



## *Xanthesma (Xenohesma) perpulchra* and *Xanthesma (Xanthesma) brachycera* are conspecific based on DNA barcodes

Kit S. Prendergast <sup>1\*</sup> & James B. Dorey <sup>2,3,4,5</sup>

<sup>1</sup> School of Molecular and Life Sciences, Curtin University, Kent Street, Bentley

<sup>2</sup> College of Science and Engineering, Flinders University, Sturt Rd, Bedford Park

<sup>3</sup> Earth and Biological Sciences, South Australian Museum, North Terrace, Adelaide

<sup>4</sup> Ecology and Evolutionary Biology, Yale University, Prospect St, New Haven

<sup>5</sup> Centre for Biodiversity and Global Change, Yale University, Prospect St, New Haven

\*Corresponding author: [kitprendergast21@gmail.com](mailto:kitprendergast21@gmail.com)

Kit Prendergast  <https://orcid.org/0000-0002-1164-6099>; James Dorey  <https://orcid.org/0000-0003-2721-3842>



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### Abstract

Reflecting the state of invertebrate taxonomy globally, many bee taxa in Australia are in need of revision, and this includes the most species-rich endemic subfamily, the Euryglossinae. In addition to undescribed species, many euryglossine species have been described from only a single sex. Over 30 taxonomic papers on euryglossines have been published, however the majority of these were by a single author, and before the advent of molecular technologies that can be used to efficiently and reliably associate the sexes of these often sexually-dimorphic species.

Additionally, the reproductive behaviours of most bee species are unknown, and published observations of reproductive activities are few and far between. Based on DNA barcoding we associate the male of *Xanthesma (Xenohesma) perpulchra* (Cockerell, 1916) (Hymenoptera: Colletidae), with the female of *Xanthesma (Xanthesma) brachycera* (Cockerell, 1914). We propose that *Xanthesma perpulchra* syn. nov. is a junior synonym of *X. brachycera*, and, due to the enlarged male eyes, that *X. brachycera* should be placed in subgenus *Xenohesma*. Consistent with other *X. (Xenohesma)*, we report swarming behaviour for this species observed in bushland remnants within an urbanised biodiversity hotspot, which can be related to the male's enlarged eyes. Our research has indicated the value of DNA barcoding, and raises further questions regarding the taxonomy of this diverse endemic Australian subfamily.

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## Introduction

Australia has 1661 described species of native bees, with hundreds more awaiting formal scientific description (Batley & Hogendoorn 2009; Australian Faunal Directory 2023). For described and undescribed species alike, there is a paucity of information on their biology and ecology, including their reproductive behaviours. The most speciose subfamily of Australian bees is the Euryglossinae (Hymenoptera: Colletidae), which includes minute to small-bodied bees (Michener 2007). Observations of their reproductive behaviour are rarely made and published — exceptions include Exley (1977) and Houston (1969). The taxonomy of the euryglossine genus *Xanthesma* Michener, 1965 is so poorly understood that even the association of sexes has been considered nearly impossible, in large part because of their marked sexual dimorphism (Exley 1969). *Xanthesma* comprises 48 described species in four subgenera, with 17 described species in the subgenus *Xanthesma* (*Xenohesma*) (Australian Faunal Directory 2022). Identification to species level is difficult because they are small (4.5–7.8 mm in body length) and the current literature makes confident identification of females difficult (Walker 2016; Exley 1969). The identification of females to subgenus is also difficult as diagnostic characters are ill-defined (Michener 2007).

In contrast to females, male *X. (Xenohesma)* are quickly recognisable as they possess remarkably large and bulbous eyes (Fig. 1; Michener (2007)). It has been suggested that the large eyes, which are an exclusively male feature in some bee groups, have evolved via intrasexual selection (sexual selection driven by competition between members of the same sex) as an adaptation to better spot females in mating swarms (Michener 2007; Somanathan *et al.* 2017). Indeed, there have been observations of male *X. (Xenohesma)* congregating in swarms and females, apparently attracted to these swarming masses (akin to leks), flying into the congregation where they then mate (Walker 2016). Exley (1977) also described these spectacular mating swarms of *X. (Xenohesma)* (species unknown) in the Northern Territory and Western Australia in 1974 and 1975. Similarly, males of several other bee genera in the families Apidae (*Apis* Linnaeus, 1758, *Exoneura* Smith, 1854, *Macrogalea* Cockerell, 1930, and *Xenoglossa* Smith, 1854) and Andrenidae (*Melitturga* Latreille, 1809 and species of the Oxaeinae subfamily) can exhibit both male swarming behaviour and enlarged compound eyes (Dorey 2018; Houston 2018; Michener 2007).

