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# A phylogenetic analysis and taxonomic revision of the oribatid mite family Malaconothridae (Acari: Oribatida), with new species of *Tyrphonothrus* and *Malaconothrus* from Australia

MATTHEW J. COLLOFF[1] & STEPHEN L. CAMERON[1,2]

[1]*CSIRO Ecosystem Sciences, GPO Box 1700, Canberra, ACT 2601, Australia. E-mail:Matt.Colloff@csiro.au*
[2]*Present address: Biogeosciences Discipline, Faculty of Science & Technology, Queensland University of Technology, Brisbane, Queensland 4000, Australia. E-mail: sl.cameron@qut.edu.au*

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## Abstract

Hitherto, the Malaconothridae contained *Malaconothrus* Berlese, 1904 and *Trimalaconothrus* Berlese, 1916, defined by the possession of one pre-tarsal claw (monodactyly) or by three claws (tridactyly) respectively. However, monodactyly is a convergent apomorphy within the Oribatida and an unreliable character for a classification. Therefore we undertook a phylogenetic analysis of 102 species as the basis for a taxonomic review of the Malaconothridae. We identified two major clades, equivalent to the genera *Tyrphonothrus* Knülle, 1957 and *Malaconothrus*. These genera are redefined. *Trimalaconothrus* becomes the junior subjective synonym of *Malaconothrus*. Some 42 species of *Trimalaconothrus* are recombined to *Malaconothrus* and 15 species to *Tyrphonothrus*. Homonyms created by the recombinations are rectified. The replacement name *M. hammerae* **nom. nov**. is proposed for *M. angulatus* Hammer, 1958, the junior homonym of *M. angulatus* (Willmann, 1931) and the replacement name *M. luxtoni* **nom. nov**. is proposed for *M. scutatus* Luxton, 1987, the junior homonym of *M. scutatus* Mihelčič, 1959. *Trimalaconothrus iteratus* Subías, 2004 is an unnecessary replacement name and is a junior objective synonym of *Malaconothrus longirostrum* (Hammer 1966). *Malaconothrus praeoccupatus* Subías, 2004 is a junior objective synonym of *M. machadoi* Balogh & Mahunka, 1969. *Malaconothrus obsessus* (Subías, 2004), an unnecessary replacement name for *Trimalaconothrus albulus* Hammer 1966 *sensu* Tseng 1982, becomes an available name for what is in fact a previously-undescribed species of *Malaconothrus*. We describe four new species of

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*Tyrphonothrus*: *T. gnammaensis* **sp. nov.** from Western Australia, *T. gringai* **sp. nov.** and *T. maritimus* **sp. nov.** from New South Wales, and *T. taylori* **sp. nov.** from Queensland. We describe six new species of *Malaconothrus*: *M. beecroftensis* **sp. nov**., *M. darwini* **sp. nov.** *M. gundungurra* **sp. nov**. and *M. knuellei* **sp. nov.** from New South Wales, *M. jowettae* **sp. nov.** from Norfolk Island, and *M. talaitae* **sp. nov.** from Victoria.

**Key words:** Phylogeny, evolution, cladistics, taxonomy, morphology, oribatid mite, parthenogenesis, Australia, Norfolk Island

## Introduction

The Malaconothridae is a family of small to medium-sized oribatid mites (length range 200–720 μm) containing two speciose genera, *Malaconothrus* Berlese, 1904 (including the subgenus *Cristonothrus* Subías, 2004) and *Trimalaconothrus* Berlese, 1916 (including the subgenus *Tyrphonothrus* Knülle, 1957). *Fossonothrus* was erected by Hammer (1962) but Subías, (2004) made it a junior synonym of *Tyrphonothrus*, and *Zeanothrus* Hammer 1966 is a junior synonym of *Trimalaconothrus* (*Trimalaconothrus*). The phylogenetic significance of the Malaconothridae is that the diverse and important group of mites, the Astigmata, are considered to be either the sister group, or derivative members, of the Malaconothroidea (Norton, 1998, 2007).

Subías (2004, 2012) listed 83 species in *Trimalaconothrus* (29 in *Tyrphonothrus*) and 64 species in *Malaconothrus* (35 in *Cristonothrus*).The genera and subgenera have cosmopolitan distributions. Many species inhabit aquatic macrohabitats including wet meadows, marshes, peat bogs, springs, streams and pools. Microhabitats include saturated *Sphagnum* and other cryptogams especially near waterfalls, stream banks and overhangs where freshwater runs off. Malaconothridae are also associated with forest leaf litter and soil, lichens and mosses on tree trunks, and above-ground vegetation including forest canopy.

The Malaconothridae was proposed by Berlese (1916) for *Malaconothrus*. Sellnick (1928) and Willmann (1931) included *Malaconothrus* and *Trimalaconothrus* in the family, and the basic family concept and generic definitions have not changed significantly since that time. The primary character still used to differentiate *Malaconothrus* from *Trimalaconothrus* is dactyly: the former are monodactylous, the latter tridactylous. In a revision of the Malaconothridae, Knülle (1957) attempted to improve the definition and differentiation of *Malaconothrus* and *Trimalaconothrus* by using a broader range of characters than just dactyly. These included the shape of the tarsi, the number of cheliceral setae, the shapes of the palp tarsal solenidion and seta *ft*" on tarsi I–III and the positions of solenidia of tarsus I. Knülle (1957) proposed the subspecies *Tyrphonothrus* for those species of *Trimalaconothrus* with elongated tarsi, 7–12 pairs of genital setae and a particular overlapping configuration of the adanal and genital plates. Weigmann (1997) considered that tridactyly was plesiomorphic in adults of the Malaconothroidea and could be used to separate *Trimalaconothrus* from *Malaconothrus*, but the other characters used by Knülle (1957) were “not necessarily sufficiently common characters in all species of the two genera.” But if dactyly is the only character that separates the two genera, is this is an adequate basis for their validity? The problem is that monodactyly is a convergent apomorphy with a mosaic-type expression within the Oribatida. For example, the crotonioid genus *Camisia* contains both monodactylous and tridactylous species (Colloff, 1993; Olszanowski, 1996). Monodactyly is relatively uninformative and cannot be used reliably as a defining character in the generic classification of Malaconothridae because it represents an oversimplification of evolutionary relationships.

Subías (2004) proposed the subspecies *Cristonothrus* for those species of *Malaconothrus* with ridges on the notogaster. On its own, this character is insufficient justification for the subgenus because notogastral ridges appear have been secondarily lost in certain species and may have evolved more than once within the Malaconothridae. Notogastral ridges are present in many species of *Tyrphonothrus*, for example. This means that any classification based on monodactyly as a generic character renders the presence of notogastral ridges homoplasous, and *vice versa* (Figs. 1a, 1b). Despite these problems, selected groups of species within *Trimalaconothrus* and *Malaconothrus* do appear to possess combinations of shared character states, especially the morphology of the prodorsal carinae, the particular shape of the notogaster, consistent patterns in the relative lengths of the notogastral setae, the presence or absence of notogastral ridges and their configuration, as well as the arrangement of the genital setae and the shape of tarsus I. A single shared character state, or even two, might reasonably be considered an example of homoplasy, but the presence of a series of shared, linked character states suggests more complex