Further cases of paternal care in Opiliones (Arachnida) *

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To the single existing observation of paternal care in opilionids two more are added: eggs glued on right leg IV in *Leytpodoctis oviger* n. gen. n. sp. (Podoctidae; Philippines: Leyte); flattened egg clutch guarded below stones and decaying wood in *Lepchana spinipalpis* Roewer 1927 (Assamiidae; Nepal). The three known cases of paternal care in opilionids are all within the superfamily Gonyleptoidea in the suborder Laniatores, but represent three different families. Apparently, this behaviour developed independently in all cases, the three families concerned not being closely related.

KEY WORDS: Opiliones, Podoctidae, Assamiidae, reproductive behaviour, paternal care.

BEHAVIOUR

Recently, MORA (1990) presented a detailed study of paternal care for egg clutches in a Panamanian opilionid, the gonyleptid *Zygopachylus albimarginis* Chamberlin 1925, a behavioural pattern which has been discovered earlier by RODRIGUEZ & GUERRERO (1976). Most surprisingly, the males of this species build an arena sur-
rounded by mud walls on logs or tree trunks. Females come to these places, mate with
the guarding male, oviposit and leave the place. This behaviour involving only the
male in parental care is unique not only among opilionids but within arachnids in
general. Maternal care seems to be more widely distributed, at least in neotropical
Gonyleptidae species, though again only a few cases have been reported. Mora (1990)
summarizes the few records. In contrast, parental care in opilionids may remain a rare
behavioural pattern; however, more careful investigations in tropical species, studies
which are almost entirely lacking up to now, may provide surprising results. The
following observations are only anecdotal, but may help to initiate detailed research.

Philippines

In a large sample of sifted soil litter from forests around Lake Danao on Leyte,
W. Schawaller and I sorted two males of a soil incrusted Podoctidae species, which is
described below as new. Both males carried eggs glued to the right femur of leg IV
(Figs 1A-B, 2, 8-9). When discovered creeping through the soil litter, they were still
alive though they had spent the night buried in the litter sack. However, they were
quite weak and died after few days when brought to Germany. The position of the
eggs did not change after preservation in 70% alcohol and remained constant for at
least 2 years. The details of the two males are as follows:

First male (Figs 1B, 8): 4 eggs; glued dorsally on femur IV, alternately 2 to the
left, 2 to the right side of the dorsal surface of the femur, the eggs glued to each other
where they meet. Three of the eggs (nos 2-4 starting from the trochanter) were alive
when collected and the embryos apparently developed. The first egg is somewhat
shrunken, yellowish, wrapped in fungus and apparently dead. The eggs cover 2/3 to
4/5 of the femur length. Small detritus pieces are attached to the eggs, but this
may have been accidental, and may have happened during the sifting process.

Second male (Figs 1A, 2, 9): 5 eggs; also glued to the dorsal side of femur IV, 3
eggs in one row dorso-medially, again closely attached to each other, 2 eggs dorso-
laterally close to eggs I and II of the inner row. Eggs of the inner row partly covered
by a brownish mucus, but no fungi are traceable. Three eggs are opaque-whitish and
developing, 2 considerably smaller ones are shrunken, somewhat folded, brownish and
apparently dead. The eggs cover about 2/3 of the femur length.

In both cases, the ventral surface of the femora is freely visible, devoid of mucus,
and no eggs are attached there.

Nepal

The medium-sized Assamiidae species Lepchana spinipalpis Roewer 1927 is wide-
ly distributed in the eastern Nepal Himalayas east of the Arun River and in Sikkim
(Martens 1977). The following observations originate from a broad-leaved forest
with heavy scrub and fern layer near the villages Mure and Hurure in the upper Arun
valley, 2150 m (this area was visited from June 9-19, 1988).

Independently, W. Schawaller and I discovered several opilionid clutches under
pieces of wood and a flat stone lying on the ground, each clutch with an adult
specimen present. They sat in front of the clutch, apparently guarding it. The clutches
were flattened and every egg was glued individually to the underside of the covering
object; clutch diameter about 1-1.5 cm. There was no enveloping thick mucus layer
Fig. 1. — *Leypdoctis oviger* n. gen. n. sp.; A, holotype ♂ carrying 5 eggs glued to right femur of leg IV; B, paratype ♂ carrying 4 eggs glued to right femur of leg IV. Photographs: J. Trautner.
covering the eggs as in other soil dwelling opilionids, e.g. Nemastomatidae, Sabaconidae and Ischyropsalididae (Jubertie 1964, Martens 1978, pers. observ.).

