



Molecular phylogeny of *Chondrocyclus* (Gastropoda: Cyclophoridae), a widespread genus of sedentary, restricted-range snails

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ABSTRACT

The genus *Chondrocyclus* Acoy, 1998 contains the majority of southern African members of the Cyclophoridae, a large family of operculate land snails. We present the first molecular phylogeny of the genus based on two mitochondrial genes (16S and CO1) and complement this with an appraisal of morphological characters relating to the shell and soft parts. Where shells on which descriptions and records of different species were based appear to be indistinguishable morphologically, testing taxonomic confusion. We show that *Chondrocyclus* cl. underwent two major radiations, one African (new) and the other largely coastal. Accordingly, we recommend a revision recognising two genera, *Chondrocyclus* s.s. contains four monophyletic lineages, each characterized by a combination of morphological features. The *Mimosa* group is shown to be a species complex; relationships within this complex could not be resolved due to insufficient DNA sequence data. The molecular data confirms the monophyly of *serena* and the recognized species and provides evidence for at least twelve undescribed species; the morphological data is broadly consistent with this finding. The morphological data suggest that the two species from countries to the north of South Africa should be removed from the genus, and that *Chondrocyclus* *serena* is endemic to South Africa. The historical biogeography of this group of microhabitat specialists with its dispersal abilities contributes an additional, phylogenetically independent datum to our understanding of the processes promoting biodiversity in southern Africa, a natural laboratory for palaeobiogeography. *serena* are narrow-range endemics, underlining the importance of conserving South Africa's threatened biotic habitats.

1. Introduction

The majority of southern African species of the gastropod family Cyclophoridae, a major old world terrestrial land snail group, are placed in the genus *Chondrocyclus* Acoy, 1998. Cyclophoridae is the most species-rich family of operculate terrestrial molluscs, containing approximately 34 genera and 800 species (Nantare et al., 2014a) and is also extremely morphologically diverse. The Afrotropical region, although not comparable in species and genus-level diversity to the Asian tropics, is taxonomically diverse and includes a few species-rich groups in Madagascar (Fenton, 2002a, 2005, 2009; Esherton and Ponder, 1999; Esherton et al., 2010). In mainland African cyclophorids are widely distributed, and currently 20 species are recognized in three genera: *Chondrocyclus* (7 species in South Africa, one species in Zimbabwe and one in Malawi), *Cyrtopoma* W. & B. Blanford, 1861 (9 species across East, Central and West Africa) and *Rhynchocyclus*

Verdcourt, 1982 (one species in East and Central Africa and one undescribed species in South Africa).

The genus *Chondrocyclus* was erected by Acoy (1998) for species "from the Cape of Good Hope, remarkable by the nature of its epidermis, its depressed shape, its thin peristome and its small size". At its last review (Connolly, 1958) the genus contained seven species, all endemic to South Africa. Subsequently, two new cyclophorids from Malawi and Zimbabwe respectively were assigned to *Chondrocyclus* (Örgüven, 1986, 1987). Three Malagasy cyclophorids were also classified in *Chondrocyclus* (Pisier-Potte et al., 1997), but these have since been reassigned to three other genera (Esherton, 2004, 2002b). Afrotropical cyclophorid genera are in need of taxonomic revision (de Winter, 2002; Esherton, 2009, 2003).

At the genus level, *Chondrocyclus* shells are readily distinguished by their small size (diameters of 3–7 mm), lenticular to discoidal shape, circular and detached peristome, large umbilicus and in fresh

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