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Short Communication

Shift in *Sabella spallanzanii* (Polychaeta, Sabellidae) spawning period in the Central Mediterranean Sea: a consequence of climate change?

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Abstract

Sabella spallanzanii is a large tubicolous filter feeder polychaete common in the Mediterranean fouling assemblages, where it plays an important role in structuring the community. Its reproductive biology is well known and had has been investigated since 1993. During the past few years, a shift in its reproductive period has been observed. In 2008 the presence of ripe eggs in the females was observed at least two months in advance compared to the past. This was confirmed during the 2009 when spawning and fertilization were observed three months in advance compared to the past. Possible causes of this shift may be related to the increasing surface temperature in the Central Mediterranean Sea.

Keywords: Polychaetes; Reproduction; Sea temperature; Structuring species; Fouling communities.

Introduction

In recent years, numerous studies have focused on the potential effects of global warming upon organisms and the interactions between global warming and changes in life cycles, physiology and behaviour for a wide range of organisms (PARMESAN & YOHE, 2003).

The change in the fauna of the Mediterranean Sea in response to global warming is becoming increasingly evident (BIANCHI, 2007), with species that were found in the southernmost parts of the basin now being found in more northerly locations (GRUBELIC *et al.,* 2004; MIKAC & MUSCO, 2010). Comparing present data on hydroid distribution with that of about 20 years ago, PUCE *et al.* (2009) found that species have reacted to increases in water temperature by modifying their seasonal patterns. Species that were active only in the summer are now present throughout the year, and northerly species are now occupying deeper and colder layers in the water column. Com-

munities are therefore changing with regard to their composition, depth of occurrence and timing of reproduction in response to increasing water temperature.

In the Mediterranean most studies on the consequences of climate change have focused on the distribution patterns of the recently introduced thermophilic alien species (OCCHIPINTI-AMBROGI & SAVINI, 2003; ZENETOS *et al.,* 2005; 2008). Few studies have dealt with the impact of the increasing water temperature on the biology and ecology of autochthonous species (eg. PUCE *et al.,* 2009; CONVERSI *et al.,* 2009; MAZARIS *et al.,* 2008), and on the ecological consequences that changes in the time of reproduction of some species can have on the entire community. Response by individual species to climate change may disrupt their interactions with others. Due to the different response or susceptibility to change, the outcome of their interactions may be altered, as long term data on both terrestrial and marine organisms indicate (WALTHER *et al.,* 2002).

We report observations on the shift in reproduction period of a species playing an important functional role within Mediterranean fouling communities, as well as a role as a structuring taxon.

Sabella spallanzanii (Gmelin, 1791): biology and ecological role

Sabella spallanzanii is a large tubicolous filter feeder polychaete common within Mediterranean fouling communities, both in pioneering and in the late stages of these assemblages. The species colonizes every artificial substrate in eutrophic environments where it can reach a density of about 800 specimens per square meter (GIANGRANDE *et al.,* 2005).

According to the most recent study (GIANGRANDE *et al.,* 2000), *S. spallanzanii* reproduces once a year in winter, and in the Mediterranean the spawning occurs from January to February. Eggs reach up to 250 μm and give rise to a lecithotrophic development with larvae spending up to 15 days in the water column. Gametogenesis occurs from July to January and appears synchronized within populations so that population dynamics were easily predictable, with massive recruitment events occurring regularly each year. The species grows rapidly, reaching about 10 cm in body length during the first year, and can live for more than 5 years, reaching up to 40 cm in length (GIANGRANDE & PETRAROLI, 1994). The species is highly efficient in removing POM, DOM and bacteria from the water column (LICCIANO *et al.,* 2005; STABILI *et al.,* 2006; CAVALLO *et al.,* 2007). This, coupled with the high density reached, led to hypothesise that this species plays an important role in controlling bacterial diversity (LICCIANO *et al.,* 2007).

The species has an Atlantic-Mediterranean distribution, although about 15 years ago, it was introduced into West Australia and subsequently into eastern Australia where it became a pest species, heavily impacting on marine ecosystems with serious coastal economic consequences (CLAPIN & EVANS, 1995). Indeed, it has been estimated that the filtering activity of *S. spallanzanii* is of the same order of magnitude as that of the native seagrass community it replaced (LEMMENS *et al.,* 1996). Manipulative experiments conducted in the area where the species was introduced, indicate that at a high density, adults of *S. spallanzanii* are able to alter the structure of benthic communities (HOLLOWAY & KEOUGH

2002a, b), with a selective action on the settlement of other invertebrates. This effect is related to its particular tree-like morphology with the fan on the top of a long slender tube creating a canopy of feeding fans, interfering with the settlement of other invertebrates.

