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PARENTAL CARE IN *CRYPTOPS HORTENSIS* (DONOVAN) (CHILOPODA: SCOLOPENDROMORPHA) FROM SERBIA, THE BALKAN PENINSULA

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Abstract. — Parental care in the geographically widespread cryptopid scolopendromorph *Cryptops hortensis* (Donovan) is described for the first time. It was observed that the adult female rolls her body around the mass of hatchlings with the ventral side against the brood. This finding supports the hypothesis that within the brooding centipedes, the female position with the terga outwards is a plesiomorphic state and probably a general feature of all Scolopendromorpha. In addition, the major external morphological characters of the fetus instar and adolescens I are described.

Key words: Centipedes, Phylactometria, brooding behavior, post-embryonic development, foetus, adolescens I., Serbia

INTRODUCTION

Parental care, defined as any form of parental behavior that appears likely to increase the fitness of a parent's offspring, is an important life-history trait in many Chelicerata, Myriapoda, Crustacea, and Hexapoda, in addition to marine invertebrates, leeches, fish, amphibians, reptiles, birds, and mammals (see Tallamy, 1984; Tallamy and Wood, 1986; Clutton-Brock, 1991; Ugolini and Vannini, 1992; Trumbo, 1996; Thiel et al., 1997; Kutschera and Wirtz, 2001; Cockburn, 2006; Alcock, 2009). In its broadest sense, parental care includes the preparation of nests and burrows, the production of large, heavily yolked eggs, the care of eggs or young inside or outside the parent's body, the provisioning of the young before and after birth, and the care of offspring after nutritional independence. In its narrowest sense, it refers only to the care of eggs or young when they are detached from the parent's body (Clutton-Brock, 1991).

The reproductive biology of centipedes has received increasing interest over recent years because brooding behavior provides a useful character for their phylogeny and taxonomy (Bonato and Minelli, 2002; Edgecombe et al., 2010; Mitić et al., 2010; see also Dohle, 1985; Edgecombe and Giribet, 2007; Minelli, 2009; Edgecombe, 2011). There are currently some 3150 valid chilopod species, ascribed to the more than 400 genera and 24 families (Bonato et al., 2011). About 38% of all species (hemianamorphic orders Scutigeromorpha and Lithobiomorpha) exhibit no parental care. Instead, females lay their eggs individually, over a long time span, and do not take care of them after they have covered them with fine soil particles (Minelli, 2011). Conversely, the monogeneric order Craterostigmomorpha, in which the anamorphic phase of the post-embryonic development is reduced to a single stadium, and the Epimorpha (comprising Scolopendromorpha and Geophilomorpha), lay all their eggs in a single batch and the female remains coiled around her offspring until hatching or even longer. The main functions of this are probably the deterrence of egg predators, removal of fungi and maintenance of eggs in humid conditions. These three orders comprise a mono-

phyletic taxon Phylactometria, the name referring to maternal care as a shared apomorphic character of the group (Edgecombe and Giribet, 2004).

Within the brooding clade, two alternative postures are observed. In *Craterostigmus* Pocock, scolopendromorphs and the mecistocephalid geophilomorph *Dicellophilus carniolensis* (C. L. Koch), the mother rolls her body around the mass of eggs or hatchlings, presenting the ventral side to them (Manton, 1965; Bonato and Minelli, 2002). The opposite position is observed in another mecistocephalid species, *Mecistocephalus togensis* (Cook), and several geophilomorph families (Bonato and Minelli, 2002; Arthur and Chipman, 2005; Edgecombe et al., 2010; Mitić et al., 2010). Here, the ventral surface of the brooding female is exposed to the outside, and this behavior is most likely associated with the presence of ventral pores – the openings of the sternal glands which have a defensive function (Schildknecht et al., 1968; Jones et al., 1976; Hopkin et al, 1990; Hopkin and Anger, 1992).

In all scolopendromorphs and geophilomorphs of the temperate regions for which adequate data are available (Verhoeff, 1902-25; Palmén and Rantala, 1954; Weil, 1958; Lewis, 1961, 1962; Bonato and Minelli, 2002; Mitić et al., 2010), brooding takes place during the summer. In the present paper, we report the first record of parental care in *Cryptops hortensis* (Donovan), a member of the scolopendromorph family Cryptopidae. This species is distributed in Madeira, Europe and Central Asia, and also widely introduced (Lewis, 2011). In Serbia, it is known only from a few localities (unpublished data). In addition, we give a brief description of two post-embryonic stadia of the analyzed species.

MATERIALS AND METHODS

Broods of *C. hortensis* were observed and photographed in a mixed beech forest on Mt. Medvednik, near Valjevo, western Serbia, by D. Ž. Antić and Jelena Nikolić, during 4-6 August 2011. The numbers of females noted for guarding their offspring and hatchlings were seven and 86, respectively. The young animals were analyzed and assigned to an age group using the criteria described by Verhoeff (1902-25), Lewis (1981), and Vedel and Arthur (2009). Voucher specimens of *C. hortensis* are at the Institute of Zoology, Faculty of Biology, University of Belgrade.

RESULTS AND DISCUSSION

Seven mature females of *C. hortensis* with a mass of hatchlings were found in brood cavities hollowed out of decayed logs and soil. The position of mothers of *C. hortensis* with respect to their clutch has not previously been described, despite the description of the early post-embryonic development of this species (Verhoeff, 1902-25). Brooding females were observed with the ventral side against the offspring and the terga outward, and no case has been recorded with the female resting in an opposite position. When found, the females remained in the same posture for a few minutes, but continued disturbance caused the mothers to abandon their young. Brood sizes varied from seven to 19 individuals (mean, 12.3).

