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Four new species of parasitoid wasp (Hymenoptera: Braconidae) described through a citizen science partnership with schools in regional South Australia

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Abstract

Involving the community in taxonomic research has the potential to increase the awareness, appreciation and value of taxonomy in the public sphere. We report here on a trial citizen science project, *Insect Investigators*, which partners taxonomists with school students to monitor Malaise traps and prioritise the description of new species collected. In this initial trial, four schools in regional South Australia participated in the program and all collected new species of the braconid subfamily Microgastrinae (Hymenoptera: Braconidae). These four species are here described as new, with the names being chosen in collaboration with the participating school students: *Choeras ramcomarmorata* Fagan-Jeffries & Austin **sp. nov.**, *Glyptapanteles drioplanetus* Fagan-Jeffries & Austin **sp. nov.**, *Dolichogenidea franklinharbourensis* Fagan-Jeffries & Austin **sp. nov.** and *Miropotes waikerieyeties* Fagan-Jeffries & Austin **sp. nov.** All four species are diagnosed against the known members of the genera from Australia, New Zealand, Fiji, Samoa and Papua New Guinea, and images and *COI* DNA barcodes are provided of the holotypes. Students had positive feedback about their experiences of the program, and there is significant potential for it to be expanded and used as a means to connect communities with taxonomic science.

Key words: Microgastrinae, citizen science, taxonomy

Introduction

Taxonomy, whilst always inherently of significant value to society, is often done in isolation by researchers at academic or cultural institutions, fundamentally disconnected from the wider populace. An estimated 70% of the species in Australia still require formal scientific description (Taxonomy Decadal Plan Working Group 2018), and ranking the priority of species to be treated is often determined by individual researchers; a decision-making process that incorporates factors as disparate as current expertise, grant funding, access to field sites, availability of specimens and type material, ease of species delineation by morphological or molecular data, and the economic or environmental importance of particular taxa. With the taxonomic community in Australia currently focussed on revolutionising the field to meet the goals of the 2018 decadal plan (Taxonomy Decadal Plan Working Group 2018), one important consideration is how the general public can participate in the process of collecting and describing Australia's biodiversity. Bringing local communities into the decision-making process of when and why we prioritise the description of certain species can only increase the awareness, appreciation, and value of taxonomy as a science and its relevance to Australian society.

Whilst robust taxonomic research requires expertise on a particular taxon group, specialist knowledge that can take years or decades to accumulate, there are numerous examples of citizen science projects that utilise local communities to discover and document species. iNaturalist is a global citizen science platform that encourages people to document biodiversity through uploading images and data of sightings, with 'research-grade' observations (those that have the necessary data to be verifiable observations, and where at least two-thirds of identifiers have agreed on

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a species-level identification) exported to the Global Biodiversity Information Facility (GBIF). The iNaturalist platform has over 3 million users and over 42 million observations identified to species-level (iNaturalist 2020), whilst the iNaturalist GBIF dataset has been cited in over 680 peer-review publications (https://www.gbif.org/resource/search?contentType=literature&gbifDatasetKey=50c9509d-22c7-4a22-a47d-8c48425ef4a7&peerReview=true). The importance of citizen science in documenting biodiversity can be seen through the numerous and varied uses of the iNaturalist dataset; from a new species of fly (Diptera: Therevidae) being described from China due to an iNaturalist record (Winterton 2020), to the platform contributing the first images of living specimens, and first records since the original description, of rare Australian grasshoppers (Orthoptera: Tetrigidae) (Skejo *et al.* 2020), to documenting the first records of several invasive terrestrial gastropod species in California, as part of the SLIME project hosted on iNaturalist (Vendetti *et al.* 2018, 2019).

Malaise traps, a passive collecting trap that primarily targets flying insects such as Hymenoptera (wasps) and Diptera (flies), are a useful citizen science sampling tool due to ease of assembly and monitoring, and have been pioneered for use in schools by the Canadian School Malaise Trap Program (SMTP). The SMTP has run Malaise traps for fortnightly periods in over 300 schools since 2013, with 91% of surveyed teachers stating that students were strongly engaged in the program (Steinke *et al.* 2017). For the program outlined here, *Insect Investigators*, four schools in regional South Australia were invited to partner in a trial citizen science project, in which the schools monitored a Malaise trap for several months. Any collected specimens of parasitoid wasps from the subfamily Microgastrinae (Hymenoptera: Braconidae) were then incorporated into a broader DNA barcoding and species discovery project. We here describe four new species, all of which include material from the *Insect Investigators* project, and which were named in collaboration with the students who collected the specimens.

Microgastrinae are a highly diverse group of parasitoid wasps, with estimates of the species richness of the subfamily reaching 30,000 – 50,000 species worldwide, yet with only about 3,000 species described to date (Fernández-Triana *et al.* 2020). All species of microgastrines are endoparasitoids of lepidopteran larvae, and are therefore important constituents of native ecosystems, as well as being both current and potential biological control agents for lepidopteran pest species in agricultural systems. There are approximately 140 species described from 22 genera for Australia (Fagan-Jeffries & Austin 2020; Fernández-Triana *et al.* 2020) with several hundred more known from molecular data (Fagan-Jeffries *et al.* 2018b), and plausibly severalfold more yet to be documented.

Methods

Design and overview of the Insect Investigators project: collecting specimens

The *Insect Investigators* project involved regional schools running a Malaise trap on or near their school grounds, with the goal of collecting new species of microgastrine wasp for description. The aims of the project were both scientific and participant-focussed; the collection of microgastrine specimens was part of a broader project to explore and document the diversity of this subfamily in Australia. The involvement of school children in the process of surveying their local insect fauna, and collecting and naming new species, aimed to better connect students with their local environment and allow them to become more aware of taxonomy as a field of science.

Four schools were involved: Macclesfield Primary School in the Adelaide Hills region (a year 5/6/7 class, students between 10–13 years of age) which ran a trap on the adjacent Macclesfield Reserve; Cowell Area School on the Eyre Peninsula (a Year 4/5 class, students between 9–11 years of age) which ran a trap on the school grounds; and Waikerie and Ramco Primary Schools in the Riverland (a Year 6/7 (students 11–13 years of age) Youth Environment Team, which ran a trap at the nearby Hart Lagoon; and a year 5/6/7 Environment group leading the 5/6/7 class (students between 10–13 years of age), which ran a trap on the school grounds, respectively) (Fig. 1, see material examined for GPS coordinates). An initial workshop was conducted in-person at each school with the class or student group by the lead author which comprised 1) an interactive presentation focussing on insects, wasps and taxonomy, 2) an opportunity for students to examine insect specimens under stereomicroscopes, and 3) setting up the Malaise trap. For the duration of the project (varying from 14 to 32 weeks, see Supplementary Material Table S1 for all dates and times schools were involved), teachers or the student group changed the ethanol bottle on the Malaise trap approximately once per fortnight (in the case of Waikerie Primary School, the bottle changes were done by a local Landcare representative), and samples were sent by post to The University of Adelaide, or collected from the school, approximately once per month.

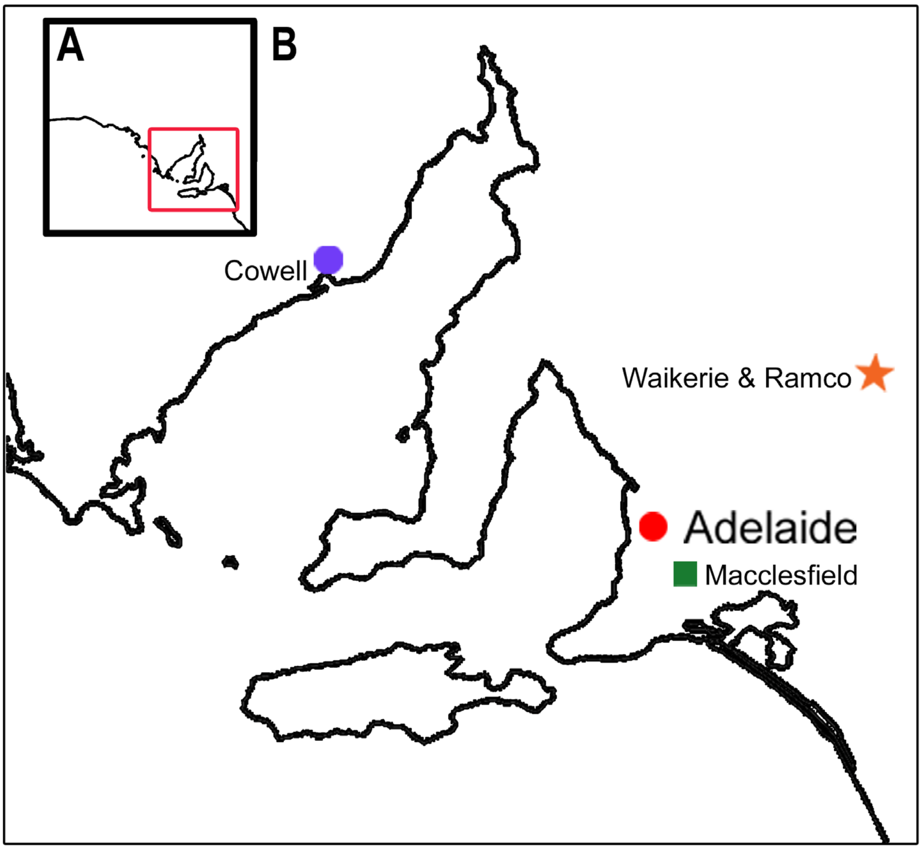

FIGURE 1. Location of regional schools involved in *Insect Investigators* in 2019/2020. **A)** Map of South Australia. **B)** Portion of South Australia indicated by the red square in **A** showing the locations of the schools: Cowell Area School indicated by a blue circle, Macclesfield Primary School indicated by a green square, and Waikerie and Ramco Primary Schools (located very close to each other in the Riverland region) indicated by an orange star. The capital city of Adelaide is indicated by a red circle.

Malaise trap samples were sorted to Order level once they arrived at The University of Adelaide, and blog posts were written to provide feedback to the students about what insects were occurring in their traps (excluding Macclesfield Primary School, in which results were presented to the students at two in-person visits in late 2019 and in late 2020). Blog posts are available online here: http://www.erinnfagan-jeffries.com/news-insect-investigators/. Originally, a second visit to each school was planned to provide face-to-face feedback on the project progress, but these were not possible between March and July 2020 due to the COVID-19 pandemic. Instead, virtual lab tours of the Arthropod Systematics and Evolution labs at The University of Adelaide with 'Question and Answer' sessions were conducted with Cowell and Ramco schools during May 2020.

