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Molecular phylogeny and evolution of the Ectemnorhinus group of weevils in the Prince Edward Islands

by

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Submitted in partial fulfillment of the requirements of the degree of Doctor of Philosophy (Entomology)

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Degree: Doctor of Philosophy (Entomology)

Declaration

I, Gert Grobler hereby declare that apart from the morphometric data that were generated by Dr Lindie Janse van Rensburg (included in Chapter 2), this thesis which is submitted for the degree of Doctor of Philosophy (Entomology) at the University of Pretoria, is otherwise my own work and has not previously been submitted by me for a degree at this, or or any other tertiary institution.

Signed:……

Date:……

Disclaimer

Each chapter of this thesis has been compiled as a separate paper for publication purposes. Chapter 2 has been published in the *Journal of Zoological Systematics and Evolutionary Research* and is formatted for the journal. Chapters 4 and 5 have been formatted for and submitted to *Antarctic Science*. Each chapter contains its own set of references. The general introduction and conclusion are tailored from the rest of the chapters and give an idea of what to expect from the thesis and about the conclusions drawn. Consequently, unavoidable overlaps may occur between chapters.

Thesis summary: All previous taxonomic studies on the Ectemnorhinus group of weevils have been based primarily on morphological data. While these studies are invaluable, some questions can only be addressed adequately through molecular studies. This is especially true when studying the genetic relationships and phylogeograpic patterns of taxa endemic to the South Indian Ocean Province (SIP) biotas that have long been controversial. The Ectemnorhinus group of genera is a monophyletic unit of weevils endemic to the region. The present study focused mainly on the Ectemnorhinus group of weevils found on the Prince Edward Islands archipelago (PEIA). The mitochondrial cytochrome oxidase I gene was targeted when investigating relationships among members of this weevil group. On the PEIA, it is important to note that Marion Island (MI) and Prince Edward Island (PEI) differ in terms of alien invasive species, such as the introduced house mouse *Mus musculus* and in conservation management strategies. Since emergence, a series of volcanic and glaciation events have occurred on Marion Island, whilst Prince Edward Island has remained largely unaffected by glaciation. Phylogenetic analyses revealed the presence of two genetically and morphometrically distinct species of *Ectemnorhinus* weevils on PEI, whilst evidence for a single species, comprising diverse genetically discrete populations was found on MI. Based on these results, the species unique to PEI has been designated *E. kuscheli* n. sp., whilst the present study confirmed the synonymy between *E. similis* and *E. marioni*, the two species originally described from MI. *Ectemnorhinus kucheli* appears to be restricted to PEI, whereas *E. similis* occurs on both MI and PEI. When investigating the population dynamics of the *Ectemnorhinus* weevils on the PEIA, the data indicated that PEI was the first of the two islands of the PEIA to be colonized by *Ectemnorhinus* weevils, at an estimated time of coalescence of approximately 0.3116 million years ago (MYA). The PEI population then acted as the source population for the colonization of MI by *Ectemnorhinus* weevils some time before the last glaciation, approximately 10 000 to 35 000 years ago. The separation by distance of the PEI *Ectemnorhinus* weevils from those on MI then gave rise to two species by allopatric speciation on MI. During the last glaciations, MI was extensively glaciated with only the southwestern corner of the island being free of ice. This extensive glaciation of MI would have resulted in the eradication of all *E. similis* on MI except for those occurring on the ice-free southwestern corner of the island. At the end of the last glacial maximum, when the ice started to melt, the coastal areas of MI emerged first from beneath the ice and were available for re-colonization by weevils. The movement of weevils that were isolated in the south-western corner of MI, along the coastal areas of the island, was assisted by strong, frequent south-western winds. Subsequent, post-glacial volcanism during the

Holocene was then responsible for the fragmentation of the new migrants, resulting in small population pockets surrounded by fresh, uninhabitable lava and subsequent divergence of each populations. When the Holocene black lava became re-colonizeable, the weevils from the different isolated populations migrated to the remainder of the island. Currently, members of the different genetically-identified populations occur in sympatry and in some cases even on the same plant, but no noticeable geneflow was detected between them. It is thus suggested that the time of isolation, before the post-glacial black lava during Holocene became hospitable, was sufficiently long and the populations sufficiently small that a number of genetically-discrete populations arose. Consequently, the present study recognises two genetically discrete populations of *E. kucheli* on PEI and seven discrete *E. similis* populations on MI that are morphologically indistinct. When examining the relationships among 13 species from five different islands within the South Indian Ocean Province (SIP) that are representative of 22 populations within the genera *Palirhoeus*, *Bothrometopus* and *Ectemnorhinus*, there was little support for separating the genus *Palirhoeus* from *Bothrometopus*, and no support for the morphologically-delineated species groups currently recognized within *Bothrometopus*. The present study shows that colonization of the Prince Edward Islands is likely to have occured repeatedly from other islands within the SIP and that *Bothrometopus parvulus* on the PEIA comprises two species that are not sister taxa. The second novel con-generic species was therefore designated *Bothrometopus huntleyi* n. sp. and examination of the genetically identified specimens resulted in the indentification of distinguishing morphological characteristics. The analyses indicated that *B. huntleyi* arose approximately 0.5 million years ago from a high-altitude population that is still present on MI. The first major intra- and inter-island dispersal event occurred ~0.338 MYA, coinciding with the glaciation-free second volcanic stage on MI. Apart from this early inter-island colonisation, only one other between-island dispersal event, corresponding with the glaciation-free seventh volcanic stage, was detected. Genetically discrete weevil complexes on each of the islands of the PEIA together with the low levels of inter-island gene flow reaffirm the need to control alien invasive mice, which are restricted to MI, and which prey on these weevil species.

Key words: Ectemnorhinus group of weevils, mtDNA, COI gene, conservation, biogeography, dispersal, speciation, invasion biology, phylogeography, Prince Edward Island, Marion Island, Coleoptera, Curculionidae, evolution, phylogeny, Southern Ocean islands, sub-Antarctic.

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Another adventure came to an end…..

Let the next adventure begin…..

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