Northeast Gulf Science

Volume 6
Number 2 *Number 2*

Article 10

10-1983

Sediment Transport by the Terebellid Polychaete, *Amphitrite ornata* (Leidy), Under Laboratory Conditions

Thomas J. Price
National Marine Fisheries Service

Gordon W. Thayer
National Marine Fisheries Service

DOI: 10.18785/negs.0602.10

Recommended Citation

Price, T. J. and G. W. Thayer. 1983. Sediment Transport by the Terebellid Polychaete, *Amphitrite ornata* (Leidy), Under Laboratory Conditions. Northeast Gulf Science 6 (2).
Retrieved from https://aquila.usm.edu/goms/vol6/iss2/10

Northeast Gulf Science Vol. 6, No. 2 October 1983

SEDIMENT TRANSPORT BY THE TEREBELLID POLYCHAETE, *Amphitrite ornata* (Leidy), UNDER LABORATORY CONDITIONS

Polychaete worms compose a significant proportion of many benthic estuarine invertebrate communities. They are a potential food source for demersal fish, decapod crustaceans, and shore birds, and they are important in the flow of energy and movement of materials within the community (Dales, 1955; Fager, 1964; Featherstone & Risk, 1977; Aller & Yingst, 1978). Worms, by their physical and biological activities, have the potential of aerating sediment, dispersing trace metals within sediment (Cross, Duke, & Willis, 1970), and channeling organic material to the surface where it becomes available to other organisms. They also have the ability to reduce the size of organic particles and thus increase their surface area for attachment of bacteria, protozoa, and fungi. Transporting and transferring sediment may be important in the recycling of nutrients in intertidal habitats. The organic fraction deposited on the surface of sediment may even be resuspended in the water column and thus become a significant food source for suspension feeding animals.

Tentacular deposit feeding is the common mode of nutrition in terebellid and ampharetid polychaetes. In the terebellids, sediment particles are transported either by retracting the entire tentacle once the underside is coated, or by a continued transport of particles to the mouth down a ciliated groove on the adoral side of the tentacles (Barnes, 1968; Aller & Yingst, 1978). Terebellids are one of the most common shallow water polychaetes (Fauchald, 1977), but the ecological processes influenced by their tentacular activity are difficult to investigate under field conditions and few quantitative data are available. We designed an experiment to assess sediment transport by *Amphitrite ornata* under laboratory conditions and compared our results with those of previously published field studies. *Amphitrite ornata* is the only representative of the genus *Amphitrite* reported for the Beaufort, N.C. area (Hartman, 1945; Day, 1973; Wilson 1979). Our identification of this species was verified using Day (1973) checklists and Fauchald (1977) and Wilson (1979) keys.

MATERIALS AND METHODS

We designed an inexpensive piece of laboratory equipment to evaluate sediment translocation by tentacular-feeding polychaetes (Fig. 1). The apparatus consists of a cylindrical grooved wood base, 30 cm diameter, and a large outer ring of plastic screen (4 mm openings) enclosed by a 68.4 μm plankton netting which fits into the groove. The netting prevents sediment from escaping while allowing water to circulate within and through the chambers. An inner enclosure, consisting of a 12 cm diameter petri dish surrounded by 4 mm mesh plastic netting confines the experimental worms, but allows them to extend their tentacles through the screen. Sediment is placed outside the inner plastic mesh to a depth equal that of the petri dish (1 cm) and extends outward 9 cm from the initially empty petri dish.

Amphitrite ornata, collected in the vicinity of an active oyster reef near Beaufort, N.C., were placed in holding chambers containing beach sand and acclimated at ambient temperature and salinity for 1 week. One worm was then placed in each of 12 experimental chambers on a laboratory seawater table. Each chamber was supplied with flowing, aerated, cotton-filtered seawater

