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Taxonomic and molecular phylogeny of New Zealand Brachyglutini (Coleoptera: Staphylinidae: Pselaphinae)

Jiawei Shen

A thesis submitted in fulfilment of the requirements for the degree of Doctor of Philosophy in Biological Sciences, the University of Auckland, 2019.
ABSTRACT

The rove beetle tribe Brachyglutini is the only tribe of Goniaceritae (Pselaphinae) present in New Zealand. The tribe comprises eight genera, of which half are endemic to New Zealand. Despite the high endemism at the generic level, the group is depauperate at the species level. This dissertation is a taxonomic study of the New Zealand Brachyglutini, with a focus on revising *Eupines* King, the most speciose genus. Both morphological and molecular approaches are applied in this study in order to gain a better understanding of their biodiversity and classification.

To achieve this goal, I examined the type series of all described species from New Zealand. Based on this a catalogue and type designations were made for all 61 known species, with 17 holotypes confirmed, 38 lectotypes and 99 paralectotypes designated. I loaned pinned and ethanol specimens from various collections and conducted three collecting trips to native forests across New Zealand. Based on examination of all available material, three genera, *Eupines*, *Anabaxis* Raffray and *Simkinion* Park and Pearce, were revised at the species level, with 27 new species described, 26 known species redescribed, 12 names synonymised, and four new combinations proposed.

During the revision of *Anabaxis*, the wide-spread species *A. foveolata* (Broun) was found to exhibit an unusual form of clinal variation in characters of the male legs. Variability of the male secondary characters and their association with latitude was analyzed statistically. The linear regression models showed that the clinal variation of the two male secondary characters is bi-directional, with the length of the tibial spine increasing with increasing latitude and the length of the mesotrochanteral spine decreasing with increasing latitude.

In previous studies, members of *Simkinion* were reported to be bryophyte specialists because all specimens were collected from moss. I sorted through all available collection
material and conducted targeted sifting of moss from multiple localities in the Northland, Gisborne and Rangitikei. The resulting data from Simkinion is unique amongst other brachyglutine genera with regard to their Northland restricted distribution and specialised microhabitats. Their natural history and the functions of the male sexual characters are discussed.

The phylogenetic relationship of New Zealand brachyglutine genera and two subgenera of Eupines were reconstructed, including representatives from Australia and New Caledonia. Bayesian and Maximum likelihood approaches were applied to combined DNA sequence data from the COI and 28S genes, obtained from 73 species. Eupines was recovered as monophyletic and I described a new genus, Pseudeupines gen. n. However, the two subgenera of Eupines were recovered as non-monophyletic. The monophyly of the other brachyglutine genera of New Zealand were also tested and are discussed, as well as two additional synonyms proposed.
ACKNOWLEDGEMENTS

If I must pick up two things that I will never regret in my life, the first thing is my birth, and the second thing is the decision to plunge into the wonderland of New Zealand when my supervisors, Richard Leschen and Thomas Buckley, said “You are absolutely welcome to work on beetles here”.

In the past three years, numerous people have showed their generosity through my doctorate. In the first place, I would like to give big thanks to my two supervisors Rich and Thomas for their infinite guidance on my research and life. Rich at no time being impatient teaching me taxonomy of beetles and helping me grow as an entomologist. I learned and enjoyed heaps on molecular phylogenetics under Thomas’ unconditional guidance, who also carefully reviewed all chapters. They offered me great knowledge not only in science, but also in life, which helped me fit into the society of New Zealand.

In my journey of Pselaphinae systematics, I owe heaps to two remarkable scientists, Donald Chandler and Christopher Carlton, who provided me with substantial knowledge of pselaphine from faunae out of New Zealand and continually reminded me to come back to what’s important in terms of taxonomy. I deeply appreciate Don’s effort on reviewing the Chapter 2, which at first gave him a headache. I am also extremely grateful to a Korean student Yeon-Jae Choi who intensively worked for two weeks on the photography, label data input and images editing in Chapter 5.

The backbone that props up this study is all the type material I examined and loaned from various museums and institutions. I must thank the following curators, collection managers and technicians for their assistance in locating types: Max Barclay, Michael Geiser and Beulah Garner (BMNH), Crystal Maier (FMNH), Catriona McPhee (MVMA), Derek Smith (AMS), Azadeh Taghavian (MNHN), Mandy Schröter (SDEI), Chris Reid and Russell
Cox (Australian Museum, Sydney). Special thanks to Keita Matsumoto (BMNH) who helped to take photos of the Broun types and to sort the access to the museum over the weekend. Without the world checklist of the Brachyglutini species from Alfred Newton (FMNH), this work would have been stranded in the first place. I owe him a huge thank you for providing a starting point to my work.

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The field trips I have done were enjoyable and fulfilled by the company of many colleagues and my supervisor Rich Leschen. I owe a great deal to Rich, Takahiro Yoshida, Naoki Ogawa, Takashi Higurashi, Vít Sýkora, Katharine Marske and Liang Tang, and especially Vit who took great efforts to apply for the permit to collect in Northland. I also appreciate the efforts for field preparation work from Chris Winks and Zane McGrath and their continuous care for my health and safety during field trips.

I must thank Talia Brav-Cubitt for her instruction on sequencing in the Ecogene lab and continually going out of her way to help me for nearly three months. It was such a big commitment for her to put up with an amateur like me, yet she never complained and was always willing to give me a hand. I am also in debt to the lab technicians Duckchul Park, Robyn Howitt, Hester Roberts for their help.

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Finally, millions of sincere thanks to my Mum who encourages me to pursue my interests. I cannot imagine finishing this thesis without the unconditional love and support from her. For so many weekends in the past three years with my close friends, their warm invitation for food, drinks and hangout will always be one of the best memories of my doctorate.
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### CO-AUTHORS

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<td>Richard Leschen</td>
<td>Assisted in loan of type material, discussion of nomenclature, manuscript editing.</td>
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| Chapter 3. Revision of Eupines King of New Zealand (Coleoptera: Staphylinidae: Pselaphinae: Goniaceritae) |

| Nature of contribution by PhD candidate | Type examination, collection of specimens, species descriptions, illustrations, photography, manuscript editing. |

| Extent of contribution by PhD candidate (%) | 95% |

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Chapter 4. Review and clinal variation of New Zealand Anabaxis Raffray (Coleoptera: Staphylinidae: Pselaphinae: Goniaceritae). Published in Zootaxa, 4382 (3), 531–552.

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Chapter 5. Revision of the genus Simkinion Park and Pearce (Coleoptera: Staphylinidae: Pselaphinae: Goniaceritae) from New Zealand.

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<td>Richard Leschen</td>
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<tr>
<td>Yeon-Jae Choi</td>
<td>80% species photography and image editing, initial label data input, measurement of all specimens.</td>
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**Chapter 6. Molecular Systematics of Eupines, a new genus and notes on New Zealand Brachyglutini (Coleoptera: Staphylinidae: Pselaphinae: Goniaceritae).**

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<td>Richard Leschen</td>
<td>Assisted in loan of material for DNA extraction, discussion of phylogenetic analyses, manuscript editing.</td>
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<tr>
<td>Thomas Buckley</td>
<td>Helped with training in DNA sequencing, Bayesian and Likelihood analyses, discussion of phlogenetic results, manuscript editing.</td>
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INTRODUCTION

1.1 General Taxonomy

Beetles (order Coleoptera) are the most diverse insect group in the world and constitutes about 25% of all extant animals on earth, with more than 420,000 named species (Ślipiński et al. 2011; Zhang et al. 2018). They inhabit virtually all kinds of terrestrial environments (Lawrence & Ślipiński 2013), and play a critical role in various ecosystems. Over centuries, taxonomists have divided this order into more than 211 valid families (Bouchard et al. 2011) due to their enormous morphological diversity. Staphylinidae is the most species-rich beetle family, accommodating more than 62,820 described species (Newton 2017). Among the 32 subfamilies of Staphylinidae (Leschen et al. 2003), the subfamily Pselaphinae occupies nearly one-sixth of the total taxa, with 40 tribes, 1259 genera and 10120 species have been recognised and classified in six supertribes (Newton & Thayer 1995; Chandler 2001; Yin et al. 2019).

Unlike other well-known beetle groups, members of Pselaphinae are often of least interest to entomologists and are often poorly curated in major collections. That is largely due to their small body size, usually 1–3 mm long, with an average of 2 mm and the largest reaching only 7 mm (Parker & Maruyama 2013). Despite their tiny size, pselaphine beetles have attracted several prolific taxonomists due to their striking body forms. The enormously diverged cuticular features such as the well-known foveature define many genera (Newton & Chandler 1989; Chandler 2001; Shen & Leschen 2018), and the male secondary modifications are often distinctive among pselaphine species. They can be easily recognised
from all the other staphylinids by the small, compact and brownish body, the distinctive antennal clubs in most members, the 3-3-3 or 2-2-2 tarsal formula and the body foveae. Due to their distinctive characteristics, this group was first treated at the family level, i.e. Pselaphidae. Though its taxonomic rank was questioned by many entomologists (e.g., Raffray 1908; Park 1942; Jeannel 1950; Naomi 1985) due to their typical staphylinid-form short elytra. Newton and Thayer (1995) formally reduced this group to subfamily rank based on a morphological phylogeny of the Omaliine Group (Fig. 1.1).

Pselaphines are generally predators of microarthropods, with prognathous mouthparts, strong mandibles and maxillary palpi (Schomann et al. 2008), but some species are also saprophagous (Thayer 2005). Some groups, especially members of the super tribe Clavigeritae, exhibit special body adaptions for co-existing with ants (Nomura & Leschen 2015; Parker 2016). Though pselaphines occur in various habitats like wetlands, grass clumps, beaches, mosses, caves and arboreal habitats, they inhabit mainly leaf litter and woody debris on the forest floor, and are most species-rich and abundant in tropics (Park 1964; Newton & Chandler 1989; Chandler 1990; Chandler 2001). Their predatory feeding habit and high species abundance in forest floor litter suggest that they are ecologically important in the terrestrial environment. This group is regarded as having great value to studies of ecology, speciation, evolution, behaviour, and biogeography (e.g., De Marzo 1985, 1986, 1988; Reichle 1967; Chandler 1987; Schomann et al. 2008; Parker 2014, 2016).

The tribe Brachyglutini is one of the most diverse pselaphine groups under the supertribe Goniaceritae, classified in four subtribes and 117 genera, with the majority of the genera recorded on landmasses of Gondwana origin (Parker 2016; Yin et al. 2019). Besides the genera-rich subtribe Brachyglutina Raffray with 105 genera, the remaining 12 genera are classified in three small subtribes, Baradina Park, Decarthrina Park, and Eupseniina Park, members of which are all restricted to the New World, with the highest species richness in
the Neotropics (Park 1951; Chandler 2001). Brachyglutine species generally have a globular and reddish-brown body and can be distinguished from other goniacerites mainly by the presence of the ocular-mandibular carinae and the ventrite 1 barely visible, in contrast to the large ventrite 2 (Chandler 2001). The time that this group diverged from other pselaphines is uncertain, but their modern body plan and characteristics were derived at least 99 million years in the mid-Cretaceous (Yin et al. 2019).

Figure 1.1. Phylogenetic tree of Pselaphinae supertribes (sensu Newton and Thayer 1995, with the inclusion of the former Bythinoplectitae within Euplectitae following Chandler 2001).
1.2 New Zealand Brachyglutini

Like many other beetle groups in New Zealand (Buckley et al. 2015), the Pselaphinae also displays faunistic disharmony. The diverse Batrisitae and the entirely inquilinous Clavigeritae are completely missing from the six supertribes within the subfamily (Klimaszewski et al. 1996; Nomura & Leschen 2006, 2015). Furthermore, of the 430 described species, the plesiomorphic supertribe Faronitae, which typically has lower relative diversity elsewhere, constitutes the majority of the pselaphine fauna, with 203 species recognised, nearly 55% of the world faronite diversity (Newton & Chandler 1989; Park & Carlton 2011, 2013, 2014a, 2014b, 2015a, 2015b, 2015c, 2015d, 2015e). Pselaphines are distributed across the whole of New Zealand, and even on the subantarctic Islands (e.g., Pselaphini were recorded in the Auckland Islands; Owens 2019), with the highest species diversity in Auckland and Coromandel regions (based on the type locality of known species).

Unlike the Australian fauna with four tribes under the supertribe Goniaceritae, Brachyglutini is the only tribe that is present in New Zealand. Eight genera are currently recognised within the tribe and all of them belong to the subtribe Brachyglutina by sharing the gular ridge (a median carina on the gular region) of head demarcated with a pair of lateral sulci (Kurbatov & Sabella 2015). The gular character is believed to be the apomorphy of the subtribe, though the ridge may not be conspicuous in the lateral view (e.g., Eupines King with narrow and slightly prominent gular ridge). Half of the genera: Anabaxis Raffray, Eupines, Eupinolus Oke and Startes Broun are shared with Australia, with Eupines also found in New Caledonia and East Asia. The remaining genera: Eupinogitus Broun, Gastrobothrus Broun, Physobryaxis Hetschko and Simkinion Park and Pearce are endemic to New Zealand. Despite the high endemism, the tribe is depauperate at the species level. Of the 62 described species, 48 of them are classified in Eupines, the remaining 14 species are described in the other seven genera including two monotypic genera.
Members of Brachyglutini are widely spread throughout New Zealand, from sea level to alpine areas, from mainland to offshore islands (e.g., the Chatham Islands). Like other pselaphines, they are most commonly found in moist leaf litter and woody debris on the forest floor. Members of one distinctive genus, Simkinion, are mostly collected in moss or moss-associated microhabitats and are all restricted to Northland (ND), and they are potential bryophyte specialists (Park & Pearce 1962). Three brachyglutine species were also reported inhabiting ant nests, yet their associations with ants maybe coincidental, since leaf litter beetles are very likely sharing habitats with ants (Nomura & Leschen 2015).

After David Sharp (1874) described the first six brachyglutine species of New Zealand, the tribe was then increased to 53 species mostly by the prolific beetle worker Thomas Broun who described 45 species from 1880 to 1923. Subsequent taxonomic work was very limited, with only Park and Pearce (1962) and Théry and Leschen (2013) adding one new genus with two species and five species, respectively. Kuschel (1990) recorded 13 brachyglutine species in his case study of the beetle diversity in New Zealand suburban environment. Nomura and Leschen (2006) presented a faunistic review of the New Zealand Pselaphinae, with all known brachyglutines documented and categorized, which provided the foundation of this thesis. However, preliminary examination of the identified species in the New Zealand arthropod collection, viz. syntypes, yielded great confusion with identification.

Thomas Broun described nearly three-fourths of the existing taxa of New Zealand brachyglutines, his prolific systematic works on other beetle groups are also impressive. However, many beetle species were described by Thomas Broun based on a single specimen or only female specimens, and many of which were synonymised by later taxonomists. For example, Broun described 146 species of zopherids, and currently, only three of them are valid (Lord & Leschen 2014). Likewise, many brachyglutine specimens could not be identified to species using Broun’s original species descriptions due to the ambiguous
diagnostic characters. For example, *Gastrobothrus sharpi* (Broun) was described based solely on females with no distinctive characteristics. Broun as well as Reitter (1880) and Raffray (1904), based most of their descriptions solely on external morphology like body size, which might only reflect variation between individuals of the same species. Therefore, for New Zealand Brachyglutini, internal morphology like the aedeagal characters should be integrated into species descriptions and phenotypic variation should also be carefully scrutinised to determine species boundaries. A thorough examination of all type material notably the “Broun types’ is imperative as a starting point for a sound taxonomic work on the brachyglutine fauna of New Zealand.

According to Kurbatov and Sabella (2015: 299) “The tribe Brachyglutini is part of the Goniaceritae, and, in turn, cannot be clearly characterized”. Furthermore, to date, no internal phylogeny of Brachyglutini has been attempted, and the monophyly of many genera are still doubtful (e.g., *Eupinolus*; Chandler 2001). Therefore, a sound phylogenetic study is needed. The New Zealand Brachyglutini is no different, for example, the phylogenetic relationship between *Gastrobothrus* and *Physobryaxis* remains uncertain, the latter was synonymised with the former by Newton and Chandler (1989) and was later separated again by Kuschel (1990). The separation of the two genera by Kuschel was followed by Nomura and Leschen (2006) due to the pronotum lacking an antebasal sulcus and a median antebasal fovea. Another remarkable brachyglutine genus *Simkinion* Park and Pearce, 1962 was described with two species from Northland and is so far known to be a bryophyte specialist. While moss is always a target when collecting pselaphines in New Zealand, moss specialised pselaphines have never been reported in New Zealand. The special natural history of *Simkinion* has not been studied since Park and Pearce (1962) and is of equal importance as other New Zealand brachyglutines.
1.3 New Zealand *Eupines* King

*Eupines* King, 1866 is the most diverse and geographically widespread brachyglutine genus in New Zealand, with 48 described species, about half the number of its Australian counterpart. The synapomorphies of *Eupines* include the lack of the following characters: the setose pits beneath eyes, the median antebasal fovea, the basal elytral fovea and the discal elytral striae. Of all type localities of the known species, Auckland, Coromandel and Waikato areas hold the major diversity of the genus, with 15, nine and five species recorded, respectively, nearly two-thirds of the total known species. Apart from the four species with type localities as New Zealand, the diversity in the North Island is nearly three times more than that of the South Island. A recent survey by Théry & Leschen (2013) of the Three Kings Islands, which are a small isolated archipelago located around 60 km northwest of Cape Reinga, revealed another four unique species. Together with the summary data above, it is very likely that a large number of undescribed species may exist in other regions of New Zealand, especially south of Waikato.

*Eupines* was first established as a subgenus of *Bryaxis* Kugelann by King (1866), and was then treated as a genus by Broun (1886), with the type species, *Eupines* (*Eupines*) *clavatula* (King) designated later by Jeannel (1952). The genus *Byraxis* was established by Reitter (1880) with the type species *Eupines* (*Byraxis*) *monstrosa* (Reitter) by monotypy and was then reduced to a subgenus of *Eupines* by Raffray (1904), together with the nominate subgenus *Eupines*. The subgenera *Eupines* and *Byraxis* can be separated by examination of the males, which have 10- or 11-segmented antennae, respectively. The females of both subgenera have 11-segmented antennae. However, due to the similarity between the two names, *Byraxis* and *Bryaxis* and the complex taxonomic history of the two subgenera, a number of species were described without following the subgeneric system developed by Raffray (1904), and were subsequently treated under the two existing subgenera *Byraxis* or
Eupines by their names (e.g., Raffray 1911, 1924; Nomura & Leschen 2006; Maddison 2010). Therefore, the subgeneric placements of many species are somewhat confusing and could potentially be erroneous. Apart from the four species recently described by Théry and Leschen (2013) which were provided with detailed illustrations, the remaining 44 species all lack informative and clear descriptions. The type material of those 44 Eupines species needs to be carefully examined to determine their subgeneric status.

The three field trips during this study have yielded a large number of undescribed species from various localities including one single male with 9-segmented antennae, which could not be classified under any of the two subgenera. The presence of this species renders the current subgeneric system problematic, and theoretically, a new subgenus characterised with males with 9-segmented antennae could be added. However, difficulties were encountered when examining the available material, and the subgeneric concept apparently needs to be reassessed before proposing a new subgenus. First, though the syntypes of the type species of Byraxis were examined, the holotype of the type species of Eupines from Australia, E. (E.) clavatula King, could not be located, and thus, the critical characters that define the two subgenera could not be verified. Secondly, the two subgenera were not established with all known species examined, some species described from New Caledonia and East Asia were not included or with subgeneric status uncertain (e.g., Eupines atomus (Schaufuss); E. spinifera Fauvel). Lastly, members of the subgenus Eupines from Australia have lateral metaventral foveae barely visible and fused to the pleural sulcus, while it is conspicuous and not fused to the pleural sulcus in the members of the same subgenus from New Caledonia and New Zealand, in which case, the current subgeneric system is not reliable. Therefore, the monophyly of the two existing subgenera should be tested, and the subgeneric concept should be reassessed carefully with an inclusion of a broad range of members from both subgenera in a phylogenetic analysis.
1.4 Thesis objectives

The overall aim of this thesis is to revise the brachyglutine fauna of New Zealand at the species level, with a focus on the genus *Eupines*, and to investigate the phylogenetic relationships of all New Zealand brachyglutine genera within the context of Australia, New Zealand and New Caledonia. The morphological revision of this thesis focuses on the most diverse genus *Eupines*, as it comprises nearly 80% of the total species recognised in the tribe Brachyglutini. It also contains several primary taxonomic problems that need to be solved such as the validity of the two subgenera and many synonyms. I also include revisionary work of two smaller brachyglutine genera, *Anabaxis* and *Simkinion*, as they display some interesting biological phenomena such as clinal variation, specialised microhabitats, restricted distribution, etc. Morphological terms for New Zealand Brachyglutini (Fig. 1.2) used in this thesis are developed from Chandler (2001). To reconstruct phylogenetic relationships and to test the classification, I utilised molecular data which represents the first attempt to reconstruct the phylogeny of Brachyglutini, even at a regional level.

Chapter 2 presents a comprehensive catalogue of all 62 described species of the tribe Brachyglutini in New Zealand. Each species is provided with complete taxonomic history, type locality, type material examined (verbatim label data), Broun number (if available), notes and type depository. I have examined type material from two main collections, the New Zealand Arthropod Collection and the Natural History Museum, London (U.K.), as well as other institutional collections. I have also written to major collections where holotypes or additional syntype specimens may exist. During the examination, one synonym was proposed, 17 holotypes were confirmed and 38 lectotypes and 99 paralectotypes were designated for all valid species, apart from *Eupines acceptus* Broun, whose type may be lost. Habitus images of all holotypes and lectotypes are provided, along with their label information images. This
Chapter has been published in *Zootaxa*, 4614 (2), 255–302, with a co-author Richard Leschen, who helped to locate and to loan the type material as well as editing the manuscript.

**Chapter 3** presents the morphological revision of the genus *Eupines* within the New Zealand fauna with a total of 58 species treated. I conducted collecting trips from localities across New Zealand and loaned type specimens and additional material from various collections such as Natural History Museum of London, National Museum of Prague, French Natural History Museum as well as private collections (i.e., John Nunn’s private collection). By examination of all material available, 22 species were redescribed, 22 new species were described, 11 names were synonymised, and 4 new combinations were proposed. All valid species that are present in New Zealand following the revision were keyed and attached with detailed illustrations and images. For this chapter, Richard Leschen facilitated loaning the type material and editing the manuscript.

**Chapter 4** presents a revision of the genus *Anabaxis* of New Zealand, with a new species described and two known species redescribed, along with an identification key and an illustrated catalogue provided for all *Anabaxis* species. Lectotypes and paralectotypes (if available) were designated for seven described species from Australia and New Zealand. The wide-spread species *A. foveolata* was found having morphological features that varied with latitude. I statistically analysed the polymorphism by examining the type specimen and 278 non-type specimens of *A. foveolata* from more than 90 localities, with 28 representatives dissected from selected localities. This chapter was published in *Zootaxa*, 4382 (3), 531–552, with a co-author Richard Leschen who helped with loaning additional material, evaluating the polymorphism and editing the manuscript.
Chapter 5 presents a morphological revision of the New Zealand endemic genus *Simkinion* to include a total of six species, with four being new. All species were keyed and illustrated in detail. I investigated multiple localities mainly in Northland and sifted moss to examine the bryophyte specialization of this genus. I discussed the natural history of members of *Simkinion* due to their peculiar Northland restricted distribution and their specialised habitats. This chapter is in review for *New Zealand Entomologist* with two co-authors: Yeon-Jae Choi who helped with taking habitus photos, image editing and label data input. Richard Leschen helped with writing the discussion on the natural history of *Simkinion* and editing the manuscript.

Chapter 6 tests the monophyly of the genus *Eupines* and its two subgenera using molecular analyses, and investigates the phylogenetic relationships of all other brachyglutine genera of New Zealand with inclusion of representatives from Australia and New Caledonia. I discuss the evolutionary relationships within New Zealand genera and whether they are monophyletic. The phylogenetic relationships between brachyglutine genera of New Zealand fauna and those from Australia and New Caledonia faunae are also analysed in combination with morphological evidence. The monophyly of *Eupines* was resolved with descriptions of a new genus, *Pseudeupines*, based on two known species previously placed in *Eupines*. A key of all New Zealand brachyglutine genera based on morphological and phylogenetic studies is provided to facilitate their identification. For this chapter, Thomas Buckley assisted in analysing the resulting molecular data, building the phylogenetic trees and editing the manuscript; Richard Leschen helped with drafting the discussion section and editing the manuscript.
Chapter 7 provides a summary of the previous chapters and highlights the key findings of this research. I briefly review the preceding research on New Zealand Pselaphinae and discuss the limitations of this study and the future research directions regarding the taxonomic work on New Zealand Brachyglutini. The foveal patterns of the New Zealand brachyglutine genera are also discussed and its value in interpreting evolutionary relationships between pselaphine groups is briefly reviewed.

**Figure 1.2.** Morphological characters of New Zealand Brachyglutini used in the species descriptions.
2.

Catalogue and type designations for New Zealand Goniaceritae (Coleoptera: Staphylinidae: Pselaphinae)

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2.1 Introduction

Pselaphinae is a mainly leaf litter dwelling beetle group and one of the largest subfamilies of the hyper-diverse family Staphylinidae. The cosmopolitan supertribe Goniaceritae is the most speciose assemblage within Pselaphinae with more than 3000 species recorded (A. Newton, pers. comm.). In recent years, portions of the New Zealand fauna have been fully (Faronitae; Park and Carlton 2011, 2013, 2014a, 2014b, 2015a, 2015b, 2015c, 2015d, 2015e) or partially revised (ant-associated Euplectitae; Nomura and Leschen 2015) or treated by region (Three Kings Islands; Théry and Leschen 2013). Work is still required for many groups, including the Goniaceritae, which has remained virtually unstudied after beetle worker Thomas Broun described most of the New Zealand pselaphine fauna. The New Zealand Goniaceritae is comprised of 8 genera, all belonging to the nominate subtribe Brachyglutina of the tribe Brachyglutini (Newton and Chandler 1989). Half of the genera are endemic, and the majority of species were described in the genus Eupines King (48 spp.; Nomura and Leschen 2006). The rest of the species were described in Anabaxis Raffray (3 spp.), Eupinogitus Broun (1
sp.), *Eupinolus* Oke (2 spp.), *Gastrobothrus* Broun (3 spp.), *Physobryaxis* Hetschko (1 sp.), *Simkinion* Park and Pearce (2 spp.), and *Startes* Broun (2 spp.).

David Sharp (1874) described the first six goniacerite species to be followed by Thomas Broun, who subsequently described 45 species from 1880 to 1923, nearly 74% of the existing taxa. During Broun’s prolific beetle career, Reitter (1880) and Raffray (1904) each described a single species of *Eupines*. After these early workers, work on this fauna was very limited. Park and Pearce (1962) described two species of *Simkinion*, Théry and Leschen (2013) described five species from the Three Kings Islands, and Shen and Leschen (2018) added a new species of *Anabaxis* from the Chatham Islands in their revision of the genus. Chandler (2001) treated some of the New Zealand fauna within the context of genera shared with Australia. In this paper, species names are stabilized by lectotype designation or by validating the holotypes in preparation for future revisionary research of the fauna.

Current subgeneric assignments for *Eupines* are somewhat confusing because Broun (1880, 1886, 1893a, 1893b, 1895), King (1863), and Sharp (1874) unfortunately named species under the similar names *Bryaxis* Kugelann and *Byraxis* Reitter, the former a Palaearctic genus of the tribe Bythinini, the latter mostly Australasian (Newton and Chandler 1989). Raffray (1904) was the first to use subgenera and thereafter species that were described under *Bryaxis*, *Byraxis*, or *Eupines* were subsequently treated under the two existing subgenera *Byraxis* or *Eupines* (e.g., Raffray 1911, 1924; Nomura and Leschen 2006; Maddison 2010).

Here I provide a catalogue for the eight New Zealand goniacerite genera. I examined nearly all types of New Zealand goniacerite members, imaged primary types and associated labels, confirmed holotypes, designated lecto- and paralectotypes, and identified one junior synonymy.
2.2 Material and Methods

Specimens were examined from the following collections:

- **AMNZ** Auckland War Memorial Museum, Auckland, New Zealand (J. Early);
- **BMNH** Natural History Museum, London, United Kingdom (M. Geiser);
- **FMNH** Field Museum of Natural History, Chicago, U.S.A. (C. Maier);
- **JNPC** John Nunn Personal Collection, Dunedin, New Zealand;
- **LUNZ** Entomology Research Museum, Lincoln University, Christchurch, New Zealand (J. Marris);
- **MNHN** Museum National d’Histoire Naturelle, Paris, France (A. Taghavian);
- **MVMA** Museum of Victoria, Abbotsford, Victoria, Australia (C. McPhee);
- **SDEI** Senckenberg Deutsches Entomologisches Institut, Müncheberg, Germany (M. Schröter);
- **NZAC** New Zealand Arthropod Collection, Auckland, New Zealand.

Most of the type material is housed in the BMNH and the NZAC. I have checked or written to all major collections where holotypes or additional syntype specimens may exist, and primary types were located for all species apart from *Eupines acceptus* Broun, whose type may be lost.

The format largely follows that of Lord and Leschen (2014). I provide the complete taxonomic history, type locality, Broun number (if available), notes if required, type depository and material examined for all species. I include two-letter Crosby Codes for regions where appropriate (Crosby et al. 1998) and the following abbreviations are applied to the type material: HL = holotype; LT = lectotype; PT = paratype; PLT = paralectotype. Presentation of label data is consistent with the format used in Lord and Leschen (2014), except single quotes (‘’’) are used to enclose label information. Likewise, handwriting and type localities were confirmed by the authors following conventions listed in Lord and
Leschen (2014). BMNH specimens with round red-bordered labels with the word “TYPE” should be cautiously regarded as true types because over time the various collections were moved or combined. Therefore, it is necessary to confirm the status of these specimens as true holotypes or lectotypes, even though curators may have carefully checked original publications. Herein, holotypes are confirmed when a species was described by monotypy. Potential syntypes without locality labels are generally not considered to be part of the syntype series when other syntypes with more detailed locality information exist. Furthermore, in cases when there are multiple potential syntypes, the best-preserved males are designated as lectotypes. All confirmed holotypes and designated lectotypes are males except where indicated. Four species of *Eupines* were based solely on female types.

Primary types and associated labels for specimens that are housed in the BMNH were photographed using a Canon EOS 1200D mounted with a Canon EF 75–300 mm f/4.0–5.6 III lens attached with a 4 × infinity objective lens. Images were then stacked using Helicon Focus V6. Specimens studied in the NZAC were imaged by a Nikon DS-Fi1 camera attached to a Leica compound microscope and multiple layers were stacked using Zerene Stacker 1.04. All figures were edited in Adobe Photoshop CS3.

Holotypes and lectotypes were affixed with red labels and paralectotypes were affixed with blue labels during 2018 (these are not included in the figures).

2.3 Checklist of the New Zealand genera of Goniaceritae

(those suffixed with asterisks are endemic genera)

1. *Aanabaxis* Raffray, 1908 (7 spp.)
3. *Eupinogitus* Broun, 1921 (1 sp.)
4. *Eupinolus* Oke, 1928 (7 spp.)

5. *Gastrobothrus* Broun, 1882 (3 spp.)

6. *Physobryaxis* Hetschko, 1913 (*=Physa Raffray, Achiraffraya Navas*) (1 sp.)


8. *Startes* Broun, 1886 (3 spp.)

### 2.4 Catalogue

**ANABAXIS** Raffray, 1908


**Anabaxis chathamensis** Shen and Leschen, 2018

*Anabaxis chathamensis* Shen and Leschen, 2018: 537.

**Type locality**: [CH] Chatham Islands, Awatotara.

**Type depository**: NZAC HT ♂, 2 PT.

**Anabaxis electrica** (King, 1863)

Figs 2.1–2.2

*Bryaxis electrica* King, 1863: 48.

*Rybaxis electrica*: Combination and redescription by Raffray 1900: 161.


**Type locality:** Parramatta, Australia.

**Type depository:** AMS LT ♂, 3 PLT.

**Notes:** Shen and Leschen (2018) designated the lectotype and three paralectotypes for *A. electrica* and stated that *A. minor* may be a junior synonym of *A. brevis*. After comparing the male lectotype of *A. electrica* with the male lectotype of *A. brevis*, these two species were found to represent a single species and are synonymised above. One male and two females of *A. brevis* were located in the MVMA and are here designated to be the paralectotypes for *Rybaxis brevis*. These specimens are mounted on the same card with the lectotype, and I designate the three specimens on the right as the paralectotypes. I also located a single female specimen of *A. minor* in the BMNH main collection matching the locality data that I have confirmed to be the holotype. After examination, *A. minor* is confirmed to be a junior synonym of *A. electrica*.

**Type material of* Rybaxis brevis* examined:** Paralectotype (MVMA): 3, mounted on the same card, ‘929 [unknown handwriting], Holotype ♂ [printed], 931 Allotype ♀, 930 ♂ 932 ♀ Parat. [unknown handwriting, on red rectangular label] // WARBURTON, Vic [printed], 27.12. 25 [in Oke’s hand], C. Oke [printed]’ // *Rybaxis brevis* Oke type. [in Oke’s hand].

**Anabaxis foveolata** (Broun, 1880)

Figs 2.3–2.4


*Bryaxis euplectoides* Broun, 1893a: 1045.

*Anabaxis euplectoides*: Synonymised by Kuschel 1990: 76. Type locality: [AK] near Howick.

Broun number: 1869.

*Anabaxis foveolata*: Combination by Kuschel 1990: 76. Type locality: [CL] Tairua.

Maddison 2010: 417; Shen and Leschen 2018: 538.

**Type locality:** [CL] Tairua.

**Broun number:** 263.

**Type depository:** BMNH LT ♂.

**Notes:** Shen and Leschen (2018) designated the lectotype for *A. foveolata* with one male and one female syntype not being located in the primary collections (BMNH Broun collection, BMNH main collection and NZAC). Broun mentioned that he had three examples for *Bryaxis euplectoides*. Two specimens in the BMNH main collection and one specimen in the NZAC matching the locality data of *Bryaxis euplectoides* were located and are here designated to be the lectotype and the two paralectotypes for *Bryaxis euplectoides*. There are four additional specimens in the BMNH main collection with labels in Broun’s hand, but do not match the locality, and are not considered to be part of the syntype series of *Bryaxis euplectoides*. The original identification label was written as *Anabaxis*, but the original combination was published under *Bryaxis*. After examination, *Bryaxis euplectoides* is confirmed to be the junior synonym of *A. foveolata*.

EUPINES King, 1866


Byraxis Reitter, 1880: 166. Type species: *Byraxis monstrosa* Reitter, by monotypy.

Reduction to subgenus by Raffray 1904: 202.

Patranus Raffray, 1890: 123. Type species: *Tychus politus* Schaufuss (*=Bryaxis globulifer* Schaufuss), by monotypy. Synonymised by Raffray 1900: 171.


Notes: There are 141 valid species of *Eupines* distributed in Australia, New Zealand, and New Caledonia (136 spp.) and Southeast Asia (5 spp.). I cover only New Zealand members here. Images and other details of the four species that were described recently from the Three Kings Islands (New Zealand) are treated by Théry and Leschen (2013).

Subgeneric assignments for *Eupines* species based on King’s (1866) classification can be readily determined by close examination of the number of male antennal segments (10
antennomeres in *Byraxis*; 11 antennomeres in *Eupines*), and which have been updated in this catalogue. Subgeneric assignments are not made for the four species of *Eupines* that are based solely on female types.

**Eupines acceptus** (Broun, 1923)


**Type locality:** [WO] Rangiriri.

**Broun number:** 4277.

**Notes:** Broun did not mention the number of specimens he examined. There are three females in the BMNH Broun collection, none of which come from Rangiriri, so I do not regard these to be part of the syntype series. In this case, I presume that the type specimens for *E. acceptus* are lost, since they cannot be found in the primary collections (BMNH Broun collection, BMNH main collection and NZAC), hence type designation and subgeneric assignment is not made for this species.

**Eupines (Byraxis) allocera** (Broun, 1893)

Figs 2.5–2.6

*Bryaxis allocera* Broun, 1893b: 172.

*Eupines (Byraxis) allocera*: combination and subgeneric assignment by Raffray 1904: 208.


**Type locality:** [WO] Mount Pirongia.
Notes: Broun based this species on a single specimen that I have confirmed to be the holotype. The original identification label was written as *Byraxis*, but the original combination was published under *Bryaxis*.


*Eupines (Byraxis) anisarthra* (Broun, 1914)

Figs 2.7–2.8


**Type locality:** [MC] Broken River.

**Broun number:** 3535.

Notes: Broun mentioned that he had one male and one female. Both specimens matching the type locality were located in the BMNH Broun collection. In order to stabilize this name, a lectotype and a paralectotype are **here designated** for *Byraxis anisarthra*.


22
**Eupines (Byraxis) bisulcifrons** (Broun, 1914)

Figs 2.9–2.10


**Type locality:** [MC] Mount Hutt.

**Broun number:** 3536.

**Notes:** Broun mentioned that he had two males collected by Mr T. Hall on 28 October 1912, at an altitude of about 3000 ft., with both specimens located in the BMNH Broun collection. In order to stabilize this name, a lectotype and a paralectotype are here designated for *Byraxis bisulcifrons*.


**Eupines (Eupines) calcarata** (Broun, 1886)

Figs 2.11–2.12

*Byraxis calcarata* Broun, 1886: 831. Raffray 1904: 244.


**Type locality:** [WO] Tuakau.

**Broun number:** 1479.

**Notes:** Broun mentioned that he collected two males, with only one matching this locality data in the BMNH Broun collection. There is one additional specimen in the same collection with labels in Broun’s hand that do not match the locality data, and hence is not considered to be a syntype. Another specimen in the NZAC with labels in Brookes’ hand matches the Broun number, but it lacks a locality label, and thus is also not considered to be a syntype. In order to stabilize this name, a lectotype is **here designated** for *Bryaxis calcarata*. The original identification label was written as *Eupines*, but the original combination was published under *Bryaxis*.


**Eupines (Byraxis) chandleri** Théry and Leschen, 2013

*Eupines (Byraxis) chandleri* Théry and Leschen, 2013: 50.

**Type locality:** [TH] Great Island, Tasman Valley, Tasman Track, Three Kings Islands.

**Type depository:** NZAC HT ♂, 16 PT; LUNZ 4 PT.

**Eupines (Eupines) clemens** Broun, 1921

Figs 2.13–2.14


**Type locality:** [NN] Glenhope and near Lake Rotoiti.
**Broun number:** 4172.

**Notes:** Broun did not mention the number of specimens he examined. There are three specimens in the BMNH Broun collection and two specimens in the NZAC matching the two type localities that I regard as syntypes. There is one additional specimen in the BMNH Broun collection that does not match the locality data and is not regarded as being part of the syntype series. In order to stabilize this name, a lectotype and four paralectotypes are here designated for *Eupines clemens*.


*Eupines (Byraxis) conspicua* (Broun, 1893)

Figs 2.15–2.16

*Byraxis conspicua* Broun, 1893a: 1415.

Type locality: [AK] Hunua Range, Maketu.

Broun number: 2464.

Notes: Broun mentioned that there were 10 males and uncertain number of females. Four specimens in the BMNH Broun collection and 12 specimens in the NZAC matching the locality data were located. One specimen in the NZAC with Broun’s handwritten number, lacks a locality label, and is not considered to be a syntype. In order to stabilize this name, a lectotype and 17 paralectotypes are here designated for Bryaxis conspicua.


**Eupines (Byraxis) costata** (Broun, 1893)

Figs 2.17–2.18

*Bryaxis costata* Broun, 1893a: 1416.

_Eupines (Byraxis) costata:_ combination and subgeneric assignment by Raffray 1904: 207.


**Type locality:** [MC] Riccarton Bush, Christchurch.

**Broun number:** 2465.

**Notes:** Broun mentioned that he examined five specimens for this species: only four in the BMNH Broun collection were located. There are two additional specimens in the BMNH Broun collection that do not match the locality data and are not considered to be part of the syntype series. There are also five specimens in the NZAC with Broun’s handwritten labels lacking locality labels and are not considered to be part of the syntype series. Similarly, eight specimens with Broun’s handwritten labels and 12 specimens with labels in Brookes’ hand that do not match the locality data are not considered to be syntypes. In order to stabilize this name, a lectotype and three paralectotypes are here designated for *Bryaxis costata*.


**Eupines** (*Byraxis*) *crassicornides* Newton, 2017

Figs 2.19–2.20

*Bryaxis crassicornis* Broun, 1880: 129.


**Type locality:** [CL] Tairua.

**Broun number:** 237.

**Notes:** Broun based this species on a single specimen that I have located in the BMNH Broun Collection and is confirmed to be the holotype. The original identification label was written as *Byraxis*, but the original combination was published under *Bryaxis*.

**Eupines (Byraxis) crosbyi** Théry and Leschen, 2013

*Eupines (Byraxis) crosbyi* Théry and Leschen, 2013: 51.

**Type locality:** [TH] Great Island, Three Kings Islands.

**Type depository:** NZAC HT ♂, 6 PT.

**Eupines (Byraxis) decens** (Broun, 1893)

Figs 2.21–2.22

*Byraxis decens* Broun, 1893a: 1046.

*Eupines (Byraxis) decens*: combination and subgeneric assignment by Raffray 1904: 207.


**Type locality:** [AK] Paparoa, near Howick.

**Broun number:** 1870.

**Notes:** Broun mentioned that he had two males, with the BMNH Broun collection having two identified specimens that match the locality data. There are also three identified specimens in the same collection with labels in Broun’s hand, two specimens in the BMNH main collection and four specimens in the NZAC with labels in Brookes’ hand: all these additional specimens are not considered to be syntypes. In order to stabilize this name, a lectotype and a paralectotype are here designated for *Bryaxis decens*. The original identification label was written as *Byraxis*, while the original combination was published under *Bryaxis*.


Eupines deformis (Sharp, 1874)

Figs 2.23–2.24

Bryaxis deformis Sharp, 1874: 499.


Bryaxis deformis: reprinted excerpt from Sharp 1874 by Broun 1880: 130.

Eupines (Byraxis) deformis: combination and subgeneric assignment by Raffray 1904: 208.


**Type locality:** New Zealand.

**Broun number:** 238.

**Notes:** Sharp based this species on a single female specimen that I found in the BMNH main Collection and is confirmed to be the holotype. In this case, the subgeneric assignment is not made for this species.

**Type material examined:** Holotype (BMNH): ‘Type H. T. [round label with red border] // N. Zeal [in Sharp’s hand] // Sharp Coll. 1905-313. // Bryaxis deformis ♀ Type. D.S. [in Sharp’s hand]’.

Eupines (Byraxis) dispar (Sharp, 1874)

Figs 2.25–2.28

Bryaxis dispar Sharp, 1874: 498.


Bryaxis dispar: reprinted excerpt from Sharp 1874 by Broun 1880: 127.

Bryaxis ovalipennis Schaufuss, 1880a: 25. Type locality: New Zealand.


Type locality: [AK] Auckland.

Broun number: 234.

Notes: Sharp received five males and a female of Bryaxis dispar from Mr Edwards. Only four of the six specimens matching the locality data in the BMNH main collection were located. Three additional specimens in the same collection, two lacking locality labels and one from a different locality, are not considered to be part of the syntype series. In order to stabilize this name, a lectotype and three paralectotypes are here designated for Bryaxis dispar. Schaufuss did not mention the number of specimens he examined for Bryaxis ovalipennis but described both sexes. Only one male was located in the SDEI; it is here designated to be the lectotype for Bryaxis ovalipennis and I confirm that Bryaxis ovalipennis is a junior synonym of Bryaxis dispar.


Eupines (Byraxis) diversides Newton, 2017

Figs 2.29–2.30
**Bryaxis diversa** Broun, 1893b: 174.

**Eupines** *(Byraxis)* *diversa*: combination and subgeneric assignment by Raffray 1904: 207.


**Type locality**: [AK] Hunua Range, Drury.

**Broun number**: 2739.

**Notes**: Broun mentioned that he had four males and seven females. Three specimens in the BMNH Broun collection, three specimens in the BMNH main collection, and two specimens in the NZAC were located and are considered to be syntypes. There are four additional specimens in the BMNH main collection that do not have the correct locality data and are not regarded to be part of the syntype series. In addition, there are three specimens in the NZAC with labels in Brookes’ hand: two lacking locality labels and one from a different locality that are not considered to be part of the syntype series. In order to stabilize this name, a lectotype and seven paralectotypes are **here designated** for *Bryaxis diversa*. The original identification label was written as *Byraxis*, but the original combination was published under *Bryaxis*.


Eupines (Byraxis) forficulida (Broun, 1890)

Figs 2.31–2.32

Byraxis forficulida Broun, 1890: 232.

Byraxis forficulida: reprint from Broun 1890 by Broun 1893a: 1047.

Eupines (Byraxis) forficulida: combination and subgeneric assignment by Raffray 1904: 207.


Type locality: [AK] Clevedon.

Broun number: 1872.

Notes: Broun based this species on a single specimen that I found in the BMNH Broun Collection and is confirmed to be the holotype. The original identification label was written as Byraxis, but the original combination was published under Bryaxis.


