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ARTICLE

A new *Brachypsectra* LeConte from Australia (Coleoptera: Brachypsectridae) with comparative notes on adults and larvae

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Abstract. A new species, *Brachypsectra cleidecostae* Lawrence, Monteith & Reid sp. nov., is described from Australia on the basis of one reared adult female from inland Queensland and larvae from the type locality and two other widely separated semi-arid localities in South Australia and Western Australia. Two of the four larval collections were from under tree bark and one was from ground litter. The species is differentiated on both adult and larval characters. The broader mandible with retention of a retinacular tooth may indicate a sister relationship with species of the genus from other continents.

Key-Words. Australia; Coleoptera; Brachypsectridae; Taxonomy; Biology.

INTRODUCTION

The genus *Brachypsectra* LeConte, 1874, contains seven named species from widely separated localities across the globe, but primarily arid regions. Among the extant species, *Brachypsectra fulva* LeConte (1874) is known from the southwestern part of North America, *B. vivafosile* Woodruff (2004) from the Dominican Republic, *B. jaechi* Petrzelkova, Makris & Kundrata (2017) from Turkey, *B. kadleci* Hájek (2010) from Iran, *B. lampyroides* Blair (1930) from India and *B. fuscula* Blair (1930) from Singapore, while the extinct species, *B. moronei* Branham in Costa *et al.* (2006) is known from Miocene amber in the Dominican Republic. In addition, an unnamed female and larva are known from Cyprus (Petrzelkova *et al.,* 2017), an extinct larva from Baltic amber (Klausnitzer, 2009) and an extant larva from northwestern Australia, first recorded and figured by Lawrence & Britton (1991) and described in detail by Costa *et al.* (2006). In the following paper we describe the first adult, a female, of the Australian species and present further larval notes and records for this species from arid regions in western Queensland and South Australia. Because of Cleide Costa's particular interest in this family, it is fitting that we name this new species in her honour on the occasion of her 80th birthday.

Brachypsectra is an unusual genus with relatively small, lightly sclerotized and nondescript adults, rarely collected and probably short-lived, and an extraordinary type of larva, which was not associated with adults until 25 years after its first description by Barber (1905) (Blair, 1930). This larval type is short, broad, flattened, dorsally covered with numerous tubercles and tubules bearing complex, scale-like setae, armed on each side with 14 slender, branched lobes lined with setiferous tubules, and with a flexible head and a narrow, elongate, articulated, apically acute ninth tergite. These larvae are ambush predators, which are capable of pinning small arthropods on the dorsal surface between the tail spine and the perforate sucking mandibles. Larvae have been shown to construct a coarsely meshed pupal enclosure of white silken threads connecting the upper and lower surface of their retreat, and to have a pupal period of about six weeks (Fleenor & Taber, 1999). Further comments on the biology of the North American *Brachypsectra fulva* are given in Costa *et al.* (2006), and available information on the habitat and habits of the new species are included below.

Phylogenetic relationships of *Brachypsectra* have a complex history, which is discussed in some detail by Costa *et al.* (2006). In a cladistic analysis based on over 500 adult and larval characters and 359 taxa representing 314 families or subfamilies of Coleoptera (Lawrence *et al.,* 2011), the genus formed a clade with Cerophytidae, Eucnemidae and Throscidae, sister to Elateridae. In the molec-

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ular study of McKenna *et al.* (2015), Bayesian analysis produced a cladogram with the above clade sister to the remaining elateroid families, excluding Artematopodidae, Omethidae and Telegeusidae. In another analysis by Kusy *et al.* (2018), *Brachypsectra* was sister to Elateroidea, excluding Artematopodidae, Omethidae, Telegeusidae, Cerophytidae, Eucnemidae and Throscidae. Until recently, the family Brachypsectridae contained only one genus, but the extinct genus *Vetubrachypsectra* Qu & Cai has been discovered in mid-Cretaceous amber deposits of northern Myanmar (Qu *et al.,* 2019), and a second extant genus, *Asiopsectra* Kovalev & Kirejtshuk (2016), has been described, based on two species from Tajikistan and Iran. The relationships of the latter genus need confirmation. Adults of both species appear to be more heavily sclerotised than any *Brachypsectra* species, and have elytral window punctures, very narrow mandibles, 12-segmented, bilamellate antennae, projecting, more or less conical procoxae, and a narrower mesoventrital process with a deep cavity continued posteriorly as a median groove. These features are absent in the Australian adult, which we describe in *Brachypsectra*.

MATERIALS AND METHODS

Morphological terms and conventions used in the present work are based primarily on those in Costa *et al.* (2006). The adult description is somewhat incomplete, because of a reluctance to completely dissect the holotype and only known adult. In the larval description and diagnosis some attempt has been made to distinguish between short setiferous tubercles and long, slender setiferous tubules; the tubules on the thoracic and posterior lateral abdominal projections are particularly long and have been described as branches. The papillae on the median conical projections of most terga are probably glandular, although there is no direct evidence for this. We have also called attention to a few larval features which may have no counterpart in other larval types, such as the unusual lateral ecdysial lines or lines of weakness on the dorsum of the head in the newly described species, as well as in *B. lampyroides*, forming a pair of post-epicranial plates. One feature used in current larval keys, namely the undivided anterior lateral lobe on abdominal tergum I or I and II, is very difficult to observe and may be somewhat variable in the species described below. Comparisons of adult and larva of the new species with those of most described forms are based in part on information contained in Costa *et al.* (2006), Klausnitzer (2009) and Petrzelkova *et al.* (2017), but comparisons with *Brachypsectra fulva* made use of North American specimens housed in the Australian National Insect Collection, Canberra, ACT, Australia **(ANIC).** Other collections cited in the text are as follows: **AMS,** The Australian Museum, Sydney, NSW, Australia; **CAS,** California Academy of Sciences, San Francisco, CA, USA; **QMB,** The Queensland Museum, Brisbane, QLD, Australia.

Adult and larval morphology images (Figs. 1-2) were taken by Geoff Thompson using the Queensland Museum's Microptica Visionary Digital imaging system. Photomicrographs of the Arkaroola larva (Figs. 3A-F) were observed with a Leica MZ16 stereomicroscope, those of the mandible and labium of *Brachypsectra cleidecostae* sp. nov. and *B. fulva* (Figs. 3G-K) with a Leitz-Wetzlar compound microscope with 16× and 32× objectives and both were photographed using a Dino-Eye AM4023XC Eyepiece Camera (without image stacking).