In the most recent revision of *X. (Xenohesma)*, only *X. (Xenohesma) stagei* and *X. (Xenohesma) clypearis* were described using both sexes (Exley 1969). These associations were made based on co-collection and, for the former, both sexes were collected at the same site yet in different years (Exley 1969). Exley noted that “it seems extraordinary that at many widely separated sites males only have been collected” (p. 535; Exley (1969)). The

female of *X. (Xenohesma) perpulchra* was unknown and the male of *X. (Xanthesma) brachycera* has been an ongoing and unresolved challenge. Exley (1974) initially designated *Argohesma* sp B (Exley 1969b) to be the male of *X. (Xanthesma) brachycera*, but later designated it as *Chaetohesma tuberculata* (Exley 1978). To further illustrate the difficult nature of taxonomy for this group of euryglossines, the females of *Chaetohesma tuberculata* were previously incorrectly assigned as *Euryglossa (Xenohesma) stagei* (Exley 1969). It is evident that, when using morphology alone, there are great challenges to the association of not only *Xanthesma* sexes but also species in related genera.

Exley (1969) noted that *X. (Xenohesma)* occurs in arid, sparsely populated regions, and emphasised that more regular collections are required. Unlike most *X. (Xenohesma)* species, specimens of *X. (Xenohesma) perpulchra* have been collected from more densely populated areas, including Nedlands and Crawley (suburbs of Perth, Western Australia), but such records occurred in 1941 (Exley 1969), when human population densities were much lower.

In this paper we use co-collections, morphology, and COI-barcoding to associate the male and female of a *Xanthesma* s. l. species. Based on DNA barcoding, we reveal that the male *X. (Xenohesma) perpulchra* (Cockerell 1916) and female *X. (Xanthesma) brachycera* (Cockerell 1914) are one species. Consequently, we propose the name *X. (Xenohesma) brachycera* (Cockerell 1914) for the species. Henceforth, we will use this name below. We provide a description of the female *X. (Xenohesma) brachycera*, a simple updated key to the females of *X. (Xenohesma)* based on Exley (1969), and images of both sexes. We document observations of swarming behaviour, which represent the first records of mating swarms for this species, as well as for *X. (Xenohesma)* in an anthropogenic landscape. This is the first time that molecular methods have been used to associate the sexes of a *Xanthesma* species, providing far greater confidence than for any other *Xanthesma* species.

## Methods

### *Specimen collection*

Male swarming behaviour of *X. (Xenohesma) brachycera* was observed whilst conducting native bee surveys as part of a project surveying native bee assemblages across 14 sites (seven bushland remnants and seven residential gardens) in urban and suburban regions of Perth, Western Australia monthly from Nov–Feb 2016/17 and Oct–March 2017/18 (Prendergast *et al.* 2020). The observations of *X. (Xenohesma) brachycera* occurred during three surveys, two at Wireless Hill Park (-32.0311, 115.8264), a declared Bush Forever site [no.336] covering 38 ha in the suburb of Ardross, Western Australia, on the 19th February 2017 and on 12th February 2018, and one instance in remnant bushland at the University

of Western Australia's research station at Shenton Park (-31.9480, 115.8264) on 12th January 2018.

Surveys involved a single researcher (K. Prendergast) recording native bees from 1045 h to 1345 h, and collecting specimens through active sweep netting and passive sampling (Prendergast *et al.* 2020). Passive sampling involved deploying 10 rectangular yellow containers (take-away containers), 10 large yellow bowls, and 20 soufflé cups of which ten were UV-reflective yellow and the other ten were UV-reflective blue all filled with water and a few drops of unscented surfactant (Tween 80).

An additional observation of a female was made on 6th January 2022 at Russo Reserve (-31.8754, 115.9102), a tiny (approximately 150 m x 200 m) bushland remnant in the City of Bayswater, as part of monthly surveys (starting September 2021) by K. Prendergast conducted at Russo Reserve, Lightning Swamp Reserve, and McPherson Park (Prendergast 2022).

Both males and females were collected concurrently on 27th January 2023 foraging on *Corymbia calophylla* at Bibra Lake along the Roe 8 Rehabilitation corridor (-32.0834, 115.8253).

We combined our occurrence data with all publicly available occurrence data. We used public data from the R package BeeBDC version 0.2.6, merging occurrence records from both names without filtering for gridded datasets, uncertain taxonomic terms, old records, and records without a date (Dorey *et al.* 2023). We then created an occurrence map using ggplot2 version 3.4.3 (Wickham 2016) (refer to Appendix 4 in the Supplementary Materials for our R script).

