod dorsally with 1 or 2 small spines; exopod with 2–4 movable spines on outer margin near position of partial diaeresis; exopod length about 3 times width, as wide as endopod, apex rounded, relatively narrow.

Measurements. Male (n = 35) 7–23 mm, female (n = 36) 7–25 mm.

Remarks. Williams (1965a) distinguished *A. spinulae* from *A. tasmaniae* on the basis of its pronounced pleonal spination, particularly of pleura 3–5 and tergites 5–6, uneven telson spine row, and apparently unusual ecology—the lacustrine habitat of Lake St Clair. *Anaspides tasmaniae* (now known to comprise several species) was thought, at the time Williams wrote, to occupy only surface creeks, tarns and streams, but subsequent discoveries from lakes throughout Tasmania refuted that assumption (Williams, 1974). The validity of *A. spinulae* has been questioned ever since (Williams, 1974; O'Brien, 1990; Jarman & Elliott, 2000). In particular, the observation of a possible "gradation of increasing spination in a southerly direction across the western portion of the Great Western Tiers" down to Lake St Clair cast doubt on the validity of *A. spinulae* (Knott, 1975; O'Brien, 1990). Moreover, *Anaspides* throughout much of

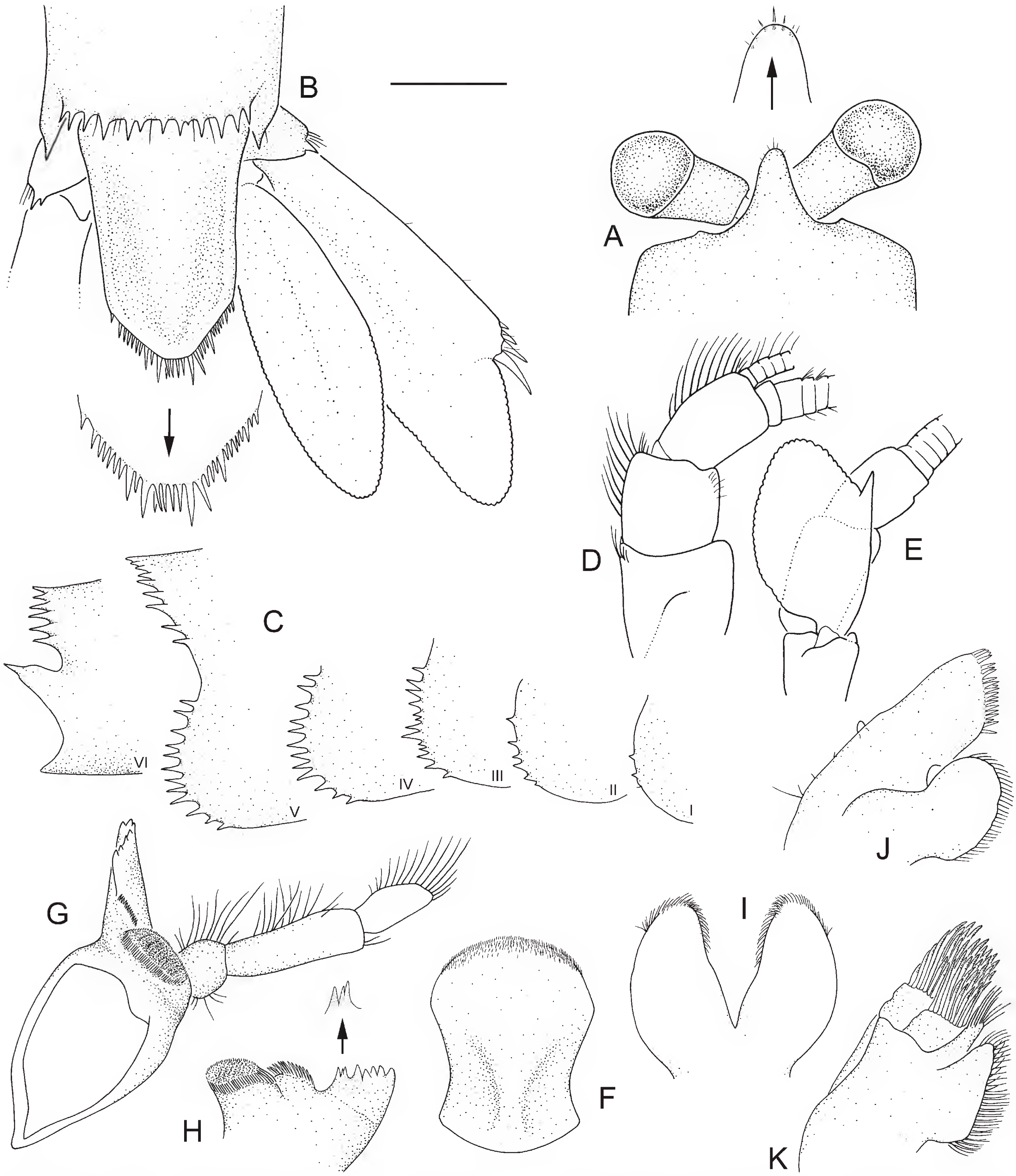

Figure 25. *Anaspides spinulae* Williams, 1965, holotype female, 25 mm, Lake St Clair, AM P14146. *(A)* cephalothorax, dorsal view; *(B)* pleonite 6, telson and right uropod; *(C)* pleonites 1–6 pleura, right lateral view; *(D)* right antennule; *(E)* right antenna; *(F)* labrum, anterior view; *(G)* right mandible; *(H)* right mandible incisor process; *(I)* paragnaths, anterior view; *(J)* right maxillule; *(K)* right maxilla. Scale: A–E = 1.0 mm; F–K = 0.7 mm.

Tasmania show some degree of pleural and tergal spination, including *A. tasmaniae* from Mt Wellington, further eroding the distinctiveness of *A. spinulae* (see O'Brien, 1990). Others have accepted a limited range for *A. spinulae*, from Lake St Clair to Clarence Lagoon (Richardson, 1985; Swain, 2000). The status of *A. spinulae* has remained debated, partly owing to the seemingly unreliable diagnostic features identified by Williams (1965a), and partly owing to the inadequate and perhaps misleading original account of the species, in which the holotype was not figured.

Review of all available material from Lake St Clair, as well as western Central Plateau specimens reported by Knott (1975) and O'Brien (1990) as *A.* "*spinulae*" (= *A. richardsoni* sp. nov.; Fig. 22), indicates that *A. spinulae* is a valid species. The present concept of *A. spinulae* emphasizes the male secondary sexual characters in addition to the

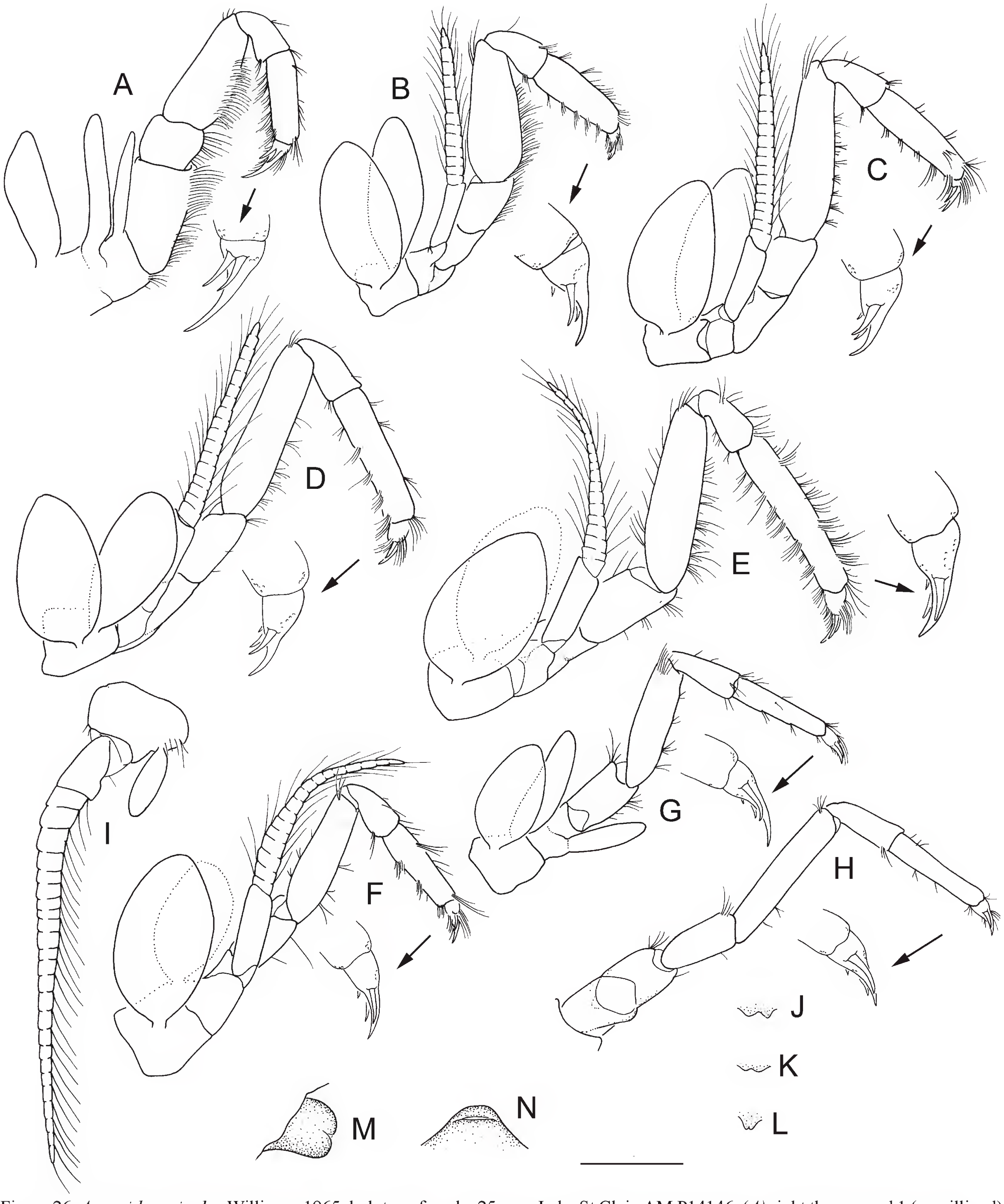

Figure 26. *Anaspides spinulae* Williams, 1965, holotype female, 25 mm, Lake St Clair, AM P14146. (*A)* right thoracopod 1 (maxilliped); *(B–H)* right thoracopods 2–8; *(I)* right pleopod 5, anterior view; *(J–L)* pleonites 3–5 median sternal processes; *(M–N)* female gonopore, right lateral and ventral views. Scale = 1.0 mm.

pleonal spination. Thus, *A. spinulae* can be distinguished from all other species of the genus by the combination of two antennular clasping spines in adult males (Fig. 27D), prominently spinose pleural margins of pleonites 2–5 and posterior tergal margins of pleonites 5–6, the prominently spiniform posterolateral angle of pleonite 6 and angular posterior margin of the telson (Figs 25, 27, 28). The cornea of *A. spinulae* is also proportionally more inflated than any of its congeners at a similar size, being noticeably wider than the stalk (Figs 25A, 27A, 28A,D).

