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Taxonomic review of the chironomid genus *Cricotopus* v.d. Wulp (Diptera: Chironomidae) from Australia: keys to males, females, pupae and larvae, description of ten new species and comments on *Paratrichocladius* Santos Abreu

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Abstract

The Australian species of the Orthocladiinae genus *Cricotopus* Wulp (Diptera: Chironomidae) are revised for larval, pupal, adult male and female life stages. Eleven species, ten of which are new, are recognised and keyed, namely *Cricotopus acornis* Drayson & Cranston **sp. nov.**, *Cricotopus albitarsis* Hergstrom **sp. nov.**, *Cricotopus annuliventris* (Skuse), *Cricotopus brevicornis* Drayson & Cranston s**p. nov.,** *Cricotopus conicornis* Drayson & Cranston **sp. nov.,** *Cricotopus hillmani* Drayson & Cranston, **sp. nov.**, *Cricotopus howensis* Cranston **sp. nov.,** *Cricotopus parbicinctus* Hergstrom **sp. nov.,** *Cricotopus tasmania* Drayson & Cranston **sp. nov.,** *Cricotopus varicornis* Drayson & Cranston **sp. nov.** and *Cricotopus wangi* Cranston & Krosch **sp. nov**. Using data from this study, we consider the wider utility of morphological and molecular diagnostic tools in untangling species diversity in the Chironomidae. Morphological support for distinguishing *Cric-*

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otopus from *Paratrichocladius* Santo-Abreu in larval and pupal stages appears lacking for Australian taxa and brief notes are provided concerning this matter.

Key words: Orthocladiinae, *Cricotopus*, new species, taxonomy, *Paratrichocladius*

Introduction

Cricotopus (Diptera: Chironomidae) is a near worldwide genus of midges that show diversity in colour pattern of the adult, often with characteristic yellow or white bands on the otherwise dark legs and abdomen. The immature stages are encountered in nearly all aquatic monitoring schemes. The genus was described originally by van der Wulp (1874) from adult males of eight Palaearctic species. The type species, *Chironomus tibialis* Meigen (type locality not given), was designated subsequently by Coquillett (1910: 528). Included species were: *Chironomus bicinctus* Meigen, *Chironomus tricinctus* Meigen, *Chironomus annulipes* Meigen, *Tipula motitator* Linnaeus, *Chironomus unifasciatus* Macquart, *Tipula sylvestris* Fabricius and *Chironomus ornatus* Meigen. Currently, with 180 species described (Ashe & O'Connor 2012), *Cricotopus* is one of the most speciose genera in the subfamily Orthocladiinae. The great majority of species described are Palaearctic and Nearctic. The Palaearctic members of the genus were reviewed by Hirvenoja (1973), who recognised 71 species in two subgenera and 17 species-groups, based on a manual cladistic analysis using 61 characters, derived mainly from adults but including several pupal and larval characters. The subgenera recognised by Hirvenoja (1973) were *Cricotopus* (*Cricotopus* van der Wulp) and *Cricotopus* (*Isocladius* Kieffer), groups treated previously as genera. Subsequently four additional subgenera have been proposed: *C*. (*Nostococladius*) by Ashe and Murray (1980) from the Nearctic region (elevating Hirvenoja's *lygropis-group* to subgeneric status; type species C. *lygropis* Edwards); *C.* (*Marius*) by Lehmann (1981) from the Afrotropical region (type species C. *kisantuensis* Goetghebuer), C. (*Pseudocricotopus*) by Nishida (1987) from Japan and the Nearctic region (type species C. *montana* Tokunaga) and the Neotropical *Oliveiriella* Weidenbrug & Fittkau (1997) recently synonymised with *Cricotopus* (with type species *O. almeidai* Olivier) is treated as a sixth subgenus by Andersen *et al.* (2013).

Two Australian taxa have been allocated to *Cricotopus*, namely *Cricotopus albitibia* (Walker) and C. *annuliventris* (Skuse) (Freeman 1961). Described originally from Sierra Leone in Africa as *Chironomus albitibia* Walker, the species was reassigned to *Cricotopus* by Freeman (1956). Specimens from New South Wales, Australian Capital Territory and Western Australia were treated as conspecific by Freeman (1961). Likewise *C. annuliventris* was described first as an *Orthocladius* by Skuse, from Lawson in the Blue Mountains of New South Wales, and reassigned to *Crlcotopus* by Freeman (1961). Both species descriptions conform to subgenus *Cricotopus* (s.s.) according to the keys and diagnoses of Hirvenoja (1973) and Cranston *et al*. (1989) for adult males. Specimens of both species examined by Freeman, now in the Australian National Insect Collection (ANIC), Canberra, have been examined. Although these are pinned rather than slide mounted, identification can be made using the identification keys presented below.

Published formal descriptions of both Australian species of *Cricotopus* are of male and female only. Although description from the adult male is traditional, descriptions of the larvae and pupae of chironomids are of greater value to freshwater biologists. Thus Hirvenoja (1973) included, where possible, descriptions of all life stages in his revision of Palaearctic *Cricotopus* and most others follow this practice.

In an unpublished thesis, Hergstrom (1974) reported four new Australian species of *Cricotopus* as well as the two species described previously. Hergstrom gave 'manuscript names' to four new taxa, namely *Cricotopus albitarsis, C. parbicinctus, C. phaesomatus* and *C. hirtellus.* Keys to the adults of the six species of *Cricotopus,* brief descriptions of the larva and pupa of one of her new species and keys to the larvae and pupae of three species were included. Hergstrom's descriptions are formally unpublished, but her thesis and many specimens are available and we discuss her descriptions of *Cricotopus* here. Two of her species, *C. albitarsis* and *C. parbicinctus* are recognised readily, and here we redescribe them in all stages, and assign to her the authorship dating from this publication.

This project started in 1987 when the 2nd author (Cranston) arrived in Australia with a remit to document the Australian Chironomidae fauna. First modern collections that included individual rearings and slide-mounts of many orthocladiines including *Cricotopus* commenced immediately and continued since (as seen from Material examined). Geographic foci included Northern Territory assisting in biomonitoring of a Uranium mine, the Murray

River system associated with the Murray Darling Freshwater Research Centre, the Wet Tropics of far north Queensland, plus opportunistic collections throughout the continent. *Cricotopus* have been included and keyed under 'codes' in several 'grey literature' reports to agencies. In 1990, senior author Drayson took on the task of reviewing all Australian material allocated to *Cricotopus* for an MSc at the Australian National University, Canberra. In the resulting unpublished thesis Drayson (1992) used codes to avoid producing taxonomically invalid names pending formal description. These codes were converted to prospective formal names by Cranston (1996) with a disclaimer that the work was 'not formal publication for nomenclatural purposes'. The thesis and coded names form a basis for this publication. The incentive to formalise names in this publication came from research from the third author (Krosch), who used the genus as a test for the utility of molecular data in (a) assessing the accuracy of the morphological species concepts against molecular data, (b) making the first estimate of the phylogeny of the genus in Australia (Krosch *et al*., submitted), and (c) seeking to understand the genetic mechanism that underpins variation in pollution tolerances exhibited within the genus.

Methods and material

Many collection methods have been used. Pupae, exuviae and drowned pharate adults were collected by exposing drift nets with a 300 µm mesh to intersect flowing water surfaces for up to 24 h. Kick nets were used to disturb lotic and lentic marginal habitats to seek larvae. All such collections were field-sorted with a dissector microscope. Adults were swept from marginal vegetation beside natal aquatic sites. Associations between larva, pupa and adult necessary for full taxonomic descriptions were attempted by rearing live larvae individually. Individual live larvae were placed in a few ml of native (or tap) water in vials stoppered with cotton wool, and maintained at cooler than ambient temperatures, without aeration. Any emerged adults and associated exuviae were preserved in 70% ethanol. Material for molecular study was obtained similarly and vouchered either by retention of all except a sacrificed fraction of the body, from which extraction was made (e.g. mid-abdomen of the specimen), or more recently by retaining the complete carcass of pupae and adults post-tissue lysis for DNA extraction (Krosch & Cranston, 2012).

Our emphasis on the immature stages, and limitations on rearing success for some species means that certain adult stages were in sub-optimal condition for descriptive taxonomy. Thus some species are known in the imaginal stage only as pharate specimens (incompletely developed, retained within the pupa). We have sought diagnostic features, minimally the genitalia of each sex. Usually obscured or under-developed in such specimens are the mature adult colour, the lengths and pigmentation of the legs, and the antennal flagellomere lengths and ratio.

Although the colour pattern of some species is characteristic enough for recognition at low magnification, most distinguishing features require slide preparation and examination under high power optics. We used both phase and Nomarski optics, especially to see hyaline structures of the pupa and larval head. Although photography can provide illustration for many taxonomic features, we prefer to use a drawing tube and tracing film to produce 'synthetic' line art to illustrate, for example, complete pupal abdomens, and the fine detail of larvae and male genitalia.

The necessary microscope slide preparation involved clearing with 10% KOH, neutralization and initiation of dehydration with glacial acetic acid, then mounting from propan-2-ol (isopropanol) into Euparal. Exuviae were displayed by dissecting the cephalothorax from the abdomen, and attempts were made to remove mature pharate adults from exuviae (with variable success). Unreared larvae often were slide mounted in Hoyer's solution (a non-permanent medium with excellent optical properties) to clear rapidly for identification for onward processing for molecular study.

Morphological terminology largely follows Sæther (1980), Cranston (1994, 2013) and Cranston, Oliver & Sæther (1989). We prefer to use the term spermatheca for the female internal reproductive system, comprising capsules, neck and ducts. In pupal descriptions we treat cuticular structures as hooks, seen in the hook row on posterior TII (Fig. 13A), spines, , usually longer than 5 µm (Fig. 13B) and dominating the major tergal patterns, and the smallest of length 1–2 µm (Fig. 13C) we term spinules although these are referred to by some authors as 'points' forming 'shagreen'. Cuticular structures located on a conjunctive are treated as if belonging to the segment anterior to it. In larval descriptions we refer to mandibular features as illustrated and labelled in Fig 12D. Although the mola is the complete inner margin, here we restrict it to the distal part bearing the seta subdentalis, which can

vary taxonomically in shape. The proximal part of the mola we refer to as the inner margin, notable for its diagnostic possession of or lack of spines. The orientation of the mandible is important to view structures used in keying.

Measurements of larvae (and many pupae) include those taken from exuviae but larval length and head capsule measurements are based mostly on complete fourth-instar larvae. Measurements of larval antennal features and calculated antennal ratio are based on the linear total length of post-basal segments (i.e. including variably distended membranous intersegmental regions). Unless indicated otherwise, measurements are in microns (µm) and rounded appropriately for the magnification used: only measurement at maximum magnification (x1000) provides 'accuracy' to 1 µm. Unless a lower number is stated, n=10 for all descriptions (larger numbers of specimens were examined for outlying values).

The first author of this paper made extensive measurements of all stages of all specimens available at that time (Drayson 1992). This was prior to McKie & Cranston's (2005) demonstration that mensural features and derived ratios are susceptible to unconsidered effects of allometry and inadequate sampling. The utility of some measurements in description and identification can be established by subsequent assessment against species concepts derived from all life stages and, more recently, from molecular analyses. For Australian *Cricotopus*, most measurements made traditionally and cited extensively in published contemporary descriptions of Chironomidae showed intra-specific variation at least as great as inter-specific variation, or were sampled inadequately in a particular semaphoront (e.g. lack of mature adults). For this reason mensural aspects of our descriptions and keys presented here are modest compared to many treatments, emphasising instead features that vary informatively with our largely molecular-derived species concept (Krosch *et al*., submitted). Interestingly, features of the pupal exuviae provide greatest concordance with our species concept. Male hypopygia are less informative than expected with, at most, subtle variation in the shape and orientation of the inferior volsella on the gonocoxite and crista dorsalis on the gonostylus—both are susceptible to orientation and variable compression of the slide-mounted hypopygia. Unassociated larvae can be distinguished with caution by permutations of non-traditional features such as the extent of pigment on the mandible, inner and outer mandible margin structures (crenulations, spines) and some antenna features.

Distributional information (material examined) is based on slide-mounted specimens with earlier identifications checked against molecular diagnoses of species taxonomy. Data are organised from north to south in eastern Australia (Queensland., New South Wales, Australian Capital Territory, Victoria, Tasmania), followed by South Australia, Northern Territory and Western Australia. If n=1 the number is omitted (hence 2P♂ is two male pupae, ♂ is one male, etc). Geographic co-ordinates range from topographic maps to GPS-derived, occasionally derived from Google Earth™, : all are rounded to the nearest minute. All collections prior to 1999 are recorded in the ANIC database.

Abbreviations. Morphological (adults unless stated) and geographic abbreviations used in the text: *Ac*, acrostichals; *ACT,* Australian Capital Territory; *Ant,* Antenna*; A.R.*, antennal ratio = length of ultimate flagellomere : combined lengths of flagellomeres 1 to penultimate (adult male) or length of basal segment : combined lengths of segments 2 to 5 (larva); *B.l*, body length; *Bl,* antennal blade length (larva); *Ck,* creek; *Clyp*, clypeus; *Co*, coronal seta (count)(Pupa); *Dc,* dorsocentral seta (count) (adult); *E,* east; *Fe*, femur; *Fl* (1-*n*), flagellomere (1-*n* combined); *Fs,* frontal seta length (pupa); *Gcx*, gonocoxite length; *Gst*, gonostylus, length; *H.l.*, head capsule length, anterior labrum to dorsal posterior margin (larva); *iv*, inferior volsella; *L*, larva or Lake; *Laps*., lateral antepronotal setal count; *Le*, larval exuviae; *Le/Pe/*♂(♀), reared adult male (female) with associated larval and pupal exuviae; *loc.*, locality; *L.R.*, leg ratio: tarsomere1 length: tibia length; *M.w.*, mentum width (compressed larval head capsule); *Md*, mandible (length) (larva); *Ms* macroseta (length) (pupa); *N,* north; *NP*, National Park; *NSW,* New South Wales; *NT,* Northern Territory*; P*, pupa; *Pa*, prealar setal count; *P1-3*, Legs (1—fore, 2—mid, 3—hind); *pc,* procercus; *pc1-3*, precorneal seta 1–3 length (pupa); *Pe*, pupal exuviae; PS(*A, B*), Pedes spurii (A, B); *P*♂(♀), pharate male (female) within pupa (maybe dissected out as teneral adult); *R.*, river; *R, R*$_1$, *R*$_{4+5}$, wing veins R, R$_1$ and R$_{4+5}$ respectively, setal count; *S,* south or sternite; *SA*, South Australia; *Sct*(*s*), scutellum (setal count); *SF*, State Forest; *SI-IX*, sternite numbered I–IX; *Sq*, squama, setal count; *TI–IX,* tergite numbered I–IX; *Ta*$_{1-5}$, tarsomeres 1–5; *Tas*, Tasmania*; Th*, thoracic horn (length); *Ti,* tibia; *U.*, upper; *Vic,* Victoria; *W*, west; *WA*, Western Australia*; Wl.*, wing length (arculus to apex) in mm.

***Cricotopus acornis* Drayson & Cranston, sp.n.**
(Figs. 1A, 2A, 4A, 8A, 10A)
urn:lsid:zoobank.org:act:EEBF8968-B52D-4344-A522-C9B5274FCAC7

Cricotopus 'sp.B' Drayson, 1992: 88
Cricotopus "acornis" sp. nov. Drayson & Cranston, in Cranston, 1996: 86 [Invalid; author states 'not formal publication for nomenclatural purposes]

Type material. Holotype: Le/Pe/♂, AUSTRALIA: NSW, Jindabyne, Rush's Ck., 36°24'S 148°40'E, 12.xii.1987 (*Cranston*). **Paratypes**: 7 Le/Pe/♀, 2 Pe, as holotype. ACT: Le/Pe/♂, Pierce's Ck., Concrete Crossing, 35°20'S 148°56'E, 23.i.1991 (*Drayson*), ♀, Corin Rd, Gibraltar Falls, 35°28'S 148°55'E, 28.ix.1990 (*Drayson*). Vic: 2Le/Pe/♀, Pe/♀, 10 km E. Mitta, Mitta R., 36°32'S 147°25'E, 30.x.1989 (*Cook*); Le/Pe/♂, Buckland R., 36°48'S 146°51'E, 6.xi.1990 (*Cranston, Cook & Nielsen*); Pe, Cann R., 37°34'S 149°09'E, 20.i.1989 (*Cranston*).

Other material examined. 7L, as Holotype.

Description. MALE (Fig. 1A) (n=2). 3.0–3.1 mm.

Head. Ant 792–864 µm; Fl 1–12 340–424 µm; Fl 13 432–440 µm. A.R. 1.03–1.20. Palp 432–376 µm. 1–2 Fr; 10–13 Po. Clyp sparsely setose.

Thorax. Mid-brown, sct sometimes pale brown, almost hyaline, with mid-brown border. Laps 4–8, Ac 22–32, Dc 17–22, Pa 3–6, Scts 8–12.

Wing. 2.0 mm. Sq 7–13, R 7.

Legs. All legs uniform mid-brown.

Abdomen. Uniform mid- to pale brown.

Hypopygium. Gcx 178 µm (n=1); iv rounded and notched posteriorly. Gst 76 µm (n=1), about 2/5 (0.43) Gcx, narrow apically; crista dorsalis strongly developed.

FEMALE (n = 2 + 3 pharate). As male except: 3.0–4.7 mm.

Ant 320–355 µm. Palp 400–420 µm.

Wing. 1.8–2.6 mm. Sq 6–10, R,12–13, R_{4+5} 8–15.

Abdomen. Brown.

Genitalia. Spermathecae comprising mid-brown, ovoid, capsules, narrow "neck" and straight or recurved ducts (Fig. 4A).

PUPA. 3.5–4.4 mm, pale brown to very pale, almost hyaline.

Cephalothorax. Slightly rugose. Thoracic horn absent. 0 Fs.

Abdomen (Fig. 8A). PSB only on II. Hook row never > 0.5 segment width (0.38–0.50). L_4 seta on VIII > 1/7 segment width (0.14–0.22). Ms 140–180 µm, < 1/15 abdomen length (0.048–0.064).

4TH INSTAR LARVA (Fig. 10A) (n = 9). 2.8–3.8 mm. H.l. 520–580 µm pale to mid-brown, abdomen hyaline.

Head**.** Ant 68–80 µm: seg 1 44–52 µm; seg 2–5 22–30 µm; A.R. 1.60–1.85. Md 52–174 µm, with serrate inner and crenulate outer margin, dark brown with distal 1/3 very dark brown. Mentum 124–136 µm, pale brown posteriorly, mid-brown anteriorly, with 6 pairs of laterals, 2nd much reduced.

Abdomen**.** Pc 15–22 µm, A.s. 540–650 µm.

Etymology. The epithet refers to the pupa lacking (*a-*) a thoracic horn (*-cornis*).

Remarks. Adult males of *C. acornis* **sp. n.** can be recognised by the combination of uniformly dark abdomen and legs and notched inferior volsella: females can be recognised by uniformly dark tergites and legs and near spherical spermathecal capsules. Pupae lack thoracic horns but otherwise resemble *C. parbicinctus* in lacking frontal setae, and having non-spinose TI and II. Differentiation can be made based on the presence of small patches of spines/spinules postero-lateral on tergites VI–VI in *C. acornis*. Note that some pupae of any species can 'lose' their thoracic horns during drift post-emergence or in subsequent handling, even in slide preparation, and identity as *C. acornis* should not be assumed. Larvae can be recognised by the mandible with a crenulate outer margin, smooth inner margin and being wide above the mola.

C. acornis **sp. n.** was collected first from an ephemeral stream that had ceased flow on a subsequent visit. Other records are scarce, from mid-order creeks and rivers in a restricted area of south-eastern Australia. No material for molecular study was collected.

***Cricotopus albitarsis* Hergstrom sp. n.**
(Figs. 1B, 2B, 4B, 6A, 7C, 8B, 10B)
urn:lsid:zoobank.org:act:84145205-2AFE-4C9C-B479-152EDEBA9336

Cricotopus albitibia (Walker, 1848: 16) sensu Freeman, 1961: 647 [misidentified].
Cricotopus albitarsis Hergstrom 1974: 94 [Invalid ICZN, 1985: Article 8a].
Cricotopus 'sp. I' Drayson, 1992: 49
Cricotopus "albitarsis" sp. nov. Drayson & Cranston, in Cranston, 1996: 86 [Invalid; author states 'not formal publication for nomenclatural purposes]

Type material. Holotype: ♂, AUSTRALIA, SA, Adelaide, Torrens Lake, 10.ii.1970 (*Hergstrom*)(ANIC). Paratypes ♂, ♀, as Holotype.

Other material examined. Qld: P♂, Mt Elliot NP, Alligator Ck., 23.iii.1998 (*Cranston*); 11 Pe, Carnarvon NP, Carnarvon Ck., 25°04'S 148°14'E., 4/5.vi.1991 (Black); Pe, Conondale Range, Stony Ck. #2, 26°52'S 152°44'E, 24.v.1990 (*Cranston*); 10 Pe, L, Atkinson Dam, 27°06'S 152°02'E, 24/25.vii.1991 (*Cook*, *Cranston & Hillman*); Le/Pe/♂, 3Pe/♀, Pe, L, Brisbane R., Mt. Crosby, 27°32'S 152°47'E, 19.i.1990 (*Cranston*); Le/Pe/♀, Brisbane R., Mt. Stanley, 270° 32'S 153°29'E, 19.i.1990 (*Cranston*).

NSW: 1♀, 1 Pe, Gaya-Dari, Upper Clarence R., 28°44'S 152°04'E, 20.i.1991 (*Cranston*); 12 Le/Pe/♂, Ginninderra Falls, 35°13'S 148°58'E, 6.xii.1987 (*Cranston*); Le/Pe/♂, Kosciuszko NP, Yarrangobilly R., Yarrangobilly Caves, 35°44'S 148°29'E, 15.i.1992 (*Cranston*); 5 Pe, Albury-Wodonga, Murray R., Noreuil Park, 36°05'S 146°56'E, 22.xii.1989 (*Cook*); 8 Pe, Albury-Wodonga, Causeway, Murray R., 36°06'S 146°55'E, 26.ii.1990 (*Cook*); Le/Pe/♂, 14 Pe, Albury-Wodonga, Murray R. Stn 6, 36°06'S 147°01'E, 17.v.1989 (*Cook*); Pe, Albury-Wodonga, Murray R., Waterworks, 36°07'S 146°04'E, 21.xi.1989 (*Cook*); ♀, Jindabyne, Rush's Ck., 36°24'S 148°40'E, 12.xii.1987 (*Cranston*).

ACT: 2 Pe, Canberra, Lake Burley Griffin, Black Mt. Peninsula, 35°16'S 149°07'E, 18.i.1992 (*Rosewarne*); 7 Pe, Tuggeranong, Isabella Pond, West shore, 35°25'S 149°06'E, 29.xii.1991 (*Rosewarne*); 5 Pe, Tuggeranong, Isabella Pond, East shore, 35°25'S 149°06'E, 29.xii,1991 (*Rosewarne*); 5 Pe/♂, 5 Pe, 2 L, Molonglo R., Coppins Crossing, 35°17'S 149°02'E, 4,ii.1988 (*Cranston*); same except ♂, 7.xi.1987; same except 3 Le/Pe/♂, 3 Le/Pe/♀ Pe, 25.ii.1991 (*Drayson*).