Specimens of microgastrines collected in the trap samples were included in a high-throughput DNA barcoding sequencing project, and potential new species were studied morphologically (see below). Once new species were confirmed, follow-up visits to the schools were conducted in September and October 2020, involving a workshop on the taxonomic process, and a discussion about what the new species from each of the school sites were to be called, taking suggestions and a final majority vote from the students.

Species delineation and description

All specimens of the new species included in this study had between 1–3 legs removed for DNA extraction, and thus nearly all type specimens are missing 1–3 legs. DNA extraction and sequencing of the cytochrome oxidase subunit 1 (*COI*) and Wingless nuclear gene DNA barcodes follows the high-throughput methods in Fagan-Jeffries *et al.* (2018b). Specimens in this study include those previously sequenced in Fagan-Jeffries *et al.* (2018b), and additional specimens sequenced using the same methods, both of which are publicly available on the Barcode of Life Database (BOLD) with the accession codes listed under each treated species. An integrative approach to species delimitation using a general lineage species concept (de Queiroz 1998) was taken, with species being delineated based on both the comparison of the molecular sequences to all other available sequences of Microgastrinae, and the comparison of morphological characters commonly used at the species level in microgastrine taxonomy to described species of Microgastrinae from Australia.

Terms for general morphology mostly follow Fernández-Triana *et al.* (2014) and terms for sculpture follow Eady (1968). We generally define colour as either pale (white, cream or pale yellow), orange, light brown or dark (dark brown or black). Images of specimens and morphological characters were generated using a Visionary Digital BK+ imaging system with a Canon EOS 7D 18 megapixel camera, compiled in Zerene Stacker, Zerene Systems LLC, PMax software, and edited for clarity in Adobe Photoshop 2021 (Adobe Systems Inc., San Jose, CA, USA). Measurements of morphological characters were done on the holotypes using images in Adobe Photoshop 2021 and for some characters, measurements were repeated using an ocular micrometer on a Leica Mz16 microscope under 10× or 100× magnification. Where measurements differed between the methods, an average is given in the description. For new species, measurements of holotypes are given, with those for paratypes (where measured) following in parentheses as ranges (see Fernández-Triana et al. (2014) for measurement terminology and appendix 1 in the same paper for discussion on characters prone to variable results when measuring).

The following abbreviations are used throughout the text

M/T = Malaise trap
OOL = ocular-ocellar line
POL = posterior interocellar line
POD = posterior ocellus diameter (largest measurement if ocellus not symmetrical)
PS = Primary School
T1 = first mediotergite
T2 = second mediotergite
T3 = third mediotergite

Institutional abbreviations

ANIC = Australian National Insect Collection, Canberra, Australia
QM = Queensland Museum, Brisbane, Australia
QDPC = Queensland Department of Primary Industries Collection, Biosecurity Queensland, Brisbane, Australia
SAMA = South Australian Museum, Adelaide, Australia
WAM = Western Australian Museum, Perth, Australia

Molecular analyses

***Choeras*.** All sequences of the *COI* and Wingless genes were downloaded from the BOLD for the genera *Sathon* Mason, 1981 and *Choeras* Mason, 1981, limiting the geography to Australia to reduce the data set for simplicity. A sequence of *Microplitis demolitor* Wilkinson, 1934b was used as an outgroup. See Supplementary Material Table S2 for the specimen data of all sequences used in the analysis. Sequences were concatenated and aligned using MUSCLE (Edgar 2004) in Geneious 9.1.8 (https://www.geneious.com). A neighbour joining tree built using the Geneious tree builder was constructed to identify the clade of *Choeras* with a small fore wing areolet, which are known to be unrelated to the clade containing *Choeras* and *Sathon* with a large fore wing areolet (Fagan-Jeffries *et al.* 2018b; Fagan-Jeffries & Austin 2018), and sequences falling into this clade were removed from the alignment. The final alignment had the best partitioning scheme (four partitions: COI codon 1 GTR+I+G; COI codon 2 GTR+I+G; COI codon 3 GTR+G; Wingless GTR+G) selected using PartitionFinder 2 (Lanfear *et al.* 2016) on the CIPRES Science Gateway (Miller *et al.* 2010) limiting the model selection to those implemented in MrBayes (Ronquist *et al.* 2012). A Bayesian analysis using MrBayes 3.2.7 was run on the CIPRES Science Gateway for 10 million generations, and the program Tracer v1.6 (Rambaut *et al.* 2018) was used to assess convergence by ensuring Estimated Sample Sizes were over 200 and by visual inspection of the likelihood plot. Trees were edited in FigTree v1.4.3 (http://tree.bio.ed.ac.uk/software/figtree) and Adobe Illustrator 2021.

***Glyptapanteles*.** All sequences of *COI* available on the BOLD for the genera *Glyptapanteles*, *Sathon*, *Cotesia* Cameron, 1891, *Lathrapanteles* Williams, 1985 and *Protapanteles* Ashmead, 1898 along with a sequence of *Microplitis demolitor* as an outgroup, were downloaded and aligned using MAFFT v7.308 (Katoh *et al.* 2002; Katoh

& Standley 2013) within Geneious 9.1.8. These genera were chosen as they can, in some cases, be confused morphologically with *Glyptapanteles* (Fernández-Triana *et al.* 2020). Contaminants were removed, and a phylogeny was built using the program FastTree v.2.1.5 (Price *et al.* 2010) within Geneious 9.1.8. Trees were edited in FigTree v1.4.3 (http://tree.bio.ed.ac.uk/software/figtree) and Adobe Illustrator 2021. See Supplementary Material Table S3 for specimen data of sequences used in the final alignment.

***Miropotes*.** All sequences of the *COI* and Wingless genes were downloaded from BOLD for the genus *Miropotes*, limiting the geography to Australia to reduce the data set for simplicity. A sequence of *Microplitis demolitor* was used as an outgroup. See Supplementary Material Table S4 for the specimen data of all sequences used in the analysis. Alignment, model selection and tree-building followed that for the *Choeras* analysis, with the only difference being the best-fit models for *COI* codons two and three (GTR+I, GTR+I+G respectively).

Collection of evaluation data and survey design

Students participating in the project from Cowell, Ramco and Waikerie schools were asked to complete a survey at the very start of the first visit to the school, and then to complete a post-workshop survey at the end of the final visit to the school. The intent of these surveys was to test the feasibility of quantifying a change in knowledge or opinions of participants as a result of their involvement in the project, as well as to collect general feedback from the students. The survey design was heavily influenced by the surveys of a pre-existing school-based citizen science project, North Carolina Candid Critters in the Classroom, with some questions removed, and others adjusted to fit the insect topic.

As the student survey was included primarily to trial the question design for use in a future, expanded program, there were several issues that prevented a rigorous analysis of the data, including a lack of control groups. The survey design was imperfect, and the trial has indicated many areas for improvement in future versions of the research project. As such, we do not present the comparative pre-post data here, but only the final three questions in the post-project survey, which asked students to state whether there had been any changes in their views on wildlife and science over the time period in which the program was conducted, and write comments on both their favourite part of the program, and one thing they learnt as a result of their involvement.

Results

Taxonomy

Choeras Mason, 1981

Choeras Mason, 1981: 76; Austin & Dangerfield 1992. See Fagan-Jeffries *et al.* (2019) and Fagan-Jeffries & Austin (2018) for a review and comments on the Australasian fauna; Fernández-Triana *et al.* (2020) for a checklist and comments on the world fauna.

Type species: *Apanteles* (*Pseudapanteles*) *consimilis* Viereck, 1911, by original designation.

Comments. *Choeras* Mason, 1981 has recently been reviewed for Australia (Fagan-Jeffries *et al.* 2019; Fagan-Jeffries & Austin 2018), with 12 species described from the continent. The Australian members of the genus as it is currently defined include two distinct, unrelated clades; a group of species with a small fore wing areolet, and group of species with a large fore wing areolet which contains species currently described as both *Choeras* and *Sathon* (Fagan-Jeffries *et al.* 2018b Figure 4b, Fagan-Jeffries *et al.* 2019 Figure 1).

Choeras ramcomarmorata Fagan-Jeffries & Austin sp. nov.

(Fig. 2)
urn:lsid:zoobank.org:act:233DB1DE-BF33-44B9-8E5C-878002D8851C

Material examined. Holotype: South Australia: ♀ Ramco Primary School, -34.169522 139.93407, 19.v–2.vi.2020, E. Fagan-Jeffries and Ramco PS 5/6/7 class, M/T EFJ2020MT40, Extraction1673 (SAMA: 32-45151, BOLD: AUMIC550-20).

Paratype: Western Australia: ♂ Albany Highway, Gleneagle State Forest, 3.iv–7.v.2005, M.S. Harvey, M/T, Extraction1491 (WAM: WAME109656, BOLD: AUMIC551-20).

Diagnosis. This species can be separated morphologically from the other Australasian members of the genera *Sathon* Mason and *Choeras* as follows:

- From *C. calacte* (Nixon, 1965)*, C. dissors* (Nixon, 1965), *C. papua* (Wilkinson, 1936), *C. parvoculus* Fagan-Jeffries & Austin, 2019*,* and *C. zygon* Fagan-Jeffries & Austin, 2019 by having a large forewing areolet.
- From *C. ceto* (Nixon, 1965), *C. tegularis* (Szepligeti, 1905), *S. albicoxus* Austin & Dangerfield, 1992*, S. moratus* (Wilkinson, 1929)*, S. naryciae* Austin & Dangerfield, 1992*, S. oreo* Fagan-Jeffries & Austin, 2019*,* and *S. resplendens* (Wilkinson, 1929) by having a complete, strong medial carina on the propodeum.
- From *C. epaphus* (Nixon, 1965), and *C. koalascatocola* Fagan-Jeffries & Austin, 2017 by having T2 narrowing posteriorly.
- From *C. helespas* Walker, 1996 by T1 without strong rugose sculpturing along length and T1 much wider anteriorly than posteriorly.
- From *C. bushblitz* Fagan-Jeffries & Austin, 2019 by the mesosoma being completely dark
- From *C. morialta* Fagan-Jeffries & Austin, 2017 by the ovipositor gently curving (not strongly bent near tip).

Description. FEMALE. Colour. Head, antenna and mesosoma all dark; all tergites and most of metasoma dark other than small pale patch at posterior end of T1, non-sclerotised areas of T1–2 and anterior sternites pale; hypopygium dark laterally with pale area ventrally, ovipositor sheaths dark (fore-, mid-, hind coxa) pale, pale, dark; (fore-, mid-, hind- trochanter) pale, pale, pale; femora (fore-, mid-, hind femur) pale to light brown, pale to light brown, mostly dark with pale stripe in proximal half; tibiae (fore-, mid-, hind tibia) pale to light brown, pale to light brown, dark with pale area proximally, all tarsi dark; tegula and humeral complex orange-brown; pterostigma dark; fore wing veins dark.