The adult females that guarded the mass of first instar hatchlings (n = 5) were curled in a simple loop (Fig. 1a), enclosing the offspring between the legs and holding them off the ground, as is usual in other Scolopendromorpha and Craterostigmomorpha. There is very little information on the post-embryonic development in scolopendromorphs. According to Lewis (1981), and also Minelli and Sombke (2011), they hatch in conditions comparable to those of a geophilomorph peripatoid. Three adolescens stadia have been recorded in this taxon, too. The specimen figured (Fig. 1b) resembles the fetus stadium of Geophilomorpha (Vedel and Arthur, 2009; Mitić et al., 2010). The body is in a circle and measures around 5 mm in length with no visible movement. The tergites, pleurites and coxal sclerites are distinct. The antennae are elongated and orientated backwards; they have the adult number of articles (17). The mouthparts, forcipules and 21 pairs of walking legs are clearly visible with structures starting to be differentiated. Pigmentation has not developed and it is whitish-cream.

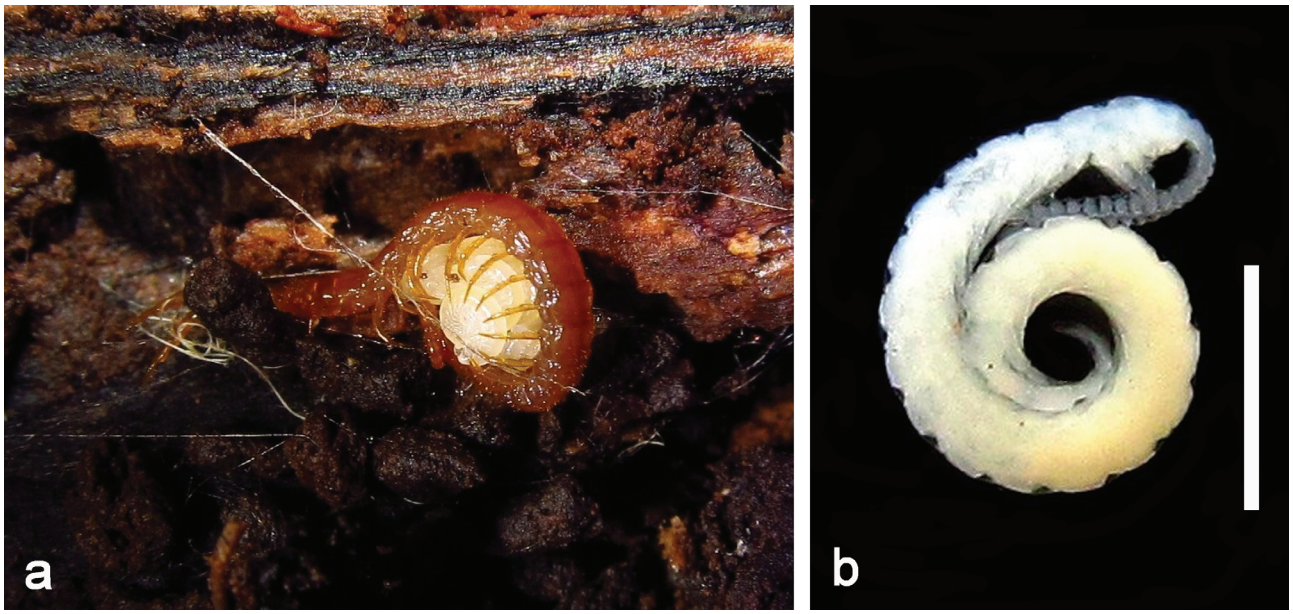

Fig. 1. Brooding in *C. hortensis* — a female coiling around the offspring with sternum inward (a), the fetus stadium (b) (scale = 1 mm).

Mothers that guarded juveniles (n = 2) were coiled around the offspring in such way that the body was S-curved (Fig. 2), as is usual in all geophilomorphs, including the mecistocephalids *D. carniolensis* and *M. togensis*. The first juvenile stadium of *C. hortensis* is very similar to the adult, with all appendages fully developed, except that the coxopleural pores, and the setae on the antennal articles, clypeus and coxopleuron are reduced in number. It is still pale in color and slightly larger than the fetus. The spiracles and the pores of the coxal organs are open. The young animals are fully active, creep over each other and explore the brood chamber. They probably leave the brood site at this instar, named adolescens I.

Although our knowledge of centipede reproductive behavior is incomplete, some evolutionary patterns are clear. Analysis of the breeding behavior in *C. hortensis* supports the hypothesis that within the clade of centipedes with prolonged parental care (Phylactometria), the female position with terga outwards is a plesiomorphic state and probably a general feature of the whole Scolopendromorpha. This posture was unambiguously described for several species of the genera *Cryptops* Leach, *Scolopendra* Lin-

Fig. 2. A mature female of *C. hortensis* with juveniles

naeus, and *Cormocephalus* Newport (see Bonato and Minelli, 2002); the only well-documented data on female brooding position in *Cryptops* come from the North American species *C. leucopodus* (Rafinesque).

On the other hand, in most geophilomorphs, the ventral surface of the brooding female is exposed to the outside, the only exception being the mecistocephalid *D. carniolensis* that behaves in this respect like Scolopendromorpha and Craterostigmomorpha. The newly observed brooding behavior of another mecistocephalid species (*M. togensis*), in the manner of Adesmata rather than that seen in *Dicellophilus* Cook, suggests that the brooding posture may be more subject to homoplasy (to convergence or reversal) than previously expected (Edgecombe et al., 2010).

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