Vic: 3♀, 41 Pe; House Ck. down-stream, 36°09'S 146°52'E, 19.xii.1989 (*Cook*); 7 Pe, Albury-Wodonga, Middle Ck., downstream White's Rd, 36°09'S 146°57'E, 20.iii,1990 (*Cook*).

WA: 2 ♂, 4♀, 2 Le/Pe/♀, 20 Pe, 2 L, Walpole-Nornalup NP, Frankland R., circular pool, 34°56'S 116°47'E, 21.xi.1990 (*Cranston*); ♂, Lake Monger, 3.iii.1955 (*Hodgkin*); 2♂, ♀, 5 L, Lesmurdie Falls, 1.xii.1978 (*Edward*).

NT; ♂, Kakadu NP, near Jabiru, Gulungul Ck., 12°39'S 132°53'E, 11.iv.1989 (*Cranston*); 3 Le/Pe/♂, 3 Pe, 2 Le/P, 2 L, Ranger Mine, Retention Pond 1 spillway, 120°41'S 132°55'E, 11.iv.1989 (*Cranston*); 18 L, Arnhem Land, East Alligator R., on escarpment, 12°47'S 133°22'E, 15.iv.1989 (*Cranston*): 17 L, 7 Pe, Arnhem Land, East Alligator R., mid/upper R. on escarpment, 29.v.1988 (*Cranston*); ♂, Kakadu NP, South Alligator R., Fisher Ck., 13°33'S 132°33'E, 18/19.iv.1989 (*Cranston*); 3♂, Kakadu NP, South Alligator R., Coronation Hill, Gimbat spillway, 13°34'S 132°35'E, 18/19.iv.1989 (*Cranston*).

Molecular material. Qld: 2P♂, L, Bunya, n. Brisbane, Carter Court, South Pine R., 27°21'S 152°56'E, 21.iii.2013, 22 m asl (*Krosch*) (Mv-SPRP1, 3, SPR2) ; 2L, Dayboro, n. Brisbane, Lee's Crossing Rd, North Pine R., 27°12'S 152°48'E, 27.ii.2014, 64 m asl (*Krosch*) (Mv-NPR1.1, 1.7); L, Numinbah Valley, Nerang R., 28°7'S 153°14'E, 20.v.2013, 120 m asl (*Krosch*) (Mv-Ner13); L, Condamine R., Hooloovale Ck., 28°34'S 148°01'E, 30.iv.2012 (*Prior*) (Mv-Hoo3); L, Warrego R., Dick's Dam, 30°19'S 145°21'E, 2010 (*Prior*) (Mv-WarD1). NSW: L, Capertee, Glen Davis Rd., Capertee R., 20.i.2013 (*Cranston*) (Mv-NSW13.6.1). Vic.: P♂, L, Keilor, Maribyrnong R., Brimbank Park Ford, 37°43'S 144°49'E, 1.xi.2006, 25 m asl (*Carew*) (Mv-MaryA1, MBF1); 2L, Wantirna, Boronia Rd, Dandenong Ck., 37°50'S 145°12'E, 24.x.2006 (*Carew*) (Mv-DBO1, 5); L, Dandenong, Kidds Rd, Dandenong Ck., 37°59'S 145°13'E, 26.x.2006, 30 m asl (*Carew*) (Mv-DKI1); L, Pillar's Crossing, Dandenong South, Dandenong Ck., 38°01'S 145°10'E, 26.x.2006 (*Carew*) (Mv-DPC1); L, Wantirna, Wantirna Rd, Dandenong Ck., 37°50'S 145°13'E, 24.x.2006 (*Carew*) (Mv-DWA1); L, Sunbury Rd, Jackson's Ck., 37°35'S 144°44'E, 3.xi.2006 (*Carew*) (Mv-Jack1); L, Dandenong South, Eumemmerring Ck., 38°01'S 145°13'E, 16.xi.2006 (*Carew*) (Mv-Eum3); L, Campbellfield, Barry Rd, Merri Ck., 37°40'S 144°58'E, 17.xi.2006 (*Carew*) (Mv-MBR1); L, Campbellfield, Mahoney's Rd, Merri Ck., 37°41'S 144°58'E, 17.xi.2006 (*Carew*) (Mv-MMC1); L, Brooklyn,

Princes Hwy, Kororoit Ck., 37°49'S 144°49'E, 10.xi.2006 (*Carew*) (Mv-KPH1); L, Stony Diversion Drain, Sunshine West, Kororoit Ck., 37°47'S 144°49'E, 9.xi.2006 (*Carew*) (Mv-KSD2). SA: L, Sawpit Rd., Hindmarsh R., 35º28'S 138º35'E, 3.x.2013, 70 m asl (*Krosch & Cranston*) (Mv-HR2).

'divergent NT *albitarsis'*. NT: P♀, L, Kakadu NP, Kambolgie Ck., 13°30'S 132°25'E, 30–31.vii.2014 (*Cranston & Krosch*) (Mv-NT14.5.P2, NT14.5.3).

Description. MALE (Fig. 1B, 2B). 3.1–3.5 mm.

Head. Ant 792–872 µm; Fl 1–12, 320–360 µm, Fl 13, 456–520 µm. A.R. 1.3–1.6. Palp 340–430 µm. Fr 0, Po 3–5, Clyp sparsely to moderately setose.

Thorax. Sct pale brown to near hyaline, with mid-brown border; otherwise mid-brown, sometimes with reticulate pattern. Other sclerites mid- to dark brown. Laps 3–7, Ac 12–25, Dc 20–40, Pa 3–5, Scts 6–12.

Wing. 1.5–1.9 mm. Sq 4–8, R 0–1.

Legs. All femora mid-brown, sometimes with paler proximal third: all tibiae very pale with distal 1/10 pale to mid-brown: foreleg tarsomeres mid- to pale brown, darker than those on other legs; tarsomeres of mid- and hind legs very pale.

Abdomen. TI and IV pale, TII mid-brown with pale anterior band, TV and VII mid-brown with pale posterior bands, remainder mid- to dark brown.

Hypopygium (Fig. 2B). Gcx 180–200 µm, iv elongated, pointed and curved towards posterior. Gst 74–86 µm, about 2/5 (0.39–0.43) Gcx, wide, and blunt apically; crista dorsalis absent.

FEMALE. As male except: 3.1–3.5 mm.

Head. Ant 234–272 µm. Palp 348–488 µm.

Wing. 1.4–2.0 mm. Sq 3–10, R 2–6; R_{4+5} 3–6.

Genitalia. Spermathecae comprising mid-brown, spheroid capsules with long, wide "neck"; and straight or recurved ducts (Fig. 4B).

PUPA. 2.5–4.1 mm, pale brown to very pale, almost hyaline; if pale brown may have faint reticulate markings on abdomen.

Cephalothorax (Fig. 6B). Slightly rugose dorsally. Th 130–200 µm; width 36–54 µm, broad, flattened, hyaline; scales absent, sometimes granular. Fs long, prominent on frons.

Abdomen. PSB on II and III. Hook row on TII about 1/2 width of segment (0.45–0.61). Small sparse spinule field may be present anterior to hook row. Ls on VIII short, Ls_3 no more than 1/10 width of segment (0.08–0.10) (Fig. 5E). Ms 120–150 µm, about 1/20 (0.042–0.065) length of abdomen.

4TH INSTAR LARVA. 2.5–4.0 mm. H.l. 450–550 µm pale to mid-brown, with pigmented areas sometimes patchy, and with darker posterior margin; abdomen hyaline; procercus hyaline, sometimes with mid-brown marking.

Head (Fig. 10B). Ant 66–76 µm; 1st 40–46 µm; 2–5 26–30 µm; A.R. 1.60–1.85. Md 130–176 µm with smooth inner and more or less crenulate outer margin, pale to mid-brown with distal 1/3 darker. Mentum 104–128 µm, pale brown posteriorly, mid-to dark brown anteriorly; with 6 pairs lateral teeth, 2nd slightly reduced.

Abdomen**.** Pc 14–20 µm wide, A.s. 300–460 µm.

Etymology. Although Hergstrom (1974) provided no derivation, we infer that the characteristic near-white tarsomeres, especially of the mid- and hind legs, gave rise to the epithet *albitarsis*. A spelling as *albitarsus* has been used, including on the labels of Hergstrom's type series: we consider this a lapsus.

Remarks. Adults of this species can be distinguished from all other Australian *Cricotopus* by leg colour, with dark femora, pale tibiae, and pale tarsomeres on mid- and hind legs. Pupae can be recognised by the frontal setae on the frons, the hyaline and non-spinose thoracic horn and regular anal macrosetae. Larvae cannot be recognised by a single feature, but by a combination of mandible with crenulate outer and smooth inner surface, mentum with 6 pairs of lateral teeth and the apices of the first lateral mental teeth posterior to the apex of the median tooth, plus the dark pigment restricted to the apical mandible only.

From Freeman's (1961) description of pinned Australian specimens, this species appears to be his *C. albitibia,* although his description differs in having the AR as 1, i.e., much lower than the range of specimens measured in this study. Calculations of the antennal ratio from dried material is notoriously error-prone and we do not consider it significant. One male from Lake Monger, WA, labelled "Cricotopus albitibia, det. P. Freeman", from the British Museum (B.M.1955-478, slide-mounted by P. S. Cranston) was studied. This, one of the six male specimens from the location given in Freeman's description, fits the description of *C. albitarsis* above, with an AR of 1.5, as does the colour of five pinned specimens from the same locality also in A.N.I.C..

The type location of C. *albitibia* is Sierra Leone in west Africa (Walker, 1848), but the species was redescribed by Lehmann (1979) from specimens from east Zaire (=D.R. Congo). Lehmann's species as re-described differs from our Australian material in the following: adult leg pattern, with *C. albitibia* having pale bands on all legs; adult thorax pattern, with *C. albitibia* having brown vittae or "mesonotal stripes" and the pupal thoracic horn, that of *C. albitibia* being long and narrow. The larva of C. *albitibia* is undescribed. For our study 3 unreared larvae, 1 pharate male, 1 adult male and 3 adult females of C. *albitibia* from Ethiopia, collected and identified by Prof. A. Harrison were examined. The specimens were uncleared before mounting, and thus several features were not visible. The larvae are larger than those of *C. albitarsis*, one having antennal length 210 µm with AR = 2.10, which is outside the range of all Australian *Cricotopus* (1.29–2.00), and appear to differ also from *C. albitarsis* in the complex 'chunky' development of a darkened mola resembling a broken tooth. The single Ethiopian pupa has a hyaline, blade-shaped thoracic horn, tapering towards the apex, spinules on TIII and IV densely covering the tergite and the hook row is very broad, 70% the width of TII, again outside the range of all Australian species (0.30–0.63). Adults appear very similar, including in the shape of the inferior volsella. However, the larva and especially the pupa appear incompatible with *C. albitarsis*. Thus we consider C. *albitibia* from Australia to have been misidentified by Freeman.

Examination of Hergstrom's proposed holotype and 2 paratypes of *"C. albitarsis* sp.nov", now in the A.N.I.C., showed that the legs have pigmented femora, the distal ends of the tibiae also are pigmented, and the tarsomeres of the forelegs are mid-brown (as on the specimens described here), although Hergstrom describes the legs as "all legs pale yellow", and the key states "Tibiae and tarsi completely without dark pigment", without mentioning the colour of the femora. She does not describe the pupa and larva. Other character states fit this species, and it appears to be Hergstrom's manuscript name C. *albitarsis*, which is validated here with her authorship.

Molecular evidence for the identity of 'albitarsis' comes from mature pupae from s.e. Queensland and Victoria close to identical to unreared larvae from across the eastern Australian range of the morphospecies. The situation regarding 2 specimens from Kambolgie Ck in southern Kakadu N.P. is uncertain. The female pupa (Mv-NT14.5.P2) conforms to the diagnoses here for *C. albitarsis*. The sole larva (Mv-NT14.5.3), is near identical to the pupa on molecular evidence, and keys to *C. albitarsis* but differs in the darker head capsule, the distinct Lauterborn organs and dark apex to the mandible less contrasting to a brown basal part. Unfortunately neither specimen is perfect – the pupa appears to have only 2 macrosetae on one side and on the other they are broken at the base and the larva has a worn/damaged median mentum. No additional candidates exist in older morphological material from the Alligator River Region. Molecular data indicate that these two specimens are divergent from *C. albitarsis* and lie as sister to the clade 'albitarsis + wangi' (Krosch *et al*., submitted), much as implied by the morphology. Probably this constitutes a cryptic species but without further material with DNA associated, we will term the taxon 'divergent N.T. albitarsis'.

C. albitarsis is a widespread species across the continent, absent only from Tasmania. It tolerates elevated water temperatures and eutrophic to mine-contaminated standing and running waters, including the country's largest rivers and those salinated. This species occurs also in relatively unimpacted waters, as evidenced by some molecular collection sites.

***Cricotopus annuliventris* (Skuse).**
(Figs 1C, 2C, 4C, 5E, 6B, 7D, 8C, 10C)

Orthocladius annuliventris Skuse, 1889: 255
Cricotopus annuliventris (Skuse); Freeman, 1961: 646.
Cricotopus annuliventris (Skuse); Drayson, 1992: 81.
Cricotopus annuliventris (Skuse), Cranston 1996: 86

Type material. Lectotype ♂ here designated: AUSTRALIA: Lawson [no further data, specimen ex-Macleay collection] slide-mounted in Euparal from dry specimen by Cranston. Pinned specimen bears red Lectotype label 'Orthocladius annuliventris Skuse' in black ink, but designation (by unknown person) appears to be unpublished. **Paralectotype,** ♂ as Lectotype.

Other material examined. Qld.: Pe, Eungella NP, Mt Dalrymple, ? Cattle Ck., 21°02S 148°35'E, 22.iii.1998 (*Cranston*). NSW: ♂, Le/Pe/♀, Sugarloaf Ck., Clyde Mt., 35°33'S 149°58'E, 10.i.1988 (*Cranston*); 1 Pe, Albury,

Murray R. Stn 6, 36°06'S 147°01'E, 17.v.1989 (*Cook*); 2 Pe, Jindabyne, Rush's Ck., 12.xii.1987 (*Cranston*); 8♂, Le/Pe/♀, 3 Pe, Rutherford Ck., Brown Mt., 36°36'S 149°47'E, 17.xii.1990 (*Cranston*). ACT: 2♂, ♀, Canberra, Black Mt., 35°17'S 149°05'E, 29.vii.1989 (*Reid*); 3♂, 4♀, Corin Rd, Gibraltar Falls, 35°28'S 148°55'E, 29.x.1990 (*Drayson*). Vic: Pe, Wodonga, House Ck. up-stream, 36°10'S 146°52'E, 19.xii.1989 (*Cook*); Pe, Mitta R., 10km E. Mitta, 36°32'S 147°25'E, 30.x.1989 (*Cook*). SA: ♂, 4L, Cox Ck., Bonython Rd, 29.ix.1989 (*Madden*); ♂, 2L, Piccadilly Valley, Vince Ck., 29.ix.1989 (*Madden*).

Molecular material. NSW: L, Kosciuszko NP, sphagnum bog, 36°26'S 148°20'E, 2–3.xii.2010 (*Cranston*) (Mv-NSWKos1); L, Kosciuszko NP, stream next to Wright's Ck., nr 36°7'S 148°20'E, 3.xii.2010 (*Cranston*) (Mv-KNPCric8); P, Kosciuszko NP, Wragge's Ck., 36°23'S 148°27'E, 1.xii.2010 (*Cranston*) (Mv-KNPCric13); 3L, Warrumbungles, Castlereaigh R., 31°16'S 149°11'E, 27.vii.2005 (*Cranston*) (Mv-NSW2M1, 2, 5). ACT: ♂, P, Condor Ck., 35°22'S 148°51'E, 14.vi.2012 (*Cranston*) (Mv-ACTCon 6, 7). Vic: L, Dobson's Lane, Dandenong Ck., 37°50'S 145°19'E, 24.x.2006 (*Carew*) (Mv-DOL3). SA: L, P, ♀, below Hindmarsh Falls, Hindmarsh R., 35°26'S 138°58'E, 3.x.2013, 220 m asl (*Krosch & Cranston*) (Mv-HF3, HFP1, SAHF3.1); 2L, Deep Creek Conservation Park, Tapanappa Rd, 35°36'S 138°14'E, 3.x.2013, 260 m asl (*Krosch*) (Mv-DC1, 4). Tas: Mt Field NP, Russell Falls Ck., 42°40'S 146°42'E, 3.xii.2013, 196 m asl (*Krosch*) (Mv-TAS13.9.2).

Description. MALE (Figs 1C, 2C) 2.8–4.2 mm.

Head. Ant 832–1088 µm; Fl 1–12 392–480 µm, Fl 13, 416–448 µm. A.R. 0.91–1.19. Palp 424–592 µm. 2 Fr; 6–10 Po.

Thorax. Uniform mid- to dark brown. Lapn 1–5, Ac 15–28, Dc 18–25, Pa 2–4, Scts 6–10.

Wings. 2.0–2.7 mm. Sq 7–15, R 2–9.

Legs. Femora mid-brown: tibiae of fore and mid-legs with white ring on proximal third. Distal 2/3 of fore and mid-tibiae, all of hind tibia and all tarsomeres mid-brown.

Abdomen. TI very pale; broad anterior pale bands on TII, IV,V, and VI, not III; narrow posterior pale bands on TIV, V, and VI ; otherwise mid- to dark brown.

Hypopygium (Fig. 2C). Gcx 180–250 µm, iv rounded and usually notched posteriorly. Gst 66–100 µm, about 2/5 Gcx (0.35–0.45); crista dorsalis large, bare and hyaline.

FEMALE (n=6). As in male except:4.1–4.3 mm.

Head. Ant 337–428 µm. Palp 544–644 µm.

Wing. 2.0–2.7 mm. Sq 8–13, R + R_1 17–19, R_{4+5} 13–15.

Abdomen. As male.

Genitalia. Spermathecae comprising mid-brown, spheroid capsules, with very narrow "neck" and recurved ducts (Fig. 4C).

PUPA (Figs 7D, 8C). 3.5–4.7 mm, pale brown to very pale, almost hyaline.

Cephalothorax. Slightly rugose dorsally. Th 56–114 µm; hyaline, cylindrical, tapered to point, covered with sparse scales, especially distally. 0 Fs.

Abdomen. PSB on II and sometimes much reduced on III. Hook row on T II always < 0.5 width of segment (0.35–0.47). Ls on VIII long, Ls_4 about 1/4 width of segment (0.22–0.31) (Fig. 5E). Ms 80–96 µm, < 1/12 abdomen length (0.06–0.08).

4^{TH} INSTAR LARVA (Fig. 10C) (n = 9). 3.5–5.4 mm. H.l. c 650 µm pale to mid-brown with mid-to dark brown posterior rim; abdomen hyaline; procercus usually hyaline, sometimes with pale brown marking.

Head. Ant 72–86 µm, 1st 42–52 µm, 2–5 28–341 µm; A.R. 1.40–1.64. Md 144–160 µm, with smooth outer margin and serrate inner margin, pale brown with distal 1/3 mid-to dark brown. Mentum 120 µm, pale brown basally, mid-brown distally; 6 pairs laterals, 2nd slightly reduced.

Abdomen. Pc 18–28 µm, A.s. 560–700 µm.

Remarks. Adults of this species can be distinguished by the pale bands on legs being restricted to the fore and mid-tibiae, and by pale bands on abdomen TII, IV and V, but not on III. Pupae can be recognised by lack of frontal setae, presence of medio-lateral spinule fields on TII with none developed as a spine band, and with 4 long Ls on VIII. Larvae can be recognised by a combination of mandible with smooth outer and serrate inner surfaces, antenna length less than 90 µm, and AR less than 1.64. Adult specimens perfectly fit the descriptions of Freeman (1961) and Hergstrom (1974). A highly genetically divergent larval form is recognized from three specimens from the Castlereaigh River (Warrumbungles, NSW). These specimens do not cluster with other *C. annuliventris* (Krosch et al., submitted), but form a group unto themselves, and with some relationship to both *C. annuliventris* and *C.*

tasmania. On morphology these larvae key to *C. annuliventris*, but may be differentiated by the mandible pigment extending to the base with less strong contrast to the mid-brown head capsule, a narrow mola, a broad rounded median mentum tooth and second lateral mentum teeth no smaller than the first laterals.

C. annuliventris is restricted to south-east Australian cool streams, often at elevation and shaded. All sites are unpolluted.

***Cricotopus brevicornis* Drayson & Cranston sp. n.**
(Figs. 1D, 2D, 4D, 5H, 6C, 7E, 8D, 10D)
urn:lsid:zoobank.org:act:1E863B19-6613-4C91-8861-F867AE4BF8DE

Cricotopus 'sp. II' Drayson, 1992: 58
Cricotopus "brevicornis" sp. nov. Drayson & Cranston, in Cranston, 1996: 86 [Invalid; author states 'not formal publication for nomenclatural purposes]

Type material. Holotype: P♂, AUSTRALIA: NSW, Albury, Murray R., Waterworks, 36°07'S 146°54'E, 21.xi.1989 (*Cook*)(ANIC). **Paratypes**: Qld.: 18 Pe, Carnarvon NP, Carnarvon Ck., 25°04'S 148°14'E., 4/5.vii.1991 (*Black*); 4 Pe, Conondale Range, Stony Ck. #2, 26°52'S 152°44'E, 24.v.1990 (*Cranston*). NSW: Pe, S.E. Araluen, Deua R., 35°45'S 149° 57'E, 29.iii.1988 (*Cranston*); Le/Pe/♀, Albury, Murray R., Noreuil Park, 36°05'S 146°56'E, 22.xii.l989 (*Cook*), Le/Pe/♀, same except 9.iv.1990; 2 Pe, Albury, Murray R. Stn 6, 36°06'S 147°01'E, 17.v.1989 (*Cook*); ♂, 23 Pe, Albury, Murray R., Waterworks, 36°07'S 146°54'E, 21.xi.1989 (*Cook*). Vic: 6 Pe, Albury, Middle Ck., Kiewa Valley Highway, 36°10'S 146°56'E, 26.ii.1990 (*Cook*); 4 Pe, Albury, Middle Ck., Street's Rd, 36°11'S 146°56'E, 26.ii.1990 (*Cook*); 8 Pe, Albury, Middle Ck., Beechworth Rd, 36°15'S 146°50'E, 26.ii.1990 (*Cook*). NT: Pe, Kakadu NP, South Alligator R., Gimbat, Coronation Hill, 13°34'S 132°35'E, 24.v.1988 (*Cranston*); 2 Pe, Kakadu NP, South Alligator R., Coronation Hill, 13°35'S 132°36'E, 4/5.vi.1988 (*Cranston*); Pe, Kakadu NP, Koolpin Ck., 13°35'S 132°36'E, 4/5.vi.1988 (*Cranston*).