Despite *A. spinulae* being a valid species clearly separated from *A. tasmaniae*, its taxonomic boundaries remain to be fully circumscribed. The secondary sexual modifications of the male antennule and presence of the pleopod 5 endopod suggest a close relationship to the northern form of *A. swaini* occurring to the immediate west and south of Lake St Clair. Although

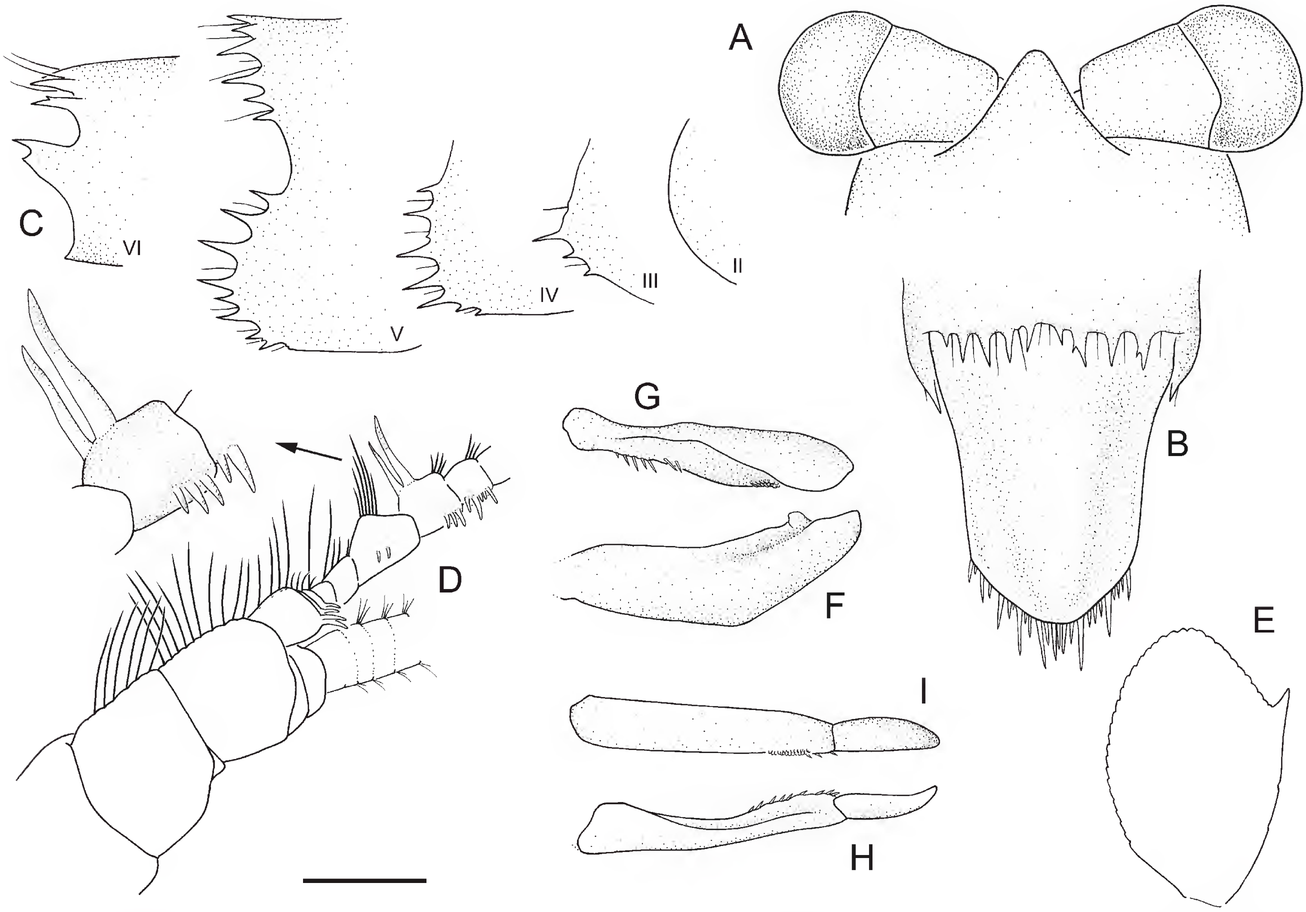

Figure 27. *Anaspides spinulae* Williams, 1965, male, 14 mm, Lake St. Clair, YPM 9194. (*A*) cephalothorax, dorsal view; *(B)* pleonite 6, telson and left uropod; *(C)* pleonites 2–6 pleura, right lateral view; *(D)* right antennule; *(E)* right scaphocerite; *(F–G)* right pleopod 1 endopod, lateral and ventral views; *(H–I)* right pleopod 2 endopod, lateral and ventral views. Scale = 0.5 mm.

Williams (1965a) hypothesized that *A. spinulae* survived the Pleistocene glaciation of Lake St Clair in adjacent periglacial lakes or melt-waters, areas currently occupied by *A. swaini*, *A. spinulae* might equally have persisted in-situ in deeper parts of the lake during that time. This more easily accounts for the very limited range of the species today, nested between the ranges of *A. swaini* and *A. richardsoni*. Knott (1975) alternatively hypothesized *A. spinulae* to be only a temporary resident in Lake St Clair, being periodically flushed into the lake from adjacent creeks and streams, with its primary habitat being the western Central Plateau. Present results, however, indicate otherwise. The nearest neighbouring *Anaspides* populations to the immediate south and west (*A. swaini*) and immediate east (*A. richardsoni*, eastern side of the Travellers Rest Range) of Lake St Clair have "normal", non-spiny pleonal ornamentation. The strongly spinose forms (*A. "spinulae"* of O'Brien, 1990) occur further afield on the western Central Plateau to the east and northeast of Lake St Clair, and although closely resembling *A. spinulae*, are referable to *A. richardsoni* having one instead of two male antennular clasping spines. It is enigmatic that the strongly spinose "spinulae" morphology is known only in *Anaspides* from Lake St Clair and the western Central Plateau, whereas the nearest neighbours to the lake all have "normal" pleonal ornamentation. As noted under the account of *A. richardsoni*, the occurrence of the spiny body form does not have an immediate ecological basis, relating neither to a lacustrine habitat nor presence of fish predators. The observed morphological patterns in *Anaspides* from west to east of Lake St Clair are presently difficult to interpret, and the limited currently available molecular data are equivocal (Jarman & Elliott, 2000; Andrew, 2005). Thus, the relationship of *A. spinulae* to neighbouring *Anaspides* populations, currently assigned to *A. swaini* and *A. richardsoni,* respectively, requires more detailed analysis beyond the scope of the present study. Although conceivably more wide ranging, *A. spinulae* is presently known with certainty only from Lake St Clair.

Previous records of *A. spinulae* from Clarence Lagoon and elsewhere on the Central Plateau are referable to *A. richardsoni*. Although resembling *A. spinulae* in pleonal spination, adult males from Clarence Lagoon, like other spiny Central Plateau forms have a single antennular clasping spine, diagnostic of *A. richardsoni*. It is notable though that the corneas of spiny *A. richardsoni* from Clarence Lagoon (Fig. 22F), like true *A. spinulae*, are proportionally larger and more expanded than size-matched *A. richardsoni* from elsewhere on the Central Plateau (including a non-spiny specimen from Clarence Lagoon; Fig. 22A).

Anaspides spinulae apparently matures at a smaller size than congeners. Development of antennular modifications begins in juvenile males at 11–13 mm, with clasping spines appearing sequentially and with increasing curvature of the proximal portion of the flagellum. By 14–15 mm body length, the male secondary sexual characters of *A. spinulae* are well-developed suggesting sexual maturity. Males of other species of *Anaspides* do not attain similar development until 18 mm or larger. Possibly also significant is that the largest known specimen of *A. spinulae*, at 25 mm, is considerably

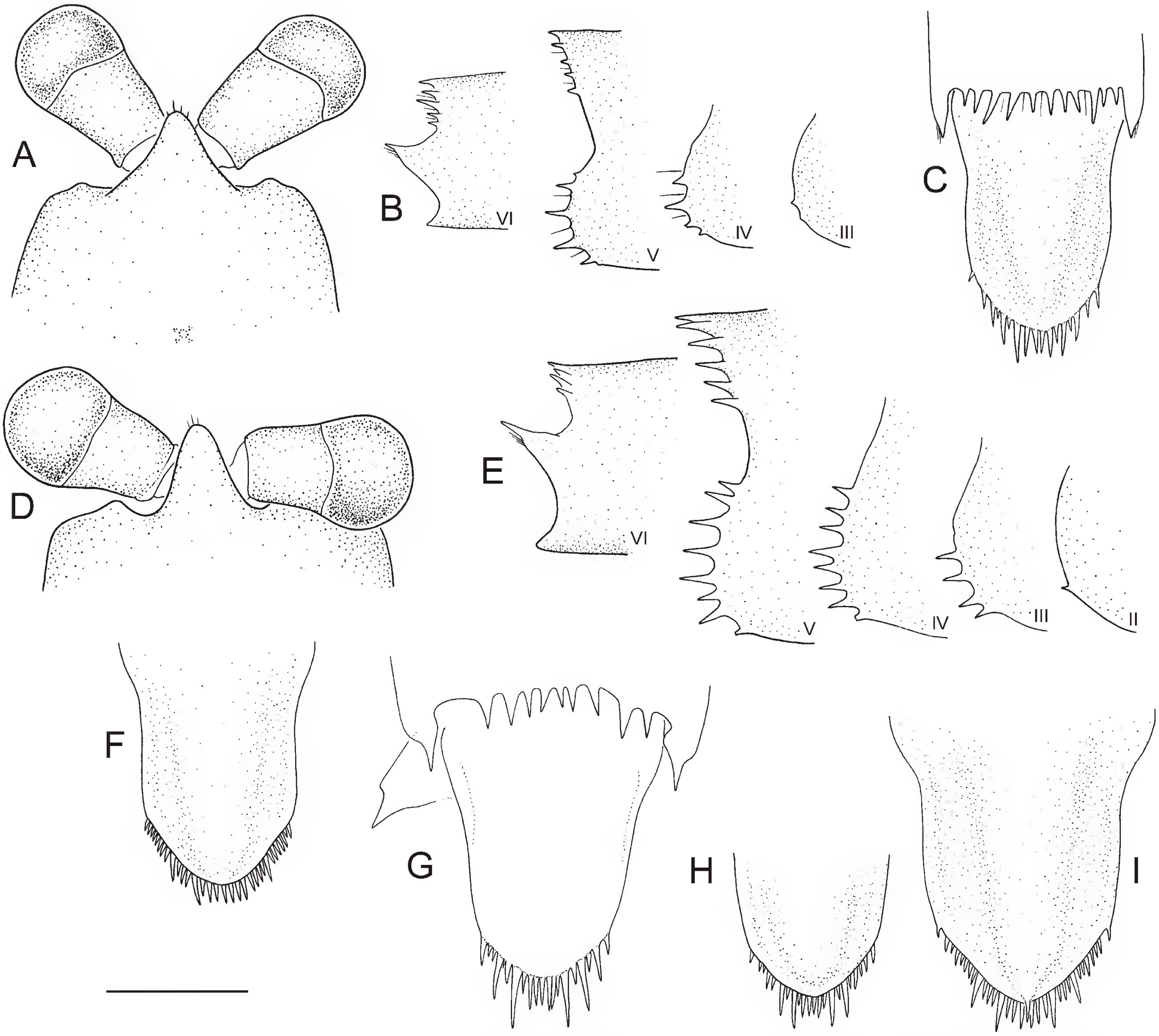

Figure 28. *Anaspides spinulae* Williams, 1965, selected features, Lake St. Clair. *(A–C)* juv. female, 10 mm, AM P99313; *(D–F)* paratype female, 21 mm, AM P14156; *(G)* paratype, sex indet, c. 10 mm, on slide, AM P14152; *(H)* paratype male, c. 13 mm, AM P14147; *(I)* paratype female, +20 mm, on slide, AM P14148. Scale: A–C, G–H= 0.5 mm; D–F, I = 1.0 mm.

smaller than the largest specimens of congeners (35 mm, *A. tasmaniae*; 38 mm, *A. clarkei*; 47 mm, *A. eberhardi*; 31 mm, *A. jarmani*; 55 mm, *A. richardsoni*; 40 mm, *A. swaini*).

Specimens of *A. spinulae* are in most respects morphologically uniform apart from typical allometric variation in the slenderness of the rostrum (increasingly slender with increasing size), eye size (proportionally larger in smaller specimens), and pleonal spine length (proportionally longest in the smaller specimens). The endopod of pleopod 5 is absent or rudimentary in juveniles up to 10 mm body length; present in all others. Pleonal spination is pronounced, even in the smallest juveniles, with pleural spines always present on pleonites 3–5, and those on pleonite 2 appearing at about 20 mm body length. The most significant allometric changes are in the spination of the posterior margin of the telson. The telson spination in the smallest specimens is markedly uneven, with 4–6 long spines evenly distributed among the shorter remaining spines (Figs 27B, 28C,G,H). With increasing body size, the longer telson spines become shorter and more similar to surrounding spines, as in the holotype, somewhat approaching adults of other epigean species (Figs 25B, 28F,I). Similar, albeit less marked changes, are also evident in other species, such as *A. richardsoni* and *A. swaini*, indicating a general developmental pattern. Apart from allometric changes, *A. spinulae* is morphologically uniform, with few other observed variations. The posterolateral spine on pleonite 6 may be accompanied by a secondary spine, and the uropodal protopod and the outer margin of the uropodal exopod have 1 or 2 and 2–4 spines, respectively.

Unfortunately, Williams' original characterization of *A. spinulae* as having a strongly uneven spine row on the telson was misleading, because his accompanying unscaled illustration (Williams, 1965a: fig. 5E) was of a small dissected juvenile (estimated c. 10 mm body length; AM P14152; Fig. 28G) in which the differences in spine length are most pronounced. At any given size, the posterior telson spines in *A. spinulae* are less regular in length than in other epigean *Anaspides* of similar size, but not nearly as pronounced as would be assumed from Williams' figure. Subsequent reports (e.g., O'Brien, 1990) of telsons "intermediate" between *A. spinulae* and typical *A. tasmaniae* were based on the implication from Williams'

(1965a) figure that an adult was depicted. Further, Williams' (1965a) description of the pleonal setae of both *A. tasmaniae* and *A. spinulae* as spines further clouded distinguishing the two forms. This possibly contributed to some of O'Brien's (1990) difficulties in distinguishing between what he called *A. spinulae*, *A. "spinulae"* and *A. tasmaniae* leading to the strong suggestion that all represent the same species. O'Brien (1990) also reported Central Plateau specimens with "longer setae… ", including specimens from Butlers Gorge. As already noted, however, the length of pleonal setae varies allometrically in *Anaspides* and is shortest in adults, as corroborated in specimens from Butlers Gorge examined herein (referrable to *A. swaini*). Whereas the posterior telson ornamentation of adult *A. spinulae* does differ from most other congeners in length and regularity, it is not nearly as marked as originally implied by Williams (1965a).