**Eupines (Byraxis) foveatissima** (Broun, 1890)

Figs 2.33–2.34

*Byraxis foveatissima* Broun, 1890: 233.

*Byraxis foveatissima*: reprint from Broun 1890 by Broun 1893a: 1047.


**Type locality:** [AK] Clevedon.

**Broun number:** 1873.

**Notes:** Broun based this species on a single specimen that I have found in the BMNH Broun Collection and is confirmed to be the holotype.


**Eupines (Byraxis) fraudulenta** (Broun, 1886)

Figs 2.35–2.36

*Byraxis fraudulenta* Broun, 1886: 944.

**Type locality:** [AK] Near Howick.

**Broun number:** 1699.

**Notes:** Broun did not mention the number of specimens he examined. Only one specimen was located in the BMNH. In order to stabilize this name, a lectotype is here designated for *Bryaxis fraudulenta*. The original identification label was written as *Byraxis*, but the original combination was published under *Bryaxis*.


**Eupines (Byraxis) glabrata** (Broun, 1886)

Figs 2.37–2.38

*Bryaxis glabrata* Broun, 1886: 830.

**Eupines (Byraxis) glabrata:** combination and subgeneric assignment by Raffray 1904: 207.


**Type locality:** [AK] Woodhill, near the Kaipara Railway.

**Broun number:** 1476.

**Notes:** Broun (1886) implied that he had one specimen by stating “I obtained my specimen in Woodhill”. Two specimens matching the locality data in the NZAC were located, with one of them bearing a locality label in Broun’s hand and another one bearing a printed locality label. Broun may have incorrectly indicated the number of specimens and I have confirmed the former specimen with all labels in Broun’s hand to be the holotype. There are five additional specimens in the BMNH Broun collection and one additional specimen in the BMNH main
collection with appropriate Broun’s handwritten labels, but from different localities: all these are not considered as being part of the syntypic series.


**Eupines (Eupines) grata** (Sharp, 1874)

Figs 2.39–2.40

*Bryaxis grata* Sharp, 1874: 500.

*Bryaxis grata*: reprint from Sharp 1874 by Sharp 1876: 278.


*Eupines (Eupines) grata*: combination and subgeneric assignment by Raffray 1904: 204.


**Type locality:** [AK] Auckland.

**Broun number:** 240.

**Notes:** Sharp did not mention the number of specimens he examined. Two specimens in the BMNH main collection lacking the locality label were located but are still considered to be syntypes because they bear the typical type labels used by Sharp. In order to stabilize this name, a lectotype and a paralectotype are here designated for *Bryaxis grata*.

*Eupines (Byraxis) halli* (Broun, 1921)

Figs 2.41–2.42


**Type locality:** [NN] Mount Saint Arnaud, Nelson.

**Broun number:** 4173.

**Notes:** Broun mentioned that he had two males and four females. Three specimens in the BMNH Broun collection and two specimens in the NZAC matching the locality data were located. In order to stabilize this name, a lectotype and four paralectotypes are here designated for *Byraxis halli*.


*Eupines (Byraxis) hectori* (Broun, 1895)

Figs 2.43–2.44
Bryaxis hectori Broun, 1895: 73.

Eupines (Byraxis) hectori: combination and subgeneric assignment by Raffray 1904: 208.


Type locality: [BP] Tarukenga, near Rotorua.

Notes: Broun based this species on two males. Only one specimen in the BMNH main collection that lacks the locality data was located and is still considered to be a syntype because it bears the typical identification label in Broun’s hand. In order to stabilize this name, a lectotype is here designated for Bryaxis hectori.


Eupines (Byraxis) ignotus (Broun, 1881)

Figs 2.45–2.46


Type locality: [ND] Manaia, Whangarei Harbour.

Broun number: 1155.

Notes: Broun based this species on a single male that I have found in the BMNH Broun Collection and is confirmed to be the holotype. The original identification label was written as Eupines, but the original combination was published under Bryaxis.

**Eupines (Byraxis) illustris** (Broun, 1914)

Figs 2.47–2.48

*Byraxis illustris* Broun, 1914b: 168. Hudson 1923: 364, 1934: 185,


**Type locality:** [MC] Broken River, Canterbury.

**Broun number:** 3534.

**Notes:** Broun mentioned that he had two specimens, both of which were located in the BMNH Broun collection. In order to stabilize this name, a lectotype and a paralectotype are **here designated** for *Byraxis illustris*.


**Eupines (Byraxis) impar** (Sharp, 1874)

Figs 2.49–2.50

*Byraxis impar* Sharp, 1874: 500.

*Byraxis impar*: reprint from Sharp 1874 by Sharp 1876: 278.

*Byraxis impar*: reprinted excerpt from Sharp 1874 by Broun 1880: 130.

**Type locality:** [AK] Auckland.

**Broun number:** 239.

**Notes:** Sharp did not mention the number of specimens he examined. Four specimens matching this locality data were located in the BMNH main collection. In order to stabilize this name, a lectotype and three paralectotypes are here designated for *Bryaxis impar*.


**Eupines (Byraxis) impressifrons** (Broun, 1880)

Figs 2.51–2.52


**Type locality:** [CL] Tairua.

**Broun number:** 235.

**Notes:** Broun based this species on a single specimen collected from Tairua that I have found in the BMNH Broun Collection and is confirmed to be the holotype. The original
identification label was written as *Byraxis*, but the original combination was published under *Bryaxis*.


**Eupines (Byraxis) lewisi** Broun, 1910

Figs 2.53–2.54


**Type locality:** [MC] Broken River, Canterbury.

**Broun number:** 3052.

**Notes:** Broun based this species on a single specimen that I have found in the BMNH Broun Collection and is confirmed to be the holotype. The type label was written as *Byraxis*, but the original combination was under *Eupines*.


**Eupines (Byraxis) longiceps** Raffray, 1904

Figs 2.55–2.56

**Type locality:** New Zealand.

**Notes:** Raffray did not mention the number of specimens he examined, nor did he indicate a specific locality. One specimen in the MNHN and two specimens in the BMNH main collection with labels in Raffray’s hand were located. In order to stabilize this name, a lectotype and two paralectotype are **here designated** for *Eupines (Byraxis) longiceps*.


*Eupines (Byraxis) micans* (Sharp, 1874)

Figs 2.57–2.58

*Byraxis micans* Sharp, 1874: 497.

*Byraxis micans*: reprint from Sharp 1874 by Sharp 1876: 276.


*Eupines (Eupines) micans*: combination and subgeneric assignment by Raffray 1904: 206.


**Type locality:** New Zealand.

**Broun number:** 231.
Notes: Sharp mentioned that he received two specimens from Mr Edwards. Both specimens were located in the BMNH main collection. In order to stabilize this name, a lectotype and a paralectotype are here designated for Bryaxis micans. I transfer this species from the subgenus Eupines to Byraxis.


Eupines (Byraxis) monstrosa (Reitter, 1880)

Figs 2.59–2.60


Type locality: Not indicated in the paper.

Broun number: 3214.

Notes: Reitter mentioned that he had two males but did not indicate the type locality. In this case, I consider the two specimens in the MNHN with the labels written in Reitter’s hand as the syntypes. There is an additional specimen in the NZAC with labels in Brookes’ hand indicating that it is from Sharp’s collection, so it is not considered to be part of the syntype series. In order to stabilize the name, a lectotype and a paralectotype are here designated for Byraxis montrosa.

**Eupines (Byraxis) mundula** (Schauffuss, 1888)

Figs 2.61–2.62

*Bryaxis mundus* Broun, 1880: 129.


*Bryaxis mundulus* Broun, 1893a: 1417. New name for *Bryaxis mundus* Broun, 1880: 129.

Unnecessary replacement name.

**Eupines (Byraxis) munda**: combination and subgeneric assignment by Raffray 1904: 207.


**Type locality:** [CL] Tairua.

**Broun number:** 236.

**Notes:** Broun mentioned that he collected five specimens from Tairua. I located two specimens in the BMNH Broun collection and three specimens in the BMNH main collection matching this locality record. Two additional specimens also matching this locality record in
the NZAC are not considered to be part of the syntype series. In order to stabilize this name, a lectotype and four paralectotypes are here designated for *Bryaxis mundus*. The type label was written as *Byraxis*, but the original combination was under *Bryaxis*.


**Eupines (Byraxis) munroi** (Broun, 1890)

Figs 2.63–2.64

*Bryaxis munroi* Broun, 1890: 231.

*Bryaxis munroi*: reprint from Broun 1890 by Broun 1893a: 1046.

**Eupines (Byraxis) munroi**: combination and subgeneric assignment by Raffray 1904: 208.


**Type locality:** [AK] Clevedon.

**Broun number:** 1871.

**Notes:** Broun mentioned that he had seven specimens which were located in the BMNH Broun collection. There are an additional two specimens in the NZAC matching the locality data with labels in Brookes’ hand, and are not regarded to be part of the syntype series. In order to stabilize this name, a lectotype and six paralectotypes are here designated for
Bryaxis munroi. The original identification label was written as Byraxis, but the original combination was published under Bryaxis.


**Eupines (Eupines) nasuta** (Broun, 1880)

Figs 2.65–2.66


- Unnecessary replacement name.


**Type locality:** [CL] Tairua.

**Broun number:** 242.

**Notes:** Broun based this species on a single specimen in the NZAC that I have confirmed to be the holotype. The original identification label was written as Eupines, but the original combination was published under Bryaxis.

Eupines (*Byraxis*) *nemoralis* (Broun, 1886)

Figs 2.67–2.68

*Byraxis nemoralis* Broun, 1886: 831.

*Eupines* (*Byraxis*) *nemoralis*: combination and subgeneric assignment by Raffray 1904: 207.


**Type locality:** [AK] Woodhill.

**Broun number:** 1477.

**Notes:** Broun based this species on a single specimen that I have located in the BMNH Broun Collection and is confirmed to be the holotype. The original identification label was written as *Byraxis*, but the original combination was published under *Byraxis*.


_Eupines nesobia_ Broun, 1914

Figs 2.69–2.70


Maddison 2010: 417.

**Type locality:** [CL] Great Barrier Island.
Broun number: 3401.

Notes: Broun received three specimens from Mr Flynn in 1911. Three specimens matching this locality record and date were located in the BMNH Broun collection. However, all the syntypes are females. In this case, the subgeneric assignment is not made. To stabilize this name, a lectotype and two paralectotypes are still here designated for Eupines nesobia.


Eupines (Byraxis) paganus (Broun, 1881)

Figs 2.71–2.72

Byraxis paganus Broun, 1881: 660.

Eupines (Byraxis) pagana: combination and subgeneric assignment by Raffray 1904: 208.


Type locality: [ND] near Whangarei Harbour.

Broun number: 1154.

Notes: Broun based this species on a single specimen that I found in the BMNH Broun Collection and is confirmed to be the holotype. The original identification label was written as Byraxis, but the original combination was published under Bryaxis.

**Eupines piciceps** (Broun, 1880)

Figs 2.73–2.74


*Eupines (Eupines) piciceps*: combination and subgeneric assignment by Raffray 1904: 205.


Type locality: [CL] Tairua.

Broun number: 233.

Notes: Broun collected two specimens in Tairua, with both being located in the BMNH Broun collection. However, they are females so that the subgeneric assignment is not made for this species. To stabilize this name, a lectotype and a paralectotype are here designated for *Byraxis piciceps*. The original identification label was written as *Eupines*, but the original combination was published under *Byraxis*.


**Eupines (Byraxis) platyartha** (Broun, 1893)

Figs 2.75–2.76

*Byraxis clavatus* Broun, 1880: 126.
Bryaxis platyartha Broun, 1893a: 1417. New name for Bryaxis clavatus Broun, 1880: 126, preoccupied by Bryaxis clavata Motschulsky, 1851: 49.


Type locality: [CL] Tairua.

Broun number: 232.

Notes: Broun mentioned that he collected two males from Tairua. One specimen in the BMNH and one (dissected) specimen in the NZAC were located with the correct locality data. In order to stabilize this name, a lectotype and a paralectotype are here designated for Bryaxis clavatus. The original identification label was written as Byraxis, but the original combination was published under Bryaxis.


Eupines (Eupines) platynota (Broun, 1893)

Figs 2.77–2.78

Bryaxis platynota Broun, 1893a: 1338. Raffray 1904: 244.


Type locality: [HB] Mangawhare, Northern Wairoa.
Broun number: 2346.

Notes: Broun based this species on a single specimen that I have located in the BMNH Broun Collection and is confirmed to be the holotype. The original identification label was written as Eupines, but the original combination was published under Bryaxis. This species was questionably placed in the subgenus Eupines by Nomura and Leschen (2006) and will be transferred to the genus Gastrobothus in a later paper.


Eupines (Byraxis) rhyssarthra (Broun, 1912)

Figs 2.79–2.80


Type locality: [WO] Mount Pirongia.

Broun number: 3215.

Notes: Broun mentioned that he had two males and three females. All the syntypes matching this locality record were located in the BMNH Broun collection. In order to stabilize the name, a lectotype and four paralectotypes are here designated for Byraxis rhyssarthra.


**Eupines (Byraxis) rudicornis** Broun, 1882

Figs 2.81–2.82

*Eupines rudicorne* Broun, 1882: 288.

*Eupines rudicorne*: reprint from Broun 1882 by Broun 1886: 759.


**Type locality:** [WN] Wellington (implied locality).

**Broun number:** 1347.

**Notes:** Broun based this species on a single specimen that I located in the BMNH Broun Collection and is confirmed to be the holotype. The original identification label was written as *Bryaxis*, but the original combination was published under *Eupines*.


**Eupines (Byraxis) sanguinea** (Broun, 1880)

Figs 2.83–2.84

*Bryaxis sanguineus* Broun, 1880: 132.

*Bryaxis vae* Schaufuss, 1888: 34. New name for *Bryaxis sanguinea* Broun, 1880: 132.

Unnecessary replacement name for *Bryaxis sanginea* Leach, 1817.

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Eupines (Byraxis) sanguinea: combination and subgeneric assignment by Raffray 1904: 207.


Type locality: [CL] Tairua.

Broun number: 243.

Notes: Broun did not mention the number of specimens he examined. Three specimens with labels in Brookes’ hand matching the locality data were located in the NZAC. Thirteen additional specimens in the NZAC with Broun numbers written in Broun’s hand lack locality labels and are not regarded as syntypes, as were two labelled as “variant”. Three additional specimens in the BMNH Broun collection, two with the locality label “Hunua” in Broun’s hand and one with the printed locality label “Howick” are also not considered to be syntypes.

In order to stabilize this name, a lectotype and two paralectotypes are here designated for Bryaxis sanguineus. The original identification label was written as Byraxis, but the original combination was published under Bryaxis.

The two replacement names proposed by Schaufuss (1888) and Broun (1893a) are unnecessary because Bryaxis sanguinea Leach, 1817 has been designated as the type species of Rybaxis Sauley by Bowman (1934).


**Eupines (Byraxis) setifera** (Broun, 1893)

Figs 2.85–2.86

*Byraxis setifer* Broun, 1893b: 173.

*Eupines (Byraxis) setifera*: combination and subgeneric assignment by Raffray 1904: 207.


**Type locality:** [WO] Mount Pirongia.

**Broun number:** 2738.

**Notes:** Broun mentioned that he had two males. Both specimens matching the locality data were located in the BMNH Broun collection. In order to stabilize this name, a lectotype and a paralectotype are here designated for *Byraxis setifer*.


**Eupines simplex** Broun, 1913

Figs 2.87–2.88


Maddison 2010: 417.

**Type locality:** [CL] Tairua.

**Broun number:** 3503.
Notes: Broun sent two specimens to Sharp, with two specimens bearing labels that match the locality data located in the BMNH main collection and are both females. One intact specimen is chosen to be the lectotype and the other specimen without head is placed as the paralectotype. There is an additional specimen in the NZAC with the label “cotype” in Sharp’s hand but does not match the locality data and is not considered to be part of the syntype series. The subgeneric assignment is not made for this species. In order to stabilize this name, a lectotype and a paralectotype are still here designated for Eupines simplex.


Eupines (Eupines) sternalis (Broun, 1893)

Figs 2.89–2.90

Bryaxis sternalis Broun, 1893b: 171.


Type locality: [ND] Ligar’s Bush, Papakura; [WO] Mount Pirongia.

Broun number: 2736.

Notes: Broun mentioned that he had eight exemplars from Papakura and two exemplars from Mount Pirongia. Four specimens from Ligar’s Bush in the BMNH Broun collection, two specimens from the same locality in the BMNH main collection, and two specimens from Mount Pirongia in the NZAC were located. Two additional specimens from Mount Pirongia
with labels in Brookes’ hand in the NZAC are not regarded to be part of the syntypes series. In order to stabilize the name, a lectotype and seven paralectotype are here designated for *Bryaxis sternalis*. The original identification label was written as *Eupines*, but the original combination was published under *Bryaxis*.


**Eupines (Byraxis) sylvicola** (Broun, 1884)

Figs 2.91–2.92

*Bryaxis sylvicola* Broun, 1884: 238.


**Type locality:** [AK] Paparoa bush, near Howick.

**Broun number:** 1645.

**Notes:** Broun mentioned that he found two specimens in the Paparoa bush. Both specimens from Paparoa in the BMNH Broun collection were located. There is an additional specimen in the BMNH main collection with labels in Broun’s hand, but lacks a locality label and is not considered being part of the syntype series. There are two specimens in the NZAC with labels in Brookes’ hand matching the locality data and nine specimens in the NZAC with labels in Brookes’ hand from different localities: all these are not considered to be syntypes. In order to stabilize this name, a lectotype and a paralectotype are here designated for *Bryaxis sylvicola*.


_Eupines (Byraxis) tronqueti_ Théry and Leschen, 2013

_Eupines (Byraxis) tronqueti_ Théry and Leschen, 2013: 52.

**Type locality:** [TH] Great Island, Castaway Track, Three Kings Islands.

**Type depository:** NZAC HT ♂, 17 PT; LUNZ 1 PT.
Eupines (Byraxis) watti Théry and Leschen, 2013

Eupines (Byraxis) watti Théry and Leschen, 2013: 53.

**Type locality:** [TH] Great Island, Tasman Valley, Tasman Track, Three Kings Islands.

**Type depository:** NZAC HT ♂, 21 PT.

**EUPINOGITUS Broun, 1921**


**Eupinogitus sulcipennis** Broun, 1921

Figs 2.93–2.96


**Type locality:** [OL] Staircase, southern end of the Remarkables.

**Broun number:** 4038.

**Notes:** Broun received this species from Mr T. Hall which he collected in Staircase, at the southern end of the Remarkables, 3500 ft., 15th March 1914. Broun did not mention the number of specimens he examined. I located four specimens in the BMNH main collection and four specimens in the NZAC matching the data of this locality and date. There are six additional specimens with labels in Brookes’ hand and three specimens with labels in Broun’s hand that do not match the date in the NZAC and are not considered to be syntypes. Broun listed *Eupinogitus picescens* as a variety (“var.”) of *E. sulcipennis* based on a single
specimen. One specimen with a designation label in Broun’s hand matching the data of this locality and date in the BMNH main collection was located and is confirmed to be the holotype. *Eupinogitus picescens* is also conspecific with *E. sulcipennis* and is confirmed as a junior synonym of this species as proposed by Nomura and Leschen (2006). In order to stabilize this name, a lectotype and seven paralectotypes are here designated for *Eupinogitus sulcipennis*.


**EUPINOLUS** Oke, 1928


**Eupinolus altulus** (Broun, 1880)

Figs 2.97–2.98


Type locality: [ND] Near Whangarei Harbour.

Broun number: 241.

Notes: Broun collected one male and one female in the wood near Whangarei Harbour. Both specimens were located in the BMNH main collection and bear the locality labels “Manaia”, which match the original description. In order to stabilize this name, a lectotype and a paralectotype are here designated for *Bryaxis altulus*.


**Eupinolus punctatus** (Broun, 1886)

Figs 2.99–2.100


**Type locality:** [AK] Paparoa, near Howick.

**Broun number:** 1478.

**Notes:** Broun did not mention the number of specimens he examined. One male in the BMNH main collection matching this locality record was located. There is another specimen in the same collection with labels in Broun’s hand whose label does not match the type locality record and is not considered to be part of the syntype series. In order to stabilize this name, a lectotype is here designated for *Bryaxis punctata*.


**GASTROBOTHRUS** Broun, 1882

**Gastrobothrus abdominalis** (Broun, 1880)

Figs 2.101–2.102

*Bryaxis abdominalis* Broun, 1880: 125.


**Type locality**: [AK] Tairua.

**Broun number**: 230.

**Notes**: Broun based this species on a single specimen that have I located in the BMNH Broun Collection and is confirmed to be the holotype.


**Gastrobothrus buckleyi** Théry and Leschen, 2013

**Gastrobothrus buckleyi** Théry and Leschen, 2013: 54.

**Type locality**: [TH] Great Island, Castaway Track, Three Kings Islands.

**Type depository**: NZAC HT ♂, 32 PT; LUNZ 3 PT.

**Gastrobothrus sharpi** (Broun, 1880)

Figs 2.103–2.104


**Type locality**: [AK] Tairua.

**Broun number**: 229.
Notes: Broun did not mention the number of specimens he examined. One specimen matching this locality record in the BMNH Broun collection was located. There are two additional specimens in the same collection that do not match the locality and are not considered to be part of the syntype series. There are also three specimens in the NZAC with labels in Brookes’ hand and one with Broun’s handwritten labels, but they do not match the type locality data, and are not considered to be part of the syntype series. Unfortunately, the only syntype is a female, but to stabilize this name, a lectotype is still here designated for Bryaxis sharpi.


PHYSOBRYAXIS Hetschko, 1913
Physoberyaxis Hetschko, 1913: 182. New name for Physa Raffray, 1890a: 122. Type species:

Achiraffraya Navas, 1925: 29. New name for Physa Raffray, 1890a: 122. Unnecessary replacement name.

Physobryaxis inflatus (Sharp, 1874)
Figs 2.105–2.106
Bryaxis inflata Sharp, 1874: 497.


Bryaxis inflata: redescription by Broun 1880: 124.


**Type locality:** [AK] Auckland.

**Broun number:** 228.

**Notes:** Sharp did not mention the number of specimens he examined. Two specimens matching the locality data were located in the BMNH main collection. There are two additional specimens in the same collection whose labels do not match the locality data and are not considered to be part of the syntype series. In order to stabilize this name, a lectotype and a paralectotype are here designated for Bryaxis inflata. These two specimens are mounted on the same card, and I designate the specimen on the left as the lectotype, the right one as the paralectotype.

**Type material examined:** Lectotype (BMNH): mounted on the same card and pin as the paralectotype, the left specimen is the lectotype, ‘♂ ♂ [written at base of card in Sharp’s hand]’ // Type H. T. [round label with red border] // Auckland New Zealand. // Auckland, N.Z. [in Sharp’s hand] // Sharp Coll. 1905-313. // Bryaxis inflatus ♂ Type. D.S. [in Sharp’s hand]’.

Paralectotype (BMNH): mounted venter-up on the same card and pin as lectotype, the right one is the paralectotype, labels same as lectotype.

**SIMKINION** Park and Pearce, 1962


*Simkinion bimanum* Park and Pearce, 1962

Figs 2.107–2.108

**Type locality:** [ND] Dobbie’s Park, Whangarei.

**Type depository:** FMNH HT ♂; BMNH 1 PT.

**Notes:** Park and Pearce (1962) designated types for this species, and one male paratype is illustrated here.

Simkinion prelaticum Park and Pearce, 1962

Figs 2.109–2.110


**Type locality:** [ND] Near Russell, North Island.

**Type depository:** FMNH HT ♂, 3 PT; BMNH 2 PT.

**Notes:** Park and Pearce (1962) designated types for this species, and the male holotype is illustrated here.

STARTES Broun, 1886


*Startes foveata* Broun, 1893

Figs 2.111–2.112


**Type locality:** [AK] Hunua Range.
Broun number: 2741.

Notes: Broun mentioned that he had five specimens. Three specimens in the BMNH Broun collection and one specimen in the NZAC collection matching this locality record were located. Another specimen in the NZAC with a Broun number label in Broun’s hand is also considered to be part of the syntype series. There are two additional specimens in the BMNH main collection and three specimens in the NZAC lacking locality labels and are not considered to be part of the syntype series. All syntypes are females, contrary to the labelling of the two specimens in the BMNH as “males”. However, as to stabilize this name, a lectotype and four paralectotypes are still here designated for Startes foveata.


Startes sculpturata Broun, 1886

Figs 2.113–2.114

**Type locality:** [AK] Waitakerei Range.

**Broun number:** 1475.

**Notes:** Broun did not mention the number of specimens he examined. One specimen in the BMNH Broun collection and one specimen in the NZAC with labels in Brookes’ hand matching this locality record were located and are considered to be syntypes. There is one additional specimen in the BMNH main collection labelled as “variant”, that I do not consider being part of the syntype series. All syntypes are females. In order to stabilize this name, a lectotype and a paralectotype are still here designated for *Startes sculpturata*.

FIGURES 2.1–2.6. Primary type specimens and labels of New Zealand genera of Goniaceritae and their extralimital species.

2.1–2.2) Holotype, *Anabaxis minor* Broun, 1921a; labels.

2.3–2.4) Lectotype, *Anabaxis euplectoides* (Broun, 1893a); labels.

2.5–2.6) Holotype, *Eupines (Byraxis) allocera* (Broun, 1893b); labels.
FIGURES 2.7–2.12. Primary type specimens and labels of New Zealand genera of Goniaceritae and their extralimital species.

2.7–2.8) Lectotype, *Eupines (Byraxis) anisarthra* (Broun, 1914b); labels.

2.9–2.10) Lectotype, *Eupines (Byraxis) bisulcifrons* (Broun, 1914b); labels.

2.11–2.12) Lectotype, *Eupines (Byraxis) calcarata* (Broun, 1886); labels.
FIGURES 2.13–2.18. Primary type specimens and labels of New Zealand genera of Goniaceritae and their extralimital species.

2.13–2.14) Lectotype, *Eupines (Byraxis) clemens* Broun, 1921b; labels.
2.15–2.16) Lectotype, *Eupines (Byraxis) conspicua* (Broun, 1893a); labels.
2.17–2.18) Lectotype, *Eupines (Byraxis) costata* (Broun, 1893a); labels.
FIGURES 2.19–2.24. Primary type specimens and labels of New Zealand genera of Goniaceritae and their extralimital species.


2.21–2.22) Lectotype, *Eupines* (*Byraxis*) *decens* (Broun, 1893a); labels.

2.23–2.24) Holotype, *Eupines deformis* (Sharp, 1874); labels.
FIGURES 2.25–2.30. Primary type specimens and labels of New Zealand genera of Goniaceritae and their extralimital species.
2.25–2.26) Lectotype, *Eupines (Byraxis) dispar* (Sharp, 1874); labels.
2.27–2.28) Lectotype, *Bryaxis ovalipennis* Schaufuss, 1880a; labels.
FIGURES 2.31–2.36. Primary type specimens and labels of New Zealand genera of Goniaceritae and their extralimital species.
2.31–2.32) Holotype, *Eupines (Byraxis) forficulida* (Broun, 1890); labels.
2.33–2.34) Holotype, *Eupines (Byraxis) foveatissima* (Broun, 1890); labels.
2.35–2.36) Lectotype, *Eupines (Byraxis) fraudulenta* (Broun, 1886); labels.
FIGURES 2.37–2.42. Primary type specimens and labels of New Zealand genera of Goniaceritae and their extralimital species.

2.37–2.38) Holotype, *Eupines (Byraxis) glabrata* (Broun, 1886); labels.
2.39–2.40) Lectotype, *Eupines (Byraxis) grata* (Sharp, 1874); labels.
2.41–2.42) Lectotype, *Eupines (Byraxis) halli* (Broun, 1921b); labels.
FIGURES 2.43–2.48. Primary type specimens and labels of New Zealand genera of Goniaceritae and their extralimital species.
2.43–2.44) Lectotype, *Eupines* (*Byraxis*) *hectori* (Broun, 1895); labels.
2.45–2.46) Holotype, *Eupines* (*Byraxis*) *ignotus* (Broun, 1881); labels.
2.47–2.48) Lectotype, *Eupines* (*Byraxis*) *illustris* (Broun, 1914b); labels.
FIGURES 2.49–2.54. Primary type specimens and labels of New Zealand genera of Goniaceritae and their extralimital species.

2.49–2.50) Lectotype, *Eupines (Byraxis) impar* (Sharp, 1874); labels.

2.51–2.52) Holotype, *Eupines (Byraxis) impressifrons* (Broun, 1880); labels.

2.53–2.54) Holotype, *Eupines (Byraxis) lewisi* Broun, 1910; labels.
FIGURES 2.55–2.60. Primary type specimens and labels of New Zealand genera of Goniaceritae and their extralimital species.

2.55–2.56) Lectotype, *Eupines (Byraxis) longiceps* Raffray, 1904; labels.

2.57–2.58) Lectotype, *Eupines (Byraxis) micans* (Sharp, 1874); labels.

2.59–2.60) Lectotype, *Eupines (Byraxis) monstrosa* (Reitter, 1880); labels.
FIGURES 2.61–2.66. Primary type specimens and labels of New Zealand genera of Goniaceritae and their extralimital species.

2.61–2.62) Lectotype, *Eupines (Byraxis) mundula* (Schaufuss, 1888); labels.
2.63–2.64) Lectotype, *Eupines (Byraxis) munroi* (Broun, 1890); labels.
2.65–2.66) Holotype, *Eupines (Byraxis) nasuta* (Broun, 1880); labels.
FIGURES 2.67–2.72. Primary type specimens and labels of New Zealand genera of Goniaceritae and their extralimital species.

2.67–2.68) Holotype, *Eupines (Byraxis) nemoralis* (Broun, 1886); labels.

2.69–2.70) Lectotype, *Eupines nesobia* Broun, 1914a; labels.

2.71–2.72) Holotype, *Eupines (Byraxis) paganus* (Broun, 1881); labels.
FIGURES 2.73–2.78. Primary type specimens and labels of New Zealand genera of Goniaceritae and their extralimital species.
2.73–2.74) Lectotype, *Eupines piciceps* (Broun, 1880); labels.
2.75–2.76) Lectotype, *Eupines (Byraxis) platyarthra* (Broun, 1893a); labels.
2.77–2.78) Holotype, *Eupines (Byraxis) platynota* (Broun, 1893a); labels.
FIGURES 2.79–2.84. Primary type specimens and labels of New Zealand genera of Goniaceritae and their extralimital species.

2.79–2.80) Lectotype, *Eupines (Byraxis) rhyssarthra* (Broun, 1912); labels.

2.81–2.82) Holotype, *Eupines (Byraxis) rudicornis* Broun, 1882; labels.

2.83–2.84) Lectotype, *Eupines (Byraxis) sanguinea* (Broun, 1880); labels.
FIGURES 2.85–2.90. Primary type specimens and labels of New Zealand genera of Goniaceritae and their extralimital species.

2.85–2.86) Lectotype, *Eupines (Byraxis) setifera* (Broun, 1893b); labels.
2.87–2.88) Lectotype, *Eupines simplex* Broun, 1913; labels.
2.89–2.90) Lectotype, *Eupines (Byraxis) sternalis* (Broun, 1893b); labels.
FIGURES 2.91–2.96. Primary type specimens and labels of New Zealand genera of Goniaceritae and their extralimital species.

2.91–2.92) Lectotype, *Eupines (Byraxis) sylvicola* (Broun, 1884); labels.
2.93–2.94) Lectotype, *Eupinogitus sulcipennis* Broun, 1921a; labels.
2.95–2.96) Holotype, *Eupinogitus picescens* Broun, 1921a; labels.
FIGURES 2.97–2.102. Primary type specimens and labels of New Zealand genera of Goniaceritae and their extralimital species.

2.97–2.98) Lectotype, *Eupinolus altulus* (Broun, 1880); labels.

2.99–2.100) Lectotype, *Eupinolus punctatus* (Broun, 1886); labels.

2.101–2.102) Holotype, *Gastrobothrus abdominalis* (Broun, 1880); labels.
FIGURES 2.103–2.108. Primary type specimens and labels of New Zealand genera of Goniaceritae and their extralimital species.
2.103–2.104) Lectotype, *Gastrobothrus sharpi* (Broun, 1880); labels.
FIGURES 2.109–2.114. Primary type specimens and labels of New Zealand genera of Goniaceritae and their extralimital species.


2.111–2.112) Lectotype, *Startes foveata* Broun, 1893b; labels.

2.113–2.114) Lectotype, *Startes sculpturata* Broun, 1886; labels.
3.

Revision of Eupines King of New Zealand (Coleoptera: Staphylinidae: Pselaphinae: Goniaceritae)

In review, Zootaxa.

3.1 Introduction

The genus Eupines was erected by King (1866) and presently includes 141 known species (Shen & Leschen 2019). The described species are disproportionately distributed in Australasia (Australia, 83; New Zealand, 48; New Caledonia, 5), with only five species recorded in East Asia. Eupines is the largest goniacerite genus of Pselaphinae in New Zealand, representing about 76% of the total described species within the supertribe. Studies on this genus are very limited after entomologist Broun’s last publication on New Zealand fauna in 1923. In recent years, only little research on Eupines has been done: Chandler (2001) transferred E. (B.) altula (Broun) and E. (E.) punctata (Broun) to Eupinolus Oke; Nomura and Leschen (2006) catalogued the New Zealand species; Théry & Leschen (2013) described four species from the Three Kings Islands; more recently, Shen and Leschen (2019) designated types for all valid species. During our examination of both dry and wet material and type specimens, many undescribed species and synonymies were discovered. Moreover, the lack of an adequate identification key and dissection of known species strongly impede
taxonomic work on this genus. Therefore, it is imperative to undertake a thorough revision to address the issues above.

Members of *Eupines* can be defined by the pronotum lacking a median antebasal fovea and the elytra lacking basal foveae and discal striae. Males are often easily identified to species by their antennae conspicuously modified, along with other sexually dimorphic characters on protrochanters, protibiae, mesotibiae, ventrite 2 (true segment 4) or ventrite 6 (true segment 8). Members of *Eupines* are distributed throughout New Zealand and are most commonly found in broadleaf forest litter and rotten wood, and sometimes in moss. Two species were collected from ant nests (Broun 1880, Nomura & Leschen 2015), yet their ant-associations may be coincidental. Two species were collected by beating which indicates their possible arboreal habitat.

In this chapter, I thoroughly revise the New Zealand fauna of *Eupines* to include a total of 48 species with 22 new species. All species are keyed, illustrated and provided with taxonomic history, type depositories and distribution maps, apart from four species covered recently (Théry & Leschen 2013). Synonyms and new combinations are proposed where needed.

### 3.2 Material and Methods

All specimens from field trips were collected under the authority of the Department of Conservation: Picton permit 69456-FAU; Nelson Lakes permit 52286-RES; the Landcare Research General concession (CA-31615-OTH). Specimens were examined from the following collections:

<table>
<thead>
<tr>
<th>Code</th>
<th>Collection</th>
</tr>
</thead>
<tbody>
<tr>
<td>AMNZ</td>
<td>Auckland War Memorial Museum, Auckland, New Zealand (J. Early);</td>
</tr>
<tr>
<td>BMNH</td>
<td>The Natural History Museum, London, United Kingdom (M. Geiser);</td>
</tr>
</tbody>
</table>
DSC University of New Hampshire, Durham, NH, U.S.A. (D. Chandler);
FMNH Field Museum of Natural History, Chicago, U.S.A. (C. Maier);
JNPC John Nunn Personal Collection, Dunedin, New Zealand;
LSAM Louisiana State Arthropod Museum, Louisiana State University, Baton Rouge, LA, U.S.A. (C. Carlton);
LUNZ Entomology Research Museum, Christchurch, New Zealand (J. Marris);
MNHN Museum National d’Histoire Naturelle, Paris, France (A. Taghavian);
NMPC National Museum, Prague, Czech Republic (M. Fikáček);
NZAC New Zealand Arthropod Collection, Auckland, New Zealand.

Format of the descriptions largely follows Shen and Leschen (2018). Taxonomic history, type localities and type depositories of previously named species are listed in Shen and Leschen (2019). Type specimens housed in the BMNH were examined, with part of them loaned for further identification. Types of new species described in this paper and non-type specimen are deposited in NZAC except where indicated. Double quotes (“”) are used to enclose label information of the holotypes. The two-letter geographic codes of New Zealand (Crosby et al. 1998) were added where needed. The following abbreviations are applied to the type material: HL = holotype; LT = lectotype; PT = paratype; PLT = paralectotype.

The numerals for abdominal tergites and ventrites refer to morphological segments (tergites 1–6 = true segments 4–9, ventrites 1–7 = true segments 3–9). Abbreviations for antennal segments are A3–A11 (= antennomere 3–antennomere 11). The majority of species can easily be sorted to species by often having unique modifications on antennomeres 4, 5, 6, 7, 8, 9, 10 or 11 of the males. A few males with similar antennal characters can also be distinguished by modifications on legs or ventrites. On the other hand, females cannot be identified to species, moreover, multiple species may be sympatric; therefore, I here record
females of known species as ‘associated females’, and only males are selected as paratypes of new species. The key and distribution maps are based solely on males.

All species, newly discovered and previously known, are described here, apart from four *Eupines* species from the Three Kings Islands described recently by Théry and Leschen (2013; *E. chandleri, E. crosbyi, E. tronqueti, E. watti*). *Eupines acceptus* (Broun) is treated as *Eupines, incertae sedis*, for which type material could not be located, and is not redescribed here. Four species based solely on female types are also not redescribed herein (*E. deformis* (Sharp), *E. nesobia* Broun, *E. piciceps* (Broun), and *E. simplex* Broun). Dissection of species represented by singletons is not done if they can be readily differentiated from other members of the genus.

External morphology was studied with a Leica MZ12 binocular stereomicroscope. Males were imaged by a Canon EOS 800DS mounted with a Laowa 25 mm F/2.8 2.5–5 × lens and were then softened in boiling water for 30 seconds or in KOH for half an hour at room temperature if dissection is needed. The extracted genitalia were dehydrated in 100% ethanol before being mounted in Euparal on an acetate card and were then photographed using a Nikon DS-Fi1 camera attached to a Leica DM 4500B compound microscope. Multiple layers were stacked in Helicon Focus V6 and were then edited in Adobe Photoshop CS6. Holotypes and paratypes are affixed with red labels and blue labels, respectively.

3. 3 Taxonomy

**EUPINES** King, 1866

Figs 3.1–3.2

*Eupines* King (subgenus of *Bryaxis* Kugelann), 1866: 309. Elevated to genus by Broun 1886: 759. **Type species:** *Bryaxis clavatula* King, subsequent designation by Jeannel 1952: 84.
Raffray 1897: 258, 1900: 171, 1908: 206; Chandler 2001: 320; Nomura and Leschen
2006: 253; Shen & Leschen: 258.

Byraxis Reitter, 1880: 166. Type species: Byraxis monstrosa Reitter, by monotypy.
Reduction to subgenus by Raffray 1904: 202.

Patranus Raffray, 1890: 123. Type species: Tychus politus Schaufuss (=Byraxis globulifer Schaufuss), by monotypy. Synonymised by Raffray 1900: 171.


**Diagnosis:** Head with asetose vertexal foveae small or lacking; lacking frontal fovea; antennal clubs 1–4 segmented; antennal tubercles moderately developed to lacking; postantennal notches small or lacking; postantennal cavities present from vaguely visible to as long as antennal tubercles; ventrolateral margin beneath eyes often rounded; median gular ridge narrow and low, barely visible in lateral view. Pronotum with lateral antebasal foveae punctiform or lacking; lacking median antebasal fovea. Elytra lacking basal foveae and discal stria. Abdominal tergite 1 lacking mediobasal foveae and discal carinae; ventrite 2 lacking mediobasal foveae.

**Redescription:** Body length 1.23–2.10 mm [based on New Zealand members of *Eupines*], generally short and compact in dorsal view; body colour reddish-brown to dark brown and rarely black; head and pronotum smooth, elytra and abdomen micropunctate or smooth; lacking setae or with sparsely scattered short decumbent setae on pronotum, elytra and abdomen, average length longer than length of eyes. Head with asetose vertexal foveae (Fig. 3.1A) small or lacking, often punctiform; lacking frontal fovea; frontal rostrum often
moderately developed; antennal tubercles moderately developed to lacking; postantennal notches distinctively margined to lacking; postantennal cavity (Figs 3.1A–B) extend from dorsal side of head to lateral side of antennal insertions, size vary from vaguely visible to as long as antennal tubercles; eyes often well developed and prominent; antennae (Figs 3.1F–G) 9-segmented, 10-segmented or 11-segmented in males and 11-segmented in females, antennal clubs 1–4 segmented, with scape and pedicel elongate; ocular-mandibular carinae (Fig. 3.1B) present; ventrolateral margin rounded beneath eyes or with short basal carinae; median gular ridge (Fig. 3.1C) narrow and low, barely visible in lateral view, curved posteriorly to asetose gular foveae (Fig. 3.1C); mouth (Figs 3.1D–E) with labial palp truncate at apex, with pair of long apical setae, mentum widest at middle, lacinia well developed, galea fused with lacinia, maxillary palpi with segment 2 slender and clavate, segment 3 trapezoidal, segment 4 large and fusiform, sensory area with stout apical setae, mandible with pair of subapical setae, labrum trapezoidal.

Pronotum about as long as wide; lacking median antebasal fovea; lateral antebasal foveae punctiform or lacking; lacking antebasal sulcus and median longitudinal sulcus; setose lateral procoxal foveae (Fig. 3.1J) small and often widely separated.

Elytra (Fig. 3.2N) slightly wider than long, longer than abdomen in dorsal view, with posterior margin often rounded; each elytron lacking basal foveae and discal carinae; sutural stria distinct to lacking.

Mesoventrite (Fig. 3.1K) with asetose prepectal foveae vaguely visible; setose median mesoventral foveae bifurcate at apex, often forming triangular cavity; pair of setose lateral mesoventral foveae large and nearly meet internally; setose lateral mesocoxal foveae often small. Metaventrite with setose lateral metaventral foveae small.

Abdomen (Figs 3.2A, 3.2G) convex, with tergite 1 about 1.5 × to 2 × longer than tergite 2; tergite 1 (Fig. 3.2B) with basolateral foveae vaguely visible; lacking mediobasal
fovea, discal carinae and mediobasal impression; tergites 2–4 (Figs 3.2C–E) lacking basolateral foveae; paratergites visible on tergites 1–3 and carinate on tergite 4. Abdominal ventrite 2 with basolateral foveae (Fig. 3.2I) vaguely visible, ventrites 3–5 (Figs 3.2J–L) lacking basolateral foveae.

Legs with protarsomereres 2 and 3 subequal in length, mesotarsomere 2 slightly longer than mesotarsomere 3, metatarsomere 2 about as long as metatarsomere 3.

Males with antennae, protrochanters, protibiae, mesotibiae, ventrite 2 or ventrite 6 modified. Aedeagus with well-developed and often symmetrical parameres; median lobe often with two sclerites; basal bulb relatively small; lacking dorsal diaphragm.

Relationships: Within the New Zealand fauna, *Eupines* is most similar to *Simkinion* Park and Pearce by the pronotum lacking a median antebasal fovea, tergite 1 lacking the mediobasal impression and ventrites 4–5 lacking the basolateral foveae. It can be readily separated from *Simkinion* by lacking the basal elytral foveae and the low median gular ridge, which is prominent in *Simkinion*. *Eupines* is also similar to *Eupinolus* Oke by lacking the basal elytral foveae and the short abdomen. They are separated by the presence of a small median antebasal fovea and the punctate pronotal base in *Eupinolus*, which are lacking in *Eupines*. In Australia, Chandler (2001) stated that *Eupines* is closely related to *Storeyella* Chandler and *Wataranka* Chandler but can be easily differentiated from both by the smooth basal pronotal area and the lack of a median antebasal pronotal fovea.

Comments: The lack of the basal elytral foveae, the median antebasal pronotal fovea and the basolateral foveae on tergites and ventrites, suggest that *Eupines* may be more derived than all other goniacerite genera in New Zealand. Two subgenera are recognised in the genus, with the subgenus *Byraxis* much more diverse in New Zealand than members of the nominate subgenus *Eupines*. In Australia, it is the reverse, with the subgenus *Eupines* having more diversity, perhaps due to wrong subgeneric placements or insufficient studies (Chandler,
The subgenus *Byraxis* is characterized by males with only 10 antennomeres, and the males of the nominate *Eupines* have 11 antennomeres: females of both subgenera have 11-segmented antennae. Nomura & Leschen (2006) listed nine species under the nominate subgenus in New Zealand, five of which are here found not members of *Eupines*, three of which are based solely on female types, and the last one was transferred to *Byraxis* (Shen & Leschen 2019). Yet, only one new species would be formally a member of the subgenus *Eupines* in New Zealand, with all remaining species placed into *Byraxis*, apart from *E. novem* sp. n., whose male has only 9 antennomeres that is not placed into a subgenus.

