

OVERWINTERING *Leiobunum elegans* (OPILIONES: PHALANGIIDAE) IN CAVES AND MINES IN NOVA SCOTIA.

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The opilionid *Leiobunum elegans* was found overwintering in caves and mines in mainland Nova Scotia and Cape Breton Island. It occurred both as adults and near-adults, usually as single individuals or small clusters, but aggregations were formed at one site. It is suggested that aggregation formation is a behavioural adaptation for coping with saturated atmospheres. This is the first published report of overwintering opilionids in such habitats from eastern Canada.

L'opilionide *Leiobunum elegans* a été trouvé en hivernement dans des caves et des mines de l'île du Cap Breton et aussi de la Nouvelle-Écosse continentale. Ceci a eu lieu comme adultes ou quasi-adultes, ordinairement comme individus ou en petits groupes, mais des agrégations ont été trouvées à un seul lieu. On suggère que la formation d'agrégations est une adaptation de comportement afin d'endurer des atmosphères saturées. La publication de l'hivernement d'opilionides dans de tels habitats est la première ayant trait à l'est du Canada.

A number of opilionid species use underground cavities for overwintering, being found seasonally in the thresholds of caves and mines in northern temperate latitudes. Examples from Europe include *Amilenus aurantiacus* (Simon) and several other species (Martens, 1978). In North America, *Nelima paessleri* (Roewer) uses caves and mines in southwestern Canada for this purpose (Holmberg et al., 1984) and *Leiobunum elegans* Weed, a widely distributed eastern species (Davis, 1934), is often reported in similar habitats in the United States (Brown, 1997). During overwintering, some species may form large aggregations of up to several thousand individuals. Holmberg et al. (1984) have reviewed the literature on this phenomenon.

We have found *Leiobunum elegans* overwintering in caves and mines in Nova Scotia. It was found in both mainland Nova Scotia and Cape Breton Island, seven of the ten winter collecting sites (five natural caves and two abandoned mineworkings) which were visited during a general faunal survey. It was found from October through to May usually in the deep threshold ("twilight zone") of the caves or mines, though an occasional specimen was taken within the dark zone. At most of the sites the species occurred as scattered individuals, or sometimes in small groups of up to twenty five. However, small aggregations were found in an abandoned mine adit at Tennycap (Hants County) known locally as Peddlar's Tunnel. The only other opilionid taken was a single specimen of *Oligolophus tridens* (C. L. Koch) (Phalangidae) in Cheverie Cave (Hants County).

Peddlar's Tunnel is an abandoned mine adit, part of the workings of Tennycap Manganese Mine dating from the end of the 19th Century (Weeks, 1948). It is situated at an altitude of approximately 50 m near Route 215, east of Walton on the Minas Basin coast of Nova Scotia. The tunnel is 50 m in length, approximately 2 m x 1.25 m in cross section, driven due north. Due to a slight bend at 24 m, the entrance is not visible looking back from the end of the tunnel, but reflected light is still visible. The entrance is almost blocked by an accumulation of debris, leaf mould and porcupine scat, creating a dam. Except during times of extreme drought, the tunnel is flooded with up to 1 m

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of water. Due to this water and the constricted entrance, relative humidity is close to 100%.

Overwintering *Leiobunum elegans* were first noticed in the adit in late 1994, and were observed in three consecutive winters: 1994/1995, 1995/1996 and 1996/1997. The animals were located between the bend and the inner end of the tunnel. A count made in January 1997 found 864 individuals: 27 (3%) occurring singly, 188 (22%) in small groups of 2-52, and 649 (75%) in aggregations of 73-156. During visits made in 1996/1997 aggregations were observed to have been formed by October 1996. By April 1997 they were breaking up and the animals had started dispersing out of the tunnel: there were fewer animals in total, and several individuals were also seen just inside the tunnel entrance.

Collections made from the aggregations in Peddler's Tunnel October 1996 and April 1997 were all adult males and females. By contrast, all specimens collected from other sites of isolated individuals and small groups were sub-adults.

These records of overwintering *Leiobunum elegans* show it to be widely distributed in the geographical region investigated. It probably occurs in winter in most of the caves and mines in Nova Scotia, typically moving into overwintering sites during October, and apparently dispersing in April-May.

Aggregation formation is a well established phenomenon in opilionids. It is apparently a behavioural adaptation for coping with environmental extremes. It is obvious that the animals use caves in winter to avoid harsh seasonal conditions, but the reason that populations at some sites form aggregations is unknown. The results show that aggression is not compulsory because aggregates have been observed at only one site in small numbers compared to those found in *Helima paessleri* communities. Holmberg *et al.* suggested that the combined effects of many opilionids' scent glands may be more effective at repelling predators, but we believe a more likely explanation is that it is a behavioural adaptation for the maintenance of water balance. Ambient relative humidity is a critical factor for most cave organisms, and obligate cavernicoles ("troglobites") appear to be adapted to an environment where the relative humidity is always at or near 100% (see, for example, Howarth, 1979). However, most terrestrial arthropods are physiologically adapted to desiccating environments, and thus they may have difficulties coping with saturated atmospheres (Bursell, 1974). It is reasonable to expect that animals that spend only a part of their life in caves have evolved strategies to overcome this problem. There is some evidence that overwintering aggregations only form in underground sites where the relative humidity remains at, or near, 100%: Holmberg *et al.* (1984) mention that their sites all had high humidity and supplies of free water, and this is also the case in Peddler's Tunnel. The densely intertwined legs may reduce air movement and help prevent precipitation of liquid water on the bodies of the animals.

A major pattern of life history in North American *Leiobunum* species is to overwinter as eggs. However some species winter-over as sub-adults, maturing and mating in the spring (Edgar, 1971 p. 10). In *Nelima paessleri*, it is only the mature adults that overwinter (Holmberg *et al.*, 1984). Based on the extant records it appears that *Leiobunum elegans* in Nova Scotia overwinters both as adults and sub-adults, only the adults forming aggregations. More records are required in order to confirm this observation.

The following specialists very kindly gave of their time to identify the collections: Drs. R. Holmberg (Athabasca University) and L. Brown (Gardner-Webb University) determined material from Peddler's Tunnel; Dr. C. Dondale (Canada) determined the (sub-adult) specimens from all other sites. C. Ewing (Nova Scotia Museum of Natural

History) determined the specimen of *Oligolophus*. Part of the cost of field work was defrayed by a Nova Scotia Museum Research Grant to one of the authors (M.M.).

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