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Westward advancement of *Pseudonereis anomala* (Polychaeta: Nereididae) in the Mediterranean Basin (Piraeus, Saronikos Bay, Aegean Sea)

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Abstract

This paper reports the establishment of the Lessepsian Pseudonereis anomala (Gravier, 1901) in its new locality in the port of Piraeus (Saronikos Bay) and provides additional information on its population. The mean densities of P. anomala ranged from 0 indiv./m² to 382.5 indiv./m² among the calcareous alga Corallina elongata. A variety of sizes (length of the head and first ten chaetigerous segments) was observed ranging from 1.3mm to 8.1mm. There are indications that P. anomala may compete with other species of Nereididae.

Keywords: *Pseudonereis anomala*; Saronikos Gulf; Polychaete; Immigrant.

Introduction

The artificial opening of the Suez Canal in 1869 led to the influx of biota from the Red Sea into the Mediterranean (Lessepsian migrants). Despite impediments such as the canal's length, shallowness, current regime, temperature and salinity extremes, hundreds of Erythrean species have managed to traverse the canal and settle in the Mediterranean (GALIL, 1993). Migration through the man-made Suez Canal is supported by a predominant south to north current (ZIBROWIUS, 1992) and thus, the vast majority of migration has been from the Red Sea to the Mediterranean. So far, more than 600 alien species of algae, invertebrates and fish have been recorded from different provinces of the Mediterranean Sea (EEA, 2006), 52% of which are introduced via the Suez Canal and 14% of the latter are polychaetes (STREFTARIS *et al.*, 2005). ERGEN *et al*. (2002) report from the Turkish coast 34 species of lessepsian polychaetes belonging to 11 families, of which Nereididae comprise 26.5% of the species. One of the lessepsian nereid species is *Pseudonereis anomala*, which has been described recently in Izmir Bay by HINAR and ERGEN (2005) and recorded in Greek waters by KAMBOUROGLOU & NICOLAIDOU (2006). The present paper provides information on a population of *P. anomala* established at the port of Piraeus, Saronikos Gulf, Greece.

Materials and Methods

Within the framework of the project: "*Invasion of allochthonus species in Greece via shipping and impacts on local ecosystems*", five stations were sampled on hard substrata at the port of Piraeus in September 2003 (Fig.

1). Sampling was carried out by scuba diving using a quadrat sampler of 400 cm^2, which is the minimum necessary surface for a statistically sound investigation on hard substrata (WEINBERG, 1978; STIRN, 1981). Three replicates per station were collected at approximately 0.5m water depth.

Stations A and B were located on either side of the outer port-wall. At station A, on the outer side, the substratum was covered by the alga *Corallina elongata*. Station B, a site used for mooring of small boats, was dominated by the alga *Ulva lactuca*. At both stations, the algae *Chaetomorpha linum, Ceramium diaphanum, Ceramium tenerimum, Gelidium latifolium* and the epiphyta *Fosliella farinosa* were also present. At station C, where large cargo vessels dock, the bottom was covered by large specimens (56.2±3.3mm) of the black mussel, *Mytilus galloprovincialis* (LAMARCK, 1819). At stations D and E, samples were taken from a wharf used by trans-oceanic passenger vessels as well as by ships which travel within Greece. These sites were also dominated by *M. galloprovincialis* but of smaller size (9.8±4.7mm).

At the time of sampling, water temperature and salinity were ~28ºC and ~38psu respectively. The material was fixed in 5% formalin immediately after collection and then transferred to the laboratory where it was sieved through a 0.5 mm mesh sieve and sorted. The organisms were preserved in 75% ethanol. Polychaetes were separated from other zoobenthic groups and the specimens were identified and counted under a stereomicroscope. When necessary, the animals were dissected in order to examine their morphological structures such as chaetae, parapods, pharynx etc. To obtain a measure of size, as most specimens were broken, the length of the head and first ten chaetigerous segments were measured (as also done by ÇINAR & ERGEN, 2005) using the Nikon SMZ-2T image analysis system.