Body length. Head to apex of metasoma: 4.0 mm.

Head. Antenna slightly longer than body length; OOL/POD 1.7; POL/ POD 1.6; antennal flagellomere 2 length/width 3.5; antennal flagellomere 14 length/width 1.9.

Mesosoma. Anteromesoscutum punctulate, punctures small (space between punctures larger than their diameter, particularly in posterior two-thirds of anteromesoscutum, punctures slightly larger and closer together anteriorly); number of pits in scutoscutellar sulcus 12; scutellar disc very smooth with only tiny punctures associated with setae. Propodeum with medial carina present and complete, clearly distinguishable from surrounding rugosity. Propodeum coarsely rugose in centre, transitioning to smoother punctate areas antero-laterally.

Wings. Fore wing length 4.0 mm; length of veins r/2RS 0.8; length of veins 2RS/2M 1.0; length of veins 2M/(RS+M)b 1.9; pterostigma length/width 2.9. Forewing areolet large, four-sided with sharp angle between veins 3RSa and rs-m, vein rs-m slightly curved at distal end.

Legs. Hind tibia inner spur length/hind basitarsus length 0.4.

Metasoma. T1 length / T1 width at posterior margin 3.1; narrowing posteriorly, smooth in anterior half, punctures associated with setae in posterior half; T2 width at posterior margin / T2 length 3.5, sclerotised area well differentiated from surrounding tergite, scattered punctures associated with setae, border with T3 smooth and only just distinguishable; T3 sculpture smooth and shiny; both T2 and T3 irregularly setose for all of length; ovipositor sheaths length/hind tibial length 1.9.

MALE. Smaller in size than female, body length 3.3 mm; T1 lighter in colouration than female specimen, light brown anteriorly with dark area in centre, fading to pale posteriorly.

Etymology. Named by the 2020 year 5–7 students of Ramco Primary School, where the holotype was collected. The students chose to use the name of the school along with the epithet 'marmorata' from the Latin 'marmor',

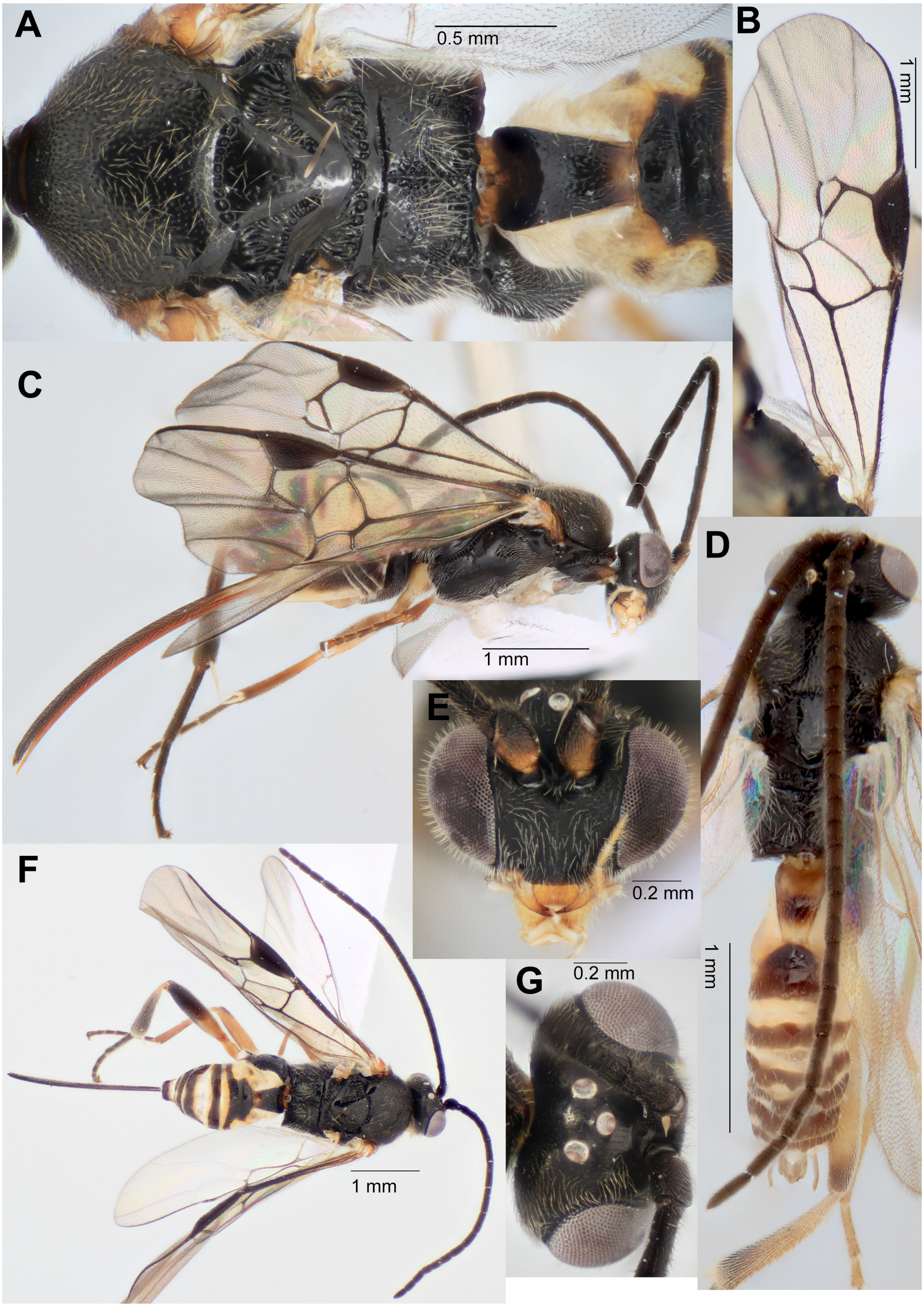

FIGURE 2. *Choeras ramcomarmorata* **A–C, E–G** Holotype; **D** Male paratype. **A)** Dorsal mesosoma and T1–2 **B)** Fore wing **C)** Lateral habitus **D)** Male dorsal habitus **E)** Anterior head **F)** Dorsal habitus **G)** Dorsal head.

for marble, as they felt that the striking black and white colouration of the species, and variation of colours on the tergites, looked like polished marble. The species name therefore unconventionally combines a place name with a Latin adjective, and should be regarded as a noun in apposition.

Distribution. Known from only a female specimen from the Riverland region, South Australia, and from a male specimen from Gleneagle, Western Australia.

Molecular information. The species constitutes BIN: BOLD:AEF8695, and is 9.63% divergent from the nearest relative on BOLD.

Remarks. This species falls within a large clade of Australian species, all with a large forewing areolet, that morphologically are intermediate between the current definition of the genera *Sathon* and *Choeras* (Fig. 3). We place this species in the genus *Choeras* as there appears to be some flexibility in the hypopygium which would exclude it from the strict definition of *Sathon*, and because it is morphologically and molecularly closely related to *Choeras morialta*. However, we note that this clade may end up being recognised as a new genus, which is not related to the group of species that possess a small forewing areolet. To confirm and revise the genus, phylogenetic studies that include the type species of *Choeras* and *Sathon* will need to be conducted.

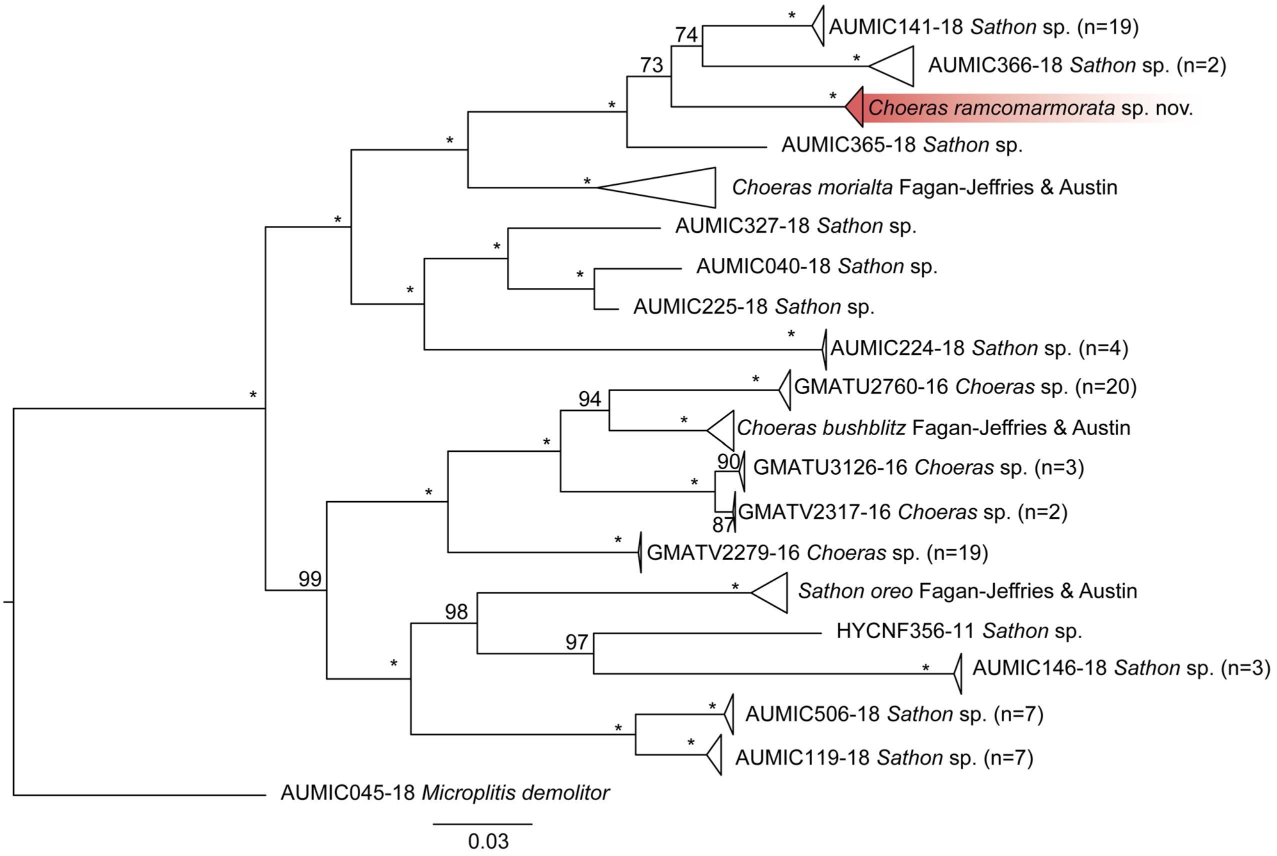

FIGURE 3. *COI* and Wingless Bayesian phylogeny showing the relationship of *Choeras ramcomarmorata* sp. nov. (in red) to other Australian specimens identified as either *Choeras* or *Sathon* with publicly available sequence data on the BOLD (not including the unrelated clade of Australian *Choeras* morphologically identified as having a small fore wing areolet). Number in brackets (n=x) represent the number of sequences in the collapsed clade. Genera identifications for the undescribed species are provided by BOLD and based on molecular data. Branch support values are posterior probabilities, with 100 represented by an asterisk.