Three species are excluded from this revision (*E. (E.) grata* (Sharp), *E. clemens* Broun and *E. (E.) sternalis* (Broun)) which I describe elsewhere as a new genus different from *Eupines* due to the presence of the shallow antebasal pronotal sulcus, the short discal elytral striae, and different genitalic characters.
3.4 Key to the males of New Zealand *Eupines* King

The species key below is based solely on males, females, of which, cannot be readily identified to species. Species endemic to the Three Kings Islands are indicated by an asterisk (*).

1 Antennae 10-segmented (Fig. 3.1G); abdominal ventrite 2 modified (except *E. (B.) nemoralis*; Fig. 3.35F)..................................................................................................................3
   - Antennae not 10-segmented; abdominal ventrite 2 unmodified ............................. 2
2 Antennae 9-segmented (Fig. 3.36B); protrochanters lacking ventral spine (Fig. 3.36D).....
   ......................................................................................................................*E. novem* sp. n.
   - Antennae 11-segmented (Fig. 3.47A); protrochanters with short ventral spine (Fig. 3.47D)
   ......................................................................................................................*E. (E.) undecim* sp. n.
3 Antennomere 5 modified (Fig. 3.3B)............................................................................. 4
   - Antennomere 5 unmodified...................................................................................... 17
4 Antennomere 10 conspicuously modified, not conical (Fig. 3.31B) ......................... 5
   - Antennomere 10 unmodified, conical .................................................................... 8
5 Protibiae with apical spine and protuberance (Fig. 3.43E); body colour black (Fig. 3.43A).
   ......................................................................................................................*E. (B.) protibialis* sp. n.
   - Protibiae unmodified; body colour often reddish-brown to dark brown................. 6
6 Antennomere 9 longer than wide (Fig. 3.31B) ...........................................*E. (B.) micans* (Sharp)
   - Antennomere 9 transverse (Fig. 3.19D)................................................................. 7
7 Antennomere 7 longer than wide .........................................................*E. (B.) crosbyi* Théry & Leschen
   - Antennomere 7 disc-shaped, much wider than long (Fig. 3.19B)...........*E. (B.) graceae* sp. n.
8 Protibiae and/or mesotibiae modified ........................................................................ 9
   - Protibiae and mesotibiae unmodified...................................................................... 13
9  Both protibiae and mesotibiae modified (Figs 3.20E–F).................. E. (B.) halli (Broun)
   - Protibiae or mesotibiae modified .......................................................... 10
10 Only protibiae modified ........................................................................... 11
   - Only mesotibiae modified ........................................................................ 12
11 Antennomere 9 much longer than antennomere 10 (Fig. 3.15B)........ E. (B.) dugdalei sp. n.
   - Antennomere 9 about as long as antennomere 10 (Fig. 3.37B).......... E. (B.) obtusa sp. n.
12 Mesotibiae with minute apical spine, much shorter than mesotibial width (Fig. 3.32E); A6 unmodified (Fig. 3.32B).............................................................................. E. (B.) minuta sp. n.
   - Mesotibiae with large apical spine, longer than mesotibial width (Fig. 3.27F); A6 enlarged and strongly asymmetrical (Fig. 3.27B).............................. E. (B.) insolita sp. n.
13 Antennomere 5 much longer than wide (Fig. 3.3C)............................... 14
   - Antennomere 5 about as long as wide (Fig. 3.38B).................................. 15
14 Antennomere 9 slightly wider than long (Fig. 3.3B)....................... E. (B.) anisarthra (Broun)
   - Antennomere 9 much longer than wide (Fig. 3.23B).................... E. (B.) huizhenae sp. n.
15 Antennomere 5 larger than remaining segments (Fig. 3.38D).......... E. (B.) ovalis sp. n.
   - Antennomere 10 larger than remaining segments .................................. 16
16 Antennomere 5 larger than antennomere 9 (Fig. 3.15B)............ E. (B.) bisulcifrons (Broun)
   - Antennomere 5 smaller than antennomere 9 (Fig. 3.28B).............. E. (B.) lewisi Broun
17 Antennomere 10 conspicuously modified (Fig. 3.29B)...................... 18
   - Antennomere 10 unmodified................................................................. 27
18 Protibiae or mesotibiae modified .......................................................... 19
   - Protibiae and mesotibiae unmodified.................................................. 20
19 Mesotibiae unmodified, protibiae with minute apical protuberance (Fig. 3.29E); aedeagus with barely visible sclerites (Fig. 3.29H)...................... E. (B.) longiceps Raffray
- Mesotibiae slightly convex near apex, with long tuft of subapical setae (Fig. 40E), protibiae unmodified; aedeagus with two slender sclerites (Fig. 3.40I)...............................E. (B.) pannicula sp. n.

20 Antennomere 10 much larger than antennomere 9 (Fig. 3.6C).................................21
- Antennomere 10 about as larger as or smaller than antennomere 9..........................22

21 Antennomere 9 slightly longer than wide (Fig. 3.34B) .........E. (B.) mundula (Schaufuss)
- Antennomere 9 strongly transverse and cupulate (Fig. 3.6B).......... E. (B.) caesta sp. n.

22 Antennomere 9 strongly transverse, 2 × wider than antennomere 10 (Fig. 3.42B) ...........
........................................................................................................E. (B.) plathyarthra (Broun)
- Antennomere 9 as wide as or narrower than antennomere 10 (Fig. 3.33B).............23

23 Antennomere 9 transverse (Fig. 3.33B).................................................................24
- Antennomere 9 longer than wide ........................................................................25

24 Ventrite 6 much wider than long (Fig. 3.10F).................................E. (B.) conspicua (Broun)
- Ventrite 6 about as long as wide (Fig. 3.33F)................................. E. (B.) monstrosa (Reitter)

25 Antennomere 6 strongly transverse (Fig. 3.39B)............... E. (B.) paganus (Broun)
- Antennomere 6 longer than wide .......................................................................26

26 Ventrite 6 with long median struts, longer than half length of ventral 6 (Fig. 3.12G);
    abdominal ventrite 2 with pair of small nude discal protuberances (Fig. 3.12F); aedeagus
    with asymmetrical sclerites (Fig. 3.12H).........................................................E. (B.) decens (Broun)
- Ventrite 6 with short median struts, about one-fifth length of ventral 6 (Fig. 3.41F);
    abdominal ventrite 2 with pair of small discal protuberances, inserted with slightly curved
    small apical setae (Fig. 3.41E); aedeagus with symmetrical sclerites (Fig. 3.41H)...........
    ..................................................................................................................E. (B.) petila sp. n.

27 Antennomere 8 elongate and concave at lateral side (Fig. 3.11C).......................28
- Antennomere 8 unmodified..................................................................................29
28 Antennomere 7 disc-shaped and much wider than antennomere 6; aedeagus with two long and curved sclerites (Fig. 3.11B) ........................................ E. (B.) crassicornides Newton
- Antennomere 7 as wide as antennomere 6; aedeagus lacking sclerites but with dense setae.
  ........................................................................................................... *E. (B.) chandleri Théry & Leschen
29 Protrochanters lacking ventral spine (Fig. 3.22D); aedeagus lacking sclerite (Fig. 3.22E)....
  ............................................................................................................ E. (B.) hoarei sp. n.
- Protrochanters modified with ventral spine; aedeagus with sclerites ................................. 30
30 Body length longer than 1.90 mm, around 2.00 mm .............................................................. 31
- Body length much shorter than 1.90 mm, around 1.50 mm .................................................... 34
31 Antennomere 10 conical, unmodified (Fig. 3.45B); aedeagus with two large sclerites (Fig. 3.45G) ........................................................................................................ E. (B.) waikaremoana sp. n.
- Antennomere 10 modified; aedeagus with single sclerite ................................................. 32
32 Antennomere 9 twice longer than wide (Fig. 3.7B); protrochanters with long ventral spine, about twice of protrochanteral width (Fig. 3.7E) ................................. E. (B.) carinata sp. n.
- Antennomere 9 about as long as wide; protrochanters with ventral spine, about as wide as protrochanters .................................................................................................................. 33
33 Antennomere 10 bean-shaped and strongly concave at lateral side (Fig. 3.14B) ...........
  ................................................................................................................. E. (B.) dispar (Sharp)
- Antennomere 10 convex at lateral side and with deep basal excavation (Fig. 3.17C)....... 
  ................................................................................................................. E. (B.) gigas sp. n.
34 Ventrite 2 lacking discal protuberance, with apical setae (Fig. 3.35F) ......................... 35
- Ventrite 2 with discal protuberances and apical setae ......................................................... 36
35 Protrochanters with long and acute ventral spine (Fig. 3.35E) ............................... E. (B.) nemoralis (Broun)
- Protrochanters lacking ventral spine but setose .......................... *E. (B.) tronqueti Théry & Leschen
36 Ventrite 2 with single fused median protuberance (Fig. 3.8F) .......................... E. (B.) coalita sp. n.
- Ventrite 2 with pair of median protuberances.................................................................37

37 Mesotibiae with small subapical spine, protibiae with minute spine in apical two-thirds
(Figs 3.26E–F)..............................................................................................................E. (B.) impressifrons (Broun)
- Mesotibiae unmodified, protibiae with apical spine or unmodified................................38

38 Protibiae modified ...........................................................................................................39
- Protibiae unmodified .........................................................................................................41

39 Antennomere 6 prolonged, about 1.5 × longer than antennomere 7 (Fig. 3.5D)...........
........................................................................................................................................E. (B.) brevis sp. n.
- Antennomere 6 as long as or slightly shorter than antennomere 7 .........................40

40 Antennomere 8 rounded at lateral side (Fig. 3.44D)...............................E. (B.) setifera (Broun)
- Antennomere 8 truncate at lateral side.......................................*E. (B.) wattii Théry & Leschen

41 Antennomere 9 much longer than antennomere 10 (Fig. 3.18D).................................42
- Antennomere 9 about as long as or shorter than antennomere 10 .......................45

42 Antennomere 8 larger than antennomere 7 (Fig. 3.18B), antennomere 9 lacking apical
spine or protuberance ..................................................................................E. (B.) glabrata (Broun)
- Antennomere 8 smaller than antennomere 7, antennomere 9 with apical small spine or
protuberance ..................................................................................................................43

43 Antennomere 9 with apical spine (Fig. 3.46C); aedeagus with four sclerites..........44
- Antennomere 9 with barely visible subapical protuberance (Fig. 3.25B); aedeagus with
two sclerites (Fig. 3.25G).........................................................................................E. (B.) impar (Sharp)

44 Antennomere 5 longer than wide (Fig. 3.46B); body colour dark brown (Fig. 3.46A)....
........................................................................................................................................E. (B.) whirinaki sp. n.
- Antennomere 5 transverse (Fig. 3.9B); body colour reddish-brown (Fig. 3.9A)...........
........................................................................................................................................E. (B.) complector sp. n.
45 Abdominal ventrite 2 with pair of large trichomes (Fig. 3.24C); protrochanters with barely visible ventral spine; antennomere 9 much shorter than antennomere 10 (Fig. 3.24B)..........

...............................................................E. (B.) illustris (Broun)
- Abdominal ventrite 2 with pair of small apical setae; protrochanters with long ventral spine, at least half of protrochanteral width; antennomere 9 as long as or slightly longer than antennomere 10 .................................................................46

46 Antennomere 9 with apical spine; protrochanters with long ventral spine, longer than half of protrochanteral width.................................................................47
- Antennomere 9 lacking apical spine (Fig. 3.30C); protrochanters with short ventral spine, shorter than half of protrochanteral width (Fig. 3.30E) ..................E. (B.) mayae sp. n.

47 Ventrite 6 with long median struts, about three-fourths of ventral length (Fig. 3.21G); aedeagus with three long sclerites (Fig. 3.21H) ......................E. (B.) hectori (Broun)
- Ventrite 6 with short median struts, about one-third of ventral length (Fig. 3.16G); aedeagus with two long sclerites (Fig. 3.16H) ..................E. (B.) fraudulenta (Broun)

**Eupines (Byraxis) anisarthra** (Broun, 1914)

Figs 3.3, 3.48


**Type locality:** [MC] Broken River.

**Type depository:** BMNH LT ♂, 1 PLT.

**Diagnosis:** Head with vertexal foveae punctiform; antennae 10-segmented with 2-segmented club; A4, A6, A7, A8 and A10 unmodified, A4 slightly asymmetrical, A5 large and
asymmetrical, wider than A4 at middle and longer than A3 + A4, outer margin pinched, A9 large, about 4 × longer than A8, A10 conical, about 1.6 × longer than A9. Abdominal ventrite 2 with pair of small discal protuberances, inserted with strongly curved apical setae; ventrite 6 with pair of median struts, about one-fourth of ventral length. Protrochanters with barely visible ventral spine, shorter than one-tenth of protrochanteral width; protibiae and mesotibiae unmodified.

**Redescription:** Body length 1.51–1.63 mm; body colour reddish-brown to dark brown with lighter coloured elytra and legs. **Head** about as long as wide; frons narrowed at end, slightly shorter than half width of head at eye level; eyes well developed, with about 34 facets; vertexal foveae punctiform; lacking antennal tubercles and postantennal notches; postantennal cavities small, slightly shorter than half length of antennal tubercles in dorsal view; antennae 10-segmented with 2-segmented club; A4, A6, A7, A8 and A10 unmodified, A4 slightly asymmetrical, A5 large and asymmetrical, wider than A4 at middle and longer than A3 + A4, outer margin pinched, A9 large, about 4 × longer than A8, A10 conical, about 1.6 × longer than A9. **Pronotum** wider than long, slightly wider than head at eye level; **Elytra** slightly wider than long, widest near middle; humeral calli slightly prominent; sutural stria distinctive at base and vaguely visible near apex. **Abdomen** with tergite 1 about 1.5 × longer than tergite 2; ventrite 2 with pair of small discal protuberances, inserted with strongly curved apical setae; ventrite 6 with pair of median struts, about one-fourth of ventral length. **Legs** with protrochanters modified with barely visible ventral spine, shorter than one-tenth of protrochanteral width; protibiae and mesotibiae unmodified. **Aedeagus** about 0.28 mm long; with elongate and thin parameres, curved downwards and twisted at apex, with two long subapical setae; median lobe with two long sclerites, slightly wider than parameres in dorsal view, left one curved inward subapically, right one bent abruptly.
Comments: *E. (B.) anisarthra* is similar to *E. (B.) minuta* by having A5 and A9 similarly modified, and can be separated from it by the unmodified mesotibiae (a small apical spine is present in *E. (B.) minuta*; Fig. 3.32E).

Distribution: South Island. MC, CO.

Additional material examined: 3 ♂♂, CO: 2, Carrick Range, Watts Rock, 1380m, 31/Oct/1979, J.C. Watt, moss 79/133; 1, JNPC, Old Man Range, Headwaters, Obelisk Ck. 1380m, 13/Jan/07. Associated females (2 ♀♀): 2, CO: Carrick Range, Watts Rock, 1380m, 31/Oct/1979, J.C. Watt, moss 79/133.

**Eupines (Byraxis) bisulcifrons** (Broun, 1914)

Figs 3.4, 3.48


**Type locality:** [MC] Mount Hutt.

**Type depository:** BMNH LT ♂, 1 PLT.

**Diagnosis:** Head lacking vertexal foveae; antennae 10-segmented with 2-segmented antennal club; A4, A6, A7, A8 and A10 unmodified, A5 asymmetrical and triangular, excavated at base, A9 asymmetrical, about 3 × longer than A8, inner apical margin expanded, A10 conical, slightly impressed at base, about 1.8 × longer than A9. Abdominal ventrite 2 with pair of small discal protuberances, inserted with strongly curved small apical setae; ventrite 6 unknown. Protrochanters with minute ventral spine, about one-ninth of protrochanteral width; protibiae and mesotibiae unmodified.

**Redescription:** Body length 1.43 mm; body colour reddish-brown with lighter coloured tibiae and tarsi. **Head** wider than long; frons slightly narrowed at end, about half width of head at eye level; eyes slightly prominent in dorsal view, with about 22 facets; lacking vertexal foveae; antennal tubercles barely visible; lacking postantennal notches; postantennal cavities large, slightly longer than antennal tubercles in dorsal view; antennae 10-segmented with 2-segmented antennal club; A4, A6, A7, A8 and A10 unmodified, A5 asymmetrical and triangular, excavated at base, A9 asymmetrical, about 3 × longer than A8, inner apical margin expanded, A10 conical and slightly impressed at base, about 1.8 × longer than A9. **Pronotum** about as long as wide, wider than head at eye level; lacking lateral antebasal foveae. **Elytra** slightly wider than long, widest at apical two-thirds; humeral calli barely visible; sutural striae distinctively extending from base to apex. **Abdomen** with tergite 1 about 2.3 × longer than
tergite 2; ventrite 2 with pair of small discal protuberances, inserted with strongly curved small apical setae; ventrite 6 unknown. **Legs** with protrochanters modified with minute ventral spine, about one-ninth of protrochanteral width; protibiae and mesotibiae unmodified.

**Aedeagus** unknown.

**Comments:** Apart from the two type specimens, no additional specimen of this species is known. For this reason, I did not attempt to dissect the syntypes, since males of this species have distinctive antennal modification (Fig. 3.4B) which can immediately separate it from its congeners.

**Distribution:** South Island. MC.

**FIGURE 3.4.** Diagnostic characters of *E. (B.) bisulcifrons* (Broun, 1914). A) Habitus. B) Abdomen, in ventral view. C) Antenna, in dorsal view. Scale bars: A = 1 mm, B, C = 0.2 mm.
Eupines (Byraxis) brevis sp. nov.

Figs 3.5, 3.48

**Diagnosis:** Head with vertexal foveae punctiform; antennae 10-segmented with 3-segmented antennal club; A4, A5, A6, A7, A8 and A10 unmodified, A6 prolonged, about 1.5 × longer than A5, A8 slightly asymmetrical, A9 largest and asymmetrical, strongly impressed at outer side, with laminate upper margin, A10 conical and slightly shorter than A9. Abdominal ventrite 2 with pair of barely visible discal protuberances, inserted with slightly curved small apical setae; ventrite 6 with pair of barely visible median struts. Protrochanters with long and acute ventral spine, about four-fifths of protochanteral width; protibiae with medium-sized apical protuberance; mesotibiae unmodified.

**Description:** Body length 1.37–1.45 mm; body colour reddish-brown with lighter coloured elytra and legs. **Head** wider than long; frons not narrowed at end, about three-fourths width of head at eye level; eyes well developed and prominent, with about 33 facets; vertexal foveae punctiform; antennal tubercles weak; lacking postantennal notches; postantennal cavities large, about as long as antennal tubercles in dorsal view; antennae 10-segmented with 3-segmented antennal club; A4, A5, A6, A7, A8 and A10 unmodified, A6 prolonged, about 1.5 × longer than A5, A8 slightly asymmetrical, A9 largest and asymmetrical, strongly impressed at outer side, with laminate upper margin, A10 conical and slightly shorter than A9. **Pronotum** slightly longer than wide, narrower than head at eye level; lacking lateral antebasal foveae. **Elytra** as long as wide, widest at apical two-thirds; humeral calli weakly developed, slightly prominent in dorsal view; sutural stria shallowly extending from base to apex. **Abdomen** with tergite 1 about 1.5 × longer than tergite 2; ventrite 2 with pair of barely visible discal protuberances, inserted with slightly curved small apical setae; ventrite 6 with pair of barely visible median struts. **Legs** with protrochanters modified with long and acute ventral spine, about four-fifths of protochanteral width; protibiae with medium-sized apical
protuberance; mesotibiae unmodified. **Aedeagus** about 0.23 mm long, with long parameres curved towards each other at apex, slightly sinuate, widest at about apical three-fourths, with three pairs of long subapical setae and two pairs of long apical setae; median lobe with two short and straight sclerites, curved downwards at apex, widest near base, about two-fifths length of parameres.

**Comments:** This species is similar to *E. (B.) setifera* by its similar A9 and apical triangular spine on protibiae, but can be separated from it by having an enlarged A6, much larger than A7, while A6 is obviously smaller than A7 in *E. (B.) setifera* (Fig. 3.44B).

**Distribution:** North Island. AK, WO, TO.

**Etymology:** This specific epithet is a Latin adjective meaning ‘short’, referring to the short sclerites of the aedeagus.

**Type material (NZAC):** **Holotype.** ♂, specimen entire, point-mounted: “NEW ZEALAND, AK, Noises Is., Otata I., 7 Dec–10 Dec 1979 // J.C. Watt & C.F. Butcher, Malaise”.


**Eupines (Byraxis) caesta** sp. nov.

Figs 3.6, 3.48

**Diagnosis:** Head with vertexal foveae punctiform; antennae 10-segmented with 2-segmented antennal club; A4, A5, A6, A7 and A8 unmodified, A9 transverse, cupulate, A10 largest, irregularly cup-shaped, broadly excavated at ventral side. Abdominal ventrite 2 and ventrite 6 unknown. Protrochanters with long and acute ventral spine, slightly shorter than protrochanteral width; protibiae and mesotibiae unmodified.
Description: Body length 1.33 mm; body colour reddish-brown with lighter coloured tarsi. Head slightly wider than long; frons not narrowed at end, about three-fourths width of head at eye level; eyes well developed, slightly prominent in dorsal view; vertexal foveae punctiform; antennal tubercles weakly developed; postantennal notches shallow and broad; postantennal cavities small, about half length of antennal tubercles in dorsal view; antennae 10-segmented with 2-segmented antennal club; A4, A5, A6, A7 and A8 unmodified, A9 transverse, cupulate, A10 largest, irregularly cup-shaped, broadly excavated at ventral side. Pronotum as long as wide, slightly narrower than head at eye level; lacking lateral antebasal foveae. Elytra as long as wide, widest near middle; humeral calli barely visible in dorsal view; sutural stria shallowly extending from base to apex. Abdomen with tergite 1 about 1.6 × longer than tergite 2; ventrite 2 and ventrite 6 unknown. Legs with protrochanters modified with long and acute ventral spine, slightly shorter than protrochanteral width; protibiae and mesotibiae unmodified. Aedeagus unknown.

Comments: Apart from the holotype, no additional specimen is known. For this reason, I did not attempt to dissect the holotype, since the male has an irregularly cup-shaped A10 (Figs 3.6B, 3.6C), which can immediately differentiate it from the other Eupines.

Distribution: North Island. NN.

Etymology: This specific epithet is a Latin noun meaning ‘glove’, referring to the irregularly cup-shaped antennomere 10.

Type material (NZAC): Holotype. ♂, specimen entire, glued on card, one proleg mounted on acetate card: “19.xii.1951, moss, nr. L. Omapere, N.I. P772 [handwritten]”.

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**Eupines (Byraxis) carinata** sp. nov.

Figs 3.7, 3.48

**Diagnosis:** Head with vertexal foveae punctiform; antennae 10-segmented with 2-segmented antennal club; A4, A5, A6, A7 and A8 unmodified, A9 greatly elongated, about five-sixths length of A10, lateral side with two deep striae extending from base to near middle, apical margin slightly wavy, A10 largest and generally conical, lateral side with three narrow carinae splitting one large basal impression and two small anterolateral impressions. Abdominal ventrite 2 with pair of barely visible discal protuberances, inserted with slightly curved large apical setae; ventrite 6 with pair of long and acute median struts, curved towards
each other at apex, about half of ventral length. Protrochanters with long and acute ventral spine, about twice of protrochanteral width; protibiae and mesotibiae unmodified.

**Description:** Body length 1.88–1.99 mm; body colour reddish-brown to dark brown with lighter coloured elytra and legs. **Head** slightly wider than long; frons slightly narrowed at end, about half width of head at eye level; eyes well developed, conspicuously prominent in dorsal view, with about 33 facets; vertexal foveae punctiform; antennal tubercles weakly developed; postantennal notches shallow; postantennal cavities long and narrow, about two-thirds length of antennal tubercles in dorsal view; antennae 10-segmented with 2-segmented antennal club; A4, A5, A6, A7 and A8 unmodified, A9 greatly elongated and about five-sixths length of A10, lateral side with two deep striae extending from base to near middle, apical margin slightly wavy, A10 largest and generally conical, lateral side with three narrow carinae splitting one large basal impression and two small anterolateral impressions. **Pronotum** about as long as wide, slightly wider than head at eye level; with punctiform lateral antebasal foveae. **Elytra** slightly longer than wide, widest near apical two-thirds; humeral distinctive in dorsal view; sutural stria distinctively extending from base to apex. **Abdomen** with tergite 1 about twice length of tergite 2; ventrite 2 with pair of barely visible discal protuberances, inserted with slightly curved large apical setae; ventrite 6 with pair of long and acute median struts, curved towards each other at apex, about half of ventral length. **Legs** with protrochanters modified with long and acute ventral spine, about twice of protrochanteral width; protibiae and mesotibiae unmodified. **Aedeagus** about 0.38 mm long, with long and straight parameres, widest near middle, with pair of long apical setae; median lobe with single large and horn-shaped sclerite, average width narrower than parameres.

**Comments:** This unique species has the largest ratio of ventral spine/protrochanteral widths (Fig. 3.7E) among all known *Eupines* in New Zealand.

**Distribution:** North Island. BP, WN.
**Etymology:** This specific epithet refers to the carina on the last antennomere of this species.

**Type material:** **Holotype.** ♀, JNPC, specimen entire, card-mounted: “NEW ZEALAND, WN, Waikawa Beach, 18 Mar 1990 // J.T. Nunn collection”. **Paratypes.** 1 ex.: **BP:** 1, Waimana Valley 20/Feb/1927 // A.E Brookes Collection.

**FIGURE 3.7.** Diagnostic characters of *E. (B.) carinata* sp. n. **A)** Habitus. **B)** Antenna, in dorsal view. **C)** Same, in lateral view. **D)** Same, in ventral view. **E)** Protrochanter. **F)** Ventrite 2. **G)** Ventrite 6. **H)** Aedeagus, in dorsal view. **I)** Same, in lateral view. **J)** Same, in ventral view. Scale bars: **A** = 1 mm, **B–F** = 0.2 mm, **G–J** = 0.1 mm.
Eupines (Byraxis) coalita sp. nov.

Figs 3.8, 3.48

**Diagnosis:** Head with vertexal foveae punctiform; antennae 10-segmented with 2-segmented antennal club; A4, A5, A6, A7 and A8 unmodified, A9 longest, slightly longer than A10, strongly impressed from middle to apex at ventral side, inserted with long spine within impression, A10 bean-shaped, slightly impressed near base at ventral side. Abdominal ventrite 2 with single fused small discal protuberance, inserted with strongly curved minute apical setae; ventrite 6 with pair of long and acute median struts, about one-third of ventral length. Protrochanters with small ventral spine, about one-third of protrochanteral width; protibiae and mesotibiae unmodified.

**Description:** Body length 1.71 mm; body colour reddish-brown with lighter coloured tarsi. **Head** wider than long; frons not narrowed at end, about three-fourths width of head at eye level; eyes moderately developed, slightly prominent in dorsal view, with about 27 facets; vertexal foveae punctiform; antennal tubercles weakly developed; lacking postantennal notches; postantennal cavities large, about as long as antennal tubercles in dorsal view; antennae 10-segmented with 2-segmented antennal club; A4, A5, A6, A7 and A8 unmodified, A9 longest, slightly longer than A10, strongly impressed from middle to apex at ventral side, inserted with long spine within impression, A10 bean-shaped, slightly impressed near base at ventral side. **Pronotum** as long as wide, about as wide as head at eye level; lacking lateral antebasal foveae. **Elytra** slightly longer than wide, widest at middle; humeral calli moderately developed, distinctively prominent in dorsal view; sutural stria barely visible. **Abdomen** with tergite 1 about 1.3 × longer than tergite 2; ventrite 2 with single fused small discal protuberance, inserted with strongly curved minute apical setae; ventrite 6 with pair of long and acute median struts, about one-third of ventral length. **Legs** with protrochanters modified with small ventral spine, about one-third of protrochanteral width; protibiae and
mesotibiae unmodified. Aedeagus about 0.35 mm long, with long and slender parameres, curved towards each other and bent downwards in lateral view, with three pairs of short subapical setae and two pairs of short apical setae; median lobe large, with two large median sclerites twisted together near apex, about as wide as parameres, left side of median lobe with three small sclerites in dorsal view, left one curved outwards, right two short and straight.

**Comments:** This species is characterized by having ventrite 2 modified with a single fused protuberance (Fig. 3.8F), which can separate it from all its congeners.

**Distribution:** North Island. ND.

**Etymology:** This specific epithet is a Latin adjective meaning ‘grow together’, referring to the fused protuberance on ventrite 2 of this species.


*Eupines (Byraxis) complector* sp. nov.

Figs 3.9, 3.48

**Diagnosis:** Head with vertexal foveae punctiform; antennae 10-segmented with 2-segmented antennal club; A4, A5, A6, A7 and A8 unmodified, A8 disc-shaped, A9 largest, slightly longer than A10, with subapical impression at ventral side and bearing a conspicuous spine at middle, A10 conical and slightly impressed at ventral side. Abdominal ventrite 2 with pair of barely visible discal protuberances, inserted with strongly curved small apical setae; ventrite 6 with pair of long and acute median struts, curved towards each other, about two-thirds of
ventral length. Protrochanters with short and acute ventral spine, slightly shorter than one-third of protrochanteral width; protibiae and mesotibiae unmodified.

**Description:** Body length 1.50–1.60 mm; body colour reddish-brown with lighter coloured tibiae and tarsi. **Head** wider than long; frons not narrowed at end, about three-fourths width of head at eye level; eyes well developed, conspicuously prominent in dorsal view, with about 35 facets; vertexal foveae punctiform; antennal tubercles moderately developed; postantennal notches broad and shallow; postantennal cavities small, about half length of antennal tubercles in dorsal view; antennae 10-segmented with 2-segmented antennal club; A4, A5, A6, A7 and A8 unmodified, A8 disc-shaped, A9 largest, slightly longer than A10, with subapical impression at ventral side and bearing a conspicuous spine at middle, A10 conical and slightly impressed at ventral side. **Pronotum** as long as wide, about as wide as head at eye level; lacking lateral antebasal foveae. **Elytra** about as long as wide, widest at middle; humeral calli and sutural stria barely visible. **Abdomen** with tergite 1 about twice length of tergite 2; ventrite 2 with pair of barely visible discal protuberances, inserted with strongly curved small apical setae; ventrite 6 with pair of long and acute median struts, curved towards each other, about two-thirds of ventral length. **Legs** with protrochanters modified with short and acute ventral spine, slightly shorter than one-third of protrochanteral width; protibiae and mesotibiae unmodified. **Aedeagus** about 0.32 mm long, with slender parameres, curved towards each other, bent downwards in lateral view, with three pairs of long subapical setae and pair of short apical setae; median lobe large, with four entwined sclerites, left one straight and short, right one long and wide, slightly wider than parameres, middle two longer than outer two in dorsal view, strongly entwined together and slightly narrower than parameres.
Comments: This species is most similar to *E. (B.) coalita* by having a similarly modified A9, but can be separated from it by having A5 transverse (Fig. 3.9B) (it is longer than wide in *E. (B.) coalita*).

Distribution: North Island. ND, TO, BP.

Etymology: This specific epithet means ‘entwined’ in Latin, referring to the strongly entwined sclerites in aedeagus of this species.


**Eupines (Byraxis) conspicua** (Broun, 1893)

Figs 3.10, 3.48

*Byraxis conspicua* Broun, 1893a: 1415.

*Eupines (Byraxis) conspicua*: combination and subgeneric assignment by Raffray 1904: 207.


**Type locality**: [AK] Hunua Range, Maketu.

**Type depository**: BMNH LT ♂, 3 PLT; NZAC 14 PLT.
**Diagnosis:** Head with vertexal foveae punctiform; antennae 10-segmented with 2-segmented antennal club; A4, A5, A6, A7 and A8 unmodified, A9 boot-shaped with curved basal spine, A10 bean-shaped, truncate at base in dorsal view, with bi-excision in ventral view. Abdominal ventrite 2 with pair of large discal protuberances, inserted with strongly curved apical setae; ventrite 6 with pair of median struts, slightly shorter than one-fourth of ventral length. Protrochanters with long ventral spine, about four-sevenths of protrochanteral width; protibiae and mesotibiae unmodified.

**Redescription:** Body length 1.45–1.56 mm; body colour reddish-brown to dark brown with lighter coloured elytra and legs. **Head** slightly wider than long; frons slightly narrowed at end, about two-thirds width of head at eye level; eyes prominent, with about 38 facets; vertexal foveae punctiform; antennal tubercles weak; postantennal notches weak; postantennal cavities well developed, about two-thirds length of antennal tubercles in dorsal view; antennae 10-segmented with 2-segmented antennal club; A4, A5, A6, A7 and A8 unmodified, A9 boot-shaped with curved basal spine, A10 bean-shaped, truncate at base in dorsal view, with bi-excision in ventral view. **Pronotum** as long as wide, about as wide as head at eye level; lacking lateral antebasal foveae. **Elytra** as long as wide, widest at apical two-thirds; humeral calli vaguely visible; sutural stria distinctively extending from base to apex. **Abdomen** with tergite 1 about twice length of tergite 2; ventrite 2 with pair of large discal protuberances, inserted with strongly curved apical setae; ventrite 6 with pair of median struts, slightly shorter than one-fourth of ventral length. **Legs** with protrochanters modified with long ventral spine, about four-sevenths of protrochanteral width; protibiae and mesotibiae unmodified. **Aedeagus** about 0.32 mm long, with parameres elongate and thick, curved downwards; median lobe with two long sclerites, narrower than parameres in dorsal view, both bent inwards subapically in dorsal view, with left one longer than right one.
**Comments:** This species is most similar to *E. (B.) monstrosa* by having similar modifications of A9 and A10, and can be separated from it by A10 lacking a small internal hook at its apex (Fig. 3.10B).

**Distribution:** North Island. ND, AK, WO, CL, TO, GB, HB.

**Additional material examined:** 23 ♂♂, **ND:** 3, 20/vi/51, moss, Ruakaka, N.I. N.Z.; **AK:** 1, Bethells, Matuku Reserve, 23/Jun/1987, R.C. Craw; **CL:** 1, AMNZ, Orewa Gorge, Karangahaka, 11/10/42, C.E. Clark Collection; **WO:** 3, JNPC, Maungatautari, Hamilton, 6/Sep/04, forest floor litter, collected by Sue Nunn; **GB:** 4, Motu river, April/1928, A.E. Brookes Collection; **To:** 1, Waipunga River, nr. Falls, 14/March/1980, C.F. Butcher; **HB:** 2, Waipatiki Res., 23/Dec/1983, J.C. Watt Sifted, Wood mould, 83/144; 3, White Pine Bush, 18/Nov/1984, J.G. Charles. **Unknown locality:** 3, 2464, T. Broun Collection, A.E. Brookes Collection; 2, 2464, T. Broun. **Associated females** (6 ♀♀): **ND:** 1, 20/vi/51, moss, Ruakaka, N.I. N.Z.; **WO:** 3, JNPC, Maungatautari, Hamilton, 6-Sep/04, forest floor litter, collected by Sue Nunn; **GB:** 2, Motu river, April/1828, A.E. Brookes Collection.

*Eupines (Byraxis) crassicornides* Newton, 2017

Figs 3.11, 3.49

*Byraxis crassicornis* Broun, 1880: 129.


**Type locality:** [CL] Tairua.

**Type depository:** BMNH HT ♂.

**Diagnosis:** Head with vertexal foveae asetose and small; antennae 10-segmented with 4-segmented antennal club; A4, A5, A6, A7 and A10 unmodified, A7 slightly asymmetrical, A8 elongate, about 3 × longer than A7, truncate at base, A9 longest, about twice as long as A8, concave at outer margin, concavity surrounded by strongly extended laminate margin, A10 conical and truncate at base. Abdominal ventrite 2 with pair of small discal protuberances, inserted with slightly curved apical setae; ventrite 6 with pair of short median struts, about one-fifth of ventral length. Protrochanters with small ventral spine, about one-third of protrochanteral width; protibiae and mesotibiae unmodified.

**Redescription:** Body length 1.40–1.52 mm; body colour reddish-brown to dark brown with lighter coloured legs. **Head** slightly wider than long; frons slightly narrowed at end, about half width of head at eye level; eyes well developed, with about 33 facets; vertexal foveae asetose and small; antennal tubercles moderately developed; lacking postantennal notches; postantennal cavities large in dorsal view, about as long as antennal tubercles in dorsal view; antennae 10-segmented with 4-segmented antennal club; A4, A5, A6, A7 and A10 unmodified, A7 slightly asymmetrical, A8 elongate, about 3 × longer than A7, truncate at base, A9 longest, about twice as long as A8, concave at outer margin, concavity surrounded by strongly extended laminate margin, A10 conical and truncate at base. **Pronotum** as long as wide, about as wide as head at eye level; lacking lateral antebasal foveae. **Elytra** as long as wide, widest at apical two-thirds; humeral calli and sutural stria vaguely visible. **Abdomen** with tergite 1 about 1.5 × longer than tergite 2; ventrite 2 with pair of small discal
protuberances, inserted with slightly curved apical setae; ventrite 6 with pair of short median struts, about one-fifth of ventral length. **Legs** with protrochanters modified with small ventral spine, about one-third of protrochanteral width; protibiae and mesotibiae unmodified. **Aedeagus** about 0.23 mm long, with parameres elongate and sinuate, with three pairs of short apical setae, two pairs of long subapical setae and one pair of long median setae; median lobe with two long sclerites, about as wide as parameres in dorsal view, both curved outwards at apex, left one more sinuate than right one.

**Comments:** This is the only species known that has its A8 conspicuously modified (Figs 3.11B–D).

**Distribution:** North Island. ND, AK, CL.


*Eupines (Byraxis) decens* (Broun, 1893)

Figs 3.12, 3.49

*Byraxis decens* Broun, 1893a: 1046.

*Eupines (Byraxis) decens*: combination and subgeneric assignment by Raffray 1904: 207.


**Type locality:** [AK] Paparoa, near Howick.
Type depository: BMNH LT ♂, 1 PLT.

Diagnosis: Head with vertexal foveae asetose and small; antennae 10-segmented with 2-segmented antennal club; A4, A5, A6, A7 and A8 unmodified, A9 largest, basally concave at inner side in dorsal view, with spine in small lateral apical excavation, A10 conical in dorsal view and flattened in lateral view, with long lateral subapical spine. Abdominal ventrite 2 with pair of small and nude discal protuberances; ventrite 6 with pair of long median struts, slightly longer than half of ventral length. Protrochanters with long ventral spine, about as long as protrochanteral width; protibiae and mesotibiae unmodified.

Redescription: Body length 1.32–1.36 mm; body colour dark brown with lighter coloured elytra and legs. Head wider than long; frons slightly narrowed at end, about three-fifths width of head at eye level; eyes well developed and prominent, with about 32 facets; vertexal foveae asetose and small; antennal tubercles barely visible; postantennal notches punctiform; postantennal cavities medium-sized in dorsal view, slightly longer than half length of antennal tubercles in dorsal view; antennae 10-segmented with 2-segmented antennal club; A4, A5, A6, A7 and A8 unmodified, A9 largest, basally concave at inner side in dorsal view, with spine in small lateral apical excavation, A10 conical in dorsal view and flattened in lateral view, with long lateral subapical spine. Pronotum as long as wide, slightly narrower than head at eye level; lacking lateral antebasal foveae. Elytra as long as wide, widest at apical two-thirds; humeral calli moderately developed; sutural stria shallowly extending from base to apex. Abdomen with tergite 1 about 1.5 × longer than tergite 2; ventrite 2 with pair of small and nude discal protuberances; ventrite 6 with pair of long median struts, slightly longer than half of ventral length. Legs with protrochanters modified with long ventral spine, about as long as protrochanteral width; protibiae and mesotibiae unmodified. Aedeagus about 0.30 mm long, with slender and slightly asymmetric parameres curved inwards, with pair of short apical setae; median lobe with two long sclerites, wide near base and gradually
convergent towards apex, both curved inwards in dorsal view, left one longer and more curved than right one.

**Comments:** This species is similar to *E. (B.) petila* by its similarly modified A10. However, the strongly asymmetrical aedeagus and long median struts of ventrite 6 of *E. (B.) decens* (Figs 3.12G, 3.12H–J) can immediately separate it from the latter.

**Distribution:** North Island. AK, CL.

**FIGURE 3.12.** Diagnostic characters of *E. (B.) decens* (Broun, 1893). 


*Eupines deformis* (Sharp, 1874)

Fig. 3.13

*Bryaxis deformis* Sharp, 1874: 499.

*Bryaxis deformis*: reprint from Sharp 1874 by Sharp 1876: 277.

*Bryaxis deformis*: reprinted excerpt from Sharp 1874 by Broun 1880: 130.

*Eupines (Byraxis) deformis*: combination and subgeneric assignment by Raffray 1904: 208.


**Type locality:** New Zealand.
Type depository: BMNH HT ♀.

Comments: Sharp (1874) described *E. deformis* from a single female (Shen & Leschen 2019) and stated that the strangely bent protibiae and mesotibiae may very likely to be an individual deformity rather than species-level characters.

**FIGURE 3.13.** Habitus of *E. deformis* (Sharp, 1874). Scale bars: A = 1 mm.

*Eupines (Byraxis) dispar* (Sharp, 1874)  
Figs 3.14, 3.49

*Byraxis dispar* Sharp, 1874: 498.

*Byraxis dispar*: reprint from Sharp 1874 by Sharp 1876: 277.

*Byraxis dispar*: reprinted excerpt from Sharp 1874 by Broun 1880: 127.

*Byraxis ovalipennis* Schaufuss, 1880a: 25. Type locality: New Zealand.
*Bryaxis ovalipennis*: reprint from Schaufuss 1880a by Schaufuss 1880b: 501. Synonymised by Raffray 1911: 82.


**Type locality**: [AK] Auckland.

**Type depository**: BMNH LT ♂, 3 PLT.

**Diagnosis**: Head with vertexal foveae punctiform; antennae 10-segmented with 2-segmented antennal club; A4, A5, A6, A7 and A8 unmodified, A9 narrowed at base, truncate at apex, with outside surface strongly polished and slightly concave, A10 bean-shaped, strongly concave at lateral side. Abdominal ventrite 2 with pair of slightly prominent discal protuberances, inserted with slightly curved apical setae; ventrite 6 with pair of long median struts, about two-thirds of ventral length, slightly curved inwards at apex. Protrochanters with long ventral spine, about as long as protrochanteral width; protibiae and mesotibiae unmodified.

**Redescription**: Body length 2.00–2.14 mm; body colour reddish-brown to dark brown with lighter coloured elytra and legs. **Head** about as long as wide; frons slightly narrowed at end, about three-fifths width of head at eye level; eyes well developed, with about 38 facets; vertexal foveae punctiform; antennal tubercles weak; postantennal notches punctiform; postantennal cavities long and narrow, slightly shorter than antennal tubercles in dorsal view;
antennae 10-segmented with 2-segmented antennal club; A4, A5, A6, A7 and A8 unmodified, A9 narrowed at base, truncate at apex, with outside surface strongly polished and slightly concave, A10 bean-shaped, strongly concave at lateral side. **Pronotum** longer than wide, slightly narrower than head at eye level; lateral antebasal foveae punctiform. **Elytra** about as long as wide, widest at apical three-fourths; humeral calli barely visible; sutural stria distinctively extending from base to apex. **Abdomen** with tergite 1 about twice length of tergite 2; ventrite 2 with pair of slightly prominent discal protuberances, inserted with slightly curved apical setae; ventrite 6 with pair of long median struts, about two-thirds of ventral length, slightly curved inwards at apex. **Legs** with protrochanters modified with long ventral spine, about as long as protrochanteral width; protibiae and mesotibiae unmodified. **Aedeagus** about 0.36 mm long, with slender parameres, with four pairs of apical setae; median lobe with single stout and long sclerite, slightly bent and widest near middle in dorsal view.

**Comments:** The lectotype and two paralectotypes of *E. (B.) munroi* were compared with the lectotype and one paralectotype of *E. (B.) dispar*, and were found to represent a single species by having identical antennal modification; the former name is here treated as the junior synonym. This species is distinguished from other *Eupines* by its modified A10 and aedeagus with single sclerite (Figs 3.14B–D, 3.14H–J).

**Distribution:** North Island. AK, WO, TK. South Island. NN, BR, WD.


Eupines (Byraxis) dugdalei sp. nov.

Figs 3.15, 3.49

**Diagnosis:** Head lacking vertexal foveae; antennae 10-segmented with 2-segmented antennal club; A4, A6, A7, A8 and A10 unmodified, A5 conspicuously enlarged, more than twice length of A4, A9 asymmetrical and largest, about 1.5 × longer than A10, base strongly narrowed, widest at middle, A10 conical. Abdominal ventrite 2 with pair of large discal protuberances, inserted with strongly curved small apical setae; ventrite 6 with pair of slender median struts, about three-fifths of ventral length. Protocoxal with long and acute ventral spine, about two-thirds of protocoxal width; protibiae with large apical protuberance; mesotibiae unmodified.