RESULTS

Brachypsectra cleidecostae sp. nov. (Figs. 1, 2, 3A-F, 3I, 3K, 5C-F, 6B)

Type material: HOLOTYPE: ♀: AUSTRALIA: "QLD: 23.707°S × 141.147°E 6.3 km N of Diamantina NP HQ, 120 m, 03Oct2011, Monteith & Turco, ex bark of gidgee trees, **39461**/adult ♀ emerged 17-18.xi.2011" (QMB, Reg. No. T245515). The dried last larval and pupal exuviae of the holotype are card-mounted and stored with the holotype.

Differential diagnosis: Distinguishing this species from the seven other described forms currently included in the genus on the basis of a single female is difficult, since most key characters are based on males, and the two sexes in this genus appear to differ considerably, at least in size, shape and antennal structure. The *B. cleidecostae* female at least differs from females of *B. fulva* with respect to features listed in Table 1. It also differs from females of *B. lampyroides* and an undescribed species from Cyprus (Petrzelkova *et al.,* 2017) with respect to the size and pronotal shape (Characters 1 and 2), which are similar to those features in *B. fulva*.

Description (Adult female): Length 3.8 mm from anterior margin of head to apex of elytra (excluding extended abdominal apex); combined pronotal and elytral length 1.90 times greatest elytral width. Color yellowish-brown; dorsal vestiture of fine, suberect setae. Head transverse, more or less declined and deeply inserted into prothorax. Eye (Figs. 1E-F) 0.32 times as long as head width behind eyes, finely facetted. Antennal insertions completely exposed, located in large, saucer-like impressions separated by slightly more than one diameter. Frontal area declined; clypeus very short and broad, anteriorly emarginate; labrum about 0.5 times as long as wide, 0.35 times as wide as clypeus and broadly rounded at apex. Antennae (Fig. 1E) about 1.4 times as long as head width behind eyes; scape 1.25 times as long as wide, pedicel about as long as wide, both subglobular but slightly wider apically; antennomere 3 about 1.2 times as long as wide and 1.2 times as long as 4; 5-10 subequal in length, gradually shorter and broader and expanded apically; antennomere 11 twice as long as 10, 1.25 times as long as wide and apically subacute. Mandibles broad at base, unidentate. Apical maxillary and labial palpomeres elongate, slender, widest at middle and narrowly rounded or truncate at apex. Pronotum (Figs. 1A-C) 0.49 times as

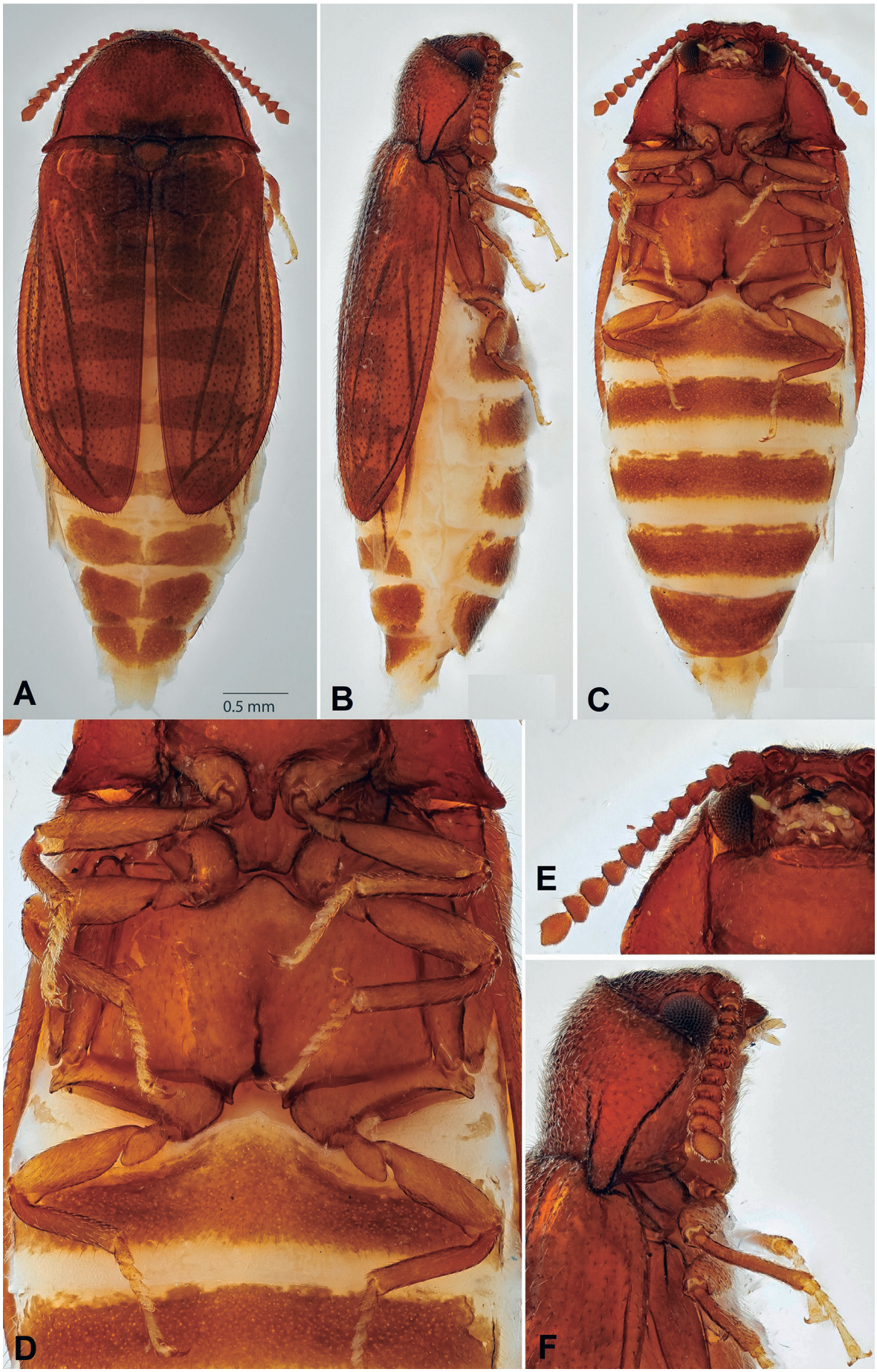

Figure 1. Holotype female of *Brachypsectra cleidecostae* sp. nov. (A) Dorsal; (B) Lateral; (C) Ventral; (D) Ventral view of thorax and legs; (E) Ventral view of head and antenna; (F) Lateral view of head, thorax and legs. (Photos: G. Thompson, Queensland Museum©).

