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Taxonomic value of morphological and morphometrical characters in the immature stages of four species of *Kampimodromus* Nesbitt (Acari: Phytoseiidae) from Italy and Croatia

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Abstract

The immature stages of four species of *Kampimodromus* Nesbitt (Acari: Phytoseiidae) from Italy and Croatia have been studied and identified both at stage and species level. Larval stages of *Kampimodromus corylosus* Kolodochka and all immature stages of *Kampimodromus ericinus* Ragusa di Chiara & Tsolakis and *Kampimodromus langei* Wainstein & Arutunjan are described for the first time. The relative length of the posterior dorsal setae *Z4* make the larvae of *Kampimodromus aberrans* (Oudemans) easy to separate from those of the other three species. Nymphs of each species had similar diagnostics to the adults of the respective species. Ontogeny of the idiosomal and leg setation of the *Kampimodromus* immatures studied in comparison to the available data from immatures of other phytoseiid species is discussed. The length of seta *Z4* in the *K. aberrans* larva, and the number of setae on leg IV of the deutonymphs of the four *Kampimodromus* species, are proposed as additional taxonomic traits for Phytoseiidae.

Key words: *Kampimodromus*, ontogeny, instars, Europe, Mediterranean area

Introduction

The taxonomy, biology and ecology of mites of the family Phytoseiidae (Acari) have been extensively studied, especially of the species important as biological control agents of phytophagous mites and thrips. In this context the identification of phytoseiids to species level is of primary importance. Since the first review of this family (Nesbitt, 1951), in which fewer than 30 species were reported, today more than 2100 species have been described (Chant & McMurtry, 2007; Tixier *et al.*, 2012; Demite *et al.*, 2014). Traditionally, species identification is based on morphological features of the adult females; less information is available on the immature stages and adult males. Few morphological studies of immatures have been published, and the larvae of only about 65 species have been described (Chant & McMurtry, 2007). Chant (1958) first provided overall descriptions of immature stages of 18 species of this family from England. In that study the author proposed a key to species based on taxonomic characters of immature and adult stages. Other authors described the immatures mainly of a single or few species.

Over the last 60 years taxonomic value of several characters of adult females, as dorsal chaetotaxy, cheliceral dentition, shape and setation of ventrianal shield as well as shape of spermatheca and occurrence of solenostomes on dorsal shields, have been evaluated in order to establish an acceptable Phytoseiidae classification, but the systematics of this family still remains problematic (Tsolakis *et al.*, 2012). Evans (1953) first stated that investigations of the developmental stages of the Mesostigmata may result in a more natural classification of this group. For Phytoseiidae, Evans (1963) and Rowell *et al.* (1978) first established at family and genus level the leg and idiosomal chaetotaxy, respectively, of all developmental stages. Several other studies have considered the structures of phytoseiid mites through ontogeny, to characterise them and to separate this family from other similar Mesostigmata, as well as to provide information for setal nomenclature and determine setal homologies (Chant, 1958, 1965, 1993a; Evans, 1957; Karg, 1965; Lindquist & Evans, 1965; Arutunjan, 1972; Rowell *et al.*, 1978; Evans & Till, 1979; Rowell & Chant, 1979; Yoshida-Shaul & Chant, 1983; Christian & Karg, 2008).

each immature stage, the diagnostics support the separation among the four *Kampimodromus* species, and (ii) at nymphal stages, these diagnostics are the same as those already used to identify the respective species from adult females (i.e. the number of dorsal solenostomes, cheliceral dentition and relative lengths of some dorsal setae) (Kolodochka, 2003; Tixier *et al.*, 2008; Cargnus *et al.*, 2012). Therefore, the identification of immature stages of other *Kampimodromus* species could be helpful to investigate on the taxonomic position of morphological entities for which the reliability of diagnostic characters of adult females has been questioned (Tixier *et al.*, 2006).

Moreover, in the present study we found that the length of the posterior dorsal pair of setae Z4 of *K. aberrans* larvae and the number of setae on the leg IV of the *Kampimodromus* deutonymphs could be considered of additional taxonomic value for the systematics of Phytoseiidae. In fact, at larval stage, *K. aberrans* currently seem to be the phytoseiid species with the shortest Z4 not only within the genus but also in the family. On the basis of this character the species could be placed at a different taxonomic level within the genus *Kampimodromus*. For the *Kampimodromus* deutonymphs, eight and seven setae on the genu IV and tibia IV, respectively, appear to be diagnostic at the genus level. The taxonomic relevance of these traits could be confirmed or refuted by further investigations on immature stages of other *Kampimodromus* species.

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