



## On the evolution of the species complex *Pachycondyla chinensis* (Hymenoptera: Formicidae: Ponerinae), including the origin of its invasive form and description of a new species

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### Abstract

Ants are one of the most successful and widespread organisms in the world. Although ants of the genus *Pachycondyla* (Hymenoptera: Formicidae: Ponerinae) are predominantly tropical in distribution, *Pachycondyla chinensis* (Emery) is especially abundant in temperate zones in Asia. Recently, *P. chinensis* has also become an abundant invasive ant species in the United States. However, it was well-known that the *Pachycondyla chinensis* species complex remained unresolved. Our molecular and morphological results allow us to distinguish two species in the species complex: the species *P. chinensis* and the new cryptic species *P. nakasujii* **sp. nov.**, and these two species are widely and sympatrically distributed and abundant in temperate forests in Japan. Moreover, phylogenetic analysis showed that *P. chinensis* has been introduced into the United States from Japan. In conclusion, our finding of the new species *P. nakasujii* suggests that much remains undiscovered even in biologically fascinating and well-studied organisms.

**Key words:** *Pachycondyla nakasujii*, cryptic species, invasive ant, phylogeography

### Introduction

The ants arose more than a hundred million years ago and eventually spread around the world (Brady *et al.* 2006; Moreau *et al.* 2006; Moreau 2009), and subsequently diversified, with differences among biogeographic regions in their species, genera and even subfamilies (Hölldobler & Wilson 1990; Bolton *et al.* 2006). Recently, humans have begun to, however unintentionally, transport ants outside of their native range, with more than a hundred and perhaps hundreds of such introduced species now established and a smaller subset invasive (McGlynn 1999). Such invasive ants often pose problems for the well-being of natural communities and ecosystems, agricultural production, and public health (Kemp *et al.* 2000; Holway *et al.* 2002; Klotz *et al.* 2005; Strayer *et al.* 2006).

Mirroring the pattern for ants more generally, the genus *Pachycondyla* (Hymenoptera: Formicidae: Ponerinae) evolved no later than 75 million years ago, when the continents had separated (Bolton *et al.* 2006; Brady *et al.* 2006; Moreau *et al.* 2006). Species of the genus then apparently dispersed from one continent to another before further diverging into the 209 extant species now recognized (Bolton *et al.* 2006; Mackay & Mackay 2006; Yamane 2007). Ants of the genus *Pachycondyla*, like many ponerine ants, are now predominantly tropical in distribution, with few exceptions (Bolton *et al.* 2006). As a consequence, the origin of *Pachycondyla* species with temperate distributions is particularly interesting. *Pachycondyla chinensis* (Emery) (formerly *Brachyponera chinensis*), widely distributed from Far Eastern Asia to Southeast Asia, is