O'Brien (1990) recorded *A. spinulae* from around the margins of Lake St Clair at about 1.5–15 m depth on multiple substrate types. It apparently does not occur on silted substrates, but is common on stony or pebbled outcrops and among exfoliating sheets of rock on weathering dolerite boulders, with highest densities under rocks, fallen logs and branches, or in *Isoetes* algal beds.

Distribution. Presently known only from Lake St Clair; 1.5–15 m depth; 737 m asl.

Anaspides swaini Ahyong, 2015

Figs 29–36

Anaspides tasmaniae. —Smith, 1909a: 64, 70 (North West Bay River). —Manton, 1930: pl. 2–3. —MacBride, 1930: 1079, unnumbered fig. —Tjønneland *et al*., 1984: 226, figs. 1–10 (heart ultrastructure). —Desmarchelier & Clarke, 1998: 14. —Jarman & Elliot, 2000: fig. 4 (clade F), tab. 1 (part, Mt Anne, Snowy North, Weld River). —Clarke, 2000: 33. —Doran *et al*., 2001, tab. 2 (Bill Nielson Cave). —Camacho *et al*., 2002: fig. 1, tab. 1. —Clarke, 2006: fig. 1.16.

Anaspides sp. (telson 'normal' type). —Eberhard *et al*., 1991: 48 (Junee-Florentine).

Anaspides sp. (telson type intermediate). —Eberhard *et al*., 1991: 48 (Deep Thought Cave, Capricorn Cave).

Anaspides swaini Ahyong, 2015: 598: fig. 1I–L.

Type material. HOLOTYPE: AM P73042,♂ (27 mm), Weld River, 42°48.78'S 146°27.49'E, 460 m asl, coll. S. Jarman. PARATYPES: AM P73043, 2♀♀ (22–28 mm), 12 juv. ♀♀ (8–16 mm), 4 indet juv. (5–7 mm), type locality.

Other material examined. *Cradle Mountain Lake St Clair National Park*: TMAG G6370, 1♂ (22 mm), 3♀♀ (24–34 mm), 2 juv. ♀♀ (13–17 mm), Mt Byron, rainforest creek flowing from Byron Gap into Lake Petrarch, 42°02.4'S 146°03.9'E, coll. R. Mawbey *et al*., 920 m asl, 1970; TMAG G6378, 4 juv. ♀♀ (12–14 mm), just downstream from Lake Petrarch, 42°03.4'S 146°06.1'E, 880 m, coll. R. Mawbey *et al*., 29 Sep 1973; TMAG G6377, 6 juv. ♂♂ (11–13 mm), 5 juv. ♀♀ (10–12 mm), Cuvier Valley below Mt Olympus, 42°03.8'S 146°06.8'E, subterranean pools in rainforest floor, 875 m asl, coll. R. Mawbey *et al*., 29 Sep 1973; TMAG G6426, 2♂♂ (23–28 mm), 6 juv. ♂♂ (14–18 mm), 3♀♀ (25–29 mm), 6 juv. ♀♀ (15–18 mm), Cuvier Valley, below Lake Petrarch, 42°04.8'S 146°08.6'E, small creek in buttongrass plain, 800 m asl coll. R. Mawbey *et al*., 28 Sep 1973; TMAG 14388/G132, 1♂ (22 mm), 2♀♀ (21–24 mm), "Lake St. Clair?", coll. D. Handley, 1937; TMAG G126, 5♂♂ (14–23) mm), 5♀♀ (12–32 mm), Lake St Clair, coll. D. Turner, Feb 1941; AM P72844, 1 juv. ♂ (22 mm), 1 juv. ♀ (13 mm), Mt Rufus, from tarn below summit, 42°07.18'S 146°06.42'E, DP265344(8113), 292-23, coll. A. Terauds, 16 Feb 1992; AM P72842, 1 juv. ♂ (18 mm), 4 juv. ♂♂ (6–7 mm), 1♀ (30 mm), 6 juv. ♀♀ (6–16 mm), Mt Rufus, 42°07.20'S 146°06.43'E, 1170 m, stream flowing into Lake St Clair, coll. S. Jarman; AM P82856, 1♂ (19 mm), 1♀ (21 mm), Mt Rufus, canal near wooden bridge, 42°09.0'S 146°07.2'E, JHB T0201, coll. J.H. Bradbury, 2 Mar 1997; QVM 10:13979, 1♀ (38 mm), Mt Rufus, 42°07.6'S 146°06.0'E, tarn plateau, 1380 m asl, coll. L.D. Crawford, 23 Sep 1951; TMAG G6390, 3♂♂ (20–21 mm), 1 juv. ♂ (17 mm), 6♀♀ (20–32 mm), 1 juv. ♀ (16 mm), Mt Rufus, 42°07.6'S 146°05.9'E, 1400 m, coll. B. Knott, 13 Nov 1971.

Wentworth Hills: QVM 10:49166, 1♂ (23 mm), 3♀♀ (21–33 mm), 1 juv. ♂ (13 mm), 8 juv. ♀♀ (9–12 mm), Wentworth Hills, 42°12'S 146°19'E, in flow, coll. B. Mawbey, 28 Mar 1990; QVM 10:49167, 3♂♂ (21–25 mm), 1♂ juv. (18 mm), 7♀♀ (20–38 mm), 8 juv. ♀♀ (9–19 mm), Wentworth Hills, 42°12'S 146°19'E, lower soaks, in flow, coll. B. Mawbey, 28 Mar 1990; TMAG G6311, 2♂♂ (22–24 mm), 5♀♀ (22–30 mm), 4 juv. ♂♂ (10–18 mm), 18 juv. ♀♀ (8–19 mm), Wentworth Hills, stream draining into Laughing Jack Lagoon, 42°12.47'S 146°19.15'E, 1030 m asl, coll. D. O'Brien & B. Mawbey, 28 Mar 1990; TMAG G6313, 2♂♂ (21–25 mm), 6♀♀ (20–32 mm), 4 juv. ♂♂ (11–14 mm), 6 juv. ♀♀ (8–11 mm), Wentworth Hills, plateau, 42°12.36'S 146°18.14'E, inflow stream to lagoon, 1100 m asl, coll. D. O'Brien & B. Mawbey, 28 Mar 1990.

Butlers Gorge: YPM 9195, 4♂♂ (22–24 mm), 2 juv. ♂♂ (12–19 mm), 3♀♀ (25–36 mm), 4 juv. ♀♀ (15–18 mm), near Butlers Gorge, 42°16.6'S 146°16.3'E, 680 m asl, coll. J.H. Wilson, 20 Oct 1964; TMAG G6406, 5♂♂ (18–22 mm), 2 juv. ♂♂ (12–15 mm), 2♀♀ (21–22 mm), 1 juv. ♀ (13 mm), near Butlers Gorge, 42°16.6'S 146°16.3'E, 680 m asl, coll. P. Tyler, 26 Nov 1963.

Franklin-Gordon Wild Rivers National Park: TMAG G6356, 4♂♂ (22–23 mm), 1 juv. ♂♂ (15–18 mm), 2♀♀ (23–27 mm), 1 juv. ♀ (12 mm), E of Mt Arrowsmith, 42°13.1'S 146°05.8'E, underground part of stream in rainforest, air temp 8.3°C, water temp 6.7°C, 800 m asl, coll. A. Richardson, R. Mawbey, B. Knott & P. Suter, 10 Nov 1974; TMAG G6498, 1 juv. ♀ (8 mm), Capricorn Cave (MR204-24), Mt Ronald Cross karst, 42°13.2'S 146°03.7'E, stream, dark zone, coll. S. Eberhard, 540 m asl, 27 Jan 1989; TMAG 14396/G140, 1♂ (22 mm), 2 juv. ♀♀ (9–11 mm), Lake Tahune, Frenchmans Cap, 42°16'S 145°50'E, 1000 m asl, coll. W.J. Fairbridge, Jan 1945; QVM 10:49053, 2 indet juv. (5–6 mm), Lake Tahune, Frenchmans Cap, 42°16'S 145°50'E, outflow creek, drift sample, 1000 m asl, coll. S. Chilcott, 28 Jan 1988; AM P99165, 2♂♂ (23–29 mm), 9♀♀ (23–30 mm), Lake Tahune, Frenchmans Cap, 42°16'S 145°50'E, 1000 m asl, coll. B.V. Timms, Jan 1989; QVM 10:13972, 1♂ (23 mm), 1♀ (25 mm), 1 juv. ♂ (damaged, c. 15 mm), Frenchmans Cap, 42°16.1'S 145°49.6'E, 1440 m, coll. B. McCausland, 15 Mar 1980; TMAG G6357, 1♀ (27 mm), creek draining into Lake Richmond outflow, King William Range, 42°18.85'S 146°11.15'E, 740 m asl, coll. A. Richardson & G. French, 28 Jan 1989; TMAG G6497, 1 juv. ♀ (19 mm), 4 indet juv. (5–7 mm), Kutikina Cave (F34-34), Franklin River karst, 42°31.8'S 145°46.1'E, 60 m asl, coll. S. Eberhard, 23 Mar 1988; TMAG G6499, 1♂ (21 mm), Kutikina Cave (F34-4), 42°31.8'S 145°46.1'E, stream, 60 m asl, coll. S. Eberhard, 21 Mar 1989; AM P99306, 1♂ (damaged), 1♀ (damaged), Lake Rhona, 42°33.2'S 146°17.2'E, 860 m asl, amongst cobbles near shore, coll. S. Jarman; TMAG G1360, 4 juv. ♂♂ (18–30 mm), 3♀♀ (33–36 mm), Lake Rhona, Upper Gordon River, below Reed's Peak, 42°33'S 146°17'E, 860 m asl, coll. A.P. Andrews & H.D. Barker, 20 Mar 1972; QVM 10:12144, 1♀ (24 mm), Bill Nielson (Rotuli) Cave, Nicholls Range karst, 42°42.3'S 145°49.3'E, small rocky side stream, 30 m asl, NR1-2, coll. S. Eberhard, 19 Feb 1987; TMAG G6400, 1♀ (25 mm), 13 juv. ♂♂ (8–13 mm), 11 juv. ♀♀ (8–13 mm), Vale of Rasselas, E of "The Thumbs", 42°40.2'S 146°23.0'E, buttongrass hole, coll. R. Swain & J. Ong, 17 Feb 1970; TMAG G6409, 1♀ (24 mm), 10 juv. ♂♂ (10–13 mm), 17 juv. ♀♀ (8–14 mm), Vale of Rasselas, E of "The Thumbs", 42°40.2'S 146°23.0'E, buttongrass hole, coll. R. Swain & J. Ong, 17 Feb 1970; TMAG G6412, 1♂ (21 mm), 2 juv. ♂♂ (11–13 mm), 4 juv. ♀♀ (7–10 mm), Vale of Rasselas, creek running parallel to track from Florentine, 42°41.7'S 146°23.8'E, buttongrass hole, coll. R. Swain & J. Ong, 17 Feb 1970.