long as its greatest width (across posterior angles) and 0.54 times as long as its width at about middle; sides gradually converging anteriorly; lateral pronotal carinae in dorsal view visible posteriorly but concealed anteriorly by sides of disc; posterior pronotal angles strongly produced posterolaterally and acute; sublateral carina extending from apex of posterior angle almost to middle of disc and accompanied mesally by a short, weak, longitudinal groove (Fig. 1F); anterior edge of pronotum subtruncate; posterior edge weakly triemarginate, with two broad lateral emarginations flanking a relatively narrow prescutellar emargination. Disc coarsely and densely punctate with punctures separated by less than half a diameter; setae moderately long and fine. Prosternum (Fig. 1C) about 1.9 times as long as mid length of procoxal cavity, with short, broad chin piece at anterior end; prosternal process about 0.50 times as wide as mid length of coxal cavity, parallel sided, extending to posterior edges of coxae, with narrowly rounded apex. Procoxal cavities widely open; postcoxal (hypomeral) processes very short and angulate; protrochantin concealed by coxal cowling. Scutellar shield 0.92 times as long as wide, weakly curved anteriorly, broadly rounded posteriorly. Elytra (Figs. 1A-B) 1.48 times as long as greatest width (at about middle); humeri well-developed but somewhat flattened; lateral margins well-developed but concealed anteriorly by humeri; disc with a series of shallow, longitudinal grooves; punctation similar to that on pronotum, but less regular and bearing moderately long, fine setae; apices independently rounded. Elytral epipleura narrow and more or less complete. Hindwings (as seen through elytral cuticle) well-developed, with relatively small apical field, elongate radial cell with oblique base and obtuse inner angle, short, slightly oblique cross-vein r3 and well-developed apical spur (continuation of MP_{1+2}); the medial field, however, is folded under, concealing the condition of MP_{3+4}, Cu, AA and AP. Mesocoxal cavities (Fig. 1D) separated by a distance subequal to the greatest longitudinal diameter of a cavity, partly closed laterally by mesanepisternum and mesepimeron; mesotrochantin concealed; mesoventrite with mesal cavity extending almost to posterior edge, which is very shallowly emarginate. Metaventrite, excluding anterior lobe, about 0.50 times as long as wide, moderately convex; discrimen 0.40 times as long as ventrite; posterior edge between metacoxae deeply, broadly emarginate. Metanepisternum 3.33 times as long as wide; more or less parallel-sided, but with curved carina extending from near anteromesal edge to lateral edge at about middle. Metacoxae (Fig. 1D) separated by a distance equal to longest longitudinal diameter of coxa; coxal plates weakly developed but complete to lateral edges. All trochanters at least slightly elongate, trochanterofemoral joints varying from very slightly oblique (fore legs) to strongly oblique (hind legs); legs (Fig. 1D) relatively short and slender, with femora, tibiae and tarsi all about equal in length; tarsi and pretarsal claws simple. Abdominal ventrite 1 (Figs. 1C-D) about 0.75 times as long as 2, 3 or 4; ventrite 5 about 1.5 times as long as 4 and very broadly rounded; posterior portions of ventrites 1-4 membranous. Most abdominal tergites lightly sclerotized, but those of segments VII and VIII more heavily sclerotized (Figs. 1A-B). Ovipositor (Fig. 1A) short, broad and lightly sclerotized (possibly not yet fully pigmented), with gonocoxites broadly rounded at apex and gonostyli slender and parallel-sided.

Larval specimens examined: AUSTRALIA. *Queensland:* 8 km N of Diamantina Lakes Homestead (23°42'25"S, 141°08'48"E), 21.xi.2002, under logs and in litter of stunted acacia on marly limestone, R. Crookshanks, 2 examples (Fig. 2) (QMB); 6 km N of Diamantina Lakes National Park HQ (23.7070S, 141.1467E), 120 m, 03.x.2011, under bark flakes of Gidgee trees (*Acacia cambagei* R.T. Baker), G.B. Monteith & F. Turco, 2 examples and one partial exuvia