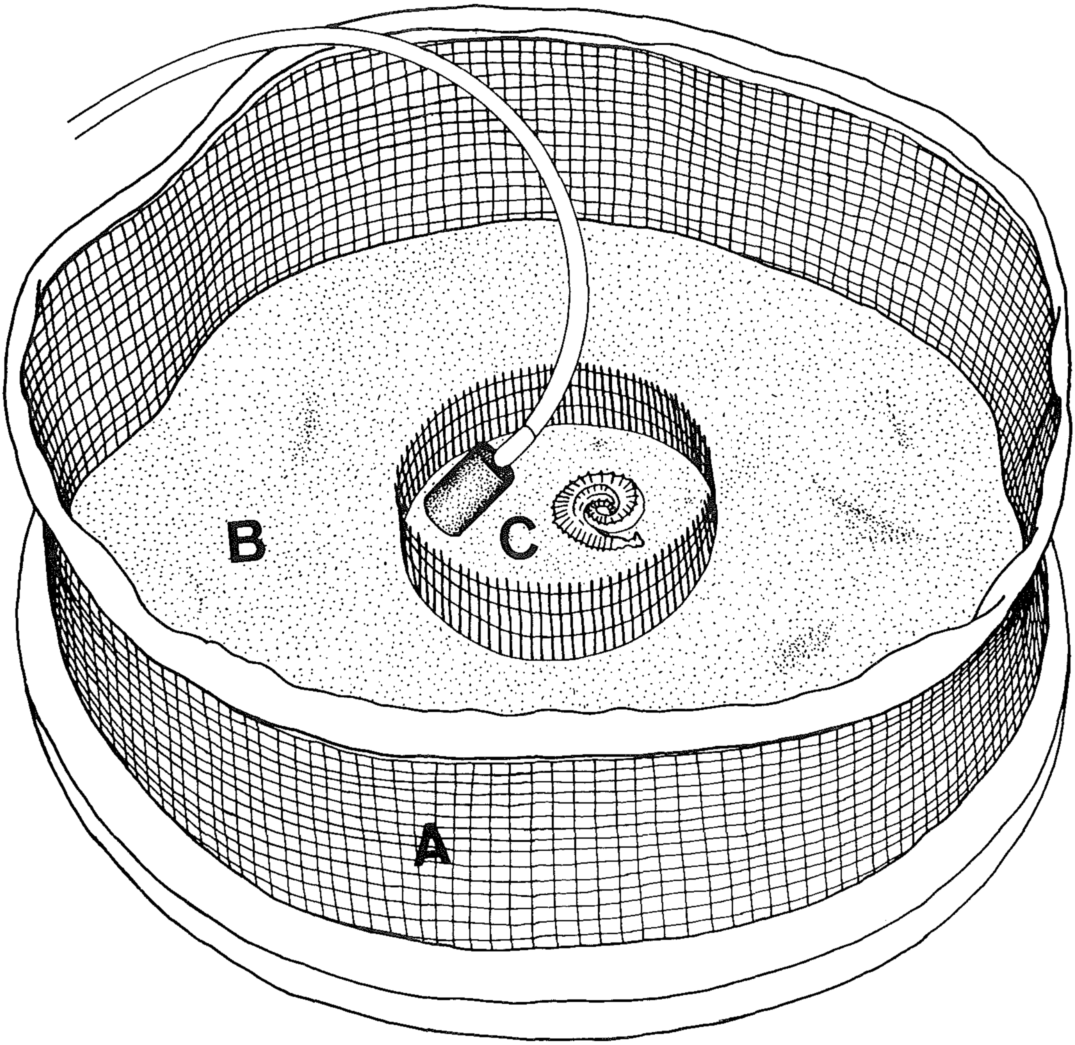

Figure 1. Experimental chamber used for transport studies of the polychaete worm *Amphitrite ornata*. A. Plastic screen (4mm openings) enclosed by a 68.4 μm plankton netting which fits into a groove in the wooden base. This prevents sediments from escaping while allowing water to circulate within and through the chambers. B. Areas where sand, 1 cm deep, is placed for manipulation by the experimental animals. C. Inner enclosure consisting of a petri dish surrounded by plastic netting, confining the worms but allowing them to extend their tentacles to retrieve sediment.

having a salinity of 29.3-31.1 ‰ and a temperature of 17.0-20.0 °C. Sediment collected from the field was muffled at 500 °C to remove organic matter, sieved through a 297 μm standard screen, and collected on a 177 μm screen. Slightly more than 75% of the weight of sediment collected on the 177 μm screen fell within the particle size range of 177-250 μm, while in excess of 85% of the weight of sediment collected on the 297 μm screen exceeded a particle diameter of 297 μm. Enclosures 1-4 were provided with particles collected on the 177 μm screen and enclosures 5-8 with an equal mixture by weight of sediment collected on the 177 μm and sediment collected on the 297 μm screen. Containers 9-11 were provided only with sediments collected on the 297 μm sieve. Sediments in the area from which the animals were initially collected are primarily silty sand with a maximum

