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## Two new genera and five new species of Teloganodidae (Ephemeroptera) from South India

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### Abstract

Two new genera and five new species of teloganodid mayflies (Ephemeroptera: Pannota: Ephemerelloidea) are described based on larvae from south India: *Janohyphella indica*, **n. gen., n. sp.**, *Indoganodes jobini*, **n. gen., n. sp.**, *Teloganodes sartorii*, **n. sp.**, *Dudgeodes palnius*, **n. sp.**, and *Derlethina tamiraparaniae*, **n. sp.** *Janohyphella*, **n. gen.**, is distinguished from the larvae of other teloganodid genera by having a combination of three subequal caudal filaments, lamellate gills on abdominal segments II through V and posterolateral processes well-developed on abdominal segments II through IX, except III. *Indoganodes*, **n. gen.**, is distinguished from the larvae of other teloganodid genera by having three subequal caudal filaments, lamellate gills on abdominal segments II through VI, posterolateral projections weakly developed on abdominal segments I through V, but distinct on segments VI through IX. Our new species of *Dudgeodes* Sartori, 2008 and *Derlethina* Sartori, 2008 represent the first discoveries of these genera outside Southeast Asia, with the latter genus previously considered endemic to Borneo. Emendations to the larval species key of known Oriental Teloganodidae are provided. We hypothesize that the occurrence of the new taxa in southern India is a result of the tectonic events associated with the split-up of Gondwana. This illustrates the profound biogeographical significance of how vicariance led to the establishment of some distinct oriental lineages initially on the rafting Indian Deccan Plate, which might have triggered dispersal events for subsequent species diversification in Southeast Asia.

**Key words:** pannota mayfly, biogeography, identification keys

### Introduction

Teloganodidae (Ephemeroptera: Furcatergalia: Pannota: Ephemerelloidea) is an ancient group of mayflies of Gondwanan origin that currently are known from throughout the Oriental region and from the southern tip of Africa (McCafferty & Wang 2000, Jacobus & McCafferty 2006). Allen (1965) established the subfamily Teloganodinae within the Ephemerellidae. Teloganodinae was raised to family status by McCafferty & Wang (1997), and the composition of the family was refined by McCafferty & Wang (2000). Significant phylogenetic and biogeographic studies of teloganodid, and ephemerelloid mayflies in general, that have contributed to our current understanding of teloganodid systematics include works by McCafferty & Wang (1997; 2000), McCafferty & Benstead (2002), Jacobus & McCafferty (2006); these works have incorporated various cladistic analyses of both Afrotropical and Oriental Teloganodidae. The recent landmark monograph on Oriental Teloganodidae by Sartori *et al.* (2008) distinguishes the Oriental lineages of Teloganodidae known at the time from the Afrotropical lineages and contributes to understanding patterns of distribution of the Oriental genera and species. The family currently includes the Afrotropical genera *Ephemerellina* Lestage, 1924, *Lestagella* Demoulin, 1970, *Lithoglea* Barnard, 1932, *Manohyphella* Allen, 1973 and *Nadinetella* McCafferty & Wang, 1998 (reviewed by Pereira-da-Conceicao

*Dudgeodes* and *Derlethina*, might have a postsplit eastern gondwanan origin in the Indian subcontinent and subsequently they might have radiated into Southeast Asia via dispersal events.

In the present context, it appears that the *Manohyphella* lineage in Madagascar and the *Janohyphella*, **n. gen.**, lineage and *Indoganodes*, **n. gen.**, lineage in peninsular India were already present prior to continental breakup. We hypothesize that *Manohyphella* became isolated in Madagascar and *Janohyphella*, **n. gen.**, and *Indoganodes*, **n. gen.**, became isolated in south India, as a result of the spatial isolation of Madagascar and India during the breakup events of eastern Gondwana. However, the origin of the Indian/Oriental lineage may have been mediated by vicariance at the time of continental breakup (McCafferty & Benstead, 2002). Rafting peninsular India might have carried Gondwanan lineages to Asia after the break-up of the Gondwana supercontinent, as per the “Out-of-India” hypothesis (Datta-Roy & Karanth, 2009).

Sartori *et al.* (2008) hypothesized that the separation of Madagascar from the Deccan plate, and its subsequent drift towards Asia, led to the *Manohyphella* lineage in Madagascar and the *Teloganodes* lineage in Asia. They also considered that the *Teloganodes* lineage evolved in two directions: a first lineage that remained around its center of origin (genus *Teloganodes*), and a second one which dispersed throughout tropical Southeast Asia, evolving into the genus *Dudgeodes*. Now that a new species of Indian *Dudgeodes*, viz. *D. palnius*, **n. sp.**, is described from the Palni hills of the Western Ghats, it is perhaps more likely that the derived genus *Dudgeodes* may have evolved in the Deccan plate of the peninsular India and further diversified into south China, throughout southeast Asia up to Sulawesi at a later date. In light of a new species of *Derlethina*, viz. *D. tamiraparaniae*, **n. sp.**, being described from the southern Western Ghats of India, and the description of two new genera reminiscent of Afrotropical genera, we hypothesize that the Deccan plate of peninsular India is an amphitheatre for the origin and evolution of several lineages and genera of Teloganodidae. We also consider it possible that *Derlethina* may occur in other montane regions of Southeast Asia and simply remains undiscovered.

Interestingly, this pattern of biogeographic history is shared by the Asian endemic dobsonfly genus *Nevromus* Rambur, 1842 in the sense that the Tertiary orogenic events after the collision between the Indian subcontinent and Eurasia probably affected speciation within the mainland clade, whereas the island formation of the Malay Archipelago shaped the fauna within the insular clade. However, a future molecular systematic study may be helpful in more accurate estimations of divergence times and in refuting or corroborating these phylogenetic and biogeographical inferences (Liu *et al.* 2012).

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