The correlation between the abundance of *P.anomala* and the native species *Websterinereis glauca* (CLAPARÈDE, 1870) was tested by the Pearson product moment

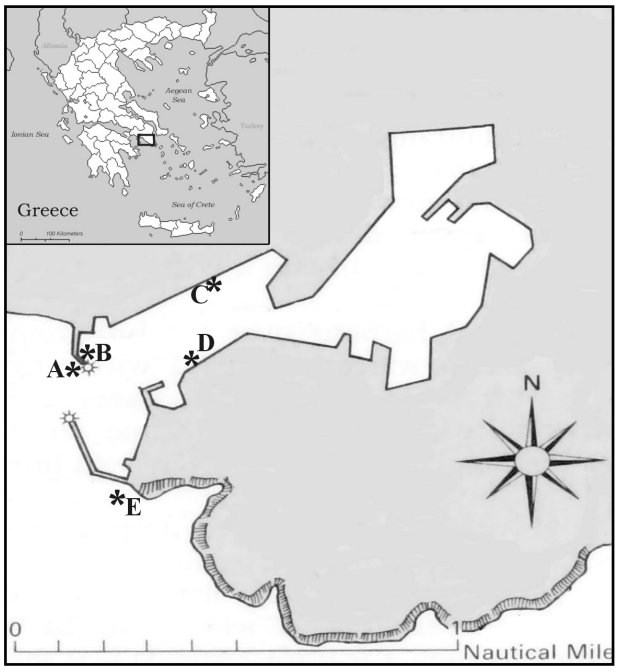

Fig. 1: Port of Piraeus and sampling sites.

correlation. The data were first transformed to logarithms as they did not conform to normality (ZAR, 1984).

The identification of the species was verified by Dr. M.E. Hinar. The specimens of *P. anomala* examined are deposited in the Department of Zoology and Marine Biology of the University of Athens.

Results and Discussion

A total of 55 specimens of *Pseudonereis anomala* were collected of which there were 46 in Station A, three in Station B and six in Station E. These correspond to mean densities of 382.5 indiv./m^2, 25 indiv./m^2 and 50 indiv./m^2 respectively. The species was missing from the other two stations. The number of individuals collected in Piraeus is the largest recorded in any one site in the Mediterranean. The largest number mentioned so far is 17 individuals in Antalya, on the Levant coast of Turkey (ÇINAR & ERGEN, 2005). In Piraeus a variety of sizes, from 1.3 mm to 8.1mm, was observed (Fig. 2), which suggests that the specimens belong to an established population. However, no reproductive stages were found.

The hypothesized progressive intrusion and present distribution of *P. anomala* in the Mediterranean is shown in Figure 3. It is difficult to postulate the time of arrival in Greek waters since very little information exists on the benthos of shallow hard substrata (SoHelMe, 2005). The successive records along the Levant coasts would suggest a stepwise migration through the Suez Canal where it has been found in large numbers (BEN-ELIAHU, 1991). With its presence in Izmir Bay (ÇINAR & ERGEN, 2005) and in Greek waters (KAMBOUROGLOU & NICOLAIDOU, 2006), *P. anomala* extended its distribution outside the Lessepsian Province (SENSU POR, 1990). Its occurrence in ports, both in Alsancak Port (Izmir Bay) and the ports of Piraeus and Kalamata suggest that the expansion of its distribution may, at least, be facilitated by shipping. ÇINAR & ERGEN (2005) also suggest that the occurrence of Lessepsian species outside the Levant Sea could be attributed to passive transport of larvae in ballast water or of adults on hulls of ships. As ZIBROWIUS (1992) points out, colonising by alien species is proportionally more important in port, estuarine and other brackish environments, which diverge from more standard conditions.