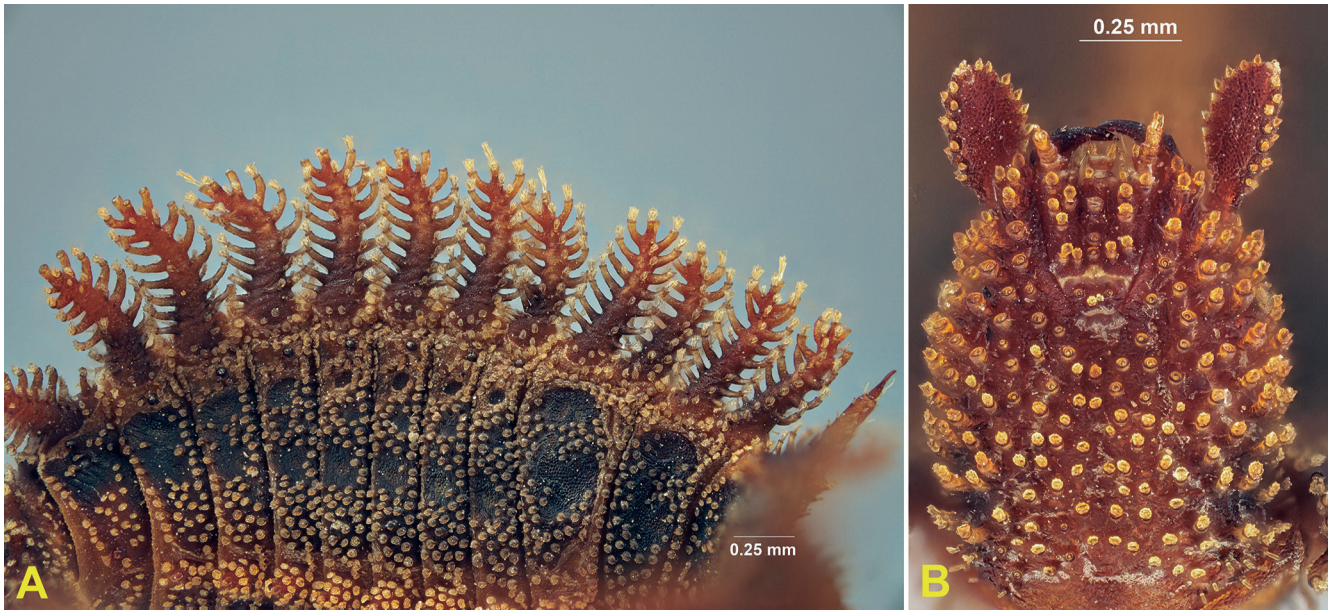

Figure 2. Dry-mounted larva of *Brachypsectra cleidecostae* sp. nov. from Diamantina Lakes NP. (A) Left side of dorsum showing lateral processes of thoracic and abdominal segments; (B) Ventral view of head and antennae. (Photos: G. Thompson, Queensland Museum©).

(Figs. 3I, 3K, 5C) (QMB); *South Australia:* Flinders Range, Arkaroola Sanctuary, Stubbs Waterhole, 22.x.2007, under fibrous bark of *Eucalyptus,* M. Anstis & W. Grimm, 1 example (Figs. 3A-F, 6A) (AMS: K379869); *Western Australia:* Winjana [sic, = Windjana)] Gorge, 100 m, 17.x.1962, E.S. Ross & D. Cavagnaro, 2 examples (CAS).

Larval differential diagnosis: The larva of *B. cleidecostae* was shown by Costa *et al.* (2006) and Petrzelkova *et al.* (2017) to differ from those of *B. fulva, B. moronei*, *B. lampyroides* and an unnamed larva from Cyprus by the pedunculate stemmata, absence of frontal arms (ecdysial lines) and gular sutures, mandible with a retinaculum (Fig. 3J), and undivided anterior lobe of the second abdominal segment (Costa *et al.,* 2006, figs. 74-86). In the present study a number of additional features were found to distinguish this new species from *B. fulva,* based on comparisons of dissected specimens and illustrations in Costa *et al.* (2006), and from *B. lampyroides* based on illustrations in Costa *et al.* (2006) and Klausnitzer (2009); these are summarized in Table 2. Among the fossil specimens, that of *B. moronei* Branham has unusual maxillary and labial palps resembling those in *B. fulva* but with the first labial palpomere expanded towards apex, while

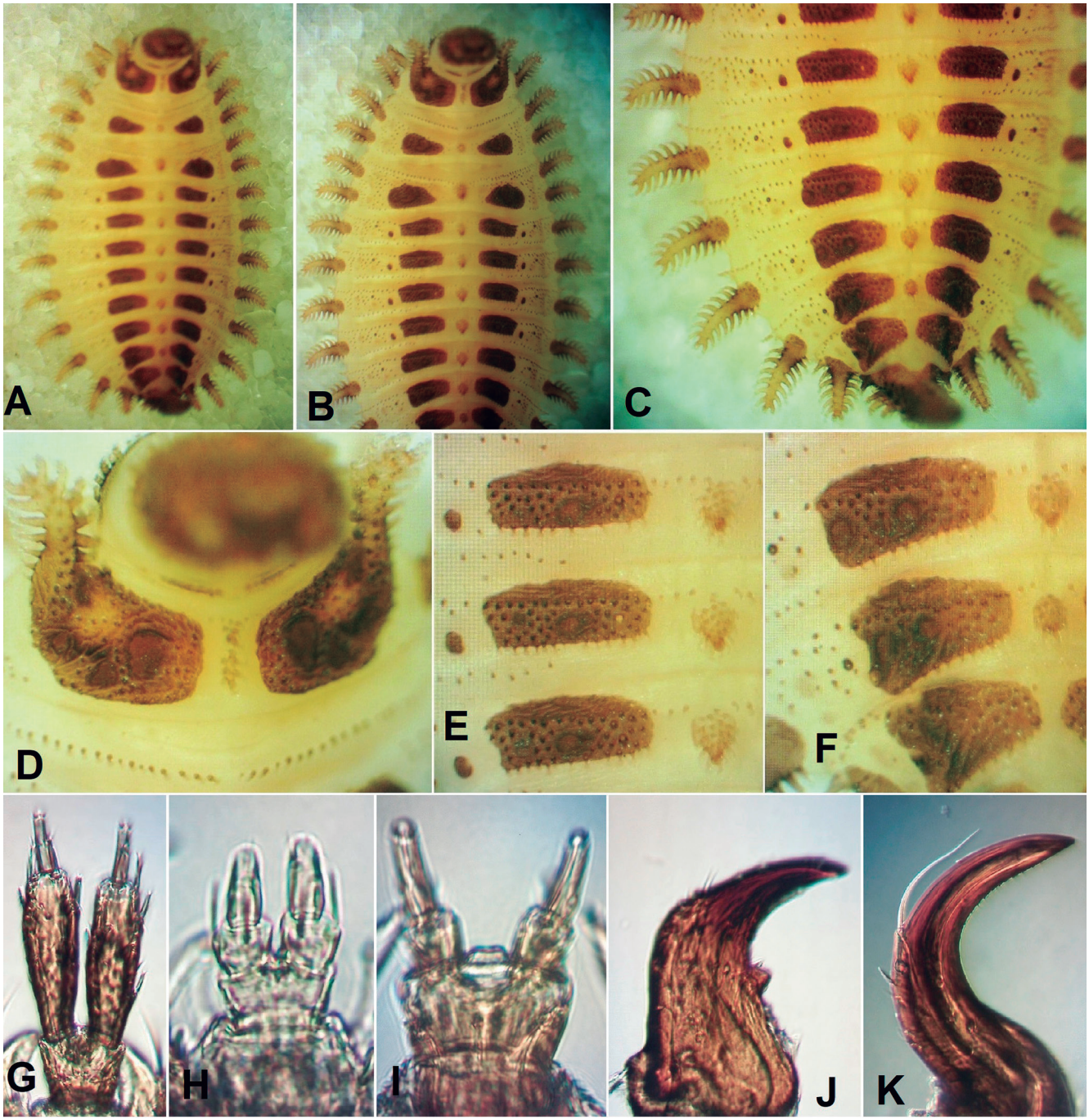

Figure 3. Larval structures of *Brachypsectra* spp. (A-F) Dorsal view of *B. cleidecostae* sp. nov. from Arkaroola; (A) Whole larva with head and tail spine raised; (B) Forebody; (C) Abdominal segments III-IX, with tail spine raised; (D) Head (raised and out of focus) and protergum; (E) Abdominal segments I-III, left portion without lateral processes; (F) Abdominal segments VI-VIII, left portion without lateral processes. (G-I) Prementum and labial palps; (G) *B. fulva,* late instar; (H) *B. fulva,* first instar; (I) *B. cleidecostae* sp. nov., late instar, Diamantina NP. (J-K) Larval mandible; (J) *B. cleidecostae* sp. nov., Diamantina NP (K) *B. fulva*. (Photos: J.F. Lawrence).