Other material examined. Qld.: P♂, Mt. Lewis, trib. Churchill Ck., 16°34'S 145°20'E, 6-7.iv.1997 (*Cranston*), same except Pe, Davies Ck., above falls, 17°01'S 145°35'E, 11–12.iv.1997 (*Cranston*); 2L, many Pe, P♂, P♀, nr. Proserpine, Brandy Ck., 21–23.iii.1998 (*Cranston*); 7Pe, Bartle Frere, Junction Ck., 17°16'S 146°55'E, 17–18.iv.1997 (*Cranston*); Pe, Lawn Hill NP, Indarri Falls, 18°42'S 138°29'E, 16.v.1995 (*Cranston*). Western Australia, Pe, N.W. Coastal Hwy, Sherlock R., 20°57'S 117°36'E (*Cranston*); 2Pe, Millstream Chichester NP, Fortescue R., below homestead, 21°33'S 117°03'E, 24–25.iv.1992 (*Cranston*); 6Pe, Chinderwarrinder Pool, 21°35'S 117°04'E, 25.iv.1992 (*Cranston*). NT: 2Pe, Kakadu NP, South Alligator R., Fisher Ck., 13°33'S 132°33'E, 24.v.1988 (*Cranston*); 6L, Pe, ♂, P♂, Kapalga, 12°36'S 132°25'E, 16.xii.1993 (*Douglas*).

Molecular material. Qld: L, Finch Hatton Gorge NP, Rawson's R., 21°04'S 148°38'E, 15.ix.2008, 736 m asl (*Krosch*) (Mv-RAW3); 2♂, L, Andy Williams Pk., Cedar Creek Rd, Cedar Ck, 27°19'S 152°48'E, 21.iii.2013, 143 m asl (*Krosch*) (Mv-CedP1, 2, Ced12); L, Bunya, n. Brisbane, Carter Court, South Pine R., 27°21'S 152°56'E, 21.iii.2013, 22 m asl (*Krosch*) (Mv-SPR17); 5L, Dayboro, n. Brisbane, Lee's Crossing Rd, North Pine R., 27°12'S 152°48'E, 27.ii.2014, 64 m asl (*Krosch*) (Mv-NPR1.2, 1.4, 1.6, 1.9, 1.13); L, Arana Hills, Dawson Parade, Kedron Brook, 27°24'S 152°58'E, 27.ii.2014, 42 m asl (*Krosch*) (Mv-KBR2.4); 2L, Numinbah Valley, Nerang R., 28°7'S 153°14'E, 20.v.2013, 120 m asl (*Krosch*) (Mv-Ner1, 2); L, Mt Barney NP, Seidenspinner Rd, Mt Barney Ck., 28°14'S 152°44'E, 21.iii.2013, 176 m asl (*Krosch*) (Mv-MtBy8); L, Currumbin Valley, Currumbin Ck., 28°13'S 153°22'E, 20.v.2013, 88 m asl (*Krosch*). NSW, L, Capertee, Glen Davis Rd., Capertee R., 20.i.2013 ((*Cranston*) (Mv-NSW17.3.1). NT: 2L, Kakadu NP, Kambolgie Ck., 13°30'S 132°25'E, 30–31.vii.2013 (*Cranston & Krosch*) (Mv-NT14.5.1, 2).

Description. MALE (Figs. 1D, 2D) n = 3 (pharate). 2.5–2.7 mm.

Head. Ant 725–880 µm; Fl 1–12 340–416 µm, Fl 13 375–472 µm; A.R. 0.9–1.1. Palp 275 µm. 1 Fr, 5 Po, Clyp moderately setose.

Thorax. All sclerites mid-brown. Laps 2–3, Ac 7–9, Dc 19, Pa 3, Scts 6.

Wings. Unmeasurable. Sq 5.

Legs. Unmeasurable.

Abdomen. TI pale, TII mid-brown with pale anterior band, TIII–IV mid-brown with pale anterior and posterior bands, other tergites mid-brown.

Hypopygium (Fig. 2D). Gcx 128–162 µm, iv elongate, pointed and curved posteriorly. Gst 48–70 µm, about 2/5 (0.41) Gcx, all microtrichiose, blunt apically; crista dorsalis absent.

FEMALE (n=2) 1.9 mm.

Head. Ant 269 µm. Palp 310 µm. 2 Co, 2 Fs

Thorax. Uniform mid-brown. Laps 3, Ac 9–12, Dc 12–15, Pa 3–5, Scts 6–8.

Wings. 1.2–1.3 mm. Anal lobe weakly produced. Sq 1, R 1–2, R_{4+5} 1–2.

Legs. Femora on all legs mid-brown; tibiae on all legs very pale, apically mid-brown; tarsomeres of foreleg basally pale, apically mid-brown, tarsomeres of mid- and hind leg white.

Abdomen. Brown.

Genitalia. Spermathecae comprising mid-brown, ovoid capsules and recurved ducts (Fig. 4D).

PUPA. 2.6–4.3 mm, very pale brown.

Cephalothorax. Slightly rugose. Th 64–100 µm; hyaline, short, apically pointed, with pointed scales especially distally (Figs. 6C, 7E). Fs (30–80 µm), on prefrons.

Abdomen (Fig. 8D). PSB on II and sometimes much reduced on III. PSA distinct also on SVII. Hook row on TII usually less than half width of segment (0.38–0.53). One, sometimes two small sparse spinule fields anterior to hook row on TII. D_4 seta on TIII clearly darker, longer and stouter than D_4 seta on TII and IV. Ms 110–160 µm, about 1/20 (0.04–0.07) length of abdomen.

4^{TH} INSTAR LARVA (Fig. 10D) (n=5). 3.7 mm. H.l. 375–515 µm, very pale yellow-brown with darker apical mandible, mentum and occipital margin; abdomen blue; procercus hyaline with mid-brown-black patch. Anterior and posterior parapods yellow.

Head. Ant 68–77 µm, 1st, 38–45 µm, 2–5 26–33 µm; A.R. 1.25–1.5. Md 125–150 µm, with smooth inner and outer margin, pale to mid-brown with distal 1/3 darker. Mentum 105–112 µm, pale brown posteriorly, mid-to dark brown anteriorly: 6 pairs laterals, evenly decreasing on slope.

Abdomen. L_4 plumose on segments A2–A6. Pc 15 µm, A.s. 500 µm.

Etymology. The epithet *brevicornis* derives from early recognition of the short (*brevi-*) thoracic horn (*-cornis*). This is no longer a discriminatory feature but the name is retained.

Remarks. Adults of *C. brevicornis* **sp.n.** can be recognised by the unique colour pattern of the abdomen (Fig. 1D). Pupae have frontal setae on the prefrons, weak pattern on TII, no paratergal spinules, and stout D_4 seta on TIII. Larvae can be recognised by the mandible uniquely amongst Australian *Cricotopus* being smooth on both inner and outer margins, and with small Lauterborn organs and 2^{nd} antennal segment subequal to combined 3^{rd} and 4^{th} segments. These features however are shared with larvae of two or more Australian members of the genus *Paratrichocladius*. From 'M1/FNQ1' *brevicornis* is separated by the normal-length apical mandibular tooth, but separation from a taxon *Paratrichocladius* 'SW QLD' is very difficult, and features used in the key may not hold up (see Comments below).

C. brevicornis is widespread in warmer parts of Australia, absent from Tasmania and present in Victoria only in the north-east on the Murray River. The species tolerates elevated temperatures and nutrient levels, in both larger rivers and creeks.

Cricotopus conicornis Drayson & Cranston sp. n.

(Figs. 1E, 2E, 4E, 6D, 7F, 8E, 11A)

urn:lsid:zoobank.org:act:6FB4E9B1-401D-49BB-A5E5-6FFC003CF76A

Cricotopus 'sp. C' Drayson, 1992: 95

Cricotopus "conicornis" sp. nov. Drayson & Cranston, in Cranston, 1996: 86 [Invalid; author states 'not formal publication for nomenclatural purposes']

Type material. Holotype: Le/Pe/♂, AUSTRALIA: ACT, Pierce's Ck. at Cotter, 35°20'S 148°56'E, 23.ix.1991 (*Drayson*)(ANIC).

Paratypes: Qld: Pe, Brisbane, Bundaroo Ck., 35°42'S 152°36'E, 27.ix.1989 (*Cranston*). NSW: 4 Pe, Warrumbungles, Shawn's Ck., Timor Rock, 31°16'S 149°09'E, 15.ix.1989 (*Cranston*); Le/P, 3 Pe, Rutherford Ck., Brown Mt., 36°36'S 149°47'E, 16.x.1990 (*Cranston*). ACT: Pe/♂, 2 Pe/♀, 2 Le/Pe/♀, 6 Pe, Le/Pe, as Holotype; 4

Pe, Corin Rd, Gibraltar Falls, 35°28'S 148°55'E, 25.viii.1989 (*Cranston*); same except Pe/♀, 4.xii.1991 (*Drayson*). Vic: P♂, P♀, Pe, Mitta Mitta, 10.x.1982 (*Brittain*); Pe, Big R., Omeo Highway, 36°54'S 147°27'E, 26.i.1989 (*Cranston*); L/P, U. Tambo R., CC10, 23.iii.1990, 36°58"S 147°54"E (*Cranston*); Le/P♂, Steavenson R., 37°28'S 145°45'E, 5.v.1993, (*Schrieber*); same except Le/P♀, 1.v.1993; 2Le/P♂, same except 7.iv.1993 (*Downes* et al); same except L/P, 20.iii.1992.

Other material examined. Qld: 2Pe, nr Mareeba, Davies Ck, 17°01'S 145°35'E, 27–28.viii. 1997 (*Cranston*); same except L(P), 2Pe, 11–12.iv.1997; same except 3Pe, 19–20.vi.1997;

5Pe, Kauri Ck., 17°06'S 145°35'E, 11.vi.1997 (*McKie*); Pe, Bartle Frere, Junction Ck. 17°16'S 146°55'E, 12–13.vi.1997 (*Cranston*), same except Pe, 27–28.viii.1997; Pe, P♀, Palmerston NP, Henrietta Ck, 17°36'S 145°45'E, 17.iv.1999 (*Cranston*); 7Pe, 17°47'S 145°41'E, 2–3.ix.1997 (*McKie*); 17Pe, Python Ck., 17°46'S 145°35'E,. 2–3.xi.1997 (*McKie*); 18Pe, Yuccabine Ck., 18°11'S 145°46'E, 9–10.vi.1997 (*McKie*); Qld: L, Mt Elliot NP, Alligator Ck., 23.iii.1998 (*Cranston*); L, Brisbane, Bundaroo Ck., 35°42'S 152°36'E, 27.ix.1989 (*Cranston*). NSW: 3L, Clyde Mt., Sugarloaf Ck., 35°33'S 149°58'E, 10.i.1988 (*Cranston*); 5Pe, Kosciuszko NP, Blue Lake, 36°24'S 148°18'S, 1875 m asl., 3.ii.1998 (*Cranston*); Pe, Kosciuszko NP, Charlotte's Pass, Snowy R., 36°25'S 148°19'E, 1.xii.2010 (*Cranston*).

Molecular material. L, P♂, Qld, Dimbula, Kauri Ck., 17°06'S 145°35'E, 30.viii.2012 (*Cranston*) (Mv-FNQ12.2.5, 12.2.6); Pe, Mt. Lewis, Churchill Ck., 16°34'S 145°20'E, 30.viii.2012 (*Cranston*) (Mv-FNQCh3); 3L, 3P♂, Tas: Devil's Gulch Res., unnamed Ck., State Forest Rd, 41°38'S 146°17'E, 25.xi.2013, 838 m asl (*Krosch*) (Mv-Tas13.1.P1-3, TAS13.1.1, 1.4, 1.11); 2L, Mt Field NP, Russell Falls Ck., 42°40'S 146°42'E, 3.xii.2013 (*Krosch*) (Mv-TAS13.9.13, 9.21); L, Mt Field NP, Tyenna R., 42°41'S 146°43'E, 3.xii.2013, 165 m asl (*Krosch*) (Mv-TAS13.10.15).

Description. MALE (Fig. 1E) (n = 4). 3.9–4.3 mm.

Head. Ant 1080–1128 µm; length Fl 1–12, 425–480 µm, Fl 13, 560–648 µm; A.R. 1.25–1.35. Palp. 364–456 µm. 2–3 Fr, 4 Po. Clyp moderately setose.

Thorax. Sct pale brown, almost hyaline, with mid-brown border. Other sclerites very pale brown with variably distinctive brown postnotum and vittae on scutum. Laps 3–6, Ac 17–19, Dc 11–15, Pa 4–5, Scts 12–14.

Wing. 2.6–2.8 mm. Sq, 9–10, R, 7–8.

Legs. All mid-brown; femora darker, tibia and tarsomeres slightly paler.

Abdomen. All tergites brown.

Hypopygium (Fig. 2E). Gcx 220–230 µm, iv rounded, with or without posterior notch. Gst 86–94 µm, about 2/5 (0.39–0.41) Gcx, with crista dorsalis strongly developed.

FEMALE (n=4). 2.9–4.1 mm.

Head. Ant 321–370 µm. Palp 352–480 µm. Setation as male.

Thorax. Colour as male. Laps 3–6, Ac 19–23, Dc 10–16, Pa 3–4, Scts 12–13.

Wing (n=3). 1.8–2.7 mm; width 0.6–0.8 mm. Sq, 3–10, R + R_1 12–22, R_{4+5} 10–14.

Legs and Abdomen. Colour as male.

Genitalia. Spermathecae comprising mid-brown, reniform, capsules with wide "neck" and straight or recurved ducts (Fig. 4E).

PUPA. 3.3–4.7mm, pale to mid-brown, with clear reticulate pattern on abdomen.

Cephalothorax. Moderately rugose dorsally. Th 140–216 µm, width 50–68 µm; clearly pigmented mid-brown, tear-shaped and covered with pointed scales, especially distally (Fig. 6D, 7F). Fs 90–150 µm conspicuous, on prefrons.

Abdomen (Fig. 8E). PSB on II and III; reduced on III. Hook row on TII never >0.5 of segment (0.34–0.46). Anterolateral spinule fields on TII. Ls on VIII short (32–80 µm), Ls_3 usually < 1/10 width of segment (0.08–0.16). Ms 120–180 µm, less than 1/15 length of abdomen (0.047–0.063). Well developed spinules on SII and III.

4TH INSTAR LARVA (Fig. 11A). (n = 4). 4.6–4.8 mm. H.l. 430–480 µm, very pale to mid-brown with darker posterior margin; abdomen hyaline; procercus hyaline.

Head. Ant 72–78 µm; Fl 1, 44–46 µm; Fl 2–5, 28–32 µm; A.R. 1.43–1.57. Md 136–148 µm, with smooth inner margin and modestly crenulate outer margin, mid-brown with distal 1/3 dark brown. Mentum 100 µm, pale brown posteriorly, mid-brown anteriorly: 6 pairs laterals, 1st laterals large, 2nd slightly reduced.

Abdomen. Pc 14–20 µm wide, A.s. 530–560 µm.

Etymology. The epithet *conicornis* derives from recognition of the cone-shaped (*coni*-) thoracic horn (*-cornis*) of the pupa. This remains a discriminatory feature.

Remarks. Adult males of *C. conicornis* can be distinguished by the combination of uniformly dark legs and abdomen and posteriorly projecting inferior volsella. Females also have uniformly dark legs and abdomen, and elongated spermathecal capsules. Pupae can be recognised by the large, apically scaly, yellow-brown thoracic horn and reticulate pattern on abdomen. Larvae can be recognised by the first lateral mental teeth being level with the median tooth, and the relatively short apical mandibular tooth relative to the large first inner tooth.

This species is similar in colour pattern to that described by Hergstrom (1974) for C. *phaeosomatus.* However *C. conicornis* differs in having the adult male AR much less than the 1.8 of Hergstrom (confirmed on Hergstrom's proposed holotype as 1.9).

The distribution of *C. conicornis* encompasses the tropical and subtropical parts of the continent, but includes some sites in alpine south-east Australia and Tasmania. The species preference seems for clean creeks and moderately healthy rivers.

Cricotopus hillmani Drayson & Cranston, sp. n.

(Figs. 1F, 2F, 3G, 4F, 6E, 7G, 8F, 11B)

urn:lsid:zoobank.org:act:91FC9509-46AC-42DA-A4DC-6DE458C0BDA5

Cricotopus 'sp. IV' Drayson, 1992: 73

Cricotopus "hillman" sp. nov. Drayson & Cranston, in Cranston, 1996: 86 [Invalid; author states 'not formal publication for nomenclatural purposes']

Type material studied. Holotype Le/Pe/♂, AUSTRALIA: NSW: Shoalhaven R., Warri Bridge, 35°21'S 149°44'E, 15.iii.1992 (*Cranston*) (ANIC). **Paratypes**: Le/Pe/♂, as holotype; NSW: 2 Pe, Warrumbungles, Shawn's Ck., Timor Rock, 31°16'S 149°09'E, 15.ix.1989 (*Cranston*), Pe, Endrick R., 6km N.E. Nerriga, 35°05'S 150°08'E, 1.ix.1988 (*Cranston*); 2 Le/Pe/♂, Pe, Shoalhaven R., Warri Bridge, 35°21S 149°44'E, 15.iii.1992 (*Cranston*); 1 Pe, Molonglo R., above Captain's Flat, 35°35'S 149°28'E, 7.iii.1989 (*Cranston*); Pe, Deua R., s.e. Araluen, 35°45'S 149°57'E, 6.ii.1989 (*Cranston*); 2 Pe, Albury, Murray R. Stn 6, 36°06'S 147°01'E, 26.vii.1989 (*Cook*); 8♂, 1♀, 68 Pe, L, Albury, Murray R., Waterworks, 36°07'S 146°54'E, 21.xi.1989 (*Cook*); 2 Pe, L, Rutherford Ck., Brown Mt., 36°36'S 149°47'E, 2.x.1989 (*Cranston*). ACT: Le/Pe/♀, 15 Pe, Cotter R., Vanity Crossing, 31°20'S 148°54'E, 4.xii.1991 (*Drayson*); 2 Pe, 3 L, Brindabellas, Blundell's Ck., 35°22'S 148°50'E, 13–16.iv.1988 (*Cranston*); ♂, Brindabellas, Blundell's Ck., 35°22'S 148°50'E, 7.i.1930 (*Tonnoir*) (misidentified by Freeman as C. *annuliventris*); ♂, 3 Pe, 3 L, same except 13–16.iv.1988 (*Cranston*); ♂, ♀, Tidbinbilla, Tidbinbilla Ck., 35°27'S 148°57'E, 19.ii.1989 (*Cranston*); ♂, ♀, 4 Pe, Corin Rd, Gibraltar Falls, 35°28'S 148°55'E, 4.xii.1990 (*Drayson*); 2♂, Le/Pe/♀, 5 Pe, Gibraltar Falls, Corin Rd, 28.ix.1990, 35°28'S 148°55'E (*Drayson*). Vic: Pe, Wodonga, House Ck., downstream, 36°06'S 146°54'E, 6.ix.1989 (*Cook*); Pe, Wodonga, House Ck., upstream, 36°10'S 146°54'E, 6.ix.1989 (*Cook*); Le/Pe/♂, 2 Le/Pe/♀, Wodonga, Middle Ck., downstream White's Rd, 36°09'S 146°57'E, 24.i.1990 (*Cook*); 3 Pe, Wodonga, Middle Ck., Street's Rd, 36°11'S 146°56'E, 26.ii.1990 (*Cook*); Pe, Wodonga, Middle Ck., Beechworth Rd, 36°15'S 146°50'E, 26.ii.1990 (*Cook*); Pe, Upper Tambo R., USWW, 37°00'S 147°53'E, 8.iii.1990 (*Hortle*). Tas: Pe, Lake St.Clair NP, Old Pelion Hut, Douglas Ck., 41°50'S 146°01'E, 25.i.1990 (*Cranston*); Pe/♂, Mt. Field NP, Tyenna R., 160m a.s.l., 42°41'S 146°43'E, 6/7.ii.1992 (*Cranston*). SA: 2 ♂, Hindmarsh Falls, 4.xi.1970 (*Hergstrom*) (Hergstrom's proposed paratypes of *"C. parbicinctus"*).

Other material examined. Qld: 3Pe, Herberton, Carrington Falls Ck, 800 m asl, 16°28'S 145°19'E, 9–10.iv.1997 (*Cranston*); L(P), nr Mareeba, Davies Ck., 17°01'S 145°35'E, 19–20.vi.1997 (*Cranston*). Pe, Eungella NP, Mt Dalrymple, Cattle Ck., 21°02'S 148°35'E, 22.iii.1998 (*Cranston*).

Molecular material. Qld: Bellthorpe NP, Stony Ck., 26°53'S 152°44'E, 5.xi.2013, 191 m asl (*Krosch*) (Mv-Stny1.12, 1.18). NSW: L, Monga SF, Mongarlowe R., 35°23'S 149°55'E, 30.iv.2012 (*Cranston*) (Mv-Mong12-9); Pe, Brindabella, Goodradigbee R, 35°23'S 148°44'E, 27.vi.2012 (*Cranston*) (Mv-NSWGd5). ACT: L, Uriarra Ck., 35°14'S 148°57'E, 13.vi.2012 (*Cranston*) (Mv-UCk-2); 6L, Corin, Gibraltar Falls, 35°31'S 148°56'E, 3.vi.2012 (*Cranston*)(Mv-ACTGF21-26). Vic: 2L, Dobson's Lane, Dandenong Ck., 37°50'S 145°19'E, 24.x.2006 (*Carew*) (Mv-DOL2, 4). Tas: L, Lake Saint Clair NP, Hugel R., 42°06'S 146°09'E, 1.xii.2013, 770 m asl (*Krosch*) (Mv-TAS13.6.4); L, Mt Field NP, Russell Falls Ck., 42°40'S 146°42'E, 3.xii.2013, 196 m asl (*Krosch*) (Mv-

TAS13.9.18). SA: 2♂, 3♀, 2Pe/♂, 2L, below Hindmarsh Falls, Hindmarsh R., 35º26'S 138º58'E, 3.x.2013, 220 m asl, (*Krosch & Cranston*) (Mv-SAHF1.1, 1.2, 2.1, 2.2, 6.1, 7.1, 7.2, HF2, 6); 2Pe/♂, L, Sawpit Rd., Hindmarsh R., 35°28'S 138°35'E, 3.x.2013, 70 m asl (*Krosch & Cranston*) (Mv-SAW1, 3, HR6); 2L, Deep Creek Conservation Park, Tapanappa Rd, 35°36'S 138°14'E, 3.x.2013, 260 m asl (*Krosch*) (Mv-DC3, 13); L, Minno Ck Junction, Sturt R., 35°02'S 138°37'E, 1.vii.2013, 200 m asl (*Madden*) (Mv-StR1); L, Southern Mt Lofty Ranges, Waterfall Gully, First Ck., 34°58'S 138°40'E, 1.vii.2013, 250 m asl (*Madden*) (Mv-Fst2); L, Southern Mt Lofty Ranges, Uraidla, Cox Ck., 34°58'S 138°44'E, 1.vii.2013, 450 m asl (*Madden*) (Mv-Cox3).