**Description:** Body length 1.45–1.55 mm; body colour dark brown to black with lighter coloured tarsi. **Head** wider than long; frons slightly narrowed at end, about half width of head at eye level; eyes moderately developed, with about 24 facets; lacking vertexal foveae; antennal tubercles barely visible; lacking postantennal notches; postantennal cavities large, about 1.3 × length of antennal tubercles in dorsal view; antennae 10-segmented with 2-segmented antennal club; A4, A6, A7, A8 and A10 unmodified, A5 conspicuously enlarged, more than twice length of A4, A9 asymmetrical and largest, about 1.5 × longer than A10, base strongly narrowed, widest at middle, A10 conical. **Pronotum** slightly wider than long, wider than head at eye level; lacking lateral antebasal foveae. **Elytra** slightly longer than wide, widest at apical three-fifths; humeral calli barely visible; sutural stria shallowly extending from base to apex. **Abdomen** with tergite 1 about as long as tergite 2; ventrite 2 with pair of large discal protuberances, inserted with strongly curved small apical setae; ventrite 6 with pair of slender median struts, about three-fifths of ventral length. **Legs** with protocoxal modified with long and acute ventral spine, about two-thirds of protocoxal width; protibiae with large apical protuberance; mesotibiae unmodified.
**Aedeagus** about 0.33 mm long, with long and large parameres, widest near apex, bent downwards in lateral view, with pair of subapical setae; median lobe with two small sclerites curved towards each other at apex, much smaller than parameres.

**Comments:** This species is similar to *E. (B.) impar* by having A9 enlarged but can be separated from it by its modified protibiae (Fig. 3.15E) (it is unmodified in *E. (B.) impar*).

**Distribution:** South Island. OL, FD, SL.

**Etymology:** This species is named after the collector of the holotype, John Dugdale.

**Type material (NZAC):** Holotype. ♂, specimen entire, point-mounted: “NEW ZEALAND, OL, Headlong Pk., 1524m, South Basin, 20 Feb 1980, J.S. Dugdale // Litter 80/26”.

**Paratypes.** 11 ex. : **OL:** 5, same data as holotype; **FD:** 1, Middle Basin, Tutoko Bench, Darran Mts. 13/Jan/1977 // J.S. Dugdale; 1, Middle Basin, Tutoko Bench, Darran Mts. 1524m // 14/Jan/1977 J.S. Dugdale; 1, Secretary I., Mt. Grono, 29/May/1982, T. Haslam // Mat plants 82/67; **SL:** 3, 1km S. Longwood Trig, 700m, Longwood Ra. 01/Feb/1976 // L.L. Deitz Mats 76/12.

**Eupines (Byraxis) fraudulenta** (Broun, 1886)

Figs 3.16, 3.49

*Byraxis fraudulenta* Broun, 1886: 944.

*Eupines (Byraxis) fraudulenta*: combination and subgeneric assignment by Raffray 1904: 208.


**Type locality:** [AK] Near Howick.

**Type depository:** BMNH LT ♂.
**Diagnosis:** Head with vertexal foveae punctiform; antennae 10-segmented with 2-segmented antennal club; A4, A5, A6, A7 and A8 unmodified, A9 largest, narrowed at base, widened gradually towards apex, with long and acute spine at lateral side, A10 long and conical, slightly shorter than A9. Abdominal ventrite 2 with pair of slightly prominent discal protuberance, inserted with strongly curved small apical setae; ventrite 6 with pair of medium-sized acute median struts, slightly shorter than one-third of ventral length. Protrochanters with long and acute ventral spine, slightly longer than protrochanteral width; protibiae and mesotibiae unmodified.

**Redescription:** Body length 1.52–1.54 mm; body colour reddish-brown with lighter coloured tarsi. **Head** slightly wider than long; frons narrowed at end, about one-third width of head at eye level; eyes moderately developed, with about 22 facets; vertexal foveae punctiform; lacking antennal tubercles; postantennal notches barely visible; postantennal cavities large, slightly shorter than antennal tubercles in dorsal view; antennae 10-segmented with 2-segmented antennal club; A4, A5, A6, A7 and A8 unmodified, A9 largest, narrowed at base, widened gradually towards apex, with long and acute spine at lateral side, A10 long and conical, slightly shorter than A9. **Pronotum** as long as wide, about as long as head at eye level; lacking lateral antebasal foveae. **Elytra** about as long as wide, widest at apical two-thirds; humeral calli barely visible; sutural stria weakly extending from base to apical half. **Abdomen** with tergite 1 about 1.5 × longer than tergite 2; ventrite 2 with pair of slightly prominent discal protuberance, inserted with strongly curved small apical setae; ventrite 6 with pair of medium-sized acute median struts, slightly shorter than one-third of ventral length. **Legs** with protrochanters modified with long and acute ventral spine, slightly longer than protrochanteral width; protibiae and mesotibiae unmodified. **Aedeagus** about 0.30 mm long, with slender parameres, widest at middle, strongly curved inwards, with four pairs of long apical setae and pair of short subapical setae; median lobe small and fusiform, with two
long sclerites curved towards each other at apex in dorsal view, widest at basal one-third, right one slightly longer than left one.

**Comments:** This species is recognised by its A9 with a long and acute spine at the lateral side (Figs 3.16B–D). No known associated females of this species were found.

**Distribution:** North Island. AK, CL.


_Eupines (Byraxis) gigas sp. nov._

Figs 3.17, 3.49

**Diagnosis:** Head with vertexal foveae punctiform, surrounded by shallow impressions; antennae 10-segmented with 2-segmented antennal club; A4, A5, A6, A7 and A8 unmodified, A9 enlarged, ventral side truncate, A10 largest and conical, about twice length of A9, with deep basal excavation at ventral side. Abdominal ventrite 2 with pair of small and flat discal protuberances, inserted with strongly curved long apical setae; ventrite 6 with pair of long median struts, curved towards each other, slightly longer than half of ventral length.
Protrochanters with long and acute ventral spine, about as long as protrochanteral width; protibiae and mesotibiae unmodified.

**Description:** Body length 1.95–2.07 mm; body colour reddish-brown to dark brown with lighter coloured elytra and legs. **Head** wider than long; frons not narrowed at end, about three-fourths width of head at eye level; eyes well developed, conspicuously prominent in dorsal view, with about 36 facets; vertexal foveae punctiform, surrounded by shallow impressions; antennal tubercles moderately developed; postantennal notches distinctive and broad; postantennal cavities large, about as long as antennal tubercles in dorsal view; antennae 10-segmented with 2-segmented antennal club; A4, A5, A6, A7 and A8 unmodified, A9 enlarged, ventral side truncate, A10 largest and conical, about twice length of A9, with deep basal excavation at ventral side. **Pronotum** about as long as wide, slightly narrower than head at eye level; lacking lateral antebasal foveae. **Elytra** as long as wide, widest near apical two-thirds; humeral calli weak, slightly prominent in dorsal view; sutural stria shallowly extending from base to apex. **Abdomen** with tergite 1 about twice length of tergite 2; ventrite 2 with pair of small and flat discal protuberances, inserted with strongly curved long apical setae; ventrite 6 with pair of long median struts, curved towards each other, slightly longer than half of ventral length. **Legs** with protrochanters modified with long and acute ventral spine, about as long as protrochanteral width; protibiae and mesotibiae unmodified. **Aedeagus** about 0.34 mm long, with parameres elongate, widest near middle, slightly curved outwards at apex, bent downwards in lateral view, with four pairs of short subapical setae and pair of short apical setae; median lobe with single small and stout sclerite, narrower than parameres.

**Comments:** This species is similar to *E. (B.) dispar* by sharing a large body size (average length around 2.00 mm) but can be easily recognised by its conical A10, while it is bean-
shaped and modified in *E. (B.) dispar* (Figs 3.14B–D). No known associated females of this species were found.

**Distribution:** North Island. TO, BP, TK, HB.

**Etymology:** This specific epithet is a Latin adjective meaning ‘large’, referring to the large body size of this species.


*Eupines (Byraxis) glabrata* (Broun, 1886)

Figs 3.18, 3.50

*Byraxis glabrata* Broun, 1886: 830.

*Eupines (Byraxis) glabrata*: combination and subgeneric assignment by Raffray 1904: 207.


**Type locality:** [AK] Woodhill, near the Kaipara Railway.

**Type depository:** NZAC HT ♂.
**Diagnosis:** Head with vertexal foveae punctiform; antennae 10-segmented with 4-segmented antennal club; A4, A5, A6, A7, A8 and A10 unmodified, A6 and A8 slightly asymmetrical, A9 largest, with a deep groove at one side, forming laterally twisted lamina at apex, A10 conical and much shorter than A9. Abdominal ventrite 2 with pair of small discal protuberances, inserted with strongly curved small apical setae; ventrite 6 with pair of short and acute median struts, about one-tenth of ventral length. Protrochanters with long and acute ventral spine, about same to protrochanteral width; protibiae and mesotibiae unmodified.

**Redescription:** Body length 1.33–1.44 mm; body colour reddish-brown to dark brown with lighter coloured tibiae and tarsi. **Head** wider than long; frons not narrowed at end, about three-fourths width of head at eye level; eyes well developed, with about 31 facets; vertexal foveae punctiform; antennal tubercles moderately developed; postantennal notches broadly extended and meet at middle of vertex; postantennal cavities medium-sized and about two-thirds length of antennal tubercles in dorsal view; antennae 10-segmented with 4-segmented antennal club; A4, A5, A6, A7, A8 and A10 unmodified, A6 and A8 slightly asymmetrical, A9 largest, with a deep groove at one side, forming laterally twisted lamina at apex, A10 conical and much shorter than A9. **Pronotum** as long as wide, slightly narrower than head at eye level; lacking lateral antebasal foveae. **Elytra** longer than wide, widest at about apical three-fourths; lacking humeral calli; sutural stria barely visible. **Abdomen** with tergite 1 about 1.2 × longer than tergite 2; ventrite 2 with pair of small discal protuberances, inserted with strongly curved small apical setae; ventrite 6 with pair of short and acute median struts, about one-tenth of ventral length. **Legs** with protrochanters modified with long and acute ventral spine, about same to protrochanteral width; protibiae and mesotibiae unmodified. **Aedeagus** about 0.28 mm long, with parameres long and clavate at apex, curved inwards; median lobe with four short and stout sclerites originating from middle in dorsal view, two outside ones curved outwards, two middle ones strongly curved inwards.
**Comments:** This species is widely distributed in the North Island, and is also reported in Marlborough Sounds. It can be distinguished from its congeners by its A8 conspicuously transverse and enlarged (Fig. 3.18C).

**Distribution:** North Island. ND, AK, WO, CL, BP, GB, TK, HB, WN, WA. South Island. SD.


**Eupines (Byraxis) graceae** sp. nov.

Figs 3.19, 3.50

**Diagnosis:** Head with vertexal foveae punctiform; antennae 10-segmented with 2-segmented antennal club; A4, A6, A7 and A8 unmodified, A5 greatly enlarged and asymmetrical, A9 highly transverse and asymmetrical, ventral side broadly impressed, with ovoid lamina at end of inner side, A10 longest and asymmetrical, irregularly shaped, with deep basal excavation at ventral side. Abdominal ventrite 2 with pair of large discal protuberances, inserted with
strongly curved small apical setae; ventrite 6 unknown. Protrochanters with short ventral spine, about two-fifths of protrochanteral width; protibiae and mesotibiae unmodified.

**Description:** Body length 1.51 mm; body colour reddish-brown with lighter coloured elytra, tibiae and tarsi. **Head** wider than long; frons slightly narrowed at end, about half width of head at eye level; eyes well developed, conspicuously prominent in dorsal view; vertexal foveae punctiform; antennal tubercles moderately developed; postantennal notches broad and shallow; postantennal cavities large, about as long as antennal tubercles in dorsal view; antennae 10-segmented with 2-segmented antennal club; A4, A6, A7 and A8 unmodified, A5 greatly enlarged and asymmetrical, A9 highly transverse and asymmetrical, ventral side broadly impressed, with ovoid lamina at end of inner side, A10 longest and asymmetrical, irregularly shaped, with deep basal excavation at ventral side. **Pronotum** about as long as wide, slightly wider than head at eye level; lacking lateral antebasal foveae. **Elytra** as long as wide, widest at apical two-thirds; humeral calli weak, slightly prominent in dorsal view; sutural stria distinctively extending from base to apex. **Abdomen** with tergite 1 about 1.4 × longer than tergite 2; ventrite 2 with pair of large discal protuberances, inserted with strongly curved small apical setae; ventrite 6 unknown. **Legs** with protrochanters modified with short ventral spine, about two-fifths of protrochanteral width; protibiae and mesotibiae unmodified. **Aedeagus** about 0.32 mm long, with long parameres bent downwards in lateral view, apex curved towards each other, nearly meet at middle, with pair of long subapical setae; median lobe with two large and stout sclerites, twisted near apex, about as wide as parameres.

**Comments:** This species is described from a singleton, and unfortunately, ventrite 6 was lost during the preparation of the genitalia. It is similar to *E. (B.) platyarthra* by having A9 transverse but can be separated easily from it by its A5 enlarged and transverse (Figs 3.19B–D), which is unmodified in *E. (B.) platyarthra*.

**Distribution:** South Island. NN.
**Etymology:** This species is named after one of the collectors for the holotype, Grace Hall, long time technician at NZAC who has helped significantly with Coleoptera research.

**Type material (NZAC):** Holotype. ♂, body parts mounted on acetate card: “NEW ZEALAND, NN, Heaphy Track, Lewis Hut, 7 Nov 1999, R. Leschen, G. Hall, leaf litter 40°56'S, 172°09'E”.

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**Eupines (Byraxis) halli** (Broun, 1921)

Figs 3.20, 3.50


**Type locality:** [NN] Mount Saint Arnaud, Nelson.

**Type depository:** BMNH LT ♂, 2 PLT; NZAC 2 PLT.

**Diagnosis:** Head with vertexal foveae punctiform; antennae 10-segmented with 2-segmented antennal club; A4, A6, A7, A8 and A10 unmodified, A5 greatly enlarged and asymmetrical, flag-shaped, dorsal side broadly concave, A7 asymmetrical, A8 disc-shaped and slightly asymmetrical, A9 largest, with laminate base and boot-shaped protuberance at lateral side, forming gulf-shaped structure, A10 conical. Abdominal ventrite 2 with pair of long and slender discal protuberances, inserted with small and strongly curved apical setae; ventrite 6 with pair of long median struts, about half of ventral length. Protrochanters with long ventral spine, about three-fourths of pro trochanteral width; protibiae with blunt apical protuberance; mesotibiae with apical minute triangle spine.

**Redescription:** Body length 1.20–1.30 mm; body colour dark brown with lighter coloured tarsi. **Head** slightly wider than long; frons slightly narrowed at end, about half width of head at eye level; eyes slightly prominent, with about 32 facets; vertexal foveae punctiform; lacking antennal tubercles and postantennal notches; postantennal cavities barely visible in dorsal view; antennae 10-segmented with 2-segmented antennal club; A4, A6, A7, A8 and A10 unmodified, A5 greatly enlarged and asymmetrical, flag-shaped, dorsal side broadly concave, A7 asymmetrical, A8 disc-shaped and slightly asymmetrical, A9 largest, with laminate base and boot-shaped protuberance at lateral side, forming gulf-shaped structure, A10 conical. **Pronotum** about as long as wide, wider than head at eye level; lacking lateral
antebasal foveae. **Elytra** slightly wider than long, widest at apical three-fourths; humeral calli barely visible; sutural stria weakly extending from base to apex. **Abdomen** with tergite 1 about 1.2 × longer than tergite 2; ventrite 2 with pair of long and slender discal protuberances, inserted with small and strongly curved apical setae; ventrite 6 with pair of long median struts, about half of ventral length. **Legs** with protrochanters modified with long ventral spine, about three-fourths of protrochanteral width; protibiae with blunt apical protuberance; mesotibiae with apical minute triangle spine. **Aedeagus** about 0.34 mm long, with parameres wide and long, slightly curved inwards, with three pairs of apical setae; median lobe relatively small, with two sclerites much narrower than parameres, strongly curved towards each other in dorsal view, basal bulb slightly longer than two sclerites.

**Comments:** This species can be immediately recognised by its bizarre form of A9 (Figs 3.20B–C).

**Distribution:** North Island. TO. South Island. BR.

**FIGURE 3.20.** Diagnostic characters of *E. (B.) halli* (Broun, 1921). **A)** Habitus. **B)** Antenna, in dorsal view. **C)** Same, in lateral view. **D)** Protrochanter. **E)** Protibia. **F)** Mesotibia. **G)** Ventrite 2. **H)** Ventrite 6. **I)** Aedeagus, in dorsal view. **J)** Same, in lateral view. **K)** Same, in ventral view. Scale bars: **A** = 1 mm, **B**–**G** = 0.2 mm, **H**–**K** = 0.1 mm.

*Eupines* (*Byraxis*) *hectori* (Broun, 1895)

Figs 3.21, 3.50

*Byraxis hectori* Broun, 1895: 73.


SYNONYMY.

Type locality: [BP] Tarukenga, near Rotorua.

Type depository: BMNH LT ♂.

Diagnosis: Head with vertexal foveae distinct and asetose; antennae 10-segmented with 2-segmented antennal club; A4, A5, A6, A7 and A8 unmodified, A9 cylindrical, about 3 × longer than A8, with medium-sized spine surrounded in small anterolateral excavation, A10 conical and slightly longer than A9. Abdominal ventrite 2 with pair of small discal protuberances, inserted with slightly curved small apical setae; ventrite 6 with pair of slender median struts, about three-fourths of ventral length. Protrochanters with medium-sized ventral spine, about three-fifths of protochanteral width; protibiae and mesotibiae unmodified.

Redescription: Body length 1.45–1.55 mm; body colour reddish-brown to dark brown with lighter coloured elytra and legs. Head wider than long; frons not narrowed at end, about three-fourths width of head at eye level; eyes well developed, with about 25 facets; vertexal foveae distinct and asetose; antennal tubercles barely visible; postantennal notches weak; postantennal cavities large, about as long as antennal tubercles in dorsal view; antennae 10-segmented with 2-segmented antennal club; A4, A5, A6, A7 and A8 unmodified, A9 cylindrical, about 3 × longer than A8, with medium-sized spine surrounded in small anterolateral excavation, A10 conical and slightly longer than A9. Pronotum slightly wider than long, slightly wider than head at eye level; lacking lateral antebasal foveae. Elytra about as long as wide, widest at apical three-fourths; humeral calli barely visible; sutural stria...
shallowly extending from base to apex. **Abdomen** with tergite 1 about 1.3 × longer than tergite 2; ventrite 2 with pair of small discal protuberances, inserted with slightly curved small apical setae; ventrite 6 with pair of slender median struts, about three-fourths of ventral length. **Legs** with protrochanters modified with medium-sized ventral spine, about three-fifths of protrochanteral width; protibiae and mesotibiae unmodified. **Aedeagus** about 0.28 mm long, with parameres slightly curved inwards, widest at basal two-thirds, bearing four pairs of long apical setae and pair of short apical setae; median lobe complex, with three long sclerites, left one and middle one about as wide as parameres in dorsal view, strongly curved towards each other, right one straight and long, with pair of slightly sclerotized laminae next to three sclerites at dorsal side, with another pair of strongly sclerotized basal laminae strongly curved at ventral side, about one-third length of parameres.

**Comments:** The lectotype of *E. (B.) hectori* was compared with the lectotype and two paralectotypes of *E. (B.) diversides* (as *E. (B.) diversa*), and were found to represent a single species by having identical modification of A9 (Figs 3.21B–D), with the latter name treated as the junior synonym. Newton (2017) proposed a new name, *E. (B.) diversides* for the junior primary homonym, *Bryaxis diversa* which is now unavailable, and is also here treated as the junior synonym of *E. (B.) hectori*.

**Distribution:** North Island. AK, WO, CL, BP, WN.

**Eupines (Byraxis) hoarei** sp. nov.

Figs 3.22, 3.50

**Diagnosis:** Head lacking vertexal foveae; antennae 10-segmented with 2-segmented antennal club; A4, A5, A6, A7, A8 and A10 unmodified, A6 and A7 asymmetrical and subequal in size, A8 shortened, about half length of A7, A9 greatly prolonged and enlarged, slightly impressed subapically at ventral side, A10 largest and conical, about 1.4 × longer than A9,
slightly impressed at base in ventral view. Abdominal ventrite 2 with pair of minute discal protuberances, inserted with slightly curved small apical setae; ventrite 6 unknown. Protrochanters, protibiae and mesotibiae unmodified.

**Description:** Body length 1.57 mm; body colour reddish-brown with lighter coloured legs. **Head** wider than long; frons slightly narrowed at end, about two-fifths width of head at eye level; eyes moderately developed, with about 28 facets; lacking vertexal foveae; antennal tubercles barely visible; postantennal notches weakly demarcated; postantennal cavities large, slightly shorter than antennal tubercles in dorsal view; antennae 10-segmented with 2-segmented antennal club; A4, A5, A6, A7, A8 and A10 unmodified, A6 and A7 asymmetrical and subequal in size, A8 shortened, about half length of A7, A9 greatly prolonged and enlarged, slightly impressed subapically at ventral side, A10 largest and conical, about 1.4 × longer than A9, slightly impressed at base in ventral view. **Pronotum** as long as wide, about as wide as head at eye level; lacking lateral antebasal foveae. **Elytra** slightly wider than long, widest at apical two-thirds; humeral calli weak; sutural stria distinctively extending from base to apex. **Abdomen** with tergite 1 about 1.7 × longer than tergite 2; ventrite 2 with pair of minute discal protuberances, inserted with slightly curved small apical setae; ventrite 6 unknown. **Legs** with protrochanters, protibiae and mesotibiae unmodified. **Aedeagus** about 0.26 mm long, with long and stout parameres curved towards each other at apex, bent downwards in lateral view, widest near middle, with pair of long subapical setae and four pairs of short apical setae; median lobe lacking sclerites, with pair of fork-shaped laminae near base, lateral apical margin of median lobe sclerotized.

**Comments:** This is the only species within the subgenus *Byraxis* with protrochanters lacking a ventral spine (Fig. 3.22D).

**Distribution:** South Island. NN.
**Etymology:** This species is named after one of its collectors, Robert Hoare, a lepidopterist at NZAC and assisted us with naming our new species.

**Type material (NZAC):** Holotype. ♂, specimen entire, glued on card, aedeagus + one antenna + one proleg mounted on acetate card: “NEW ZEALAND, NN, Oparara Gorge, 19 Feb 1999, R. Leschen & R. Hoare, at light, 41°13'S 172°09'E”.

**Eupines (Byraxis) huizhenae sp. nov.**

Figs 3.23, 3.50

**Diagnosis:** Head with vertexal foveae punctiform; antennae 10-segmented with 2-segmented antennal club; A4, A6, A7, A8 and A10 unmodified, A4 asymmetrical, lateral side strongly extended, A5 largest and somewhat bean-shaped, with apex subacute and base acute in lateral view, A9 cylindrical and elongate, about 3.5 × longer than A8, A10 conical, about 1.5 × longer than A9. Abdominal ventrite 2 with pair of flat and wide discal protuberances, inserted with strongly curved large apical setae; ventrite 6 with pair of slender median struts, about half of ventral length. Protrochanters with long ventral spine, about half of protrochanteral width; protibiae and mesotibiae unmodified.

**Description:** Body length 1.41–1.43 mm; body colour dark brown with lighter coloured elytra and legs. **Head** as long as wide; frons not narrowed at end, about three-fourths width of head at eye level; eyes moderately developed, slightly prominent in dorsal view, with about 29 facets; vertexal foveae punctiform; antennal tubercles weakly developed; lacking postantennal notches; postantennal cavities long and narrow, slightly shorter than antennal tubercles in dorsal view; antennae 10-segmented with 2-segmented antennal club; A4, A6, A7, A8 and A10 unmodified, A4 asymmetrical, lateral side strongly extended, A5 largest and somewhat bean-shaped, with apex subacute and base acute in lateral view, A9 cylindrical and elongate, about 3.5 × longer than A8, A10 conical, about 1.5 × longer than A9. **Pronotum** about as long as wide, wider than head at eye level; with punctiform lateral antebasal foveae. **Elytra** as long as wide, widest at middle; humeral calli indistinctive, slightly prominent in dorsal view; sutural stria barely visible from base to middle, shallowly extending from middle to apex. **Abdomen** with tergite 1 about twice length of tergite 2; ventrite 2 with pair of flat and wide discal protuberances, inserted with strongly curved large apical setae; ventrite 6 with pair of slender median struts, about half of ventral length. **Legs** with protrochanters...
modified with long ventral spine, about half of protrochanteral width; protibiae and mesotibiae unmodified. Aedeagus about 0.28 mm long, with long and sinuate parameres, bent downwards in lateral view, apex curved towards each other, with pair of long subapical setae; median lobe with two large sclerites, base nearly meet, strongly curved from middle and entwined apically.

**Comments:** This species is most similar to *E. (B.) minuta* and *E. (B.) ovalis* by their similar antennal modification, but can be differentiated from both by having its protrochanters modified with long ventral spine that is otherwise barely visible (Figs 3.32D; 3.38E).

**Distribution:** South Island. KA.

**Etymology:** This species is named after HuiZhen Yu, the first author’s mother, for her unending support.


Eupines (Byraxis) illustris (Broun, 1914)

Figs 3.24, 3.50


Type locality: [MC] Broken River, Canterbury.

Type depository: BMNH LT ♂, 1 PLT.
**Diagnosis:** Head with vertexal foveae punctiform; antennae 10-segmented with 3-segmented antennal club; A4, A5, A6, A7 and A8 unmodified, A9 large and asymmetrical, strongly transverse and obliquely truncate at apex, with lateral acute spine, A10 largest and conical, with basal excavation. Abdominal ventrite 2 with pair of large discal protuberances, inserted with strongly curved large apical trichomes; ventrite 6 unknown. Protrochanters with minute ventral spine, about one-tenth of protrochanteral width; protibiae and mesotibiae unmodified.

**Redescription:** Body length 1.64 mm. body colour reddish-brown with lighter coloured tarsi.

**Head** slightly wider than long; frons not narrowed at end, about three-fourths width of head at eye level; eyes moderately developed, with about 31 facets; vertexal foveae punctiform; antennal tubercles weak; postantennal notches weak; postantennal cavities large, about as long as antennal tubercles in dorsal view; antennae 10-segmented with 3-segmented antennal club; A4, A5, A6, A7 and A8 unmodified, A9 large and asymmetrical, strongly transverse and obliquely truncate at apex, with lateral acute spine, A10 largest and conical, with basal excavation. **Pronotum** about as long as wide, wider than head at eye level; lacking lateral antebasal foveae. **Elytra** as long as wide, widest at about apical three-fourths; humeral calli slightly prominent; sutural stria distinctively extending from base to apex. **Abdomen** with tergite 1 about twice length of tergite 2; ventrite 2 with pair of large discal protuberances, inserted with strongly curved large apical trichomes; ventrite 6 unknown. **Legs** with protrochanters modified with minute ventral spine, about one-tenth of protrochanteral width; protibiae and mesotibiae unmodified. **Aedeagus** unknown.

**Comments:** Apart from the two type specimens, no additional specimen is known. For this reason, I did not attempt to dissect the syntypes; but also, males of this species have distinctive A9 modification and two tufts of large trichomes on ventrite 2 (Figs 3.24B–C), which can immediately differentiate it from its congeners.

**Distribution:** South Island. MC.

**Eupines (Byraxis) impar** (Sharp, 1874)

Figs 3.25, 3.51

*Byraxis impar* Sharp, 1874: 500.

*Byraxis impar*: reprint from Sharp 1874 by Sharp 1876: 278.

*Byraxis impar*: reprinted excerpt from Sharp 1874 by Broun 1880: 130.


**NEW SYNONYMY.**


**Type locality:** [AK] Auckland.

**Type depository:** BMNH LT ♂, 3 PLT.

**Diagnosis:** Head with vertexal foveae punctiform; antennae 10-segmented with 2-segmented antennal club; A4, A5, A6, A7 and A8 unmodified, A6 slightly asymmetrical, A9 largest, about 1.5 × longer than A10, with apical impression at ventral side, impression about two-fifths length of A9, inserted with a barely visible protuberance at middle, A10 conical, with small basal impression at ventral side. Abdominal ventrite 2 with pair of barely visible discal protuberances, inserted with small apical setae; ventrite 6 with pair of long median struts, about half of ventral length. Protrochanters with a medium-sized ventral spine, about half of protrochanteral width; protibiae and mesotibiae unmodified.
**Redescription:** Body length 1.38–1.49 mm; body colour reddish-brown to dark brown with lighter coloured elytra and legs. **Head** wider than long; frons slightly narrowed at end, about half width of head at eye level; eyes well developed and prominent, with about 35 facets; vertexal foveae punctiform; antennal tubercles moderately developed; postantennal notches weak; postantennal cavities large, slightly shorter than antennal tubercles in dorsal view; antennae 10-segmented with 2-segmented antennal club; A4, A5, A6, A7 and A8 unmodified, A6 slightly asymmetrical, A9 largest, about 1.5 × longer than A10, with apical impression at ventral side, impression about two-fifths length of A9, inserted with a barely visible protuberance at middle, A10 conical, with small basal impression at ventral side. **Pronotum** slightly wider than long, as wide as head at eye level; lateral antebasal foveae punctiform. **Elytra** slightly wider than long, widest at apical two-thirds; lacking humeral calli; sutural stria barely visible. **Abdomen** with tergite 1 slightly more than twice length of tergite 2; ventrite 2 with pair of barely visible discal protuberances, inserted with small apical setae; ventrite 6 with pair of long median struts, about half of ventral length. **Legs** with protrochanters modified with a medium-sized ventral spine, about half of protrochanteral width; protibiae and mesotibiae unmodified. **Aedeagus** about 0.28 mm long, with slender parameres, bent near base and sinuate towards apex, curved downwards, with two pairs of apical short setae and pair of subapical long setae; median lobe bent downwards in lateral view, with two long sclerites, about as long as parameres, both sclerites curved inwards at apex in dorsal view, left one slightly shorter than right one.

**Comments:** The holotype of *E. (B.) foveatissima* and the lectotype of *E. (B.) sanguinea* were examined and were found having the identical modification of A9 as the lectotype of *E. (B.) impar*. These names are formally synonymised here, with the former two names treated as junior synonyms. This species is similar to *E. (B.) complector* by having similar form of A9.
but can be distinguished by its A9 with a barely visible protuberance (Fig. 3.25B), which is a conspicuous apical spine in *E. (B.) complector* (Fig. 3.9B).

**Distribution:** North Island. ND, AK, WO, CL, TO, BP, GB.


*Eupines (Byraxis) impressifrons* (Broun, 1880)

Figs 3.26, 3.51


Type locality: [CL] Tairua.

Type depository: BMNH HT ♂.
Diagnosis: Head with vertexal foveae punctiform; antennae 10-segmented with 2-segmented antennal club; A4, A5, A6, A7, A8 and A10 unmodified, A9 cylindrical and flat at dorsal side, with apical spine at lateral side, A10 conical and slightly longer than A9. Abdominal ventrite 2 with pair of large discal protuberances, inserted with large and strongly curved apical setae; ventrite 6 with apical margin sinuate, with pair of short and acute median struts, about one-seventh of ventral length. Protrochanters with small ventral spine, about one-third of protochanteral width; protibiae with minute spine in apical two-thirds; mesotibiae with barely visible subapical spine.

Redescription: Body length 1.68–1.72 mm; body colour reddish-brown with lighter coloured tarsi. Head slightly wider than long; frons not narrowed at end, about three-fourths width of head at eye level; eyes well developed and prominent, with about 30 facets; vertexal foveae punctiform; antennal tubercles weak; postantennal notches weak; postantennal cavities medium-sized, about three-fourths width of antennal tubercles in dorsal view; antennae 10-segmented with 2-segmented antennal club; A4, A5, A6, A7, A8 and A10 unmodified, A9 cylindrical and flat at dorsal side, with apical spine at lateral side, A10 conical and slightly longer than A9. Pronotum wider than long, slightly wider than head at eye level; lacking lateral antebasal foveae. Elytra slightly longer than wide, widest at middle; humeral calli weak; sutural stria shallowly extending from base to apex. Abdomen with tergite 1 about 1.4 × longer than tergite 2; ventrite 2 with pair of large discal protuberances, inserted with large and strongly curved apical setae; ventrite 6 with apical margin sinuate, with pair of short and acute median struts, about one-seventh of ventral length. Legs with protrochanters modified with small ventral spine, about one-third of protochanteral width; protibiae with minute spine in apical two-thirds; mesotibiae with barely visible subapical spine. Aedeagus about 0.31 mm long, with parameres long and wide, narrowed at base and sinuate towards apex, strongly bent downwards at apex in lateral view; median lobe small, with two small and
slender sclerites, strongly curved towards each other at apex, basal bulb large, about as long as median lobe.

**Comments:** This species can be separated from all other *Eupines* by its protibiae and mesotibiae modified with small or minute spines (Figs 3.26E–F).

**Distribution:** North Island. AK, CL. South Island. BR.


**Eupines (Byraxis) insolita** sp. nov.

Figs 3.27, 3.51

**Diagnosis:** Head with vertexal foveae punctiform; antennae 10-segmented with 2-segmented antennal club; A7, A8 and A10 unmodified, A4 disc-shaped, about half length of A3, with long spine at lateral side, A5 largest, with large excavation at middle, outer side slightly impressed, with long and laminate basal projection, inner side impressed at apex, A6 enlarged and strongly asymmetrical, outer side with scoop-shaped impression, A9 cylindrical and slightly asymmetrical at apex in dorsal view, A10 conical, about 1.5 × longer than A9. Abdominal ventrite 2 with pair of flat and wide discal protuberances, inserted with strongly curved large apical setae, nearly meet at middle; ventrite 6 with pair of short and stout median struts, about two-fifths of ventral length. Protrochanters with minute ventral spine, about one-ninth of protrochanteral width; protibiae unmodified; mesotibiae with short subapical spine and long apical spine.

**Description:** Body length 1.47–1.49 mm; body colour dark brown with lighter coloured legs. **Head** wider than long; frons not narrowed at end, about three-fourths width of head at eye level; eyes moderately developed, slightly prominent in dorsal view, with about 30 facets; vertexal foveae punctiform; antennal tubercles weakly developed; lacking postantennal notches; postantennal cavities large, about as long as antennal tubercles in dorsal view; antennae 10-segmented with 2-segmented antennal club; A7, A8 and A10 unmodified, A4 disc-shaped, about half length of A3, with long spine at lateral side, A5 largest, with large excavation at middle, outer side slightly impressed, with long and laminate basal projection, inner side impressed at apex, A6 enlarged and strongly asymmetrical, outer side with scoop-shaped impression, A9 cylindrical and slightly asymmetrical at apex in dorsal view, A10 conical, about 1.5 × longer than A9. **Pronotum** as long as wide, wider than head at eye level; lacking lateral antebasal foveae. **Elytra** as long as wide, widest near middle; humeral calli
weak, barely visible in dorsal view; sutural stria shallowly extending from base to apex. **Abdomen** with tergite 1 about 1.5 × longer than tergite 2; ventrite 2 with pair of flat and wide discal protuberances, inserted with strongly curved large apical setae, nearly meet at middle; ventrite 6 with pair of short and stout median struts, about two-fifths of ventral length. **Legs** with protrochanters modified with minute ventral spine, about one-ninth of protrochanteral width; protibiae unmodified; mesotibiae with short subapical spine and long apical spine. **Aedeagus** about 0.31 mm long, with symmetrical and large parameres, slightly sinuate, widest at middle, apex bent downwards in lateral view and curved towards each other, with two pairs of long subapical setae and pair of short subapical setae; median lobe with two highly curved sclerites, widest near base, much narrower than parameres, right one longer than left one in dorsal view.

**Comments:** This species can be distinguished from all other *Eupines* by having its mesotibiae modified with a long apical spine and A6 modified (Figs 3.27B–D, 3.27H).

**Distribution:** North Island. TO.

**Etymology:** This specific epithet is a Latin adjective meaning ‘unusual’, referring to the unusual antennal form of this species.

**Type material (NZAC):** Holotype. ♂, specimen entire, card-mounted: “28.xi.51, moss, Huka Falls, Taupo P550 [handwritten]”. 

**Eupines (Byraxis) lewisi** Broun, 1910

Figs 3.28, 3.51


**Type locality:** [MC] Broken River, Canterbury.

**Type depository:** BMNH HT ♂
**Diagnosis:** Head with vertexal foveae punctiform; antennae 10-segmented with 2-segmented antennal club; A4, A6, A7, A8 and A10 unmodified, A5 large and asymmetrical, bean-shaped, lateral margin laminate and curved, forming bowl-shaped excavation, A7 asymmetrical, A8 disc-shaped, A9 large and asymmetrical, slightly shorter than A10, inner side strongly excavated in dorsal view, with upper margin laminate and extended, forming gulf-shaped structure, A10 largest and conical, about 1.2 × longer than A9. Abdominal ventrite 2 with pair of large discal protuberances slightly curving towards each other, inserted with strongly curved small apical setae; ventrite 6 with pair of short and acute median struts, about one-fourth of ventral length. Legs with protrochanters modified with small ventral spine, about one-third of protrochanteral width; protibiae and mesotibiae unmodified. Protrochanters with small ventral spine, about one-third of protrochanteral width; protibiae and mesotibiae unmodified.

**Redescription:** Body length 1.58–1.60 mm; body colour dark brown with lighter coloured legs. **Head** about as long as wide, frons slightly narrowed at end, about half width of head at eye level; eyes moderately developed, with about 29 facets; vertexal foveae punctiform; antennal tubercles weak; lacking postantennal notches; postantennal cavities medium-sized, about half length of antennal tubercles in dorsal view; antennae 10-segmented with 2-segmented antennal club; A4, A6, A7, A8 and A10 unmodified, A5 large and asymmetrical, bean-shaped, lateral margin laminate and curved, forming bowl-shaped excavation, A7 asymmetrical, A8 disc-shaped, A9 large and asymmetrical, slightly shorter than A10, inner side strongly excavated in dorsal view, with upper margin laminate and extended, forming gulf-shaped structure, A10 largest and conical, about 1.2 × longer than A9. **Pronotum** about as long as wide, wider than head at eye level; lacking lateral antebasal foveae. **Elytra** as long as wide, widest at apical two-thirds; humeral calli distinctively prominent; sutural stria distinctively extending from base to apex. **Abdomen** with tergite 1 about 1.8 × longer than
tergite 2; ventrite 2 with pair of large discal protuberances slightly curving towards each other, inserted with strongly curved small apical setae; ventrite 6 with pair of short and acute median struts, about one-fourth of ventral length. **Legs** with protrochanters modified with small ventral spine, about one-third of protrochanteral width; protibiae and mesotibiae unmodified. **Aedeagus** about 0.32 mm long, with sinuate parameres long and stout, widest near basal one-fourth, apex strongly bent downwards and twisted in lateral view, with three short apical setae; median lobe with two short sclerites, much shorter and narrower than parameres in dorsal view, left one distinctively curved outwards, right one point inwards.

**Comments:** The special antennal modification (Figs 3.28B–D) can easily separate this species from all its congeners.

**Distribution:** North Island. BP. South Island. NN, MC.


_Eupines (Byraxis) longiceps_ Raffray, 1904

Figs 3.29, 3.51


**Type locality:** New Zealand.

**Type depository:** MNHN LT ♂; BMNH 2 PLT.

**Diagnosis:** Head with vertexal foveae barely visible; antennae 10-segmented with 4-segmented antennal club; A4, A5, A6, A7 and A8 unmodified, A7 and A8 asymmetrical and
short, A9 with apical half impressed at dorsal side, lateral side excavated, with curved spine at upper margin of excavation, A10 axe-shaped, with long setae around margin, broadly impressed at lateral and ventral side, strongly narrowed at base. Abdominal ventrite 2 with pair of large discal protuberances, inserted with short and wide apical setae; ventrite 6 with apical margin slightly sinuate, with pair of short median struts, slightly shorter than one-third of ventral length. Protochanter with medium-sized ventral spine, about half of protochanteral width; protibiae with minute apical protuberance; mesotibiae unmodified.

**Redescription:** Body length 1.55–1.64 mm; body colour reddish-brown to dark brown with lighter coloured elytra and legs. **Head** as long as wide; frons slightly narrowed at end, about half width of head at eye level; eyes well developed, with about 29 facets; vertexal foveae barely visible; antennal tubercles moderately developed; lacking postantennal notches; postantennal cavities large, slightly longer than antennal tubercles in dorsal view; antennae 10-segmented with 4-segmented antennal club; A4, A5, A6, A7 and A8 unmodified, A7 and A8 asymmetrical and short, A9 with apical half impressed at dorsal side, lateral side excavated, with curved spine at upper margin of excavation, A10 axe-shaped, with long setae around margin, broadly impressed at lateral and ventral side, strongly narrowed at base. **Pronotum** slightly longer than wide, about as wide as head at eye level; lacking lateral antebasal foveae. **Elytra** slightly longer than wide, widest at apical three-fifths; humeral calli barely prominent; sutural stria distinct and narrow, extending from base to apex. **Abdomen** with tergite 1 about 1.5 × longer than tergite 2; ventrite 2 with pair of large discal protuberances, inserted with short and wide apical setae; ventrite 6 with apical margin slightly sinuate, with pair of short median struts, slightly shorter than one-third of ventral length. **Legs** with protochanter modified with medium-sized ventral spine, about half of protochanteral width; protibiae with minute apical protuberance; mesotibiae unmodified. **Aedeagus** about 0.34 mm long, with long and stout parameres, sinuate towards apex, slightly
narrowed at base, apex strongly curved inwards and twisted, forming hook-shaped end; median lobe small, with two symmetrical horn-shaped sclerites slightly curved towards each other in dorsal view, basal bulb large, nearly twice length of median lobe.

**Comments:** The last antennal segment of *E. (B.) longiceps* (Figs 3.29B–C) resembles the head of an axe, which can separate this species from all other *Eupines* in New Zealand.

**Distribution:** North Island. WN. South Island. NC, MC, MK.


*Eupines (Byraxis) mayae* sp. nov.

Figs 3.30, 3.51

**Diagnosis:** Head with vertexal foveae punctiform; antennae 10-segmented with 2-segmented antennal club; A4, A5, A6, A7, A8 and A10 unmodified, A9 asymmetrical and enlarged, slightly shorter than A10, with ventromedial excavation and minute protuberance at lateral side, A10 largest and conical. Abdominal ventrite 2 with pair of large discal protuberances close to each other, inserted with slightly curved medium-sized apical setae; ventrite 6 with pair of long and acute median struts, about one-third of ventral length. Protrochanters with
short ventral spine, about two-fifths of protrochanteral width; protibiae and mesotibiae unmodified.

**Description:** Body length 1.34–1.40 mm; body colour reddish-brown to dark brown with lighter coloured elytra and legs. **Head** wider than long; frons not narrowed at end, about three-fourths width of head at eye level; eyes well developed and prominent in dorsal view, with about 34 facets; antennal tubercles moderately developed; postantennal notches broad and distinctive; vertexal foveae punctiform; postantennal cavities large, slightly shorter than antennal tubercles in dorsal view; antennae 10-segmented with 2-segmented antennal club; A4, A5, A6, A7, A8 and A10 unmodified, A9 asymmetrical and enlarged, slightly shorter than A10, with ventromedial excavation and minute protuberance at lateral side, A10 largest and conical. **Pronotum** slightly wider than long, as wide as head at eye level; lacking lateral antebasal foveae. **Elytra** slightly longer than wide, widest near middle; humeral calli slightly prominent in dorsal view; sutural stria weak, shallowly extending from base to apex. **Abdomen** with tergite 1 about 1.2 × longer than tergite 2; ventrite 2 with pair of large discal protuberances close to each other, inserted with slightly curved medium-sized apical setae; ventrite 6 with pair of long and acute median struts, about one-third of ventral length. **Legs** with protrochanters modified with short ventral spine, about two-fifths of protrochanteral width; protibiae and mesotibiae unmodified. **Aedeagus** about 0.37 mm long, with long and stout parameres, curved towards each other at apex and bent downwards in lateral view, with three pairs of short subapical setae; median lobe with two slender sclerites, curved towards each other at apex, shorter and much narrower than parameres.

**Comments:** This species can be distinguished from all other *Eupines* by its simple antennal modification and ventrite 2 with a pair of large discal protuberances close to each other (Figs 3.30B–D, 3.30F).

**Distribution:** North Island. ND.
**Etymology:** This species is named after the collector of the holotype, V.A. May.

**Type material (NZAC):** Holotype. ♂, specimen entire, card-mounted: “NEW ZEALAND, ND, Mangamuka Smt., 386m, 13 Dec 1976, V.A. May Litter 76/109”. **Paratypes.** 1 ex.:

**Unknown locality:** T. Broun Collection // A.E. Brookes Collection.

Eupines (Byraxis) micans (Sharp, 1874)

Figs 3.31, 3.51

Byraxis micans Sharp, 1874: 497.


Eupines (Eupines) micans: combination and subgeneric assignment by Raffray 1904: 206.


Type locality: New Zealand.

Type depository: BMNH LT ♂, 1 PLT.

Diagnosis: Head with vertexal foveae small and asetose; antennae 10-segmented with 2-segmented antennal club; A4, A6, A7 and A8 unmodified, A5 large and asymmetrical, about twice length of A4, A9 with narrow stria at middle and strongly excavated at lateral side near middle, with long apical spine at lateral side, A10 bean-shaped, with broad basal impression at inner side, base strongly narrowed. Abdominal ventrite 2 with pair of minute protuberances, inserted with long and strongly curved apical setae; ventrite 6 with pair of long and acute median struts, slightly shorter than ventral length. Protrochanters with long ventral spine, about two-thirds of protrochanteral width; protibiae and mesotibiae unmodified.

