



<http://dx.doi.org/10.11646/zootaxa.3794.1.2>

<http://zoobank.org/urn:lsid:zoobank.org:pub:AE0A99F2-1D71-46CB-89E2-08ED4C010E17>

## Differentiation among cave populations of the *Eukoenenia spelaea* species-complex (Arachnida: Palpigradi) in the southwestern Alps

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### Table of contents

Abstract .....	52
Introduction .....	53
Material and methods .....	53
Adult morphology: similarities and differences between the populations .....	61
Adult morphology: morphometric analysis .....	71
Immature morphology .....	72
Hypothesis of phyletic coherence and species assignment .....	74
Systematics .....	75
Descriptions of new taxa .....	75
<i>Eukoenenia roscia</i> Christian, species nova .....	75
<i>Eukoenenia lanai</i> Christian, species nova .....	79
Discussion .....	82
Acknowledgements .....	84
References .....	84

### Abstract

Current knowledge of the taxonomy and distribution of European cave palpigrades largely rests upon incidental records. Samples seldom comprise more than one or two specimens, and many regions have only been unevenly explored, if at all. The present study is the first to investigate morphological variability within, and differentiation between, subterranean palpigrade populations in a small, geographically coherent area. It is based on relatively abundant material from six localities in the SW Alps (Piedmont, Italy) and two non-Italian comparative localities. Discrete and continuous characters reveal, on the one hand, a close grouping within the *Eukoenenia spelaea* species-complex, and, on the other hand, a remarkable short-range endemism. The occurrence of five distinct morphologies in a SW Alpine area of just 2000 square kilometres or so indicates that subterranean biodiversity parallels the rich above-ground biodiversity there. The Cottian Alps in the North harbour *E. roscia* Christian **sp. n.**, *E. lanai* Christian **sp. n.** and the widespread *E. spelaea*. Two caves in the Maritime and Ligurian Alps are populated by *E. bonadonai*, which was originally described from the Provence Alps, while the Bossea cave in the Ligurian Alps remains the only known locality for *E. strinatii*. We evaluate the traditionally employed morphological characters and those recently proposed for use in *Eukoenenia* systematics. Further, we provide data on the formerly undescribed females of *E. strinatii* and *E. bonadonai*, and provide comprehensive pictorial information on the SW Alpine cave palpigrades to set new benchmarks for the taxonomy of the *E. spelaea* species-complex.

**Key words:** Palpigrade, taxonomy, morphology, morphometry, Principal Component Analysis, new species, subterranean, troglobiotic, Piedmont, Italy

More puzzling are the rank and position of the palpigrades from Fornaci and Monfieis. These two populations differ from *E. spelaea* in greater mean body size and in the occurrence of individuals with more than 3 setae *a* on at least one of the sternites IV–VI; from *E. strinatii* in the number of blades in the lateral organ; and from *E. bonadonai* in the much less pronounced sexual dimorphism in the number of setae *a*. The Fornaci and Monfieis populations differ from each other in the number of blades in the lateral organ, in the length ratio *fs/rs* (Monfieis individuals have a very short forked seta compared to the rod seta), in the dome-shaped bases of the fusules on the first genital lobe of the males from Monfieis, and in an ensemble of continuous variables that leads to a clear separation in the PCA plot.

The Fornaci and Monfieis populations are discriminable entities that merit, in our opinion, formal taxonomic names, in order to provide ‘landmarks’ in the difficult terrain of the *E. spelaea* complex. However, should these populations be most appropriately regarded as species or subspecies? We are aware that any decision is likely to meet with criticism. Describing subspecies implies evolutionary hypotheses that we are unable to defend: we simply have no clue about which existing species taxon or taxa might include the Fornaci and Monfieis populations. Describing them as new species, on the other hand, implies (complete) speciation, which we cannot demonstrate beyond doubt. Our decision to introduce the new species *E. roscia* for the Fornaci population and *E. lanai* for that from Monfieis, was chiefly made to avoid conjectures about their sister taxa.

In any event, we are confronted with a multitude of short-range endemic taxa (Harvey 2002), a fact that has a significant bearing on conservation policies and possibly also on our understanding of evolutionary processes in the subterranean realm. However, the roles of vicariance and dispersal (Culver & Pipan 2009) are difficult to assess in our case, because the signals are partly inconsistent. The distribution of *E. bonadonai* suggests some power of dispersal. Hardly any morphological difference exists between the populations from Italy and the type specimen from France, although the Caudano and Clue caves are 110 km apart. In contrast, the clearly differing *Eukoenenia* populations of Partigiano and Fornaci (10 km apart) indicate low dispersal rates of palpigrades, particularly since the faunas of the two localities are similar overall. The troglolithic carabid beetle *Doderotrechus casalei*, for example, occurs in both caves (Lana 2013). Bossea and Caudano (7 km apart) harbour different *Eukoenenia* species, in the same way that they have different, short-range endemic spiders of the genus *Troglohyphantes*: *T. pedemontanus* occurs in Bossea and *T. pluto* in Caudano (Isaia *et al.* 2011). On the other hand, the rhagidiid mite *Troglocheles lanai* has been reported from these two and a few other caves, including Litrôn, at a distance of 45 km from Bossea. This extremely troglomorphic mite is likewise a poor disperser, such that Zacharda *et al.* (2011) envisaged cryptic speciation. It is possible that SW Alpine members of the *E. spelaea* complex have speciated (or are continuing to speciate) in a similar, albeit less cryptic, way.

## Acknowledgements

Many thanks to those who provided palpigrade specimens or photographs, or helped with collecting in the caves: Alberto Chiarle, Davide Giuliano, Enrico Lana, Stefano Mammola, Mariagrazia Morando, Elena Piano and Giovanni Soldato. Special thanks go to Lubomír Kováč and Christian Komposch, who provided the comparative material. Also, thanks are due to John Plant for linguistically checking the original manuscript.

Fieldwork of MI and collaborators was supported by CAVELAB “From microclimate to climate change: caves as laboratories for the study of the effects of temperature on ecosystems and biodiversity”, an interdisciplinary research project funded by the Compagnia di San Paolo and the University of Turin (2012–2015).

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