DOI: 10.18785/negs.0602.10

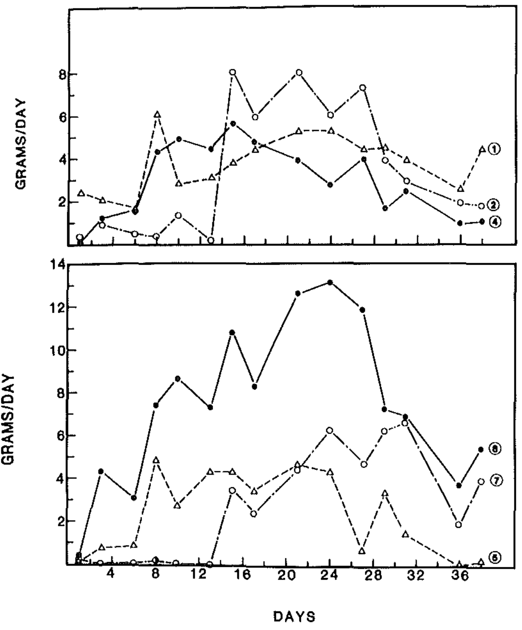

Figure 2. Average wet weight of sediment moved per day per individual *Amphitrite ornata* over the course of the experiment. The circled numbers refer to experimental animals (see Table 1).

diameter of ≈ 250 µm.

Sediment obtained by the worm's tentacular responses outside the confinement area was deposited in the inner petri dish. The material was removed daily to obtain wet and dry weights. During the first 8 days, worms 3, 6, 10, and 12 died. Data from these worms were not utilized in the analyses. The remaining polychaetes upon which our data and analyses are based, remained active and appeared healthy for the entire period. Worms surviving the experimental period of 38 days were wet-weighed periodically.

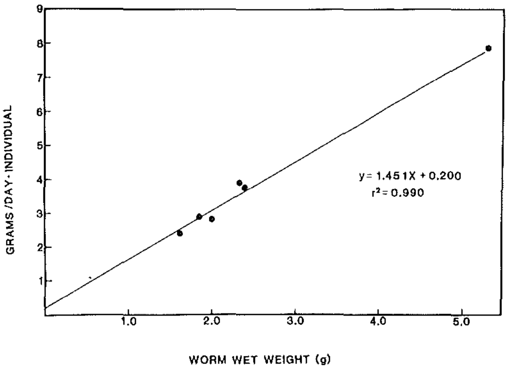

Figure 3. Least squares regression relating sediment translocation to wet weight of *Amphitrite ornata.*

RESULTS AND DISCUSSION

Movement of sediment varied daily, but the total amount of sediment moved was a function of the size of the worm. Sediment movement generally was low during the first week, increased to a maximum during the next three weeks, and

Table 1. Wet weight of sediment tranlocated by *Amphitrite ornata* in the laboratory. Data are presented on the weights of worms and sediment particle sizes. Data are based on a 38-day experimental period. Statistics ($\bar{X} \pm$ 1 SE) also are provided.

Amphitrite		Sediment	Sediment Translocation			
Number	Wet Weight (g)	Particle Size (µm)	Total (g)	Per Individual (g/day)	Per Wet Weight (g/d.g^{-1})	Per Average Worm (g/day)
1	2.38	177	142.99	3.76	1.58	3.97
2	2.32	177	146.96	3.87	1.67	4.16
4	1.85	177	110.25	2.90	1.57	3.91
5	1.61	177 + 297	92.50	2.43	1.51	3.76
7	2.02	177 + 297	108.16	2.85	1.41	3.51
8	5.31	177 + 297	298.20	7.85	1.48	3.68
			$\bar{X}$=	3.94 ± 0.81	1.53 ± 0.04	3.82 ± 0.09
9	2.13	297	35.80	0.94	0.44	1.10
11	2.23	297	194.13	5.11	2.29	5.70

decreased in the latter part of the experimental period (Fig. 2). The greatest total amount of sediment (298.2 g wet weight) was moved by the largest worm (5.31 g wet weight) and the least amount (92.5 g, was moved by the smallest worm (1.61 g) (Table 1). Except for worms exposed to only the large-sized particles (i.e. No. 9 and 11), there was a significant linear relation between the average amount of sediment moved per day and the weight of the worms ($r^2 = 0.99$) (Fig. 3). Using only those six *A. ornata* presented the mixture of the 177 μm collected sediments, there was a fairly uniform average sediment translocation on a tissue wet weight basis (mean ± 1 SE = 1.53 ± 0.04 g sediment/d·g tissue, N = 6) (Table 1). Sediment translocation by those *A. ornata* provided only sediment$\geq$ 297 μm (sediment sizes not normally encountered by the worm in the Beaufort area) varied over five-fold (Table 1).