Description. MALE (Fig. 1F). 3.2–4.7 mm.

Head. Ant 800–112 µm; Fl 1–12, 336–440 µm, Fl 13, 440–650 µm; A.R. 1.2–1.5. Palp 415–472 µm. 3 Fr, 7–10 Po, Clyp moderately setose.

Thorax. Pale yellow brown with distinctive brown vittae on scutum and postnotum; scutellum pale. Laps 1–4, Ac 12–21, Dc 17–31, Pa 3–5, Scts 7–12.

Wing (n=2). 2.6–2.7 mm. Sq 14–18, R 6–8. Anal lobe moderately produced.

Legs. All legs mid-brown with proximal 2/3 of tibiae paler, notably on mid- and hind legs.

Abdomen. TI and IV pale to very pale yellow-brown, other tergites mid-brown. TIII and VI with lateral setal band connected posteriorly (Fig. 3G).

Hypopygium (Fig. 2F). Gcx 186–266 µm, iv with posteriorly projecting rounded lobe. Gst 77–106 µm, about 2/5 (0.37–0.42) Gcx, pointed apically; crista dorsalis strongly developed.

FEMALE (n = 5 + 3 pharate). As male except: 4.0–4.9 mm.

Head. Ant 340–400 µm. Palp 468–504 µm. 3 Fr, 5–6 Po.

Wing (n=3). 1.8–2.1 mm. Sq 9–10; R + R_1 16–30, R_{4+5} 9–12.

Thorax. Colour as male. Laps 1–4, Ac 9–21, Dc 17–31, Pa 3–5, Scts 7–12.

Abdomen. As male.

Genitalia. Spermathecae comprising mid-brown, elongate-ovoid capsules with narrow "neck" and curved ducts (Fig. 4F).

PUPA. 3.1–5.0 mm, pale brown to very pale, almost hyaline, with noticeable dark adhesion scars on T I–VIII.

Cephalothorax. Slightly rugose dorsally. Th 80–120 µm, width 20–40 µm; hyaline, flattened, blunt, with or without rounded scales, especially distally (Figs 6E, 7G). Fs 70–140 µm, on prefrons,

Abdomen (Fig. 8F). PSB on segments II and III, less developed on III. Hook row on TII about 0.5 segment width but very variable (0.30–0.63). Ls VIII short (32–80 µm), Ls_3 about 1/10 width of segment (0.08–0.14). Ms about 1/20 total length of abdomen (0.42–0.52). Dark adhesion marks on TII to VII.

4TH INSTAR LARVA (Fig. 11B). 3.6 mm. H.l. 480–510 µm, pale to mid-brown with mid- to dark brown posterior rim; abdomen blue; procercus hyaline, sometimes with pale brown marking.

Head. Ant 74–90 µm, Fl 1, 44–50 µm, Fl 2–5, 28–36 µm; A.R. 1.29–1.56. Md 152–182 µm, about 2x ant (1.90–2.24), with smooth inner margin and weakly crenulate outer margin; pale brown with distal 1/3 mid-to dark brown. Mentum 116–144 µm, pale brown posteriorly, mid-brown anteriorly; 6 or usually 7 pairs of laterals, 2nd laterals slightly reduced, 7th laterals small to occasionally absent.

Abdomen. Pc 20–24 µm, A.s. 440–550 µm.

Etymology. The epithet for this species, '*hillmani'*, recognises Dr. Terry Hillman, past Director of the Murray Darling Freshwater Research Centre, who supported taxonomic, ecological and biodiversity studies of the Chironomidae of the Murray River and tributaries in the Albury-Wodonga region.

Remarks. Adults of *C. hillmani* can be distinguished from all except *C. varicornis* by the combination of dark vittae on thorax and pale TI and IV. They can be distinguished from *C. varicornis*, for which the leg pattern is not known, only by the pattern of tergal setation, and the spermathecal capsule shape, both of which features may be unreliable. Pupae are easily recognised by the dark adhesion marks on all abdominal segments. The frontal setae are present on the prefrons, tergites I and II essentially bare of spines or spinules, and mid-paraterga spinulose. From the otherwise similar *C. howensis*, it can be distinguished by the thoracic horn bearing apical/subapical small tubercles (Fig. 6E). Larvae can be recognised by the mandible having a moderately elongate apical tooth, crenulate outer and smooth inner margin, antennal blade reaching apex of antenna with large Lauterborn organs, and especially, but not always, the presence of a small 7th lateral tooth on the mentum.

As discussed below, Hergstrom (1974) included specimens of *C. hillmani* in her *"C. parbicinctus*". A specimen in the A.N.I.C. collection was identified by Freeman as C. *annuliventris,* but the thorax, legs and abdomen clearly show it to belongs to *C. hillmani.*

C. hillmani is an essentially south-eastern Australian species (including Tasmania) with an anomalous record from far north Queensland. Records are all from rivers and creeks in good water health.

***Cricotopus howensis* Cranston sp. n.**
(Figs 3A, 4G, 6F, 9A, 11C)
urn:lsid:zoobank.org:act:A94258F4-FF55-4F81-ABA8-0A8927739D77

Cricotopus "howensis" Cranston sp. nov. Cranston 1996: 87 [Invalid; author states 'not formal publication for nomenclatural purposes]

Type material. Holotype Pe/♂, AUSTRALIA: Lord Howe Island, Rocky Run Ck., at coast, 31°33'S 159°05'E, 30.xi.1993 (*Cranston & Gullan*). **Paratypes**: ♀, 4Pe/♂, Le/ Pe♂, Le/ P♀, 3L/P, 13Pe, 12L, as Holotype; 4Pe, Erskine Valley, Erskine Ck., 31°34'S 159°04'E, 2.xii.1993 (*Cranston & Gullan*); 2Pe, upper Rocky Run Ck., 31°33'S 159°05'E, 28.x.2012 (*Cranston & Gullan*).

Other material examined. 10Pe, Erskine Valley, Erskine Ck., 31°34'S 159°04'E, 30.x.2012 (*Cranston*); Le/ P♀, 2L, upper Rocky Run Ck., 31°33'S 159°05'E, 28.x.2012 (*Cranston*).

Molecular material. P♀, Erskine Valley, Erskine Ck., 31°34'S 159°04'E, 30.x.2012 (*Cranston*) (Mv-LHI11); 2♀, Le/P♀, L, upper Rocky Run Ck., 31°33'S 159°05'E, 28.x.2012 (*Cranston*) (Mv-LHI12, 13, 15, 16).

Description. MALE (n=4, all teneral). 3.5mm. Thorax yellow-brown with contrasting dark vittae. Legs are teneral but may be substantially pale except for dark tarsomere 5.

Head. Ant 710–740 µm; Fl 1–12, 345–370 µm, Fl 13, 350–390 µm; A.R. 1.02–1.05. Palp 335–350 µm. 1–2 Fr, 8 Po, Clyp moderately setose.

Thorax. Mid-brown with vittae slightly darker. Laps 1–3, Ac 9–16, Dc 25–32 (longest posteriorly), Pa, 6–8, Scts 9–16.

Wing and legs teneral; sq 5–6.

Abdomen. TI, anterior 1/2 TII and IV pale, other tergites mid-brown.

Hypopygium (Fig. 3A). Gcx 180–195 µm, iv with small posteriorly projecting rounded lobe, apically bare. Gst 80–88 µm, about 1/2 (0.44–0.48) Gcx, pointed apically; crista dorsalis short, high, hyaline.

FEMALE (n = 2 + 2 pharate). 3.7 mm (n=1).

Head. Ant 325 µm. Palp 415–450 µm. ?1 Co, 4–5 Fr, 6–8Po, Clyp strongly setose.

Thorax. Mid-brown, vittae darker and prominent. Laps 2–3, Ac 16, Dc 30 (longest posteriorly), Pa 5–6, Scts 14–23.

Wing (n=1, teneral). Sq 10, R + R_1 12, R_{4+5} 11.

Abdomen. As male.

Genitalia. Spermathecae comprising pale-brown, elongate-ovoid capsules with broad elongate"neck" abruptly tapering to thin recurved ducts; resembling *C. varicornis* (Fig. 4I) with shorter ducts.

PUPA. 3.4–4.0 mm, pale brown, adhesion scars scarcely darker.

Cephalothorax. Slightly rugulose postero-dorsally. Th 100–117 µm, width 20–27 µm; hyaline, sausage-shaped, tapering basally, tapering or rounded apically with few scales distally (Fig. 6F). Fs 72–75 µm, on prefrons.

Abdomen (Fig. 9A). PSB modestly developed on II and weak or absent on III. Hook row on TII about 0.5 segment width (0.45–0.52). Ls VIII short (38–50 µm), Ls_4 about 1/7 (0.11–0.17) width of segment. Ms about 1/20 total length of abdomen (0.48–0.58). Adhesion scars pale brown.

4TH INSTAR LARVA (Fig. 11C). 4.2–4.9 mm. H.l. 420–460 µm, brown; mandibles, mentum and occipital margin only slightly darker brown than background; thorax yellow-green with some blue, abdomen strongly blue-tinged; procercus tinged brown; procercal anal setae and posterior parapod claws brown.

Head. Ant 67–72 µm; 1, 42–45 µm; 2–5, 25–30 µm; A.R. 1.5–1.7; blade 20–23 µm not extending beyond 5th segment

Md 135–140 µm. 2x ant., outer margin moderately crenulate, mola curved distally with smooth inner margin, mid-brown gradually grading into slightly paler base; seta subdentalis broad, apically hooked.

Mentum 95–110 µm, mid-brown; 6 pairs laterals, 1st swollen, 2nd reduced near appressed to 1st.

Abdomen. l_4 seta 30 µm, plumose at least on abd IV–VI. Pc short, with brown pigment patches, 17–25 µm, A.s. 450–500 µm.

Etymology. The epithet *howensis*, is an adjective derived for the only known location for this species which is endemic to Lord Howe Island, that lies in the Pacific Ocean 600 km due east of Port Macquarie on mainland New South Wales, eastern Australia.

Remarks. All adults of *C. howensis* are teneral, and the colour of body and legs cannot be determined unambiguously. It is possible that the thorax, abdomen and leg colour resembles that of *C. albitarsis* in both sexes (Fig. 1B). In the male hypopygium, the shape of the postero-medially directed inferior volsella, with a hyaline distal area may be distinctive. The female genitalia seem variable between specimens regarding the shape of the spermathecal vesicles and ducts The pupa has frontal setae on the prefrons, spinulose paratergite on segments III and IV, and the smooth thoracic horn tapers apically to a point. Larval *C. howensis* can be distinguished by the mid-brown head capsule with mentum and mandible only slightly darker, and with mandibular dark pigment extending far basally. This is the only species present on Lord Howe Island, and adult *Cricotopus* found there should belong to this species.

Both creeks from which the species is reported are in excellent condition and likely to be permanent. The species was not found in cattle-contaminated water bodies.

Cricotopus parbicinctus Hergstrom sp. n.

(Figs 1G, 3B, 4H, 5C, 6G, 7H, 9B, 11D)
urn:lsid:zoobank.org:act:1ED970B3-823A-4233-A8C4-113179ADFC45

Cricotopus parbicinctus Hergstrom, 1974: 95 [Invalid ICZN, 1985: Article 8a].
Cricotopus 'sp. III' Drayson, 1992
Cricotopus "parbicinctus Hergstrom" in Cranston,1996: 86 [Invalid; author states 'not formal publication for nomenclatural purposes]

Type material. Holotype ♂: AUSTRALIA: SA: Mt Gambier, Leg of Mutton Lake, 26 Aug 1969 (*Hergstrom*) (ANIC). **Paratypes**: ♂, ♀, SA: Hindmarsh Falls, 4 Nov 1970 (*Hergstrom*) (ANIC).

Other material examined. Qld: 2 Pe, Eungella NP, Mt Dalrymple, ? Cattle Ck., 21°02'S 148°35'E, 22.iii.1998 (Cranston); 4 Pe, Conondale Range, Stony Ck. #2, 26°52'S 152°44'E, 24.v.1990 (*Cranston*); 1 Pe, Mt. Crosby, Brisbane R., 27°32'S 152°47'E. 19.i.1991 (*Cranston*); 1 Pe, Mt. Stanley, Brisbane R., 27°32'S 153°29'E, 19.i.1991 (*Cranston*); 1 Pe, n.w. Brisbane, Bundaroo Ck., 35°42'S 152°36'E, 27.ix.1989 (*Cranston*). NSW: Le/Pe/♂, Pe, Deua R., S.E. Araluen, 35°45'S 149°57'E, 29.iii,1988 (*Cranston*); Pe, Barrengarry R., Belmore Falls, 34°38'S 150°33'E, 3.iv.1991 (*Cranston*); 3 Pe, Endrick R., 6 km N.E. Nerriga, 35°05'S 150°08'E, 1.ix.1988 (*Cranston*); 1♂, 1 Pe, Ginninderra Falls, 35°13'S 148°58'E, 6.xii.87 (*Cranston*); ♂, Le/Pe/♂, 2 Le/Pe/♀, 3 Pe, 1L, Sugarloaf Ck., Clyde Mt., 35°33'S 149°58'E, 10.i.1988 (*Cranston*); 3 Le/Pe/♂, 2 Pe, Shoalhaven R., Gundillion, 35°35'S 149°37'E, 4.xi.1991 (*Cranston*); 19 Pe, Albury, Murray R. Stn 6, 36°06'S 147°01 'E, 17.v.l989 (*Cook*); ♂, 3 Le/Pe/♂, 3 Le/Pe/♀, 10 Pe, Albury, Murray R., Waterworks, 36°07'S 146°54'E, 21.xi.1989 (*Cook*); 1♂, Jindabyne, Rush's Ck., 36°24'S 148°40'E, 12.xii,1987 (*Cranston*); 2Pe, Kosciuszko NP, Club Lake, 36°25'S 148°17'S, 30.xii.1997 (*Cranston*); L, Kosciuszko NP, Blue Lake, 1875 m asl. 3.ii.1998 (*Cranston*); 2 Pe, Kosciuszko NP, Spencer's Ck., 1730m, 36°26'S 148°22'E, 2.i.1988 (*Cranston*); Pe, Kosciuszko NP, Hedley Tarn, 36°25'S 148°19'E, 30.xii.1989 (*Cranston*); 3♂, Le/Pe/♀, 8 Pe, Rutherford Ck., Brown Mt., 36°36'S 149°47'E, 17.xii,1990 (*Cranston*); Pe, Bugong Rd to Kangaroo Valley, xi. 1990, Edward. ACT: Pe, Canberra, Lake Burley Griffin, Black Mt. Peninsula, 35°16'S 149°07'E, 18.i.1992 (*Rosewarne*); 3♂, 3 Le/Pe/♀, Molonglo R., Coppins Crossing, 35°17'S 149°02'E, 7 xi 1987 (*Cranston*); 2 Pe, Pierce's Ck., 35°20'S 148°56'E, 23.ix.1991 (*Drayson*); ♀, 4 Pe, Cotter R., below dam, 35°21'S 148°56'E, 7.xi.1987 (*Cranston*); 2 Pe, Brindabellas, Blundell's Ck., 35°22'S 148°50'E, 13–16.v.1988 (*Cranston*),; 5 Pe, Tidbinbilla, Tidbinbilla Ck., 35°27'S 148°57'E, 19.ii.1989 (*Cranston*); ♂, ♀, 4Pe, Corin Rd, Gibraltar Falls, 35°28'S 148°55'E, 28.ix.1990 (*Drayson*); ♂, Pe, Namadgi NP, Orroral R., 35°39'S 148°59'E, 21.ii.1988 (*Cranston*). Vic: ♀, Pe, House Ck. up-stream, 36°10'S, 146°52'E 19.xii,1989 (*Cook*); Pe, L, 6 Le/Pe/♂ ♀, 8 Le/Pe/♀, Pe, Wodonga, Middle Ck., downstream White's Rd, 36°09'S 146°57'E, 20.iii.1990 (*Cook*); ♂, *,2* Le/Pe/♂,, 3 Pe, Le/Pe, Wodonga, Middle Ck., Street's Rd, 36°11'S 146°56'E 26.ii.1990 (*Cook*); Pe, Wodonga, Middle Ck., Beechworth Rd, 36°15'S, 146°50'E 26.ii.1990 (*Cook*); ♀, Pe, Le/Pe, Mitta Mitta, Snowy Ck., 36°33'S 147°23'E, 29.i.1988 (*Cranston*); ♂, 11 Pe, Le/Pe, Buckland R., 36°48'S 146°51'E, 6.xi.1990 (*Cranston, Cook* & *Nielsen*); ♂, 2 Pe, Cann R., 37°34S 149°09E, 20.i.1989 (*Cranston*).

Tas: 3 Pe, Lake St.Clair NP, Ranger Hut, Douglas Ck., 41°50'S 146°02'E, 25.i.1990 (*Cranston*); Pe, Franklin R., Lyall highway crossing, 42°12'S 146°02'E, 17.i.1990 (*Cranston*).

SA: ♂ Eric Bonython Reserve, 8.iv.1970 (*Hergstrom*). WA: 6 Pe, Stirling Range, Bluff Knoll, 34°22'S 118°14'E, 20.xi.1990 (*Cranston*).

Molecular material. Qld: L, Dimbula, Kauri Ck., 17°06'S 145°35'E, 30.viii.2012 (*Cranston*) (Mv-FNQ12.2.7); L, Paluma NP, Birthday Ck., 18˚58'S 146˚09'E, 24.ix.2008, 760 m asl (*Krosch*) (Mv-PAh1); L, Bellthorpe NP, Stony Ck., 26˚53'S 152˚44'E, 5.xi.2013, 191 m asl (*Krosch*) (Mv-Stny1.1); L, Mt Barney NP, Seidenspinner Rd, Mt Barney Ck., 28°14'S 152°44'E, 21.iii.2013, 176 m asl (*Krosch*) (Mv-MtBy12). NSW: ♀, Capertee Valley, Glen Davis Rd, Coco Ck., 33°08'S 150°6'E, 20.ii.2013 (*Cranston*) (Mv-NSW13-5.6); Pe, Newnes, Little Capertee Ck., 33°10'S 150°14'E, 19.ii.2013 (*Cranston*) (Mv-NSW13-4.1); Pe, Tarago Rd., Tarlo Ck., 34°28'S 150°00'E, 7.ii.2013 (*Cranston*) (Mv-NSW13.1.2); L, Belmore Falls, Barrengarry R., 34°38'S 150°33'E, 3.iii.2011 (*Cranston*) (Mv-NSWBel1); 3L, Windellama, Windellama Ck., 35°00'S 149°53'E, 16.v.2013 (*Cranston*) (Mv-NSWWin1-3); ♂, 5L, Monga SF, Mongarlowe R., 35˚23'S 149˚55'E, 30.iv.2012 (*Cranston*) (Mv-Mong12-2,4-8); P, P♀, Currowan SF, Cabbage Tree Ck., 35°34'S 150°02'E, 31.xii–2.i.2009, (*Cranston*) (Mv-CTC09-1,3); 2L, P, Brown Mt., Rutherford Ck., 36°36'S 149°47'E, 27.xi.2010 (*Cranston*) (Mv-Bmt10-1, NSWBMt6, 7); 2L, Pe, ♂, Brindabella, Goodradigbee R., 35°23'S 148°44'E, 27.vi.2012 (*Cranston*) (Mv-NSWGd1, 3, 4, 10); Kosciuszko NP, trib. Bogong Ck., 36°21'S 148°12'E, 4.xii.2010 (*Cranston*) (Mv-NSWKos8). ACT: Uriarra Ck., 35°14'S 148°57'E, 13.vi.2012 (*Cranston*) (Mv-UCk13-6); L, Condor Ck., 35°22'S 148°51'E, 14.vi.2012 (Cranston) (Mv-ACTCon 5). Vic: 4L, P, ♂, Grampians, Zumsteins, McKenzie R., 37°06'S 142°24'E, 7–8.i.2011 (*Cranston*) (Mv-VicGr18, 19, 21, 23–25); L, Sunbury Rd, Jackson's Ck., 37°35'S 144°44'E, 3.xi.2006 (*Carew*) (Mv-Jack2); L, Campbellfield, Mahoney's Rd, Merri Ck., 37°41'S 144°58'E, 17.xi.2006 (*Carew*) (Mv-MMC2); L, Campbellfield, Barry Rd, Merri Ck., 37°40'S 144°58'E, 17.xi.2006 (*Carew*) (Mv-MBR3); L, Brooklyn, Princes Hwy, Kororoit Ck., 37°49'S 144°49'E, 10.xi.2006 (*Carew*) (Mv-KPH8); L, Stony Diversion Drain, Sunshine West, Kororoit Ck., 37°47'S 144°49'E, 9.xi.2006 (*Carew*) (Mv-KSD3). Tas: L, Lake Saint Clair NP, Hugel R., 42°06'S 146°09'E, 1.xii.2013, 770 m asl (*Krosch*) (Mv-TAS13.6.5). SA: P, L, Southern Mt Lofty Ranges, Cox Creek, Uraidla, 34°58'S 138°44'E, 1.vii.2013, 450m (*Madden*) (Mv-CoxP1, Cox2); 2♀, L, below Hindmarsh Falls, Hindmarsh R., 35°26'S 138°58'E, 3.x.2013, 220 m asl, (*Krosch & Cranston*)(Mv-SAHF5.1, 2, HF1); P♂, P♀, L, Sawpit Rd., Hindmarsh R., 35°28'S 138°35'E, 3.x.2013, 70 m asl (*Krosch & Cranston*) (Mv-HRP1, SAW2, HR1); L, Deep Creek Conservation Park, Tapanappa Rd, 35°36'S 138°14'E, 3.x.2013, 260 m asl (*Krosch*) (Mv-DC2); L, Minno Ck. Junction, Sturt R., 35°02'S 138°37'E, 1.vii.2013, 200 m asl (*Madden*) (Mv-StR2); L, Southern Mt Lofty Ranges, Waterfall Gully, First Ck., 34°58'S 138°40'E, 1.vii.2013, 250 m asl (*Madden*) (Mv-Fst1).

Description. MALE (Fig.1G). 2.8–3.7 mm.

Head. Ant 856–1000 µm: Fl 1–12, 336–440 µm; Fl 13, 464–592 µm. AR 1.13–1.56. Palp 352–432 µm. 1 Fr, 9 Po. Clyp sparsely setose.

Thorax. Uniform mid-brown. Lapn 0–4, Ac 11–21, Dc 15–31, Pa 2–4, Scts 5–12.

Wing. 1.7–2.1 mm. Sq 8–15, R 4–5.

Legs. Tibiae of all legs mid-brown with pale ring on proximal third. All femora and tarsi mid-brown.

Abdomen. Uniform mid-brown.

Hypopygium (Fig. 3G). Gcx 190–220 µm, iv with posteriorly projecting rounded lobe. Gst 74–90 µm, about 2/5 (0.36–0.45) Gcx, narrow apically; crista dorsalis strongly developed but without setae and often extremely hyaline.

