

Protohydra leuckarti near Plymouth

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A new location for Protohydra leuckarti is reported near Plymouth at Millbrook Lake (Tamar Estuary). To place this finding in context, notes follow on a familiar habitat of this species in the White Sea, and on the general ecology and distribution of Protohydra and its enigmatic phylogeny.

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Published records of the solitary hydrozoan *Protohydra leuckarti* Greeff 1870 in the Plymouth area refer only to the River Tavy at Bere Ferrers and the estuary of the River Plym at Chelson Meadow (Baker, 1912; Hickson, 1920; Lebour, 1930; Marine Biological Association of the United Kingdom, 1957). Its presence at Millbrook Lake, a shallow creek near the mouth of the River Tamar, is reported in this preliminary note. It was found by C.C.K. during the period March 1970 to February 1971 while sampling estuarine oligochaetes, and was still present at this site in June 2007 (National Grid Reference SX 4401 5245).

The surface sediment consists mainly of silt with small amounts of sand and is relatively firm when exposed. At high water marine conditions obtain, with the salinity of standing water in depressions at low tide, up to 35.45 ppm (determined by silver nitrate titration). After heavy rain, lower salinities were recorded (10.40–24.20 ppm).

In 1970–1971 the meiofauna was sampled at regular monthly intervals from a 5 m² fixed quadrat situated at about mid-tide level, by means of a simple coring device. Sediment samples were taken to a depth of 10 cm using a clear plastic tube (internal diameter 3.1 cm) with a piston for expelling the core. A 10 cm length of core was cut into 2 cm sections as it was extruded. Ten cores were taken at random within the quadrat, furnishing 50 samples which were preserved within 4 h of collection by adding 4% formaldehyde solution containing 0.2% rose Bengal. The meiofauna was extracted later by stirring gently with tap water, giving a suspension that was washed into a small sieve (250 µm). The residue was sorted in a flat glass dish under a stereobinocular microscope, and specimens stored in 70% ethanol (see Hulings & Gray (1971) in Fenchel, 1978).

The meiofauna was dominated numerically by small worms: polychaetes (*Manayunkia aestuarina* Bourne and *Streblospio shrubsolei* Buchanan), and oligochaetes in smaller numbers (mainly *Tubificoides* (= *Pelosclex*) *benedeni*

Udekem). Nematodes and copepods, upon which *P. leuckarti* often feeds (Heip & Smol, 1976) were less numerous.

Preserved *P. leuckarti* were approximately 1 mm long and deeply stained with rose Bengal. They were all in the top sections of cores (at 0–2 cm depth); see Table 1. In the course of 12 months 94 polyps were found in 1.8 l of sediment.

The presence of *P. leuckarti* at this site was confirmed in June 2007 by a field excursion. Surface mud was collected at the same sampling station or next to it (10 separate samples, total volume 1.2 l). Suspensions of mud in seawater were filtered on a 250-µm sieve which retained sand grains together with strands of filamentous green alga (*Enteromorpha* sp.). This material was allowed to stand in Petri dishes and scrutinized at intervals under a stereobinocular microscope. Over a 24 h period five living polyps were found. They were identified by observing nematocysts under the microscope with the help of Dr Carina Östman. All were from a 300 ml sample collected within 25 m of the original site where the mud was firmer, possibly due to a slightly higher sand content. No other polyps were found, suggesting that *P. leuckarti* may be unevenly distributed over small areas (see also Table 1).