Table 1. Comparisons of adult females of two species of *Brachypsectra.*

Character	*B. cleidecostae* sp. nov.	*B. fulva* LeConte
1) length	3.8 mm	5.0-7.7 mm
2) sides of pronotum	gradually converging anteriorly	sinuate to subparallel posteriorly, distinctly curved and converging anteriorly
3) prosternum	less than 1.9 times as long as mid length of procoxal cavity	more than 2.5 times as long as mid length of procoxal cavity
4) prosternal process	about 0.5 times as wide as mid length of procoxal cavity	about 0.33 times as wide as mid length of procoxal cavity
5) distance between mesocoxal cavities	equal to greatest longitudinal diameter of coxal cavity	less than half longitudinal diameter of coxal cavity
6) apex of mesoventrital process	very shallowly emarginate	deeply emarginate
7) metathoracic discrimen	less than 0.5 times as long as metaventrite	about 0.9 times as long as metaventrite
8) distance between metacoxae	about equal to longitudinal diameter of metacoxa	about 0.20 times longitudinal diameter of metacoxa

that of an unnamed species from Cyprus (Petrzelkova *et al.,* 2017) closely resembles the larva of *B. lampyroides* from southern India, as illustrated in Costa *et al.* (2006); whether that larva is conspecific with those illustrated by Klausnitzer (2009) from Goa is uncertain. It is interesting to note that the greatly expanded maxillary and labial palps of late instar *B. fulva* and *B. moronei* are not present in first instar larvae of the former species, based on specimens collected in southern California.

Larval description (Figs. 2-3): Length of largest larva (Arkaroola, SA) about 8.8 mm including head and tail spine; major portion of body 5.8 mm long and about 1.2 times as long as wide, including lateral branched lobes, which occur on all body segments excluding IX and X. Body flattened; upper surfaces completely covered with numerous protuberances (small tubercles to long, narrow tubules) bearing a variety of modified scale-like setae and sclerotized plates of varying size and extent. Head dorsally about 0.9 times as long as wide and ventrally 1.45 times as long as wide, sides more or less parallel behind stemmata, then slightly narrowed anteriorly. Ecdysial lines consisting of very short epicranial stem but no frontal arms; an additional pair of ecdysial lines or lines of weakness extending laterally from the epicranial stem, separating a pair of postepicranial plates. Dorsal and ventral surface densely clothed with narrow, tubular projections bearing complex setae (Fig. 2B). Stemmata relatively large and pedunculate. Frontoclypeal area just in front of stemmata slightly declined; frontoclypeal suture absent. Anterior edge of clypeus weakly emarginate. Antenna (Fig. 2B) about half as long as head width, extending anteriorly but slightly tilted laterally; antennomere 1 short, transverse and simple, 2 about 8.2 times as long as 1 and 2.6 times as long as wide, narrow at base, gradually expanded to apical third, then narrowed to broadly rounded apex, its dorsal and lateral surfaces covered with complex setae, but without tubular projections and its ventral surface smooth; antennomere 3 and sensorium minute, lying side by side at the apex of antennomere 2, with the sensorium subconical and about 0.75 times as long as antennomere 3. Labrum subquadrate, its apex concave with pair of paramedian setiferous tubules located posterior to anterolateral ones. Mandible (Fig. 3J) 1.85 times as long as wide, widest at base; outer edge straight to middle then abruptly curved mesally; apex unidentate; incisor edge with small, acute retinaculum; and base slightly expanded but without any obvious armature; internal channel present. Ventral mouthparts deeply retracted; hypostomal cavity with straight, posteriorly converging sides and subtruncate posterior edge. Cardines completely fused together forming a trapezoidal plate; stipites elongate and slender, converging posteriorly but slightly separated by postmentum; lacinia lightly sclerotized, curved and narrowly acute at apex; galea small, articulated with apical seta; maxillary palp 4-segmented, ratio of palpomere lengths 1.07: 1.00: 1.36: 1.14; first palpomere 0.67 times as long as wide, with setose tubule attached to inner edge; palpomeres 2-4 each narrower than the one preceding it; second palpomere 0.8 times as long as wide; third 1.5 times as long as wide; terminal palpomere 3.8 times as long as wide. Prementum (Fig. 3G) slightly transverse; labial palps separated by a distance about as wide as a basal palpomere; apical palpomere about 1.5 times as long as basal one and distinctly narrower. Gular sutures absent. Dorsal surfaces (Figs. 3A-F) of all thoracic and abdominal segments with scattered, minute setiferous tubercles and anterior edges of meso- and metaterga each with transverse row of similar tubercles; cervical region with pair of slender, oblique sclerites; thoracic terga and abdominal terga 1-8 each with a pair of darkly pigmented plates extending from near the midline usually to the lateral fourth of the tergum; plates of protergum (Fig. 3D) irregularly quadrate, each anterolaterally contiguous with an anteriorly projecting branched lobe; plates of the meso- and metaterga (Figs. 3A-B) more or less teardrop-shaped, subacute mesally and broadly rounded laterally, more widely separated at middle than on protergum; plates of abdominal terga 1-6 (Figs. 3E-F) narrowly quadrate, broadly rounded or truncate at each end and more widely separated at midline; plates of tergum 7 shorter, broader and more narrowly separated at midline, those on tergum 8 even shorter, broader and contiguous at midline. Mesal interspaces between paired plates lightly pigmented, that on protergum with a small cluster of setiferous tubules anteriorly and a larger one posteriorly, that on mesotergum with a small circular prominence covered with setiferous tubules and a small pair of papillae, that on metatergum with the largest somewhat conical prominence and a darker lobe posteriorly bearing paired papillae, and those on abdominal terga 1-7 with gradually smaller prominences with similar lobes bearing paired papillae. Lateral apigmented areas of abdominal terga 1-4 each with a small, circular dark plate mesally and a small spiracle on a short tube laterally; on

Table 2. Comparisons of larvae of three species *Brachypsectra*.