### Morphology

Specimens were pinned, and identified using Exley (1969) and the database PaDIL (<https://www.padil.gov.au/pollinators/search?query=Type=all>). High-resolution morphology images were taken using a Canon EOS 7D mk II and either the Canon EF 100mm f/2.8L Macro IS USM lens, at 1x magnification, or Canon MP-E 65mm f/2.8 1-5x Macro lens at 2x magnification. Male internal characters of Western Australian material were dissected and imaged using a Canon EOS 5DSR mounted onto a Nikon eclipse 50i at 20x magnification. Images were combined using Zerene Stacker and then imported into Adobe Photoshop where calibrated scales were applied.

To verify the synonymy of *X. (Xanthesma) perpulchra* and *X. (Xenohesma) brachycera* we compared our specimens with images of the types (*X. (Xanthesma) perpulchra*, Holotype BMNH Hym.17.a.279 ♀, Kalamunda, WA; *X. (Xenohesma) brachycera*: Holotype BMNH Hym.17.a.273 f, Townsville, QLD) housed at the Natural History Museum London. Additionally, we compared our specimens with Exley's collection housed at the Queensland Museum.

Body size was measured (body length and intertegular span) from high-resolution photographs (Cane 1987). Comparison between sexes in intertegular span was measured from four specimens of each sex. Relative measurements of the head followed Houston (1990) and Leijs *et al.* (2018), whereby head width was set to 50 units.

Abbreviations for relative head measurements are: FL — flagella length; HL — head length; HW — head width; IAD — interantennal distance; LID — lower interocular distance; OOD — ocellocular distance; SL — scape length; UID — upper interocular distance; WOC — width of ocellar cluster from the outer ocelli.

### DNA Barcoding

To confirm the conspecific status of *X. (Xenohesma) brachycera* sexes, we COI-barcoded two specimens of each sex. Tissue samples for DNA extraction were obtained from a single hind leg of each and sent to the Centre for Biodiversity Genomics (Appendix 1 Table A1). There, DNA was extracted and sequenced with the SEQUEL platform using the methods described in Hebert *et al.* (2018). The resulting sequences were checked against the National Center for Biotechnology Information (NCBI) BLAST database to screen for non-target DNA.

## Results

### Specimen collection

When foraging, all specimens were collected on *Corymbia calophylla*, *Eucalyptus marginata*, and *Melaleuca lanceolata* (Myrtaceae). Specimens were observed in January and February. At Wireless Hill, Shenton Park (Appendix 3) and Russo Reserve, mating swarms comprising "clouds" of males, approx. 1–2 m<sup>3</sup> and numbering in the hundreds, were observed flying back and forth along open, bare sandy ground, approximately 1 m above the substrate.

### Morphology

The collection of both sexes at the same locations in Western Australia, and the fact that no other *Xanthesma* species were collected could, by Exley's previous standards, suggest an association of sexes (Fig. 1). Comparison between our specimens and the holotypes revealed that the males matched *X. (Xenohesma) perpulchra* (Fig. 2), whilst the females collected with these males matched *X. (Xanthesma) brachycera*. This was also confirmed by comparison with Exley's collection at QM, and by comparing male internal characters (Fig. 3). It should be noted that even within a mating swarm males post-collection varied in the colour of the abdomen, ranging from bright yellow to honey-yellow.

### DNA barcoding

We successfully COI barcoded three specimens collected in Western Australia — a male and two females —

all collected from Wireless Hill (639–657 bp; Appendix 1 Table A1). The fourth specimen, a male collected from Shenton Park, sequenced as a potential numt (nuclear mitochondrial pseudogenes) — non-functional copies of mtDNA in the nucleus (Bensasson *et al.* 2001) — and consequently was excluded. All three successful sequences were identical (BOLD:ACG2612), indicating that they are indeed conspecifics.

Both our DNA data and morphological examinations (see below) indicate that these specimens belong to the same species. Following (Michener 1965), enlarged eyes in males place this species in the subgenus *X. (Xenohesma)*. However, the name *X. (Xanthesma) brachycera* has precedent. On this basis, we place *X. brachycera* within the subgenus *Xenohesma*.

### Discussion

The validity of subgeneric assignments in *Xanthesma* s. l. have been called into doubt in the past. For example, Exley (1977) found a gynadromorph specimen where the male half had the diagnostic characters of *X. (Xenohesma)*, but the female half had the appearance of *Xanthesma* sensu stricto. Michener (2007) cast further doubts when he noted that the characteristics of female *X. (Xenohesma)*, as described by Exley (1969), do not differ from those characterising *Xanthesma* sensu stricto. However, Exley (1978) also suggested that *X. (Xenohesma)* deserved generic status, and noted that many females currently placed in *Xanthesma* are likely the females of *X. (Xenohesma)* species.