FEMALE. As male except: 3.4–3.8 mm.

Head. Ant 325–365 µm. Palp 472–544 µm.

Wing. 2.2–2.5 mm. Sq 9–11, R + R_1 7–14, R_{4+5} 6–15.

Genitalia. Spermathecae comprising mid-brown, spheroid capsules with narrow "neck" and recurved ducts (Fig. 4H).

PUPA. 3.5–4.6 mm, pale brown to almost hyaline.

Cephalothorax. Slightly rugose dorsally. Th 140–230 µm; hyaline, cylindrical, tapered to distal point, covered with sparse pointed scales, especially distally (Figs 6G, 7H). 0 Fs.

Abdomen (Fig. 9B). PSB on II only. Hook row on TII about 1/3 width of segment (0.0.31–0.38). Ls on VIII long, Ls_4 about 1/4 width of segment (0.18–0.33). Ms < 1/15 length of abdomen (0.05–0.062).

4TH INSTAR LARVA (Fig. 11D). 3.5–5.4 mm. H.l. 460–550 µm, pale to mid-brown with mid-to dark brown posterior rim; body blue-purple; procercus hyaline.

Head. Ant 90–106 µm, Fl 1, 50–68 µm, Fl 2–5, 30–34 µm; A.R. 1.36–2.00. Md with smooth outer margin and serrate inner; pale brown with distal 1/3 mid- to dark brown; length 142–170 µm, < 2x length of ant (1.53–1.92). Mentum 100–140 µm, pale brown posteriorly, mid-brown anteriorly; 6 pairs laterals, 2nd slightly reduced.

Abdomen**.** Pc 20–29 µm, A.s. 500–600 µm.

Etymology. The name *parbicinctus* is likely a lapsus for intended *parabicinctus* (Hergstrom states in her description "Very similar to *bicinctus ... "*). We see no reason to emend Hergstrom's name and we recognise her as the sole author, validated here.

Remarks. Adults of this species can be distinguished from all other Australian *Cricotopus* by the pale bands on the tibiae of all legs (this banding is easily visible to the naked eye). Pupae are recognised by absence of frontal setae, lacking PSB on segment III, 4 long l_4 setae on VIII, and TII anterior to the narrow hook row bare. From the otherwise similar *C. acornis* it can be distinguished by the presence of a characteristic long, narrow, spinose thoracic horn. Larvae recognised only by a combination of the mandible with smooth outer and serrate inner margin and antenna length more than 90 µm.

Although this species appears to be *"C. parbicinctus"* of Hergstrom (1974), she describes "tergite I, anterior parts of n, III, IV and V yellow in most specimens" and describes the larva as having "about 5 serrations on inner surface and with wrinkled outer surface". Her proposed holotype, now in A.N.l.C., has anterior and posterior pale bands on TII–VI, but TI is dark. Two of her proposed paratypes have vittae on the thorax and in fact belong to *C. hillmani* (q.v.). The species differs from the Palaearctic species *bicinctus* in colour of the thorax and abdomen and shape of genitalia of males, absence of PSB on segment III of pupa, and lack of crenulation on outer margin of mandible of larva (Hirvenoja 1973). A highly genetically divergent form is recognized from larvae and a single adult male from several locations throughout Queensland and New South Wales. This genetic form is reciprocally monophyletic to all other *C. parbicinctus* and branch lengths between the clades are substantial. Larvae of this divergent form may be separable from *C. parbicinctus* only by the extent of mandible pigment (extending to the external seta or beyond in the divergent form). More extensive sampling may reveal this taxon to be a true biological species; however, we consider it only as a form pending further work.

C. parbicinctus is a widespread species, but represented in Western Australia only by one location in the southern hills and one in Tasmania, and seemingly absent from Northern Territory. Within its range it inhabits pristine to slow to stagnant, macrophyte-dominated and nutrient enriched waters.

Cricotopus tasmania Drayson & Cranston sp. n.

(Figs IH, 3C, 4H, 5F, 6H, 7I, 9C, 12A)

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Cricotopus 'sp. E' Drayson, 1992: 109

Cricotopus "tasmania" Drayson & Cranston sp. nov. in Cranston, 1996: 86 [Invalid; author states 'not formal publication for nomenclatural purposes]

Type material. Holotype: ♂, AUSTRALIA: Tas, Mt. Field NP, Rodway Hut, 1200m. 42°41'S 146°34'E, 3.ii.1992 (*Cranston*) (ANIC). **Paratypes:** 10 Pe, L/P, 2 L, as Holotype; Tas: 3 Pe, Lake St.Clair NP, Ranger Hut, Douglas Ck., 41°50'S 146°02'E, 25.i.1990 (*Cranston*).

Other material examined. Qld: 3 Pe, Eungella NP, Mt Dalrymple, ? Cattle Ck., 21°02S 148°35'E, 22.iii.1998 (Cranston). Tas.: 10 Pe, L/P, 2 L; Mt. Field NP, Rodway Hut, 1200m. 42°41'S 146°34'E, 3.ii.1992 (*Cranston*).

Molecular material. ACT: ♂, Corin Rd, Gibraltar Falls, 35°28'S 148°55'E, 3.vii.2012 (*Cranston*) (Mv-ACTGF27); 2♀, Brindabella, Goodradigbee R., 35°23'S 148°44'E, 27.vi.2012 (*Cranston*) (Mv-NSWGd11, 12). NSW: 2L, Bramina Ck., 35°23'S 148°44'E, 27.vi.2012, 543 m asl, (*Cranston*) (Mv-NSWBramCr1, 2); Kosciuszko NP, L, trib. Bogong Ck., 36°21'S 148°02'E, 4.xii.2010 (*Cranston*) (Mv-KNPCric3); P♀, Pipers Ck., 36°23'S 148°26'E, 2.xii.2010 (*Cranston*) (Mv-KNPCric6); P♂, L, Leather Barrel Ck., 36°31'S 148°11'E, 4.xii.2010 (*Cranston*) (Mv-NSWKos13, 14). Tas: L, Devil's Gulch Res., unnamed Ck., State Forest Rd, 41°38'S 146°17'E, 25.xi.2013, 838 m asl (*Krosch*) (Mv-Tas13.1.3); L, Cradle Mountain NP, Pencil Pine Ck., 41°35'S 145°55'E, 26.xi.2013, 811 m asl (*Krosch*) (Mv-Tas13.2.3); 3L, Cradle Mountain NP, Fagus Ck., 41°38'S 145°56'E,

27.xi.2013, 920 m asl (*Krosch*) (Mv-Tas13.3.1, 3.12); 3L, Lake Saint Clair NP, unnamed Ck., 42°06'S 146°10'E, 1.xii.2013, 764 m asl (*Krosch*) (Mv-Tas13.7.3, 7.7, 7.9); 2L, Mt Field NP, Rodway Hut, 42°41'S 146°34'E, 2.xii.2013, 1242 m asl (*Krosch*) (Mv-TAS13.8.1, 8.2); L, Mt Field NP, Russell Falls Ck., 42°40'S 146°42'E, 3.xii.2013 (*Krosch*) (Mv-TAS13.9.14); L, Mt Field NP, Tyenna R., 42°41'S 146°43'E, 3.xii.2013, 165 m asl (*Krosch*) (Mv-TAS13.10.14).

Description. MALE (Fig. IH) (n=3, partial). 4.1–4.2 mm.

Head. Ant 960 µm; Fl 1–12, 440–480 µm, Fl 13, 520–535 µm; A.R. 1.1–1.2. Palp 490–690 µm. Fr 2–4, Po 8. Clyp sparsely setose (c 8 setae).

Thorax. Uniform mid-brown. Laps 2–3, Ac 17–23, Dc 15–21, Pa 2–3, Scts 7–10.

Wing. 2.4 mm. Sq 7–11, R 8, R_{4+5} 0.

Legs. All legs very pale yellow-brown; without dark section(s).

Abdomen. TI and IV totally pale; broad anterior pale band on TII, narrower pale band anterior on V, evidence of pale anterior band on VI–VII.

Hypopygium (Fig. 3C). Gcx 245–248 µm, iv somewhat squared off. Gst 83–90 µm, 0.36 x Gcx, with triangular pointed to elongate rounded crista dorsalis.

FEMALE. (Fig. 4H) (n=1–2, partial). As male except: 4.2–4.6 mm.

Head. Ant 325–365 µm. Palp 420–690 µm. Co 0, Fr 2, Po 5, Clyp setose (c 20 setae).

Thorax. Vittae mid-brown against yellow background. Laps 2, Ac unviewable, Dc 18, Pa 5, Scts 10.

Wing. 2.6–2.7 mm. Sq 10–11, R + R_1 12–15, R_{4+5} 0.

Genitalia. Spermathecae comprising mid-brown, variably ovoid to elongate-oval capsules tapering into long "neck" and ducts variably curved according to pressure on specimen (Fig. 4H, left specimen #Mv-Gd11, right #Mv-Gd12).

PUPA. 3.5–4.1 mm, pale to mid-brown.

Cephalothorax. Moderately rugose dorsally. Th 14–80 µm; hyaline to pale brown, variable in shape (see Fig. 6H), may have apical scales (Fig. 7I). 0 Fs.

Abdomen (Fig. 9C). PSB on II only. TII with hook row >1/2 width of segment (0.27–0.44); narrow sparse spinule field anterior to hook row; two medio-lateral spinule fields usually present. VIII with 5 prominent Ls (100–160 µm), Ls_4 > 1/4 width of segment (0.27–0.33) (Fig. 5F). Ms 160–200 µm, < 1/12 length of abdomen (0.06–0.07).

4TH INSTAR LARVA (Fig. 12A) (n=4). 4.2–5.6 mm. H.l. 480–550 µm mid-brown with dark brown posterior margin; abdomen yellow-blue; procercus hyaline with mid-brown marking.

Head. Ant 72–90 µm; 1, 40–54 µm; 2–5, 32–36 µm; A.R. 1.25–1.69. Md with serrate inner and smooth outer margin, mid-brown with distal 1/3 dark brown; length 156–180 µm, about 2x antenna (1.98–2.18). Mentum 112–148 µm, mid-brown; 6 pairs laterals, 2nd slightly reduced.

Abdomen. Pc 22–27 µm, A.s. 500–530 µm.

Etymology. The epithet '*tasmania'*, a noun in apposition, derives from its original collections suggesting endemism to Tasmania. We retain the name although there is molecular evidence showing the species presence in high elevation alpine and sub-alpine streams in south-eastern mainland Australia.

Remarks. Adults of *C. tasmania* can be distinguished by their uniformly pale legs, pattern of pale tergites and in the male the A.R. is unusually low. Pupae can be recognised by the presence of spine/spinule fields on TII and by the usual presence of 5 long L setae on VIII. Specimens from mainland Australia seemingly can lack the distinctive 5th L seta on VIII, but whether this is damage or true absence is unclear. Larvae can be recognised by the mandible having a smooth outer margin, serrate inner margin, and being narrow above the mola. The validity of the colour contrasts used in the key need verification.

The adult of this species resembles in colour and pattern C. *phaeosomatus* described by Hergstrom (1974), but differs in having the A.R. of adult males much less than the value of 1.9 (as inverse 0.53 of Hergstrom, and confirmed by Cranston).

Molecular data suggest monophyletic non-Tasmanian specimens are embedded in a diversity of Tasmanian sampled specimens (Krosch et al., submitted).

C. tasmania inhabits clean cool streams often at elevation, in south-east Australia including Tasmania where it appears widespread.

***Cricotopus varicornis* Drayson & Cranston sp. n.**
(Figs. 1I, 3D,F, 5I, 7A,J, 9D, 12B)
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Cricotopus 'sp. D' Drayson, 1992: 102 (nec larva, misassociated)
Cricotopus 'sp. V' Drayson, 1992: 73
Cricotopus "varicornis" Cranston sp. nov. in Cranston, 1996: 87 [Invalid; author states 'not formal publication for nomenclatural purposes]
Cricotopus "cooki" sp. nov. Drayson & Cranston, in Cranston, 1996: 86 [Invalid; author states 'not formal publication for nomenclatural purposes']

Type material. Holotype: P♂, AUSTRALIA; ACT, Corin Rd, Gibraltar Falls, 35°28'S 148°55'E, 23.ix.1991 (*Drayson*). **Paratypes**: as holotype, except ♂, 2 Pe/♂, 2♀, 2 Pe/♀, 27 Pe, 5 L, 2 Le/P.

Additional material examined 1. Assigned to form *varicornis*.: ♂, Le/P♂, Le/P♀, 2P♀, 3LP, 7Pe, , as type except13.x.1993 (Cranston); ♀, as type, except 20.x.1993 (Cranston); L as type except 23.x.1993. 2. Assigned to form *cooki*: Vic: Pe, Wodonga, House Ck., upstream, 36°10'S 146°52'E, 19.ii.1989 (*Cook*); 1Pe, Wodonga, Middle Ck., Street's Rd, 36°11'S 146°56'E, 26.ii.1990 (*Cook*); 11 Pe, Wodonga, Middle Ck., Boyes Rd., 36°13'S 146°54'E, 7.xii.1989 (*Cook*); 3Pe, Wodonga, Middle Ck., Beechworth Rd, 36°15'S 146°50'E, 5.i.1990 (*Cook*).

Molecular material. 2L, P♀, ACT, Paddy's R., 35°27'S 149°01'E, 22.iv.2013 (*Cranston*) (Mv-ACTPR6-8 - *cooki*); NSW: P♀ Pipers Ck., 36°23'S 148°26'E, 2.xii.2010 (*Cranston*) (Mv-KNPCric7- *varicornis*).

Description. MALE (Fig. 1I) (n = 2 + 3 pharate). 2.7–3.3 mm.

Head. Ant 680–744 µm; Fl 1–12, 350–400 µm, Fl 13, 275–400 µm; A.R. 0.7–0.96. Palp 308–324 µm. Fr 2, Po 3. Clyp moderately setose.

Thorax. Background yellow-brown, with mid-brown scutal vittae and postnotum distinctive. Laps 4–7, Ac 9–17, Dc 12–25, Pa 5–6, Scts 7–12.

Wing. 1.8 mm. Sq 5–9, R 0–5.

Legs. Unmeasurable; fore tibia pale from basal area to mid-tibia, otherwise weakly to distinctly dark.

Abdomen. T I and IV very pale; broad anterior pale band on TII, otherwise segments mid-to dark brown. TIII and VI with lateral setal bands not connected (Fig. 3G).

Hypopygium (Fig. 3D). Gcx 170–200 µm, iv directed postero-medially, very setose, without hyaline apex. Gst 70–88 µm, about 1/2 (0.4–0.5) Gcx; crista dorsalis high, elongate.

FEMALE (n=4, pharate). As in male except: 3.3–3.6 mm.

Head. Ant 301–316 µm. Palp 382–394 µm.

Thorax. Laps 5–7, Ac 12–23, Dc 12–22, Pa 4–6, Scts 8–10.

Wing. 1.9–2.0 mm. Sq 2–5, R + R_1 10–19; R_{4+5} 8–11.

Legs. Brown with paler section from near base to middle of fore-tibia, indicated also on mid- and hind legs.

Genitalia. Spermathecae comprising brown, ovoid capsules with narrow "neck" and recurved ducts (Fig. 4I).

PUPA. 2.9–5.4 mm, pale brown to almost hyaline.

Cephalothorax. Moderately rugose dorsally. Th 26–150 µm; hyaline to brown pigmented, very variable in shape, with or without apical scales (Fig 7A,J). Fs 26–70 µm, on frons.

Abdomen (Fig. 9D). PSB on II, smaller on III. Hook row about 1/2 of segment (0.42–0.56). Spinule fields present on TI and anterior to hook row on TII (Fig. 5I). Paratergite spinulose on II–V. Ls_3 VIII short, 56–80 µm, < 1/5 segment width (0.12–0.20).

Ms 110–220 µm, less than 1/15 length of abdomen (0.05–0.06). Extensive spinulation on sternites II and III.

4TH INSTAR LARVA (Fig. 12B, C) (n=3) Length not measurable. H.l. 470–480 µm very pale with pigmented areas including posterior margin dark brown; abdomen yellow with strong blue colour; procercus hyaline, with mid-brown marking. Anterior parapod claws pale yellow; posterior parapod claws darker yellow.

Head. Ant 74–78 µm, 1st 37–40 µm, 2–5 32–37 µm; A.R. 1.0–1.2. Md 130–140 µm with smooth inner and strongly or weakly crenulate outer margin, dark brown to notch and distal mola, posterior ½ to ⅔ pale yellow. Mentum 107–117 µm, middle tooth wide, perhaps complex, 22–25% mentum width, pale brown posteriorly, mid- to dark brown anteriorly; with 6 pairs lateral teeth on even slope.

Abdomen**.** Pc 20 µm, A.s. 500 µm.

Remarks. The variation in morphology of this taxon, reflected in the epithet '*varicornis'*, has caused

confusion since the earliest material was collected in the late 1980s. Two near identical pupal exuvial types exist, one with a variably shaped but always short (less than 100 µm) hyaline thoracic horn and always smooth or nearly so, and another with thoracic horn longer (to 150 µm), darker pigmented, and apically rugose. The former was named informally as '*varicornis'*, the latter as '*cooki'*. Molecular data associate larvae with a pupal morphotype that are distinctive by their wide, seemingly complex, median mental tooth, antennal segment 2 near wedge-shaped, shorter than the 3rd segment, and antennal ratio closer to 1.0. However, Drayson's illustrated purported larva of '*varicornis'* (1992: 102) differs with narrow median mental tooth, antenna with segment 2 cylindrical and longer than 3rd and A.R. greater than 1.5. However even recognising this error, significant variation exists also amongst larvae otherwise with 'diagnostic' morphology, not least in features that have been considered central to larval recognition. Thus the outer mandibular crenulation ranges from distinct ('*varicornis'*) to slight or absent ('*cooki'*), and the extent of mandibular pigment also varies. Adult males associated with each pupal type, though few, appear identical including in fine details of the hypopygium.

Based on the material currently available, we consider all larvae and pupae to vary in characters considered otherwise to be diagnostic. Evidence for conspecificity derives from other morphological features. Molecular evidence, although based on few specimens, shows '*cooki'* is sister to a solitary pupa identified as *varicornis* (Krosch *et al.*, submitted). Should additional material and molecular data clarify that two species are involved, *cooki* is available for specimens that conform to the larval and pupal features described above. For this reason we restrict the type-series to the morphotype pupa with shorter hyaline thoracic horn, but with length and pigment variation not extending to the '*cooki'* form, and a larval morphotype with crenulate outer mandible and with extended pigment.

We treat each as a form, and include both in the larval and pupal keys.

C. varicornis inhabits clean, cool, south-eastern Australian streams.

Cricotopus wangi **Cranston & Krosch sp. n.**

(Fig. 3E, 5A,D, 9E, 12C)

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Cricotopus "wongi" sp. nov. Cranston, in Cranston, 1996: 86 [Invalid; author states 'not formal publication for nomenclatural purposes]

Type material. Holotype: Le/Pe/♂, AUSTRALIA: NT, Litchfield NP, Wangi Falls, 13°10'S 130°41'E, 6.viii.1990 (*Cranston*). **Paratypes**: Le/Pe/♀, Le/Pe, 4L, as holotype; Le/Pe, Pe, NT/Qld, Border Waterhole, 18°37'S 137°59'E, 19.v.1995 (*Cranston*); WA, Hamersley Range NP, Fortescue Falls, Circular Pool, 22°28'S 118°33'E, 23–24.iv.1992 (*Cranston*).

Molecular material. 2P, 2L, as holotype except 29.vii.2014 (*Cranston & Krosch*) (Mv-NT14.1.P1, P2, NT14.1.1, 1.3); L, Kakadu NP, Rockhole Ck., 13°34'S 132°15'E, 30.vii.2014 (*Cranston & Krosch*) (Mv-NT14.3.1); 2P, 3L, Kakadu NP, Gimbat, Upper S. Alligator R., 13°34'S 132°36'E, 31.vii.2014 (*Cranston & Krosch*) (Mv-NT14.6P1, P2); 3P, 2L, Kakadu NP, Gunlom, Waterfall Ck., 13°25'S 132°25'E, 1.viii.2014 (*Cranston & Krosch*) (Mv-NT14.7.P1-3).

Description. MALE (n=1, immature pharate). 3.0 mm.

Head. Ant 505 µm; Fl 1–12, 300 µm, Fl 13, 225 µm; A.R. 0.75. Palp 308–324 µm. Clyp sparsely setose, 9.

Thorax. Brown. Laps 2–3; Ac 20, Dc 20 biserial. Pa and Scts not visible.

Wing, legs and abdomen not measurable.

Hypopygium (Fig. 3E). Gcx 175, iv with medio-posteriorly rounded lobe; Gst 85 µm, about 1/2 (0.48) gcx; crista dorsalis not developed.

FEMALE (n = 1, pharate). 3.2 mm.

Head. Ant 245 µm. Fr 2, Po 2, Clyp 17; Palp 350 µm.

Thorax. Laps 2, Ac 9, Dc 20–21, Pa 2–4, Scts 6–8.

Wing, legs and abdomen not measurable.

Genitalia. Spermathae comprising ovoid capsules with tapering "neck" and gently curved ducts (as in Fig. 4B).

PUPA (n=6). 2.7–3.2 mm, pale to mid-brown.

Cephalothorax. Moderately rugose dorsally. Th 100–138 µm, width 37–50 µm; hyaline, elongate ovoid, without apical scales or spines (Fig 7B). Fs 120–138, long, semi-taeniate, on frons (Fig. 5A).

Abdomen (Fig. 9E). PSB on I, II and III. Hook row broad, about 2/3 of segment (0.65–0.72). No spinules or spines on TI or anterior to hook row on TII; anterolateral patches of very weak spinules on VII, VIII and IX. Paraterga bare. Ls_3 VIII 20–25 µm, < 1/15 segment width (0.06) (Fig. 5D).

Ms 60–80 µm, anteriormost displaced medially from margin 44–70 µm, < 1/25 length of abdomen (0.04).

4TH INSTAR LARVA (Fig. 12C). 3.7–4.1 mm. H.l. 350 µm, dark-brown; mandibles, mentum, occipital margin black; thorax yellow-green, abdomen blue-pigmented; procercus hyaline; procercal anal setae and posterior parapod claws black.

Head. Ant 52–55 µm; 1, 30–32 µm; 2–5, 21–22 µm; A.R. 1.36–1.41; blade 25–27 µm extending beyond apical segment.

Md 107–120 µm, outer margin strongly crenulate, inner smooth, completely dark brown (a little paler basally); seta subdentalis a spine.

Mentum 80–85 µm, dark brown; 6–7 pairs laterals, first well developed, second slightly reduced, outermost mentum may be worn or appressed with 7th lateral indistinct.

Abdomen. l_4 seta not plumose. Pc very short, with brown pigment patches, 12–14 µm, A.s. 250–280 µm.

Etymology. The epithet *wangi* derives from the name of the waterfall in Litchfield National Park, Northern Territory where the first specimens were collected (although in manuscript spelled as 'wongi'). The name is a noun in apposition.