Character	*B. cleidecostae* sp. nov.	*B. fulva* LeConte	*B. lampyroides* Blair
1) postepicranial plates	present	absent	present
2) sides of head	subparallel	converging anteriorly	subparallel
3) stemmata	pedunculate	not pedunculate	not pedunculate
4) labral apex	concave	subtruncate	trilobed
5) antennomere 2: anterolateral protuberance	absent; antennomere 3 and sensorium at mid apex	present; antennomere 3 and sensorium at its apex	present; antennomere 3 and sensorium at its apex
6) mandible: outer edge	straight to middle, apically curved	continuously curved	continuously curved
7) mandible: retinaculum	present	absent	absent
8) cardines	completely fused together	completely fused together	contiguous but separated
9) stipites and postmentum	separate	partly fused together	partly fused together
10) maxillary palpomere 2	shorter than 1, 3 or 4	> 3 times as long as 1, 3 or 4	longer than 1, 3 or 4
11) labial palpomere 1	shorter than 2	shorter than 2	longer than 2
12) gular sutures	absent	present	present
13) dorsal cervical region	pair of slender oblique sclerites	transverse row of fine setiferous tubercles	transverse row of fine setiferous tubercles
14) meso- and metatergal plates	undivided, uniformly sclerotized	divided into several small sclerites	divided into several small sclerites
15) median conical tergal projections	relatively small except on metatergum	all large except for mesotergum and tergum VIII	relatively small except on metatergum
16) small circular tergal plates on I-V	one pair	two pairs	two pairs
17) anterior branched lobe on protergum	narrow and gradually curved laterally	broad, truncate, abruptly curved laterally	narrow and gradually curved laterally
18) most posterior sterna	without small plates	with small circular plates	with small circular plates

tergum 5 same area with circular plate partly fused to median plate and on terga 6 and 7 plate entirely fused to median plate; spiracles on 5-7 similar to those anteriorly, but that on tergum 8 fused to median plate. All thoracic terga and abdominal terga I-VIII with two pairs of lateral lobes (Figs. 2A, 3A-F, 6B); both pairs on thoracic segments and posterior pair on abdominal segments similarly shaped, large, elongate, moderately sclerotized and horizontally branched, with more than 10 branches, each bearing a modified seta; anterior lobes on all abdominal segments highly reduced, lightly sclerotized, bearing one or a few setiferous tubules, and often difficult to see. Anterior branched lobe on protergum projecting anteriorly, narrowed and curved laterally at apex, shorter than posterior lobe, which is straight and projecting anterolaterally; branched lobes on meso- and metaterga similar in length, narrowed apically and curved posteriorly; posterior lobes on abdominal terga I-VII similar in shape and curved posteriorly, but those on VIII slightly shorter, straight and projecting posterolaterally. Tergum IX forming a flexible tail spine about 3.4 times as long as wide, slightly curved dorsally, widest at base and narrowing to subacute apex, heavily sclerotized, and armed with a series of setiferous tubules, the first 4 lateral longest and the remainder shorter and varying in size, with lateral and ventral tubules longer than those on dorsum, except for a medial longitudinal row of longer dorsal tubules. Ventral surfaces, excluding larger lateral branched lobes and tail spine, lightly sclerotized or membranous, except for cervicosternum, which has paired subtriangular plates narrowly separated at midline, sterna VIII and IX, each of which bears a pair of small, circular plates, mesothoracic spiracular tubes and legs. Prosternum lightly pigmented, but without distinct plates; meso- and metathorax mainly membranous, with precoxal sclerites lightly pigmented. Spiracular tubes located on anterolateral portions of mesosternum, close to edge of prosternum, each one more or less conical, well sclerotized and facing laterally. Legs relatively heavily sclerotised and armed with short spicules; fore leg slightly shorter than midleg, which is 0.67 times as long as width of mesothorax excluding lateral processes, with coxa short and subconical, trochanter and femur separated by a diagonal suture and the two together 1.14 times as long as tibiotarsus; pretarsus 0.43 times as long as tibiotarsus with paired setae lying side by side near base. Most abdominal sterna membranous or very lightly sclerotized but clothed with a series of scattered, very fine tubercles.

Etymology: Named for Professor Cleide Costa in honour of her numerous contributions to Entomology and particularly her work on beetle larvae.

Distribution and habitat: Larval specimens of *Brachypsectra cleidecostae* sp. nov. reported on in this paper have been collected on four occasions from three very widely separated localities (Fig. 4) in three different Australian states (Western Australia, Queensland and

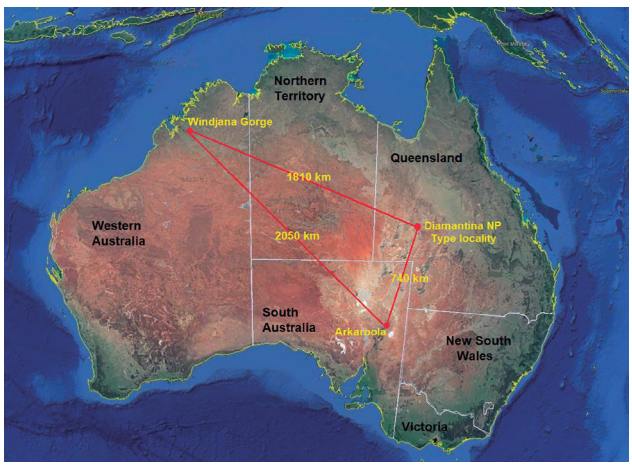

Figure 4. Collection sites of *Brachypsectra cleidecostae* sp. nov. in Australia, with distance between sites indicated. (Base map from GoogleEarth).