Our findings, and the notes of Exley and Michener, do not necessarily mean that the subgenera *Xenohesma* and *Xanthesma* are phylogenetically invalid. The most parsimonious explanation for the presence of enlarged eyes in the males of *X. (Xenohesma)* is a single state-change and hence represents a single origin (monophyly). This is supported by Michener's use of the enlarged male eyes to separate *X. (Xenohesma)* from *Xanthesma* s. str., indicating that these might still be phylogenetically-relevant groupings. However, in large carpenter bees, *Xylocopa* Latreille, 1802, enlarged male eyes appear to have evolved independently multiple times (Leijs & Hogendoorn 2008). A robust systematic revision that incorporates phylogenetic techniques will be vital to confirm assignment of (i) sexual morphotypes to species, (ii) species to subgenera, and (iii) subgenera to genera. We show here that at least the former is easily achieved and we encourage further examination of the latter points. Our findings also draw attention to how some species may have widely disjunct distributions. Whether the disparate locations are due to a lack of collections in the intervening parts of Australia or are a result of other biogeographic processes remains to be determined. Furthermore, this is not the first species of tiny euryglossine to be found on opposite sides of the country (Fig. 4 and see Houston & Prendergast 2022). It poses an interesting question regarding the biogeogra-

phy of native bee taxa (Dorey *et al.* 2021). In addition to their taxonomy, the biology of *X. (Xenohesma)* species remains poorly understood. Michener (2007) proposed that *X. (Xenohesma)* mostly foraged on Myrtaceae species, however observations of foraging bees are extremely limited (Exley 1977). We support this, given our observations of collecting females solely on *Corymbia calophylla*, *Eucalyptus marginata*, and *Melaleuca lanceolata*. Additionally, an analysis of *Xanthesma* pollen provisions, which comprised exclusively *Eucalyptus* (Houston 1969), indicates that *Xanthesma* s. l. species are oligolectic — foraging on a small subset of Myrtaceae genera. A 1996 collection by Terry Houston of a male *X. (Xenohesma) brachycera* at Eneabba, Western Australia, was from a swarm over *Adenanthos cygnorum* (Proteaceae), indicating that swarms might not always be associated with female food plants (Houston 2000).

Although the nesting substrate of *X. (Xenohesma) brachycera* has not been published, nor that of any *X. (Xenohesma)* species, they likely nest in the ground. This is based on observations of nesting activity and nest architecture of two other *Xanthesma* s. str. species (Houston 1969). However, inspections of the ground below the mating swarms failed to uncover any nesting females, suggesting that swarms might not be associated with nesting sites. Identification and observations of nesting sites will provide greater insight into *X. (Xenohesma)* phenology. Current data on *X. (Xenohesma) brachycera* indicates activity occurs between November and February (materials examined; Exley (1974)). The Atlas of Living Australia only shows collections of *X. (Xenohesma)* as occurring between September and January (Atlas of Living Australia 2022).

It is notable that both males and females were collected in the survey at Wireless Hill, in adjacent bushland remnants (Lightning Swamp, City of Bayswater), and at Bibra Lake, all in February (in 2017, 2021, and 2022, respectively). Exley (1969) noted that often only males of *X. (Xenohesma)* were collected in high abundances at widely separated locations, and postulated that there might be a time lag between male and female emergence. Of course, both sexes must overlap temporally in order to mate and our concurrent collection of both sexes supports this. However, large male mating swarms, and the height of many Myrtaceae species where females will be foraging, likely bias towards the collection of males. Indeed, the female specimen from Wireless Hill was not collected from within the swarm and was instead collected passively in a pan trap. While it seems reasonable to assume that mate choice occurs, and the extreme sexual dimorphism supports this assumption, the exact mechanism(s) of choice and what might attract females to the mating swarm remain unknown. Possible attractants could include sound, increased visibility, or possibly chemical pheromones. Leijs and Hogendoorn (2008) proposed that broadly-distributed food or nesting resources might encourage lekking behaviour in bees,

where finding and patrolling resources might be too energetically costly. This could be particularly relevant for very small bees, like *X. (Xenohesma)*, that cannot travel large distances in arid environments where resources might be sparse. It might also provide an explanation for the decoupling of female resources and leks. However, nearby nectar resources could encourage leks because male swarming should be energetically costly.