Dolichogenidea Viereck, 1911

Dolichogenidea Viereck, 1911: 173 (as a subgenus of *Apanteles* Foerster s.l.); generic status by Mason 1981: 34. Austin and Dangerfield 1992: 27. See Fernández-Triana *et al.* (2020) for a checklist and comments on the world fauna.

Type species, by original designation, *Apanteles* (*Dolichogenidea*) *banksi* Viereck.

Comments. *Dolichogenidea* has recently had the Australian fauna reviewed (Fagan-Jeffries *et al.* 2018a, 2019), which raised the number of species described from the continent to 15, with many more potential species identified from *COI* barcoding data (Fagan-Jeffries *et al.* 2019, Figure 8).

Dolichogenidea franklinharbourensis Fagan-Jeffries & Austin sp. nov.

(Fig. 4)
urn:lsid:zoobank.org:act:01E75EAA-CC91-4A7D-B689-0E57C6C381B1

Material examined. Holotype: South Australia: ♀ Cowell Area School, -33.684293 136.917315, 16.iii–30.iii.2020, E. Fagan-Jeffries & Cowell Area School 4/5 class, 10 m, M/T, EFJ2020MT31, Extraction1039 (SAMA: 32-45152, BOLD: AUMIC548-20).

Paratype: South Australia: ♀ Andamooka Station, -30.8198802 137.1783585 to -30.6998403 137.1574435, R. Leijs, Vehicle net, Bush Blitz Lake Torrens, Extraction568 (SAMA 32-035788, BOLD: AUMIC360-18).

Diagnosis. This species is morphologically very similar to *D. kelleri* Fagan-Jeffries, 2019, but clearly distinct using both *COI* and *Wingless* DNA barcodes. In the specimens currently available, it can be differentiated by T3 with only sparse setae in the anterior half (*D. kelleri* with T3 regularly setate over whole length).

Of the Australasian species without sequence data, this species most closely resembles *D. miris*, and can be separated from it by T2 smooth and shining (T2 shallowly sculptured in *D. miris*) and by flagellomere 14 slightly longer (antennal flagellomere 14 length/width 1.6 – 1.7, whilst in *D. miris* flagellomere 14 length/width approximately 1.2).

Dolichogenidea franklinharbourensis can be separated from the remaining Australasian *Dolichogenidea* species in the following ways:

- From *D. biroi* (Szepligeti, 1905), *D. ilione* (Nixon, 1967), *D. lipsis* (Nixon, 1967), *D. tasmanica* (Cameron, 1912) by the absence of a white gena blotch.
- From *D. acratos* (Nixon, 1967), *D. brabyi* Fagan-Jeffries & Austin, 2019, *D. eucalypti* Austin & Allen, 1989, *D. expulsa* (Turner, 1918), *D. forrestae* Fagan-Jeffries & Austin, 2019, *D. garytaylori* Fagan-Jeffries & Austin, 2019, *D. hyposidrae* (Wilkinson, 1928), *D. orelia* (Nixon, 1967) by having ovipositor sheaths of similar length to the metatibia (all species listed here have ovipositor sheaths significantly shorter than metatibia).
- From *D. coequata* (Nixon, 1967), *D. cyamon* (Nixon, 1967), *D. finchi* Fagan-Jeffries & Austin, 2018a, *D. labaris* (Nixon, 1967), *D. mediocaudata* Fagan-Jeffries & Austin, 2018, *D. platyedrae* (Wilkinson, 1928), *D. xenomorph* Fagan-Jeffries & Austin, 2018a by having ovipositor sheaths of similar length to the metatibia (all species listed here have ovipositor sheaths significantly longer than metatibia).
- From *D. bonbonensis* Fagan-Jeffries & Austin, 2019, *D. lobesiae* Fagan-Jeffries & Austin, 2019 by having a clearly differentiated white patch on the proximal third of the pterostigma.
- From *D. agonoxenae* (Fullaway, 1941), *D. carposinae* (Wilkinson, 1938), *D. gentilis* (Nixon, 1967), *D. heterusiae* (Wilkinson, 1928) by having T2 completely smooth.
- From *D. hyblaeae* (Wilkinson, 1928), *D. inquisitor* (Wilkinson, 1928), *D. iulis* (Nixon, 1967), *D. stantoni* (Ashmead, 1904) by the absence of a complete areola in the anterior half of the propodeum.
- *D. upoluensis* (Fullaway, 1941), reared from a leaf-mining caterpillar on *Ficus* in Samoa, was described from a single male specimen, which was unable to be examined. Despite being unable to examine the holotype, we feel that *D. upoluensis* is highly unlikely to be the same species as that described here. Fullaway's character, the "first tergite…a little wider at apex than at base, the sides then hardly parallel though straight" (Fullaway, 1941) could possibly be used to differentiate the species, as *D. franklinharbourensis* has T1 parallel sided.

Description. FEMALE. Colour. Head, antenna and mesosoma all dark; all tergites and most of metasoma dark, non sclerotised areas of T1–2 and anterior sternites dark (but paler than sclerotised areas of dorsal tergites); hypopygium dark laterally and mostly dark ventrally, ovipositor sheaths dark; (fore-, mid-, hind coxa) dark, dark, dark; (fore-, mid-, hind- trochanter) all transitioning from dark to pale; femora (fore-, mid-, hind femur) mostly pale (in paratype, missing in holotype), pale with dark line along length, mostly dark with pale area at proximal end; tibiae (fore-, mid-, hind tibia) mostly pale (in paratype, missing in holotype), pale, pale transitioning to dark distally; hind

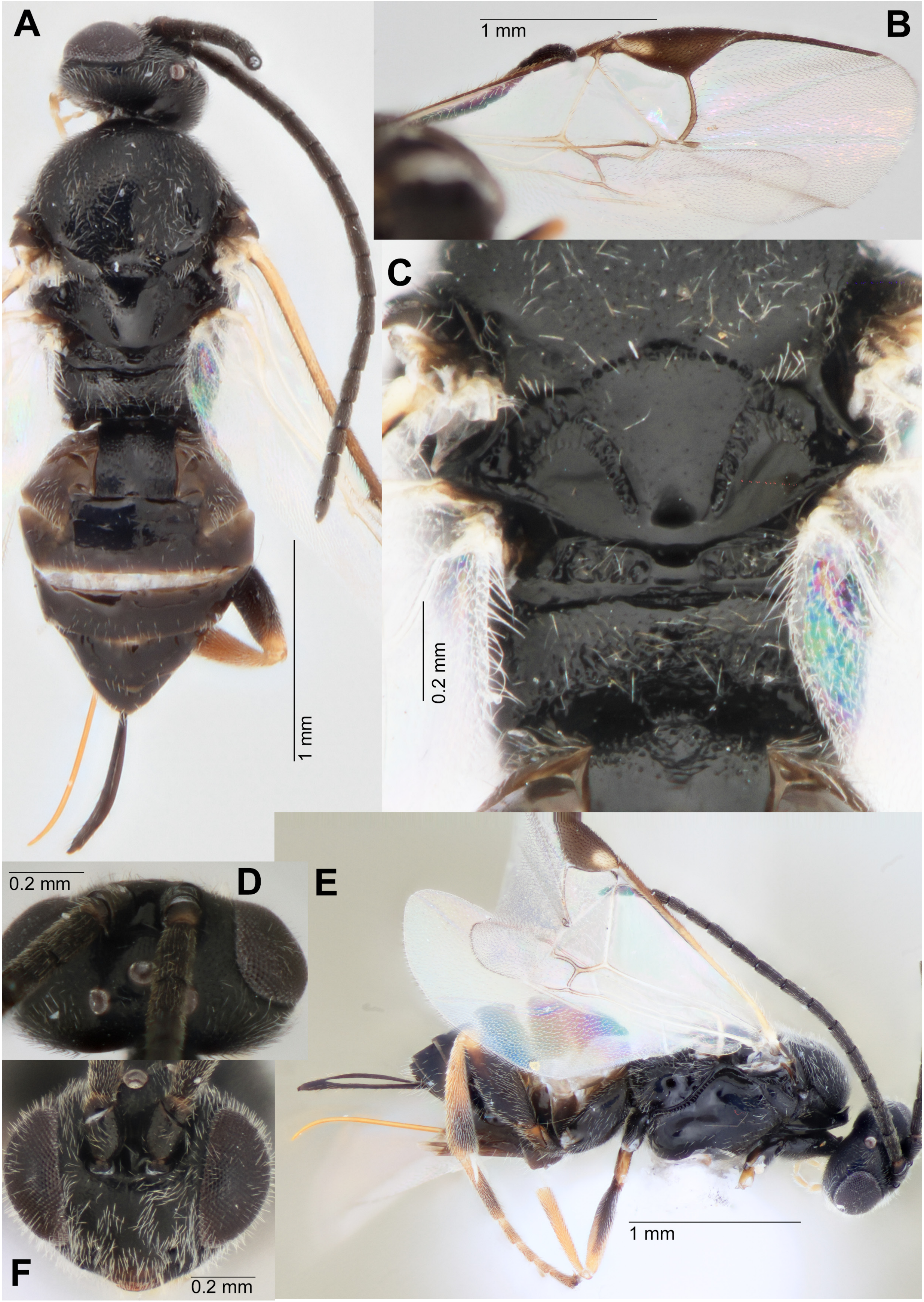

FIGURE 4. *Dolichogenidea franklinharbourensis* holotype **A)** Dorsal habitus **B)** Fore wing **C)** Dorsal mesosoma **D)** Dorsal head **E)** Lateral habitus **F)** Anterior head.

tarsi light brown, all paler proximally than distally; tegula and humeral complex dark; pterostigma dark with small pale patch proximally; fore wing veins dark.

Body length. Head to apex of metasoma: 2.8 mm.