Redescription: Body length 1.60–1.68 mm; body colour dark brown with lighter coloured legs. Head wider than long; frons not narrowed at end, about three-fourths width of head at eye level; eyes well developed and prominent, with about 34 facets; vertexal foveae small and asetose; antennal tubercles weak; postantennal notches shallow and long; postantennal cavities large, about as long as antennal tubercles in dorsal view; antennae 10-segmented with 2-segmented antennal club; A4, A6, A7 and A8 unmodified, A5 large and asymmetrical, about twice length of A4, A9 with narrow stria at middle and strongly excavated at lateral
side near middle, with long apical spine at lateral side, A10 bean-shaped, with broad basal impression at inner side, base strongly narrowed. **Pronotum** as long as wide, about as wide as head at eye level; with weak punctiform lateral antebasal foveae. **Elytra** about as long as wide, widest at middle; humeral calli slightly prominent; sutural stria shallowly extending from middle to apex. **Abdomen** with tergite 1 slightly longer than tergite 2; ventrite 2 with pair of minute protuberances, inserted with long and strongly curved apical setae; ventrite 6 with pair of long and acute median struts, slightly shorter than ventral length. **Legs** with protrochanters modified with long ventral spine, about two-thirds of protrochanteral width; protibiae and mesotibiae unmodified. **Aedeagus** about 0.36 mm long, fin-shaped parameres narrow at base and gradually widened towards apex, apex curved inwards and slightly bent upwards in lateral view, with three pairs of long apical setae; median lobe with three slender sclerites nearly meet in dorsal view, left one and right one strongly bent near middle, middle one bifurcate near base, forming hole-shaped structure, with left sclerites pass through it.

**Comments:** This species is characterized by its A9 with a weak transverse suture, suggesting a pseudosegment (Figs 3.31B–C), a feature that is not found in its congeners.

**Distribution:** North Island. ND, CL.


**FIGURE 3.31.** Diagnostic characters of *E. (B.) micans* (Sharp, 1874). **A)** Habitus. **B)** Antenna, in dorsal view. **C)** Same, in lateral view. **D)** Same, in ventral view. **E)** Protochanter. **F)** Ventrite 2. **G)** Ventrite 6. **H)** Aedeagus, in dorsal view. **I)** Same, in lateral view. **J)** Same, in ventral view. Scale bars: **A** = 1 mm, **B–F** = 0.2 mm, **G–J** = 0.1 mm.
**Eupines (Byraxis) minuta sp. nov.**

Figs 3.32, 3.52

**Diagnosis:** Head with vertexal foveae punctiform; antennae 10-segmented with 2-segmented antennal club; A4, A6, A7, A8 and A10 unmodified, A5 greatly enlarged and asymmetrical, lateral side with large and shallow basal impression, A9 cylindrical, about 5 × longer than A8, A10 conical, about 1.4 × longer than A9. Abdominal ventrite 2 with pair of large and round discal protuberances, inserted with strongly curved small anterolateral setae; ventrite 6 with pair of short and acute median struts, about one-fourth of ventral length. Protrochanters with minute ventral spine, about one-seventh of protrochanteral width; protibiae unmodified; mesotibiae with minute apical spine.

**Description:** Body length 1.41–1.48 mm; body colour dark brown with lighter coloured tarsi. **Head** as long as wide; frons greatly narrowed at end, about one-third width of head at eye level; eyes moderately developed, slightly prominent in dorsal view, with about 27 facets; vertexal foveae punctiform; antennal tubercles weak; postantennal notches distinctive and small; postantennal cavities small, about half length of antennal tubercles in dorsal view; antennae 10-segmented with 2-segmented antennal club; A4, A6, A7, A8 and A10 unmodified, A5 greatly enlarged and asymmetrical, lateral side with large and shallow basal impression, A9 cylindrical, about 5 × longer than A8, A10 conical, about 1.4 × longer than A9. **Pronotum** about as long as wide, wider than head at eye level; with punctiform lateral antebasal foveae. **Elytra** as long as wide, widest at middle; humeral calli weak, slightly prominent in dorsal view; sutural stria shallowly extending from base to apex. **Abdomen** with tergite 1 about twice length of tergite 2; ventrite 2 with pair of large and round discal protuberances, inserted with strongly curved small anterolateral setae; ventrite 6 with pair of short and acute median struts, about one-fourth of ventral length. **Legs** with protrochanters modified with minute ventral spine, about one-seventh of protrochanteral width; protibiae
unmodified; mesotibiae with minute apical spine. *Aedeagus* about 0.32 mm long, with long and stout parameres, curved downwards in lateral view, apex slightly curved, with pair of long subapical setae; median lobe with two long and stout sclerites, slightly twisted at apex, slightly shorter and narrower than parameres.

**Comments:** This species is characterized by its A5 greatly enlarged and asymmetrical (Figs 3.32B–C), a feature that is not found in its congeners.

**Distribution:** South Island. SD, NN.

**Etymology:** The specific epithet refers to the minute apical spine on mesotibiae of this species.


*Eupines (Byraxis) monstrosa* (Reitter, 1880)

Figs 3.33, 3.52


Type locality: Not indicated in the paper (Reitter 1880).

Type depository: MNHN LT ♂, 1 PLT.

Diagnosis: Head with vertexal foveae punctiform; antennae 10-segmented with 3-segmented antennal club; A4, A5, A6, A7 and A8 unmodified, A7 asymmetrical, about twice length of A8, A8 disc-shaped, A9 large, transverse and cupulate, with ventral impression and basolateral excavation, with hook-shaped spine at upper margin of excavation, A10 largest, forming claw-shaped structure with A9, base narrowed, with impression at ventral side and lateral side, gradually enlarge towards rounded apex. Abdominal ventrite 2 with pair of long discal protuberances, inserted with large and strongly curved apical setae; ventrite 6 with pair of short and acute median struts, about one-ninth of ventral length. Protrochanters with long ventral spine, about two-thirds of protrochanteral width; protibiae and mesotibiae unmodified.

Redescription: Body length 1.52–1.60 mm; body colour reddish-brown to dark brown with lighter coloured elytra and legs. Head wider than long; frons slightly narrowed at end, slightly longer than half width of head at eye level; eyes well developed and prominent, with about 31 facets; vertexal foveae punctiform; antennal tubercles weak; postantennal notches...
distinct and rounded; postantennal cavities medium-sized and wide, about half length of antennal tubercles in dorsal view; antennae 10-segmented with 3-segmented antennal club; A4, A5, A6, A7 and A8 unmodified, A7 asymmetrical, about twice length of A8, A8 disc-shaped, A9 large, transverse and cupulate, with ventral impression and basolateral excavation, with hook-shaped spine at upper margin of excavation, A10 largest, forming claw-shaped structure with A9, base narrowed, with impression at ventral side and lateral side, gradually enlarge towards rounded apex. **Pronotum** slightly longer than wide, about as wide as head at eye level; lacking lateral antebasal foveae. **Elytra** about as long as wide, widest near middle; humeral calli barely visible; sutural stria weakly extending from base to apical four-fifths. **Abdomen** with tergite 1 slightly longer than twice length of tergite 2; ventrite 2 with pair of long discal protuberances, inserted with large and strongly curved apical setae; ventrite 6 with pair of short and acute median struts, about one-ninth of ventral length. **Legs** with protrochanters modified with long ventral spine, about two-thirds of protrochanteral width; protibiae and mesotibiae unmodified. **Aedeagus** about 0.33 mm long, with long and stout parameres, slightly bent inwards, apex curved downwards in lateral view, bearing pair of short apical setae and pair of long subapical setae; median lobe with two asymmetrical sclerites narrower than parameres, both curved inwards, left one longer than right one in dorsal view.

**Comments:** The lectotype of *E. (B.) costata*, the holotype of *E. (B.) rudicornis* and the lectotype of *E. (B.) monstrosa* were found representing a single species by having identical forms of A9 and A10 (Figs 3.33B–D), with the former two names treated as junior synonyms. This species is most similar to *E. (B.) conspicua* by having similar modifications of A9 and A10, and can be separated from it by A10 with a small internal hook at its apex.

**Distribution:** North Island. AK, TO, RI, WI, WA. South Island. SD, NN, BR, MC, WD, FD.


**Eupines (Byraxis) mundula** (Schauffuss, 1888)

Figs 3.34, 3.52

*Bryaxis mundus* Broun, 1880: 129.

Bryaxis mundulus Broun, 1893a: 1417. New name for Bryaxis mundus Broun, 1880: 129.

Unnecessary replacement name.

Eupines (Byraxis) munda: combination and subgeneric assignment by Raffray 1904: 207.


Type locality: [CL] Tairua.

Type depository: BMNH LT ♂, 4 PLT.

Diagnosis: Head with vertexal foveae punctiform; antennae 10-segmented with 3-segmented antennal club; A4, A5, A6, A7 and A8 unmodified, A9 large and trapezoidal, with anterolateral impression in ventral view, with minute lateral tubercle in dorsal view, A10 largest, bean-shaped, base obliquely truncate. Abdominal ventrite 2 with pair of median struts, inserted with strongly curved short anterolateral setae; ventrite 6 with pair of short median struts, slightly shorter than one-fourth of ventral length. Protrochanters with small ventral spine, about one-third of protrochanteral width; protibiae and mesotibiae unmodified.

Redescription: Body length 1.57–1.63 mm; body colour reddish-brown with lighter coloured tibiae and tarsi. Head slightly wider than long; frons slightly narrowed at end, about half width of head at eye level; eyes well developed, with about 29 facets; vertexal foveae punctiform; antennal tubercles weak, postantennal notches small and distinct; postantennal cavities medium-sized, about half length of antennal tubercles in dorsal view; antennae 10-segmented with 3-segmented antennal club; A4, A5, A6, A7 and A8 unmodified, A9 large
and trapezoidal, with anterolateral impression in ventral view, with minute lateral tubercle in dorsal view. A10 largest, bean-shaped, base obliquely truncate. **Pronotum** slightly wider than long, wider than head at eye level; lacking lateral antebasal foveae. **Elytra** about as long as wide, widest near middle; humeral calli slightly prominent; sutural stria distinctively extending from base to apex. **Abdomen** with tergite 1 about 1.5 × longer than tergite 2; ventrite 2 with pair of median struts, inserted with strongly curved short anterolateral setae; ventrite 6 with pair of short median struts, slightly shorter than one-fourth of ventral length. **Legs** with protrochanters modified with small ventral spine, about one-third of protrochanteral width; protibiae and mesotibiae unmodified. **Aedeagus** about 0.36 mm long, with parameres stout and wide, slightly sinuate, bent downwards in lateral view, apex curved towards each other, with two pairs of subapical setae, subequal in length; median lobe with two asymmetrical sclerites, strongly curved inwards, left one longer than right one in dorsal view.

**Comments:** The holotype of *E. (B.) forficulida* was compared with the lectotype and one paralectotype of *E. (B.) mundula*, and were found to represent a single species based on the identical forms of A9, A10 and ventrite 2. These names are here synonymised, with the former name treated as the junior synonym. This species is similar to *E. (B.) hoarei* by having similar modifications of A9 and A10 and can by distinguished from it by protrochanters with ventral spine, which is lacking in *E. (B.) hoarei* (Fig. 3.22D).

**Distribution:** North Island. AK, CL, TO, BP, GB, HB, WN, WA.


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**FIGURE 3.34.** Diagnostic characters of *E. (B.) mundula* (Schaufuss, 1888). **A**) Habitus. **B**) Antenna, in dorsal view. **C**) Same, in lateral view. **D**) Protrochanter. **E**) Ventrite 2. **F**) Ventrite 6. **G**) Aedeagus, in dorsal view. **H**) Same, in lateral view. **I**) Same, in ventral view. Scale bars: A = 1 mm, B–E = 0.2 mm, F–I = 0.1 mm.
Eupines (Byraxis) nemoralis (Broun, 1886)

Figs 3.35, 3.52

Byraxis nemoralis Broun, 1886: 831.

Eupines (Byraxis) nemoralis: combination and subgeneric assignment by Raffray 1904: 207.


Type locality: [AK] Woodhill.

Type depository: BMNH HT ♂.

Diagnosis: Head with vertexal foveae small and asetose; antennae 10-segmented with 3-segmented antennal club; A4, A5, A6, A7, A8 and A10 unmodified, A8 slightly asymmetrical, A9 asymmetrical and broadly impressed at lateral side, with slightly extended and laminate margin in lateral view, A10 conical, slightly longer than A9. Abdominal ventrite 2 lacking protuberances, with two small discal tufts of setae; ventrite 6 with pair of short median struts, about one-sixth of ventral length. Protrochanters with long and acute ventral spine, about two-thirds of protrochanteral width; protibiae and mesotibiae unmodified.

Redescription: Body length 1.39–1.44 mm; body colour reddish-brown with lighter coloured tarsi. Head wider than long, frons not narrowed at end, about three-fourths width of head at eye level; eyes well developed and prominent, with about 26 facets; vertexal foveae small and asetose; antennal tubercles moderately developed; postantennal notches weak; postantennal cavities large, slightly shorter than antennal tubercles in dorsal view; antennae 10-segmented with 3-segmented antennal club; A4, A5, A6, A7, A8 and A10 unmodified, A8 slightly asymmetrical, A9 asymmetrical and broadly impressed at lateral side, with slightly extended and laminate margin in lateral view, A10 conical, slightly longer than A9. Pronotum about as long as wide, slightly narrower than head at eye level; lacking lateral antebasal foveae. Elytra about as long as wide, widest at apical two-thirds; humeral calli...
distinct and moderately prominent; sutural stria barely visible and shallowly extending from middle to apex. **Abdomen** with tergite 1 about 1.2 × longer than tergite 2; ventrite 2 lacking protuberances, with two small discal tufts of setae; ventrite 6 with pair of short median struts, about one-sixth of ventral length. **Legs** with protrochanters modified with long and acute ventral spine, about two-thirds of protrochanteral width; protibiae and mesotibiae unmodified. **Aedeagus** about 0.22 mm long, with slender parameres, apex slightly curved inwards, with three pairs of subapical long setae and two pairs of long apical setae; median lobe with two helix-shaped sclerites, gradually narrowed towards apex, slightly wider than parameres in dorsal view.

**Comments:** This is the only species within the subgenus *Byraxis* that lacks the protuberance on andominal ventrite 2 (Fig. 3.35F), the only other species in New Zealand lacking this character is *E. novem* sp. n., which has a 9-segmented antenna.

**Distribution:** North Island. ND, AK, CL.


*Eupines nesobia* Broun, 1914


**Type locality:** [CL] Great Barrier Island.

**Type depository:** BMNH LT ♀, 2 PLT.

**Comments:** This species is based solely on female types.
Eupines novem sp. nov.

Figs 3.36, 3.52

**Diagnosis:** Head with vertexal foveae punctiform; antennae 9-segmented with one-segmented antennal club; A4, A5, A6, A7 and A8 unmodified, A9 widest at middle, base strongly concave at inner side, slightly impressed near basal two-fifths in lateral view. Abdominal ventrite 2 unmodified; ventrite 6 unknown. Protrochanters with long ventral seta, about twice of protochanteral width, lacking ventral spine; protibiae and mesotibiae unmodified.

**Description:** Body length 1.33 mm; body colour dark brown with lighter coloured legs. **Head** wider than long; frons not narrowed at end, about three-fourths width of head at eye level; eyes moderately developed, with about 16 facets; vertexal foveae punctiform; antennal tubercles moderately developed; postantennal notches distinct and broad; postantennal cavities large, about as long as antennal tubercles in dorsal view; antennae 9-segmented with single segmented antennal club; A4, A5, A6, A7 and A8 unmodified, A9 widest at middle, base strongly concave at inner side, slightly impressed near basal two-fifths in lateral view. **Pronotum** slightly longer than wide, slightly narrower than head at eye level; lacking lateral antebasal foveae. **Elytra** as long as wide, widest near apical two-thirds; lacking humeral calli; sutural stria barely visible in dorsal view. **Abdomen** with tergite 1 about 1.3 × longer than tergite 2; ventrite 2 unmodified; ventrite 6 unknown. **Legs** with protrochanters modified with long ventral seta, about twice of protochanteral width, lacking ventral spine; protibiae and mesotibiae unmodified. **Aedeagus** unknown.

**Comments:** This species has an anomalous 9-segmented antenna (Figs 3.36B–C), which separates it from all other Eupines species. I did not dissect the singleton of this new species nor establish a subgenus for it until I can find the evidence that the two existing subgenera are monophyletic.
**Distribution**: North Island. ND.

**Etymology**: This specific epithet means ‘nine’ in Latin, referring to the nine-segmented antennae of this species.

**Type material (NZAC): Holotype.** ♂, specimen entire, card-mounted: “NEW ZEALAND, ND, Pukenui Forest, Taraire Ridge Loop, 12 Nov 2018, J. Shen // sifted leaf litter & rotten woods, 35°41'96"S, 174°15'90"E”.

![Image of a beetle showing diagnostic characters](image)

Eupines (Byraxis) obtusa sp. nov.

Figs 3.37, 3.52

**Diagnosis:** Head lacking vertexal foveae; antennae 10-segmented with 2-segmented antennal club; A4, A6, A7, A8 and A10 unmodified, A5 greatly enlarged and asymmetrical, about 3.5 × longer than A4, A7 slightly asymmetrical, A8 about half length of A7, A9 large, about as long as A10, base slightly impressed at dorsal side, widest near apex, A10 conical. Abdominal ventrite 2 with pair of large discal protuberances, inserted with strongly curved small apical setae; ventrite 6 with pair of long median struts, about one-third of ventral length. Protrochanters with long and acute ventral spine, about three-fifths of protrochanteral width; protibiae with large and blunt apical protuberance; mesotibiae unmodified.

**Description:** Body length 1.42–1.50 mm; body colour dark brown to black with lighter coloured legs. **Head** wider than long; frons slightly narrowed at end, about half width of head at eye level; eyes moderately developed, with about 23 facets; lacking vertexal foveae; antennal tubercles barely visible; lacking postantennal notches; postantennal cavities long and wide, slightly longer than antennal tubercles in dorsal view; antennae 10-segmented with 2-segmented antennal club; A4, A6, A7, A8 and A10 unmodified, A5 greatly enlarged and asymmetrical, about 3.5 × longer than A4, A7 slightly asymmetrical, A8 about half length of A7, A9 large, about as long as A10, base slightly impressed at dorsal side, widest near apex, A10 conical. **Pronotum** as long as wide, slightly wider than head at eye level; lacking lateral antebasal foveae. **Elytra** slightly longer than wide, widest near middle; humeral calli slightly prominent; sutural stria shallowly extending from base to apex. **Abdomen** with tergite 1 about 1.2 × longer than tergite 2; ventrite 2 with pair of large discal protuberances, inserted with strongly curved small apical setae; ventrite 6 with pair of long median struts, about one-third of ventral length. **Legs** with protrochanters modified with long and acute ventral spine, about three-fifths of protrochanteral width; protibiae with large and blunt apical protuberance;
mesotibiae unmodified. Aedeagus about 0.33 mm long, with long and stout parameres nearly meet at apex, bent downwards in lateral view, with two pairs of long subapical setae and pair of short apical setae; median lobe with two slender sclerites, slightly sinuate, strongly curved towards each other at apex, much narrower than parameres.

**Comments:** This species can be distinguished from all other species by its protibiae modified with a rounded apical protuberance, along with A5 modified (Figs 3.37B–C, 3.37E).

**Distribution:** North Island. TO, TK. South Island. WD.

**Etymology:** This specific epithet is a Latin adjective meaning ‘blunt’, referring to the blunt apical protuberance on protibiae of this species.

Eupines (Byraxis) ovalis sp. nov.

Figs 3.38, 3.52

**Diagnosis:** Head with vertexal foveae punctiform; antennae 10-segmented with 2-segmented antennal club; A4, A6, A7, A8 and A10 unmodified, A4 asymmetrical, A5 largest and ovoid, dorsal side broadly impressed, A9 cylindrical and elongate, slightly asymmetrical at apex, A10 conical, about $1.5 \times$ longer than A9. Abdominal ventrite 2 with pair of flat and wide discal protuberances, with strongly curved large apical setae; ventrite 6 with pair of short
median struts, about one-fourth of ventral length. Protrochanters with short ventral spine, about one-seventh of protrochanteral width; protibiae and mesotibiae unmodified.

**Description:** Body length 1.50 mm; body colour dark brown with lighter coloured elytra and tarsi. **Head** as long as wide; frons slightly narrowed at end, about half length of head at eye level; eyes moderately developed, slightly prominent in dorsal view, with about 31 facets; vertexal foveae punctiform; antennal tubercles weak; lacking postantennal notches; postantennal cavities large, slightly longer than antennal tubercles in dorsal view; antennae 10-segmented with 2-segmented antennal club; A4, A6, A7, A8 and A10 unmodified, A4 asymmetrical, A5 largest and ovoid, dorsal side broadly impressed, A9 cylindrical and elongate, slightly asymmetrical at apex, A10 conical, about $1.5 \times$ longer than A9. **Pronotum** slightly longer than wide, wider than head at eye level, with punctiform lateral antebasal foveae. **Elytra** about as long as wide, widest near middle; humeral calli barely visible in dorsal view; sutural stria shallowly extending from base to apex. **Abdomen** with tergite 1 about $1.5 \times$ longer than tergite 2; ventrite 2 with pair of flat and wide discal protuberances, with strongly curved large apical setae; ventrite 6 with pair of short median struts, about one-fourth of ventral length. **Legs** with protrochanters modified with short ventral spine, about one-seventh of protrochanteral width; protibiae and mesotibiae unmodified. **Aedeagus** about 0.27 mm long, with wide and stout parameres, slightly sinuate, bent downwards in lateral view, apex slightly curved, with pair of long subapical setae; median lobe with two large sclerites slightly entwined at apex, widest near middle, much narrower than parameres.

**Comments:** This species can be distinguished from all other species by its large and ovoid A5 (Figs 3.38B–D).

**Distribution:** South Island. BR.

**Etymology:** The specific epithet refers to the oval-shaped antennomere 5.
Type material (NZAC): Holotype. ♂, specimen entire, glued on card, aedeagus + one antenna mounted on acetate card: “NEW ZEALAND, BR, Sewell Peak, 15 Jan 2014, T. Buckley, M. Gimmel, R. Leschen // ant nests under rock, 810m, 42°24.497'S, 171°20.457'E”.


**Eupines (Byraxis) paganus** (Broun, 1881)

Figs 3.39, 3.52

*Byraxis paganus* Broun, 1881: 660.


**Type locality:** [ND] near Whangarei Harbour.

**Type depository:** BMNH HT ♂.

**Diagnosis:** Head with vertexal foveae punctiform; antennae 10-segmented with 2-segmented antennal club; A4, A5, A7 and A8 unmodified, A6 wide and asymmetrical, much wider than A7, A9 asymmetrical, gradually narrow towards apex at outer side, broadly impressed from middle to apex in ventral view, A10 conical, broadly impressed at base in ventral view and slightly longer than A9. Abdominal ventrite 2 with pair of large and asymmetrical discal protuberances, inserted with strongly curved medium-sized apical setae; ventrite 6 large and stout, with lower median margin convex, with pair of long and stout median struts, about one-
third of ventral length. Protrochanters with medium-sized ventral spine, slightly less than two-thirds of protrochanteral width; protibiae and mesotibiae unmodified.

**Redescription:** Body length 1.52–1.59 mm; body colour reddish-brown to dark brown with lighter coloured elytra, tibiae and tarsi. **Head** wider than long; frons slightly narrowed at end, slightly longer than half width of head at eye level; eyes slightly prominent, with about 30 facets; vertexal foveae punctiform; antennal tubercles barely visible; postantennal notches barely visible; postantennal cavities medium-sized, about two-thirds length of antennal tubercles in dorsal view; antennae 10-segmented with 2-segmented antennal club; A4, A5, A7 and A8 unmodified, A6 wide and asymmetrical, much wider than A7, A9 asymmetrical, gradually narrow towards apex at outer side, broadly impressed from middle to apex in ventral view, A10 conical, broadly impressed at base in ventral view and slightly longer than A9. **Pronotum** slightly wider than long, about as long as head at eye level; lacking lateral antebasal foveae. **Elytra** about as long as wide, widest at apical two-thirds; humeral calli barely visible, sutural stria shallowly extending from base to apex. **Abdomen** with tergite 1 about as long as tergite 2; ventrite 2 with pair of large and asymmetrical discal protuberances, inserted with strongly curved medium-sized apical setae; ventrite 6 large and stout, with lower median margin convex, with pair of long and stout median struts, about one-third of ventral length. **Legs** with protrochanters modified with medium-sized ventral spine, slightly less than two-thirds of protrochanteral width; protibiae and mesotibiae unmodified. **Aedeagus** about 0.44 mm long, with long and stout parameres, slightly curved towards each other at apex, strongly bent downwards in lateral view, with four pairs of short subapical setae; median lobe with two long sclerites, narrower than parameres in dorsal view, strongly curved inwards at apex, left one sinuate near middle.

**Comments:** I examined types of *E. (B.) allocera, E. (B.) sylvicola, E. (B.) rhyssarthra* and *E. (B.) paganus* and determined that these species are conspecific based on their identical
antennal modification and ventrite 2. These names are here synonymised, with the former three names treated as junior synonyms. This species can be distinguished from all other *Eupines* by its A6 transverse and asymmetrical (Figs 3.39B–D).

**Distribution:** North Island. ND, AK, CL, BP, RI.


*Eupines (Byraxis) pannicula* sp. nov.

Figs 3.40, 3.53

**Diagnosis:** Head with vertexal foveae small and asetose; antennae 10-segmented with 2-segmented antennal club; A4, A5, A6, A7 and A8 unmodified, A9 enlarged, about 3.2 × longer than A8, ventral side truncate near apex, A10 conical, with basal impression at ventral view. Abdominal ventrite 2 with pair of medium-sized discal protuberances, inserted with strongly curved small apical setae; ventrite 6 with pair of long and stout median struts, about one-fourth of ventral length. Protrochanters with short ventral spine, about one-third of
protrochanteral width; protibiae unmodified; mesotibiae slightly convex near apex, with long tuft of subapical setae.

**Description:** Body length 1.52–1.62 mm; body colour reddish-brown with lighter coloured legs. **Head** slightly wider than long; frons not narrowed at end, about three-fourths width of head at eye level; eyes well developed, conspicuously prominent in dorsal view, with about 31 facets; vertexal foveae small and asetose; antennal tubercles moderately developed; postantennal notches broad and long; postantennal cavities large and long, about as long as antennal tubercles in dorsal view; antennae 10-segmented with 2-segmented antennal club; A4, A5, A6, A7 and A8 unmodified, A9 enlarged, about 3.2 × longer than A8, ventral side truncate near apex, A10 conical, with basal impression at ventral view. **Pronotum** as long as wide, about as wide as head at eye level; lacking lateral antebasal foveae. **Elytra** longer than wide, widest near middle; humeral calli weak, slightly prominent in dorsal view; sutural stria shallowly extending from base to middle, barely visible from middle to apex. **Abdomen** with tergite 1 about as long as tergite 2; ventrite 2 with pair of medium-sized discal protuberances, inserted with strongly curved small apical setae; ventrite 6 with pair of long and stout median struts, about one-fourth of ventral length. **Legs** with protrochanters modified with short ventral spine, about one-third of protrochanteral width; protibiae unmodified; mesotibiae slightly convex near apex, with long tuft of subapical setae. **Aedeagus** about 0.34 mm long, with long and stout parameres, meet at apex, widest near middle, curved downwards in lateral view, with four pairs of subapical short setae; median lobe with two slender sclerites, slightly sinuate and meet at apex.

**Comments:** This species can be distinguished from all other *Eupines* by its mesotibiae modified with a long tuft of subapical setae (Fig. 3.40E).

**Distribution:** North Island. ND.
**Etymology:** This specific epithet means ‘tuft’ in Latin, referring to the long tuft of subapical setae on mesotibiae.


*Eupines (Byraxis) petila* sp. nov.

Figs 3.41, 3.53

**Diagnosis:** Head with vertexal foveae small and asetose; antennae 10-segmented with 2-segmented antennal club; A4, A5, A6, A7 and A8 unmodified, A9 elongate, about as long as A10, truncate at dorsal side; apical margin extended in lateral view, A10 conical and truncate at dorsal side. Abdominal ventrite 2 with pair of small discal protuberances, inserted with slightly curved small apical setae; ventrite 6 with pair of short median struts, about one-fifth
of ventral length. Protrochanters with a long and acute ventral spine, about three-fourths of protrochanteral width; protibiae and mesotibiae unmodified.

**Description:** Body length 1.30–1.40 mm; body colour reddish-brown with lighter coloured elytra and legs. **Head** longer than wide; frons not narrowed at end, about three-fourths width of head at eye level; eyes moderately developed, with about 19 facets; vertexal foveae small and asetose; antennal tubercles conspicuously developed; postantennal notches broad and long; postantennal cavities large, slightly shorter than antennal tubercles in dorsal view; antennae 10-segmented with 2-segmented antennal club; A4, A5, A6, A7 and A8 unmodified, A9 elongate, about as long as A10, truncate at dorsal side, apical margin extended in lateral view, A10 conical and truncate at dorsal side. **Pronotum** about as long as wide, wider than head at eye level; lacking lateral antebasal foveae. **Elytra** about as long as wide, widest at apical two-thirds; humeral calli weak, slightly prominent in dorsal view; sutural stria weak, visible near base and apex. **Abdomen** with tergite 1 about 1.3 × longer than tergite 2; ventrite 2 with pair of small discal protuberances, inserted with slightly curved small apical setae; ventrite 6 with pair of short median struts, about one-fifth of ventral length. **Legs** with protrochanters modified with a long and acute ventral spine, about three-fourths of protrochanteral width; protibiae and mesotibiae unmodified. **Aedeagus** about 0.35 mm long, with strongly elongated parameres, slightly sinuate, curved inwards at apex, with three pairs of long subapical setae and two pairs of long apical setae; median lobe with two long and slender sclerites, curved towards each other at apex, widest near base, shorter than parameres.

**Comments:** This species can be distinguished from all other *Eupines* by its A10 conical and truncate at dorsal side (Figs 3.41B–D).

**Distribution:** North Island. ND, CL, BP.

**Etymology:** This specific epithet is derived from a Latin adjective meaning ‘slender’, referring to the slender parameres of aedeagus of this species.

**Eupines piciceps** (Broun, 1880)


*Eupines (Eupines) piciceps*: combination and subgeneric assignment by Raffray 1904: 205.


**Type locality:** [CL] Tairua.

**Type depository:** BMNH LT ♀, 1 PLT.

**Comments:** This species is based solely on female types.

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**Eupines (Byraxis) platyartha** (Broun, 1893)

Figs 3.42, 3.53

*Bryaxis clavatus* Broun, 1880: 126.

*Bryaxis platyartha* Broun, 1893a: 1417. New name for *Bryaxis clavatus* Broun, 1880: 126, preoccupied by *Bryaxis clavata* Motschulsky, 1851: 49.

*Eupines (Byraxis) platyartha*: combination and subgeneric assignment by Raffray 1904: 207.


**Type locality:** [CL] Tairua.

**Type depository:** BMNH LT ♂; NZAC 1 PLT.

**Diagnosis:** Head with vertexal foveae punctiform; antennae 10-segmented with 2-segmented antennal club; A4, A5, A6, A7 and A8 unmodified, A9 largest and strongly transverse, with deep lateral impression and laminate margin at inner side, A10 conical and slightly shorter than A9, lateral side broadly impressed. Abdominal ventrite 2 with pair of minute discal protuberances, inserted with small strongly curved apical setae; ventrite 6 with pair of long
median struts, about as long as ventral length. Protrochanters modified with medium-sized ventral spine, about half of protrochanteral width; protibiae and mesotibiae unmodified.

**Redescription:** Body length 1.60 mm; body colour reddish-brown with lighter coloured tibiae and tarsi. **Head** wider than long; frons not narrowed at end, about three-fourths width of head at eye level; eyes slightly prominent, with about 29 facets; vertexal foveae punctiform; antennal tubercles weak; postantennal notches weak; postantennal cavities small, about half width of antennal tubercles in dorsal view; antennae 10-segmented with 2-segmented antennal club; A4, A5, A6, A7 and A8 unmodified, A9 largest and strongly transverse, with deep lateral impression and laminate margin at inner side, A10 conical and slightly shorter than A9, lateral side broadly impressed. **Pronotum** slightly longer than wide, about as wide as head at eye level; lacking lateral antebasal foveae. **Elytra** slightly longer than wide, widest at apical two-thirds; humeral calli slightly prominent; sutural stria shallowly extending from base to apex. **Abdomen** with tergite 1 about 1.5 × longer than tergite 2; ventrite 2 with pair of minute discal protuberances, inserted with small strongly curved apical setae; ventrite 6 with pair of long median struts, about as long as ventral length. **Legs** with protrochanters modified with medium-sized ventral spine, about half of protrochanteral width; protibiae and mesotibiae unmodified. **Aedeagus** about 0.29 mm long, with elongate parameres slightly sinuate, longer than median lobe and basal bulb combined, slightly curved downwards at apex in lateral view, with two pairs of stout subapical setae at inner side, pair of slender subapical setae at outer side and pair of short apical setae; median lobe with two sclerites highly twisted, slightly asymmetrical, gradually narrowed towards apex, both curved inwards at apex.

**Comments:** This species can be distinguished from all other *Eupines* by its strongly transverse A9 (Figs 3.42B–D).

**Distribution:** North Island. CL.

*Eupines (Byraxis) protibialis* sp. nov.

Figs 3.43, 3.53

**Diagnosis:** Head lacking vertexal foveae; antennae 10-segmented with 2-segmented antennal club; A4, A6, A7 and A8 unmodified, A5 greatly enlarged and asymmetrical, about 2.5 × longer than A4, A8 short, about half length of A7, A9 largest, about 1.4 × longer than A10, slightly impressed at base in dorsal view, widest near apex, A10 bean-shaped, slightly impressed near base in lateral side. Abdominal ventrite 2 with pair of long discal protuberances curved towards middle, inserted with strongly curved small apical setae; ventrite 6 with pair of long median struts, about half of ventral length. Protrochanters with
long and acute ventral spine, about two-thirds of protrochanteral width; protibiae with large triangle apical protuberance and apical long spine; mesotibiae unmodified.

**Description:** Body length 1.59–1.63 mm; body colour black with lighter coloured tibiae and tarsi. **Head** wider than long; frons slightly narrowed at end, about half width of head at eye level; eyes weakly developed, slightly prominent in dorsal view, with about 23 facets; lacking vertexal foveae; antennal tubercles barely visible; lacking postantennal notches; postantennal cavities long and wide, slightly shorter than antennal tubercles in dorsal view; antennae 10-segmented with 2-segmented antennal club; A4, A6, A7 and A8 unmodified, A5 greatly enlarged and asymmetrical, about 2.5 × longer than A4, A8 short, about half length of A7, A9 largest, about 1.4 × longer than A10, slightly impressed at base in dorsal view, widest near apex, A10 bean-shaped, slightly impressed near base in lateral side. **Pronotum** as long as wide, wider than head at eye level; lacking lateral antebasal foveae. **Elytra** about as long as wide, widest near middle; humeral calli weak; sutural stria shallowly extending from base to apex. **Abdomen** with tergite 1 about 1.5 × longer than tergite 2; ventricle 2 with pair of long discal protuberances curved towards middle, inserted with strongly curved small apical setae; ventricle 6 with pair of long median struts, about half of ventral length. **Legs** with protrochanters modified with long and acute ventral spine, about two-thirds of protrochanteral width; protibiae with large triangle apical protuberance and apical long spine; mesotibiae unmodified. **Aedeagus** about 0.29 mm long, with long and stout parameres curved towards each other, almost meet at apex, bent downwards in lateral view, with four pairs of small subapical setae; median lobe with two short sclerites, strongly curved at apex, much narrower than parameres.

**Comments:** This species is similar to *E. (B.) dugdalei* by sharing with it the dark body colour and the similar antennal modification and the aedeagal structures but differs from it by having A9 subparallel-sided (Fig. 3.43B).
**Distribution:** South Island. SL, SI.

**Etymology:** This specific epithet refers to the protibiae of this species with long apical spine.


**Eupines (Byraxis) setifera** (Broun, 1893)

Figs 3.44, 3.53

*Byraxis setifer* Broun, 1893b: 173.

**Eupines (Byraxis) setifera**: combination and subgeneric assignment by Raffray 1904: 207.


**Type locality**: [WO] Mount Pirongia.

**Type depository**: BMNH LT ♂, 1 PLT.

**Diagnosis**: Head with vertexal foveae small and asetose; antennae 10-segmented with 4-segmented antennal club; A4, A5, A6, A7, A8 and A10 unmodified, A8 slightly asymmetrical, A9 strongly asymmetrical and concaved at lateral side, margin of concavity laminate and extended in ventral view, A10 conical and slightly impressed at base in ventral view. Abdominal ventrite 2 with pair of barely visible discal protuberances, inserted with slightly curved apical setae; ventrite 6 with pair of short median struts, about one-sixth of ventral length. Protrochanters with long and acute ventral spine, about two-thirds of protrochanteral width; protibiae with minute apical spine; mesotibiae unmodified.

**Redescription**: Body length 1.21–1.30 mm; body colour reddish-brown to with lighter coloured tibiae and tarsi. **Head** wider than long; frons not narrowed at end, about three-fourths width of head at eye level; eyes well developed, with about 25 facets; vertexal foveae small and asetose; antennal tubercles moderately developed; postantennal notches distinct and broad; postantennal cavities large, about two-thirds length of antennal tubercles in dorsal view; antennae 10-segmented with 4-segmented antennal club; A4, A5, A6, A7, A8 and A10 unmodified, A8 slightly asymmetrical, A9 strongly asymmetrical and concaved at lateral side, margin of concavity laminate and extended in ventral view, A10 conical and slightly impressed at base in ventral view. **Pronotum** as long as wide, slightly narrower than head at
eye level; with punctiform lateral antebasal foveae. **Elytra** slightly wider than long, widest at apical two-thirds; humeral calli weak, slightly prominent; sutural stria weak, extending from basal one-third to apex. **Abdomen** with tergite 1 about $1.2 \times$ longer than tergite 2; ventrite 2 with pair of barely visible discal protuberances, inserted with slightly curved apical setae; ventrite 6 with pair of short median struts, about one-sixth of ventral length. **Legs** with protrochanters modified with long and acute ventral spine, about two-thirds of protrochanteral width; protibiae with minute apical spine; mesotibiae unmodified. **Aedeagus** about 0.24 mm long, with slender parameres, slightly curved inwards at apex, slightly sinuate in dorsal view, with three pairs of long subapical setae and two pairs of long apical setae; median lobe with two short sclerites, strongly curved towards each other at apex, slightly narrower than parameres.

**Comments:** This species is similar to *E. (B.) nemoralis* by similar antennal modification but can be distinguished from it by its protibiae with a minute apical spine (Fig. 3.44F), which is lacking in *E. (B.) nemoralis*.

**Distribution:** North Island. ND, AK, WO, CL, RI.

**Additional material examined:** 10 ♂♂, **ND:** 1, Paihia Opua SF. 22/Jan/1981 G. Kuschel; 2, Waipoua SF. Toronui Track 30/Oct 1980 G. Kuschel; **AK:** 1, Bethells Matuku Res. 21/Dec 1944; **CL:** 2, Little Barrier I. 07/Apr 1984 C.T. Duval sifted litter; 2, AMNZ, Great Barrier I. Little Windy Hill 200m, 21/Nov–13/Dec 2002; **RI:** 1, NE Ohingaiti Mangamako Rd. Paki-iti Fam 23/Aug 1985 C.T. Duval sifted litter. **Associated females** (16 ♀♀): **ND:** 3, Paihia Opua SF. 22/Jan/1981 G. Kuschel; 13, Waipoua SF. Toronui Track 30/Oct 1980 G. Kuschel.

*Eupines simplex* Broun, 1913


**Type locality:** [CL] Tairua.

**Type depository:** BMNH LT ♀, 1 PLT.

**Comments:** This species is based solely on female types.
**Eupines (Byraxis) waikaremoana sp. nov.**

Figs 3.45, 3.53

**Diagnosis:** Head with vertexal foveae punctiform; antennae 10-segmented with 2-segmented antennal club; A4, A5, A6, A7, A8 and A10 unmodified, A8 slightly shorter than A7, A9 reversed cone-shaped, slightly asymmetrical, with apical spine at ventral side, A10 conical and slightly longer than A9. Abdominal ventrite 2 with pair of minute discal protuberances, inserted with strongly curved minute apical setae; ventrite 6 with pair of long and acute median struts, about half of ventral length. Protrochanters with long and acute ventral spine, about three-fourths of pro trochanteral width; protibiae and mesotibiae unmodified.

**Description:** Body length 1.91 mm; body colour reddish-brown with lighter coloured tibiae and tarsi. **Head** longer than wide; frons not narrowed at end, about three-fourths width of head at eye level; eyes moderately developed, slightly prominent in dorsal view, with about 27 facets; vertexal foveae punctiform; antennal tubercles weakly developed; lacking postantennal notches; postantennal cavities large, slightly shorter than antennal tubercles in dorsal view; antennae 10-segmented with 2-segmented antennal club; A4, A5, A6, A7, A8 and A10 unmodified, A8 slightly shorter than A7, A9 reversed cone-shaped, slightly asymmetrical, with apical spine at ventral side, A10 conical and slightly longer than A9. **Pronotum** longer than wide, about as wide as head at eye level; lacking lateral antebasal foveae. **Elytra** slightly longer than wide, widest near middle; humeral calli weak, slightly prominent in dorsal view; sutural stria barely visible. **Abdomen** with tergite 1 about 1.3 × longer than tergite 2; ventrite 2 with pair of minute discal protuberances, inserted with strongly curved minute apical setae; ventrite 6 with pair of long and acute median struts, about half of ventral length. **Legs** with pro trochanters modified with long and acute ventral spine, about three-fourths of pro trochanteral width; protibiae and mesotibiae unmodified. **Aedeagus** about 0.36 mm long, with slender parameres curved towards each other at apex,
apex bent downwards in lateral view, with five pairs of long apical setae; median lobe with two large sclerites, curved towards each other at apex, widest near middle, right one longer and much wider than left one in dorsal view.

**Comments:** This species is most similar to *E. (B.) carinata* by sharing the large body size (average length around 2.00 mm), but can be separated from it by having A10 unmodified (Fig. 3.45B).

**Distribution:** North Island. GB.

**Etymology:** This species is named after the holotype locality.

**Type material (NZAC):** Holotype. ♂, specimen entire, glued on point, aedeagus + proleg on acetate card: “GB, L. Waikaremoana, 19 Nov 1975, G. Kuschel [in hand]”.

Aedeagus, in dorsal view. **H)** Same, in lateral view. **I)** Same, in ventral view. Scale bars: A = 1 mm, B–E = 0.2 mm, F–I = 0.1 mm.

**Eupines (Byraxis) whirinaki sp. nov.**

Figs 3.46, 3.53

**Diagnosis:** Head with vertexal foveae punctiform; antennae 10-segmented with 2-segmented antennal club; A4, A5, A6, A7 and A8 unmodified, A9 cylindrical and largest, about 1.5 × longer than A10, with apical small impression surrounding small spine at ventral side, A10 conical and slightly flattened at ventral side near base. Abdominal ventrite 2 with pair of minute discal protuberances, inserted with pair of slightly curved minute apical setae; ventrite 6 unknown. Protrochanters with short ventral spine, about two-fifths of protrochanteral width; protibiae and mesotibiae unmodified.

**Description:** Body length 1.52 mm; body colour dark brown with lighter coloured tibiae and tarsi. **Head** wider than long; frons not narrowed at end, about three-fourths width of head at eye level; eyes well developed, conspicuously prominent in dorsal view, with about 32 facets; vertexal foveae punctiform; antennal tubercles weak; postantennal notches shallow; postantennal cavities large, slightly shorter than antennal tubercles in dorsal view; antennae 10-segmented with 2-segmented antennal club; A4, A5, A6, A7 and A8 unmodified, A9 cylindrical and largest, about 1.5 × longer than A10, with apical small impression surrounding small spine at ventral side, A10 conical and slightly flattened at ventral side near base. **Pronotum** about as long as wide, slightly wider than head at eye level; lacking lateral antebasal foveae. **Elytra** slightly wider than long, widest near middle; humeral calli barely visible; sutural stria barely visible near base and apex, distinctive near middle. **Abdomen** with tergite 1 about twice length of tergite 2; ventrite 2 with pair of minute discal protuberances, inserted with pair of slightly curved minute apical setae; ventrite 6 unknown. **Legs** with protrochanters modified with short ventral spine, about two-fifths of
protrochanteral width; protibiae and mesotibiae unmodified. **Aedeagus** about 0.33 mm long, with slender parameres asymmetrical, curved towards each other and nearly meet at apex, with two pairs of long subapical setae and three pairs of long apical setae; median lobe with two large and two small sclerites, large two slightly entwined near apex, wider and slightly shorter than parameres, small two straight.