Unlike most *X. (Xenohesma)* species, specimens of *X. (Xenohesma) brachycera* have been previously collected from more densely-populated areas, including Crawley and Nedlands in Western Australia, but such records occurred in 1933 and 1941, respectively (Exley 1969), when human population densities were much lower (Hedgcock & Alexander 2010). Aerial imagery of Perth from 1953 shows that the vegetation at both Shenton Park and Wireless Hill were contiguous with vegetation that extended outside of Perth (Western Australian Land Information Authority 1953). These maps also indicate that large areas of urban bushland have since been cleared. That mating swarms were only observed in bushland remnants and not residential sites indicates that *X. (Xenohesma)* are likely sensitive to habitat destruction. This demonstrates the value of urban bushland remnants for the persistence of diverse native bees in suburban areas and highlights the conservation value of such habitats (Prendergast *et al.* 2022). This work adds to a growing body of literature that links anthropogenic changes to habitats and communities with changes in bee populations and ranges (Dorey *et al.* 2021; Dorey 2021; López-Urbe *et al.* 2016; Hogendoorn *et al.* 2020). Additionally, the reliance of *Xanthesma* s. l. species on Myrtaceae, some of which don't flower for several years following fire, as well as other life-history traits, might make them vulnerable to extirpation in fragmented habitats following wildfires (Dorey *et al.* 2021; Law *et al.* 2000).

Due to the incomplete key and limited descriptions for the females of *X. (Xenohesma)*, morphological comparisons between species and subgenera remains challenging. Uncertainty surrounding the relationships within *Xanthesma* s. l. are further complicated by our morphological and DNA results. Because the sexes of *X. (Xenohesma) brachycera* belonged to different subgenera we suggest that further changes are likely as genetic and phylogenetic techniques are applied to the group. Further taxonomic and phylogenetic works are required to better understand the species, subgeneric, and generic relationships of our specimens with those of other euryglossines. Our results highlight the need for future research to resolve the taxonomic relationships between euryglossine groups as well as the Australian bee fauna as a whole.

The Euryglossinae — with 32 of now 34 revisions all written by Exley between twenty and over forty years ago, are a group that is a prime candidate to use more modern molecular technologies (Hogendoorn *et al.* 2015;

Packer *et al.* 2009). Together, DNA and morphological data are needed to reappraise the taxonomy of the euryglossines. Such examinations will likely lead to new species, combinations, and synonyms. Further genetic analyses could also explore the demographics of these populations in order to determine population trends and connectedness.

We highlight the need for further taxonomic revisions and genetic analyses, involving a number of Euryglossinae genera. This work should be a priority given widespread taxonomic uncertainty. We also highlight the value of publishing biological interactions and life-histories because such observations are shared infrequently limiting our understanding and ability to make meaningful inferences. We cannot reliably assess the conservation statuses of bee species without understanding their taxonomy and life-histories. Nor can we understand bee biogeography or species richness and diversity in Australia at large.

## Taxonomy

### Key to the described females of the subgenus *Xanthesma (Xenohesma)* (adapted from Exley (1969))

1	Head entirely yellow	
		<b><i>X. brachycera</i> (Cockerell 1914)</b>
1:	Head not entirely yellow	2
2	Head entirely black	2
2:	Head dark brown or black with some yellow markings	4
3	Dorsum of scutellum and metanotum black	
		<b><i>X. maculata</i> (Smith 1879)</b>
3:	Dorsum of scutellum and metanotum bright yellow	<b><i>X. scutellaris</i> (Michener 1965)</b>
4	Yellow markings on clypeus distinctly bounded by suture between clypeus and supraclypeal area; lateral angles of pronotum absent	
		<b><i>X. clypearis</i> (Michener 1965)</b>
4:	Extent of yellow marking on clypeus variable, but always extending onto supraclypeal area; lateral angles of pronotum present and raised	5
5	Dorsum of metanotum yellow	
		<b><i>X. stagei</i> (Exley 1969a)</b>
5:	Dorsum of metanotum dark brown	
		<b><i>X. federalis</i> (Michener 1965)</b>

### Family COLLETIDAE Lepelletier 1841

### Subfamily Euryglossinae Strand 1911

### Genus *Xanthesma* Michener 1965

### *Xanthesma (Xenohesma) brachycera* (Cockerell 1914)

*Euryglossa brachycera* Cockerell, 1914: 7

*Euryglossa perpulchra* Cockerell, 1916: 434.

*Xanthesma brachycera* (Cockerell, 1914) — Michener 1965: 97.