Head. Antenna approximately equal to body length; OOL/POD 1.9 (2.2); POL/ POD 2.7 (2.5); antennal flagellomere 2 length/width 2.7 (2.5); antennal flagellomere 14 length/width 1.6 (1.7).

Mesosoma. Anteromesoscutum relatively smooth and shiny, shallowly and regularly punctate; number of pits in scutoscutellar sulcus 12 (13); scutellar disc very smooth and shiny, with only shallow pits associated with setae; maximum height of mesoscutellum lunules/maximum height of lateral face of mesoscutellum 0.6. Propodeal areola clearly differentiated in posterior half of propodeum, with lateral carina clearly visible. In anterior half, areola only differentiated by denser sculpturing than surrounding area. Rest of propodeum mostly smooth and shiny with scattered punctures concentrated in the anterior third.

Wings. Fore wing length 3.0 mm; length of veins r/2RS 1.3; length of veins 2RS/2M 1.4; length of veins 2M/(RS+M)b 1.1; pterostigma length/width 2.8 (2.4).

Legs. Hind tibia inner spur length/hind basitarsus length 0.4.

Metasoma. T1 length / T1 width at posterior margin 1.1; parallel sided, reticulate rugose sculpturing in posterior half with some areas verging on strigose, smooth area in posterior centre, T2 width at posterior margin / T2 length 3.8 (4.2), short and wide with curved lateral sides, very smooth, border with T3 very subtle, only very shallowly indented; T3 sculpture smooth and shiny with scattered setae concentrated in lateral posterior corners; ovipositor sheaths length/hind tibial length 1.1; ovipositor sharply angled approximately 45 degrees below the horizontal in the posterior third.

MALE. Unknown.

Etymology. This species is named by the 2020 Year 4/5 class of students of Cowell Area School, after the collection locality of the type specimen and the district where the school is located. The species epithet is an adjective.

Distribution. This species is only known from South Australia, from one locality on the Eyre Peninsula and one locality in the central arid regions near Lake Torrens.

Host. Unknown.

Molecular information. *Dolichogenidea franklinharbourensis* forms BIN BOLD:ADL4429 and is 5.31% divergent from the nearest relative on BOLD.

Glyptapanteles Ashmead, 1904

Glyptapanteles Ashmead 1904b: 147. For notes on the Australasian fauna see Austin & Dangerfield (1992) and for a checklist of the world fauna see Fernández-Triana *et al.* (2020).

Type species, by monotypy, *Apanteles ashmeadi* Wilkinson, 1928: 84, a replacement name for *Glyptapanteles manilae* Ashmead, 1904a.

Comments. The description of a new species of *Glyptapanteles* will raise the number of species described from Australia from two to three, and this precedes a comprehensive revision of the genus, currently underway, which is expected to include at least 30 species.

Glyptapanteles drioplanetus Fagan-Jeffries & Austin sp. nov.

(Fig. 5)
urn:lsid:zoobank.org:act:A33DD298-01DD-47EC-AFFA-AF369D00B898

Material examined. Holotype: South Australia: ♀ Macclesfield Primary School, Bush Block, -35.17084 138.84025, 14.x.2019 – 6.xi.2019, E. Fagan-Jeffries & Macclesfield PS yr 5–7 class, M/T, EFJ2020MT9, Extraction1033 (SAMA: 32-45153, BOLD: AUMIC549-20).

Paratypes: South Australia: ♀ Douglas Scrub, -35.18438 138.59952, 27–28.ix.2010, GS Taylor, S. Mantel M/T, 2010 001, Extraction79 (SAMA:32-45154, BOLD: AUMIC507-18). **Western Australia:** ♀ Gleneagle State Forest, 29/xi/2005, M.S. Harvey, M/T, Extraction117 (WAM: WAME10965, BOLD: AUMIC019-18).

Diagnosis. This species can be separated from the currently described species of *Glyptapanteles* from Australasia in the following ways:

- From *G. afiamaluanus* (Fullaway, 1941), from Samoa, by the absence of a medial carina on the propodeum.
- *G. artonae* (Rohwer, 1926) probably does not occur in the Australasian region (Austin & Dangerfield 1992), but *G. drioplanetus* can be separated from *G. artonae* by having T1 considerably more narrow.
- *G. aucklandensis* (Cameron, 1909) was described from a single male from Auckland, NZ, and the type is missing the abdomen. The type is therefore not particularly helpful in providing diagnostic characters, however we feel comfortable determining that it is a different species to *G. drioplanetus* as there is generally very little overlap in the microgastrine fauna between Australian and New Zealand.
- From *G. deliasa* (Austin & Dangerfield, 1992), from Australia, by the absence of a faint medial carina or striation on the propodeum.
- From *G. demeter* (Wilkinson, 1934), from New Zealand, by having the mesosoma not dorsally-ventrally flattened.
- From *G. fullawayi* Austin & Dangerfield, 1992, from Samoa, by having approximately 9–10 small pits in the scutoscutellar sulcus.
- From *G. mnesampela* Austin, 2000, from Australia, by having T2 dark and the absence of a white gena spot.
- *G. phytometrae* (Wilkinson, 1928). Whilst we were unable to examine the type, as this species is only recorded from Samoa, Sumatra and Fiji, we feel it is extremely unlikely to be the same species.
- From *G. operculinae* (Fullaway, 1941), from Samoa, by having T1 narrowing posteriorly less significantly, not strongly wedge-shaped.
- *G. taylori* (Wilkinson, 1928) probably does not occur in the Australasian region (Austin & Dangerfield 1992), but *G. drioplanetus* can be separated by having T2 triangular, with straight rather than curved lateral sides.

Description. FEMALE. Colour. Head, antenna and mesosoma all dark; all tergites and most of metasoma including hypopygium and ovipositor sheaths dark, non sclerotised areas of T1–2 and anterior sternites pale; (fore-, mid-, hind coxa) pale, pale, dark; (fore-, mid-, hind- trochanter) pale, pale, pale with darker area distally femora (fore-, mid-, hind femur) pale, pale, pale transitioning to dark distally; tibiae (fore-, mid-, hind tibia) pale, pale darkening slightly distally, pale darkening significantly distally; tarsi (fore-, mid-, hind tarsi) light brown, light brown, dark; tegula and humeral complex pale; pterostigma uniformly dark; fore wing veins mostly dark.

Body length. Head to apex of metasoma: 2.3 mm (2.4–2.8 mm).

Head. Antenna approximately equal to body length; OOL/POD 1.4 (2.0); POL/ POD 2.2 (2.3); antennal flagellomere 2 length/width 2.8 (3.5–3.7); antennal flagellomere 14 length/width 1.6 (2.4).

Mesosoma. Anteromesoscutum relatively smooth and shiny, very shallowly, and regularly punctate; number of pits in scutoscutellar sulcus approximately 11, but very irregular in size and definition. Scutellar disc very smooth, with only very shallow pits. Propodeum extremely smooth, no discernible sculpturing or carinae other than very shallow pits associated with scattered setae.

Wings. Fore wing length 2.4 mm (2.3–2.9 mm); length of veins r/2RS 1.4 (1.1–1.4); length of veins 2RS/2M 1.3 (1.0–1.5); length of veins 2M/(RS+M)b 0.9 (1.1–1.5); pterostigma length/width 2.4 (2.3–2.5).

Legs. Hind tibia inner spur length/hind basitarsus length 0.6 (0.4–0.5).

Metasoma. T1 length / T1 width at posterior margin 3.0 (2.4–2.9); narrowing slightly posteriorly (in Douglass Scrub paratype nearly parallel sided) irregularly punctate in posterior half; T2 width at posterior margin / T2 length 1.7 (1.6), subtriangular, smooth in centre, border with T3 shallowly crenulate; T3 sculpture smooth and shiny with scattered setae concentrated in posterior half; ovipositor sheaths length/hind tibial length 0.16 (0.3–0.18); ovipositor gently curved.

MALE. Unknown.

Etymology. This species is named by the 2020 Year 5/6/7 students of Macclesfield Primary School, who agreed upon a name that means ‘bush wanderer’; *drio-* from the Greek ‘drios’ for copse or thicket, and *planetus* from the Greek verb ‘planao’: to wander. The species epithet is an adjective.

Distribution. This species is currently only known from two sites in South Australia, and from a single locality in south-western WA.

Host. Unknown.