**Comments:** This species is described from a singleton lacking ventrite 6. It is similar to *E. (B.) hectori* by having A9 modified with a small apical spine, but differs from it by having A9 about twice the length of A10 (Figs 3.46B–D).

**Distribution:** North Island. TO.

**Etymology:** This species is named after the holotype locality.

**Type material (NZAC):** **Holotype.** ♂, body parts on acetate card: “NEW ZEALAND, TO, Whirinaki SF. 12 Sep 1984, C. Crowe & A. Davis, Litter 84/66”.

*Eupines (Eupines) undecim* sp. nov.

Figs 3.47, 3.53

**Diagnosis:** Head with vertexal foveae punctiform, surrounded by shallow impressions; antennae 11-segmented with 2-segmented antennal clubs; A4, A5, A6, A7, A8 and A9 unmodified, A10 trapezoidal, about twice length of A9, dorsal side truncate, A11 longest, spear-shaped, with basolateral excavation, basal margin truncate at dorsal side. Abdominal ventrite 2 unmodified; ventrite 6 with pair of long and acute median struts, about one-third of
ventral length. Protrochanters with short ventral spine, about one-fifth of protrochanteral length; protibiae and mesotibiae unmodified.

**Description:** Body length 1.25–1.33 mm; body colour reddish-brown with lighter coloured tibiae and tarsi. **Head** wider than long; frons not narrowed at end, about three-fourths width of head at eye level; eyes moderately developed, prominent in dorsal view, with about 16 facets; vertexal foveae punctiform, surrounded by shallow impressions; antennal tubercles moderately developed; postantennal notches distinctive and broad; postantennal cavities large, slightly shorter than antennal tubercles in dorsal view; antennae 11-segmented with 2-segmented antennal clubs; A4, A5, A6, A7, A8 and A9 unmodified, A10 trapezoidal, about twice length of A9, dorsal side truncate, A11 longest, spear-shaped, with basolateral excavation, basal margin truncate at dorsal side. **Pronotum** as long as wide, about as wide as head at eye level; lacking lateral antebasal foveae. **Elytra** slightly wider than long, widest near middle; lacking humeral calli and sutural stria. **Abdomen** with tergite 1 about 1.2 × longer than tergite 2; ventrite 2 unmodified; ventrite 6 with pair of long and acute median struts, about one-third of ventral length. **Legs** with protrochanters modified with short ventral spine, about one-fifth of protrochanteral length; protibiae and mesotibiae unmodified. **Aedeagus** about 0.22 mm long, with stout and symmetrical parameres, apex curved downwards in lateral view, with two pairs of long subapical setae and pair of long apical setae; median lobe with two large and symmetrical sclerites, curved towards each other in dorsal view, widest at base and narrower than parameres.

**Comments:** This is the only New Zealand species that can be placed into the subgenus *Eupines* by having 11-segmented antennae. Ventrite 2 of *E. (E.) undecim* is unmodified, as it is in *E. novum* sp. n., while it is modified in all species of the subgenus *Byraxis*, apart from *E. (B.) nemoralis* (Fig. 3.35F).

**Distribution:** North Island. ND.
**Etymology:** This specific epithet means ‘eleven’ in Latin, referring to the 11-segmented antennae of this species.


view. G) Same, in ventral view. H) Same, in lateral view. Scale bars: A = 1 mm, B–D = 0.2 mm, E–H = 0.1 mm.

INCERTAE SEDIS

_Eupines acceptus_ (Broun, 1923)


**Type locality:** [WO] Rangiriri.

**Comments:** Type material for _E. acceptus_ could not be located (Shen and Leschen 2019).

OTHER TAXONOMIC CHANGES

_Eupinolus calcaratus_ (Broun, 1886) NEW COMBINATION

(Figs 11–12 in Shen and Leschen, 2019)

_Byraxis calcarata_ Broun, 1886: 831. Raffray 1904: 244.


**Type locality:** [WO] Tuakau.

**Type depository:** BMNH LT ♂.

**Comments:** An examination of the lectotype of _E. (E.) calcarata_ found that it has a median antebasal fovea and a punctate pronotal base, characters which are consistent with members of the genus _Eupinolus_ Oke, thereby resulting in the new combination recognised above.
**Eupinolus altulus** (Broun, 1880)

(Figs 97–98 in Shen and Leschen, 2019)


**Type locality:** [ND] Near Whangarei Harbour.

**Type depository:** BMNH LT ♂, 1 PLT.

**Comments:** *Eupines. (E.) nasuta* has a median antebasal fovea and a punctate pronotal base, characters that are consistent with members of the genus *Eupinolus*. The small subapical protuberance of protibiae in males and the narrow frons also match the types of *Eupinolus altulus*, resulting in the new synonymy recognised above.

**Gastrobothrus ignotus** (Broun, 1881) **NEW COMBINATION**

(Figs 45–46 in Shen and Leschen, 2019)


**Type locality:** [ND] Manaia, Whangarei Harbour.

**Type depository:** BMNH HT ♂.

**Comments:** The holotype of E. (B.) ignotus has strongly narrowed elytral bases and the glabrous pronotum lacking median antebasal fovea and the antebasal sulcus that are consistent with members of the genus Gastrobothrus Broun. Here I formally transfer this species from Eupines to Gastrobothrus.

**Gastrobothrus platynotus** (Broun, 1893) **NEW COMBINATION**

(Figs 77–78 in Shen and Leschen, 2019)

*Bryaxis platynota* Broun, 1893a: 1338. Raffray, 1904: 244.


**Type locality:** [HB] Mangawhare, Northern Wairoa.

**Type depository:** BMNH HT ♂.

**Comments:** The holotype of E. (E.) platynota has strongly narrowed elytral bases and the glabrous pronotum lacking median antebasal fovea and antebasal sulcus that are consistent with members of the genus Gastrobothrus. Here I formally transfer this species from *Eupines* to *Gastrobothrus.*
FIGURE 3.53. Geographic distributions of *E. (B.) pannicula* sp. n., *E. (B.) petila* sp. n., *E. (B.) platyarthra* (Broun, 1893), *E. (B.) protibialis* sp. n., *E. (B.) setifera* (Broun, 1893), *E. (B.) waikaremoana* sp. n., *E. (B.) whirinaki* sp. n. and *E. (B.) undecim* sp. n. in New Zealand.
4.

Review and clinal variation of New Zealand

*Anabaxis* Raffray

(Coleoptera: Staphylinidae: Pselaphinae: Goniaceritae)

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4.1 Introduction

The pselaphine genus *Anabaxis* Raffray of the tribe Brachyglutini comprises seven species distributed in Australia (6 spp.) and New Zealand (2 spp.) (Chandler 2001; Nomura & Leschen 2006). According to the collection data, members of *Anabaxis* are most likely to be collected in leaf litter and wood debris, and, in Australia, they are also recorded from moss and under bark of dead *Eucalyptus* (Chandler 2001). They are relatively small in size (1.3–2.5 mm), and sexually dimorphic with males possessing various secondary characteristics such as having spines on the mesotrochanter and mesotibia. *Anabaxis* can be readily distinguished from other members of Brachyglutini by three characters of the head: the presence of a pair of dorsal postantennal pits near the lateral margin, the broad and prominent median gular ridge and the strongly concave ventrolateral margin beneath eyes.

*Anabaxis* was erected by Raffray (1908) to accommodate three species, *Bryaxis electrica* King, *Bryaxis euplectoides* Broun and *Bryaxis lunatica* King. Kuschel (1990) transferred *Euplectus foveolata* Broun to *Anabaxis* and treated *A. euplectoides* as a junior

Members of *Anabaxis* could be found throughout New Zealand yet based on the examination of museum collections; species richness is low, with only *A. foveolata* common in both North and South Islands, apart from the introduced species, *A. brevis*. And here I describe a new species from three specimens collected from the offshore Chatham Islands. Morphological features of the elytral foveae, male sexual characters, and male genitalia are variable for *A. foveolata*. I analyzed this variation and concluded that it does not indicate clear breaks in species-level taxa, and hypothesize that there is a single widespread species (*A. foveolata*).

In this chapter, The New Zealand members of the genus *Anabaxis* Raffray are revised to accommodate three species, including one new species: *Anabaxis chathamensis* sp. n. A key and an illustrated catalogue to the described species from New Zealand and Australia are included. Lectotypes are designated for *A. brevis* (Oke), *A. electrica* (King), *A. foveolata* (Broun), *A. inusitata* (Blackburn), *A. lunatica* (King), *A. quinquefoveolata* (Raffray) and *A. vagus* (Oke). I also clarify the valid name of the species introduced to New Zealand and discuss the variation of *A. foveolata* in detail.

### 4.2 Material and Methods

Specimens were examined from the following collections:

- **AMNZ** Auckland War Memorial Museum, Auckland, New Zealand (J. Early);
- **AMS** Australian Museum, Sydney, New South Wales, Australia (D. Smith);
- **BMNH** The Natural History Museum, London, United Kingdom (B. Garner);
External morphology was examined using a Leica MZ12 binocular stereomicroscope and genitalia (mounted in Euparal) were examined using a Leica DM 4500B compound microscope. Image capture was made with a Nikon DS-Fi1 camera attached to the compound microscope and stacked from multiple layers using Zerene 1.04 software. Area-codes and their abbreviations follow Crosby et al. (1998). Terminology follows Chandler (2001) and Lawrence et al. (2010).

The following abbreviations are applied: PL = pronotal length; PW = pronotal width; EL = elytral length; EW = elytral width. Body length is measured from the anterior clypeal margin of the head to the posterior edge of the abdomen. Aedeagus length is measured from the posterior edge of the median lobe to the anterior edge of the parameres. Holotype and paratype labels are red and blue, respectively.

Nearly 350 individuals including more than 300 dried, pinned specimens were examined during the study, and 278 non-type specimens of *A. foveolata* from more than 90 localities and the type specimen of *A. foveolata* were examined for evaluating the morphological variation. Representative species were compared with type specimens housed in the AMS (*A. electrica* and *A. lunatica*), the BMNH (*A. foveolata* and *A. inusitata*), the MNHN (*A. quinquefoveolata*), and photos of type material from the MVMA (*A. brevis* and *A. vagus*).
Variability of the male secondary sexual characters of A. *foveolata* was statistically analyzed. Line charts were produced using the RStudio (version 1.0.153) with the package of Plotrix (Lemon *et al.* 2017). Linear regression models were used to determine the relationship between latitude and size of male secondary sexual characters. To simplify geographic data, I numbered the latitude from low to high (north to south) with integers from 1 to 28. I measured at least three individuals per locality, if available. Measurements of mesotrochanteral modifications and mesotibial modifications are compared to the ventral length of the mesotrochanters and the length of the mesotarsal claws, respectively.

### 4.3 Taxonomy

**AANABAXIS** Raffray, 1908

Figs 4.1–4.2

*Anabaxis* Raffray, 1908: 252. **Type species:** *Bryaxis lunatica* King, 1863, subsequent designation by Newton & Chandler, 1989: 42.

**Diagnosis:** Body size small to large (1.3–2.5 mm), stout and pubescent in dorsal aspect. Head with distinct setose vertexal foveae, with pair of postantennal pits; median gular ridge broad and prominent; antennal club usually formed by apical 2 to 3 antennomeres, antennomere 3 elongate and strongly narrow basally. Pronotum with median antebasal fovea asetose smaller than setose lateral antebasal foveae, often connected by slightly visible antebasal sulcus. Elytra with long discal striae, each elytron with 1 to 4 basal foveae. Tergite IV (visible tergite I) with setose basal impression between mediobasal foveae; ventrite IV (visible ventrite II) with deep basolateral sulci.

**Redescription:** Body slightly convex, dorsal vestiture typically biseriate with short scattered decumbent setae, with or without 1 to 4 longitudinal rows of long suberect setae on elytra,
abdomen, and paratergites (setae often effaced). Head with or without frontal fovea, with pair of setose vertexal foveae (Fig. 4.1A); ventrolateral margin strongly concave beneath eyes; antennal tubercles weak, with pair of conspicuous postantennal pits; antennae 11-segmented, antennomeres lacking distinct modifications, with scape elongate, cylindrical, about 1.5 × as long as A2, pedicel almost as long as A3; A3 elongate and strongly narrow basally; A4–A6 rounded and identical; A7 rounded, shorter than preceding segment and almost twice the length of A8, club 2- or 3- segmented (A9 of A. quinquefoveolata weakly enlarged), A10 subrectangular and much larger than A9, A11 punctuate with long setae at apex, slightly longer than A9 and A10 combined (Fig. 4.1F); ocular-mandibular carinae present; median gular ridge broad and prominent (Fig. 4.1B), abruptly curved posteriorly to gular foveae (Fig. 4.1C); maxillary palpi with segment 2 gradually widened towards apex, segment 3 triangular to globular, segment 4 large, slightly narrow at base, with long apical setae (Fig. 4.2A).

Pronotum slightly wider than long, with asetose median and setose lateral antebasal foveae, median antebasal fovea often slightly smaller than lateral antebasal foveae (Fig. 4.2B); antebasal sulcus clearly delimited to lacking; lacking median longitudinal sulcus; lateral procoxal foveae widely separated (Fig. 4.2C).

Each elytron with 1 to 4 basal foveae, with outer 2 often merged when more than 2 basal foveae present (Fig. 4.2E); 2 faint subbasal elytral foveae present (Fig. 4.2E); sutural stria present, discal striae often extending to apical four-fifths of elytral length or more (Fig. 4.2D); posterior margin of elytra weakly to strongly sinuate.

Mesoventrite (Fig. 4.1D) with broadly opened lateral mesoventral foveae connecting internally, small prepectal foveae present, median mesoventral fovea short; lateral mesocoxal foveae present. Metaventrite with lateral metaventral foveae adjacent, or with single bifurcate median metaventral fovea.

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Abdomen (Figs 4.2F–H) with tergite IV (first visible tergite) variable in length, from as long as remaining segments combined to slightly longer than half of their combined length, mediobasal foveae present, mediobasal impression present and setose, basolateral foveae visible on tergites IV–VII, tergite VII lacking paratergites; ventrite IV (visible ventrite II) with basolateral foveae present, mesal margin of deep basal sulci with small and transverse mediobasal foveae almost meeting internally (Fig. 4.1E).

Legs usually with pro- and mesotarsomeres 2 and 3 subequal in length, metatarsomere 3 about as long as to three-fourths length of tarsomere 2.

Sexes dimorphic with males having mesotrochanters and mesotibiae modified (type of *A. inusitata* is single female after examination). Aedeagus with median lobe and parameres symmetrical, parameres fused to widely separated at base, internal sac often comprising complex sclerites and sclerotized laminae.

**Comments:** The description above is modified from Chandler (2001). Within the Australasian fauna, *Anabaxis* is most similar to the genus *Mallanganee* Chandler and shares with it the presence of the dorsal postantennal pits on head, the weakly indicated antebasal sulcus on pronotum and the elongate discal stria on the elytra. *Anabaxis* can be distinguished from *Mallanganee* by the presence of a broad median gular ridge, the antennomere 3 elongate and strongly narrowed at base, and the presence of a distinct median pronotal fovea. In New Zealand, *Anabaxis* is similar to *Startes* Broun by sharing the broad and prominent median gular carina of the head, and the visible tergite I (morphologically tergite IV) has a mediobasal impression and foveae. *Anabaxis* can be readily separated from *Startes* by having the postantennal pits on head, lacking a sharply defined impression around the median pronotal fovea, and having a short discal stria on the elytra.
4.4 Key to male *Anabaxis*

Only males can be readily identified to species. The New Zealand species are indicated by an asterisk (*).

1 Metatibia with well-developed spine (Fig. 4.7C) .............................................. *A. vagus* (Oke)
   - Metatibia lacking spine ............................................................................. 2

2 Body length more than 2.2 mm; tergite IV with deep basal impression between mediobasal foveae (Fig. 4.7B) ................................................................. *A. quinquefoveolata* (Raffray)
   - Body length less than 2.0 mm; tergite IV with shallow basal impression between mediobasal foveae ............................................................................. 3

3 Discal carinae shorter than half length of tergite IV ................................. 4
   - Discal carinae as long as or longer than half length of tergite IV ............. 5

4 Head with frontal fovea (Fig. 4.7E) ................................................................. *A. foveolata* (Broun)
   - Head lacking frontal fovea (Fig. 4.7D) ...................................................... *A. lunatica* (King)

5 Elytra much wider than long (Fig. 4.6D) ....................................................... *A. inusitata* (Blackburn)
   - Elytra as long as or slightly wider than long ............................................ 6

6 Mesotibia with large spear-shaped subapical spine (Fig. 4.4D) ............... *A. brevis* (Oke)
   - Mesotibia with small apical spine ............................................................. 7

7 Body small and weakly convex in lateral view, length no longer than 1.4 mm (Fig. 4.6C) ................................................................. *A. electrica* (King)
   - Body larger and more convex in lateral view, length longer than 1.7 mm (Fig. 4.3A) ................................................................. *A. chathamensis* sp. n.
Anabaxis brevis (Oke, 1928)

Fig. 4.3


Type locality: Warburton and Belgrave, Victoria, Australia.

Diagnosis: Body length around 1.5 mm, body compressed. Tergite IV (visible tergite I) with discal carinae from as long as to longer than half length of tergite IV; median antebasal fovea much smaller than lateral antebasal foveae. Mesotrochanters with slender spine around three-fourths ventral length of trochanter. Aedeagus with symmetrical and strongly elongate parameres, widened basally, and well separated, bearing 2 pairs of subapical setae, apical setae curved mesally and longer than basal setae; internal sac with several slender sclerites near base.

Redescription (n = 8): Body length 1.45–1.53 mm, compressed; colour reddish-brown, palpi, and tarsi lighter. Dorsal vestiture uniseriate, average length shorter than length of eye. Head squared, slightly wider than long at eye level (Fig. 4.3A); frontal fovea and vertexal foveae asetose. Eyes well-developed, rounded and protuberant with 22–30 facets. Pronotum subglobular, slightly wider than long, about 1.1 × as long as wide (PL/PW = 0.32–0.34/0.37–0.39 mm), wider than head at eye level, widest at anterior two-fifths; lateral antebasal foveae setose; median antebasal fovea much smaller than lateral antebasal foveae; antebasal sulcus weakly impressed. Elytra slightly wider than long, about 1.1 × as long as wide (EL/EW = 0.54–0.56/0.61–0.63 mm), widest near middle; each elytron with 4 basal foveae, with outer 2 merged (Fig. 4.3C); posterior margin slightly sinuate. Abdomen compressed, slightly narrower than elytra at base; tergite IV (first visible tergite) with discal carinae extending from half to three-fifths of tergal length. Male. Eyes with 26–30 facets. Mesotrochanters with slender spine around three-fourths ventral length of trochanter (Fig. 4.3B); mesotibiae
modified by large spear-shape apical spine about $1.2 \times$ length of mesotarsal claw (Fig. 4.3D). 

**Aedeagus** (Figs 4.3E–G) 0.35–0.37 mm long; with symmetrical and strongly elongate parameres, widened basally, and well separated, bearing 2 pairs of subapical setae, apical setae curved mesally and longer than basal setae; internal sac with several slender sclerites near base. **Female.** Eyes with 22–24 facets. Mesotrochanters and apical mesotibiae unmodified.

**Comments:** Oke (1928) described this species from a male and a female from Warburton and Belgrave. And based on an image of a male supplied by the MVMA labelled as ‘Holotype’ there must be additional syntype material. I designate the specimen imaged as the lectotype. This species is most similar to *A. electrica* by sharing the small body size and tergite IV (first visible tergite) with long discal carinae extending more than half of tergal length. It can be distinguished from *A. electrica* by its compressed body and males with the mesotibiae modified with a large spear-shape apical spine.

**Distribution:** New Zealand: ND, AK, CL, NN; Australia: Victoria.

**Type material examined: Lectotype (here designated;** Fig. 4.6A; MVMA): ‘929 [unknown handwriting], Holotype ♂ [printed], 931 Allotype ♀ 930 ♂ 932 ♀ Parat. [unknown handwriting, on red rectangular label] // *Ryphasis brevis*, Oke type. [in Oke’s hand] // WARBURTON, Vic [printed], 27.12.25 [unknown handwriting], C. Oke [printed]’.

**Additional material examined:** 7 ex. (all NZAC), **AK:** 1 ♂, J.C. Watt, C.F. Butcher, Malaise trap, Noises Is., Otata Is., 7–10/Dec/1979; 1 ♀, Waitakere, T. Broun Collection, A.E. Brookes Collection; 1 ♂, 1 ♀, Titiranga, 1869, A.E. Brookes Collection; **CL:** 1 ♀, Broun Collection, Tairua, E. coast North Is., T. Broun Collection; **NN:** 1 ♂, Glenhope Nelson, ? 1869, T. Broun Collection, A.E. Brookes Collection, Entomology Division. **Unknown locality:** 1 ♀, 1869, T. Broun Collection, A.E. Brookes Collection.
Anabaxis chathamensis sp. nov.

Fig. 4.4

**Diagnosis:** Body length nearly 2.0 mm. Tergite IV (visible tergite I) with discal carinae longer than half length of tergite IV; median antebasal fovea slightly smaller than lateral antebasal foveae. Mesotrochanter with slender spine as long as ventral length of trochanter. Aedeagus with symmetrical parameres elongate and thin, curved and nearly meet at apex, with subapical lobes bearing 2 pairs of lateral setae, apical setae longer than basal setae; internal sac with dense patches of sclerites on internal surface, two twisted sclerotized slender and long laminae present at basal two-thirds.

**Description (n = 3):** Body length 1.75–1.80 mm; colour reddish-brown, antennal club, palpi and tarsi lighter. Dorsal vestiture uniseriate (head and pronotum) or biseriate (elytra and abdomen), average length longer than length of eye (Fig. 4.4A). **Head** transverse, slightly wider than long at eye level, dorsal vestiture long and uniseriate; frontal fovea setose, vertexal foveae asetose. Eyes well-developed, rounded and protuberant, with 17–19 facets. **Pronotum** slightly convex and subglobular, slightly wider than long, about 1.1 × as long as wide (PL/PW = 0.37–0.38/0.41–0.43 mm), wider than head at eye level, widest at anterior two-fifths; dorsal vestiture long and uniseriate; lateral antebasal foveae setose; median antebasal fovea slightly smaller than lateral antebasal foveae; antebasal sulcus weakly impressed. **Elytra** slightly wider than long, about 1.2 × as long as wide (EL/EW = 0.53–0.55/0.65–0.67 mm), widest near middle; dorsal vestiture biseriate with shorter scattered decumbent setae and with 2 longitudinal rows of longer suberect setae; each elytron with 2 basal foveae (Fig. 4.4B); posterior margin moderately sinuate. **Abdomen** convex, slightly narrower than elytra at base; dorsal vestiture biseriate with short scattered decumbent setae and 2 longitudinal rows of long suberect setae; tergite IV (first visible tergite) with discal carinae extending three-fifths of tergal length. **Male.** Eyes with 17–18 facets.
Mesotrochanters with slender spine as long as ventral length of trochanter (Fig. 4.4C); mesotibiae modified by small apical spine about one-fourth length of mesotarsal claw (Fig. 4.4D).  

**Aedeagus** (Figs 4.4E–G) 0.38–0.39 mm long; with symmetrical parameres elongate and thin, curved and nearly meet at apex, with subapical lobes bearing 2 pairs of lateral setae, apical setae longer than basal setae; internal sac with dense patches of small sclerites near base, pair of long sinuate sclerites and two long and slender sclerotized laminae twisted at basal two-thirds. **Female.** Eyes with around 19 facets. Mesotrochanters and apical mesotibiae unmodified.

**Comments:** This species is similar to *A. electrica* and can be distinguished from it based on its large body size. Both *A. chathamensis* and *A. electrica* can be readily separated from the similar-looking species *A. foveolata* by having the discal carinae longer than half the length of tergite IV.

**Etymology:** The specific epithet is derived from its geographical distribution, Chatham Islands.

**Distribution:** New Zealand: Offshore Islands: CH.

**Type material examined:** Holotype. ♂ (NZAC), specimen entire, glued on a card, aedeagus mounted on acetate: “CHATHAM IS., NZ, Awatotara, 16. Feb. 1967, G. Kuschel, litter 67/123”. Paratypes: 2 ex. (1 ♂, 1 ♀), same data as holotype.
Anabaxis foveolata (Broun, 1880)
Figs 4.5, 4.7E, 4.8–4.16

Euplectus foveolata Broun, 1880: 143.


Anabaxis foveolata. Combination by Kuschel 1990: 76.

Type Locality: Tairua, Coromandel, New Zealand.

Diagnosis: Body length around 1.75 mm. Tergite IV (visible tergite I) with discal carinae extending from slightly visible to two-fifths of tergal length; median antebasal fovea much smaller than lateral antebasal foveae. Mesotrochanters with spine from one-fourth to four-fifths ventral length of trochanter. Aedeagus with symmetrical parameres elongate and thin, curved and nearly meet, with subapical lobes bearing 2 pairs of lateral setae, apical setae longer than basal setae; internal sac with dense or scattered sclerites and two variable sclerotized laminae.

Redescription (n = 278): Body length 1.70–1.84 mm; colour reddish-brown, antennal club, palpi and tarsi lighter. Dorsal vestiture uni- (head) or biseriate (Pronotum, elytra and abdomen), average length longer than length of eye (setae often effaced) (Fig. 4.5A). Head transverse, slightly wider than long at eye level, dorsal vestiture long and uniseriate; frontal fovea setose, vertexal foveae asetose (Fig. 4.7E). Eyes well-developed, rounded and protuberant, with 20–25 facets. Pronotum slightly convex and subglobular, slightly wider than long, about 1.1 × as long as wide (PL/PW = 0.35–0.42/0.42–0.47 mm), wider than head at eye level, widest near anterior two-fifths; dorsal vestiture long and biseriate with short scattered decumbent setae, with or without 1 longitudinal row of longer suberect setae; lateral antebasal foveae setose; median antebasal fovea much smaller than lateral antebasal foveae; antebasal sulcus from invisible to weakly impressed. Elytra slightly wider than long, about
1.2 × as long as wide (EL/EW = 0.54–0.58/0.66–0.70 mm), widest near middle; dorsal vestiture biseriate with shorter scattered decumbent setae, with or without 1 to 2 longitudinal rows of long suberect setae; each elytron with 1 to 4 basal foveae, with outer 2 often merged when more than 2 basal foveae present (Figs 4.5C, 4.9, 4.10); posterior margin moderately to strongly sinuate. **Abdomen** convex, slightly narrower than elytra at base; dorsal vestiture biseriate with shorter scattered decumbent setae, with or without 2 to 4 longitudinal rows of longer suberect setae, paratergites with or without 1 longitudinal row of longer suberect setae; tergite IV (first visible tergite) with discal carinae extending from barely visible to two-fifths of tergal length. **Male.** Eyes with 22–25 facets. Mesotrochanters with spine from one-fourth to three-fifths ventral length of trochanter (Figs 4.5B, 4.15); mesotibiae modified with apical spine from about one-ninth to as long as length of mesotarsal claw (Figs 4.5D, 4.16). **Aedeagus** (Figs 4.5E–G, 4.11–4.14) 0.36–0.39 mm long; with symmetrical parameres elongate and thin, curved and nearly meet, with subapical lobes bearing 2 pairs of lateral setae, apical setae longer than basal setae; internal sac with dense or scattered sclerites and two variable sclerotized laminae. **Female.** Eyes with 20–24 facets. Mesotrochanters and apical mesotibiae unmodified.

**Comments:** Broun (1880) mentioned that he had two males and one female, and I designate a specimen in the BMNH that was labelled as the ‘type’ as the lectotype. Kuschel (1990) synonymised *A. euplectoides* with *A. fovealata*, but I was unable to examine the type specimen of the former species. This is a distinct species and an image of *A. euplectoides* provided by Christopher Carlton from what may be the type series is a specimen of *A. fovealata* based on the relative proportions of the body segments and especially the form of the abdomen. This species is similar to *A. chathamensis* and can be distinguished from it by the discal carinae being shorter than half the length of tergite IV. The species is highly
variable, and characters that are analyzed in detail below do not warrant the division of this polymorphic species into separate taxa.

**Distribution:** New Zealand.

**Type material examined:** *Lectotype (here designated;* Fig. 4.6B; BMNH): ‘Type [round label with red border] // Tairua // 263 // New Zealand [red underline] Broun Coll. Brit. Mus. 1922—482. // Anabaxis foveolata [in Broun’s hand].’

4.5 Catalogue of Australian species (*A. brevis* covered above)

*Anabaxis electrica* (King, 1863)

(Fig. 4.6C)

*Anabaxis electrica* King, 1863: 48.


*Anabaxis minor* Broun, 1921a: 519. Synonymised by Kuschel 1900: 76 (type not examined).

*Anabaxis electrica*: Kuschel 1900: 76.

**Type Locality:** Parramatta, Australia.

**Notes:** In his description, King (1863) noted that this species that been found “on fences at sunset when the air is charged with electricity; when a thunderstorm is rising of an evening it may almost certainly be looked for on the summit of my paling fence”. He did not mention the number of specimens, and I examined five specimens mounted in two rows on the same card from AMS that had ‘Holotype’ written on the card. Due to the poor condition of the specimens I did not attempt to remount the series and have designated the upper left male specimen as the lectotype and the rest, apart from the right bottom (which is *Anabaxis lunatica*) as paralectotypes. Raffray (1900) redescribed the species, with a question mark at the species heading, from specimens collected at Swan River in Western Australia, Tasmania, and an unknown locality. These are doubtfully conspecific with *A. electrica*. Kuschel (1990) synonymised *A. minor* with *A. electrica*, but I was unable to examine the type specimen of the former species, and the synonymy is in doubt. An image of *A. minor* was provided by Christopher Carlton from what may be the type series. The photograph is of a female, which appears to be a specimen of *A. brevis* that has the typical short and flattened abdomen of this species. All of the specimens I examined that were collected from New Zealand and were labelled as *A. electrica* are *A. brevis*. 

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Type material examined: Lectotype (here designated, the upper left specimen on the card; AMS): ‘n 22503 [in King’s hand] // Bryaxis electrica [in King’s hand] // Anabaxis electrica (King) [unkown handwriting], Kuschel det.1976 [printed] // Holotype [red rectangular label] // K 209154’. Paralectotypes (here designated, the second and third specimens on the first row and the first specimen on the second row; AMS): same data as the lectotype.

Anabaxis inusitata (Blackburn, 1891)

(Fig. 4.6D)

Bryaxis inusitata Blackburn, 1891: 79.


Type Locality: Near Port Lincoln, Australia.

Notes: Blackburn (1891) named this species based on two specimens that he could not sex. I designate the single female specimen that I borrowed from the BMNH as the lectotype.


Anabaxis lunatica (King, 1863)

(Figs 4.7A, 4.7D)

Bryaxis lunatica King, 1863: 48.

Ryaxis lunatica Raffray, 1900: 160. Redescription.

Anabaxis lunatica. Combination by Raffray, 1908: 252.


Type Locality: Parramatta, Australia.
Notes: King (1863) did not mention the number of specimens he examined when describing this species, and I examined two male specimens in the AMS that were originally mounted on the same card that was labelled ‘Holotype’. I remounted the specimens and designated one specimen as the lectotype and the other as a paralectotype. Raffray (1900) redescribed the species, and indicated by a question mark at the species heading, from a single specimen from New South Wales that is doubtfully conspecific with *A. lunatica*.

Type material examined: **Lectotype (here designated; AMS):** ‘Bryaxis lunatic 130 [in King’s hand] // n 22502 [in King’s hand] // Holotype [red rectangular label] // K 209154’.

Paralectotype (here designated, AMS): same data as the lectotype.

*Anabaxis quinquefoveolata* (Raffray, 1900)

(Fig. 4.7B)

*Rybaxis quinquefoveolata* Raffray, 1900: 159.


Type Locality: New South Wales, Australia.

Notes: Raffray (1900) described this species from a male and a female and I designate the male specimen in the MNHN that was labelled as ‘type’ as the lectotype.

Type material examined: **Lectotype (here designated; MNHN):** ‘MUSEUM PARIS 1917 COLL. A. RAFFRAY [rectangular label with powder black border] // Type [red rectangular label] // R. quinquefoveolata [unknown handwriting], A. Raffray det. [printed] //Australia [unknown handwriting]’.

*Anabaxis vagus* (Oke, 1932)

(Fig. 4.7C)


**Type Localities:** Victoria, Mitchell Gorge, Warburton, Fern tree Gully; New South Wales, Dorrigo. Australia.

**Notes:** Oke (1932) described this species from four different localities. I select the specimen imaged of a male (mounted dorsally) supplied by the MVMA and labelled as ‘type’ to be the lectotype.

**Type material examined:** Lectotype (here designated; MVMA): ‘*Rybaxis vagus* Oke [hand], ♂-2663, Type ♀-2664 [unknown handwriting] (red rectangular label) // WMITCHELL GORGE [printed], Jan 1929 [unknown handwriting], C. Oke Vic. [printed]’.
FIGURE 4.7. Primary type specimens and diagnostic features of Anabaxis Raffray. A) Lectotype, Anabaxis lunatica (King). B) Lectotype, Anabaxis quinquefoveolata (Raffray). C) Lectotype, Anabaxis vagus (Oke). D) Head of Anabaxis lunatica, in dorsal view. E) Head of Anabaxis foveolata, in dorsal view. Scale bars: A, B, C = 0.3 mm, D, E = 0.15 mm.
FIGURE 4.8. Geographic distribution of Anabaxis foveolata (Broun) and selected populations for dissection in New Zealand.
4.6 Morphological Variation in *A. foveolata*

*Anabaxis foveolata* is a geographically widespread species that is highly polymorphic. At first, I considered that the polymorphic variation might reflect variation between species and that there are several taxa on the mainland with a single species on the Chatham Islands. However, dissections of geographic exemplars from the length of New Zealand (Fig. 4.8) revealed a single species with characteristics that vary in males (mesotrochanter, mesotibia, and internal sac of the aedeagus) and elytral foveature for both sexes. I discuss this character variation below.

The foveature of pselaphine beetles is a character system paramount for the classification of the subfamily at all taxonomic levels (e.g., Chandler 2001). Homologies of the foveae are based on where they occur on each body part and their diagnostic number. The number of basal elytral foveae (bef) (Figs 4.9, 4.10) varies within most, but not all populations of *A. foveolata*, and is not sex-related or geographically linked. Each elytron typically has 1 to 4 foveae, but the two outer (laterad) foveae tend to merge when there are more than two foveae present, and the fusion of these is rarely symmetrical, and does not seem to be biased to the right or left elytron. The total number of bef in the southern populations tends to be more than that in the northern populations, but this needs statistical testing.

In many groups of pselaphines, females are difficult to identify to species, and the Austral Brachyglutini is no different: most members of *Anabaxis* can only be distinguished based on male characters. While males of many pselaphines exhibit an extraordinary set of external characters diagnostic for species identification, characters of the genitalia are often highly complex and useful to separate species, even those species that are identical externally. As a matter of recourse, it is important to dissect the genitalia of widespread species of New Zealand from many localities because the complex geological and climatic history of the
island-continent has produced variations that may obscure population- or species-level variation. For example, the scaphidiine staphylinid *Brachynopus scutellaris* Redtenbacher has the widest range of body sizes of all species of the subfamily and based on the consistent morphology of the genitalia it is considered a single species (Löbl & Leschen 2003). I dissected *A. foveolata* from throughout its range, and the shape and form of the laminae in the internal sac of the aedeagus are quite variable. In general, the two internal sclerites (indicated by white outlines) are always separated (Fig. 4.11A) but maybe entwined (Fig. 4.11B). The two laminae tend to be separated and symmetrical in southern areas, while they tend to be entwined and asymmetrical in northern areas. This variation is present among all populations on the North and South Islands, though their position and shape are more consistent in southern areas (Figs 4.12–4.14). This range of variation is present in many groups of beetles and has been reported in some groups of pselaphines in continental areas, most recently by Owens & Carlton (2016). I hypothesize that this variation does not reflect sympatric species and consider *A. foveolata* a single species because all other genitalia features (e.g., form of parameres) are consistent in representatives over both islands.

FIGURE 4.11. Variability of the laminae of aedeagus in *A. foveolata*, in dorsal view (laminae are highlighted by white outlines). **A)** SI, Stewart Island. **B)** BP, Te Aroha Summit. Scale bars: 0.15 mm.

The mesotrochanter of *A. foveolata* males bears a small ventrally located basal spine that ranges in size from 1/4 to 3/5 of the full ventral length of mesotrochanter, with the shortest spines present in the southern portion of its range (Figs 4.15A–D). Similarly, the apex of the mesotibia of males bear a spine, a much smaller one in contrast to the mesotrochanteral spine, that ranges in size from about 1/9 to as long as the length of the tarsal claw of the middle leg. Interestingly, the mesotibial spine is larger in the southern populations, in contrast to the mesotrochanteral spine which is larger in the northern populations (Figs 4.16A–F).
FIGURE 4.15. Variability of modified mesotrochanters in *A. foveolata*, in ventral view. A) ND, Mangamuka Summit. B) GB, Pukeamaru. C) WN, Tararua. D) SI, Secretary Island. Scale bars: 0.15 mm.

Variation of secondary sexual characters is commonly observed in most animal groups that are sexually dimorphic (Eberhard 1985). Based on the location of the spines they probably do not function in male-male combat like the horns of dung beetles (Knell & Simmons 2010), nor for detecting mates like the antennae in longhorn beetles (Moller & Zamora-Munoz 1997). It is possible that the spines are used in courtship, either functioning in sexual selection by female choice, like the elongate forelegs of male harlequin beetles for guarding females and oviposition sites (Zeh et al. 1992). For female choice, variation must exist in the male characters, which is true for the variation observed in spine length within populations of *A. foveolata*; but females do not possess obvious structures that interact or lock with male spines, so responses by females must be studied further by making behavioural observations of courtship. The clinal variation of the two spine characters is bi-directional: the mesotrochantral spine tends to be smaller with increasing latitude (Fig. 4.17A, adjusted correlation $r^2_{adj} = 0.8697$, $F_{1,57} = 388$, and $P < 2.2 \times 10^{-16}$); while the mesotibial spine tends to be larger with increasing latitude (Fig. 4.17B, $r^2_{adj} = 0.8996$, $F_{1,57} = 520.7$, and $P < 2.2 \times 10^{-16}$). I did not test if this trend is associated specifically with the body size of the beetle, but climate gradients in allometry are widespread and often follow Bergmann’s rule or are the converse of Bergmann’s rule (Blanckenhorn & Demont 2004), whereby mean body size increases or decreases with latitude. This has been shown in the New Zealand brentid beetle *Lasiorhynchus barbicorns* (Fabricius) (Painting et al. 2014), where the elongate male rostrum in these beetles has steeper allometric slopes between rostral and body size at lower latitudes. It is quite possible that courtship strategies in *A. foveolata* also co-vary with latitudinal gradient. Mating opportunities in southern climates may be constrained by having a shorter summer, but how this would affect leaf litter beetles is unknown.
Partitioning of the data by island indicates a break in morphological distribution, as shown in the two charts that have separate linear regressions for each Island (purple dots for North Island and red dots for South Island). The degree of phenotypic variation of spine lengths in northern locations (Fig. 4.18A, $r^2_{adj} = 0.2449$, $F_{1,23} = 8.782$, and $P = 0.006962$; Fig. 4.18B, $r^2_{adj} = 0.5309$, $F_{1,23} = 28.16$, and $P = 2.186 \times 10^{-5}$) is more variable than that in southern locations (Fig. 4.18A, $r^2_{adj} = 0.6464$, $F_{1,32} = 61.34$, and $P = 6.199 \times 10^{-9}$; Fig. 4.18B, $r^2_{adj} = 0.6108$, $F_{1,32} = 52.79$, and $P = 2.956 \times 10^{-8}$). This pattern may have been the result of Pleistocene effects. During this period there was a loss of large areas of forest habitat and the formation of refugia. Subsequent glacial retreats resulted in reforestation and litter species then expanded their ranges (Marske et al. 2012; Painting et al. 2017). The decreased amount of phenotypic variation in spine morphology in the southern A. foveolata may be directly correlated with a range shift from the north (Marra et al. 2004) where southern populations are more recently formed and have yet to phenotypically diversify over time, a pattern that can be further explored by genetic studies.
FIGURE 4.17. Regressions of the length of modifications in male *A. foveolata* from localities throughout New Zealand along with the increasing latitudes. A) Relative length of mesotrochanteral spine to the ventral length of mesotrochanter. B) Relative length of mesotibial spine to the length of mesotarsal claw.

FIGURE 4.18. Split regressions of the length of modifications in male *A. foveolata* from localities of North Island and South Island respectively along with the increasing latitudes. A) Relative length of mesotrochanteral spine to the ventral length of mesotrochanter. B) Relative length of mesotibial spine to the length of mesotarsal claw.
Revision of the genus *Simkinion* Park and Pearce (Coleoptera: Staphylinidae: Pselaphinae: Goniaceritae) from New Zealand

In review, *New Zealand Entomologist*.

5.1 Introduction

The genus *Simkinion* was described by Park and Pearce (1962) based on two species and is one of the four endemic New Zealand genera within the tribe Brachyglutini. It has three characters that are typical for Brachyglutini: 1) the presence of the ocular-mandibular carinae, 2) the first visible abdominal ventrite 1 vaguely visible between metacoxal bases, 3) the maxilla with palpomere 3 short and triangular, palpomere 4 elongate and spindle-form (Chandler 2001). Members of *Simkinion* have the median gular ridge conspicuously prominent in lateral view and margined by a pair of sutures that places it in the subtribe Brachyglutina (Kurbatov & Sabella 2015). *Simkinion* differs from other New Zealand brachyglutines most significantly by the combination of their first and second visible tergites subequal in length, slender legs, and relatively small body size. All members lack fully developed hindwings and their elytra are firmly attached to the scutellary shield. Like most pselaphines, *Simkinion* is sexually dimorphic with males having extraordinary head and tergal modifications. Similar male secondary sexual characters are also recorded by Chandler (2001)
in other members of the tribe from Australia (e.g., *Bundjulung* Chandler; *Reichenbachia* Leach).

While moss is always a target for general collecting of leaf-litter and ground-dwelling beetles, moss specialization is known for several groups of phytophagous beetle lineages, and in New Zealand, this includes Byrrhidae, brachycerine moss weevils, and some chrysomelines (Kuschel 1990; May 1993; Klimaszewski & Watt 1997). Both known species of *Simkinion* (*S. bimanum* Park & Pearce, *S. prelaticum* Park & Pearce) have been collected from moss (Park & Pearce 1962). I evaluate the potential specialization on moss of *Simkinion* species by examining recently collected material.

*Simkinion* belongs to the cosmopolitan Brachyglutini, which is the most diverse tribe within Pselaphinae accommodating 117 genera (Yin *et al.* 2019). In New Zealand, it is the only tribe under Goniaceritae, comprising 8 genera, with half of them endemic (Shen & Leschen 2019). The group has been virtually unstudied since Thomas Broun’s last publication (Broun 1923), apart from one new genus with two species described by Park and Pearce (1962), five new species described from the Three Kings Islands fauna (Théry & Leschen 2013), and one new species described by Shen and Leschen (2018) in the revision of *Anabaxis* Raffray. To better understand the goniacerites of the New Zealand fauna, I aim to revise each genus, and here I revise the genus *Simkinion*, with descriptions of four new species, all known from single specimens. All species are known from Northland, and the rarity of these species may be related to their strong association with moss. Here, I include a discussion about their natural history.
5.2 Material and Methods

Specimens were examined from the following collections:

BMNH    The Natural History Museum, London, United Kingdom (M. Barclay);
DSC     University of New Hampshire, Durham, NH, U.S.A. (D. Chandler);
FMNH    Field Museum of Natural History, Chicago, U.S.A. (C. Maier);
NZAC    New Zealand Arthropod Collection, Auckland, New Zealand.

All *Simkinion* specimens from Northland were collected under Picton permit (69456-FAU) from the Department of Conservation. External morphology was examined using a Leica MZ12 binocular stereomicroscope and genitalia (mounted in a droplet of Euparal on a transparent acetate card and pinned beneath the specimen) were examined using a Leica DM 4500B compound microscope. Three specimens of *S. bimanum* were fully disarticulated. Image capture was made with a Nikon DS-Fi1 camera attached to the compound microscope and stacked from multiple layers using Zerene stack 1.04 software. All figures were edited in Adobe Photoshop CS3. The area code ‘ND’ is an abbreviation for Northland following Crosby et al. (1998). Terminology follows Chandler (2001) and Lawrence et al. (2010). The numerals for abdominal tergites and ventrites correspond to visible segments (tergites 1–6 = true segments 4–9, and ventrites 1–7 = true segments 3–9). Diagnoses are based on males due to the lack of females for all new species. The females of *S. bimanum* and *S. prelaticum* included in the descriptions below were identified by Park and Pearce or based on association with males in the same collecting event. The new species were not dissected because they are known by single specimens and can be easily separated from each other and the known species by their male secondary characters.

The following abbreviations for measurements are: HL = length of visible portion of head; HW = greatest width of head; PL = pronotal length at midline; PW = greatest pronotal width; EL = elytral length at midline; EW = greatest elytral width; AL = abdominal length at
midline; AW = greatest abdominal width. Body length (BL) is measured from the anterior clypeal margin of the head to the posterior edge of the abdomen. Holotypes are affixed with red labels and are all deposited in the NZAC.