Southwest National Park: ZSRO 859, 4 juv. ♂♂ (9–11–13 mm), 11 juv. ♀♀ (9–15 mm), Mueller Road, 2 km behind gate, Weld River, creeks, 42°48.76'S 146°24.54'E, 1WP6, 500 m asl, 24 Feb 2013; TMAG G6389, 10 juv. ♀♀ (8–17 mm), SW of Mt Mueller, Port Davey track, between Scotts Peak Road and "Damper Inn", 42°49.5'S 146°23.7'E, first patch of rainforest, 580 m asl, coll. R. Swain, I. Wilson & J. Ong, 18 Feb 1970; TMAG G6364, 16♂♂ (19–25 mm), 3 juv. ♂♂ (11–16 mm), 17♀♀ (19–26 mm), 17 juv. ♀♀ (9–12 mm), S of Mt Mueller, stream at "Damper Inn", 42°49.8'S 146°27.5'E, 470 m, coll. R. Swain, I. Wilson & J. Ong, 18 Feb 1970; OM Iv12886, 2♂♂ (20–21 mm), 1 juv. ♀ (14 mm), Huon River, 2000 ft asl [600 m]; TMAG G6388, 1♂ (27 mm), 19 juv. ♂♂ (8–13 mm), 61 juv. ♀♀ (7–15 mm), 10 indet juv. (6–7 mm), Port Davey track N of Mt Bowes, tributary of Weld River, 42°50.3'S 146°24.6'E, 530 m asl, coll. R. Swain, I. Wilson & J. Ong, 18 Feb 1970; TMAG G128, 3♀♀ (11–24 mm), Mt Bowes, 42°51.6'S 146°24.6'E, 956 m asl, Apr 1939; TMAG 14369/G113, 4♂♂ (24–29 mm), 6♀♀ (23–34 mm), Snowy Mountains, 42°53.4'S 146°39'E, 2000 ft asl [600 m], coll. C.D. King, 20 Feb 1939; TMAG 14373/G117, 4♂♂ (25–32 mm), 6♀♀ (19–33 mm), Snowy Mountains, 42°55.5'S 146°40.5'E, 3000 ft asl [900 m], small Lake, coll. C.D. King, Feb 1939; AM P56374, 2 juv. ♂♂ (22–29 mm), Lake Skinner, Snowy Mountains, 42°57'S 146°41'E, C.62T, small stream at end of track to Lake, coll. W. Ponder *et al*., 15 Jan 1982; AM P73044, 2 juv. ♂♂ (17–28 mm), 3 juv. ♀♀ (10–25 mm), Snowy North, stream flowing into Styx River, 42°53.26'S 146°39.30'E, 590 m asl, coll. S. Jarman; TMAG G397, 1♀ (40 mm), plateau on summit of Mt Snowy, small pool 3 inches deep, 3500 ft asl [1050 m], coll. J.F. Thompson, 31 Jan 1962; TMAG G3432, 5♀♀ (24–33 mm), Lake Skinner, Snowy Mountains, 42°56.8'S 146°40.5'E, 970 m asl], coll. D. Farnell, 28 Jan 1962; TMAG G6387, 28 juv. ♂♂ (20–27 mm), 8♀♀ (25–33 mm), 18 juv. ♀♀ (18–25 mm), Lake Skinner, Snowy Mountains, 42°56.8'S 146°40.5'E, 970 m asl, coll. M. Fenton, 29 Nov 1971; TMAG G130, 2♂♂ (32–34 mm), 6♀♀ (17–35 mm), Lake Denison, 42°57.4'S 146°41.0'E, 1900 ft asl [570 m], coll. C. King, Feb 1936; TMAG G127, 1♂ (25 mm), 5 juv. ♀♀ (13–20 mm), Lake Denison, 42°57.4'S 146°41.0'E, 1900 ft asl [570 m], coll. C. King, Feb 1939; TMAG G112, 3♂♂ (23–27 mm), 9♀♀ (22–31 mm), Lake Skinner, Snowy Mountains, 42°56.8'S 146°40.1'E, c. 3000 ft asl [970 m], coll. C.D. King, Feb 1939; TMAG G6374, 1♀ (53 mm), Lake Skinner, Snowy Mountains, 42°56.8'S 146°40.5'E, 970 m asl, coll. D. Farnell, 28 Jan 1962; TMAG G6407, 2♂♂ (28–29 mm), 6 juv. ♂♂ (20–22 mm), 10 ♀♀ (23–26 mm), 9 juv. ♀♀ (8–14 mm), Snowy Mountains, 42°54'S 146°42'E, tarn, coll. M. Fenton, 19 Nov 1970; TMAG G6361, 1 juv. ♂ (12 mm), Snowy South, 42°56.7'S 146°39.4'E, small Lake on slope, 1340 m asl, coll. P. Davies, Apr 1986; NMV J42439, 1♂ (25 mm), 1♀ (26 mm), Gordon River, Capt. Sutton, Jan 1949; TMAG G136, 1 juv. ♀ (18 mm), Lake Pedder [probably near Maria Creek, 42°53.8'S 146°17.3'E, coll. C. King, Apr 1939; AM P99307, 2♀♀ (damaged), Coronation Peak, 42°54.81'S 146°00.68'E, tarn, coll. S. Jarman; TMAG G6316, 1♂ (23 mm), 1 juv. ♂ (22 mm), 4♀♀ (23–31 mm), 6 juv. ♀♀ (14–21 mm), Mt Anne Plateau,

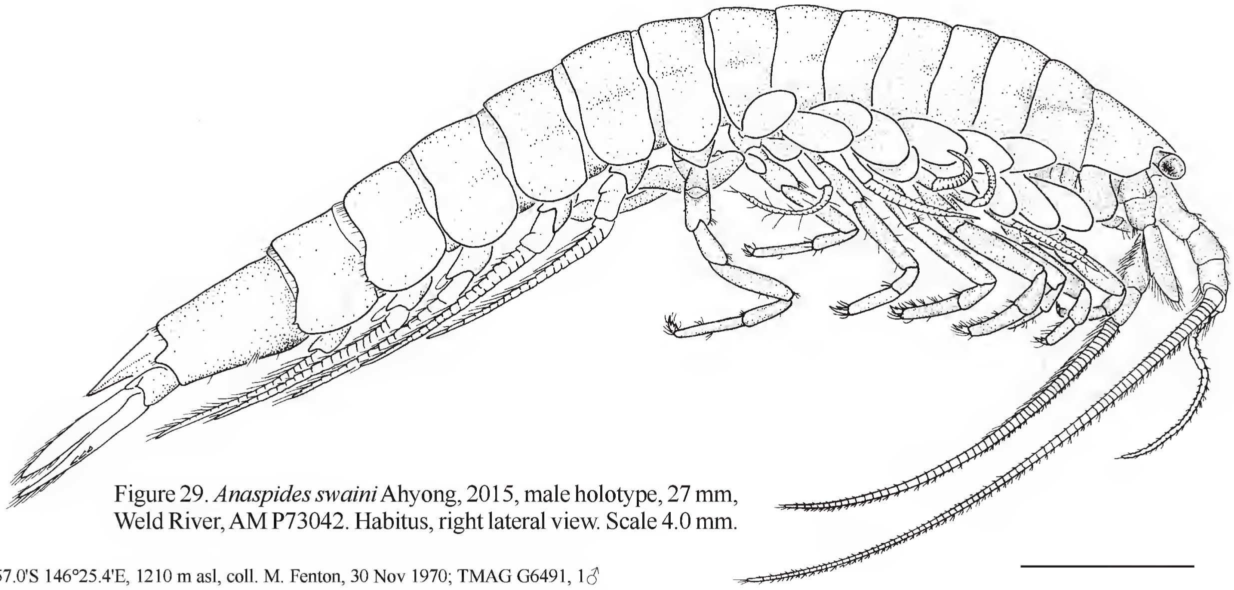

Figure 29. *Anaspides swaini* Ahyong, 2015, male holotype, 27 mm, Weld River, AM P73042. Habitus, right lateral view. Scale 4.0 mm.

42°57.0'S 146°25.4'E, 1210 m asl, coll. M. Fenton, 30 Nov 1970; TMAG G6491, 1♂ (25 mm), Deep Thought Cave (MA10), Mt Anne, 42°56.0'S 146°26.5'E, at 180 m in, 1000 m asl, coll. S. Eberhard, 12 Jan 1987; TMAG G6496, 1♂ (25 mm), 1♀ (29 mm), Deep Thought Cave (MA10-1), Mt Anne, 42°56.0'S 146°26.5'E, at 180 m in, 1000 m asl, coll. S. Eberhard, 13 Jan 1987; TMAG G6416, 1 juv. ♀ (9 mm), Search Camp, Mt Anne, 42°56.8'S 146°25.4'E, 1240 m asl, coll. J. Bludhorn, 4 Mar 1972; TMAG G6430, 1 juv. ♂ (21 mm), Search Camp, Mt Anne, 42°56.8'S 146°25.4'E, 1240 m asl, coll. J. Bludhorn, 4 Mar 1972; QVM 10:49052, 1♀ (21 mm), Croaking Lake, Remote Peak, 42°58.07'S 146°03.05'E, benthos, 820 m asl, coll. S. Chilcott, 13 Nov 1986; TMAG G6358, 1♂ (25 mm), 1 juv. ♂ (16 mm), 1♀ (32 mm), 6 juv. ♀♀ (9–15 mm), small creek draining into Lake Edgar, 43°02.9'S 146°20.7'E, 300 m asl, coll. R. Swain *et al*., 3 Jun 1970; TMAG G6453, 2♂♂ (24–25 mm), 4 juv. ♂♂ (16–20 mm), 2♀♀ (24–28 mm), 3 juv. ♀♀ (12–16 mm), Lake Fortuna, Western Arthurs, 43°07.61'S 146°13.68'E, 1240 m asl, coll. Project Raleigh, Western Arthurs Team, 15 Jan 1987; TMAG G6354, 2♀♀ (21 mm), 1 juv. ♀ (17 mm), Lake Cygnus, Western Arthurs Range, 43°07.80'S 146°14.16'E, coll. P. Hamr & L. Cook, 7 Nov 1990; TMAG G6451, 1 juv. ♂ (19 mm), 8♀♀ (20–29 mm), Lake Cygnus, Western Arthurs Range, 43°07.80'S 146°14.16'E, coll. Project Raleigh, Western Arthurs Team, 16 Jan 1987; AM P99311, 1♂ (damaged), 1 juv. ♀ (damaged), Square Lake, Western Arthurs, 43°09.08'S 146°16.09'E, amongst cobbles near shore, 860 m asl, coll. S. Jarman; TMAG G6322, 1♂ (20 mm), 3 juv. ♀♀ (12–19 mm), Square Lake, 43°08.59'S 146°15.58'E, 860 m asl, coll. Western Arthurs Team, Project Raleigh, 17 Jan 1987; TMAG G6437, 10 ♂♂ (18–24 mm), 23 juv. ♂♂ (9–17 mm), 27♀♀ (19–37 mm), 33 juv. ♀♀ (8–18 mm), Square Lake, Western Arthurs, 43°08.6'S 146°15.6'E, 860 m asl, coll. R. Swain, 4 Feb 1971; TMAG G6447, 2 juv. ♂♂ (15–16 mm), 4 juv. ♀♀ (8–16 mm), Square Lake, Western Arthurs, 43°08.6'S 146°15.6'E, 860 m asl, coll. M. Fenton, Jan 1971; NMV J40508, 4♀♀ (24–43 mm), Lake Oberon, Western Arthur Ranges, 43°09.1'S 146°16.0'E, 840 m asl, coll. G. Poore, 28 Feb 1990; AM P99310, 1♂ (damaged), 1♀ (damaged), Lake Oberon, 43°08.92'S 146°16.10'E, amongst cobbles near shore, coll. S. Jarman; AM P99309, 2♀♀ (damaged), Haven Lake, Western Arthurs, 43°10.35'S 146°19.92'E, coll. S. Jarman; TMAG G6436, 3♂♂ (15–18 mm), 1 juv. ♂ (10 mm), 6♀♀ (18–20 mm), 1 juv. ♀ (12 mm), Haven Lake, Western Arthurs, 43°10.3'S 146°20.0'E, 900 m asl, coll. M. Fenton, Jan 1971; TMAG G6417, 1♀ (20 mm), Prom Lake, 43°10.0'S 146°21.6'E, 820 m asl, coll. D. Gotts, 27 Jan 1970; TMAG G6452, 5♀♀ (19–26 mm), Lake Ceres, Western Arthurs, 43°08.53'S 146°15.07'E, 780 m asl, coll. Project Raleigh, Western Arthurs Team, 17 Jan 1987; TMAG G6425, 9 juv. ♂♂ (15–17 mm), 5♀♀ (21–26 mm), 3 juv. ♀♀ (15–17 mm), Lake Sirona, Western Arthurs, 43°10.0'S 146°21.6'E, 1020 m asl, coll. M. Fenton, Jan 1971; AM P99308, 1♂ (damaged), Lake Picton, 43°09.56'S 146°38.23'E, coll. S. Jarman; TMAG G6317, 10 juv. ♂♂ (15–28 mm), 20 ♀♀ (24–33 mm), 11 juv. ♀♀ (14–21), Lake Picton, 43°09.5'S 146°38.3'E, 900 m asl, 23 Jan 1969; TMAG G6424, 1♂ (23 mm), 2 juv. ♂♂ (26–28 mm), 25♀♀ (23–36 mm), Lake Picton, 43°09.5'S 146°38.2'E, 900 m asl, P. Tyler, Jan 1969; NMV J42445, 1 juv. ♂ (21 mm), 5♀♀ (25–27 mm), Hanging Lake, near Federation Peak, 43°16.7'S 146°27.8'E, 1140 m asl, coll. I. Stuart, 17 Jan 1974.

