



## Toward a unified taxonomy of *Niphargus* (Crustacea: Amphipoda): a review of morphological variability

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### Abstract

*Niphargus* is the largest genus of freshwater amphipods, burdened with problematic and largely incomplete taxonomy. This paper is an overview of the morphological characters relevant for niphargid taxonomy, and is conceived as an early step toward a unified taxonomy in the emerging era of cyber-taxonomy. The core element is a taxonomic on-line revision system based on a continuously updated, peer-reviewed and freely accessible morpho-databases (see for example <http://niphargus.info/>) that would provide a source of data necessary for comparisons of taxa, generation of species descriptions, and testing phylogenetic hypotheses. In *Niphargus*, the coding of morphological variability is not straightforward. Several characters are continuous, polymorphic, or subject to allometric growth. We here present a detailed overview of published and new characters together with their variability levels, and describe how the characters are measured and quantified.

**Key words:** subterranean crustaceans; cyber-taxonomy; morpho-databases

### Introduction

With over 300 described species and subspecies, the genus *Niphargus* Schiödte (Amphipoda: Niphargidae) is the largest genus of freshwater amphipods (Väinöla *et al.* 2008). It is distributed across most of Europe, mainly—but not exclusively—south of the Pleistocene ice sheet boundary (Ruffo 1953a; Karaman & Ruffo 1986; Proudlove *et al.* 2003). Few species are known from the Arabian Peninsula, Turkey and Iran (Karaman 1986a, 1998; Bat *et al.* 2001). Over most of the Pyrenean Peninsula only its presumed close relative *Haploglymus* Mateus & Mateus can be found (Karaman & Ruffo 1986).

Most of the species inhabit groundwater, and the genus is among the most important elements of subterranean aquatic fauna in Europe (Sket 1999). They inhabit virtually all types of subterranean waters like the interstitial, subterranean streams, fissure systems (including epikarst), wells and springs, brackish, mineral and thermal waters. In addition, about ten species live in surface waters such as forest ditches, *Sphagnum* moss, or small streams (Sket 1999; Fišer *et al.* 2006a). Local species diversity can be high—up to eight species in a single cave, e.g. Vjetrenica, Bosnia Herzegovina, or up to six interstitial species in a single well, e.g. at Ljubljana, Slovenia (Sket 1972, 2003; Sket *et al.* 2006). Most species are presumed to be endemic, many of them known from their type localities only. Large-ranged nominal species often constitute complexes of cryptic species (Trontelj *et al.* 2009).

In line with its diverse ecology, *Niphargus* shows an extremely diverse morphology (Karaman & Ruffo 1986; Sket 1999) caused by numerous highly variable body parts assembled in mosaic-like combinations. Nevertheless, differences between species can be small, and they were often overlooked or have remained taxonomically unevaluated. Characters that are hypothesized to be adaptive to subterranean environments