### 5.3 Taxonomy

**SIMKINION Park and Pearce, 1962**

Figs 5.1–5.3


**Diagnosis:** Head with asetose vertexal foveae (obscured by vertexal modifications in males; foveae lacking in *S. corniculum*); lacking frontal fovea; antennal clubs formed by apical 3 antennomeres; ventrolateral margin rounded beneath eyes; median gular ridge broad and prominent. Pronotum lacking median antebasal fovea; asetose lateral antebasal foveae present. Each elytron with 2 asetose basal foveae; with barely visible to conspicuously visible discal striae extending posteriorly from apical one-fifth to half of elytral length. Abdominal tergite 1 with single setose mediobasal fovea between barely visible discal carinae; ventrite 2 with distinct basolateral sulci. Profemora often slightly enlarged at distal one-third.

**Redescription:** Body small in size (1.45–1.81 mm), generally elliptical and convex in dorsal view; dorsal vestiture of short decumbent setae uniseriate, smooth on head, with few scattered setae near base, short on pronotum and elytra, tergal setae elongate, average length slightly longer than length of eye; body colour bright reddish-brown, tarsi and tibiae paler; body surface micropunctate. Head with asetose vertexal foveae (Fig. 5.1A) small to punctiform (obscured when vertex modified in males) or lacking (*S. corniculum*); lacking
frontal foveae; frontal rostrum moderately developed; antennal tubercles weak, lacking postantennal pits; antennae (Fig. 5.1D) 11-segmented (10-segmented in males of S. prelaticum), antennal clubs formed by apical 3 antennomeres, scape and pedicel cylindrical, antennomeres 3–8 rounded and nearly identical (antennomere 5 or 6 prolonged and enlarged when modified in males), A9 slightly widened or not, A10 sub-rectangular and much wider than A9, A11 fusiform and about as long as A8 + A9 + A10; ocular-mandibular carinae (Fig. 5.1B) present; ventrolateral margin rounded; median gular ridge (Fig. 5.1B) broad and prominent, strongly curved posteriorly to asetose gular foveae (Fig. 5.1C); mouth (Fig. 5.1H) with round and widened labial palp, mentum elongate, lacinia well developed, galea hardly visible, maxillary palpi with segment 2 gradually widened towards apex, segment 3 trapezoidal, segment 4 large and spindle-form, sensory area with apical short setae.

Pronotum lacking median antebasal fovea; lateral antebasal foveae (Figs 5.1E, 5.3C–D) asetose and small; lacking antebasal sulcus and median longitudinal sulcus; setose lateral procoxal foveae (Figs 5.1F, 5.3C–D) well developed and widely separated.

Elytra slightly shorter than abdomen in dorsal view, with base firmly attached to scutellary shield, lacking hindwings; each elytron (Fig. 5.2D) with 2 asetose basal foveae; adsutural stria present, discal cariae vaguely delimited to extending posteriorly to half of elytral length; posterior elytral margin strongly sinuate.

Mesoventrite (Fig. 5.1G) with prepectal foveae shallow; setose median mesoventral fovea shallow, flanked with broadly opened setose lateral mesoventral foveae, with branches nearly meet internally and delimited at midline; setose lateral mesocoxal foveae widely opened. Metaventrite with setose lateral metaventral foveae adjacent and opened outwardly.

Abdomen convex with tergite 1 about as long as tergite 2, with single setose mediobasal fovea (Fig. 5.2A), margined by pair of short discal carinae, lacking mediobasal impression; basolateral foveae (Fig. 5.2A) present on tergites 1–4 (foveae punctiform on
tergites 2–4), and project internally with ends strongly sclerotized (Fig. 5.3B); paratergites well defined on tergites 1–4, tergite 4 with paratergites visible as carinae. Abdominal ventrite 2 with setose mediobasal foveae (Fig. 5.2B) meeting internally under basal sulci; basolateral foveae (Fig. 5.3A) on ventrites 2–3 small and punctiform, ventrites 4–5 lacking basolateral fovea.

Legs long and slender, profemora slightly to obviously enlarged at distal one-third; three-segmented tarsi with protarsomeres 2 and 3 subequal in length, mesotarsomere 2 slightly longer than mesotarsomere 3, metatarsomere 2 about 1.5 × length of tarsomere 3.

Sexes dimorphic with males having vertex variously modified, antennomere 5 (S. *convexum*) or 6 (S. *prelaticum*) modified, profemora slightly more enlarged than that in females (based on females of S. *bimanum* and S. *prelaticum*), metatibiae enlarged apically in most species, tergite 1 simple (S. *bimanum*) or modified to form a complex structure consisting of a posteromedial cavity, with or without flanking polished discs. Aedeagus (based on males of S. *bimanum* and S. *prelaticum*) symmetrical with parameres partially fused with median lobe, with dorsal diaphragm, internal sac with dense sclerites convergent or not, basal bulb strongly curved internally.

**Comments:** *Simkinion* can be readily distinguished from other New Zealand brachyglutines by the following characters: body small in size (1.4–1.8 mm); body colour bright reddish-brown; tergites 1 and 2 subequal in length; legs long and slender; profemora more or less enlarged. Outside of New Zealand, *Simkinion* is most similar to *Triomicrus* Sharp of China and Japan (Park & Pearce 1962), differing by having maxilla palpomere 2 clavate and mesocoxae widely separated. The male sexual characters are particularly striking, with the vertex modified with horns, crests, or concavities, and the tergite 1 often modified with a posteromedia cavity, bearing internal trichomes and often laterally flanked with polished discs. The remarkable tergal modifications in males are also reported in other groups of
Pselaphinae, like members of *Arthromelodes* Jeannel (Yin 2018) in Asia and the *excavata* species-group of *Sagola* Sharp (Park & Carlton 2014b) in New Zealand.

Cuticular invaginations (i.e., pits and foveae) of pselaphines are critical character systems used to define taxa at all taxonomic levels (Chandler 2001). Within New Zealand fauna, the abdominal foveal pattern of *Simkinion* is most similar to that of *Anabaxis* and *Startes* Broun by the presence of the mediobasal foveae on tergite 1 and the basolateral foveae on tergites 1–4 and differs from the former by the absence of the postantennal and the latter by the absence of a median antebasal pronotal fovea. The paranotal foveal pattern of *Simkinion* is most similar to that of *Gastrobothrus* Broun and *Eupines* King by the absence of a median antebasal fovea, and can be distinguished from both by each elytron having two basal elytral foveae. The lateral metaventral foveae of *Simkinion* are clearly separated like those of four brachyglutine genera: *Eupinogitus* Broun, *Gastrobothrus*, *Physobryaxis* Hetschko and *Startes*, while they are approximate in position or fused in *Anabaxis* and *Eupinolus* Oke.
Figure 5.3. Morphology of *Simkinion* Park and Pearce (dissection of *S. bimanum*). A) Ventrites 2–5. B) Tergites 1–4. C) Prothorax, in lateral view. D) Same, line drawing. Abbreviations: blf—basolateral foveae, laf—lateral antebasal foveae, lpcf—lateral procoxal foveae. Scale bars: 0.1 mm.
5.4 Key to males of Simkinion

1 Antennae 10-segmented, antennomere 6 prolonged and flattened at middle (Fig. 5.5B); vertex with complex trilobed horn (Fig. 5.6C) .................................. S. prelaticum Park and Pearce
   - Antennae not 11-segmented, antennomere 6 simple; vertex lacking horn .......................... 2

2 Tergite 1 simple, lacking posteromedial cavity (Figs 5.4A–B) .................................................
   ............................................................................................................................... S. bimanum Park and Pearce
   - Tergite 1 with posteromedial cavity .............................................................................. 3

3 Antennomere 5 strongly inflated and globular (Fig. 5.4E) ..................... S. convexum sp. n.
   - Antennomere 5 simple .................................................................................................. 4

4 Metatibiae simple (Fig. 5.5D); tergite 1 lacking sublateral polished discs (Fig. 5.7D) ......
   ......................................................................................................................................... S. tepaki sp. n.
   - Metatibiae greatly enlarged at apex (Figs 5.7F–I); tergite 1 with sublateral polished discs (Figs 5.7A–E) ................................................................. 5

5 Head broadly concave and extended anterolaterally (Fig. 5.6G); lacking vertexal foveae; eyes hidden in dorsal view (Fig. 5.4D) ................................. S. corniculum sp. n.
   - Head with vertex bulged, vertexal foveae present (Fig. 5.6f); eyes visible in dorsal view (Fig. 5.5C) ........................................................................ S. schomannae sp. n.
Figure 5.4. Dorsal habitus of Simkinion males and antennal character of S. convexum sp.n. A) S. bimanum (morphotype 1). B) S. bimanum (morphotype 2). C) S. convexum. D) S. corniculum. E) Antenna (S. convexum). Scale bars: 0.5 mm, except E = 0.2 mm.

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Figure 5.5. Dorsal habitus of Simkinion males and antennal character of S. prelaticum Park and Pearce. A) S. prelaticum. B) Antenna (S. prelaticum). C) S. schomannae. D) S. tepaki. Scale bars: 0.5 mm, except B = 0.2 mm.
Figure 5.7. Diagnostic characters of tergite 1 (A–E) and metatibiae (F–I) of Simkinion males. A) S. prelaticum. B) S. convexum. C) S. corniculum. D) S. tepaki. E) S. schomannae. F) S. prelaticum. G) S. convexum. H) S. corniculum. I) S. schomannae. Scale bars: 0.2 mm.
Simkinion bimanum Park and Pearce, 1962
Figs 5.4A–B, 5.6A–B, 5.6D–E, 5.8A–F, 5.9


Diagnosis: Head with heart-shaped concavity at vertex, with anterior edge sharp or weak, vertexal foveae small; antennae 11-segmented, antennomeres 5 and 6 simple. Elytra with discal striae extending posteriorly to apical half of elytral length. Abdominal tergite 1 simple. Profemora enlarged at distal one-third; metatibiae simple.

Redescription: Body (Figs 5.4A–B) length 1.51–1.78 mm (BL, ♂, 1.55–1.78 mm; ♀, 1.51–1.62 mm). Head about as long as wide (HL/HW = 0.27–0.29/0.27–0.29 mm), with vertexal foveae small; eyes rounded and protuberant, with 10–11 facets; antennae 11-segmented, antennomeres 5 and 6 simple. Pronotum convex and about 1.1 × wider than long (PL/PW = 0.31–0.36/0.35–0.38 mm), wider than head at eye level. Elytra about 1.3 × wider than long (EL/EW = 0.38–0.40/0.54–0.56 mm), discal striae extending posteriorly to apical half of elytral length. Abdomen about 1.2 × longer than wide (AL/AW = 0.56–0.68/0.51–0.56 mm), tergite 1 simple. Metatibiae simple. Male. Head (Figs 5.6A–B, 6D–E) with heart-shaped concavity at median part of vertex between vertexal foveae, with anterior edge sharp or weak; eyes with 10–11 facets; profemora conspicuously enlarged at distal one-third. Aedeagus (Figs 5.8A–F) symmetric, about 0.31 mm long, with parameres fused with median lobe, internal sac with dense sclerites convergent towards apex, basal bulb large and curved internally. Female. Head with vertex simple; eyes with 10–11 facets; profemora slightly enlarged at distal one-third.

Comments: This species is most similar to S. tepaki and shares with it the slightly modified vertex of the head (Fig. 5.6H), enlarged profemora and simple antennae and metatibiae. It can be readily separated from it and all other Simkinion species by the simple tergite 1. There are
two morphotypes among the males, one of which has a well-developed concavity and sharp vertexal ridge on head (morphotype 1, Figs 5.4A, 5.6A–B) which includes specimens that were originally described by Park and Pearce (1962). Morphotype 2 has a shallow impression and a weak vertexal ridge on head (Figs 5.4B, 5.6D–E). The aedeagus of morphotype 2 (Figs 5.8D–F) differs from that of morphotype 1 (Figs 5.8A–C; described above) by smaller parameres and the internal sac with non-convergent sclerites. The geographic distribution (Fig. 5.9) of morphotypes 1 and 2 are sympatric in the central part of Northland (Omahuta) and despite the variation, I consider these forms representing a single species.

Park and Pearce (1962) based the description on two specimens from Dobbie’s Park, Whangarei from a single collection event. They listed additional material from near Russell, Puketi Forest and ‘the Kauri Forest’ near Kaeo (some from these series are listed below, indicated by an asterisk [*]).

**Type depository:** FMNH HT ♂; BMNH 1 PT.

**Additional material examined:** **Morphotype 1.** 24 ex. (all NZAC except where indicated), *1 ♂, Kauri Forest, nr. Kaeo, 29/May/1951, moss, P. 10; *1 ♀, Kauri Forest, nr. Kaeo, 29/May/1951, moss, P. 8; 1 ♂, Omahuta SF., J.S. Dugdale, 23/Apr/1975, liverworts and moss from tree bases and ground 75/142; 2 ♂♂, 2 ♀♀, Paihia, K.P. Lamb, *Leptospermum*, scrub, R. A. Cumber Collection, Jan/1953, ex leaf mould, B. 32; 1 ♀, Pahia, K.P. Lamb, R. A Cumber Collection, 31/Aug/1952, ex leaf litter and moss, B. 31; 2 ♂♂, 2 ♀♀, Omahuta, SF., J.S. Dugdale, 22/Apr/1975, liverworts & moss, 75/141; 1 ♂, 1 ♀, Waitangi SF., G. Kuschel, 2/Nov/1981, Litter and decayed wood, 81/116; 2 ♂♂, DSC, Omahuta Forest, Omahuta Kauri Sanctuary, 340 m, kauri-podocarp, A. Newton/M. Thayer 693, 29/Nov/1984, berl., leaf & log litter, forest floor; 2 ♂♂, 2 ♀♀, Pokenui Forest, Taraire Ridge Loop, 35°41'96"S, 174°15'90"E, 250m, sifted leaf litter & rotten wood, 12/Nov/2018, J. Shen; 1 ♂, 1 ♀, Omahuta Forest, Pukekohe Stream Tk., 35°14'28"S, 173°36'54"E, 270m, sifted leaf litter,

Figure 5.8. Aedeagi (left, dorsal view; middle, lateral view; right, ventral view). A–C) S. bimanum (morphotype 1). D–F) S. bimanum (morphotype 2). G–I) S. prelaticum. Scale bars: 0.1 mm.
Simkinion convexum sp. nov.

Figs 5.4C, 5.4E, 5.6F, 5.7B, 5.7G, 5.9

**Diagnosis:** Head with sharp transverse anterior carina at frons, vertex highly bulged, vertexal foveae small; antennae 11-segmented, antennomere 5 highly inflated and globular, antennomere 6 simple. Elytra with short discal striae extending posteriorly to apical one-fifth of elytral length. Abdominal tergite 1 modified with large bilobed posteromedial cavity, bearing 4 small basal tufts and long curved setae around margin, laterally flanked with polished discs. Profemora slightly enlarged at distal one-third; metatibiae enlarged apically.

**Description (male):** Body (Fig. 5.4C) length 1.55 mm. **Head** (Fig. 5.6F) about as long as wide (HL/HW = 0.28/0.29 mm), with sharp transverse anterior carina at frons, vertex highly bulged, vertexal foveae small; eyes rounded and protuberant, with 10 facets; antennae (Fig. 5.4E) 11-segmented, antennomere 5 highly inflated and globular, about as long as antennomeres 6–8 combined, antennomere 6 simple. **Pronotum** convex and about 1.1 × wider than long (PL/PW = 0.32/0.36 mm), wider than head at eye level. Elytra about 1.2 × wider than long (EL/EW = 0.47/0.54 mm), short discal striae extending posteriorly to apical one-fifth of elytral length. **Abdomen** about as long as wide (AL/AW = 0.48/0.50 mm); tergite 1 (Fig. 5.7B) modified with large bilobed posteromedial cavity, bearing 4 small basal tufts and long curved setae around margin, laterally flanked with polished discs. Profemora slightly enlarged at distal one-third; metatibiae (Fig. 5.7G) enlarged at apex. **Female.** Unknown.

**Comments:** This species is similar to *S. prelaticum, S. corniculum* and *S. schomannae* by having tergite 1 similarly modified with a posteromedial cavity. It is separated from all other *Simkinion* species by the vertex of head highly bulged with a carina on the frons and the antennomere 5 highly inflated and globular.
Etymology: The epithet is derived from the Latin word ‘convexus’, referring to the highly convex vertex of the head in the male of this species.

Type material examined: Holotype. ♂, point-mounted with left antenna missing: “NEW ZEALAND ND, Ngaiotonga Reserve, 3 Nov 1981, G. Kuschel // Litter and decayed wood, 81/119”.

*Simkinion corniculum* sp. nov.

Figs 5.4D, 5.6G, 5.7C, 5.7H, 5.9

Diagnosis: Head broadly concave and extended anterolaterally obscuring eyes in dorsal view, lacking vertexal foveae; antennae 10-segmented, antennomeres 5 and 6 simple. Elytra with discal striae extending posteriorly to apical two-fifths of elytral length. Abdominal tergite 1 modified with large bilobed posteromedial cavity, bearing 4 small basal tufts and long curved setae around margin, laterally flanked with polished discs. Profemora enlarged at distal one-third; metatibiae enlarged apically.

Description (male): Body (Fig. 5.4D) length 1.75 mm. Head (Fig. 5.6G) about 1.3 × wider than long (HL/HW = 0.35/0.44 mm), dorsal side broadly concave and extended anterolaterally, lateral side of frons and vertex fully obscure eyes in dorsal view, basal part of vertex punctuate and with median notch, lacking vertexal foveae; eyes rounded and flat, with 4 facets; antennae 11-segmented, antennomeres 5 and 6 simple. Pronotum convex and about 1.2 × wider than long (PL/PW = 0.33/0.39 mm), narrower than head at vertexal level. Elytra about 1.2 × wider than long (EL/EW = 0.52/0.60 mm), discal striae extending posteriorly to apical two-fifths of elytral length. Abdomen about as long as wide (AL/AW = 0.54/0.55 mm); tergite 1 (Fig. 5.7C) modified with large bilobed posteromedial cavity, bearing 4 small basal tufts and long curved setae around margin, laterally flanked with polished discs. Profemora
slightly enlarged at distal one-third; metatibiae (Fig. 5.7H) enlarged at apex. **Female.**

**Unknown.**

**Comments:** This species is similar to *S. prelaticum*, *S. convexum* and *S. schomannae* by having tergite 1 similarly modified with a posteromedial cavity, laterally flanked with polished discs. It is separated from its congeners by its large body size, eyes with only 4 facets, head modification and antennomeres 5 and 6 simple.

**Etymology:** The specific epithet is a Latin noun meaning ‘horn’, referring to the horn-like projections above the eyes in the male of this species.

**Type material examined:** **Holotype.** ♂, point-mounted: “NEW ZEALAND ND, Ngaiotonga Saddle, 3 Nov 1981, G. Kuschel // Litter and decayed wood, 81/120”.

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**Simkinion prelaticum** Park and Pearce, 1962

Figs 5.5A–B, 5.6C, 5.7A, 5.7F, 5.8G–I, 5.9


**Diagnosis:** Head with trilobate frontal process underlain by deep transverse groove and with shallower medial concavity located behind, vertexal foveae punctiform; antennae 10-segmented, antennomere 5 simple, antennomere 6 prolonged and flattened at middle. Elytra with barely visible discal striae extending posteriorly to apical one-fifth of elytral length. Abdominal tergite 1 modified with large bilobed posteromedial cavity, bearing 4 small basal tufts and long curved setae around margin, laterally flanked with polished discs. Profemora slightly enlarged at distal one-third; metatibiae enlarged apically.

**Redescription:** Body (Fig. 5.5A) length 1.45–1.63 mm (BL, ♂, 1.45–1.63 mm; ♀, 1.49–1.54 mm). **Head** about 1.1 × wider than long (HL/HW = 0.27–0.32/0.31–0.35 mm), vertexal
foveae punctiform; eyes rounded and flat, with 10–11 facets. **Pronotum** convex and about 1.2 × wider than long (PL/PW = 0.30–0.34/0.35–0.36 mm), as wide as head at eye level. **Elytra** about 1.2 × wider than long (EL/EW = 0.40–0.48/0.51–0.54 mm); with barely visible discal striae extending posteriorly to apical one-fifth of elytral length. **Abdomen** about 1.1 × wider than long (AL/AW = 0.41–0.51/0.49–0.53 mm). **Male.** Head (Fig. 5.6C) with trilobate frontal process underlain by deep transverse groove and with shallower medial concavity located behind, vertexal foveae hardly visible, obscured by vertexal modification; eyes with 9–10 facets; antennae (Fig. 5.5B) 10-segmented, antennomere 6 prolonged, about twice length of preceding segment and flattened in lateral view; tergite 1 (Fig. 5.7A) with large bilobed posteromedial cavity, bearing 4 small basal tufts and long curved setae around margin, laterally flanked with polished discs; metatibiae (Fig. 5.7F) enlarged at apex. **Aedeagus** (Figs 5.8G–I) small and symmetric, about 0.21 mm long, with parameres fused with median lobe and bifurcate near middle, with pair of long apical setae, internal sac with sparse sclerites convergent towards apex, basal bulb large and internally curved. **Female.** Head with vertex simple, vertexal foveae conspicuous; eyes with 10–11 facets; antennae 11-segmented, antennomere 6 simple; tergite 1 simple; metatibiae simple.

**Comments:** The males of this species are similar to *S. convexum*, *S. corniculum* and *S. schomannae* by the similarly modified tergite 1 but can be readily separated from these and other *Simkinion* species by the trilobate process on the head. It can also be separated from its congener by having the antennomere 6 prolonged and flattened at middle and having the metatibiae enlarged at apex.

Park and Pearce (1962) based the description on six specimens collected in the forest in ‘which the main road extends’ near Russell which I interpret as the Russell-Whakapara road. Ngaitotonga Saddle (or Reserve) is on the same road and is also the type locality for *S. corniculum*. 
Type depository: FMNH HT ♂, 3 PT; BMNH 2 PT.

Additional material examined: 3 ♂♂ (NZAC), Ngaiotonga Saddle, G. Kuschel, 3/Nov/1981, Litter and decayed wood, 81/120.

Simkinion schomannae sp. nov.

Figs 5.5C, 5.6I, 5.7E, 5.7I, 5.9

**Diagnosis:** Head bulged from middle of vertex to frons, frons with medial impression, vertexal foveae contained within distinct impressions, separated at middle by short ridge; antennae 11-segmented, antennomeres 5 and 6 simple. Elytra with barely visible discal striae extending posteriorly to apical one-fifth of elytral length. Abdominal tergite 1 modified with large bilobed posteromedial cavity, bearing 4 small basal tufts and long curved setae around margin, laterally flanked with polished discs. Profemora slightly enlarged at distal one-third; metatibiae enlarged apically.

**Description (male):** Body (Fig. 5.5C) length 1.81 mm. **Head** (Fig. 5.6I) about 1.1 × longer than wide (HL/HW = 0.37/0.33 mm), bulged from middle of vertex to frons, frons with medial impression, vertexal foveae contained within distinct impressions, separated at middle by short ridge; eyes rounded and flat, with 7 facets; antennae 11-segmented, antennomeres 5 and 6 simple. **Pronotum** convex and about 1.1 × wider than long (PL/PW = 0.34/0.37 mm), wider than head at eye level. Elytra about 1.2 × wider than long (EL/EW = 0.52/0.60 mm), barely visible discal striae extending posteriorly to apical one-fifth of elytral length. **Abdomen** about as long as wide (AL/AW = 0.59/0.58 mm); tergite 1 (Fig. 5.7E) modified with large bilobed posteromedial cavity, bearing 4 small basal tufts and long curved setae around margin, laterally flanked with polished discs. Profemora slightly enlarged at distal one-third; metatibiae (Fig. 5.7I) enlarged at apex. **Female.** Unknown.
Comments: This species is similar to *S. prelaticum*, *S. convexum* and *S. corniculum*, all of which have a similarly modified tergite 1 that is laterally flanked with polished discs. The male of *S. schomannae* can be easily separated from all other *Simkinion* species by the head modification and the simple antennae and metatibiae.

Etymology: This species is named after one of the collectors, Andrea Schomann, and in recognition of her efforts towards a better understanding of the New Zealand staphylinids.

Type material examined: Holotype, ♂, card-mounted: “NEW ZEALAND ND, Puketi Forest, Manginangina, Res. LNR., nature walk; 35°12'40.80"S 173°47'34.2"E (±250 m), 320 m, 18 ii 2011, litter. A. Schomann & J. Pedersen”.

*Simkinion tepaki* sp. nov.

Figs 5.5D, 5.6H, 5.7D, 5.9

Diagnosis: Head slightly convex at middle of vertex, vertexal foveae present; antennae 11-segmented, antennomeres 5 and 6 simple. Elytra with discal striae extending posteriorly to apical two-fifths of elytral length. Abdominal tergite 1 modified with small posteromedial cavity, lacking marginal setae and lateral polished discs. Profemora slightly enlarged at distal one-third; metatibiae simple.

Description (male): Body (Fig. 5.5D) length 1.58 mm. Head (Fig. 5.6H) about 1.1 × longer than wide (HL/HW = 0.32/0.28 mm), vertex slightly convex at middle, vertexal fovea present; eyes rounded and protuberant, with 10 facets; antennae 11-segmented, antennomeres 5 and 6 simple. Pronotum convex and about 1.1 × wider than long (PL/PW = 0.32/0.34 mm), wider than head at eye level. Elytra about 1.2 × wider than long (EL/EW = 0.43/0.50 mm), discal striae extending posteriorly to apical two-fifths of elytral length. Abdomen about as long as wide (AL/AW = 0.51/0.50 mm); abdominal tergite 1 (Fig. 5.7D) modified with small
posteromedial cavity, lacking marginal setae and lateral polished discs. Profemora slightly enlarged at distal one-third; metatibiae simple. **Female.** Unknown.

**Comments:** This species is most similar to *S. bimanum* by having the head modification simple and the simple antennae and metatibiae. It can be easily separated from all its congener by tergite 1 having a small posteromedial cavity.

**Etymology:** The specific epithet refers to its type locality, Te Paki, which is an area known for having a high number of endemic insects.


### 5.5 **Natural History of Simkinion**

All specimens of *Simkinion* have so far only been collected from Northland (Fig. 5.9), and four of which are known only by singletons. Furthermore, *S. prelaticum* is known only from the syntypes and a single collecting event by Willy Kuschel at the type locality, leaving *S. bimanum* the only widespread and commonly collected species in the genus. The other five *Simkinion* species are all recorded from single localities, two of them are known from the Te Paki area, an area of high endemism (e.g., Buckley & Bradler 2010; Ball *et al.* 2013) and Puketi forest, respectively; the remaining three were all collected in Ngaiotonga Reserve (Russell Forest). Like other beetle groups having local Northland endemics (e.g., Seldon & Leschen 2011; Park & Carlton 2014b; Leschen & Buckley 2015; Seldon & Buckley 2019), I expect that additional undescribed species of *Simkinion* may exist in Northland. By virtue of their rarity, *S. convexum*, *S. corniculum*, *S. prelaticum*, *S. schomannae* and *S. tepaki* are classified here as ‘range restricted’ and ‘data sparse’ following the criteria in the Department
of Conservation Threatened Species List (see Leschen et al. 2012). More information about Simkinion natural history and distribution is required, not only for their potential management, but to better understand their behaviour and ecology.

Many pselaphine species are specialists of leaf litter and woody debris in forest habitats (e.g., Chandler 1987, 2001; Sakchoowong et al. 2008). A scan through the material examined in taxonomic papers shows that goniacerites are sometimes collected among a mix of habitats including moss (e.g., Löbl & Kurbatov 1996). Though species in other groups of pselaphines form New Zealand were collected from moss (e.g., Sagola spp., Park & Carlton 2014b; Pselaphini spp., Owens et al. 2019), I am unaware of species that are strictly associated with moss. We, perhaps like most staphylinid collectors, sample habitats generally,
and to ascertain true moss specificity in *Simkinion* and other pselaphines, targeted collecting is needed.

Park and Pearce (1962) considered members of *Simkinion* to be bryophyte specialists because all the specimens they studied were collected from moss. Among the 62 specimens I examined for this study, 53.2% of them were obtained from samples that were either specifically collected from moss or were from samples that were a mix of coarse woody debris, litter and moss. The remaining specimens were collected from general litter sampling, which often includes a swathe of microhabitats, moss, one of them.

To further examine the bryophyte specialization in *Simkinion*, I sampled specifically for *Simkinion* during a survey in Northland in November 2018. The capture rate of *Simkinion* from moss was about 25%: for 16 collecting events of the survey, only four contained specimens of *S. bimanum* from moss. Three collections in Russell Forest where three new *Simkinion* species are sympatric, yielded no additional specimens, though it is an area with a particularly high amount of feral pig damage, and this could have also contributed to the lack of specimens. Clearly, additional sampling is needed to confirm bryophyte specialization in *Simkinion*. Moss sampling from areas south of Northland and southward to the Tararua Ranges did not produce any specimens of *Simkinion*, consistent with them being restricted to Northland.

Like many species of Goniaceritae (e.g., members of *Eupines*), females of *Simkinion* are unmodified and difficult to distinguish at the species level. Males, on the other hand, are often modified with various kinds of characters useful for identifying species. Functions of these secondary structures are unknown, but they may have multiple purposes. The modifications of the male head are like those found in other beetle groups that have males with horn-like structures, traits that may or often linked with intraspecific competition (e.g., Emlen *et al.* 2007). In species with male-male competition I would expect variation of
exaggerated traits within populations, but the morphotypes in *S. bimanum* (strongly developed versus weakly developed carinae on the frons) are parapatric (Fig. 5.9). Numbers of individuals does not correlate with a noticeably skewed sex ratio that may be expected if females were choosy about mate selection (64% of the specimens examined were males). This kind of variation and geographic distribution in *Simkinion* suggests that these features may be involved with species recognition.

The complex tergal structure, absent in *S. bimanum*, is like the cuticular features present in other beetles, especially some social beetle inquilines (Parker 2016) whose structures are involved with the release of chemicals. *Simkinion* has not been collected with ants and, besides, records from ant nests for brachyglutines in New Zealand are slim and incidental (Nomura & Leschen 2015). It could be that the tergal structures are involved with mate attraction, the cavity serving as an external reservoir for secretions, the trichomes may function as wicks, and the polished discs serve as evaporative structures. Observational and experimental data are needed to understand the function of sexually dimorphic characters.
Molecular Systematics of *Eupines*, a new genus and notes on New Zealand Brachyglutini (Coleoptera: Staphylinidae: Pselaphinae: Goniaceritae)

In review, *The Coleopterists Bulletin*.

6.1 Introduction

The tribe Brachyglutini is the most speciose pselaphine assemblage, containing 117 genera worldwide (Yin *et al.* 2019) and is the only tribe under Goniaceritae in New Zealand fauna, comprising eight genera with half of them endemic (Shen & Leschen 2019). Despite the high generic endemism, the tribe is depauperate, in contrast to its hyper-diverse counterpart in the neighbouring landmass Australia (28 known genera; Chandler 2001). Up to now, 63 species from eight genera are recorded in mainland New Zealand and adjacent islands (including the Chatham Islands), while no identification key or phylogenetic study was made to support their systematics.

The genus *Eupines* King, the focus of this study, contains the majority of brachyglutine species within New Zealand, members of which are characterised by the lack of the median antebasal pronotal fovea, the basal elytral foveae and the elytral discal striae, which clearly separate them from other endemic genera. This species-rich genus is distributed in Australia (83 spp.), New Zealand (48 spp.), New Caledonia (5 spp.) and Southeast Asia (5 spp.).
spp.), and currently classified into two subgenera that have a confusing taxonomic history. The subgenera *Eupines* Raffray and *Byraxis* Reitter are recognised by 10- or 11-segmented antennae, respectively, though one species in New Zealand has nine segments (Chapter 3: *Eupines novem* sp. nov.).

Like other New Zealand insect taxa (Buckley *et al*. 2015), and especially beetles (Lord and Leschen 2014), known for their faunistic disharmony, the beetle group Pselaphinae is no different. Two supertribes are missing from a total of six within the subfamily (Klimaszewski *et al*. 1996; Nomura & Leschen 2006, 2015) with Faronitae extremely diverse (370 species worldwide with 203 species described in New Zealand; Park & Carlton 2011, 2013, 2014a, 2014b, 2015a, 2015b, 2015c, 2015d, 2015e). After the first prolific works by entomologist Broun in the early 20th century, research of the brachyglutines was largely neglected, only two species were described by Park and Pearce (1962). Recently, Théry and Leschen (2013) described four species in their regional treatment of the Three Kings Islands, Shen and Leschen (2018) described a species from the offshore Chatham Islands. With the ongoing studies focusing on three supertribes (Faronitae, Pselaphitae and Euplectitae) by collaborators, I attempt to clarify the classification of the tribe Brachyglutini of Goniaceritae and focus here on the classification and monophyly of the genus *Eupines* and its subgenera.

While our revisionary work on *Eupines* resulted in numerous new synonymies and new combinations, the monophyletic status of the genus and two subgenera have never been critically determined through phylogenetic study. I undertake a molecular study to determine the monophyly of New Zealand *Eupines* and then to address the monophyly of its subgenera with the inclusion of representatives of Brachyglutini from New Zealand, Australian and New Caledonia. I assembled a dataset consisting of the nuclear rDNA (28S) and the mitochondrial protein-coding gene (COI), obtained from a total of 73 species representing all genera of New Zealand, 17 genera from Australia and New Caledonia, and three outgroup
taxa. I also aim to address the monophyly of other New Zealand brachyglutine genera, and as a result, a new genus based on two known species of *Eupines* is described herein, along with two synonyms proposed. An identification key for the New Zealand brachyglutine genera is provided.

### 6.2 Material and Methods

#### 6.2.1 Taxa sampling

In the present study, 70 brachyglutine species representing all genera from New Zealand, 13 genera from Australia and six genera from New Caledonia were included in the dataset. Three non-Brachyglutini pselaphine members available from GenBank were selected as outgroups. In total, 73 taxa are included in the dataset with their taxonomic names, voucher codes, localities and coordinates provided in Table A1 (Appendix A), all DNA sequences have been submitted to GenBank (accession numbers pending).

Ethanol material from Australia was identified to 10 known genera and three undescribed genera following the key in Chandler (2001) and comparison with loaned representatives for all Australian brachyglutine genera from University of New Hampshire, Durham, U.S.A. (D. Chandler). Unlike the Australian taxa, some of the New Caledonia brachyglutines could not be identified with great certainty, because the fauna has not been revised. For example, Genus E, which is similar to *Baraxina* Raffray, but the description is uninformative.

Voucher specimens were collected and preserved in 95% ethanol in the field, and then stored at −18°C before extraction. After extraction, some samples were pinned when needed for secondary identification and have been deposited together with the remaining samples in the New Zealand Arthropod Collection, Auckland, New Zealand (NZAC).
6.2.2 Morphology

The terminology largely follows Shen and Leschen (2018), except that numerals for abdominal tergites and ventrites refer to morphological segments (tergites 1–6 = true segments 4–9, ventrites 1–7 = true segments 3–9). The two-letter geographic codes of New Zealand (Crosby et al. 1998) are used. The two abbreviations, LT and PLT are applied to type material, lectotype and paralectotype, respectively.

Examination of external morphological characters and dissections were conducted using a Leica MZ12 binocular stereomicroscope. For male habitus images, specimens were first floated off from insect pins in hot water for cleaning, followed by careful card remounting with all dorsal parts stretched. The repositioned specimens were cleaned again to remove dust using an insect pin and were then imaged by a Canon EOS 800DS mounted with a Laowa 25 mm F/2.8 2.5–5 × lens. Male specimens were softened in boiling water for 30 seconds or in KOH for half an hour at room temperature and were dissected with ventrite 7 and aedeagus removed from abdomen. The extracted genitalia were first dehydrated in 100% ethanol and were then mounted in Euparal on acetate. The mounted aedeagus and other body parts were photographed using a Nikon DS-Fi1 camera attached to a Leica DM 4500B compound microscope. Multiple layers were stacked in Helicon Focus V6 and were then edited in Adobe Photoshop CS6.

Measurements were taken by the built-in ocular graticules in both stereomicroscope and compound microscope in dorsal view. Measuring body length for pselaphines especially brachyglutines can be easily biased by the mounting orientation due to their compact body plan. Pinned specimens usually with their head and/or abdomen oriented downwards, much lower than the level of pronotum and elytra. Therefore, the total body length (from anterior margin of clypeus to apex of abdomen) was calculated by the combined measurements of head, pronotum + elytra and abdomen.
All New Zealand ethanol material of Brachyglutini were collected under several permits (see Chapter 3). Specimens examined for the new genus are deposited in the NZAC. Additional material is indicated in the ‘additional material examined’ section, and is examined from the following collections: John Nunn’s Private Collection (JNPC; Dunedin, New Zealand; now housed in the NZAC), Entomology Research Museum (LUNZ; Christchurch, New Zealand; J. Marris) and National Museum (NMPC; Prague, Czech Republic; M. Fikáček).

6.2.3 DNA extraction, amplification and gene sequencing

Ethanol preserved specimens were dried and non-destructively immersed in a 200 μl ATL and 20 μl proteinase mix followed by incubation at 55°C for 24 hours. After incubation, DNA was extracted from the solution using a Qiagen DNeasy tissue kit following manufacture’s quick-start protocol except that only 100 μl of AE buffer was added in the final elution to ensure higher concentration of DNA.

A region of mitochondrial gene cytochrome c oxidase subunit I (COI, ~710bp) and the nuclear gene (28S rRNA, ~700bp) were amplified and sequenced. The partial COI sequence was amplified using the primer pairs LCO-1490 and HCO-2198 designed by Folmer et al. (1994) or with alternative primer pairs dgLCO-1490 and dgHCO-2198 (Meyer 2003) for the same region if the first amplification failed. The 28S fragment was generated with primers 28sDD (Hillis & Dixon 1991) and Pselaphinae-specific 28sFFPsel (Parker & Maruyama 2013). Unsuccessful 28S amplifications were repeated by replacing 28sFFPsel with the primer 28sFF (Hillis & Dixon 1991). Primer sequences and references are shown in Table A2 (Appendix A).

All PCR reactions were conducted in a final volume of 20 μl comprising 2 μl of genomic DNA, 12 μl of MilliQ water, 2 μl of 10 × FastStart Taq DNA Polymerase PCR
Buffer with MgCl$_2$ (Roche), 2 μl of 2mM dNTP mix (Roche), 0.8 μl of 10 μg/ml BSA (Roche), 0.5 μl of 10 μM each primer, 0.2 μl (1 Unit) of FastStart Taq DNA Polymerase (Roche). PCR reactions were carried out in the following condition: initial denaturation at 95°C for 5min; followed by 40 cycles of denaturation for 45s at 94°C, annealing for 45s at 50°C and extension for 45s at 72°C; and 10 min at 72°C for final extension. When amplification failed, PCR reaction were repeated by raising the annealing temperature from 50°C to 52°C with the cycles increased from 40 to 45 at the second stage. PCR products for 28S and COI (only those amplified by dgLCO-1490 and dgHCO-2198) were purified with MinElute 96 UF PCR Purification Kit (Qiagen) and were eluted in 20 μl of water.

Bidirectional sequencing was carried out using the BigDye® Terminator v3.1 Cycle Sequencing Kit (Applied Biosystems). Thermal cycling conditions follow Platt et al. (2007). Sequencing products were purified using the Big Dye® Xterminator™ Purification kit (Applied Biosystems).

6.2.4 Multiple alignment and Phylogenetic analysis

DNA sequences were first trimmed and assembled in Geneious R10 (Kearse et al. 2012), and then consensus sequences of each genetic marker were aligned independently including the three additional outgroup sequences downloaded from GenBank. Pairwise alignments of protein-coding COI gene and length variable 28S gene were generated using Geneious Alignment with default setting. COI alignment was realigned using Geneious Translation Align with Genetic code: Invertebrate Mitochondrial. The two alignments were then manually inspected to correct poorly aligned regions.

The alignments were partitioned into two sets; 28S (1–862) and COI (863–1449) to account for variable substitution patterns between these two genes. The phylogenetic reconstruction was then performed by Bayesian inference (BI) using MrBayes v3.2.6
(Huelsenbeck & Ronquist 2001) as implemented in Geneious R10 under the model GTR + G for both partitions. With regard to prior probability distribution of both partitions, I set for “ratepr = variable”, used an unconstrained Gamma distribution (1.0,0.1,1.0,1.0) for “brlenspr” and exponential distribution (10.0) for “shapepr”. All parameters were unlinked for both partitions. Four Markov Chain Monte Carlo (MCMC) chains were run simultaneously for $5 \times 10^6$ generations, with sample frequency of 1000, and an MCMCMC temperature of 0.2. The starting tree was randomly selected, and the first 500 trees were discarded as burn-in. The consensus tree was rooted using Bryaxis curtisii Leach (Goniaceritae: Bythinini). Maximum likelihood (ML) analysis was performed using RAxML v8 (Stamatakis 2004) under the model GTR + G, with 1000 bootstrap replicates and the same partitioning strategy used for MrBayes analysis.

6.3 Results

The final concatenated molecular dataset was aligned along 1449 bp comprising COI (587 bp) and 28S (862 bp). All individuals (except Eupinolus sp. 1) used for the phylogenetic analysis contain the 28S gene, with 10 individuals missing the COI gene due to unsuccessful amplification or contamination.

The resulting tree topologies yielded from BI (Fig. 6.1) and ML (Fig. 6.2) analyses were similar in species-level groupings, but were incongruent in generic level placements. Within the genus Eupines, one group from New Zealand, which is presently classified in Eupines is named here as a new genus, Pseudeupines gen. n. The monophyly of the new genus was recovered by high values of both Bayesian posterior probability (BPP = 1) and bootstrap (BS = 100%), and was unambiguously split from all the other Eupines. The remaining Eupines consisting of New Zealand, Australia and New Caledonia lineages was
recovered as being monophyletic with strong support (BPP = 1, BS = 96%); only subtle differences of the species placements within several poorly supported clades of New Zealand lineage were shown between the two trees. The *Eupines* subgenus *Byraxis* was rendered paraphyletic by one species of the subgenus *Eupines* from New Zealand, and the monophyly of the New Zealand *Eupines* members is strongly supported (BPP = 1, BS = 82%).

The group formed by *Gastrobothrus* Broun, *Physobryaxis* Hetschko, *Eupinogitus* Broun and *Rybaxis* Saulcy was well supported as a whole (BPP = 0.85, BS = 94%), but the position of *Rybaxis* being sister taxa of *Eupinogitus* or of *Gastrobothrus + Physobryaxis + Eupinogitus* could not be resolved. I refer to this lineage as the “*Gastrobothrus* group”. *Gastrobothrus* was moderately supported to be paraphyletic with one species split out of the main group. *Gastrobothrus* sp. 1 showed a sister group relationship with *Physobryaxis inflatus*, however, this was poorly supported. Specimens identified as *Gastrobothrus abdominalis* (Broun) and *Gastrobothrus sharpi* (Broun) have identical 28S sequences and COI sequences that are 99.7% identical. The monophyly of the New Zealand endemic genus *Eupinogitus* was recovered with BPP value of 1 and BS value of 100%. *Eupinolus* Broun and *Startes* Broun are recovered as being monophyletic, but the Australian forms were not available for this study. The monophyletic status of *Anabaxis* Raffray and *Simkinion* Park and Pearce remains undetermined, because only one species of each genus were sequenced. Although all the Australian and New Caledonia genera with multiple species included in our dataset were recovered to be monophyletic, for example, *Batraxis* Reitter (BPP = 1, BS = 100%), *Iluka* Chandler (BPP = 1, BS = 100%) and *Anasopsis* Raffray (BPP = 1, BS = 100%), the intergeneric relationships among them, some new genera, and the New Zealand genera were poorly resolved.
FIGURE 6.1. Bayesian phylogenetic tree of Brachyglutini resulting from the concatenated dataset of COI and 28S sequences. Posterior probabilities (expressed as percentages) greater than or equal to 50 are shown at each node. Colours of branches correspond to the figure legend on the left.
FIGURE 6.2. Maximum likelihood tree of Brachyglutini resulting from the concatenated dataset of COI and 28S sequences. Bootstrap percentages greater than or equal to 50 are shown at each node. Colours of branches correspond to the figure legend on the left.
6.4 Discussion

6.4.1 Monophyly of Eupines

This phylogenetic study represents the first attempt to evaluate the monophyly of New Zealand Eupines. One shortcoming is that the geographic sampling is limited to Australia and New Caledonia, not including the Southeast Asia taxa, though these two Gondwanan landmasses are considered geologically close to New Zealand and share widespread fauna (Chambers et al. 2001; Gibbs 2006; Ladiges & Cantrill 2007).

The new genus, Pseudeupines, was strongly supported as being monophyletic, and was unambiguously separated from Eupines in both analyses. Members of the new genus have a similar reductive foveature to members of Eupines, except that they have the presence of mediobasal foveae on ventrite 2. They are superficially similar to Eupines by having a globular and compact body plan, along with a glabrous pronotum. However, the consistent presence of the shallow antebasal pronotal sulcus and the discal elytral striae among some specimens are indicative of a generic level difference. Furthermore, members of the new genus have rectangular-shaped genitalia with short parameres, which are significantly different from the slender genitalia with long parameres of Eupines. Pseudeupines is also closely related to an undescribed Australian genus (Genus B) by sharing with it the lack of a median antebasal pronotal fovea and the basal elytral foveae, and can be separated from it by the presence of the lateral metaventral foveae. However, their status as sister taxa was poorly supported.