The author (I.A.K.) who found the live specimens is familiar with *P. leuckarti* and its habitat in the vicinity of the White Sea Biological Station of Moscow State University, at 66°34'N 33°06'E (see Bozhenova *et al.*, 1989; Stepanjants, 1989). It is found there in muddy sand in the middle part of the intertidal zone (estimated proportion of sand at least 80%; grains of medium size). The location is marked by the presence of *Arenicola marina*, *Macoma baltica* and sometimes *Mya arenaria*. The characteristic meiofauna consists of harpacticoid copepods, nematodes, small gastropods (*Hydrobia* sp.), oligochaetes and polychaetes. The salinity is on average 18–24 ppm and may fall to ~5 ppm. Seawater temperatures range from 12–14°C (summer) to below zero (winter). The White Sea polyps are usually observed adhering to organic particles by the basal peduncle but they can move interstitially by peristalsis. They readily catch and engulf prey (e.g. nematodes). In summer, the surface sediment of an area 20 × 20 cm may contain 10–20 polyps, among which it is not uncommon to find individuals undergoing transverse fission.

Protohydra leuckarti was first recorded in the White Sea at Seldjanaya Bay, an intertidal brackish habitat near a small

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Table 1. *Protohydra leuckarti* in intertidal mud samples from Millbrook Lake (all found at depth 0–2 cm).

Date	Number per 10 cores
1970	
March	Nil
April	Nil
May	1
June	Nil
July	26
August	29
September	6
October	2
November	6
December	1
1971	
January	7
February	16
Total	94

stream, consisting of muddy sand (Stepanjants, 1989; Anokhin, 2001; and personal communications).

The ecology and distribution of *P. leuckarti* are considered by McIntyre (1969) and Fenchel (1978) in general reviews of meiobenthos. *Protohydra leuckarti* appears almost cosmopolitan in its distribution (e.g. Omer-Cooper, 1964; Clausen, 1971; Anokhin, 2001; Schuchert, 2006; Sergeeva, 2006). It is recorded from a wide range of brackish marine sediments. It is euryhaline and tolerates pollution and low oxygenation. Its habitat preferences differ from those of cnidarian psammo-fauna (Teissier (1950) in Delamare-Deboutteville, 1960; Swedmark, 1964; Stepanjants, 1989). It occupies the top layer of sand or muddy sand, usually with detritus or else a surface diatom layer. In common with other vermiform interstitial species its robust burrowing behaviour and adhesive ability ensure survival.

The population ecology of *P. leuckarti* has been studied by Muus (1966, 1967), Heip (1971) and Heip & Smol (1976). It feeds voraciously on copepods, nematodes or small polychaetes, capturing passing prey by means of nematocysts. *Protohydra leuckarti* is a top predator and influences the structure of prey populations (Heip, 1977). In favourable conditions it multiplies asexually (Muus (1967) records up to 20/cm²). In contrast, the life cycle of *Protohydra* remains largely unknown. Several authors have described gonads (ovaries with a single large oocyte, or testes) and although sexual individuals are not uncommon, fertilization and the course of embryonic development have not yet been observed (Nyholm, 1951; Muus, 1966).

Protohydra has an evolutionary history that is shrouded in mystery. Its simple form makes it very challenging to infer its relationship to other hydrozoans. Nevertheless, *Protohydra* has traditionally been classified (in its own family Protohydridae) close to Hydridae (e.g. Naumov, 1960; Bouillon, 1985; Schaefer, 1996). Hydridae contains species of *Hydra*, which have made such excellent model organisms that more is known about their biology (from development to genomes) than that of any other cnidarians. If Protohydridae were shown to be the sister group of Hydridae, it would make an important point of comparison when assessing the generality of features studied in *Hydra*. However, Petersen (1990) noted that *Protohydra* could conceivably share an ancestry with any number of different

groups of capitate hydrozoans, given its relative lack of characters. More recently, Stepanjants *et al.* (2000) suggested that *Protohydra* and *Hydra* may have independent origins from within Corymorphidae. Molecular data have since confirmed a close relationship between representatives of Corymorphidae and Hydridae, in the clade dubbed Aplanulata (Collins *et al.*, 2005, 2006). Genetic data extracted from our new samples of *Protohydra* should allow the shroud to be lifted so that we might see a bit into the past of this fascinating animal.

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