Remarks. The combination of long frontal setae located on the frons, short L setae on VIII, hyaline non-spinose thoracic horn and short anal macrosetae with displaced basal setae allow easy recognition of the pupa of *C. wangi*. Larvae are characterised by the fully dark head capsule, including all-dark mandible. The mandible has strong crenulations on the outer margin and smooth mola, with a simple lance-shaped seta subdentalis. The antenna is uniquely short, maximally 55 µm long.

Cricotopus wangi **sp. n.** appears to be restricted to northern Australia where the immature stages live on hygropetric surfaces of waterfalls, with few exceptions in riffles in permanent creeks.

Key to adult males of Australian *Cricotopus*

(excluding *C. howensis*, *C. wangi*, inadequately known as adult male)

1	Tergite IV wholly pale (Fig. 1B,F,H,I)	2
-	Tergite IV wholly (Fig. 1A,E,G) or partly (Fig. 1C,D) dark	5
2	Tibiae and tarsomeres of mid- and hind legs pale (Fig. 1B,H)	3
-	Tibiae of all legs dark, with or without pale bands; all tarsomeres dark (Fig. 1F,I)	4
3	All legs pale apart from small dark patch proximal on tibia (Fig. 1H)	*C. tasmania* **sp. n.**
-	All femora pigmented, tarsomeres of fore-leg darkened (Fig. 1B)	*C. albitarsis* Hergstrom **sp. n.**
4	Tergite IV with median and lateral setae separate (Fig. 3F)	*C. varicornis* **sp. n.**
-	Tergite IV with median and lateral setae connected by posterior setae (Fig. 3G)	*C. hillmani* **sp. n.**
5	Tergite I dark (Fig. 1A,E,G)	6
-	Tergite I pale (Fig. 1C,D)	8
6	All tibiae with pale bands (Fig. 1G)	*C. parbicinctus* Hergstrom **sp. n.**
-	All tibiae uniformly dark (Fig. 1A,E)	7
7	Inferior volsella bilobed (Fig. 2A)	*C. acornis* **sp. n.**
-	Inferior volsella unilobed (Fig. 1E)	*C. conicornis* **sp. n.**
8	Tergites II, IV, V & VI dark with pale anterior band (Fig. 1C), inferior volsella bilobed or rounded (Fig. 2C)	C. *annuliventris* (Skuse)
-	Tergite II mid brown with pale posterior band, tergites III & IV dark with pale anterior and posterior pale bands (Fig. 1D), inferior volsella elongate, pointing posteriorly (Fig. 2D)	*C. brevicornis* **sp. n.**

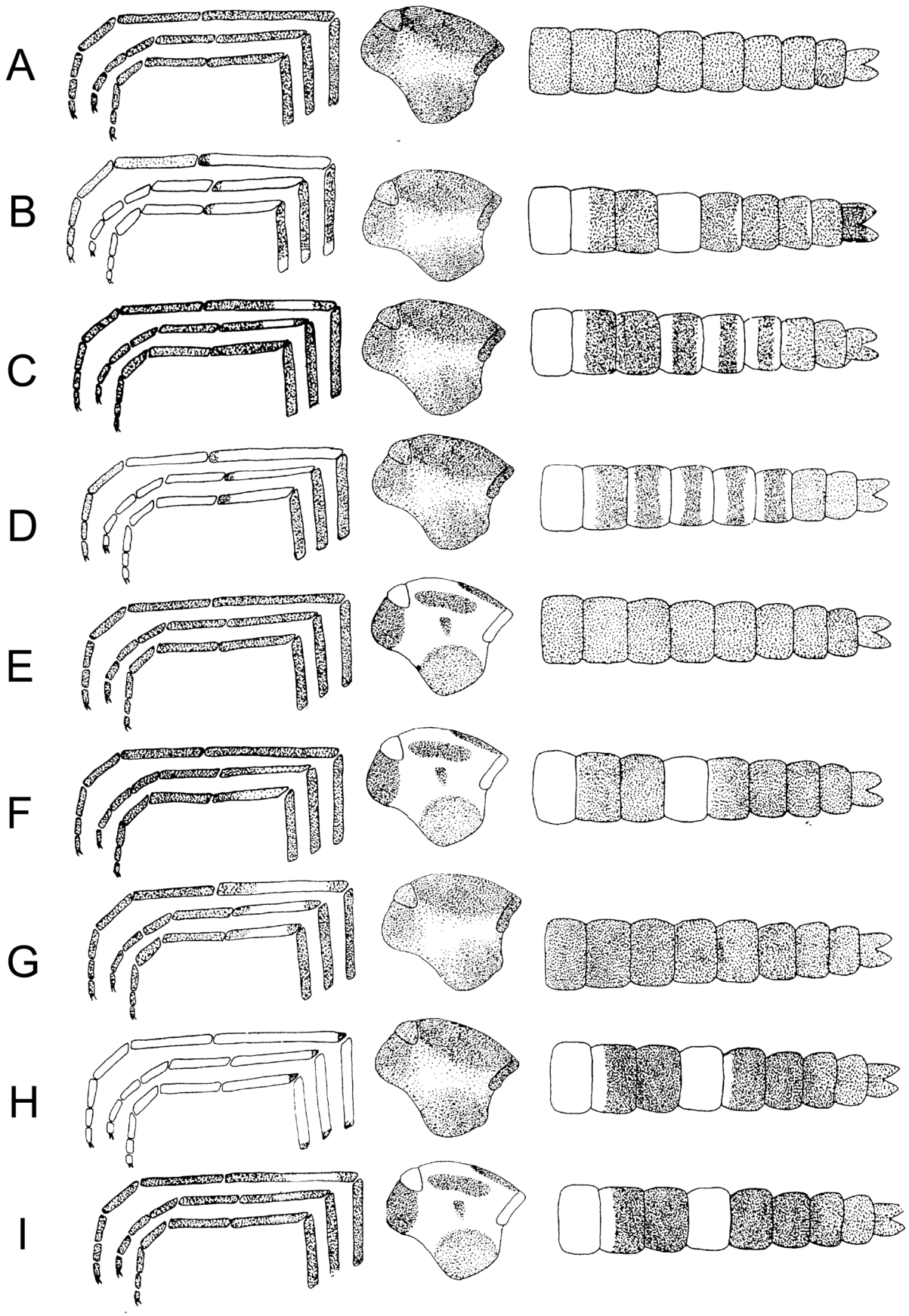

FIGURE 1. *Cricotopus* adult males. Columns (left to right): legs, anterior to posterior; thorax; dorsal abdomen. A. *C. acornis*, B. *C. albitarsis*, C. *C. annuliventris*, D. *C. brevicornis*, E. *C. conicornis*, F. *C. hillmani*, G. *C. parbicinctus*, H. *C. tasmania*, I. *C. varicornis*.

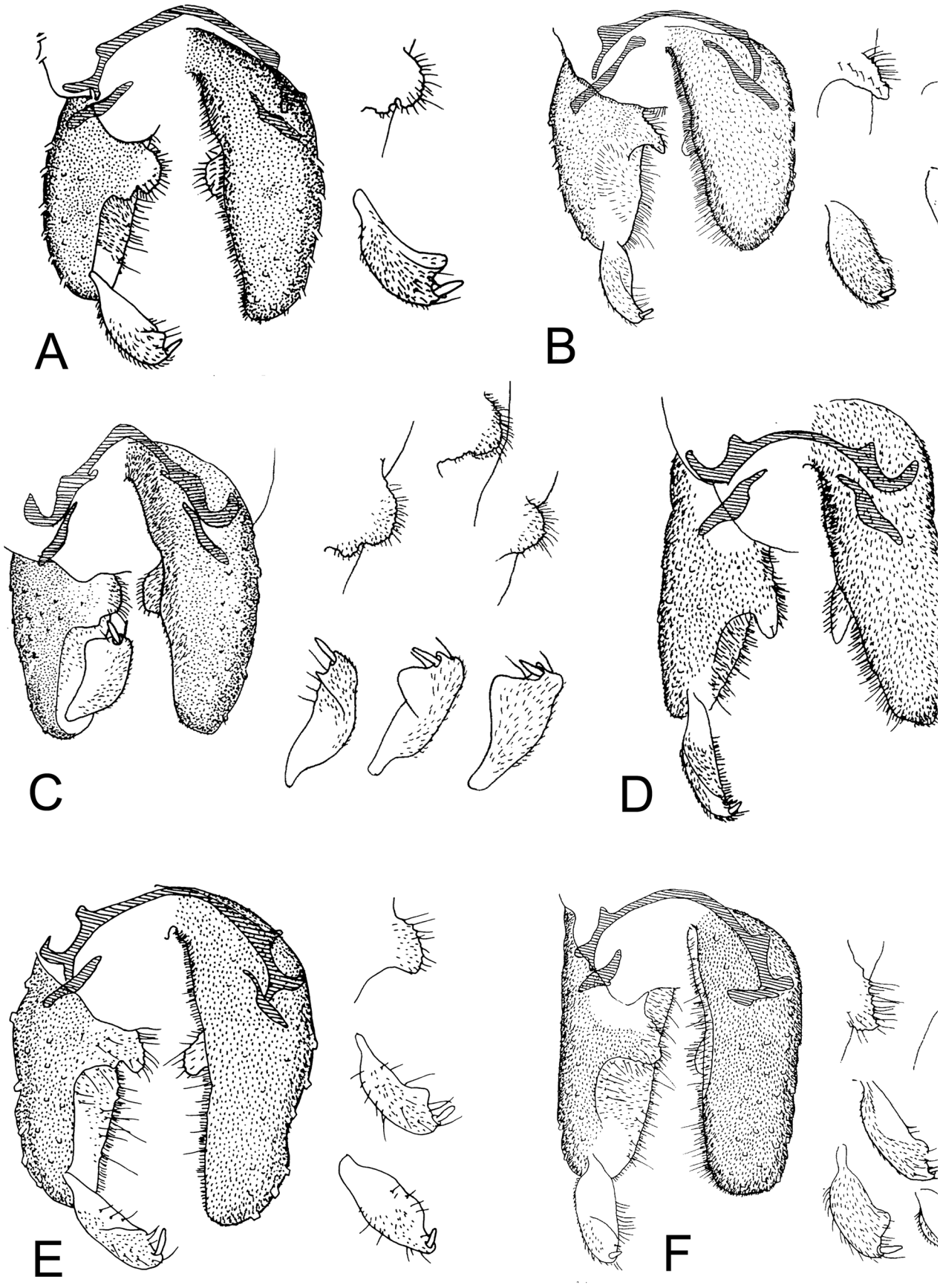

FIGURE 2. *Cricotopus* male genitalia, part, (inset variations in inferior volsella above, gonostylus below). A. *C. acornis*, B. *C. albitarsis*, C. *C. annuliventris*, D. *C. brevicornis*, E. *C. conicornis*, F. *C. hillmani*.

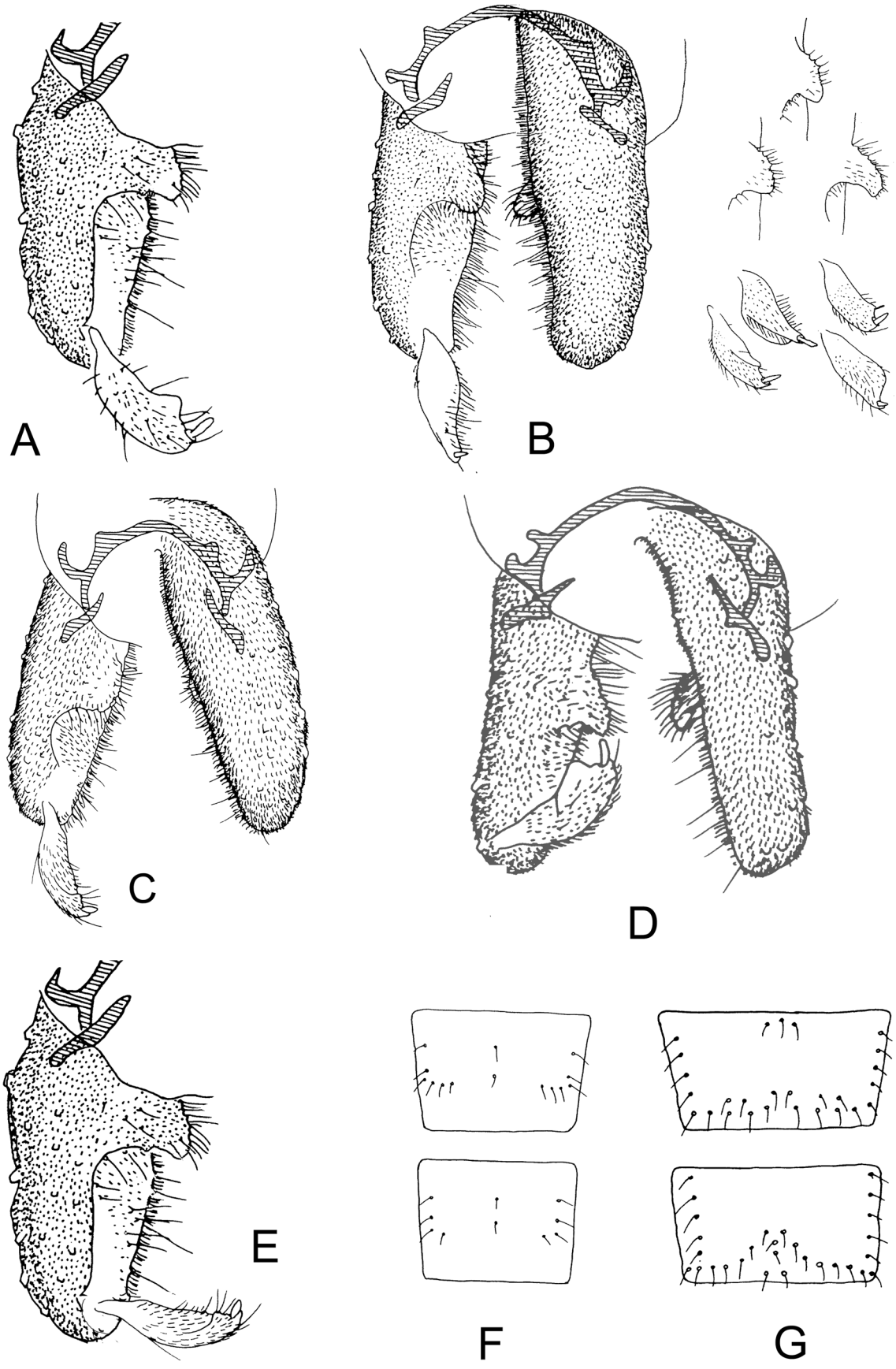

FIGURE 3. *Cricotopus* male genitalia, part. A. *C. howensis,* B. *C. parbicinctus* (inset variation in inferior volsella above, gonostylus below), C. *C. tasmania*, D. *C. varicornis*, E. *C. wangi.* Tergite III, IV setation: F. *C. varicornis*, G. *C. hillmani*.

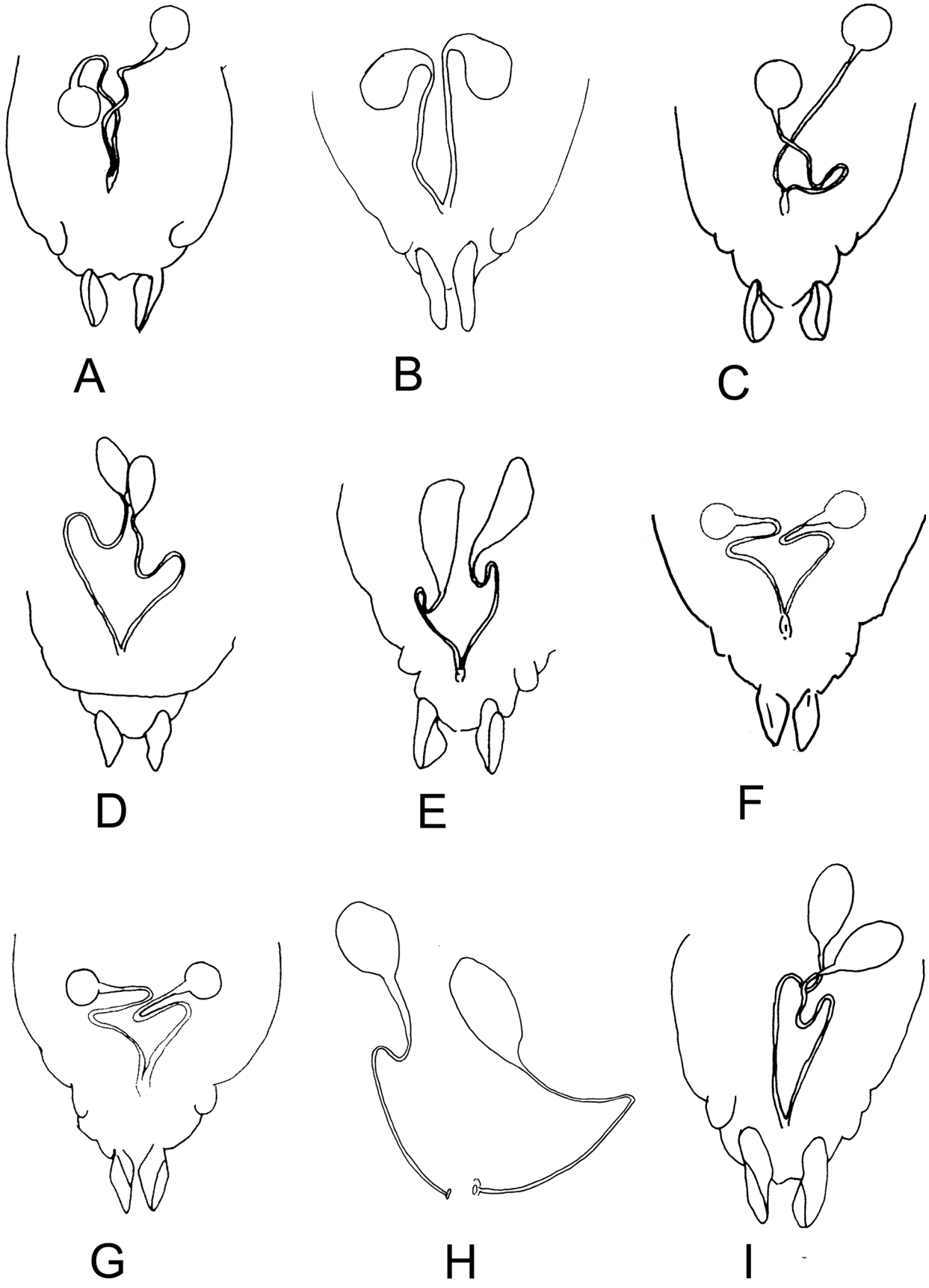

FIGURE 4. *Cricotopus* female. Spermathecae. A. *C. acornis*, B. *C. albitarsis*, C. *C. annuliventris*, D. *C. brevicornis*, E. *C. conicornis*, F. *C. hillmani*, G. *C. parbicinctus*, H. *C. tasmania*, I. *C. varicornis*.

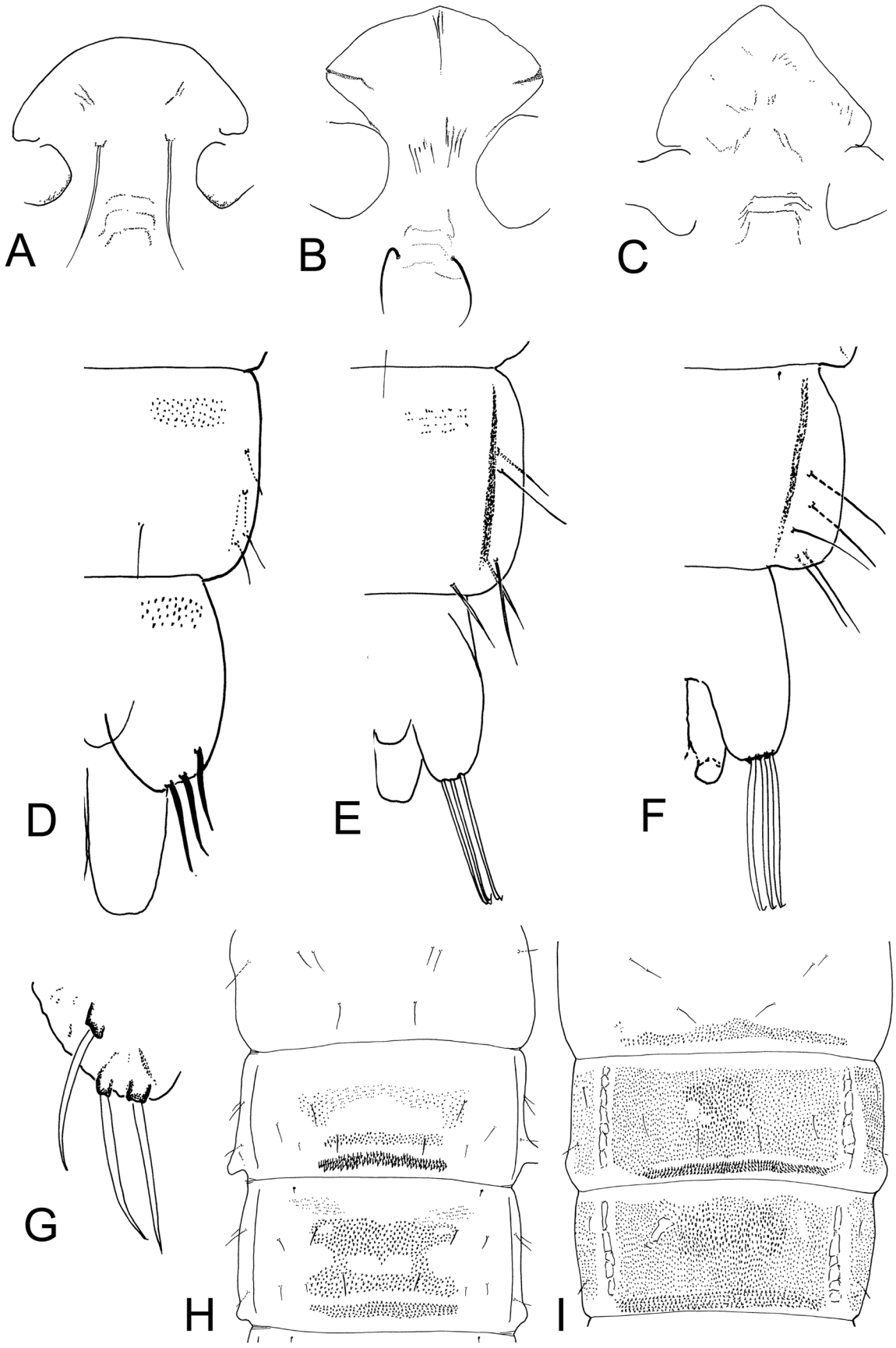

FIGURE 5. *Cricotopus* pupa. Frons: A. *C. wangi*, B. *C. howensis,* C. *C. parbicinctus.* Lateral segment VIII: D. *C. wangi*, E. *C. annuliventris*, F. *C. tasmania*. Anal lobe: G. *C. wangi*. Anterior tergites: H. *C. brevicornis*, I. *C. varicornis*.

