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Guarding by Males in the Opilionid Family Cranaidae

One of the most abundant and common arthropod groups found in tropical forests is the harvestmen, which are potentially useful indicator species (Wade *et al.* 2011). Of the four suborders of Opiliones, Laniatores is the most diverse, with 26 families and 3,700 species, most of which are found in the Southern Hemisphere. One of these families is the large-bodied Cranaidae (Machado and Warfel 2006), which has a range extending from "the northern region of South America along the Andes and Amazon Basin up to Panama and Venezuela" (Pinto-da-Rocha and Kury 2003). *Phareicranaus calcariferus,* formerly known as *Santinezia serratobialis,* was synonymised by Pinto-da-Rocha and Bonaldo (2011). It is the only species of cranaid found in Trinidad and Tobago, and is one of the most common species of harvestman on Trinidad (Machado and Warfel 2006). Parental care of offspring has been documented in all orders of arachnids (Mora 1990), with most species of harvestmen exhibiting maternal care (Machado and Macías-Ordóñez 2007). The superfamily Gonyleptoidea, which includes the Cranaidae, has been documented as containing nearly 80% of the total cases of maternal care reported in the order (Machado and Warfel 2006). The first reported observations of maternal care in the family Cranaidae were made in Trinidad (Machado and Warfel 2006; Hunter *et al.* 2007) and noted guarding of eggs and early nymphs. Little information on paternal care in these animals is known; it has been observed in relatively few species, including *Zygopachylus albomarginis,* which formerly was assigned to the family Gonyleptidae (Mora 1990) but which has been reassigned to the Manaosbiidae (Kury 2003), and *P. calcariferus* (Machado and Warfel 2006). The objective of this paper is to provide further insights into the association of nymphs and adult males of the harvestman *P. calcariferus* over an extended period of time.

Observations were made during July 2010 and July 2011 in two localities in Trinidad: Acono Road, Maracas Valley (10° 43.147' N; 61° 23.639' W) at an elevation of approximately 190 metres, and Caura Valley (10° 41.309' N; 61° 22.248' W) at an approximate elevation of 127 metres. Both localities are situated in the Northern Range. Observations on egg clusters in Maracas Valley were made in July 2010, while those in Caura Valley were recorded in 2010 and 2011.

Each batch of eggs along with the guarding adult were photographed to count the eggs and identify the species. A positive identification was made from a collected adult specimen by use of the key developed by Townsend *et al.* (2008). Voucher specimens (Catalogue nos. UWIZM.2014.2.1 and UWIZM.2014.2.2) were deposited in the Land Arthropod Collection of the University of the West Indies, St. Augustine, Trinidad and Tobago.

Three batches of eggs in Maracas Valley were observed from the 14 July to 2 August, 2010 between 0745 and 1400 h. All clusters of eggs were situated under a rock sticking out horizontally from a vertical bank at the side of the trail. The surrounding area was heavily shaded and moist. The first batch (Fig. 1) contained 52 eggs and was located approximately 10 cm from the edge of the protruding rock, while the second batch contained 117 eggs and was situated approximately 36 cm from the edge of the first cluster and 13 cm from the edge of the rock. The batches were comprised of eggs in different stages of development. Younger eggs were cream coloured with little speckling, while older ones were brown and speckled with black, with much of the embryos visible through the eggshells. The male on batch one abandoned the cluster on day 18, while the guarding male on batch two persisted until all but one of the embryos had developed and hatched; that batch was abandoned by the adult three days later (day 19), after which 17 nymphs remained around the cluster, comprising a little more than half the egg mass area. Eggs in batch one were also covered with mould. A similar substance covered one undeveloped egg in batch two after all of the other eggs had hatched.

Fig. 1. Eggs of *Phareicranaus calcariferus*, Maracas Valley, July 2010.

Batch three contained 91 eggs and was situated under an overhanging rock at a lower elevation (10° 43.067' N; 61° 23.669' W) along the side of the trail. The cluster was located approximately 20cm from the edge of the rock. This batch was first observed on 23 July, 2010 with only six eggs still remaining unhatched when observed a week later. This batch appeared to consist of eggs all in the same stage of development, with all being white in

colour. Three days later, the egg mass and guarding adult were absent, with two individuals of a different, unidentified species of harvestmen occupying the space.

In Caura Valley, observations were recorded from a single batch of eggs from 25 July to 5 August, 2010 and from 9-19 July, 2011. The batch was located under a small, exposed rock 5-8cm wide under an overhanging dirt bank, approximately 125cm above ground level and 13cm from the edge of the rock. The eggs in both batches were all white in colour and appeared to be in the same developmental stage. First observed on 25 July, 2010, the egg batch was next observed seven days later; during the intervening time, the embryos had developed. Two days later, no eggs, larvae, or nymphs were present; however, the adult male was still present, and it remained until two days later. It was noted that when no eggs were present, the flash of the camera caused the male to move off his batch; however, when eggs were present, the male did not move in response to the flash.

The typical position of the male was at the side of the cluster of eggs, covering 5-15 eggs with the body and two legs on the same side of the body. It maintained this body position throughout the development of the eggs, even when the eggs became covered in mould. When the spiderlings hatched, the male kept its legs behind its body.

The evolution of parental care and the matter of which parent cares for the offspring is determined by factors such as the mode of fertilisation, the order of gamete release, and the certainty of paternity. Maternal care is expected when females are able to fulfil the following three requirements: 1) they are long-lived so that they can provide some benefit to the offspring after oviposition, 2) they can defend the offspring, and 3) they are constrained to semelparity. However, parental care by males is considered costly not only because it exposes them to predators and reduces their foraging time, as is the case with females, but males are also using energy not directly related to their maintenance and growth (Requena *et al.* 2009). There have been no reports of males and females caring for offspring at the same time in opilionids (Mora 1990); however, Requena *et al* (2009) showed that paternal care is just as effective as that given by females in opilionids. Furthermore, it has been suggested that caring for an egg batch makes a male a more attractive mate and that as a result the pair will copulate more frequently (Requena *et al.* 2009). This may be the same benefit to *P. calcariferus* males that cared for clutches that contained eggs in different stages of development as that which has been reported for other species of opilionid males that exhibited parental care; it also may be the result of multiple ovipositions from different females, as referred to by Requena *et al.* (2009).

One of the most important functions of parental care is guarding against egg mortality. An important source of egg mortality is fungal attack (Requena *et al.* 2009), which is not surprising due to the moist conditions in which the batches were found, conditions ideal for fungal growth. The guarding males of species like *Z. albomarginis* have been noted to chase away potential predators like ants and conspecifics and to remove fungus from eggs (Mora 1990). *Iporangaia pustulosa* males apply a mucus coating to eggs, which most likely physically deters egg predators (Requena *et al.* 2009). However, males of *P. calcariferus* did not appear to utilise measures to deter egg predators, nor were they observed to remove any fungus that had accumulated on the batches. Opilionid males have been observed to leave the clutches unattended frequently and to move as far as five metres away from the egg batch (Requena *et al.* 2009); however, this was not observed in males of *P. calcariferus*.

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