South Australia) over a time span of 49 years. The wide spread of these localities, coupled with the apparent rarity and/or crypticity of specimens and the fact that all collections appear to be conspecific, indicates that *B. cleidecostae* is probably widespread through the arid parts of the continent. The fact that the habitat and climate is quite different at each of the three sites also suggests that the species does not have habitat restrictions on its distribution. Windjana Gorge lies at 125 m elevation, is dominated by low eucalypt woodland and has 600-800 mm annual rainfall, almost all rain falling during the summer monsoon period, leaving most of the year semi-arid. Diamantina Lakes NP (Figs. 5A-B) is at 120 m elevation with sparse desert shrubland and scattered, stunted trees, and only 200-300 mm of annual rainfall, which also is largely dependent on the summer monsoon season. Stubbs Waterhole at Arkaroola (Fig. 6A) is at 220 m elevation, with annual rainfall of 250 mm, mostly falling in the winter months, in a rocky, mountainous landscape with scattered eucalypt woodland.

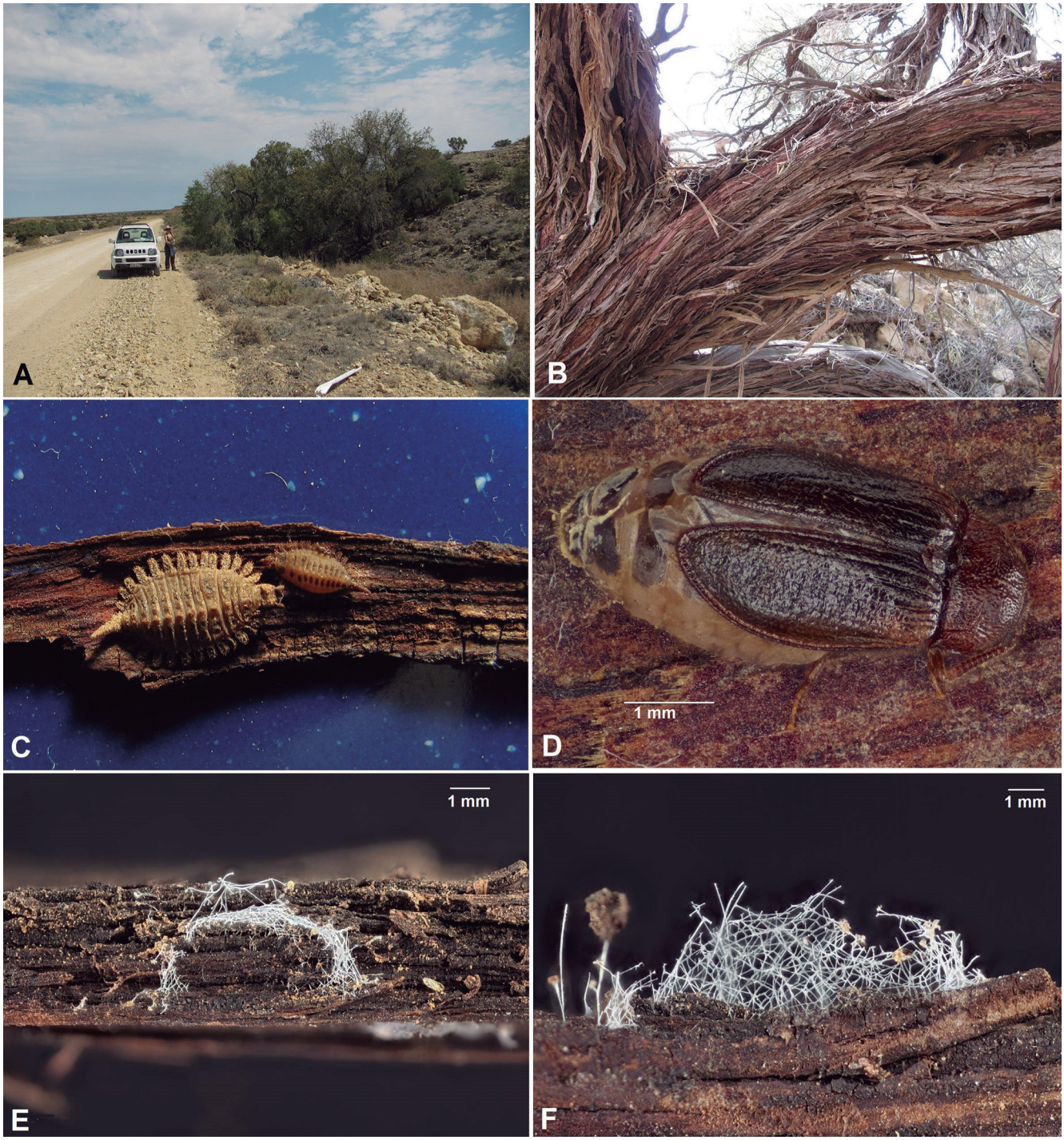

Figure 5. Collections details of *Brachypsectra cleidecostae* sp. nov. at type locality, Diamantina Lakes National Park. (A) Clump of gidgee and bauhinia trees where larvae were collected; (B) Base of gidgee tree showing many-layered bark flakes; (C) Two living larvae (3 mm and 6 mm) collected under gidgee bark flakes; (D) Newly emerged holotype female of *B. cleidecostae* sp. nov. which developed from 6 mm larva in Fig. C; (E-F) dorsal and lateral views, respectively, of silken shelter in which 6 mm larva was collected. (Photos: A-C, G. Monteith; D, G. Thompson, Queensland Museum©; E-F, F. Turco, Queensland Museum©).

Circumstances of collection in Australia: The first collection was by CAS entomologists, Ed Ross and David Cavagnaro, who took two larvae at Windjana Gorge in the arid NW of Western Australia in October 1962. No collection method is given but since leader Ed Ross's main interest was in Embioptera, which occur frequently under bark, they may have been taken in that situation. These specimens were the basis of the first notice and illustration of the family in Australia by Lawrence & Britton (1991).