Mt Field, Junee-Florentine Karst: TMAG G6435, 3♂♂ (18–20 mm), 1 juv. ♂ (12 mm), 1♀ (19 mm), 1 juv. ♀ (12 mm), Robert Tarn, Tarn Shelf, Mt Field, 42°40.7'S 146°34.2'E, sample 1, 1200 m asl, coll. I. Wilson & J. Ong, 25 Jan 1970; TMAG G8172, 2♂♂ (22–30 mm), 2 juv. ♂♂ (14–16 mm), Robert Tarn, Tarn Shelf, Mt Field, 42°40.7'S 146°34.2'E, 1200 m asl, coll. T. Walker, Mar 1972; QVM:2016:10:0003, 1♂ (23 mm), Mawson Plateau, Mt Field, 42°41.4'S 146°35.1'E, 1270 m asl, coll. C. Reid, 1975; QVM 10:12456, 1♀ (28 mm), 2 juv. ♀♀ (10–15 mm), Khazad Dum (JF4-17), Junee-Florentine karst, streamways, 42°42.6'S 146°33.6'E, 700 m asl, coll. S.M. Eberhard *et al*., 27 Jun 1989; AM P99305, 1♀ (shrivelled, poor condition, c. 30 mm), Risby Basin Cave (Ray Benders Cave) (RB-X4), Risby Basin Karst, SW of Maydena, 42°46.6'S 146°36.9'E, underside of large boulder in stream, dark zone, 998-11, coll. A. Clarke, 13 Sep 1998.

Arve Valley–Hartz: TMAG G2214, 1♀ (25 mm), Arve Loop Road, Arve Valley, 43°07.7'S 146°44.9'E, from creek, 390 m asl, coll. R. Shoobridge, 14 Feb 1980; TMAG G6382, 24 juv. ♂♂ (13–28 mm), 8♀♀ (26–32 mm), 39 juv. ♀♀ (8–24 mm), 1 indet juv. (7 mm), Hartz Mountains [almost certainly from northern Hartz], coll. R. Swain & G. Bert, Feb 1970.

Wellington Range: TMAG G6402, 5♂♂ (22–31 mm), 10 ♀♀ (27–34 mm), Myrtle Forest Creek, 42°51.6'S 147°10.3'E, 440 m asl, coll. R. Swain, Jun 1969; TMAG G6403, 5♂♂ (28–33 mm), 14 juv. ♂♂ (17–26 mm), 17♀♀ (24–38 mm), 3 juv. ♀♀ (18–21 mm), Myrtle Forest Creek, 42°51.6'S 147°10.3'E, 440 m asl, coll. R. Swain, Jun 1969; TMAG G983, 19♂♂ (18–25 mm), 12♀♀ (14–26 mm), Sorell Creek, Myrtle Gully [Myrtle Forest], Collinsvale, 42°53.8'S 147°15.4'E, 400 m asl, coll. museum staff, 9 Dec 1964; TMAG G6315, 4♂♂ (24–28 mm), 6♀♀ (25–32 mm), Myrtle Forest, Collinsvale, 42°51.6'S 147°10.3'E, 440 m asl, coll. R. Swain, Sep 1969; AM P4143, 1♂ (32 mm), 1♀ (34 mm), Mt Wellington, 42°53.8'S 147°14.5'E, coll. E.A. Briggs, pre 1918; AM P14772, 2♂♂ (24–26 mm), 1 juv. ♂ (19 mm), 1♀ (21 mm), Mt Wellington, 42°54'S 147°14'E, from University of Sydney Biology Dept in 1964; AM P14773, 1♂ (36 mm), Mt Wellington, from University of Sydney Biology Dept in 1964, possible Haswell label; AM G1779, 1♂ (24 mm), 3♀♀ (24–27 mm), 5 juv. ♀♀ (14–20 mm), summit of Mt Wellington, 42°54'S 147°14'E, pres. C. Hedley, pre 1898; AM P2266, 1♂ (34 mm), Mt Wellington, 42°54'S 147°14'E, pres. E.G. Goddard; AM P2551, 1♂ (32 mm), 4 juv. ♂♂ (19–20, 22 mm), 3♀♀ (23–24 mm), 4 juv. ♀♀ (12–20 mm), Mt Wellington, 42°54'S 147°14'E, coll. T.T. Flynn; USNM 59126 (ex AM P2551), 2♂♂ (24–25 mm), Mt Wellington, coll. T.T. Flynn; USNM 78433, 1♂ (29 mm), Mt Wellington, snow pools in swamp, from Mel Ward; OM Iv.1395, 3♂♂ (15–25 mm), 15♀♀ (8–28 mm), no data; USNM 25030, 1♂ (27 mm), 1♀ (25 mm), "Lakes (4000 ft) Tasmania", G.M. Thomson; AM P9217, 11 juv. ♂♂ (18–29 mm), 12 juv. ♀♀ (19–27 mm), Wishing Well, Mt Wellington, 42°55.67'S 147°14.76'E, 1450 feet asl [442 m], coll. C. Anderson, A. Musgrave, G.P. Whitley, 23 Jan 1928; AM P10724, 2♂♂ (19–22 mm), 6 juv. ♂♂ (16–18 mm), 2♀♀ (19–24 mm), 13 juv. ♀♀ (8–17 mm), Mt Wellington, 42°54'S 147°14'E, coll. F.D. Manning, Jan 1935; AM P56375, 1♂ (32 mm), 3 juv. ♂♂ (14–18 mm), 1♀ (20 mm), 6 juv. ♀♀ (12–16 mm), Mt Wellington, small pools (running water) 2500 ft [750 m], coll. J.W. Evans, Dec 1938; AM P82859, 1♂ (24 mm), 2 juv. ♂♂ (9–11 mm), 1♀ (23 mm), 15 juv. ♀♀ (8–12 mm), Mt Wellington, 12 Mar 1997; TMAG G794, 1♂ (23 mm), back of Mt Wellington, coll. G.E. Nicholls, 16 Dec 1933; WAM C58162, 2♀♀ (29–34 mm), Mt Wellington, coll. J. Searle; WAM C367 (ex No. 6613), 3 juv. ♀♀ (16–17 mm), Mt Wellington, coll. J. Searle, 29 Jan 1913; SAMA C473, 2♀♀ (shrivelled, previously dried; c. 25–26 mm), 2 juv. ♀♀ (9–13 mm), 2 indet juv. (6 mm), North West Bay River, Mt Wellington, 42°55.3'S 147°11.2'E, 2700 ft [810 m], coll. Prof. Osborn; AM P9218, 2♂♂ (30–32 mm), 3 juv. ♂♂ (20–22 mm), 5♀♀ (28–34 mm), 7 juv. ♀♀ (15–23 mm), Fern Tree Glen, Mt Wellington, 42°55.5'S 147°15.7'E, coll. C. Anderson, A. Musgrave, G.P. Whitley, 23 Jan 1928; TMAG G6450, 3♂♂ (30–33 mm), 3 juv. ♂♂ (16–22 mm), 6♀♀ (26–40 mm), 4 juv. ♀♀ (18–23 mm), St. Crispins Well, Mt Wellington, 42°55.76'S 147°12.57'E, 640 m asl, coll. R. Swain, 14 Feb 1971; SAMA C8445, 1♂ (21 mm), 2♀♀ (22–28 mm), Huonville, creeks, coll. R.T.T.

Orford: TMAG G120, 1 juv. ♂ (c. 17 mm), 1 juv. ♀ (16 mm), "?Orford, east coast, 1926".

No data: TMAG, 1 juv. ♂ (14 mm), 2 juv. ♀♀ (16–19 mm), label faded, from R. Swain.

Description. Eyes with well-developed cornea, pigmented, wider than and longer than half length of stalk (epigean specimens) to slightly reduced, slightly narrower than stalk, half length of stalk (in some subterranean forms); stalk with subparallel margins.

Rostrum narrow in adults, apex blunt.

Pleonites with pleura sparsely setose, rounded; pleura 1–2 unarmed; pleuron 3 usually unarmed, at most with small serration; pleura 4–5 unarmed or with 0–3 and 0–6 small spines, respectively, usually unarmed or with 1 spine

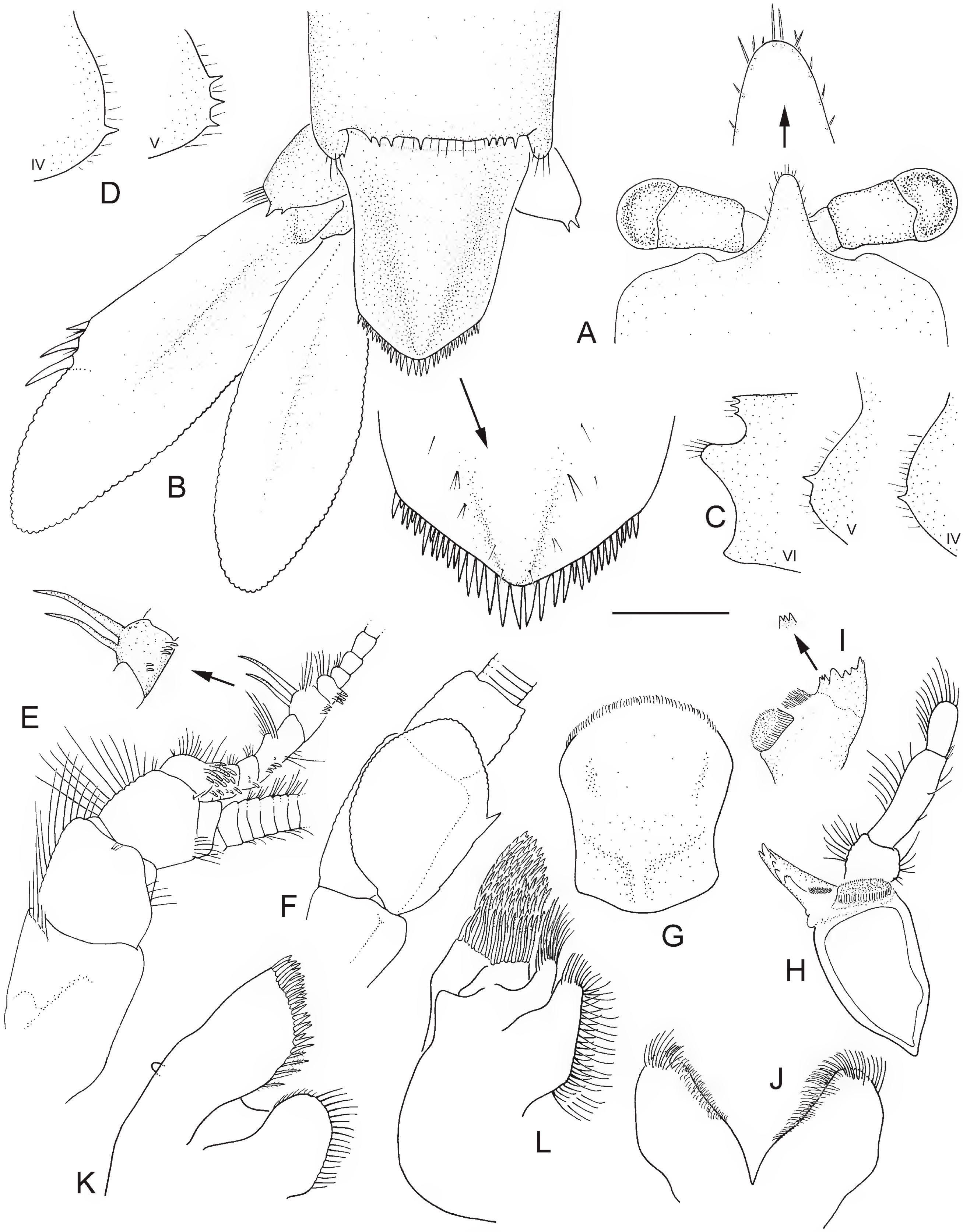

Figure 30. *Anaspides swaini* Ahyong, 2015, male holotype, 27 mm, Weld River, AM P73042. *(A)* cephalothorax, dorsal view; *(B)* pleonite 6, telson and left uropod; *(C)* pleonites 4–6 pleura, right lateral view; *(D)* pleonites 4–5 pleura, left lateral view; *(E)* right antennule; *(F)* right antenna; *(G)* labrum, anterior view; *(H)* right mandible; *(I)* right mandible incisor process; *(J)* paragnaths, anterior view; *(K)* right maxillule; *(L)* right maxilla. Scale: A–F = 1.0 mm; G–L = 0.5 mm.