10 June 1988. A male guards 20-30 recently hatched larvae still clustered together on the lower surface of a flat stone, the male in front of them. Apart from male and young, a female was also sitting under this stone. It was pregnant with about 25 eggs ready for oviposition. Both adults and 13 young were removed.

11 June 1988. Two clutches underneath a single piece of bark lying on the forest floor were each accompanied by a single male. They did not move when disturbed and apparently «guarded» the clutches.

14 June 1988. In the open, close to the forest edge, under a burnt piece of wood, a male was sitting in front of a clutch of about 120 eggs. Under the same piece of wood, a female was also present, but sitting apart from the male and the clutch. The

Figs 2-3. — Leypodoctis oviger n. gen. n. sp.; Fig. 2, holotype ♂, dorsal view; Fig. 3, lateral view left side including leg 1, pedipalp and chelicera.
female was pregnant with about 15 eggs ready for oviposition. Both adults were removed. The next day, under this very piece of wood, another male was sitting, again displaying a guarding posture with pedipalps and chelicerae close to the eggs. Several of the young were hatching. This second male was removed and no other specimen was found the next day. This clutch consisted of eggs at different stages of the developmental cycle. Newly deposited whitish eggs were present as well as darkly pigmented ones, in which the embryos were ready for hatching (Fig. 4). The large number of eggs and broad span of developmental stages indicate that several females took part in compiling this clutch, or that a single female returned several times to the spot to oviposit.

During the stay in this forest, 10 adult specimens (7 males, 3 females) of *Lepchana spinipalpis* were collected, but only the 4 clutches described were discovered. Although the monsoon period, with strong precipitation, started about June 5, the reproductive period of *Lepchana* must have begun considerably earlier, because one clutch had already hatched on June 12.

More specimens of *Lepchana spinipalpis* were collected in two more localities between April 13 and 29 (Yamputhin and Dhorpa Kharka, 5 males, 1 female), but there was no sign of reproductive behaviour; several of the specimens were still hidden in the winter quarters, mainly decaying tree trunks.

**DISCUSSION**

I assume that the eggs attached to the legs of the males of *Leypodoctis oviger* n. sp. are correctly identified as eggs of that species. The identification of the eggs as opilionid eggs is not difficult. At least in one case, the translucent cover allows inspection of the interior of the egg and the developing embryo, especially the knobs of the appendages, are to be seen. Furthermore, the application of secretion to the eggs in order to fix them under rotten wood or under a stone is a normal behaviour in many opilionid families (compiled in Martens 1978) including those of the suborder Laniatores. The attachment of the eggs to the leg seems to be strong and not at all accidental. I did not try to remove the eggs, but they did not fall during usual handling of the specimens: extracting the genitalia, flattening the legs in order to draw the specimens, etc. This observation is the second one to confirm paternal care in an opilionid and the first, in which the male carries the eggs attached to itself, namely to the legs.

As no additional biological data are available at present to supplement the facts described above, only preliminary speculations with reference to the observations and experiments of Mora (1990) are possible. In *Zygopachylus albimarginis*, the species observed by her, the male waits for a female in the mud arena, which it guards; females arrive from time to time, court the male, copulate, oviposit and disappear. The male guards the eggs of various females, and it seems clear that most of them, at least, are fertilized by the resident male, immediately after copulation has taken place.

The mating system in *Leypodoctis oviger* seems to be quite different. Attachment of eggs to the leg in moderate numbers enables the animal to wander around with constant control of the clutch. With no need to stay in a given place in order to guard the eggs, the «carrier male» may move to places suitable for egg development:
moisture, temperature and possibly other factors may be provided as appropriate. However, the position of the eggs on the fourth femur is certainly not favourable with respect to special care of the eggs: the mouthparts cannot reach the area, for example to remove developing fungi. In both cases, not all of the eggs were still alive when the carrying males were collected, and at least one of the eggs was fungi-infested.

Application of the eggs to the fourth male leg must be a highly stereotyped procedure, and both male and female are thought to participate. If both animals are at hand, the eggs are attached at identical positions, even on the same leg, and the slight differences between the two specimens are due to the different number of eggs in each case. The stereotyped position and the equal developmental stage of the eggs make it highly probable that the eggs originate from one female.