The second Australian collection was by Roy Crookshanks, an amateur mollusc enthusiast who regularly sent land snails to the QMB malacology collection. Among a batch of small snails sent in 2002 from the remote desert reserve of Diamantina Lakes National Park were two dried larvae (Fig. 2) of *B. cleidecostae,* included because of their unusual form. Crookshanks reported (pers. comm.) that they were found while searching under logs and in leaf litter in a patch of stunted acacia trees, and he gave the exact GPS coordinates of the site. Nine years later, in October 2011, QMB entomologists Federica Turco and co-author Geoff Monteith returned to the exact spot and found a small dense patch of gidgee (*Acacia cambagei* R.T. Baker) and bauhinia (*Lysiphyllum* sp.) trees about 25 m in diameter in an otherwise harsh desert shrubland landscape (Fig. 5A). Gidgee trunks have many layers of hard, persistent bark flakes (Fig. 5B) with numerous narrow interspaces which seemed suitable for brachypsectrid larvae. In several hours of systematic levering off of bark flakes with screwdrivers, one large (6 mm) and one small (3 mm) larvae were found on October 3, both by Turco (Fig. 5C). The smaller larva was free living but the larger was enclosed in an oval pupal shelter formed of stiff, thick, white, silken mesh joining two bark surfaces (Figs. 5E-F), identical to the shelters described for the north American *Brachypsectra fulva* by Fleenor & Taber (1999) and illustrated by a photograph of a laboratory reared specimen taken by Margaret Thayer in Costa *et al.* (2006). The two specimens were taken live to Brisbane where, after photography during which the small larva was lost, the large larva built a new shelter between bark and tissue paper in a petri dish on about 8-9 October. The silken mesh was incomplete and of much finer threads than the original. The larva remained in a rigid S-shaped posture, identical to that shown in the Thayer photograph of *B. fulva,* until 28 October when it pupated. The pupa remained partly sheathed in the stiff larval exuvia and moved actively when touched. On the night of November 17 a female emerged (Fig. 5D). It had a greatly distended abdomen and exuded a quantity of thick creamy material. It remained inactive and died after 2-3 days. This specimen is the holotype of *B. cleidecostae* sp. nov. Its pupal period of 3 and a half weeks was considerably less than the six weeks recorded for *B. fulva* in North America (Fleenor & Taber, 1999). The collection of these Diamantina NP specimens was informally recorded by Monteith & Turco (2011).

The fourth collection from Australia was at Stubbs Waterhole, 6 km east of the homestead of Arkaroola private conservation sanctuary (Fig. 6A), at the northern end of the Flinders Ranges in South Australia. Herpetologists Marion Anstis and Wendy Grimm, associates of AMS, took a large (8.8 mm) larva (Fig. 6B) in October 2007 while peeling fibrous bark from a eucalyptus tree (Fig. 6A) in search of insect food for captured frogs and geckos. The specimen was photographed while alive, then preserved and returned to AMS where it was recognised as Brachypsectridae. Photographs were published informally by Grimm & Grimm (2016).

DISCUSSION

Comments on phylogenetic relationships of this new Australian *Brachypsectra* would ideally require a thorough study of males, females and larvae of the six other extant species. Based on the single female and a few larvae of *B. cleidecostae,* adults and larvae of *B. fulva,* and information included in Costa *et al.* (2006) and Petrzelkova *et al.* (2017), we can make some tentative

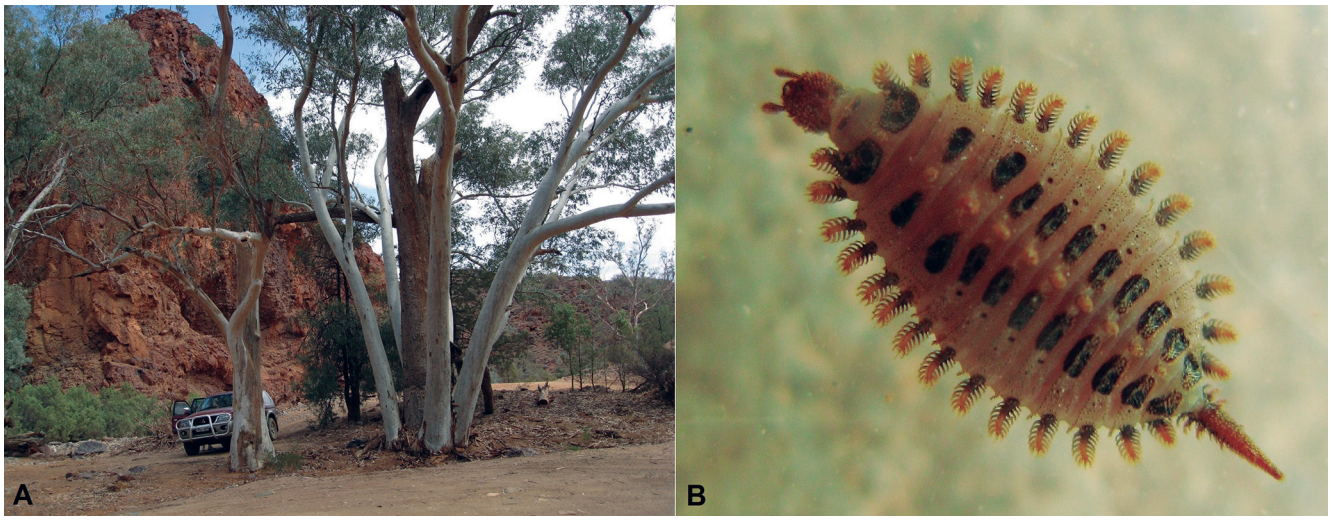

Figure 6. Arkaroola locality for *Brachypsectra cleidecostae* sp. nov. (A) Car park at Stubb's Waterhole where larva was collected under bark of dark, fibrous-barked tree to right of vehicle; (B) 8.8 mm larva collected at Stubb's Waterhole. (Photos: Wendy Grimm and Marion Anstis).

comments on the position of the Australian species. There are minor differences between our single female and that of *B. fulva,* such as the smaller size, slightly different pronotal shape, shorter prosternum, slightly broader prosternal process, more widely separated mesocoxae and metacoxae. Some features of the Australian larva, however, suggest that *B. cleidecostae* may be sister to the remaining species of *Brachypsectra*. The larval mandible, in particular, which is broader, with a retinaculum and a less well-developed internal channel, may be a forerunner of the strongly curved, slender, perforate mandibles characteristic of both *B. fulva* and *B. lampyroides*. Other larval comparisons are given in Table 2. Many of these uncertainties about relationships of this Australian *Brachypsectra* species may be resolved when the male is discovered. More adults from more localities will also test our assumption, based on broad similarity of larvae from widespread localities, that there is only one species in Australia.

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Contribution of the Authors

JF Lawrence led the project, described adults and larvae and wrote the first draft. GB Monteith wrote the biology section and coordinated the figures. CAM Reid supplied the Arkaroola larva, commented on larval and adult descriptions and contributed to the discussion.

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