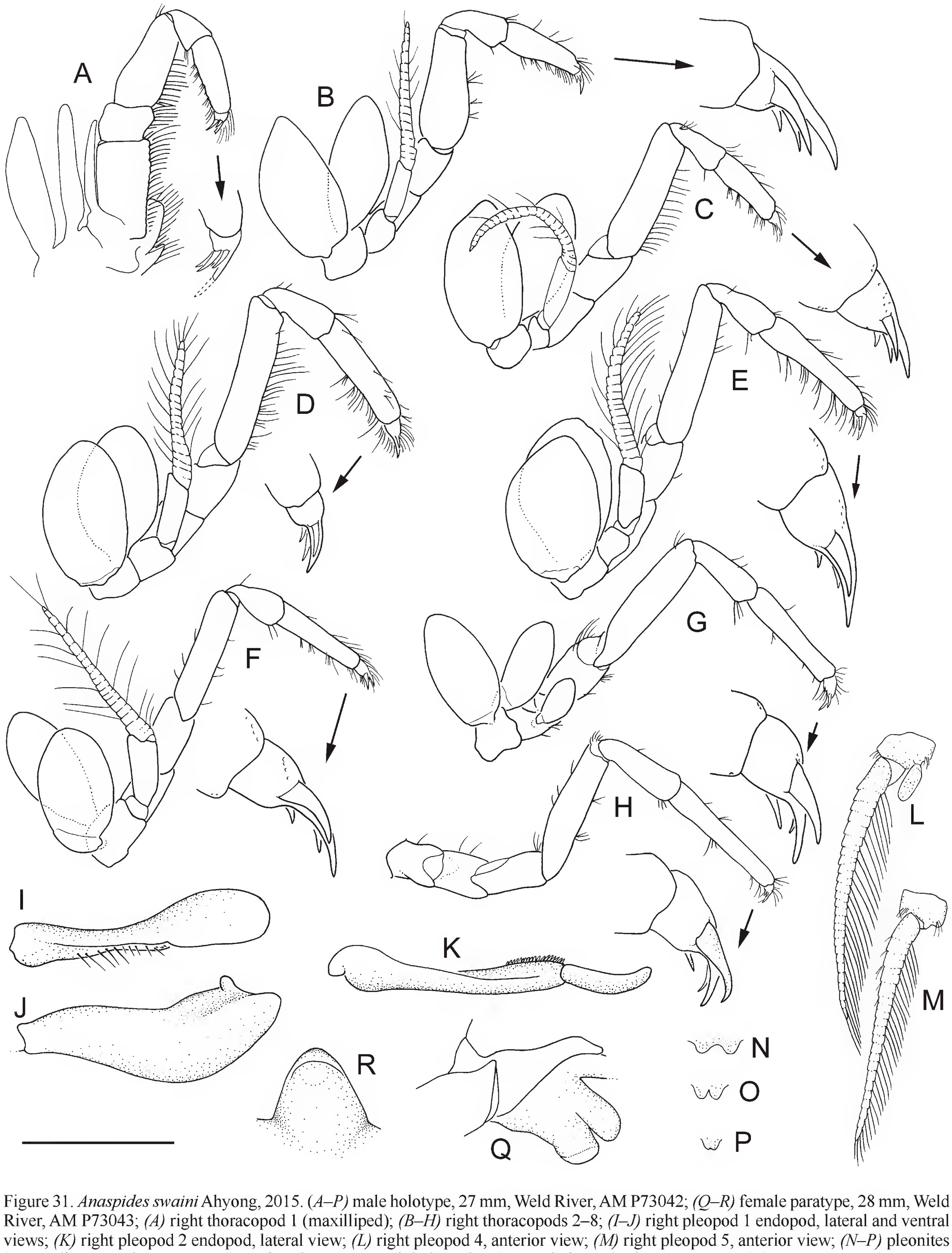

Figure 31. *Anaspides swaini* Ahyong, 2015. (*A–P)* male holotype, 27 mm, Weld River, AM P73042; *(Q–R)* female paratype, 28 mm, Weld River, AM P73043; *(A)* right thoracopod 1 (maxilliped); *(B–H)* right thoracopods 2–8; *(I–J)* right pleopod 1 endopod, lateral and ventral views; *(K)* right pleopod 2 endopod, lateral view; *(L)* right pleopod 4, anterior view; *(M)* right pleopod 5, anterior view; *(N–P)* pleonites 3–5 median sternal processes; *(Q–R)* female gonopore, right lateral and ventral views. Scale A–H, L, M = 2.0 mm; N–R = 1.4 mm.

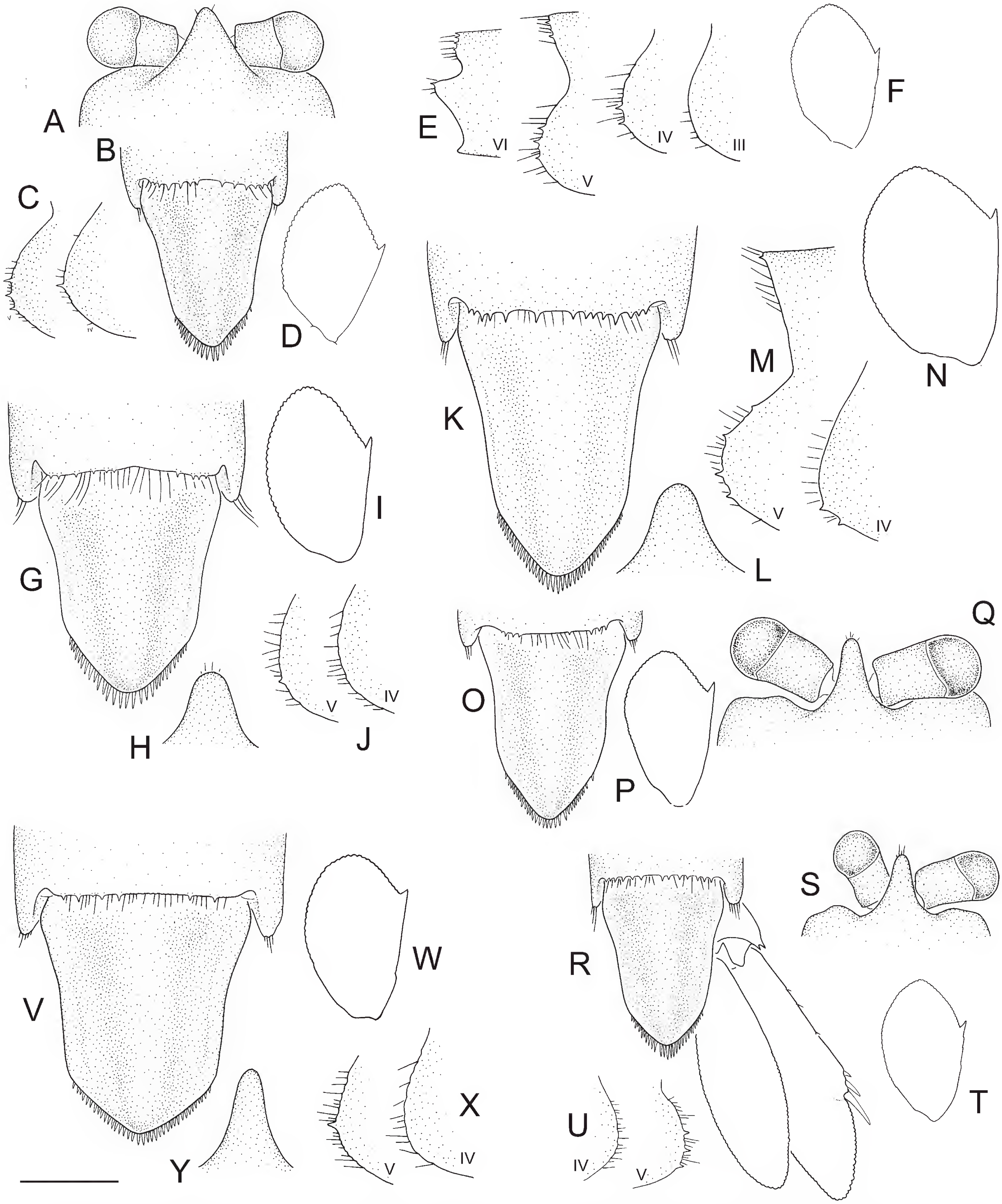

Figure 32. *Anaspides swaini* Ahyong, 2015, selected features. (*A–D)* male, 19 mm, Robert Tarn, Mt Field, TMAG G6435. (*E–F)* paratype female, 22 mm, AM P73043; *(G–J)* female, Arve Valley, TMAG G2214; *(K–N)* female, 25 mm, Vale of Rasselas, TMAG G6400; *(O–Q)* male, c. 23 mm, Square Lake, AM P99311; *(R–U)* female, 18 mm, Lake Pedder, TMAG G136; *(V–Y)* male, 27 mm, Lake Tahune, Frenchmans Cap, AM P99165. *A, Q, S,* anterior cephalothorax. *B, G, K, V,* telson. *C, E, J, M, U, X,* pleonal pleura. *D, F, I, N, O, T, W,* scaphocerite. *H, L, Y,* rostrum. *R,* telson and right uropod. Scale = 1.0 mm.

on pleuron 5. Pleonite 5 posterior tergal margin (usually) unarmed or with 3–7 small spines either side of midline, setose. Pleonite 6 posterior margin weakly to fully spinose, setose; posterolateral margin setose, rounded, with or without minute denticle. Pleonal sternites 3–4 with distinctly bilobed median processes between pleopod bases, widest on sternite 3; sternite 5 with narrow, weakly emarginate lobe.

Telson length and width subequal or longer than wide, pentagonal, widest proximally; lateral margins sinuous in dorsal outline, distally subparallel to convergent; transition from lateral to posterior margin obtusely angular; posterior margin angular to slightly rounded, blunt medially; posterior

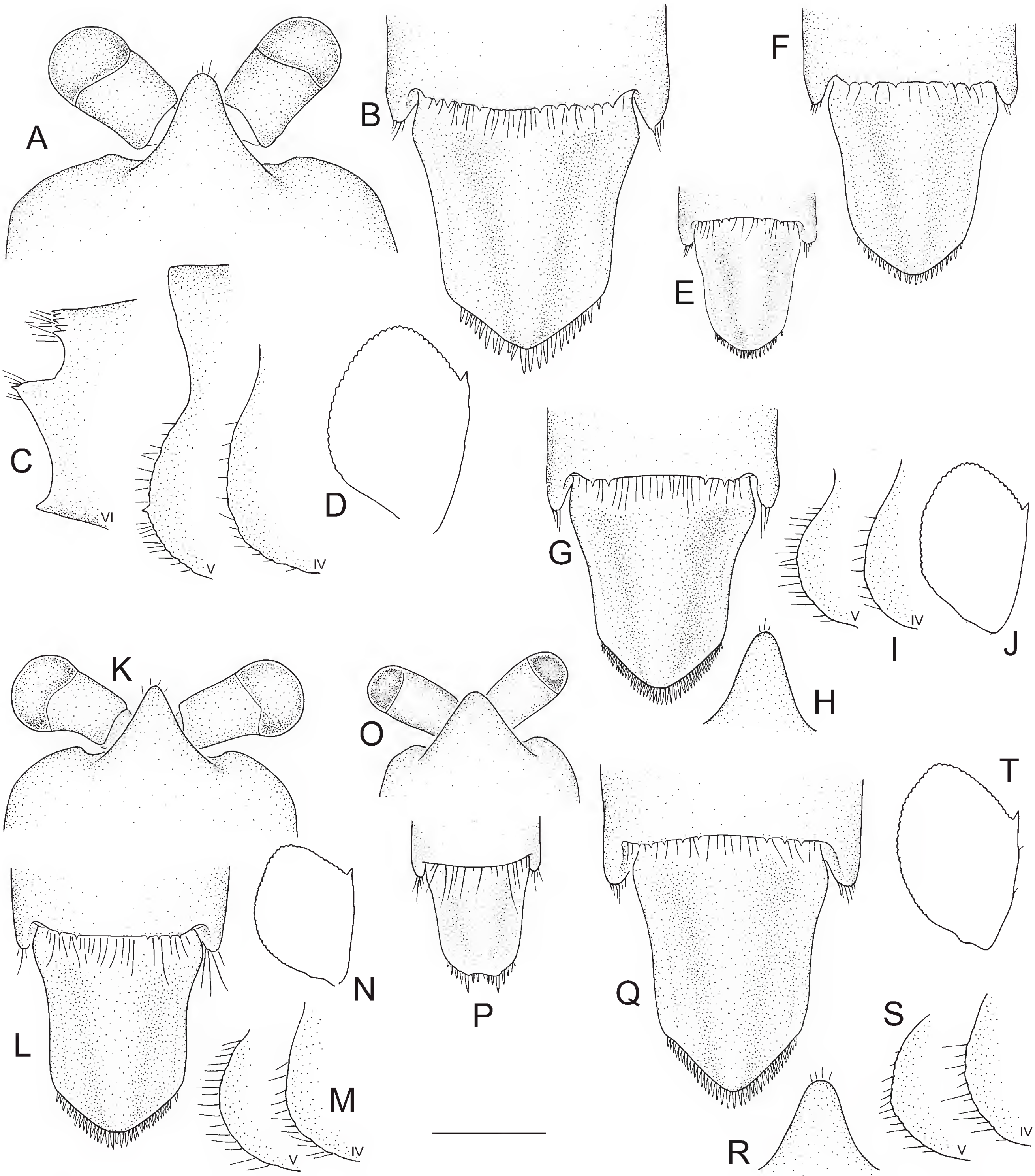

Figure 33. *Anaspides swaini* Ahyong, 2015, selected features. (*A–D)* male, 33 mm, St. Crispins Well, North West Bay River, Mt Wellington, TMAG G6450; *(E–F)* juv. male (16 mm), juv. female (23 mm), St. Crispins Well, Mt Wellington, TMAG G6450; *(G–J)* male, 22 mm, Sorell Creek, Myrtle Forest, TMAG G983; *(K–N)* male, 24 mm, Butlers Gorge, YPM 9195; *(O–P)* indet juv, 8 mm, Mt Rufus, AM P72842; *(Q–T)* female, 30 mm, Mt Rufus, AM P72842. *A, K, O,* anterior cephalothorax. *B, E–G, L, P, Q,* telson. *C, I, M, S,* pleonal pleura. *D, J, N, T,* scaphocerite. *H, R,* rostrum. Scale: A–N, Q–T = 1.0 mm; O–P = 0.5 mm.

spine row with 19–54 slender, evenly graded, closely spaced spines, longest medially.