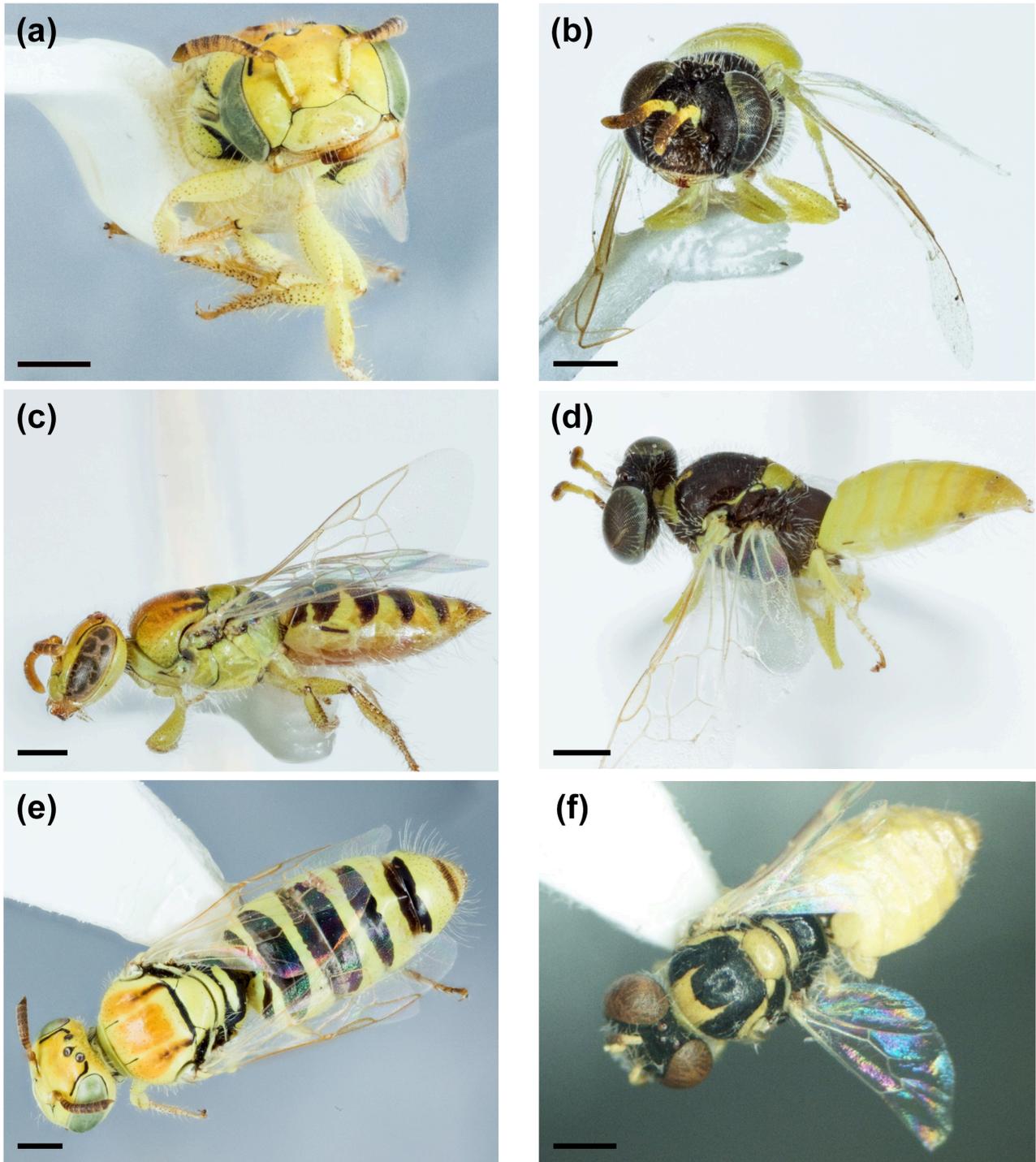


Figure 1. Female (left) and male (right) *Xanthesma (Xenohesma) brachycera*. Images are anterior (a and b), lateral (c and d), and dorsal (e and f). Scale bars are 0.5 mm.

*Euryglossa (Xenohesma) perpulchra* Cockerell, 1916 — Michener 1965: 96. syn. nov.

**Diagnosis**

**Females:** Of the females described in our key, *X. (Xenohesma) brachycera* females can be distinguished from all others based on their entirely yellow head.

**Males:** In Exley's key on the subgenus *Xenohesma* (1968), *X. (Xenohesma) perpulchra* was distinguished from *X.*

*(Xenohesma) melanoclypearis* on the basis of the scape black dorsally, first 6 flagellar segments mainly yellow, as opposed to antennae scape entirely yellow.

**Description**

**Females**

**Size:** Body length 4.72 mm; intertegular span 0.97–1.07 mm; head width 1.16 mm.

Relative head measurements: HW 50; HL 40.4; UID 28.4; LID 30.8; WOC 8.5; OOD 6.5; IAD 14.1; SL 13; FL 254.3.

**Structure:** Face slightly wider than long; antennae low on face, located approximately two-thirds from the vertex (Fig. 1a); scape reaching just below the bottom of the facial fovea, approximately one-third from the vertex; pedicel longer and wider than any flagellomere; mandibles simple; eye inner margins convergent both below and above; supra-clypeus raised and defined by suture; clypeus only weakly transversely convex; black facial fovea extending one third down eye, and converging mesad at the vertex to nearly meet the lateral ocelli; basitibial plates well-defined, dark (Fig. 1c).