The remaining 29 species of Eupines were strongly supported to form a monophyletic clade. The synapomorphies of Eupines include the lack of the setose pits beneath eyes, the median antebasal fovea, the basal elytral fovea and the discal elytral striae. Australia, New Caledonia and New Zealand Eupines lineages are well segregated, with the New Caledonia lineage well supported as a sister taxon of the New Zealand lineage. This
sister relationship corroborates earlier studies on the close relationship between New Zealand and New Caledonia insect faunae (e.g., Buckley et al. 2015).

The two *Eupines* subgenera, defined by the number of male antennomeres, are rendered as paraphyletic in this study, and the continued use of these names may be invalid, but more sampling for the molecular study is needed across the genus, especially members of the subgenus *Byraxis* from Australian and New Caledonia. A further complication is that though the syntypes of *Eupines (Byraxis) monstrosa* Reitter (type species of *Byraxis* Reitter) was examined, the holotype of *Eupines (Eupines) clavatula* King (type species of *Eupines* from Australia) is lost. Therefore, former descriptions regarding the critical characters of the two subgenera could not be verified. On the other hand, there is some evidence that the genus could be parsed into monophyletic taxa by region. For example, members from the Australian lineage have a broad and prominent gular ridge, while those from New Caledonia have a slightly prominent gular ridge, and those from New Zealand have a narrow and flat gular ridge. Whether these characters represent a grade requires additional sampling and further study.

Many of the brachyglutine genera are very similar, and this study provides a cautionary note for further study of *Eupines*, and the generic limits of the existing genera. For example, members of the undescribed Genus A from Australia were initially identified as *Eupines (Byraxis)* spp. due to the same reductive dorsal foveature and the 10-segmented antennae in males. However, Genus A can be readily separated from *Eupines* by its members having the lateral mesocoxal foveae fused to the pleural sulcus and the last segment of maxillary palpi longer than the second segment. A careful examination of the Australian type specimens is critical for determining if some of the named species of *Eupines* would fall into Genus A.
6.4.2 The *Gastrobothrus* Group

The monophyly of the group formed by *Gastrobothrus, Physobryaxis, Eupinogitus* and *Rybaxis* were well-supported, but may form a grade, indicated by the poor support value of the second split beyond *Gastrobothrus abdominalis* (Broun) and *Gastrobothrus sharpi* (Broun) containing the remaining genera and *Gastrobothrus* sp. 1. *Gastrobothrus* is morphologically similar to the endemic New Zealand genus *Physobryaxis*, which was previously synonymised with *Gastrobothrus* by Newton and Chandler (1989) and was later separated by Kuschel (1990) and followed by Nomura and Leschen (2006) due to the pronotum lacking an antebasal sulcus and a median antebasal fovea. The sister relationship between *Gastrobothrus* sp. 1 and *Physobryaxis inflatus* in both trees confirms their putative close relationship, though it is poorly supported (BPP = 0.75, BS = 52%).

The cosmopolitan genus *Rybaxis* and the New Zealand genus *Eupinogitus* are morphologically similar by sharing two characters unique in both Australian and New Zealand fauna: the elytral flanks have the subhumeral foveae and the pronotum have a sharply defined antebasal sulcus. Yet their phylogenetic position is poorly supported in our molecular tree. More taxon sampling across these two genera is expected in the future to determine their phylogenetic relationship.

The genus *Gastrobothrus* is currently composed of three species: *Gastrobothrus abdominalis* (Broun), *Gastrobothrus sharpi* (Broun) and *Gastrobothrus buckleyi* Théry & Leschen. The former two species were based on specimens from the same type locality (Tairua), moreover, the lectotype of *G. sharpi* was identified as a female (Shen & Leschen 2019), which indicate that *G. sharpi* may be the female specimen of *G. abdominalis*. To verify the hypothesis, representatives of both species from Kauaeranga Valley road, which is about 20 km away from Tairua and belongs to the same forest were sequenced. Their identical 28S sequences and nearly identical *COI* sequences (99.7%) are consistent with them.
being the same species. These two names were published in the same paper (Broun 1880), and herein I treat the second name, *Bryaxis abdominalis*, as the junior synonym. **NEW SYNONYMY.**

### 6.4.3 Comments on Other New Zealand Genera

The New Zealand *Anabaxis* was revised by Shen and Leschen (2018) with a new species described from the Chatham Islands and two species recorded on the mainland (one introduced from Australia). The synapomorphies of this genus in New Zealand fauna consists of the presence of the dorsal postantennal pits, the broad median gular ridge and the distinct median pronotal fovea. The widespread species *Anabaxis foveolata* (Broun) exhibits a large amount of variation of male characters, and to confirm its monophyly. Two individuals of *Anabaxis foveolata* from two geographically distant populations, Northland (ND) and Westland (WD) were sequenced, and were confirmed to be conspecific with identical 28S sequences and nearly identical COI sequences (99.4%).

Chandler (2001) redescribed the genus *Eupinolus* and indicated that it may be paraphyletic by its greatest diversity of form among the brachyglutine genera of Australia. Unfortunately, no *Eupinolus* specimen from Australia was obtained in the present study to test this hypothesis. However, the four *Eupinolus* species from New Zealand included in the dataset formed a monophyletic group with strong support in both analyses, though its phylogenetic position was not resolved. Only one *Simkinion* species, *S. bimanum* Park and Pearce was obtained for this study and its monophyly has yet to be confirmed by molecular evidence; though the following characters support its monophyly: pronotum lacking a median antebasal fovea, first and second visible tergites subequal in length and slender legs. Likewise, the phylogenetic position of the genus *Startes* was not congruent in two analyses, yet its
monophyly was consistent with the four identified species unambiguously grouped together and split from other brachyglutine genera.

6.5 Conclusion

The monophyly of *Eupines* was recovered with the exclusion of two species, which were morphologically and molecularly supported to be members of a new genus, *Pseudeupines*. However, the two subgenera of *Eupines* were recovered as paraphyletic, which renders the current subgeneric concept problematic. A more comprehensive taxon sampling is needed in the future to resolve this confusion within *Eupines*. Problems with the phylogenetic resolution of the *Gastrobothrus* group are attributed to limited taxon sampling, since only two species of *Eupinogitus*, one species of *Physobryaxis* and one species of *Rybatis* were obtained for the analyses. In this study, only two DNA fragments were obtained for analyses, which also contributes to the weakly supported genus-level phylogeny apart from the limited taxon sampling. Lastly, in the present study, a large number of undescribed genera identified from Australian and New Caledonia and the genera with their monophyly undetermined from New Zealand indicate that a more inclusive study of the Australasian fauna is needed. Apart from this, a global phylogenetic study based on molecular and morphological data would help to clarify and reconstruct the classification of Brachyglutini.

6.6 Systematics

*PSEUDEUPINES* Shen & Leschen, gen. nov.

Figs 6.3–6.4

**Type species:** *Bryaxis sternalis* Broun, 1893b.
**Etymology:** The generic name comprising two parts, the Greek noun ‘*pseudo*’ meaning lie, and the genus name *Eupines* King. The new name refers to the morphological similarity between the new genus and *Eupines*. The gender is feminine.

**Diagnosis:** Head with punctiform vertexal foveae; lacking frontal fovea; antennae 11-segmented, antennal clubs formed solely by antennomere 11; postantennal cavities present and range from about half-length to as long as postantennal tubercles; ventrolateral margin often rounded beneath eyes; median gular ridge narrow and prominent. Pronotum lacking median antebasal fovea; lateral antebasal foveae punctiform and barely visible; shallow antebasal sulcus disconnected at middle and extending to lateral antebasal foveae. Elytra lacking basal foveae, with shallow discal striae often extending posteriorly to apical two-thirds. Abdominal tergite 1 lacking mediobasal foveae and discal carinae; ventrite 2 with pair of small and setose mediobasal foveae.

**Description:** Body length 1.32–1.60 mm, colour reddish-brown, generally ovoid and compact; body surface smooth; dorsal vestiture sparse with short decumbent setae, average length shorter than length of eye.

Head trapezoidal and rounded; vertexal foveae (Fig. 6.3A) punctiform and barely visible; lacking frontal fovea; frontal rostrum moderately developed; antennal tubercles slightly prominent or lacking; postantennal sulcus shallowly extending between postantennal tubercles or lacking; postantennal cavities (Figs 6.3A–B) range from about half-length to as long as postantennal tubercles in dorsal view; eyes distinct and slightly prominent in dorsal view; antennae (Fig. 6.4D) 11-segmented, antennal clubs single segmented, scape and pedicel slightly widened; ocular-mandibular carinae (Fig. 6.3B) present; ventrolateral margin often rounded beneath eyes and slightly concave towards gular ridge; median gular ridge (Fig. 6.3B) narrow and prominent, curved abruptly to asetose gular foveae (Fig. 6.3C); Mouth (Fig. 6.3G) with trapezoidal labrum retuse at apex, mandible with three large teeth at inner side and one
medium-sized teeth at outer side, labial palp clavate and with long apical setae, mentum widest at middle, lacinia well developed and fused with galea, maxillary palpi with segment 2 strongly clavate, segment 3 highly transverse, segment 4 largest and fusiform, sensory apex with single stout seta.

Pronotum about as long as wide, slightly wider than head at eye level; lacking median antebasal fovea; lateral antebasal foveae punctiform and barely visible; shallow antebasal sulcus disconnected at middle and extending to lateral antebasal foveae; lacking median longitudinal sulcus. Prothorax with setose lateral procoxal foveae (Fig. 6.3F) widely opened and separated.

Elytra (Fig. 6.4E) longer than wide, widest at middle and longer than abdomen in dorsal view; each elytron with discal stria shallow and often extending posteriorly to apical two-thirds; lacking basal foveae; sutural stria distinct.

Mesoventrite (Fig. 6.4A) with minute asetose prepectal foveae; setose median mesoventral fovea widely opened and meet internally with large and setose lateral mesoventral foveae; setose lateral mesocoxal foveae distinct. Metaventrite with setose lateral metaventral foveae large and close to each other.

Abdomen (Figs 6.4B–C) short and strongly convex, with tergite 6 and ventrite 7 internalized; tergite 1 about as long as tergite 2, with minute basolateral foveae; lacking mediobasal fovea, discal carinae and mediobasal impression; tergites 2–4 lacking basolateral foveae; paratergites visible on tergites 1–4. Abdominal ventrite 2 with pair of small and setose mediobasal foveae and barely visible basolateral foveae, ventrites 3–5 lacking basolateral foveae.

Legs with protibiae slightly enlarged at apex, protarsomeres 2 and 3 subequal in length, mesotarsomere 2 slightly shorter than mesotarsomere 3, metatarsomere 2 slightly longer than metatarsomere 3.
Sexual dimorphism: males with last antennomere slightly enlarged; eyes enlarged and distinctively prominent; apical margin of metaventrite and/or ventrite 2 modified. Aedeagus squared and symmetrical, with short and stout parameres, median lobe with two sclerites, dorsal diaphragm symmetrical and wing-shaped, internal sac large and opened at ventral side.

**Distribution:** The genus is recorded throughout New Zealand.

**Included taxa:** *Bryaxis grata* Sharp and *Bryaxis sternalis* Broun.

**Comments:** *Pseudeupines* embodies the following character that constitute its synapomorphies: 1) pronotum with disconnected shallow antebasal sulcus; 2) elytra lacking basal foveae; 3) discal elytral striae present; 4) abdominal ventrite 2 with pair of small and setose mediobasal foveae. It is morphologically close to *Eupines* in New Zealand and *Eupinella* Raffray in Australia and can be separated from both by characters 1), 3), 4) and 1), 2) respectively. Although females of this genus can be easily separated from males by their small eyes, they are ambiguously demarcated at the species level, and thus, are herein recorded as ‘associated females’.

*Pseudeupines grata* (Sharp, 1874)

Figs 6.5, 6.6

*Bryaxis grata* Sharp, 1874: 500.

*Bryaxis grata*: reprint from Sharp 1874 by Sharp 1876: 278.


**Type locality:** [AK] Auckland.

**Type depository:** BMNH LT ♂, 1 PLT.

**Diagnosis:** Head lacking antennal tubercles; postantennal cavities large and about as long as antennal tubercles in dorsal view. Elytra with discal striae shallow and extending posteriorly to apical three-fourths. Metaventrite slightly projected at apex, middle part between metacoxae slightly concave. Abdominal ventrite 2 unmodified; ventrite 6 with pair of short median struts, about one-sixth of ventral length.

**Redescription of male:** Body (Fig. 6.5) length 1.45–1.60 mm. **Head** wider than long; eyes slightly prominent in dorsal view, with about 17 facets; vertexal foveae punctiform; lacking antennal tubercles; postantennal sulcus shallowly extending between antennal tubercles; postantennal cavities large, about as long as antennal tubercles in dorsal view; antennae (Fig. 6.6C) with last segment elongate and conical. **Pronotum** slightly wider than long, slightly wider than head at eye level; vertexal foveae punctiform; antebasal sulcus shallow. **Elytra** about as long as wide, widest near apical two-thirds; humeral calli distinct and slightly prominent; discal striae shallow and extending posteriorly to apical three-fourths. **Metaventrite** (Fig. 6.6D) slightly projected at apex, with two tufts of strongly curved apical setae; middle part between metacoxae slightly concave. **Legs** with mesotibiae modified with minute and curved apical spine in some males (Fig. 6.6B). **Abdominal** ventrite 2 unmodified...
(Fig. 6.6A); ventrite 6 (Fig. 6.6E) with pair of short median struts, about one-sixth of ventral length. Aedeagus (Figs 6.6F–H) about 0.22 mm long, with short parameres about as long as median lobe, widest near middle, apex acute; median lobe with two sclerites almost meet near apex and slightly narrower than parameres in ventral view.

Remarks: After examining the lectotype of *E. (E.) clemens* Broun and the lectotype of *E. (E.) grata* (Sharp), they were found to represent a single species, with the former name chosen as the junior synonym. The minute apical mesotibial spine in males of this species is not a consistent character among all individuals examined, and therefore, it is not useful for species-level identification. This species can be easily distinguished from *P. sternalis* by its unmodified ventrite 2.

Distribution: North Island. AK. South Island. NN, BR, WD, MC, OL, FD.


**FIGURE 6.5.** Dorsal habitus of *Pseudeupines grata* (Sharp). A) Male. B) Female. Scale bars: 1.0 mm.
**Pseudeupines sternalis** (Broun, 1893)

Figs 6.7, 6.8

*Bryaxis sternalis* Broun, 1893b: 171.

*Eupines* (*Eupines*) *sternalis*: combination and subgeneric assignment by Raffray 1904: 204.


**Type locality:** [ND] Ligar’s Bush, Papakura; [WO] Mount Pirongia.

**Type depository:** BMNH LT ♂, 5 PLT; NZAC 2 PLT.

**Diagnosis:** Head with antennal tubercles slightly prominent; postantennal cavities medium-sized and about half length of antennal tubercles in dorsal view. Elytra with discal striae shallow and extending posteriorly to apical two-thirds. Metaventrite distinctively projected at apex, middle part between metacoxae distinctively concave. Abdominal ventrite 2 with deep mediobasal impression; ventrite 6 with pair of minute median struts, about one-twelfth of ventral length.

**Redescription of male:** Body (Fig. 6.7) length 1.32–1.54 mm. **Head** wider than long; eyes slightly prominent in dorsal view, with about 18 facets; vertexal foveae punctiform; antennal tubercles slightly prominent; postantennal sulcus indistinct or lacking; postantennal cavities medium-sized and about half length of antennal tubercles in dorsal view; antennae (Fig. 6.8E) with last segment strongly elongate. **Pronotum** slightly wider than long, slightly wider than head at eye level; vertexal foveae punctiform; antebasal sulcus shallow. **Elytra** about as long as wide, widest near middle; humeral calli visible and slightly prominent; discal striae shallow and extending posteriorly to apical two-thirds. **Metaventrite** (Fig. 6.8C) with apex distinctively projected, with two tufts of strongly curved apical setae, middle part between metacoxae distinctively concave. **Legs** unmodified. **Abdominal** ventrite 2 with deep mediobasal impression (Figs 6.8A–B); ventrite 6 (Fig. 6.8D) with pair of minute median

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struts, about one-twelfth of ventral length. **Aedeagus** (Figs 6.8F–G) about 0.28 mm long, with short parameres slightly shorter than median lobe, widest near middle, apex slightly bifurcat; median lobe with two large and stout sclerites widely separated, apex twisted, wider than parameres in ventral view.

**Remarks:** This species is morphologically confusing with *Pseudeupines grata* in dorsal view, and the only subtle difference is that the antennae of the former are longer and more loosely articulated than that of the latter. But it can be immediately differentiated from *Pseudeupines grata* at ventral side by ventrite 2 having deep mediobasal impression.

**Distribution:** North Island. ND, AK, WO, CL, BP, TO, WI. South Island. SD, NN, FD. Offshore Islands: CH.

J.S. Dugdale litter; **SD:** 2, Reservoir Track Picton, 21/Mar/1949, A.E. Brookes Collection; **FD:** 2, Secretary I. Grono Bay 24/Mar/1984 C.F. Butcher sifted litter; **Unknown locality:** 6, 240, T. Broun Collection, A.E. Brookes Collection.

**FIGURE 6.7.** Dorsal habitus of *Pseudeupines sternalis* Broun. **A)** Male. **B)** Female. Scale bars: 1.0 mm.
6.7 Key to the genera of Brachyglutini of New Zealand

1 Pronotum with sharply defined antebasal sulcus; elytra flanks with subhumeral foveae ..............
   .........................................................................................................................................Eupinogitus Broun
   - Pronotum often lacking antebasal sulcus, or moderately defined when present; elytra
     flanks lacking subhumeral foveae ................................................................. 2
2 Head with dorsal postantennal pits ..............................................................Anabaxis Raffray
   - Head lacking dorsal postantennal pits ................................................................. 3
3 Elytra strongly narrowed at base; body size often more than 2 mm ......................... 4
   - Elytra not narrowed at base; body size often less than 2 mm ......................... 5
4 Pronotum with median antebasal fovea and conspicuous antebasal sulcus ..............
   .........................................................................................................................................Physobryaxis Hetschko
   - Pronotum lacking median antebasal fovea and antebasal sulcus .............Gastrobothrus Broun
5 Head prolonged apically; pronotum with sharply defined impression around large median
   antebasal foveae ............................................................................................................Startes Broun
   - Head as long as wide or slightly transverse; pronotum lacking impression, median
     antebasal fovea lacking or shallow ............................................................................ 6
6 Pronotum with median antebasal fovea shallow and slightly smaller than lateral antebasal
   foveae, with coarse punctate base ........................................................................... Eupinolus Oke
   - Pronotum lacking median antebasal fovea, lateral antebasal foveae small or barely visible,
     with smooth base ........................................................................................................ 7
7 Head with median gular ridge broad and prominent; pronotum with lateral antebasal foveae
   small, but clearly visible; each elytron with two basal foveae .... Simkinion Park and Pearce
   - Head with median gular ridge narrow and slightly prominent; pronotum with lateral
     antebasal foveae barely visible; elytra lacking basal foveae .................................... 8
8 Pronotum with antebasal sulcus shallow; elytra with discal striae short; abdominal ventrite 2 with pair of small mediobasal foveae.......................... *Pseudeupines* gen. n.
- Pronotum lacking antebasal sulcus; elytra lacking discal striae; abdominal ventrite 2 lacking mediobasal foveae.......................................................... *Eupines* King
7.

GENERAL DISCUSSION

7.1 Key Findings and Implications

In this study, I sought to revise the New Zealand taxa from the tribe Brachyglutini and to interpret their phylogenetic relationships using a molecular approach, with a focus on the species-rich genus *Eupines*. Prior to this research, Brachyglutini in New Zealand was virtually unstudied since 1923, with only small pieces of taxonomic work carried out in recent years (Park & Pearce 1962; Nomura & Leschen 2006, 2015; Théry & Leschen 2013). Likewise, there has been no phylogenetic study on New Zealand brachyglutines, apart from some comments made by Nomura and Leschen (2006) in their faunistic review. Major taxonomic confusion exists such as the lack of useful identification key at the generic and species levels, uninformative and inadequate descriptions of a large number of species, the problematic subgeneric system of *Eupines*, etc. The faunistic review of Pselaphinae from New Zealand by Nomura and Leschen (2013) and the checklist of the world Brachyglutini from Alfred Newton (pers. comm.) provided the initial framework for this study.

7.1.1 Type designations

A sound revisionary work should always begin with type examinations and designations to stabilize the nomenclature before further taxonomic works. During this phase of the project, a large number of New Zealand pselaphine type material was found residing in the NZAC, of which the taxonomic value is remarkable. The NZAC, as well as the BMNH collection,
should always be considered as the first place to start taxonomic work of New Zealand Pselaphinae, preceding any collecting trip.

Of the 62 described brachyglutine species, about three quarters were described by Thomas Broun, of which types were found mostly deposited in the Natural History Museum, London (BMNH) bearing a round label with a red border and the word “type” (Lord & Leschen 2014). These should be considered to be the most probable syntypes, and they are either deposited in the ‘Broun Collection’ or ‘Main Collection’ in the BMNH. If a type from Broun could not be located in the NZAC or the BMNH, they were presumed to be lost, most likely due to the frequent trade in beetle type material during previous decades (Lord & Leschen 2014).

During the examination of type material, I produced a catalogue for all described species with detailed taxonomic history based on the study of the primary literature. Type material was examined from various collections with 17 holotypes confirmed, 38 lectotypes and 99 paralectotypes designated (Chapter 2). Four species were found to be based solely on female specimens, and I have treated them as valid species because that brachyglutine females lack distinctive characters for species-level identification, and there is insufficient evidence to challenge their species status. From my perspective, a pselaphine species should never be described from a single female specimen, even if it possesses distinctive characters. For example, Sharp (1874) described *E. deformis* from a single female (Shen & Leschen 2019) due to the strangely bent protibiae and mesotibiae, which may very likely be an individual deformity rather than species-level characters. Even though Sharp doubted the species rank of *E. deformis* in the description, such taxonomic acts can still easily cause subsequent confusion and should be avoided in future Pselaphinae taxonomy.
7.1.2 Revision of Eupines

During revision of the species-rich genus *Eupines*, I found that the taxonomic history of the two subgenera, *Byraxis* and *Eupines*, was ambiguous. Some species were not placed under the two subgenera by the distinctive characteristic of the antennomere number. Furthermore, based on the distinctive antennal characters, many described species were found to be potential synonyms and few species were not even members of *Eupines*. In previous studies, *Eupines* species from New Zealand were mostly described from only external characters (e.g., Broun 1880, 1912, 1923), and internal characters such as genitalia were not considered, until their value was recognised by Sharp and Muir (1912). In *Eupines* males, species boundaries can be ambiguous when they have similar antennal characters; for these species, the genitalia character could always easily separate them. Therefore, the male genitalia were photographed and described for all species to help with identification, apart from three species represented by singletons, which all have distinctive antennal character sets, and can be readily separated from other *Eupines*. A further complication is that many ventral characters were not noticed by Broun, which were proven to be useful for *Eupines* identification.

Male aedeagi were photographed in three views (dorsal, lateral and ventral views) for more precise identification. This is due to the morphological similarity between a lot of species such as the similar antennal modifications; few of them even have similar genitalia. Notwithstanding they can still be differentiated easily by characters on the ventral side of the aedeagus such as the presence and absence of a lamina, which is sometimes obscured by the median lobe in dorsal view. Therefore, ventral and lateral views of male genitalia are also necessary for *Eupines* classification. As the result of this revision, I described 22 new species, synonymised 11 species and transferred two species to *Eupinolus* and *Gastrobothrus*, respectively (Chapter 3). All valid species, apart from those based solely on female types were illustrated and categorized in the key.
The antennal modifications in males were found to be of greater taxonomic importance at the species level compared to other sexual characters in *Eupines* such as modifications of ventrite 2 and the protrochanteral spines, which vary between individuals. Species can be easily distinguished by the positions, shapes and sizes of the antennal modifications. Characters such as the size of the eyes, body colour, body setae or body proportion were found to be unreliable and inconsistent among individuals. These should not be applied to identification for *Eupines* species, and according to my experience, these should also be avoided for identification elsewhere in Brachyglutini. Sorting and identification of *Eupines* species can begin with separating morphospecies by the distinctive antennal modifications in males, followed by dissection of male genitalia for secondary confirmation. In contrast to the clear species boundaries in males, the females of this genus can be separated only when the body size is significantly different from other females such as *E. (B.) dispar*, *E. (B.) fraudulenta* and *E. (B.) gigas*, females of which have the average body size of nearly 2 mm. In addition, females of *E. (E.) undecim*, can also be easily distinguished from other females as the body is consistently covered with long setae. Apart from those above, other female specimens are barely distinguishable and were assigned to species by association with males from the same collecting events.

Sympatric distribution is very common for *Eupines* species. For example, at one locality, Tairua (Coromandel), more than 10 species were collected. In this case, sequencing male and female specimens is appropriate for identification, and comparing female genitalia may also be useful. Apart from the four species described by Théry and Leschen (2013) from the Three Kings Islands, 27 of the remaining 44 species are distributed only on North Island, with the highest diversity in Auckland (13 species) and Coromandel (14 species) regions. Six species have the range across both islands, and only 11 species are specifically distributed on South Island. The higher diversity in the northern North Island may indicate the preferred
habitats for *Eupines* or due to relatively insufficient collecting in other regions of New Zealand.

### 7.1.3 Revision of *Anabaxis*

The genus *Anabaxis* has only three species in New Zealand, apart from the introduced species (*A. electrica*) from Australia and the Chatham Islands species (*A. chathamensis*), only *A. foveolata* is geographically widespread in mainland New Zealand. The two individuals of *A. foveolata* included in the phylogenetic analysis in Chapter 6 were selected from two geographically separated populations in Northland and Westland. The former is the northern tip of the North Island, and the latter is the midwestern side of the South Island. Those two species were verified to represent a single species. The phylogenetic result in Chapter 6 is consistent with my conclusion in Chapter 4 that the observed morphological variation represents a single species. Six distinctive *Anabaxis* species are recorded from southeast Australia, in contrast to a single species in mainland New Zealand. The haplotype variation of *A. foveolata* across New Zealand may be the result of Pleistocene environment changes and associated with shifts in distribution (Marske *et al.* 2012). The population variation must be relatively recent as speciation has not occurred. The distribution of the introduced species *A. electrica* is from Northland to Nelson (northern tip of the South Island). This species also occurs in Victoria, Australia, and it has clearly arrived recently in New Zealand as it is morphologically indistinguishable from the Australian populations of *A. electrica*. *Anabaxis chathamensis* may be a neo-endemic species due to the recent isolation of the Chatham Islands biota (e.g., *Brachynopus scutellaris*, Buckley & Leschen 2013).

*Anabaxis foveolata* is highly polymorphic in male secondary characters as well as the number of basal elytral foveae in both sexes. The variation of the male secondary sexual characters may be related to sexual selection as per discussion in Chapter 4, whereas the
variation of the number of basal elytral foveae seems not relate to sex or geography. Similar variation was also observed by Chandler (2001) with the two genera *Reichenbachia* Leach and *Trissemus* Jeannel, which can only be differentiated by the number of basal elytral foveae and were suspected to represent a single genus. He also stated that many Australian genera were observed with variable numbers of basal elytral foveae among their members at the species level. Likewise, the number of foveae is variable among individuals of *A. foveolata*, including asymmetrical numbers among left/right elytra (which is rare). In this case, the basal elytral foveae may not relate to the complex geological and climatic history of New Zealand, and their presence or absence may not be the result of natural selection.

The clinal variation of the two spines on the male legs is bi-directional, with the mesotrochantral spines tending to be smaller with increasing latitude and vice versa for the mesotibial spines. I hypothesize that the mesotrochanteral spines may be used in mating for additional grip by males as they are copulating with females, and the trend of this character is towards loss. The mesotibial spines in males may have a similar function for gripping females when mating, and the spines tend to be larger with increasing latitude. The bi-directional trend in two spines may also be associated with a shift in function, but I refrain from hypothesizing the underlying reason of this trend because no behavioural observation was attempted during this research due, in part, to their tiny size.

### 7.1.4 Revision of *Simkinion*

Park and Pearce (1962) described the potential bryophyte specialist *Simknion*, with two species from Northland, and thereafter, the genus was not studied by beetle workers, though it has an unusual natural history in contrast to other litter-dwelling New Zealand pselaphines. Based on collecting information of material from prior collections and my field trips, species
of *Simkinion* were confirmed to be restricted to Northland, and most of the specimens were collected either directly from moss or in habitats associated with moss.

In my Northland collecting trip, 16 localities were visited, with the moss + associated rotten wood and forest litter sifted separately to obtain less biased results. *Simkinion* specimens were only found in the moss + associated rotten wood sifting with a capture rate of about 25%, while no specimens were collected from the forest litter only sifting. However, I still cannot firmly ascertain that members of *Simkinion* are bryophyte specialists, since my targeted sifting also contains rotten wood that associated with moss, and some specimens may live in the rotten wood, thus, were accidentally collected. But their strong association with moss can be confirmed and this has never been observed in any other New Zealand pselaphine species.

Four new species were discovered from the collection material, with three of them recorded from Ngaiotonga Reserve (Russell Forest). The high diversity of *Simkinion* from Ngaiotonga Reserve indicates that extensive collecting in the Northland area should amount to higher diversity. However, the field trip to Northland was not as promising as I expected; only one species, *S. bimanum*, was collected from the trip. Based on their rarity (the four new species are only known from singletons) and the strongly moss associated habitats, I hypothesize that this group is highly sensitive to climate, and their presence or absence may be influenced by even subtle environmental changes, and my visit was in the time when the weather was rainy and cold. Another hypothesis is that members of *Simkinion* are bryophyte specialists, and their abundance may have decreased as the result of the feral pig damage in a large number of Northland forest habitats.

A further noteworthy result is the remarkable tergal modifications of *Simkinion* males (lacking in *S. bimanum*). Similar modifications were also reported in species of *Batriscenellus* Jeannel, *Batrisceniola* Jeannel and *Arthromelodes* Jeannel from the supertribe
Batrisitae (Yin et al. 2011; Yin & Li 2014; Yin 2018). However, with respect to the function of the complex tergal structures, only that of the myrmecophilous pselaphines, notably Clavigeritae, have been discussed before (e.g., *Claviger testaceus*, Cammaerts 1974). The tergal trichomes at the base of the abdomen of clavigerites were found to serve as chemical glands for surviving in ant nests. Beyond that, the function of the tergal structures which appear as male secondary characters here has never been discussed before. Members of *Simkinion*, like all other brachyglutines in New Zealand (Nomura & Leschen 2015), have never been collected with ants, and the tergal structure could be used during mating. However, it is probably not used in physical interactions between males and females, since no corresponding structure in females, which interacts with the male tergal modifications could be found. The complex tergal structures probably function in sexual attraction, and the trichomes may serve as chemical glands like those in clavigerites, but secreting chemicals that attract females.

### 7.1.5 Phylogeny of Brachyglutini

The focus of this study, *Eupines*, was shown to be monophyletic in both Bayesian and maximum likelihood trees with the exclusion of the new genus, *Pseudeupines*. *Eupines* is more derived than most of the brachyglutine genera based on the phylogenetic trees, which is in accordance with their reductive foveature, though this is not well supported. All newly described and known species were supported as valid species. However, the two subgenera were recovered as non-monophyletic with one member of the nominate subgenus *Eupines* embedded in the *Byraxis* group. The *Eupines* fauna of New Zealand and New Caledonia forms a single lineage, while the Australian lineage is divergent.

With the discovery of the new species with 9-segmented antennae and the paraphyly of the two subgenera, the current subgeneric system is rendered problematic and should be
modified to include the new species. However, during type examination of the two subgenera, the holotype of *E. clavatula* (type species of the subgenus *Eupines*) could not be located in the two collections and is presumably lost. Therefore, the critical antennal character of the subgenus *Eupines* could not be verified and I refrain from establishing a new subgenus to accommodate the new species before the subgeneric system is stabilized. On the other hand, it is obvious that the 10- and 11-antennomere system should be abandoned and new characters should be found to redefine subgenera or species groups for this hyper-diverse genus. This requires a thorough examination of all known species, whereas examining the types of those species from Australia, New Caledonia and East Asia, which comprise 92 species, was too time-consuming for this study and were not considered. In order not to cause further taxonomic confusion within this genus, I choose to keep the current subgeneric concepts as per discussion in Chapter 6.

Within the *Gastrobothrus* group, which is consisted of *Gastrobothrus* + *Physobryaxis* + *Eupinogitus* + *Rybaxis*, the sister relationship of the cosmopolitan genus *Rybaxis* and the New Zealand endemic genus *Eupinogitus* is not congruent between the two phylogenetic trees, but their morphological similarity is certain. The presence of the subhumeral foveae of elytral flanks and the sharply defined antebasal sulcus of pronotum can quickly separate these two genera from all other brachyglutines of New Zealand and Australia. Examination of representatives of *Rybaxis* and *Eupinogitus* revealed their highly similar morphology, and the latter could be a potential synonym of the former. Unfortunately, due to the limitation of the Australian material, only one specimen of *Rybaxis* was available for DNA sequencing.
7.2 The Foveal Pattern of New Zealand Brachyglutini

Cuticular cavities on beetles are important key characters used to distinguish different species or even higher taxa (e.g., dung beetles, Jessop 1985; ground beetles, Borges et al. 2004), and are especially of great importance in Pselaphinae (Chandler 2001). Their function has always been intriguing to many entomologists. For example, it is reported that the external exoskeletal cavities in some beetle groups (e.g., scolytine and platypodine weevils) may function as mycangia (Grebennikov & Leschen 2010) or by secreting sexual pheromones (Lopes-Andrade et al. 2003).

The exoskeletal cavities in the subfamily Pselaphinae and other Staphylinidae such as Scydmaeninae are commonly referred to as ‘foveae’. The foveal formula of Pselaphinae is always one of the key features to identify genera and species since Park (1942) proposed the first system for categorizing the foveal pattern of ventral thorax of Pselaphinae. Subsequent pselaphine workers have been documenting the systematic value and probable function of foveae (e.g., Grigarick & Schuster 1980; Coulon 1989), and most recently, Chandler (2001) who provided a complete foveal system with all foveae named. Chandler speculated that the function of foveae is mainly to provide structural rigidity (foveae of head and abdomen) and may have initially served a sensory function (foveae of thorax). He also commented on the evolutionary trend of the foveae: “The basic trend in evolution is towards fusion and/or loss, with their presence being the primitive state for those foveae composing the primitive foveal pattern”. For example, the supertribe Faronitae of Pselaphinae has always been considered as the first lineage to split off from the remaining pselaphines and this is supported by phylogenetic studies of both morphological and molecular evidence (Newton & Thayer 1995; Chandler 2001; Parker 2016). Accordingly, members of Faronitae bear more cuticular foveae than that of the other more derived groups in Pselaphinae. The foveal pattern has always been a critical character to recognise pselaphine genera and therefore, learning the foveal patterns
of New Zealand brachyglutine genera is an additional approach to interpret their generic limits and phylogenetic relationships.

Among all cuticular foveae of New Zealand Brachyglutini, the following seven vary the most: frontal fovea; vertexal foveae; median and lateral antebasal foveae of pronotum; basal elytral foveae; lateral mesocoxal foveae; lateral metaventral foveae. *Anabaxis* can be quickly recognised by the presence of the frontal fovea on head, which is lacking in all other New Zealand brachyglutines. A pair of vertexal foveae are present in all genera, whereas the forms are different among them. The foveae are punctiform and may be barely visible in *Eupines, Eupinolus* and *Pseudoepines*, while they are conspicuous in the remaining genera, especially in *Physobryaxis*, of which the distance between the vertexal foveae is about two-thirds of the head width. The median antebasal fovea is present in four genera, *Anabaxis, Eupinogitus, Physobryaxis* and *Startes*, but is only setose in *Startes*. Apart from *Eupines* and *Pseudoepines* that have the lateral antebasal foveae punctiform and barely visible, they are large and setose in *Anabaxis, Eupinogitus, Physobryaxis* and *Startes*, and are small and asetose in *Eupinolus, Gastrobothrus* and *Simkinion*. The lateral mesocoxal foveae are small in *Eupines and Pseudoepines*, but these are large and setose among the other seven genera. *Anabaxis* is the only genus with the lateral metaventral foveae adjacent and opened inwards, which are opened outwards in the other eight genera. *Gastrobothrus, Pseudoepines* and *Startes* have the lateral metaventral foveae adjacent, while it is widely separated in *Eupines, Eupinogitus, Eupinolus, Physobryaxis* and *Simkinion*. *Eupines and Pseudoepines* can be easily separated from congeners by lacking the basal elytral foveae, apart from *Eupinolus*, of which the elytral foveae vary among species. All genera can be recognised and separated from each other by the combination of two different foveae as described above. While molecules are used to reconstruct phylogenetic relationships, scoring foveal pattern in a
morphological analysis offers an valuable additional character set for reconstructing the relationships among the pselaphine taxa.

7.3 Limitations and Future Directions

Although the monophyly of the genus *Eupines* was recovered, no samples of the subgenus *Byraxis* from Australia and New Caledonia were able to be obtained for phylogenetic study. Therefore, the resulting topology may not represent the true phylogenetic status of the genus, and it may change as more species are included in future studies. The validity of the two subgenera, *Byraxis* and *Eupines* could not be ascertained due to the possible loss of the holotype of *E. clavatula*, the type species of the genus, and the holotype should be located and examined by searching further through museum collections. A new subgeneric system or species group may be proposed for the species-rich genus, *Eupines*, but this would require a complete revision of the entire genus. The monophyly of *Physobryaxis*, *Anabaxis* and *Simkinion* has not been tested because only one species of each genus was included in the dataset. Additional field investigation should be conducted in the future to obtain more material for a more comprehensive phylogenetic study of the New Zealand Brachyglutini. The phylogenetic work of the Brachyglutini fauna of New Zealand also revealed a large number of undescribed taxa from Australia and New Caledonia, which need to be described. The diversification of the antennal characters of male *Eupines* can be coded and combined with the molecular trees data to analyze the evolution of these traits.

The clinal variation in sex-linked characters of the male legs of *Anabaxis foveolata* may be related to the body size, which itself may be an adaptation to the complex climate gradients of New Zealand. The measurements of the body size can be integrated into the
statistical analysis I performed to test the potential allometry between the male secondary characters and body size. Apart from a few publications on inquilinous pselaphines (Park 1942, 1964; Kistner 1982; Chandler 2001; Parker & Grimaldi 2014; Parker 2016a, 2016b) and behavioural observations of pselaphine larvae (De Marzo & Vit 1982; De Marzo 1986, 1988), no adult copulation observations have been conducted. Courtship observations of Anabaxis foveolata would give insights into the function of the sexual characters and correlated clinal changes.

To date, our knowledge of moss associated pselaphines is anecdotal, and Simkinion may be the only bryophyte specialist among the New Zealand pselaphines. More than half of the Simkinion specimens were collected in moss or moss related microhabitats. Their small body size may allow them to easily undulate through moss substrate, and their Northland restricted distribution may be explained by their preference of certain kinds of moss, which are only present in the Northland area. However, whether they are bryophyte specialist still could not be ascertained due to the lack of targeted collecting. In my trip to Northland, although leaf litter and moss samples were separated, moss and the associated rotten wood samples were mixed. To prove if Simkinion is obligate moss guest, extensive moss targeted collecting in Northland with control sifting of rotten wood only should be conducted in the future.
APPENDIX A. Supplementary material (Chapter 6)

Table A1. Taxonomic names, voucher codes, localities and coordinates of the sequenced specimens.

<table>
<thead>
<tr>
<th>Taxon</th>
<th>Code in alignment</th>
<th>Locality</th>
<th>Coordinate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Anabaxis foveolata</td>
<td>A-0</td>
<td>WD, Mt. Aspiring, Blue pools walk</td>
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<td>ND, North Cape Scientific Reserve</td>
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<td>Eupines (Byraxis) monstrosa</td>
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<td>OL, Pleasant Flat</td>
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</tr>
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<td>E-2</td>
<td>ND, Russell Forest</td>
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<td>AK, Waitakere Ranges</td>
<td>36.9644° S 174.5122° E</td>
</tr>
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<td>Eupines (B.) setifera</td>
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<td>ND, Whangarei</td>
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<td>Eupines (B.) impar</td>
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<td>WN, Kapiti Island</td>
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<td><em>Pseudeupines</em> <em>grata</em></td>
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<td>OL, Pleasant Flat</td>
<td>44.6247° S 169.8972° E</td>
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<td>Mount Bartle Frere</td>
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</tr>
<tr>
<td><em>Eupines</em> (E.) sp. 5</td>
<td>AE-9</td>
<td>Pascoe River</td>
<td>12.8850° S 143.0070° E</td>
</tr>
<tr>
<td><em>Eupinopsis</em> sp.</td>
<td>AE-10</td>
<td>Mount Gannon</td>
<td>28.1980° S 153.3170° E</td>
</tr>
<tr>
<td>Iluka sp. 1</td>
<td>AE-11</td>
<td>Mount Garnet</td>
<td>17.9100° S 144.8800° E</td>
</tr>
<tr>
<td>Iluka sp. 2</td>
<td>AE-12</td>
<td>East Claudie River</td>
<td>12.7140° S 143.2870° E</td>
</tr>
<tr>
<td>Batraxis sp. 1</td>
<td>AE-13</td>
<td>Goldsborough Rd</td>
<td>17.2210° S 145.7610° E</td>
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Table A1 continued

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<th>Genus/Species</th>
<th>Code</th>
<th>Location</th>
<th>Coordinates</th>
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<tr>
<td>Batraxis sp. 2</td>
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<td>Iron Range</td>
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<td>Rybaxis sp.</td>
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<td>Bonython</td>
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<td>Garradunga</td>
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<tr>
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<td>AE-17</td>
<td>East Claudie River</td>
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<tr>
<td>Booloumba sp.</td>
<td>AE-18</td>
<td>Bunyas Mountains</td>
<td>26.8750° S 151.5940° E</td>
</tr>
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<td>Bundjulung sp.</td>
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<td>Garradunga</td>
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<td>Wataranka sp.</td>
<td>AE-20</td>
<td>Lamb Range</td>
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<td>Wollomombi sp.</td>
<td>AE-21</td>
<td>O’Reillys road</td>
<td>28.1980° S 153.1250° E</td>
</tr>
<tr>
<td>Genus F sp.</td>
<td>NC-1</td>
<td>Mont Do</td>
<td>21.7636° S 166.0025° E</td>
</tr>
<tr>
<td>Genus G sp.</td>
<td>NC-2</td>
<td>Mont Do</td>
<td>21.7636° S 166.0025° E</td>
</tr>
<tr>
<td>Eupines (E.) sp. 6</td>
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<td>Col d’ Amieu</td>
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<td>Eupines (E.) sp. 8</td>
<td>NC-8</td>
<td>Mont Do</td>
<td>21.7558° S 166.0031° E</td>
</tr>
<tr>
<td>Eupines (E.) sp. 10</td>
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<td>Col d’ Amieu</td>
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</tr>
<tr>
<td>Eupines (E.) sp. 11</td>
<td>NC-11</td>
<td>Col d’ Amieu</td>
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</tr>
<tr>
<td>Genus D sp.</td>
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<tr>
<td>Anasopsis sp. 1</td>
<td>NC-15</td>
<td>Mont Do</td>
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<tr>
<td>Anasopsis sp. 2</td>
<td>NC-16</td>
<td>Mont Do</td>
<td>21.7558° S 166.0031° E</td>
</tr>
<tr>
<td>Genus E sp.</td>
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<td>Mont Do</td>
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**Table A2.** Primers used for PCR amplification and DNA sequencing.

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<th>Gene</th>
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<th>Sequence (5’ – 3’ )</th>
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<td><strong>COI</strong></td>
<td>LCO-1490</td>
<td>GGTCACCAAAAATCATAAAGATATTGG</td>
<td>Folmer <em>et al.</em> 1994</td>
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<td>dgLCO-1490</td>
<td>GGTCACCAAAAAATCATAAAGAYATYGG</td>
<td>Meyer 2003</td>
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<td>dgHCO-2198</td>
<td>TAAACTTCAGGGTGACCAAAARAYCA</td>
<td></td>
</tr>
<tr>
<td><strong>28S</strong></td>
<td>28sDD</td>
<td>GGGACCCCGTCTTTGAAACAC</td>
<td>Hillis &amp; Dixon 1991</td>
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<td></td>
<td>28sFF</td>
<td>TTACACACTCTTCTTAGCGGAT</td>
<td></td>
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<td></td>
<td>28sFFPse</td>
<td>ACCGTCTCTGCTGTCTTTAGTT</td>
<td>Parker &amp; Maruyama 2013</td>
</tr>
</tbody>
</table>
APPENDIX B. Area codes and boundaries of mainland New Zealand (after Crosby et al. 1998)
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