Antennule inner flagellum about 0.2 × body length (19–20 articles in holotype); article 7 inner margin obtusely angled in adult males, with 2 long, slender clasping spines proximally; outer flagellum 0.4–0.6 × body length (78–80 articles in holotype) in epigean specimens, 0.5–0.7 × in subterranean specimens. Antennal flagellum 0.3–0.4 × body length (57–58 articles in holotype) in epigean and subterranean specimens; scaphocerite elongate, ovate, lateral spine slightly distal to midlength; apex reaching as far as midlength of distal peduncular article.

Pleopods 1–4 or 5 with endopod in adults. Adult male pleopod 1 distally widened, scoop-like, lateral margins expanded, obscuring retinacular lobe in lateral view.

Uropodal protopod dorsally unarmed or with 1 or 2 small spines; exopod with 2–4 movable spines on outer margin near position of partial diaeresis; exopod length about 2.5–3 times

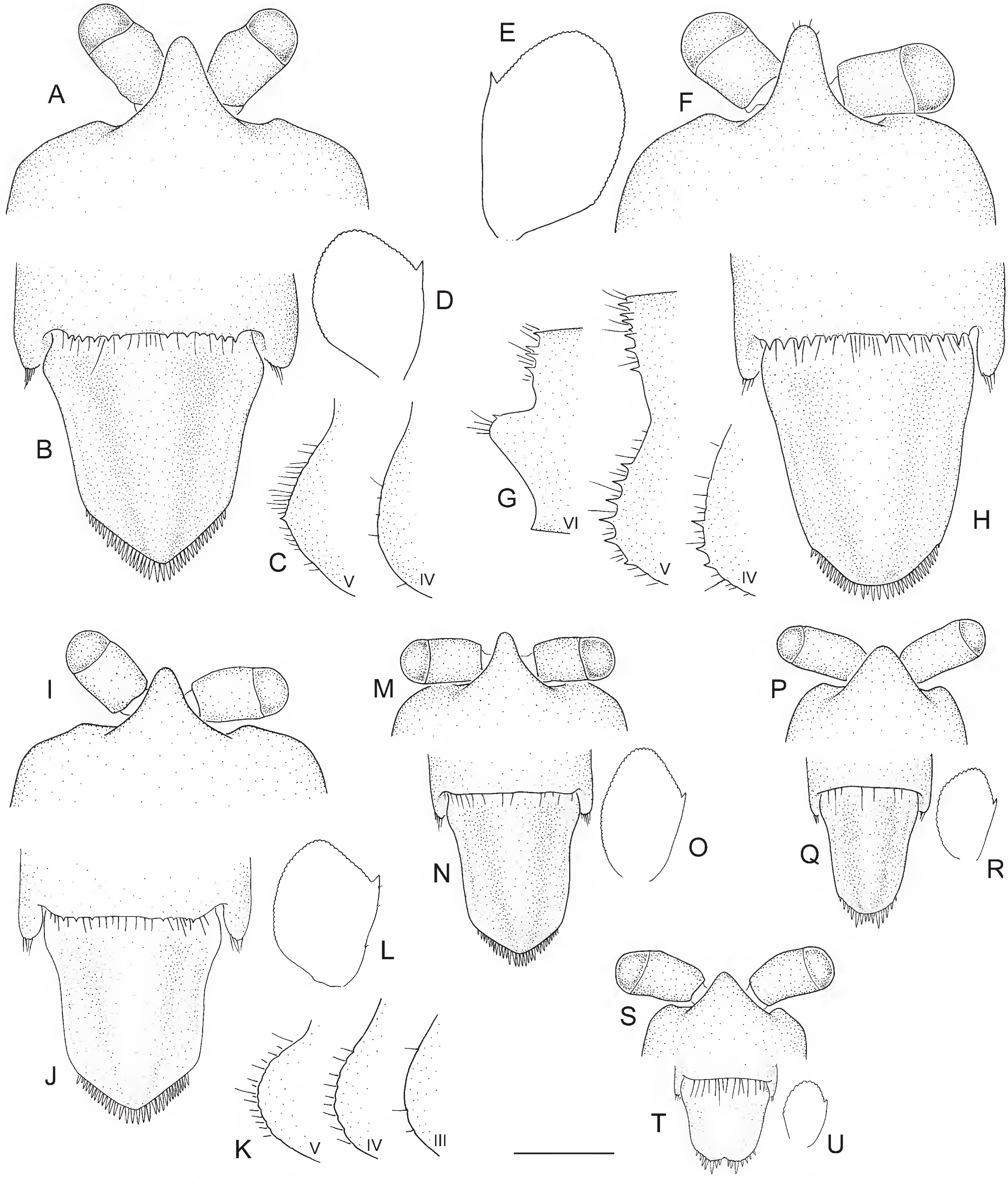

Figure 34. *Anaspides swaini* Ahyong, 2015, selected features. *(A–D)* male, 30 mm, Deep Thought Cave, Mt Anne, TMAG G6496; *(E–H)* female, 28 mm, Khazad Dum Cave, Mt Field, QVM 10:12456; *(I–L)* female, 24 mm, Bill Nielson Cave, QVM 10:12144; *(M–O)* male, 21 mm, Kutikina Cave, TMAG G6499; *(P–R)* juv. female, 8 mm, Kutikina Cave, TMAG G6497; *(S–U)* indet juv, 7 mm, Capricorn Cave, Mt Ronald Cross, TMAG G6498. *A–D, E–H, I–L,* anterior cephalothorax, telson, pleonal pleura and scaphocerite. *M–O, P–R, S–U,* anterior cephalothorax, telson and scaphocerite. Scale: A–O = 1.0 mm; P–U = 0.5 mm.

width, slightly wider than endopod, apex rounded, narrow to relatively broad.

Measurements. Male (n = 433) 6–34 mm, female (n = 794) 6–40 mm, indet (n = 13) 5–7 mm.

Remarks. *Anaspides swaini* is distinguished from other congeners by the combination of the angular posterior margin of the telson, blunt or minutely spinose posterolateral angles of pleonite 6, and the presence of two clasping spines in adult males (Fig. 30B,C,E). *Anaspides swaini* ranges widely in southern Tasmania, from the Wellington range in the southeast, southwest to the Snowy and Arthur Ranges, flanking lakes Pedder and Gordon, and north to the vicinity of Lake St Clair (Fig. 36).

Three subtly different morphological forms of *A. swaini* are recognized here. Form 1 (Figs 29–31, 32A–U, 34A–H), corresponds to *A. swaini* sensu stricto and has short spines along the upper posterior margins of pleonite 6 (and often pleonite 5 in specimens from the vicinity of Weld River, Vale of Rasselas and caves in the vicinity of Mt Field), 1–3 small spines on the pleura of pleonites 4–5, no endopod on pleopod 5 (except in specimens from the Vale of Rasselas, and some specimens from Mt Mueller and Federation Peak), and a usually trifid proximal tooth on the right mandibular incisor process. Form 1 has a southern range, essentially around the periphery of Lake Gordon and Lake Pedder, from Lake Rhona to Mt Field (where it may overlap with *A. richardsoni*) and Mt Mueller to the Snowy Mountains, Federation Peak, the Arthur Ranges and at least as far north as Coronation Peak on the southwestern side of Lake Pedder. Note that the distributional overlap between *A. richardsoni* and *A. swaini* at Mt Field is largely epigean versus subterranean, respectively, though the two species are occasionally sympatric in surface waters of Mt Field. Specimens labelled as possibly from "?Orford" are juvenile *A. swaini*, with antennular modifications as yet incomplete in the male. As argued by O'Brien (1990), the Orford locality is almost certainly erroneous, being well outside of the known range of *A. swaini* (Fig. 36). Moreover, the specimens correspond most closely to specimens from the Vale of Rasselas, having a spinose pleonite 6 and pleura 4–5 (larger juvenile), and an endopod on pleopod 5.

Form 2 (Figs 32V–Y, 33K–T, 34I–U) has a northern range largely beyond Lakes Gordon and Pedder. On the surface, Form 2 ranges from the western vicinity of Lake St Clair including the Cuvier Valley and Mt Rufus south to Butlers Gorge and Wentworth Hills and Frenchmans Cap; it continues further south in caves in the Nicholls Range karst (Bill Nielson) and Franklin River karst (Kutikina), where it is apparently isolated from surface forms (Eberhard *et al.*, 1991). Specimens of Form 3 typically have a few spines on pleonite 6, unarmed pleura 4–5 (occasionally 1 or 2 small spines on pleuron 5), presence of the pleopod 5 endopod in adults (variable in specimens from Frenchmans Cap) and a bifid right proximal mandibular incisor tooth.

Form 3 (Fig. 33A–J), has a southeasterly range, stretching from the western and northern Wellington Range, including the North West Bay River catchment of Mt Wellington, to at least the Huonville area; it may overlap with *A. tasmaniae* at Mt Wellington (see Remarks under account of *A. tasmaniae*). Form 3 has similarly minimal pleonal spination as Form 2, but usually lacks the pleopod 5 endopod and usually has a trifid right proximal mandibular incisor tooth as in Form 1. Form 3 also frequently has a less angular posterior margin of the telson than Forms 1 and 2.

The three forms, however, are not strictly discrete morphologically, with some intergrading in parts of their ranges. For instance, at Lake Tahune and Frenchmans Cap, at the southern end of the epigean range of Form 2 (northern), the condition of the pleopod 5 endopod is variable, being present or absent on one or both sides. Similarly, specimens from the Vale of Rasselas in the northern range of Form 1 (southern) share features of Forms 1 and 2 in the pleonal spination of the former and presence of the pleopod 5 endopod of the latter. In addition, the presence of the pleopod 5 endopod in some specimens from Federation Peak in the southern part of the range of Form 1 is anomalous. Morphological and distributional continuity between Form 1 and Form 2 is consistent with the likely persistence of *A. swaini* in periglacial lakes formed to the west of Lakes St Clair and King William during the Pleistocene glaciations that dominated most of the Central Plateau and adjacent areas (Kiernan, 1990). These lakes and associated glaciers fed the Franklin and Gordon Rivers in which *A. swaini* is widespread. Forms 1 and 2 both occur to the west of the biogeographic discontinuity known as Tyler's Line (Shiel *et al.*, 1989; Mesibov, 1994; Andrew, 2005), and Form 3 to the east.

Overall, *A. swaini* from the southwest generally have a more spinose pleon and usually lack the pleopod 5 endopod whereas northern and southeastern specimens are minimally spinose, and generally with (northern) or without (southeastern) the pleopod 5 endopod. Each of these forms might represent separate species or subspecies, but until more detailed population data are available, they are considered to represent a single wide ranging species.

Within the three broad forms of *A. swaini* identified here, specimens are rather consistent morphologically. The largest Butlers Gorge specimen (female, 36 mm) is aberrant, however, in having a posteriorly rounded rather than angular telson, and the 34 mm female has an abnormal pleopod 5 exopod that is basally trifurcate. A male from Lake Tahune (29 mm, AM P99165) has the right pleopod 3 endopod developed like the modified pleopod 2 endopod. Two lots of *A. swaini* labelled as from "Lake St Clair?" and "Lake St Clair" collected in 1937 and 1941, respectively, are probably from creeks in the vicinity of the lake rather than the lake itself as argued by Nicholls (1947), Williams (1965a) and O'Brien (1990). All specimens from Lake St Clair proper, including juveniles, exhibit the characteristic pleon and telson spination of *A. spinulae*.