**Colouration:** Eyes in live specimens blue; head yellow with black border separating the clypeus from supra-clypeus and paraocular area; scape yellow, flagellum honey-brown; mandibles pale yellow and darkening at the tip (Fig. 1a); scutum bright yellow with honey-gold markings along the scutum-scutellum border and extending laterally up to the level of the pronotal lobes, parapsidal lines black (Fig. 1e); scutellum and axillae bright yellow, metanotum yellow bordered by black, propodeum black with yellow ellipse dorsally (Fig. 1e); sides of the thorax, legs, and tegula bright yellow (Fig. 1c); sternites cream, tergites yellow with thick bands dark brown on anterior of tergite, with lighter dark brown bands on the posterior of the tergite (Fig. 1e).

**Sculpture:** Body and head largely impunctate, with small, sparse punctures on anterior scutum and at base of hairs around vertex and on legs (Fig. 1a, c, e); horizontal part of propodeum longer than vertical part, propodeal triangle unsculptured and without a carina, but demarcated by being black rather than yellow (Fig. 1e).

**Pubescence:** Sparse, simple, relatively long hairs along bottom of the clypeus, genal region, forecoxa (Fig.1a), hind metatarsi, and the lateral and ventral region of the last tergite (Fig. 1c, e); shorter, sparse hairs along other parts of the legs, head, sides of the thorax, and anterior scutum (Fig. 1a, c, e).

### Males

**Size:** Body length 4.00 mm; intertegular span 1.20 mm; head width 1.40 mm.

Relative head measurements: HW 50; HL 30.0; UID 17.0; LID 25.5; WOC 11.5; OOD 3.0; IAD 11.0; SL 11.0; FL 19.1.

**Structure:** Face wider than long, and concaved (Fig. 1b); antennae low on face, located approximately two-thirds from the vertex; eyes large and bulbous, converging above and below, slightly more above, the orbits arches outwards; scape reaches just below the bottom of the facial fovea, approximately one-third from the vertex; mandibles simple; clypeus only weakly transversely convex.

**Colouration:** Eyes in life black; head black-brown; scape dark brown at base, changing to yellow near pedicel; basal flagellomeres yellow; distal flagellomeres brown; mandibles pale yellow and darkening at the tip (Fig. 1b); scutum black, with yellow pronotal collar, pronotum and pronotal lobes; yellow markings from pronotum extending just outside of the notauli to adjacent with start of tegulae, concave in the middle (Fig. 1f); tegulae, mesepisternum, axillae and scutellum yellow (Fig. 1d); wing veins yellow; legs yellow; abdomen yellow (Fig. 1d), in some specimens darkening on posterior tergites and sternites.

**Sculpture:** Body and head largely impunctate, with small, sparse punctures on anterior scutum; larger punctures on legs; propodeal triangle unsculptured and without a carina.

**Pubescence:** Sparse, simple, short hairs dorsally on thorax and ventrally on abdomen, on clypeus, and medially on frons (Fig. 1b,d,f); propodeum bare; relatively longer, denser hairs along bottom of the clypeus, genal region, forecoxa, hind metatarsi, and along sides of propodeum and pronotum (Fig. 1b, d, f). Shorter, sparse hairs along other parts of the legs, head, sides of the thorax, and anterior scutum (Fig. 1b, d, f).

1♀: WA: Wireless Hill, Ardross (-32.0311, 115.826), 19 Jan 2017, Lge Yellow Bee Bowl; 1♀: WA: Star Swamp, North Beach (-31.8574, 115.7602) 5 Feb 2017, Lge Yellow Bee-Bowl; 16♂ WA: Wireless Hill, 32.031054°S, 115.826448°E, 12 Feb 2017, Sweepnet, PM, KS Prendergast; 1♀: Lightning Swamp, Bayswater (-31.8696923, 115.9068847) 16 Feb 2022, Sweepnetted on *C. calophylla*, KS Prendergast Bayswater2\_093; 4♀: WA: Wireless Hill, Ardross (-32.0311, 115.826), 19 Feb 2017, Sweepnet; 2♀: WA: Wireless Hill, Ardross (-32.0311, 115.826) 8 Dec 2017, Sweepnet; 2♀ & 18♂: WA: Wireless Hill, Ardross (-32.0311, 115.826), 12 Feb 2018, Sweepnet; 22♂ WA: Shenton Park, 31.948°S, 115.795°E, 12 Jan 2018, Sweepnet, PM, KS Prendergast (KSP\_108533, KSP\_108534, KSP\_108536); 1♀: Bold Park (-31.9562, 115.7712) 18 Feb 2018, Sweepnet; 2♂ WA: Maxwell Park/Russo Reserve -31.8735963, 115.9052369, 6 Jan 2022, Sweepnet, K.S. Prendergast (Bayswater2\_079, Bayswater2\_080); 2♀ & 5♂: WA: Roe 8 Rehab Corridor, Bibra Lake (-32.0834, 115.8253) 27 Jan 2023, ♀ Roe8\_016, Roe8\_017 and ♂ Roe8\_037, Roe8\_038, Roe8\_039, Roe8\_053, Roe8\_054.