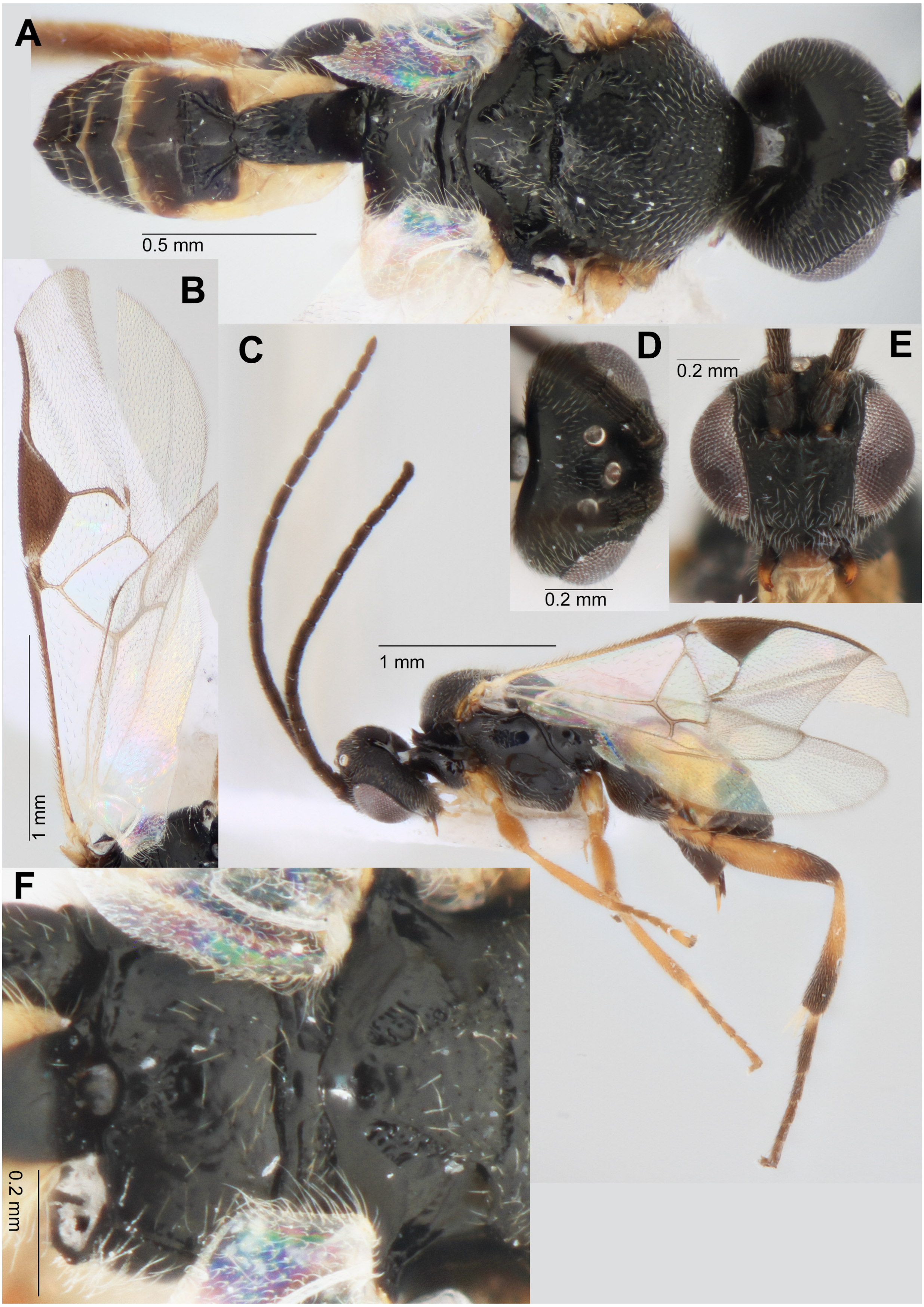

FIGURE 5. *Glyptapanteles drioplanetus* holotype **A)** Dorsal habitus **B)** Fore wing **C)** Lateral habitus **D)** Dorsal head **E)** Anterior head **F)** Scutellar disk and propodeum.

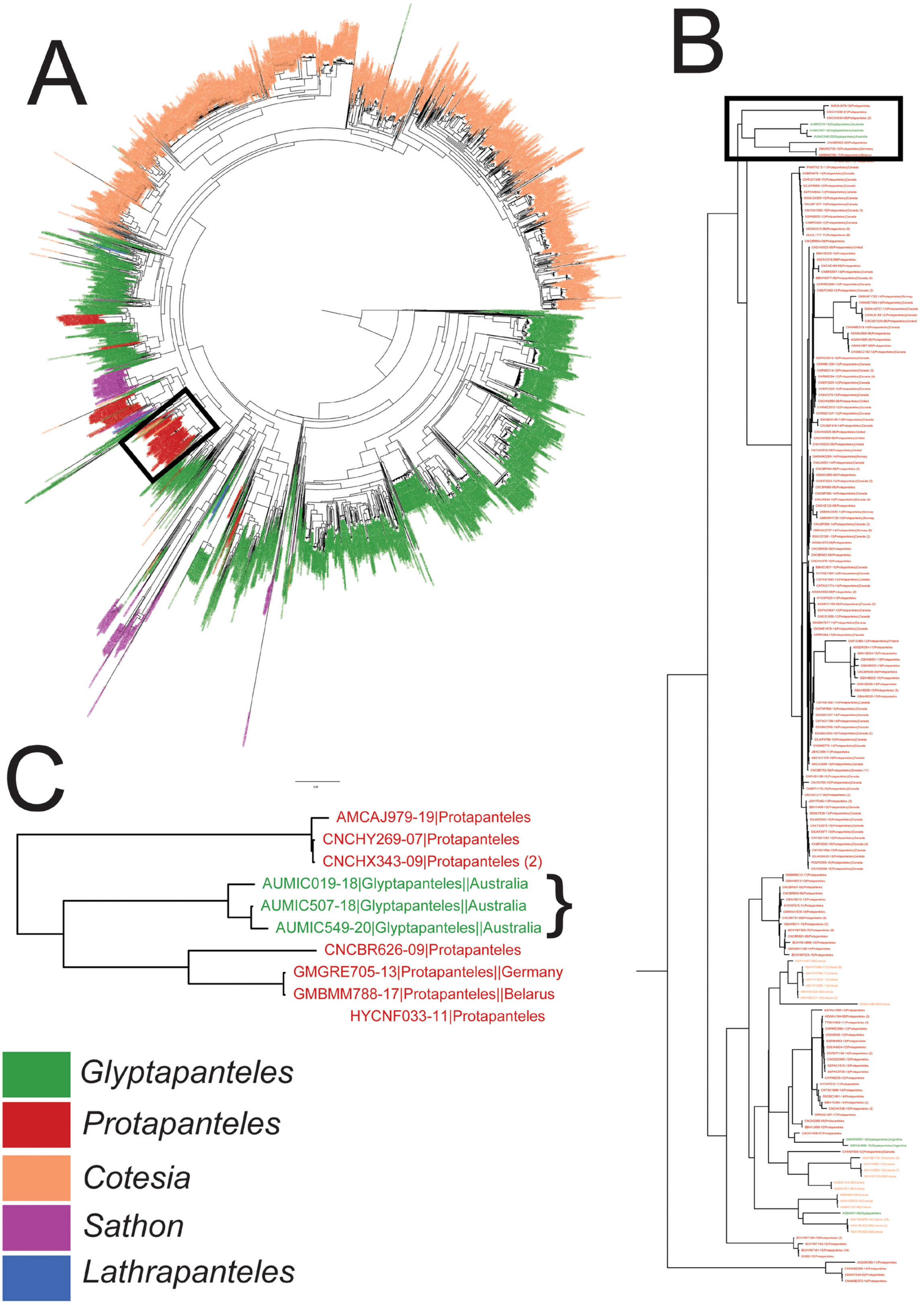

FIGURE 6. FastTree analysis of *COI* gene fragments showing the relationship of *G. drioplanetus* to the genera *Glyptapanteles*, *Protapanteles*, *Cotesia*, *Sathon* and *Lathrapanteles* available on the BOLD. **A)** Complete phylogeny, with the clade enlarged in **B** shown in a black rectangle. **B)** Clade containing *G. drioplanetus*, with the clade enlarged in **C** shown in a black rectangle. **C)** *G. drioplanetus* (indicated with a bracket) and the most closely related *COI* sequences, which are identified by the BOLD as the genus *Protapanteles*.

Molecular information. This species constitutes the BIN BOLD:ADL3660, and is 2.66% divergent from the nearest neighbour on the BOLD.

Remarks. This species, when analysed alongside all available *COI* sequences of *Glyptapanteles*, *Protapanteles*, *Sathon* (Mason 1981)*, Lathrapanteles* and *Cotesia* on BOLD, is closely related to species of *Protapanteles,* including *P. alaskensis* Ashmead, 1902 (Fig. 6). The morphological distinction between *Glyptapanteles* and *Protapanteles* appears to be difficult to define. According to Fernández-Triana *et al.* (2020), "In *Glyptapanteles*, T1 is either parallel-sided anteriorly and then strongly narrowing posteriorly, or its sides are gradually to strongly converging posteriorly when compared to *Protapanteles* which has T1 parallel-sided throughout, except for a strongly rounded apex, and propodeum sculpture that is usually, but not always, more rugose and carinated than in *Glyptapanteles*." However, several species of *Glyptapanteles*, including the paratypes of *G. drioplanetus*, have T1 of similar shape to that of *Protapanteles*, and many of the undescribed *Glyptapanteles* in Australia have a rugose propodeum. As *Protapanteles* is currently not documented from Australia, and is mostly confined to the Holarctic region (Fernández-Triana *et al.* 2020), we place *G. drioplanetus* in *Glyptapanteles,* but note that it is likely closely aligned with several species of *Protapanteles* and may need to be reclassified when a better understanding of the generic boundaries for the Microgastrinae is developed.

Miropotes Nixon, 1965

Miropotes Nixon, 1965: 200; see Austin (1990) for a revision of the Australian fauna, Fernández-Triana *et al.* (2014a) for the first description of species outside Australia, and Fernández-Triana *et al.* (2020) for a checklist of the world fauna.
Type species, by original designation, *Miropotes creon* Nixon, 1965.

Comments. The Australian fauna of the genus *Miropotes* was revised for Australia by Austin (1990), and the genus was originally thought to be endemic to the continent. Fernández-Triana *et al.* (2014a) described the first species from outside Australia, raising the number of described species to 13 for Australasia, with the genus also known from the Oriental (one species) and Afrotropical regions (one species).

Miropotes waikerieyeties Fagan-Jeffries & Austin sp. nov.

(Figs. 7-8)

Material examined. Holotype: South Australia: ♀ Hart Lagoon, Waikerie, -34.171389 139.963611, 23.iv-12.v.2020, E. Fagan-Jeffries & Waikerie PS YETies, M/T, EFJ2020MT37, Extraction1044 (SAMA: 32-45155, BOLD: AUMIC552-20).

Paratypes: Australian Capital Territory: ♂ Namadgi NP, Nursery Swamp Track, -35.6575 148.9577, Nov 29–Dec 9 2018, Evangelista & Rodriguez, 1049m, Bush Blitz BB-JR-013, M/T, Extraction899, (ANIC: 32 130301, BOLD: AUMIC554-20) **Queensland:** ♀ Samsonvale Cemetery, -27.2703 152.856, 22.x-13.xi.2014, S. Wright, M/T in Casuarina/open forest 8.5km SSE Dayboro, Extraction204 (QM: T208411, BOLD: AUMIC089-18). ♂ data as holotype but dates 13–27.v.2020, EFJ2020MT39, Extraction 1171 (SAMA: 32-45156, BOLD: AUMIC553-20).

Diagnosis. *Miropotes waikerieyeties* strongly resembles *M. burringbaris* Austin, 1990, and keys to that species in Fernández-Triana *et al.* (2014a), but can be distinguished from it both on molecular data (*COI* barcode > 10% divergent) and by the carina running from the anterior point of the pentagonal propodeal areola to the anterior edge of the propodeum being significantly shorter, i.e. the pentagonal areola covering a larger proportion of the length of the propodeum (Fig. 8).

Description. FEMALE. Colour. Head dark with white gena spot at posterior-ventral corner of eye, antenna and mesosoma all dark; all tergites and most of metasoma including hypopygium and ovipositor sheaths dark, non sclerotised areas of T1–2 and anterior sternites white; (fore-, mid-, hind coxa) pale, pale, dark; (fore-, mid-, hind-trochanter) all pale; femora (fore-, mid-, hind femur) pale/light brown, light brown, mostly dark; tibiae (fore-, mid-, hind tibia) pale/light brown, light brown, light brown; tarsi (fore-, mid-, hind tarsi) all light brown; tegula and humeral complex pale; pterostigma uniformly dark; fore wing veins mostly dark.