Like other epigean species of *Anaspides*, *A. swaini* also occurs in caves (Fig. 34): Mt Anne (Deep Thought Cave), Mt Field (Junee-Florentine and Risby's Basin systems), Nicholls Range (Bill Nielson Cave), Franklin River karst (Kutikina) and Mt Ronald Cross karst (Capricorn Cave). These subterranean specimens resemble epigean forms, and at most show more elongate antennular flagella, slightly reduced corneal size (Fig. 34A), and sometimes reduced pigmentation, unlike more strongly cave adapted populations of *A. richardsoni* and *A. jarmani*, or obligate troglobites such as *A. clarkei* and *A. eberhardi*, with noticeably reduced corneas and pigmentation. Specimens, from Khazad Dum (Fig. 34E–H) and Risbys Basin caves, presently known only from ♀♀, have a more rounded posterior telson margin, armed pleonite 5–6 terga and usually armed pleura as well; they are strongly pigmented as in epigean specimens. Eberhard *et al.* (1991) delineated three morphological types of telson in *Anaspides*: a "normal" form as exhibited by epigean populations; a "cave" type, in which the telson spines are few in number, stout and widely spaced (as in *A. clarkei* and *A. eberhardi*); and an "intermediate" form, recorded from Capricorn Cave (Fig. 34S–U) and Deep Thought (Fig. 34A–D). Re-examination of the "intermediate" form specimens showed the Mt Anne telson to be of the "normal" type, and the Capricorn Cave specimen to be a very early stage juvenile (with normal spination for its stage) in which the telson ornamentation is yet to be fully developed. No specimens have so far been observed with a telson that could be considered as intermediate between the "normal"

Figure 35. *(A) Anaspides tasmaniae* (Thomson, 1893), female, Mt Wellington, specimen not preserved; *(B) A. clarkei* Ahyong, 2015, female, 24 mm, Eastern Passage streamway of Little Grunt Cave and Exit Cave, QVM 10:49168; *(C) A. clarkei* Ahyong, 2015, male, Lake Pluto, Wolf Hole, specimen not examined; *(D) A. richardsoni* sp. nov., female, Tarn Shelf, Mt Field, specimen not preserved; *(E) A. richardsoni* sp. nov., female, 32 mm, Kellys Pot, Mole Creek karst, TMAG G6463; *(F) A. richardsoni* sp. nov., female, 35 mm, Marakoopa Cave, Mole Creek karst, specimen not preserved. Photo credits: *A,* Kristi Ellingsen, used under a Creative Commons Attribution-NonCommercial license (http://creativecommons.org/licenses/by-nc/2.0/); *B, E,* ©Stefan Eberhard; *C, F,* ©Arthur Clarke; *D,* ©Simon Grove, TMAG.

and "cave type", with the possible exception of an aberrant specimen of *A. clarkei* with asymmetrically developed spination (Fig. 8W–Y).

Sexual maturity (indicated by development of secondary sexual features) is usually reached by 18–23 mm body length in both sexes, typically 20–21 mm. Unusually, however, at Lake Picton, parts of the Snowy Range including Lake Skinner, Hartz area, Lake Rhona, and two Mt Wellington localities (St Crispins Well, Wishing Well), secondary sexual characteristics are not expressed until very late, at sizes well above that which individuals are otherwise sexually mature (24–33 mm, usually 28 mm body length or above). Additionally, development of secondary characteristics in these immature males seems to be particularly attenuated, with an incomplete complement of antennular clasping spines. Because of their relatively large size, these immature male *A. swaini* with as yet incomplete antennular modification could be overlooked as *A. richardsoni*, which

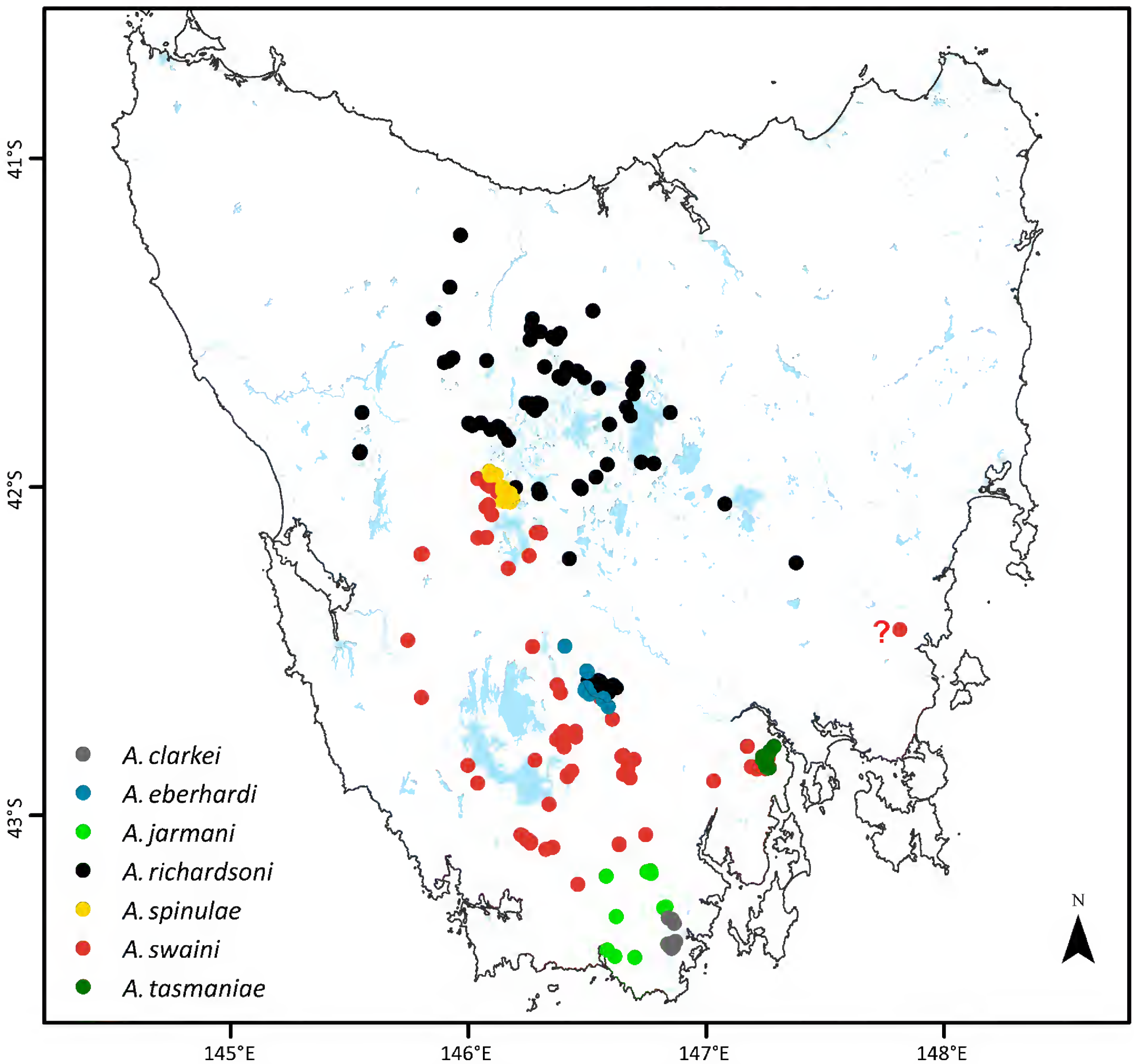

Figure 36. Distribution of *Anaspides*. Dubious Orford record of *A. swaini* indicated by "?".

has only one antennular clasping spine in adult males. The causes of the late onset of sexual maturity are not known.

Distribution. Southern Tasmania from the Weld River, Snowy Mountains region, Mt Field and Mt Wellington (North West Bay River catchment) to the Western Arthurs, throughout the Franklin-Gordon drainages, north to Lake Rhona and Frenchmans Cap, Mt Rufus and the vicinity of Lake St Clair; 300–1440 m asl (epigean), 30–1000 m asl (subterranean).

Discussion

Anaspides is demonstrably more diverse than previously supposed, with at least seven species now recognised. Secondary sexual characters of the male antennules and pleopodal endopods proved instrumental to taxonomic delineations. *Anaspides* is now known as far north as Great Western Cave, Gunns Plain (41°18'S) (Fig. 36). The southernmost records are from the far south at Precipitous Bluff (43°29'S), westernmost records are from the Tyndall Range (145°35'E), and easternmost records from the Oatlands area (c. 146°22'E) and Mount Wellington (147°17'E). The previous doubtful east coast record from Orford is almost certainly erroneous (see account of *A. swaini*).

Throughout most of the range of the genus, *Anaspides* has entered subterranean habitats; some normally epigean species also occur in caves but two wholly troglobitic species are also recognized here, *A. clarkei* and *A. eberhardi*. Williams (1965b) emphasized the role of caves as oligothermal refuges, especially during the warmer climate of the Tertiary, and perhaps during glacial maxima too, so it is significant that the specimens from the lowest altitudes at present are also from caves (e.g., *A. clarkei*, 70 m, Exit cave; *A. swaini*, 30 m asl, Bill Nielsen Cave) including the northernmost record from Great Western Cave, Gunns Plain (*A. richardsoni*, 109 m asl). The distributions of species are largely discrete, with minor overlap of *A. richardsoni* and *A. swaini* in the Mt Field area, and *A. swaini* and *A. tasmaniae* at Mt Wellington, and with the two obligate cave species (*A. clarkei* and *A. eberhardi*) in close geographic proximity to respective, closely related epigean species (*A. jarmani* and *A. richardsoni*). Glacial expansion and contraction during the Pleistocene has almost certainly influenced the distributions of epigean and subterranean species of *Anaspides*. Today, *Anaspides* distributions broadly correspond to the biogeographical discontinuity known as Tyler's Line, which runs approximately diagonally between the 146th and 147th parallel, marking a significant geological discontinuity and dividing the drier eastern from the wetter western parts of Tasmania (Shiel *et al*., 1989; Mesibov, 1994; Rees & Cwynar, 2010). *Anaspides jarmani* and *A. clarkei*, *A. spinulae*, and two forms of *A. swaini* occur to the west of Tyler's line. *Anaspides tasmaniae*, *A. eberhardi* and one form of *A. swaini* occur east of Tyler's Line. *Anaspides richardsoni* also occurs largely to the east of Tyler's Line, crosses over in the northern part of its distribution, extending westwards to the West Coast Range.

Based on the extensive series of *Anaspides* examined here, the largest so far assembled, the taxonomy and distributions of the species are significantly clarified. Nevertheless, important questions remain. The several morphological forms identified within each of the most widely ranging species *(A. richardsoni*, *A. swaini* and *A. jarmani)* might represent simple phenotypic variatnts or indicate more significant population differentiation. This is particularly apropos to *A. richardsoni*, which, in addition to non-spinose epigean forms, includes three cave forms at Mole Creek and markedly spinose forms similar to *A. spinulae* on the western Central Plateau. The relationship between Central Plateau *A. richardsoni* and *A. spinulae* itself requires further investigation. In this connection, additional sampling is required to fill distributional "gaps", as in the Cradle Mountain area between the Walls of Jerusalem and the West Coast Range, for which few specimens, especially adult males are known. Similarly, sampling is sparse in the north-western part of the range of *A. swaini* including a number of cave sites, for which only juveniles are available, and between Mt Field and the Western Lakes on the Central Plateau, for which no records of *A. richardsoni* are presently available. More detailed delimitation of the distributions of *Anaspides tasmaniae* and *A. swaini* on the Wellington Range is required.

The most recent conservation assessments of *Anaspides* assumed *A. tasmaniae* to be widespread throughout much of Tasmania (Wells *et al*., 1983; Horwitz, 1990; O'Brien, 1990). The revised taxonomy of the genus, however, indicates that the conservation status of all species of *Anaspides* requires review. Ironically, *A. tasmaniae* may have the narrowest range of all epigean species, so far limited to the eastern drainages of Mt Wellington. In this regard, the possible translocation of *A. swaini* to the lower Browns River on the southeastern face of Mt Wellington is of potential concern (see Remarks under account of *A. tasmaniae*). Other narrow range species are *A. spinulae* from Lake St Clair, the subterranean *A. clarkei* from the Hastings-Ida Bay karsts and *A. eberhardi* from the Junee-Florentine karst system. *Anaspides jarmani*, *A. richardsoni* and *A. swaini* have the widest ranges, particularly the latter two. Because much of the range of *Anaspides* is encompassed by the Tasmanian World Heritage Area, a degree of protection from agriculture and forestry already exists (Horwitz, 1990). Other major biotic factors, however, such fish predation, warrant further scrutiny, particularly on the Central Plateau, where trout predation may have already had significant impact on *Anaspides* populations (Lake & Knott, 1973; Williams, 1974; O'Brien, 1990).

The distributions of species determined herein are based on all available specimens, some from localities at which *Anaspides* might no longer occur. Therefore, given the current rate of environmental change, whether from land-use practices, climate warming or trout predation, further surveys are required to determine the current distributions of species of *Anaspides* in order to best inform management decisions.

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