BEN-ELIAHU (1991) considers *P. anomala* as an ecological generalist concerning its habitat. In the present case,

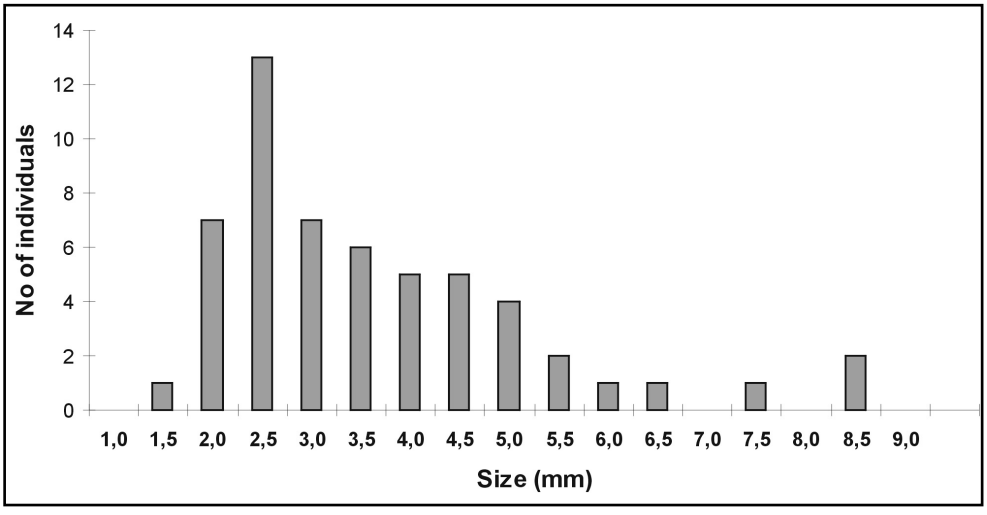

Fig. 2: Size distribution of *P. anomala* in Piraeus.

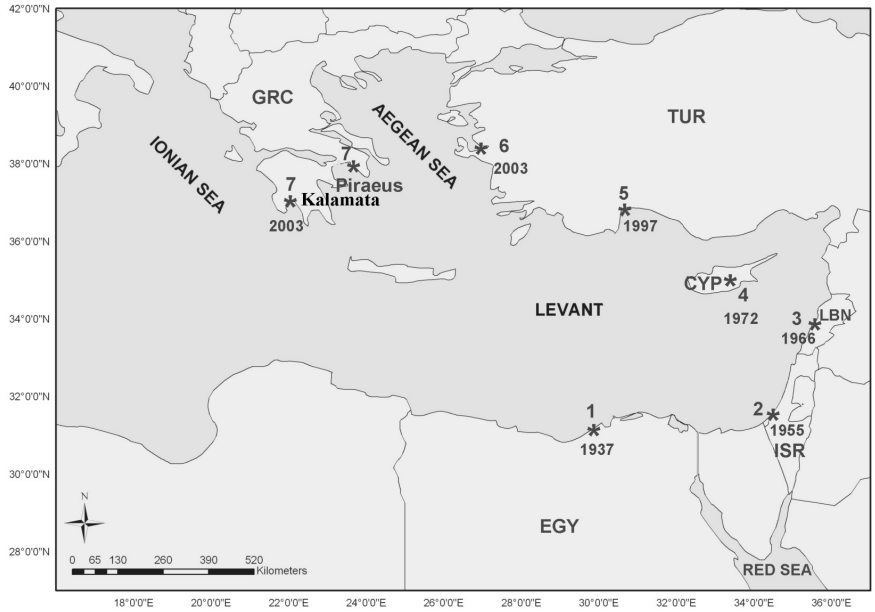

Fig. 3: Distribution of *Pseudonereis anomala* within the Mediterranean Sea. 1: FAUVEL (1937); 2: FAUVEL (1955); 3: LAUBIER (1966); 4: BEN-ELIAHU (1972); 5: ERGEN & ÇINAR (1997); 6: ÇINAR & ERGEN (2005); KAMBOUROGLOU & NICOLAIDOU (2006).