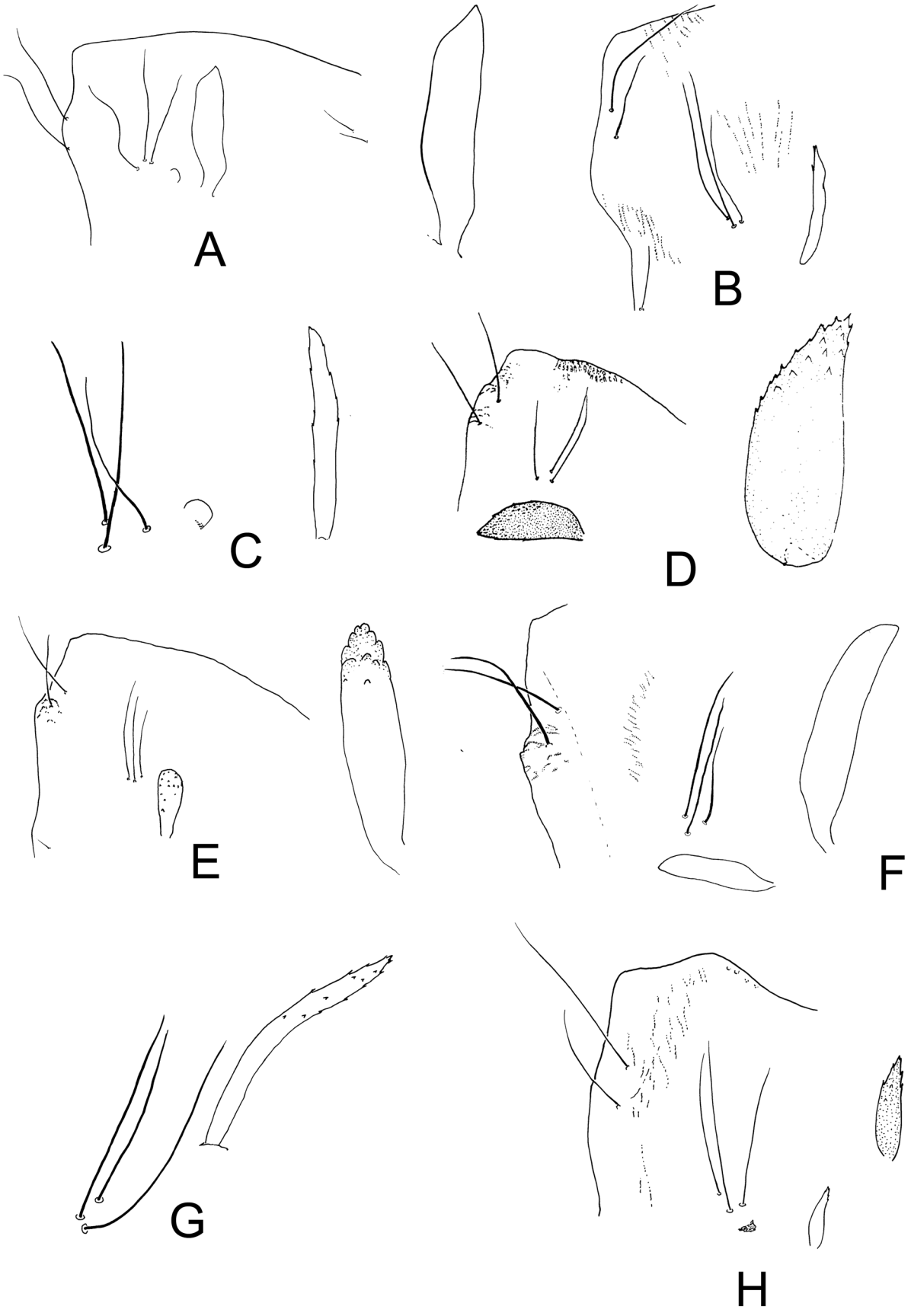

FIGURE 6. *Cricotopus* pupa, thorax and thoracic horns. A. *C. albitarsis*, B. *C. annuliventris*, C. *C. brevicornis*, D. *C. conicornis*, E. *C. hillmani,* F. *C. howensis*, G. *C. parbicinctus*, H. *C. tasmania*.

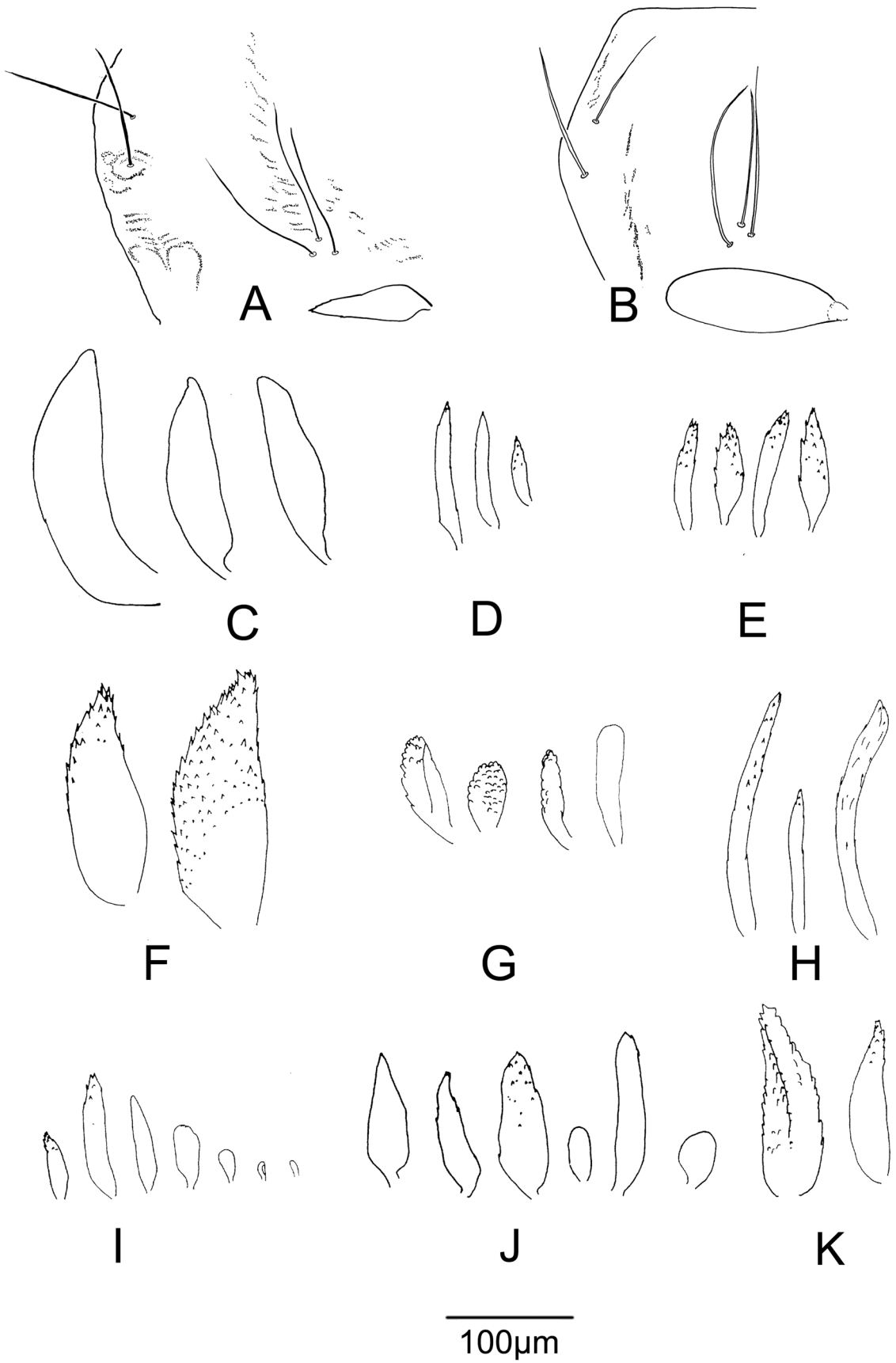

FIGURE 7. *Cricotopus* pupa, thorax and thoracic horn. A. *C. varicornis*, B. *C. wangi*. Variation in thoracic horn shape and size (all drawn to scale). C. *C. albitarsis*, D. *C. annuliventris*, E. *C. brevicornis*, F. *C. conicornis*, G. *C. hillmani*, H. *C. parbicinctus*, I. *C. tasmania*, J. *C. varicornis s.s.*, K. *C. varicornis* f. *cooki*.

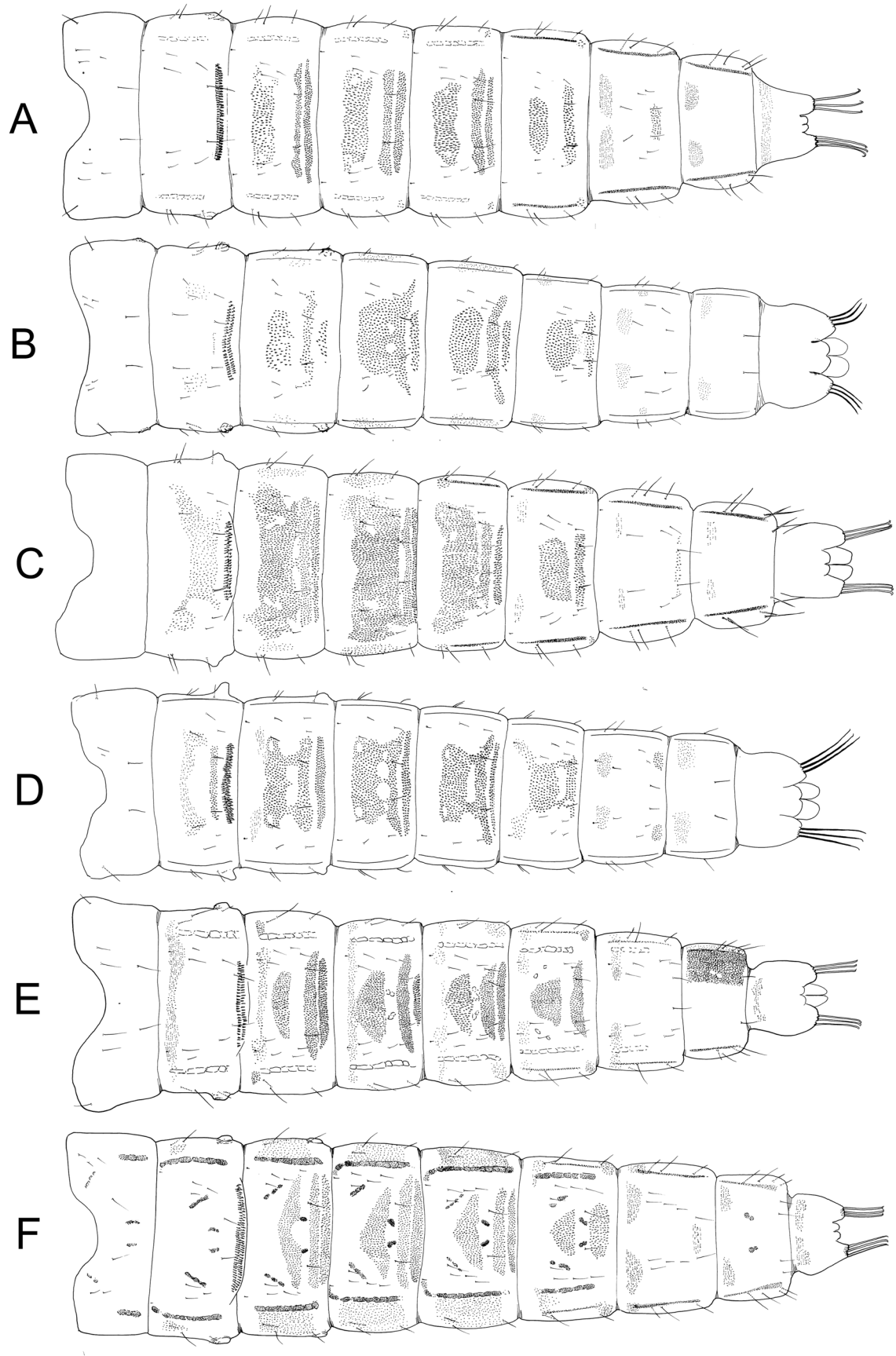

FIGURE 8. *Cricotopus* pupa, tergites. A. *C. acornis*, B. *C. albitarsis*, C. *C. annuliventris*, D. *C. brevicornis*, E. *C. conicornis* (reticulations shown only on part TVIII), F. *C. hillmani*

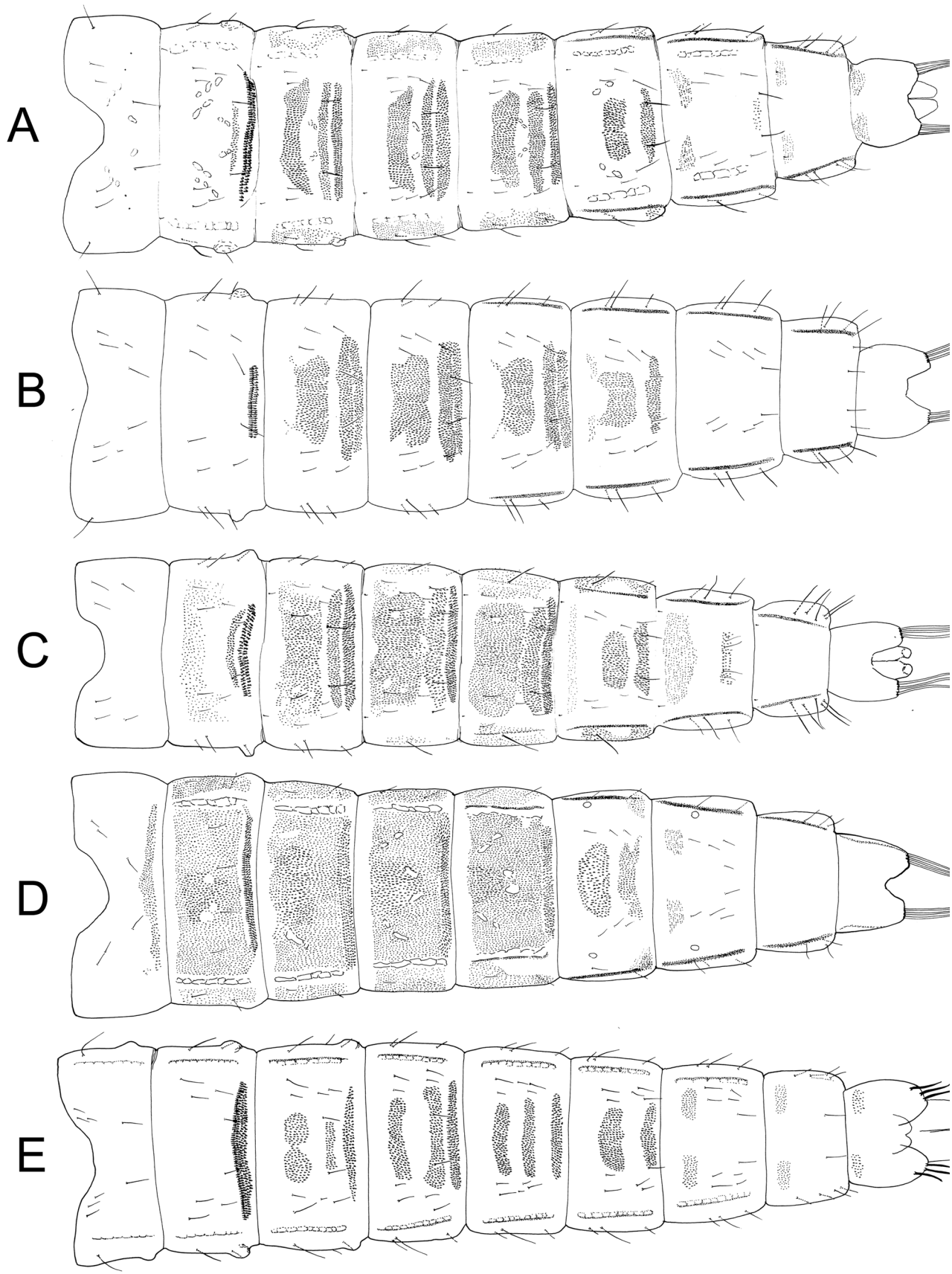

FIGURE 9. *Cricotopus* pupa, tergites. A. *C. howensis*, B. *C. parbicinctus*, C. *C. tasmania*, D. *C. varicornis*, E. *C. wangi*.

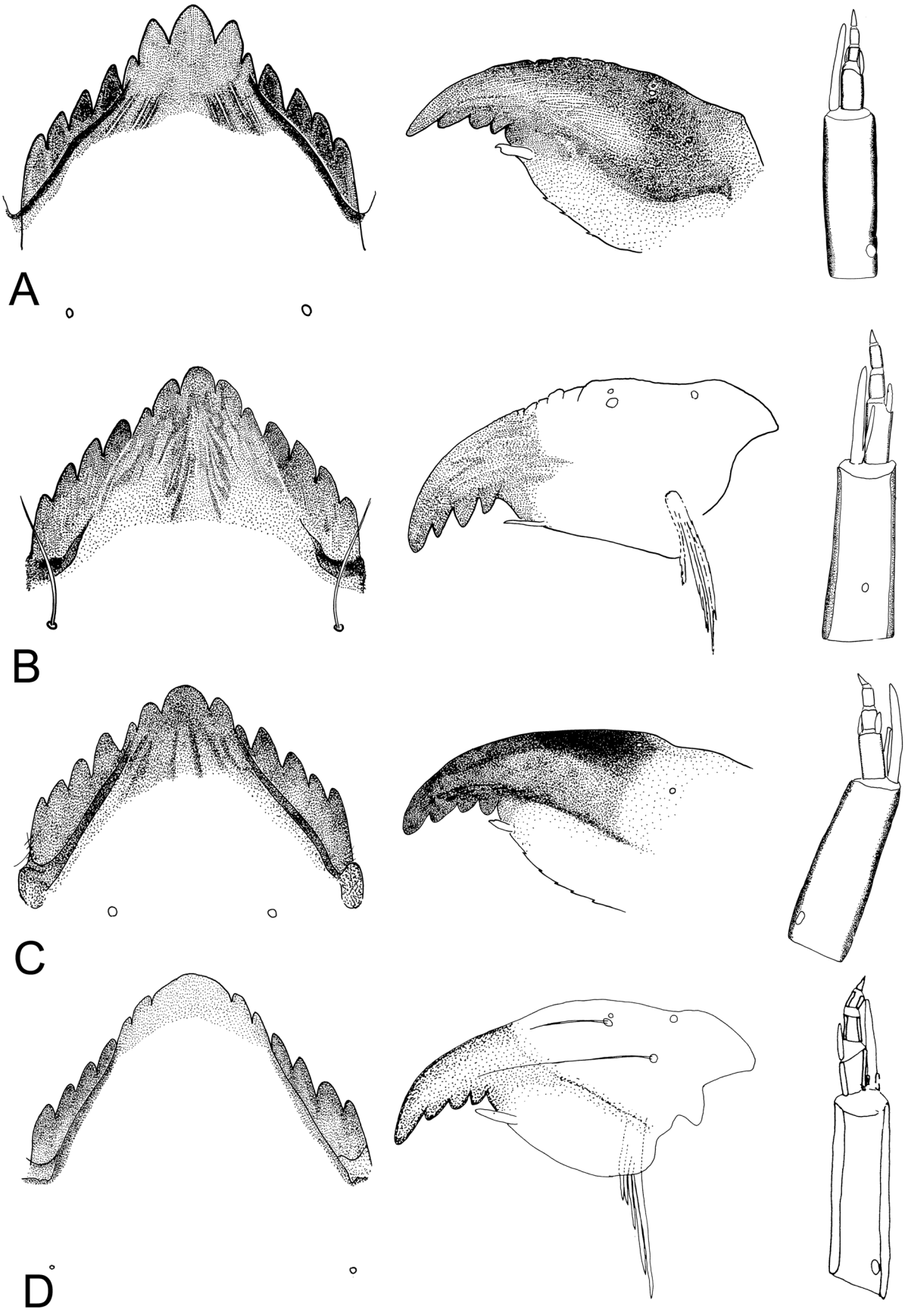

FIGURE 10. *Cricotopus* larva, mentum, mandible, antenna. A. *C. acornis*, B. *C. albitarsis*, C. *C. annuliventris*, D. *C. brevicornis*.

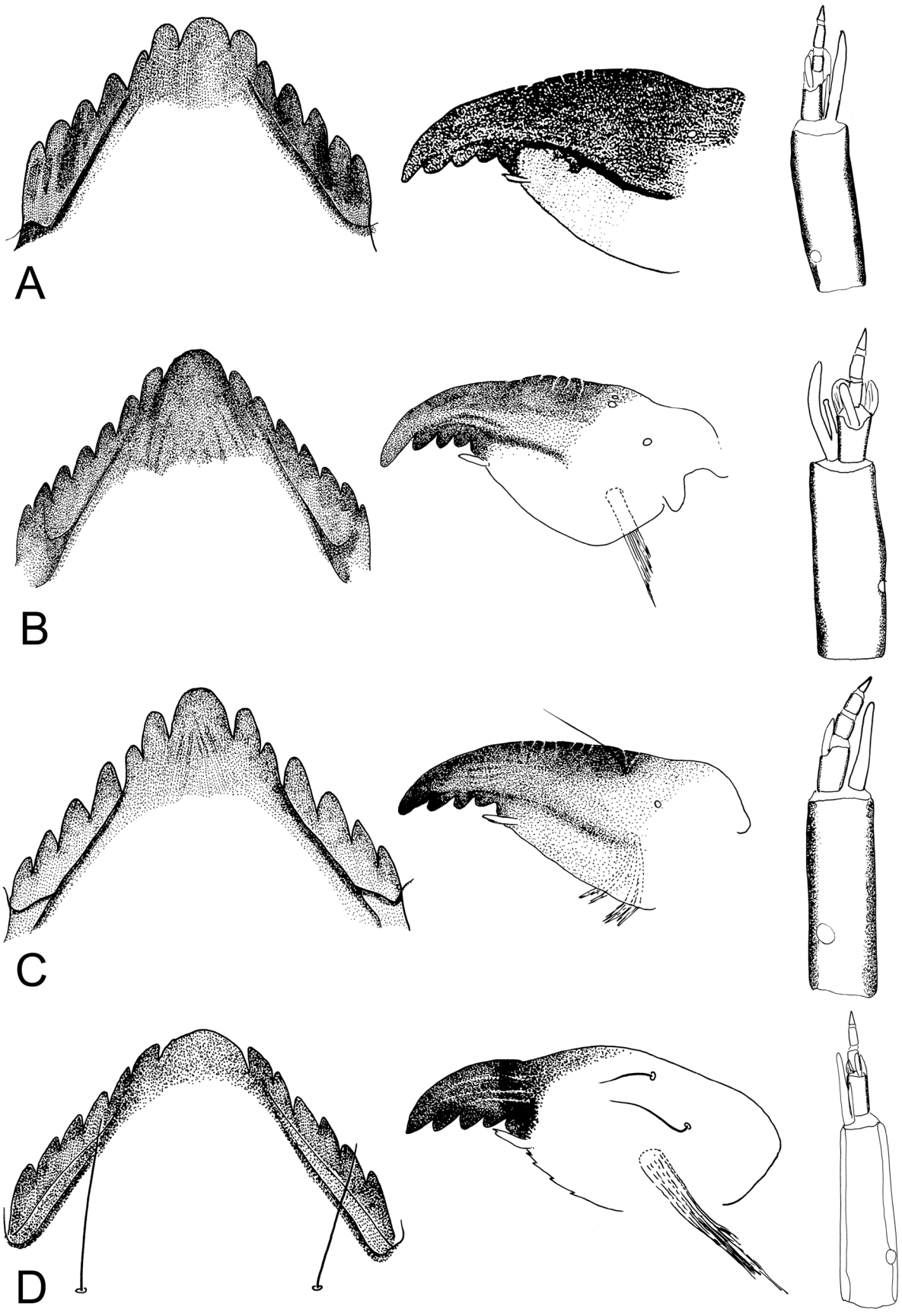

FIGURE 11. *Cricotopus* larva, mentum, mandible, antenna. A. *C. conicornis*, B. *C. hillmani*, C. *C. howensis*, D. *C. parbicinctus*.