Body length. Head to apex of metasoma: 2.75 mm (2.7 mm).

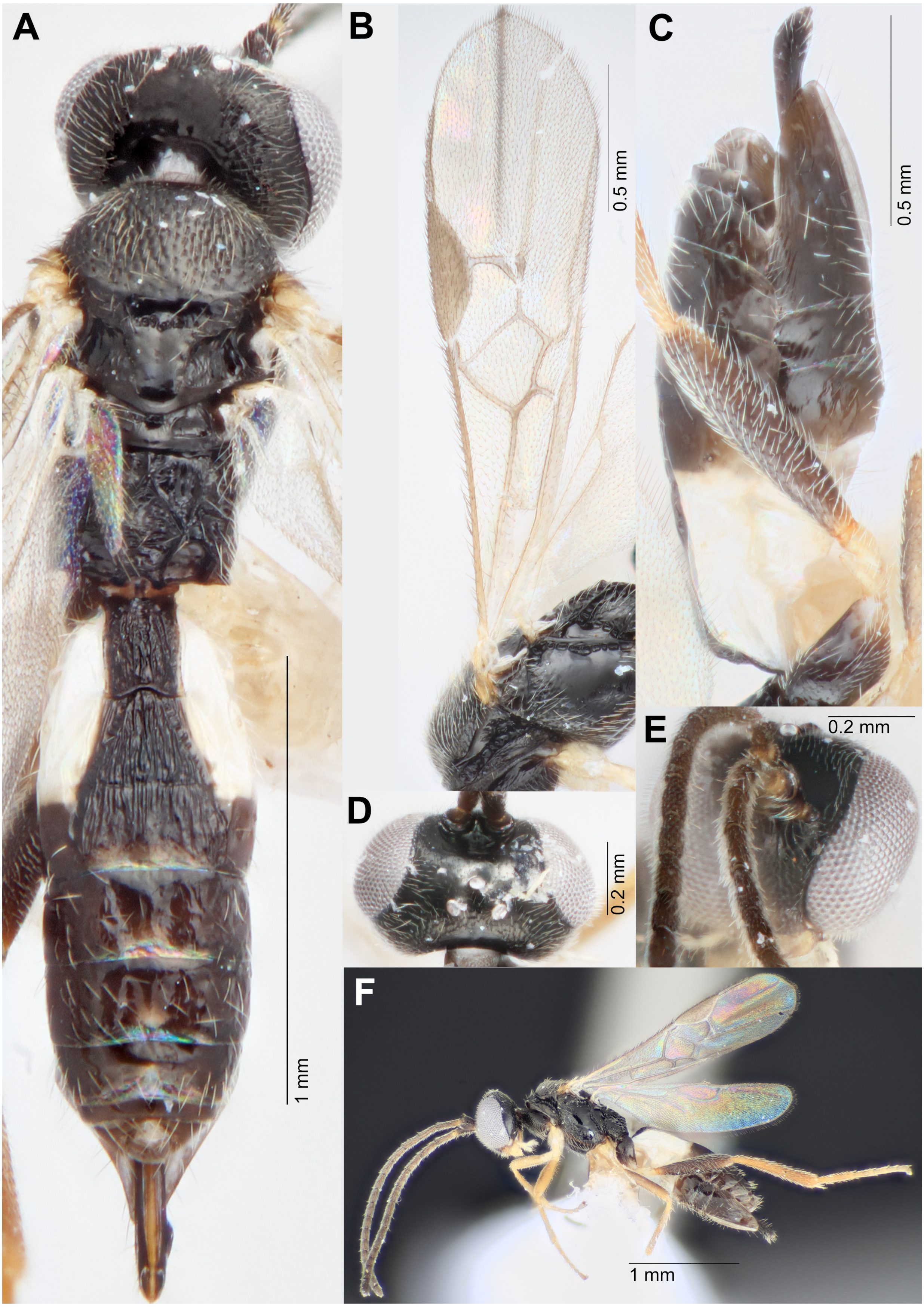

FIGURE 7. *Miropotes waikerieyeties* holotype **A)** Dorsal habitus **B)** Fore wing **C)** Lateral metasoma **D)** Dorsal head **E)** Anterior head **F)** Lateral habitus.

Head. Antenna slightly shorter than body length; OOL/POD 2.6 (2.7); POL/ POD 1.8 (1.8); antennal flagellomere 2 length/width 3.8 (4.0); antennal flagellomere 14 length/width 1.3 (1.3).

Mesosoma. Anteromesoscutum regularly punctate, clearly defined smooth and shiny spaces between large punctures; number of pits in scutoscutellar sulcus approximately 8, but irregular in size and definition and in holotype not in a straight line, the line of pits curved downwards at centre producing a smooth space above pits in centre of scutellar disk. Scutellar disc very smooth, with only very shallow pits associated with setae. Propodeum smooth, complete pentagonal areola, taller than it is wide (measuring from inside the areola carinae, anterior-posterior line (Fig. 8A.ii) 0.21 mm, transverse line (Fig. 8A.iii) 0.18 mm), with the carinae from the top of the pentagon to the anterior edge of the propodeum (Fig. 8A.i) measuring 0.04 mm, ratio of the length of that carina to the anterior-posterior line 0.19.

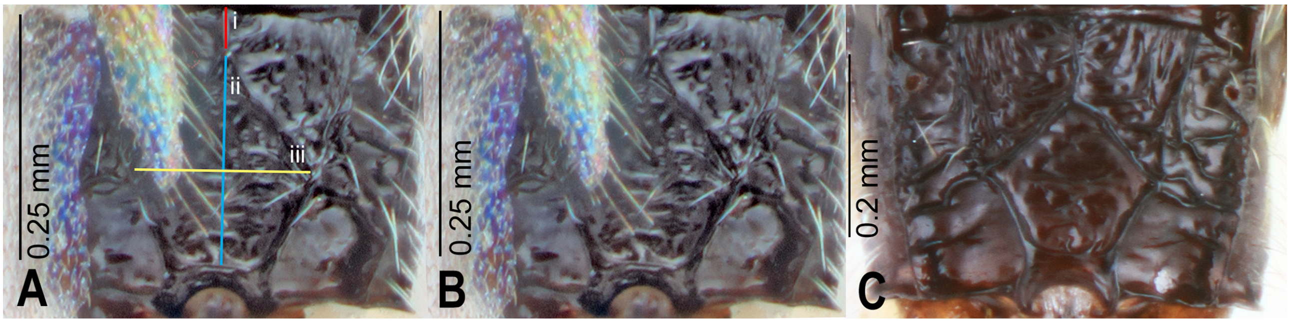

FIGURE 8. Comparison of the propodeal areola between the holotype of **A–B)** *Miropotes waikerieyeties* and **C)** a female paratype of *Miropotes burringbaris* from the holotype locality of Rex Range Lookout (QDPC 0-169243). **A)** The measurements used for the propodeal areola measurements in the description and diagnosis of the new species: anterior-posterior line (ii, blue), transverse line (iii, yellow) and the carinae from the top of the pentagon to the anterior edge of the propodeum (i, red).

Wings. Fore wing length 2.14 mm (1.9 mm); fore wing areolet enclosed, moderately large (not reduced to slit) triangular in shape, length of veins r/2RS 1.2 (1.0); length of veins 2RS/2M 0.9 (0.9); length of veins 2M/(RS+M)b 1.0 (1.4); pterostigma length/width 3.4 (2.7).

Legs. Hind tibia inner spur length/hind basitarsus length 0.24 (0.34).

Metasoma. T1 length / T1 width at posterior margin 2.3 (2.0); relatively parallel-sided, strongly longitudinally strigose, irregularly rugose in areas; T2 width at posterior margin / T2 length 1.4 (1.3), subtriangular, strongly longitudinally strigose, border with T3 shallowly crenulate; T3 sculpture strongly longitudinally strigose; ovipositor sheaths length/hind tibial length 0.24; ovipositor sharply bent to nearly 90 degrees at tip, ovipositor sheaths broadening posteriorly so that they are clavate at tip.

MALE. As female, antennae longer than body, eyes smaller in proportion to head size.

Etymology. This species was named by the 2020 Year 6/7 class of students at Waikerie Primary School, who named it for the school and the Youth Environment Team (nicknamed ‘the YETies’) who led the project. The species epithet is a noun in apposition.

Distribution. The species as it is currently defined is found in the Riverland region of South Australia, near Canberra in the ACT, and south of Brisbane in Queensland. The actual distribution of the species may be more extensive.

Host. Unknown.

Molecular information. *Miropotes waikerieyeties* forms BOLD BIN: BOLD:ADL5296 and is 4.17% divergent from the nearest neighbour.

Remarks. *Miropotes waikerieyeties* strongly resembles *M. burringbaris,* and without molecular information we would have hesitated to describe it as a new species. Partial *COI* sequences (approximately 150 bp) of two paratypes of *M. burringbaris*, one from the holotype locality of Rex Range in northern Queensland (BOLD: AUMIC555-20, QDPC 0-169243) were sequenced, and when compared to the available sequences of Microgastrinae, the sequence of the paratype from the holotype locality was most closely related to a full length sequence of a specimen of *Miropotes* sp. from Kuranda, northern Queensland (BOLD: AUMIC335-18), differing by four base pairs. This 658 bp *COI* sequence (AUMIC335-18), is over 10% divergent from the *COI* sequences of the specimens of *Miropotes waikerieyeties* (Figure 9).