P. anomala showed a preference for C*orallina elongata* on which it may feed. ÇINAR & ERGEN (2005) have found large quantities of another coralline alga, *Jania rubens*, in its digestive tract. No worms, or only small numbers, were observed among *Mytilus galloprovincialis* in Piraeus. Most specimens collected by ÇINAR & ERGEN (2005) were also found among mussels and their densities were small. Whether the mussel inhibits *P. anomala* directly or indirectly through preventing the establishment of algae, which the worms prefer, cannot be presently inferred. Nevertheless, it is known that *M. galloprovincialis* is a strong competitor and that its size affects the outcome of competition between the mussel and its competitors (BRANCH & STEFFANI, 2004).

Another possible interaction is between *P. anomala* and the native nereid species, *Websterinereis glauca* (CLAPARÈDE, 1870), which was also dominant in the samples from Piraeus. *W.glauca* attained its highest density (10.25 indiv./m^2) in the absence of *P. anomala.* (Figure 4). A Pearson product moment correlation between the two species, showed a significant negative correlation although the relationship was moderately strong (R^2 =0.51, P=0.03). These results are only preliminary, however, *P. anomala* is thought to exclude another Nereididae species, *Perinereis cultifera,* from Mediterranean habitats (BEN-ELIAHU, 1991).

P. anomala was first recorded in the Mediterranean in 1937 (FAUVEL, 1937) and its advancement has been slow. In the 70 years of its presence there has been no evidence that it is causing serious problems to local communities. However, should global warming affect the Mediterranean sea-water temperature this erythrean immigrant may gain distinct advantage over the native species. Thus, the mode of reproduction and dispersal, the reproductive potential of *P. anomala* in the

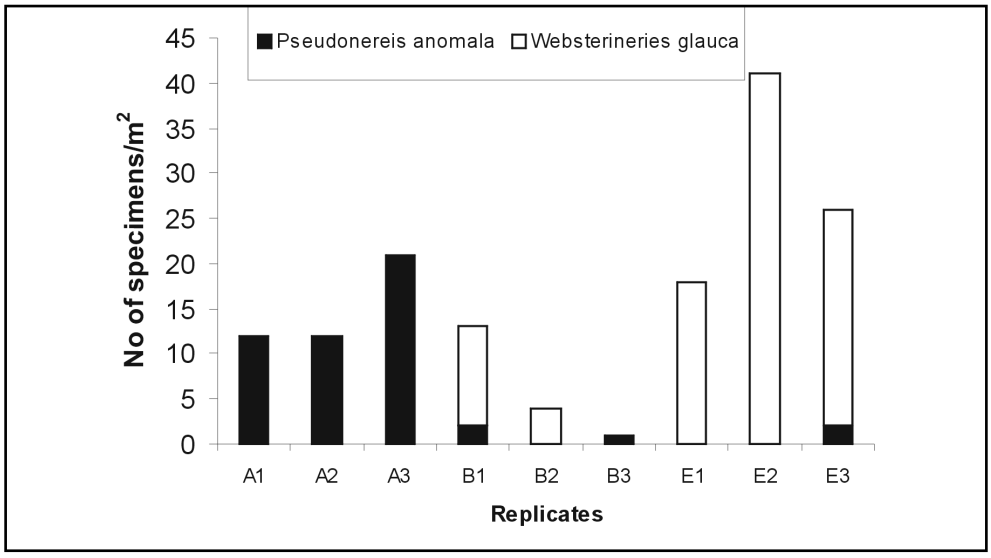

Fig. 4: Relationship between the abundance of *Pseudonereis anomala* and *Websterinereis glauca.*

Mediterranean and its interactions with other species are subjects that merit further investigation.

Acknowledgements

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