

Shipwrecked tube worms

SIR — Large vestimentiferan tube worms (Pogonophora, Obturata) are typical members of both hydrothermal and cold seep communities in the Pacific Ocean (see, for example, refs 1, 2). In the Atlantic Ocean, Vestimentifera are known only from the western side, at sulphidic hydrocarbon seeps in the Gulf of Mexico at depths of 350–3,266 m (refs 3, 4), at 500 m depth off Guyana⁵ and at 300 m depth off Montevideo⁶. None was observed at hydrothermal vents on the mid-Atlantic Ridge⁷. In September 1991, during initial exploration of the wreck of the cargo ship *Francois Vieljeux*, we recovered vestimentiferan tube worms and bivalve molluscs, *Idasola* sp (K. W. Ockelmann, personal communication). Both animals are known to contain chemoautotrophic symbiotic bacteria. This is the first report of giant tube worms from the east Atlantic and the first time they have been recorded in a habitat other than a vent or seep site.

The wreck lies at 42° 7.95' N 9° 29.69' W, approximately 30 miles west of Vigo, Spain. It foundered during a storm in 1979, after developing a list due to shifting cargo. Containers on the deck were smashed open and the hatch covers

on some of the holds were broken before the vessel landed on the sea floor at 1,160 m water depth. Tins of pineapple were scattered over the sea bed and some of them fell into the open holds. When loaded, the upper part of one hold had contained sacks of beans and sunflower seeds on top of polythene-wrapped bales which contained rolls of sisal twine. Some of this was recovered using an orange-peel grab equipped with a video camera. Most of the seeds were washed away during recovery but

some were retained by the bales.

Two vestimentiferan tube worms (see figure) were found lying on top of one of the bales. One of the tubes was 960 mm long with an intact anterior end of 10 mm outside diameter, tapering to 4.5 mm diameter at the broken end. The upper 250 mm had marked growth collars. The soft tissues were not preserved and it is therefore not possible to identify the species. (We extracted high-molecular-mass DNA from the remains of the animal tissue in the tube 5 weeks after recovery but the vestimentiferan material had been lost to dominant fungal DNA (P. W. H. Holland, personal communication).) The second tube was a middle section 1,270 mm long tapering from 6.0 mm diameter to 4.0 mm. On recovery the upper 200–240 cm of the tubes was a pale straw colour. The lower black portion of the tubes is believed to have been buried in the rotting beans which were black and pulpy when recovered. The tubes are similar in appearance to those of *Lamellibrachia barhami* (Webb)^{1,8} found in water at depths of 1,125–2,050 m off the coasts of Oregon and California, but have smaller collars than two *Lamellibrachia* species from the Atlantic coast of South America^{5,6}.

Bacterial breakdown of the beans would provide substrates for sulphate-reducing bacteria, creating a hydrogen sulphide-rich habitat for the Vestimentifera. Assuming that a minimum of 2 years was required for initial breakdown and colonization by vestimentiferan larvae from presumed nearby cold-seep habitats on the slope, the animals must have grown to their present size in 10 years or less. This gives minimum growth rates of 9.5 and 12.7 cm per year, which compares with observed rates of 9.2–50 cm per year for Vestimentifera from warmer hydrothermal vent habitats². At the depth where the wreck lies there is a strong northgoing flow of warm, high-salinity water of Mediterranean origin (10.7–10.9 °C and 36.12–36.17 ‰)^{9,10}. For vestimentiferans to colonize the wreck under these conditions suggests the existence of nearby sources of larvae.

The animals in chemosynthesis-based communities that obtain nutrition from symbiotic chemoautotrophic bacteria are clearly opportunist in colonizing habitats that contain sufficient sulphide. Such sites include hydrocarbon seeps, sunken wood, whale skeletons¹¹ and, as we now report, organic-rich ship cargoes. The steep continental slope of the north-eastern Atlantic is difficult to explore with surface vessels and has been subject to few observations from submersibles. Our discovery considerably extends the

known range of large tube worms and points to the occurrence of cold saline or hydrocarbon seeps along the Atlantic slope of the Iberian peninsula, providing a normal habitat for these animals. Vestimentifera may be present along most continental margins at seep sites.

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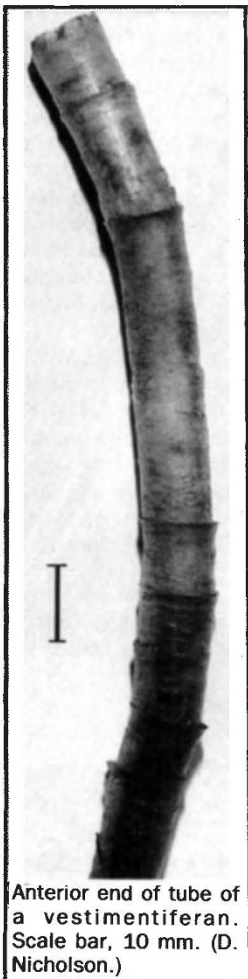
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Cross-pollination

SIR — Questions raised by Madsen *et al.*¹ and by Parker² on the adaptive value of multiple mating for female adders are remarkably similar to those being asked by plant reproductive ecologists. Multiple pollinations of a flower increase the size and genetic diversity of the pollen load^{3,4}, which in turn may affect the intensity of 'pollen competition' and the opportunity for female 'mate choice'^{5–7}. It is often possible to determine *in vivo* performance of pollen (for example, rate of pollen-tube elongation), and performance can vary with the intensity of pollen competition as well as with male identity^{8,9}. Parker finds it improbable that mate choice could evolve on the basis of parental combination, but this is one way to describe self- and cross-incompatibility reactions in higher plants, and pollen performance may vary with parental combination more generally¹⁰.

The link between pollen performance and progeny fitness is under investigation. A substantial fraction of the genes expressed by haploid pollen also is expressed in diploid progeny^{11,12}. Further, large pollen loads sometimes are associated with reduced fruit abortion and more vigorous progeny^{13,14}, and parental combinations that yield better pollen performance may also produce the most



Anterior end of tube of a vestimentiferan. Scale bar, 10 mm. (D. Nicholson.)