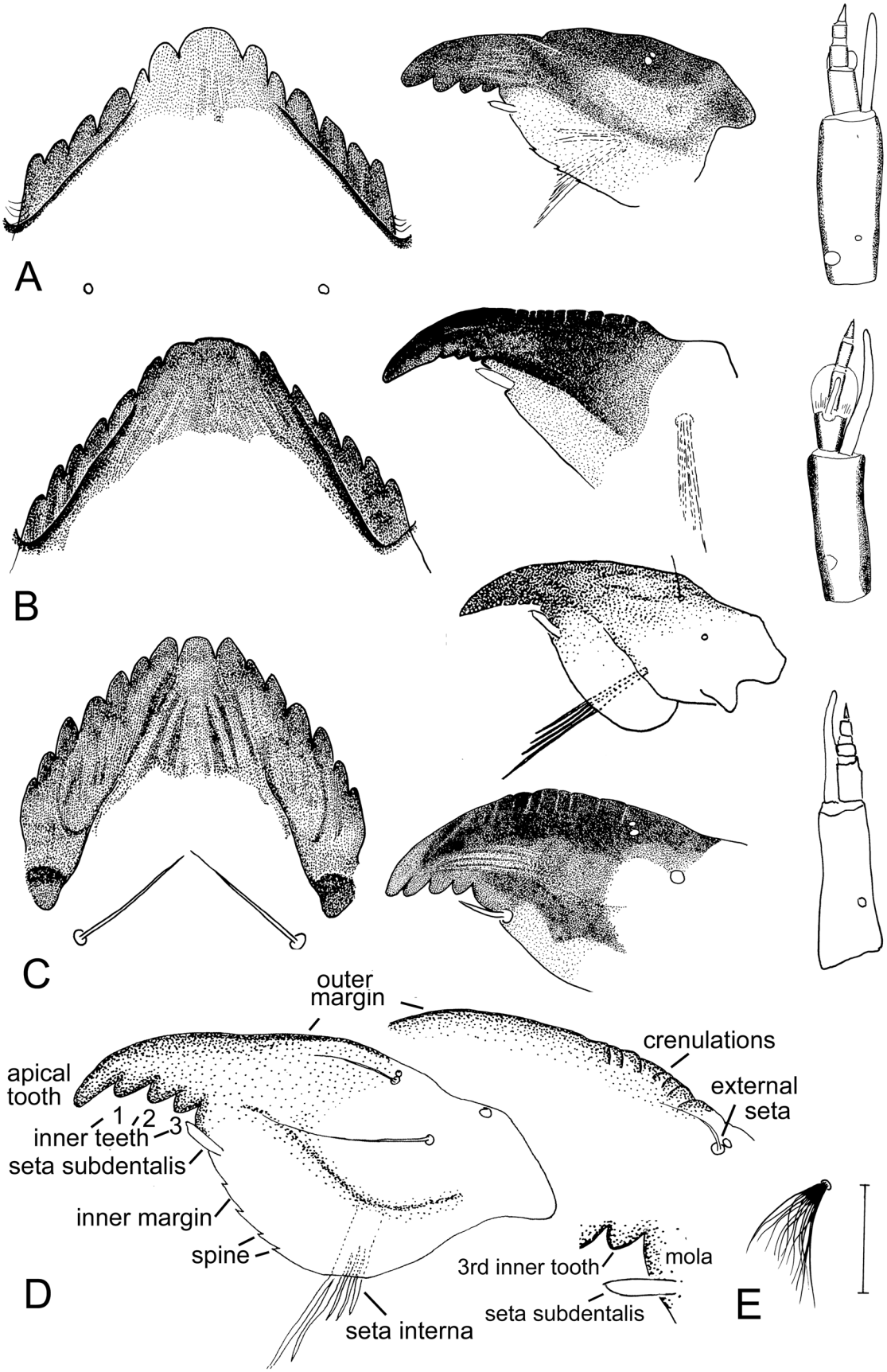

FIGURE 12. *Cricotopus* larva, mentum, mandible, antenna. A. *C. tasmania*, B. *C. varicornis* (lower mandible 'cooki' form), C. *C. wangi*. D. *Cricotopus* spp. larvae, detail of mandible. E. abdominal l_4 seta, *C. acornis*, scale = 100 µm.

Key to adult females of Australian *Cricotopus*

(excluding *C. howensis*, *C. wangi*, inadequately known as adult female; colour patterns may be as in Male (Fig. 1))

1	Tergite IV wholly pale	2
-	Tergite IV wholly or partly dark	5
2	All legs pale, with no dark sections	*C. tasmania* **sp. n.**
-	Some darkening of some leg segments	3
3	Tibiae and tarsomeres of mid- and hind legs pale	*C. albitarsis* Hergstrom **sp. n.**
-	All tibiae dark, with or without pale bands; all tarsomeres dark	4
4	Spermathecal capsules ovoid (Fig. 4I)	*C. varicornis* **sp. n.**
-	Spermathecal capsules spheroid (Fig. 4F)	*C. hillmani* **sp. n**.
5	All tergites uniformly dark	6
-	Tergite I pale; pale bands on tergites II and IV	8
6	All tibiae with pale bands	*C. parbicinctus* Hergstrom **sp. n.**
-	All tibiae uniformly dark	7
7	Spermathecal capsules spheroid (Fig. 4A)	*C. acornis* **sp. n.**
-	Spermathecal capsules elongate (Fig. 4E)	*C. conicornis* **sp. n.**
8	Tarsomeres of mid- and hind legs pale; all tibiae pale with distal 1/10 dark	*C. brevicornis* **sp. n.**
-	Tarsomeres dark; fore and mid-tibiae pale on proximal1/3; hind tibia dark	C. *annuliventris* (Skuse)

Key to pupae of Australian *Cricotopus**

1	Frontal setae present (Fig. 5A, B). Longest lateral setae of VIII < 1/7 width of segment (Fig. 5D). Segment III often with pedes spurii B (Fig. 5H)	2
-	Frontal setae absent (Fig. 5C). Longest lateral setae of VIII > 1/7 width of segment (Fig. 5E, F). Segment III lacking pedes spurii B (Fig. 5I)	9
2	Frontal setae on frons, dorsal to antennal sheaths (Fig. 5A)	3
-	Frontal setae on prefrons, ventral to antennal sheaths (Fig. 5B)	5
3	Thoracic horn mid-brown, spinose (Fig. 6D); abdomen with reticulate pattern (Fig. 8E)	*C. conicomis* **sp. n.**
-	Thoracic horn hyaline, smooth; abdomen non-reticulate	4
4	Macrosetae <0.5 anal lobe length; proximal macroseta displaced anteromedially (Fig. 5D)	*C. wangi* **sp. n.**
-	Macrosetae > anal lobe length, aligned evenly (Fig. 5E, F)	C. *albitarsis* Hergstrom **sp. n.**
5	Tergite I bare (Fig. 5H). Tergite II with sparse spinule field anterior to hook row (Fig. 5H), or bare (Fig. 8F)	6
-	Tergite I with sparse posterior or medio-lateral spinule fields (Fig. 5I). Tergite II with extensive spinule field anterior to hook row (Fig. 5I)	8
6	Segments III and IV without spinule fields on paraterga; tergite III with D_4 setae noticeably stouter than on tergites II and IV; tergites II–VII with pale adhesion marks (Fig. 8D)	*C. brevicornis* **sp. n**.
-	Segments III and IV with spinule fields on paraterga; tergite III with D_4 setae similar to those on tergites II and IV; tergites II–VII with dark adhesion marks (Figs 8F, 9A)	7
7	Thoracic horn virtually smooth, apex tapers to narrow, rounded point (Fig. 6F)	*C. howensis* **sp. n.**
-	Thoracic horn with subapical tubercles, apex blunt (Fig. 6E)	*C. hillmani* **sp. n.**
8	Thoracic horn up to 100 µm long, hyaline, with few or no spinules, variable (Fig. 7J)	*C. varicornis* ('varicornis' form)
-	Thoracic horn 120–150 µm long, yellow-tinged, with thorn-like spines (Fig. 7K)	*C. varicornis* ('cooki' form)
9	Tergite II with medio-lateral spine/spinule fields anterior to hook row (Fig. 8C)	10
-	Tergite II bare anterior to hook row (Figs 8A, 9B)	11
10	Tergite II with transverse band of spines between D_5 setae, separate from narrow anterior area of spinules (Fig. 9C). Segment VIII usually with 5 lateral setae (Fig. 5F)	C. *tasmania* **sp. n.**
-	Tergite II bare between D_5 setae, separate from broader anterior spinule area (Fig. 8C). Segment VIII with 4 lateral setae (Fig. 5E)	*C. annuliventris* (Skuse)
11	Thoracic horn absent. Tergites IV–VI with small postero-lateral spinule field (Fig. 8A)	*C. acornis* **sp. n.**
-	Thoracic horn present. Tergites IV–VI without postero-lateral spinules (Fig. 9B)	C. *parbicinctus* Hergstrom **sp. n.**

* Pupae of *Paratrichocladius* lack frontal setae and pedes spurii B are weak or absent on segment III. LS on VII and VIII are located on the extreme posterolateral margin of the segment and a potential unifying feature is the near fusion of the broad transverse spinule conjunctival bands on at least TIII–V with the posterior spine/spinule band immediately anterior to it (Cranston & Krosch, submitted).

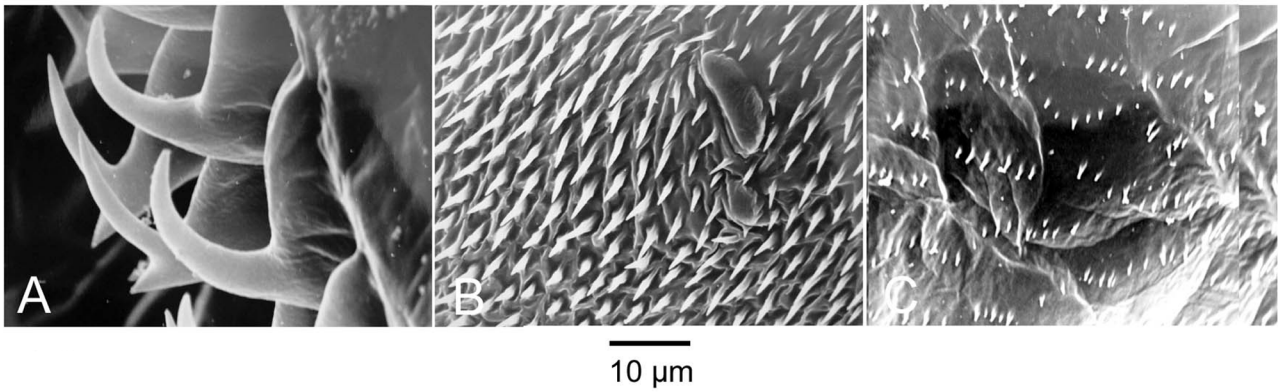

FIGURE 13. *Cricotopus* pupal exuvial morphology, SEM images, scale = 100 µm. A. hooks, B. spines, C. spinules.

Key to larvae of Australian *Cricotopus* & *Paratrichocladius*

1 Outer edge of mandible strongly crenulate (Fig. 10A, B). 2
- Outer edge of mandible smooth excepting notch or only subtly crenulate (Fig. 10C, D) 7
2 Inner edge of mandible serrate (Fig. 10A) . . . . . *C. acornis* **sp. n.**
- Inner edge of mandible smooth (Fig. 10B) 3
3 Darkening of mandible extending only as far as mola (Fig. 10B). . . . . *C. albitarsis* Hergstrom **sp. n.**
- Darkening of mandible extending proximally towards base of mandible (Figs. 11C, 12C). 4
4 Antennal blade not extending past 4th segment (Fig. 11C). Head mid-brown, with weak contrast to mandible and mentum . . . . . *C. howensis* **sp. n.**
- Antennal blade extending to apex of antenna or beyond (Fig. 12C). Head pale, with strong contrast to dark apical mandible and mentum 5
5 Lauterborn organs small, less than 0.5 length of 3rd segment (Fig. 12C) . . . . . *C. wangi* **sp. n.**
- Lauterborn organs large, encompassing total 3rd antennal segment (Fig. 12B) 6
6 Mola broad and very flat; seta subdentalis narrow ending in simple point; apical mandible tooth 2x 1st inner, 'kitchen knife' shaped (Fig. 12B) . . . . . *C. varicornis* **sp. n.** (part, s.s.)
- Mola broad and squared off; seta subdentalis broad ending in hooked point; apical mandible tooth 1.5x length of 1st inner and similar in shape (Fig. 11B) . . . . . *C. hillmani* **sp. n.**
7 Inner edge of mandible serrate (Fig. 12A) 8
- Inner edge of mandible smooth (Fig. 11A) 12
8 Mentum golden-brown with median area paler (Fig. 12A) 9
- Mentum evenly mid- to dark brown (Fig. 10A) 11
9 Pigmented area of mandible and mentum in modest contrast to mid-brown head (Fig. 12A) . . . . . *C. tasmania* **sp. nov.**
- Pigmented area of mandible and mentum in strong contrast to brown head (Fig. 11D). 10
10 Pigmented area of mandible not extending basally past the mola/notch . . . . . 'divergent *parbicinctus'*
- Pigmented area of mandible extending at least to external seta (Fig. 11D) . . . . . *C. parbicinctus* Hergstrom **sp. n.**
11 Mid-brown mandible pigment extends to external seta in strong contrast to pale head. Mola broad, rounded. Median mentum tooth narrow with 2nd lateral teeth clearly smaller than 1st (Fig. 10C). . . . . *C. annuliventris* (Skuse)
- Dark brown-black mandible pigment extends to base and less strongly contrast to mid-brown head; mola narrow. Median mentum tooth broad, rounded, with 2nd lateral teeth not smaller than 1st. . . . . 'divergent *annuliventris'*
12 Mandible pigment extending to base of mandible; apical mandible tooth subequal to 1st inner tooth, both near 2x 2nd inner tooth (Fig. 11A). . . . . *C. conicornis* **sp. n.**
- Mandible pigment extending to mola / external seta; apical mandible tooth 1.5x > 1st inner tooth; 1st inner tooth <1.5x size of 2nd inner tooth. 13
13 Lauterborn organs large, dilate, extending to apex of 3rd antennal segment; antennal segments 2–5 short, subequal (Fig. 12b) . . . . . *C. varicornis* **sp. n.** (part, var. '*cooki'*)
- Lauterborn organs moderately developed, tapering; 2nd antennal segment equal to 3+4, with short 5th. 14
14 Apical mandible tooth flanged, giving 'kitchen knife' shape, inner teeth aligned with inner edge of apical tooth. Mandible dark pigment extends to external seta. . . . . *Paratrichocladius* 'M1/FNQ1'
- Apical mandible tooth same shape as inner teeth. Mandible dark pigment extends distal to mola. 15
15 Lateral mental teeth bulbous basally and pointed apically. 1st inner mandible tooth equal in length to 2nd tooth. Antennal blade extends to apex of antenna. . . . . *Paratrichocladius* 'SW QLD'
- Lateral mental teeth non-bulbous basally; 1st inner mandible tooth 1.5x longer than 2nd tooth; antennal blade extends to apex of 4th segment (Fig. 10D). . . . . *C. brevicornis* **sp. n.**

Discussion

Species concepts and DNA evidence. A deterrent to earlier publication of studies of Australian *Cricotopus* has been uncertainty in relating species delimitation based on morphology of different life stages, and interpretation of variation. Only with recently obtained molecular data, especially derived from the CO1 mitochondrial gene, have we obtained better insights into species limits. These molecular data also have allowed association of previously unknown life stages, interpretation of geographical variation and especially the testing of previous provisional taxa and keys based on morphological segregates. In general morphospecies delimitations found support, especially when based on pupal morphology and adult colour patterns visible on hardened specimens. However, certain larval features are more plastic than expected. For example, the 'diagnostic' presence of a 7th lateral tooth in the mentum of *C. hillmani* is inconsistent—previously larval specimens with 6 lateral teeth (conventional in all other species) will have been misidentified.

DNA 'barcoding' is not a universal practical panacea for taxonomic problems such as these identified for Australian *Cricotopus* (contrary to some advocates). Sampling intensity of widespread species for molecular study often and inevitably is lower than is often available for morphological studies for which older material can be included. Consequently, interpretation can be ambivalent or misleading if sampling cannot differentiate clinal variation from species differentiation (e.g. Krosch *et al.*, 2013). That is, some so-called barcode gaps (as identified for example in Chironomidae by Silva *et al*. 2013) may be artifacts of incomplete sampling across the geographic range. For this reason, here we treat 'cooki' conservatively as a form despite its differentiation by DNA from *C. varicornis*, based on its representation by a single molecular sample (Krosch *et al*, submitted). Furthermore, DNA analyses often reveal divergent ('cryptic') clusters for which vouchers may be inadequate to assess morphological variation, such as 'divergent' taxa we find associated with *C. albitarsis*, *annuliventris* and *parbicinctus*. We recognise but do not name these entities. Such outcomes are quite familiar in integrative studies of the Chironomidae, and are insightfully discussed *inter alia* by Silva & Wiedenbrug (2014).

In this study we remain reliant on morphology to segregate Western Australian *Cricotopus*, as despite all best intentions we have been unable to material from west of the Nullarbor suitable for molecular analysis. Thus we cannot comment on the validity of using for the Western Australian taxa the molecularly-verified names established for segregates in northern and eastern Australia.

Australian *Cricotopus* and *Paratrichocladius*—wider implications. Studies on Chironomidae with high northern hemisphere representation inevitably pay deference to the north even when shown to be inadequate in the southern hemisphere (e.g. Brundin 1966). The major revisionary study on *Cricotopus* by Hirvenoja (1973) was an extraordinarily thorough, phylogenetic-based work, purportedly to be global, but in reality centered substantially on the western Palaearctic. With the passage of time the systematics, especially delimitation of species groups, has been challenged even within the substantially shared Nearctic fauna (e.g. LeSage & Harrison 1981; Simpson *et al*. 1982). In keying and diagnosing the Holarctic Chironomidae (larvae, Cranston *et al*. 1983; pupae, Coffman *et al.* 1986; adult males, Cranston *et al*, 1989) difficulties with species groups outside the western palaearctic were recognised, as was the problem to separate larvae and pupae especially from *Orthocladius* Wulp and *Paratrichocladius* Santos-Abreu.

Given that Australia is biogeographically distinct from the northern hemisphere, it is unsurprising to find that problems of systematic separation of *Cricotopus* from other genera, and internal arrangements already alluded to elsewhere, apply here. The absence from Australia of *Orthocladius* Wulp, *Halocladius* Hirvenoja and *Paracladius* Hirvenoja, each of which may be confused in some life stages with *Cricotopus*, ought to simplify matters. However, at least two species of *Paratrichocladius* occur in Australia, and rearings show that features of larvae and pupae suggested to separate from *Cricotopus* in the northern hemisphere fail to separate Australian taxa. In the adult, *Paratrichocladius* differs from *Cricotopus* only by the dorsocentral setae arising from small pale pits rather than direct from the cuticle as in *Cricotopus*. Australian pupae of *Paratrichocladius* conform neither to the key to Holarctic genera of Coffman *et al.* (1986) nor to any other northern hemisphere regional key. Australian larvae cannot be separated by the key to Holarctic genera of Cranston *et al.* (1983) or Andersen *et al*. (2013). Particular problems in Australia stem from the close resemblance of the larvae of *C. brevicornis* sp. nov. to some larvae associated by rearings (and DNA) with adults possessing dorsocentral setae that arise from pale areas (i.e. conforming to *Paratrichocladius*). This extends even to the presence of a plumose l_4 seta in an Australian larva that develops to an adult characteristically *Paratrichocladius*. Parallel molecular studies (Krosch *et al*., submitted)

point to these long-standing problems arising because *Paratrichocladius*, sampled widely within and outside Australia, renders *Cricotopus* paraphyletic. That is, *Paratrichocladius* seems to have evolved from within *Cricotopus* and is sister to only a subgroup of *Cricotopus* (Cranston & Krosch, submitted). Here we key the larval forms of Australian *Paratrichocladius* with those of *Cricotopus* to allow identification, prior to formalisation of any new status.

Drayson (1992) recognised all Australian species as belonging to the subgenus *Cricotopus* as defined by Hirvenoja (1973) and followed in subsequent publications. This is confirmed here. There is minimal evidence for allocation of Australian taxa to any defined species group, as Drayson (1992) also concluded. A feature considered as potentially significant in larval species groups is the larval abdominal segments bearing distinct (under phase contrast or Nomarksi interference) setal tufts (Fig. 12E) of about 100 µm in length. This tuft seems invariate in all species except for absence in *C. wangi*. The presence of such setal tufts occurs with both smooth and crenulate outer mandible margins, and possession of a single-toothed premandible that lacks any brush. With these restricted range of features, many larvae key in Anderson *et al*. (2013) to the *tremulus* group, yet no associated adult males and few pupae do. No species belongs in all life stages to any single species group; others are incompatible with any group using keys to adults and pupae. It seems that these species groups, defined from intuitive morphological phylogenetics by Hirvenoja (1973), actually have little or no phylogenetic basis and thus we allocate no Australian species to any pre-existing group, and make only one suggestion for a new one.

As discussed above under *C. albitarsis*, this species had been recognised earlier as the Afrotropical species *C. albitibia,* and they are indeed similar. In molecular studies (Krosch *et al*., submitted*)* South African and Singaporean taxa identified as *C. albitibia* or close, associated as sister to the Australian clade *C. albitarsis* plus *C. wangi*. This may be reason to recognise a *C. albitibia* group to which *C. albitarsis* and *C. wangi* would also belong.

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