Our data for the six *A. ornata* presented sediments in size ranges normally encountered are consistent among themselves and similar to the few available published accounts. Even though our data were obtained from worms under laboratory conditions, they agree with data of Rhoads (1967) and Aller & Yingst (1978) for sediment reworking by *A. ornata.* Aller & Yingst (1978) reported that the rate of sediment movement by a single worm in an undisturbed box core collected from the field but held in the laboratory for 1 week at 20°C was 4.5 g/d; the daily rate was variable, averaging 2.6 g/d during the first 2 days and 5.2 g/d over the following 5 days. Rhoads (1967) also reported a highly variable rate in a field reworking study (0.36 to 9.6 g/d), with a mean ± 1 SE of 4.6 ± 1.1 g/d at 17°C. The overall mean we calculated for sediment movement per individual (regardless of size) for those six organisms presented the mixture or the 177 μm sieved sediment was similar to these averages; an individual *A. ornata* moved an average 3.94 g sediment/d (Table 1). We also observed lower daily rates initially (Fig. 2) and the variability was similar to that reported by Rhoads (1967).

Although neither Rhoads (1967) nor Aller & Yingst (1978) presented information on the size of *A. ornata* in their studies, the similarity of results on an individual basis derived from both laboratory and field studies suggests that our data are reasonable and can be extrapolated with caution to field situations. This similarity also indicates that aeration of the medium in which the worms were held in our experiments probably had no adverse impact on the animals that survived. The success of the apparatus that we developed also suggests that it can be employed to estimate the reworking process of terebellids in the field. For example, an oyster reef sampled near our laboratory had a mean density of 17 *A. ornata*/m^2. If we assume they average about the same size as the worms in our experiment (≈ 2.5 g wet weight), each has the potential of reworking about 3.7 g of sediment each day (Table 1) or about 63 g/m^2· day. This reworking of the sediment alters the roughness characteristics of the bottom and provides material which has the potential of being resuspended by water currents, thus making this sediment and its organic matter available to the oysters and other organisms in the community in which these worms live.

ACKNOWLEDGMENTS

The authors thank Robin R. Berry of the College of Charleston, Charleston, S.C., for her assistance in this research. This research was supported through a cooperative agreement between the U.S. Department of Commerce (National Marine Fisheries Service) and the U.S. Department of Energy. Contribution Number 83-29B of the National Marine Fisheries Service, NOAA Southeast Fisheries Center, Beaufort Laboratory, Beaufort, NC 28516.

LITERATURE CITED

Aller, R.C., and J.Y. Yingst. 1978. Biogeochemistry of tube-dwelling: A study of the sedentary polychaete *Amphitrite ornata* (Leidy). J. Mar. Res. 36: 201-254.

Barnes, R.D. 1968. The annelids, p. 204-208. *In* Barnes, R.D. Invertebrate zoology. W.B. Saunders, Philadelphia.

Cross, F.A., T.W. Duke, and J.N. Willis. 1970. Biogeochemistry of trace elements in a coastal plain estuary: Distribution of manganese, iron, and zinc in sediments, water, and polychaetous worms. Chesapeake Sci. 11: 211-234.

Dales, R.P. 1955. Feeding and digestion in terebellid polychaetes. J. Mar. Biol. Assoc. 34: 55-79.

Day, J.D. 1973. New polychaeta from Beaufort with a key to all species recorded from North Carolina. NOAA Technical Report NMFS Circ-375. 140 p.

Fager, E.W. 1964. Marine sediments: Effects of a tube-building polychaete. Science (Wash. D.C.) 143: 356-359.

Fauchald, K. 1977. The polychaete worms, definitions and keys to orders, families and genera. Nat. Hist. Mus. Los Ang. Cty. Sci. Ser. 28. 188 p.

Featherstone, R.P., and M.J. Risk. 1977. Effect of tube-building polychaetes on intertidal sediments of the Minas Basin, Bay of Fundy. J. Sediment. Petrol. 47: 446-450.

Hartman, O. 1945. The marine annelids of North Carolina. Bull. No.2. Duke University Press. 53 p.

Rhoads, D.C. 1967. Biogenic reworking of intertidal and subtidal sediments in Barnstable Harbor and Buzzards Bay, Massachusetts. J. Geol. 75: 461-476.

Wilson, Jr., W.H. 1979. An annotated checklist of the shallow-water marine invertebrates of the Morehead City-Beaufort region of North Carolina. Edited by C.H. Peterson. Inst. Mar. Sci., Univ. North Carolina. 42 p.

Thomas J. Price and Gordon W. Thayer, *National Marine Fisheries Service, NOAA, Southeast Fisheries Center, Beaufort Laboratory, Beaufort, N.C. 28516.*