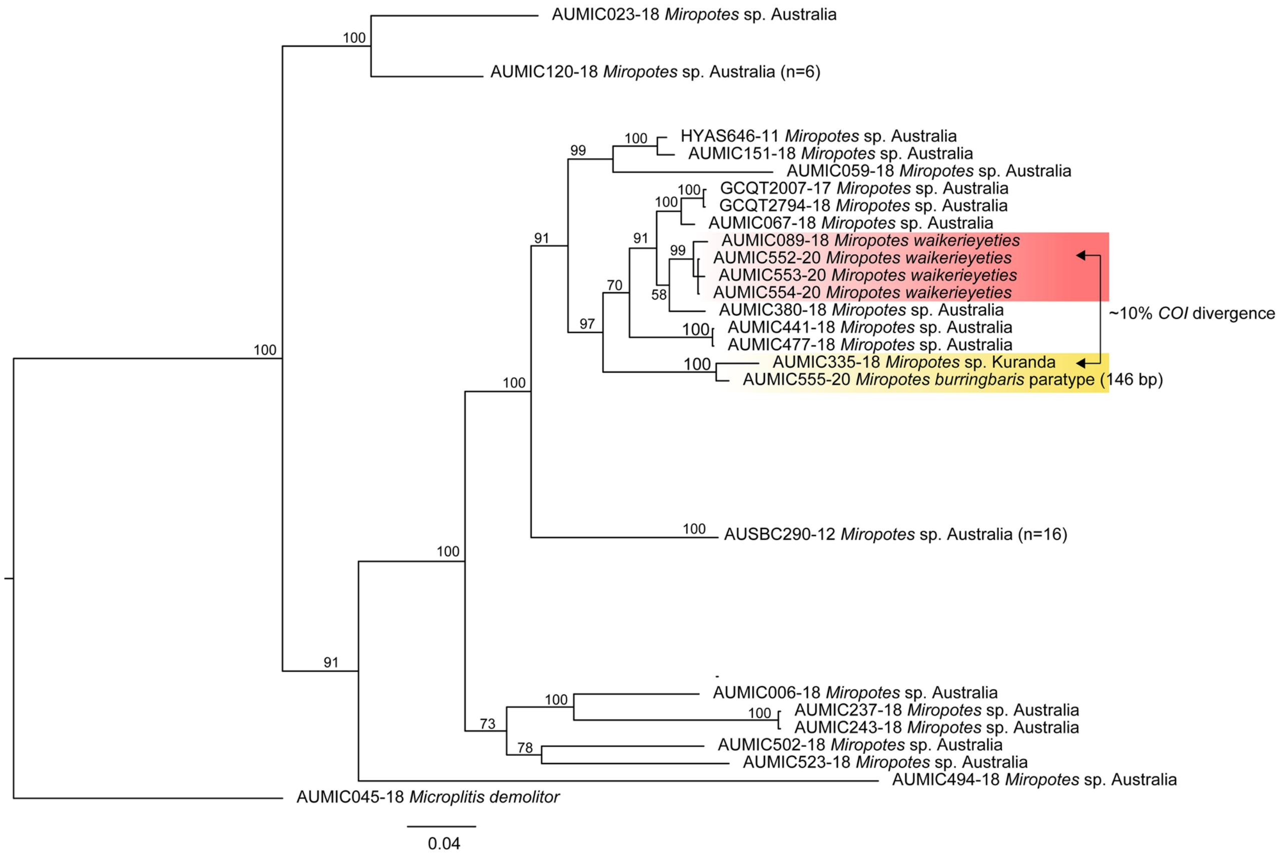

FIGURE 9. *COI* and Wingless Bayesian phylogeny of the Australian specimens identified by the BOLD as *Miropotes*, showing the relationship between *Miropotes waikerieyeties* (in red) and the partial sequence of the *M. burringbaris* paratype and closely related specimen from Kuranda (in yellow). Number in brackets (n=x) represent the number of sequences in the collapsed clade. Branch support values are posterior probabilities.

Whilst the partial *COI* sequences of the paratypes of *M. burringbaris* contain several ambiguities, they are clearly distinct from the sequences of *M. waikerieyeties* (9 base pairs different). This relatively large divergence, even over just 150 bp, along with the consistent morphological character (at least on the available specimens) of the propodeal areola proportions, allow us to feel confident that *M. waikerieyeties* is a distinct species from *M. burringbaris*. The propodeal areola was measured on images of the holotype of *M. burringbaris* from the original description (Austin 1990) and on two female specimens from the holotype locality (QDPC 0-169243 and 0-169244).

Evaluation of the citizen science project: survey of students. Students were asked whether their views on wildlife and science had changed over the course of the program. Of the students who responded and had consent to participate in the study (n=32), 66% stated that their interest in insects had increased, 84% indicated that their knowledge about insects in the local area had increased, whilst 59% felt their desire to protect their environment had increased (Fig. 10). Over half the students felt their connection to nature increased during that time period, whilst 41% stated that their interest in pursuing a career in science had increased. Interestingly, 15.6% of students stated their interest in pursuing a career in science had decreased during that time.

Some of the comments from students about their favourite part of the program included (spelling and grammar corrected for clarity): “that we got to name a bug”, “finding out about the new wasp”, “us checking the trap”, “finding a new species” and “learning about the funny [species] names and cool facts”. As the feedback survey was conducted immediately after a workshop that included lollies (candy/sweets) as part of a classification activity, several students also responded that the lollies were their favourite part of the whole program. This highlights that the timing of feedback surveys can have a significant impact on the responses, and it needs to be carefully considered when evaluating programs. The word cloud of these responses (n=27) suggests that students really appreciated the fact they were finding ‘new’ wasp species (Fig. 11).

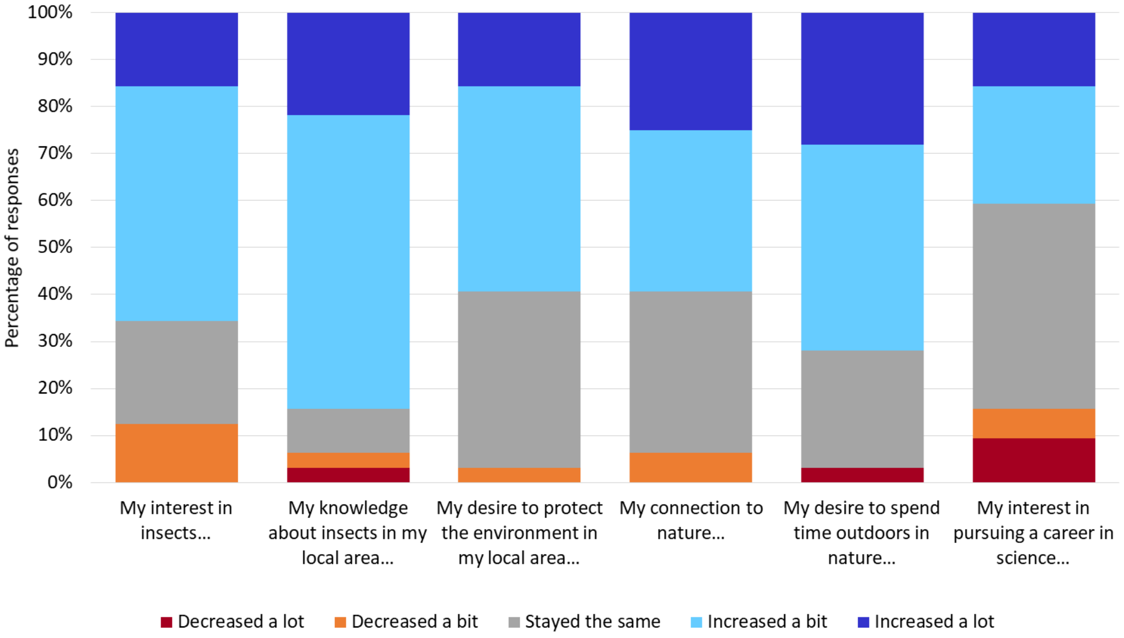

FIGURE 10. Student responses (n=32) to the Likert-scale question: "Over the past two months or so, did your views of wildlife and science change in any of the following ways? If so, how?"

FIGURE 11. Word cloud of the written responses (n=27) to the question "What was your favourite part of the Insect Investigators program". The size of the words is relative to the number of times that word appeared in the responses; the largest word, 'new' appeared 10 times, whilst the smallest words appeared once.

Students listed many comments under the question "What is something you learnt from the *Insect Investigators* project?", including several which highlight that despite the difficulty in quantitatively evaluating the impacts of the program, students had clearly absorbed information and new knowledge. Comments included (spelling and grammar corrected for clarity): "that not all wasps sting", "lots of bugs live in Cowell, they're just really small", "that new [species] can come [from] anywhere", "that there are lots of unnamed bugs", "that there are rules about naming insects", "some [wasps] lay eggs in butterflies" and "that there are tiny, tiny wasps as well".

Discussion

With a mission to describe all of Australia's remaining biodiversity with increased efficiency, the taxonomic community will need to decide how to prioritise the order in which species are formally documented and named, and how the wider community will be a part of this process. The most biodiverse groups of organisms, which are also generally the groups with the largest proportion of unnamed species, are typically organisms that do not catch the general public's attention; namely groups like protists, nematodes, fungi, arachnids, flatworms and insects (Taxonomy Decadal Plan Working Group 2018). *Insect Investigators* is a project that brings taxonomy directly into communities by involving school students in the collection and naming of new species, and which then prioritises the formal description of these species. Whilst the four new species described here are, perhaps, an almost insignificant proportion of the undescribed diversity of the Microgastrinae, let alone of Australia's undescribed wasp species more broadly, they serve a purpose greater than their simple description. The species described here represent new bonds between communities and the process of taxonomy, and between communities and an organism which does not generally attract significant emotional connection: a parasitic wasp.

The involvement of the community in deciding the names of new species is not a new concept in Australia; in 2016 ABC Radio National held a competition in conjunction with the Western Australian Museum to name a new species of nudibranch which attracted thousands of entries (ABC Radio National 2016), whilst a new species of rainforest plant, *Tecomanthe burungu* Zich & A.J. Ford was named in consultation with Traditional Owners of the land, and is a name for the place where one of the populations is found (Zich & Ford 2018). Whilst involving non-taxonomists in both the collection *and* the naming of a species can be time-consuming and less efficient than more broad-stroke methods of species discovery, if utilised selectively it could create an opportunity for people to feel an involvement in the process, and by consequence, the organism and habitat in question.

The *Insect Investigators* pilot project presented here allowed for the testing of a survey design to attempt to quantify impacts of the program on participants, and generally highlighted that trialling question design is inherently important. Future renditions of the project will need to include surveys that are shorter, with more targeted and accessible questions for primary school children, and a more carefully planned timing of delivery. However, despite the flaws in the evaluation, the comments from students clearly indicate that a large proportion of students felt the program had an impact on them in one way or another, and the diversity of 'favourite parts' and 'new things learnt' from the project exhibit the large range of reactions to being involved in this taxonomy-themed citizen science project.

Insect Investigators was a trial project that operated on a small scale, with a very modest budget and staffing, but it is a project that could be scaled up considerably. If the samples sent in by schools were concurrently used by many active insect taxonomists at a time, specimens of new species from broader taxonomic groups would be more quickly identified, and schools would be more likely to be involved in the naming of a new species. Whilst all four schools involved in this iteration of the project had a positive experience with discovering new species, tempering expectations and the inherent disappointment of participants if no new species are found in their collection samples will be an important aspect to consider in future projects. A negative experience of participants caused by disappointment could have adverse effects on their opinion of taxonomy and biodiversity, and it will be important to highlight the goals and outcomes of *documenting*, rather than just *discovering* species in any future iterations of the project.

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