Although the number of eggs per clutch is not known for any podoctid, 4 and 5 eggs in the present specimens seems quite low. The highly specialized gonyleptid *Z. albimarginis* ovisposits an average of only 3 eggs at a time (MORA 1990): on the other hand, the size of the eggs, 0.8-1.1 mm in diameter, seems to be extraordinarily large for an opilionid of about 4 mm (3.5 mm in male, female still unknown). Eggs of about this size are ordinarily found in species of much larger size: 1.2 mm in *Pachylus quinamavidensis* Muñoz-Cuevas 1969 (female: 8 mm body length, MUÑOZ-CUEVAS 1969, JUBERTHIE & MUÑOZ-CUEVAS 1971). In another gonyleptid, *Acanthopachylus*
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*aculeatus* (Kirby 1819), 1.2 mm is given for the egg diameter (*Capocasale & Bruno Trezza* 1964); the body length of this species is about 10 mm (L. Acosta pers. comm.).

A much more simple behaviour, though complicated enough, is displayed by the assamiid *Lepechana spinipalpis* from Nepal. The males «merely» watch the clutches, which are glued to the underside of old wood or stones, apparently until the young hatch. It remains for detailed studies to determine whether the eggs originate from a female fertilized by the guarding male or if they are deposited by an alien female. More questions are raised by the fact that one clutch attracted a second «guarding» male after the first was removed. Is it a pheromone which attracts and holds males at the spot, regardless of whether the eggs are those of a personally inseminated female or only eggs of an «unknown» female are concerned?

The fact that one of the clutches examined in more detail contained about 130 eggs, in all developmental stages, also requires explanation. Possibly more than one female contributed to the clutch at different times, resulting in a «superclutch». Obviously, such behaviour would parallel that of male *Zygopachylus albinus*, which mate with several females in the arena at different times and guard the eggs of all females.

Paternal care is a rare behavioural pattern in opilionids and it was discovered with certainty only recently (*Rodriguez & Guerrero* 1976, *Mora* 1990) in the neotropical family Gonyleptidae. The two additional cases reported here originate from SE Asia (Nepal, Philippines) and concern two more families: Assamiidae and Podoctidae. The latter family is entirely tropical Asia in distribution (*Roewer* 1923, 1949), whereas the Assamiidae have a wider range extending at least over the whole Palaeotropics (*Roewer* 1923, 1935). The relationships of the three families in question are certainly not close; they are united only in sharing the same superfamily, Gonyleptoidea (*Martens* 1976, 1986). But within this taxon, their position is rather isolated. Apparently, paternal care developed independently within the Laniatores, the suborder concerned here, and reached different levels of «perfection». This inference is strongly supported by the scarcity — at least as we can currently judge — of this behaviour within generally species-rich families and by the very different forms the behaviour takes. It is conceivable that arena construction and the attachment of eggs to the legs may be derived from pure guarding of a clutch deposited by the female as in ordinary non-guarding species. However, taxonomic evidence contradicts this view: because the species and even families concerned are not closely related, it follows that egg guarding by the male evolved independently. Once this fact is realized, more surprising discoveries, especially in the tropics of all continents, may be expected.

**SYSTEMATICS**

*Leytpodoctis* n. gen.

A genus of the family Podoctidae, characterized by its genital morphology, armament of first leg and armament of dorsal body surface.

Genital morphology: expanded glans displaying a tube, dorsally somewhat prolonged, only the surface folded; both claspers protruding from the distal opening, stylus
with somewhat extended opening between the bases of the two clasps. First leg: unarmed except femur ventrally with several spines. Body surface: body wrapped in a layer of secretion, which glues small particles of the soil layer to the surface.

Type species: *Leytpodoctis oviger* n. sp.

Related genera: genera of Podoctidae are not easy to tell apart. The outer appearance of many species is most similar and the heavy, often luxuriant armament with cones and spines displays characters which vary greatly. Suzuki (1977) synonymized many mostly monotypic genera created by Roewer (1923, 1935), but was mainly led by the outer appearance of the species in question as given by Roewer's drawings. Genital morphology was used to specify species by Šilhavý (1969) and Suzuki (1977), but constructional morphology was considered, in order to identify a general pattern for the entire family, only by Martens (1986). Not less embarrassing is the current division of the family into the subfamilies Podoctinae, Erecananinae, and Ibaloniinae, again by characters of outer appearance, which most certainly do not reflect phylogenetic relationships. Thus, the correct position of the genus *Leytpodoctis* is not easy to ascertain. It is erected here on the basis of clear differences from any other podoctid species or genus. First the almost complete lack of the luxuriant armament of the first leg as displayed in most podoctids of the genera *Philibalonius* Roewer 1926 and *Ibalonianus* Roewer 1923 in the Ibaloniinae, and displayed in other undescribed species of my Leyte collection. Furthermore, the pedipalp in those two genera is more heavily armed than in *Leytpodoctis*. Paternal care and secretion-incrusted cuticle, however, are not treated, at least not at present, as characters warranting generic division (see below).