At present we are investigating the role that *S. spallanzanii* can exert in the Mediterranean area, in the biotope where it normally is a dominant taxon. Preliminary observations suggest that this polychaete can exert a role in structuring the community also during the early stage of colonization when specimens are still too small to show a canopy effect (unpublished data).

Sabella spallanzanii: present observed changes

We have been studying this species in the Mediterranean since 1993. Initially we investigated its life cycle (GIANGRANDE & PETRAROLI, 1993; GIANGRANDE *et al.,* 2000) also in the light of its employment as a bioremediator of aquaculture waste (GIANGRANDE *et al.,* 2005). In a pilot study the species was reared in polyculture with *Mytilus galloprovincialis,* collecting juveniles using the same strategy utilized for mussels (CECERE *et al.,* 2006; PIERRI *et al.,* 2006). Recruitment of *S. spallanzanii* was easily observed over several years from 2001 to 2005. Although very variable in abundance from year to year, young settlers (few cm in length, corresponding to about 1 month of life) were usually present in early March on collectors previously placed in October or November. At the same time, the examination of germinal products always confirmed the previous observed trend with spawning occurring at the beginning of the year. During 2006 and 2007 the complete absence of settled juveniles on collectors led us to reinvestigate on the reproductive cycle of this species by egg measurements. During 2008 we observed females carrying ripe eggs ready to be spawned, in advance early when compared to the previous investigated period: eggs from females collected in early November 2008 measured 225 ± 24 μm vs an average of 151 ± 45 μm observed during November 2000. A similar advance in egg maturation was found during late October 2009, when individuals spawned in the laboratory and 100% of the fertilization occurred. This confirmed an advance in the spawning period of at least 3 months if compared to the past.

Discussion

In the past, spawning of *S. spallanzanii* occurred when seawater temperatures ranged from 11 to 14° C both in the Mediterranean area (February) (GIANGRANDE *et al.,* 2000) and in Port Phillip Bay in Australia (August) (CURRIE *et al.,* 2000), leading to the hypothesise that the reproductive cycle was consistent with either temperature or photoperiod controlling gametogenesis. However, according to CURRIE *et al.* (2000) the relative importance of these two physical parameters in controlling the gametogenic cycle of *S. spallanzanii* was difficult to determine.

The present observed temporal shift in egg maturation (about three months in advance) suggests that temperature is the main factor in controlling reproduction of this species. The change observed in the *S. spallanzanii* life cycle could be interpreted as a very short physiological response to increasing water temperature, i.e. the high surface temperature recorded during the

past few years from July to October could have produced the reduction of the gametogenesis period, leading to an earlier spawning. In other polychaete species, the timing of gametogenesis is proved to be controlled by a gonadotrophic hormone promoting egg protein synthesis in developing oocytes, which in turn is controlled by environmental cues, particularly temperature, and which may be affected by climate change (LAWRENCE, 1996).

In the central Mediterranean Sea, temperature changes occurring over the last decades have led to progressively warmer summers, while winters have remained cold. In fact, while Mediterranean sea surface temperature (SST) has increased by 0.5° C between 1970 and 2005, this increase was not uniform over the year, winter temperatures appear to shows no long-term change, while the spring, summer, and fall temperatures have increased by 0.6, 1.0, and 1.1° C, respectively (CONVERSI *et al.,* 2009). Moreover, according to LUTERBACHER *et al.* (2007) autumn 2006 and winter 2007 have been the warmest of the last 500 years.

Interestingly, a similar shift in reproduction is likely to also affect the co-occurring mussel *M. galloprovincialis,* (PRATO, personal communication), an important commercial species having similar ecological and biological features of to *S. spallanzanii,* including the spawning period. The observed shifts in reproduction period must be more deeper investigated, at a range of sites within the Mediterranean Sea, to establish if this phenomenon is widespread.

However, if the settlement of *S. spallanzanii* is now occurring in October when the SST is higher than in February, which is the normal settlement period of the worm, we suggest that this may impact on the subsequent stages of the species' life cycle.

Each species may have its own peculiar response to the environmental changes and ecological consequences can be higher greater when species playing an important role in their community are involved. Considering that *S. spallanzanii* is a structuring taxon, the changes in its reproduction period might influence the entire community, with the possible disruption of the peculiar equilibrium that fouling communities have reached over an evolutionary time. The next step will be to investigate the ecological and economical consequences of the shifted spawning period of this structuring taxon.

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