All fresh specimens were collected by K. Prendergast as part of the “Bees in the burbs PhD surveys”, City of Bayswater Native Bee Surveys, and Roe 8 Rehabilitation Native Bee Surveys. All specimens are deposited in the WA Museum Entomology Collection (WAM: 108537, 108538, 108539, 108540).

**Remarks.** Using measurements of males and females collected in the same region, we also found that females were slightly smaller than males — female intertegular span  $1.04 \pm 0.02$  mm (n=4) vs. male intertegular span

1.21 ± 0.03 mm (n=4). Although Exley (1969) described the basitibial plate as not clearly delineated in all *Xanthesma* s. l., in this species it was well-defined. The pygidial plate however was weak.

**Host flowers.** As with all records of *Xanthesma* s. l. to date (Exley 1969), this species appears to be oligolectic on Myrtaceae. In the present surveys, females were collected from *Corymbia calophylla*, *Melaleuca lanceolata*, and *Eucalyptus marginata* (Myrtaceae).

**Mating swarm observations and collections.** Across two years of surveying, three male mating swarms were observed at two sites, and females were collected from three sites. An additional mating swarm was also observed after these surveys. No observations of *X. (Xenohesma) brachycera* occurred in residential garden sites.

An initial observation of a mating swarm was made at Wireless Hill Park on the 19th of February, 2017. A small (ca. 30 cm x 50 cm) swarm was observed ca. 80 cm above the ground across a pedestrian walkway and the adjacent bare sandy soil between 1100 h and 1200 h. Another, much larger (ca. 2 m x 3 m), swarm was observed ca. 50 cm above the ground nearby at 1330 h. This swarm was also observed flying above a walkway and the adjacent bare sand. On February 12th, 2018, another mating swarm was observed at Wireless Hill at ca. 1300 h. This swarm was observed flying ca. 1 m above the ground, and over prostrate vegetation away from the walking tracks. Another large mating swarm of males (ca. 3 m x 2 m in area) was also observed at another location, Shenton Park, on Jan 12th, 2018, in native vegetation near the University of Western Australia's field research station. A smaller swarm (ca. 1 m x 1 m in area, and less dense than previous male swarms) was observed flying in an open clearing above grass and sand at Russo Reserve, Noranda, on Jan 6th, 2022. Specimens were taken from each swarm to confirm identity, all of which were male (Fig. 1).

No females were observed in or collected from the swarms; however, given the small size of the bees, and their rapid flight, females might have been present. Although no females were collected from these swarms, female specimens were collected foraging on Myrtaceae species (*Corymbia calophylla* and *Eucalyptus marginata*; Fig. 1) at Wireless Hill during the surveys when the male swarms were observed. A female specimen was also sweep-netted from *Corymbia calophylla* at Lightning Swamp, a bushland reserve 1.2 km from Russo Reserve where males were observed in the mating swarm a month prior. Female specimens were also collected in the absence of males, in a yellow bee bowl both at Wireless Hill in January 2017, as well as at two other bushland remnants, including in a yellow bee bowl at Star Swamp in February 2017, and sweep-netted from *Melaleuca lanceolata* (Myrtaceae) at Bold Park in February 2018.

## Disclosures

The authors declare no conflicts of interest.

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## Supplementary Data

All relevant data have been made available with this manuscript and its supplementary materials available open access on FigShare (<https://doi.org/10.6084/m9.figshare.20448675>). GenBank accession numbers are found in Table S1.

### Supplementary data

#### Appendix 1. Specimens of *Xanthesma (Xenohesma) brachycera* sent for DNA barcoding

**Table S1.** Specimens of *Xanthesma (Xenohesma) brachycera* that were sent for DNA barcoding: their collection details and for those that were successfully sequenced, their BIN and GenBank accession numbers. WAM voucher refers to the voucher number at the Western Australian Museum Entomology Collection.

#### Appendix 2. Specimens used for body-size measurements

**Table S2.** Specimens of *Xanthesma (Xenohesma) brachycera* used for body-size measurements. ITD = intertegular distance. WAM = Western Australian Museum.

#### Appendix 3. Video of mating swarm of *Xanthesma (Xenohesma) brachycera*

Video of a mating swarm of *Xanthesma (Xenohesma) brachycera* taken at Shenton Park Bushland on 19th Jan 2018.

#### Appendix 4. R script used to produce the Collection map of *Xanthesma (Xenohesma) brachycera*

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