**Leytpodoctis oviger** n. sp. (Figs 1-3, 5-14)


*Paratype.* Male (Coll. J. Martens); carrying 4 eggs; together with holotype.

*Diagnosis.* Characterized by the genital morphology, armament of pedipalp and first leg and of the body, which is covered by secretion and a layer of soil particles.

*Description.* Body length (in mm, type/paratype): 3.4(3.7), width: 2.5(2.7). Leg II (type/paratype): Fe 3.9(4.1), Pt 0.9(1.0), Ti 3.1(3.3), Mt 2.9(3.1), Ta 1.5(1.5).

Colour and pattern (Figs 2-3). Body dark brown, due to the incrustation with secretion and soil particles no distinct pattern recognizable.

Armament (Figs 1A-B, 5). Indistinctly visible due to secretion cover; dorsally coarse, on each granule a short whitish seta, mainly lying flattened on the surface. Marked sculpture on thoracic tergite II (with 2 paramedian low cones), abd. area I, II and III row of 6 granules each of different size, abd. area IV with 2 long pointed cones forming highest elevation of entire body. Tu. oc. (Figs 2-3): well developed but low, close to front margin of cephal., much broader than long, eyes laterally exposed and close to the cephalothoracic surface. Median spine emerging with broad bases, somewhat bent forward; coarsely granulated, sparsely decorated with whitish hairs.

Chelicera (Fig. 6). Pedipalp (Fig. 5). Slender, poor in armament. Tr ventral 1, Fe ventro-basal 2 blunt tubercles, Pt without spiny armament, Ti 2 small tubercles medio-ventral, topped by a large bristle, Ta large spines only ventral. Legs (Fig. 7) all
Figs 5-9. — _Leytpodoctis ouiger_ n. gen. n. sp., holotype δ; Fig. 5, right pedipalp, medial view; Fig. 6, left chelicera, medial view; Fig. 7, leg I, trochanter and femur, medial view; Figs 8-9, right femur of leg IV; Fig. 8, paratype; Fig. 9, holotype. Scales in mm.

joints rounded, unarmed, except leg I with Fe ve-ba with 4 long spines. Tarsal joints (type/paratype) 3(3)-8(8)-5(5)-5(5).

Genital morphology (Figs 10-14; for nomenclature see MARTENS 1986).

Valvae of glans triangular, with stout setae close to tip, dorsal folded sac (sac of lamellae) with only a small area of elongated folds, in expanded state (Fig. 14) forming a tube with folds extending beyond the distal hole, clasps and stylus inserted into the hole.

_Distribution and ecology._ Up to now known only from the quickly vanishing primary forests around Lake Danao in the NW part of Leyte, Philippines. The species is apparently confined to soil litter and does not climb logs or rocks. The specimens in question were gathered by sieving soil litter. Both males collected on March 9 had 4 and 5 eggs respectively glued to leg IV indicating that reproduction was in full progress.

Remarks. Body cover of secretion and soil particles has not previously been reported for podoctids. But this camouflage may be more commonly distributed in this family than the absence of information suggests. In my Leyte collection, there are
four more podoctid species besides *L. oviger*. Two of them display the same or even heavier incrustation, the armament of leg I being totally hidden. Another species shows slight secretion on the body surface, but no adherent soil particles. This is a long-legged species, which does not live in or on the soil proper. The last species, again a short-legged one confined to the soil layer, does not carry either a visible secretion on the body surface or soil particles. Concerning genital morphology, two of them are closely related, with very similar general characters of genital morphology — one without secretion and camouflage — the other one with heavy soil incrustation! Although camouflage of body generally applies to all the species of a family, as in the Trogulidae and Dicranolasmatidae, in the Podoctidae this behaviour may have been developed independently several times.

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