

The temporal and spatial occurrence of *Tetrastemma fozensis* (Hoplonemertini) in intertidal bivalves

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Abstract

The bivalve *Scrobicularia plana*, which is commonly found on tidal flats in northwestern Europe, has disappeared from many locations during the past two decades. Its local disappearance has been suspected to be a result of pollution, but other factors such as parasites have also been discussed. The occurrence of *Tetrastemma fozensis*, a small hoplonemertine inhabiting the mantle cavity of *S. plana*, was examined in bivalves from six different estuaries in northern Spain. The bivalves are easily collected, and the nemertines leave the bivalves when placed in a small jar with seawater for 72 h. Regular examinations at 6–10 wk intervals of *S. plana* from the estuary of Plencia revealed that the percentage of bivalves containing nemertines *T. fozensis* decreased during the summer months, but was above 70% during the rest of the year. In most estuaries about 40–60% of the bivalves contained nemertines, but in March 1994, 100% of the bivalves from the estuary of Hendaye were hosts for nemertines. Nemertines were not found in *S. plana* from the highly polluted estuary of Bilbao in either March or September 1994. The number of nemertines within individual bivalves was positively correlated with the size of the bivalves in locations where the percentage of bivalves containing nemertines was above 75%. In one estuary where the nemertines disappeared almost completely from the bivalves between March 1994 and September 1994, parasitic copepods appeared within some bivalves in September 1994. The ecology of the nemertine *T. fozensis* still remains largely unknown, but we suspect that the nemertines may be beneficial for their hosts.

Introduction

The disappearances of species from coastal marine environments are often cause for concern. In some instances, these events could be related to pollution, introduction of other species or destruction of habitats. However, in many cases these local extinctions could not be related to one or more specific factors. This is also the case for the bivalve *Scrobicularia plana* which has disappeared from many locations during the past two decades. Pollution has been discussed as the most important factor causing the local extinction of *S. plana* (Ruiz et al., 1994a), but also parasitism has been discussed (Lauckner, 1990), yet no conclusive evidence

has been brought forward to elucidate the riddle of *S. plana* (see e.g. Reise, 1982; Essink et al., 1991).

It is not anticipated to solve this riddle with our contribution, but we intend to provide some additional information about the biology of *S. plana*. Recently it was found that *S. plana* is host for the hoplonemertine *Tetrastemma fozensis* (Gibson & Junoy, 1991). The nemertine has been identified in *S. plana* from northwestern Spain and southern England (Gibson & Junoy, 1991), but nothing is known about the small-scale distribution and the seasonal occurrence of *T. fozensis*. When addressing the question of the disappearance of bivalves or drastic abundance variability, it may be helpful to look at the presence of organisms living within the body of these bivalves (sensu Sousa, 1991).

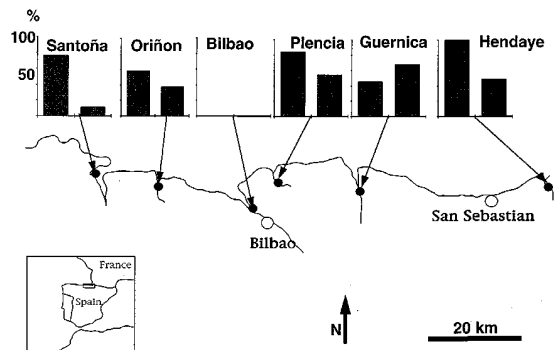


Figure 1. Percentage of bivalves *Scrobicularia plana* containing nemertines *Tetrastemma fozensis* in six estuaries of northern Spain in March and September 1994; $n = 45\text{--}72$ bivalves collected at each sampling site and sampling date.

Our study aims to answer the questions whether the nemertine is present in *S. plana* from different locations, and whether its numbers or the frequency of its occurrence change seasonally.

Material and methods

Bivalves *Scrobicularia plana* were collected from six different estuaries in northern Spain (Pais Vasco and Cantabria) (Figure 1). The estuary of Bilbao is highly polluted with heavy metals and organic pollutants (Seebold et al., 1982; Azkona et al., 1984; Swindlehurst & Johnston, 1991; Ruiz, 1993; Ruiz de la Rosa & Saiz Salinas, 1993), the estuaries of Plencia and Hendaye have intermediate pollution levels (Villate et al., 1990; Borja & Valencia, 1993; Saiz Salinas et al., 1995a, 1995b, 1996) whereas the other 3 estuaries (Santoña, Oriñon and Guernica) can be considered as largely unpolluted (Borja & Valencia, 1993; Ruiz, 1993; Ruiz de la Rosa & Saiz Salinas, 1993). Between 41 and 72 bivalves were collected from each site at each sampling date and placed for 72 h in a small jar with seawater. The jars were monitored every 12 h. All nemertines that had left the bivalves were collected and counted. The individual bivalves *S. plana* were then measured along their longest diameter. Bivalves from the estuary of Plencia were collected at regular intervals of 6–10 wk between March 1994 and February 1995. In the other five estuaries, bivalves were collected in March and September 1994.

In addition, the metal contents of sediments from all estuaries are provided. The data are primarily based on literature values supported by own measurements. In

most cases, sediments were digested with high-purity nitric acid, and the residue then redissolved in 1 N hydrochloric acid (for details see Saiz-Salinas et al., 1996).

Results

Nemertines *Tetrastemma fozensis* were present in 15–100% of the *Scrobicularia plana* from the estuaries of Santoña, Oriñon, Plencia, Guernica and Hendaye, but were never found in bivalves from the estuary of Bilbao (Figure 1). In four estuaries the percentage of bivalves containing nemertines decreased between March and September 1994, whereas in one estuary (Guernica) it increased during this time period (Figure 1). In the estuary of Plencia the percentage of *S. plana* containing nemertines also decreased between March and September 1994, but then increased again until February 1995 (Figure 2). The average size of *S. plana* collected from the estuary of Plencia varied between 36 and 44 mm (Figure 3a). During most of the year the average number of nemertines/bivalve was about 2.0 nemertines/bivalve, but in July and September 1994 it dropped below 1.0 nemertine/bivalve (Figure 3b). The average size of *S. plana* collected from the six estuaries varied between 28 and 44 mm (Figure 4a). No nemertines were found in bivalves from the estuary of Bilbao, but up to five nemertines/bivalve (March 1994, estuary of Hendaye) were found in the other estuaries (Figure 4b). In September 1994 we collected *S. plana* from an additional site in the estuary of Bilbao (Benedicta; average size of *S. plana*: 31.35 mm, $n = 38$), but also did not find any nemertines in these bivalves. In the other 5 estuaries the values varied most commonly between 1.0 and 2.0 nemertines/bivalve (Figure 4b). The highest number of nemertines/bivalve that we encountered during our survey was 15 nemertines in one *S. plana* which was collected from the estuary of Plencia (17th February 1995). Only in the estuary of Hendaye, where in March 1994 100% of all bivalves contained nemertines, did a significant correlation between the size of the bivalves and the number of nemertines/bivalve exist (t -test; $p < 0.005$) (Figure 5).

In September 1994 when only 6 out of 52 *S. plana* from Santoña contained nemertines, parasitic copepods were found in several of the collected bivalves from this estuary. At no other site or sampling date did we encounter these parasitic copepods.

Table 1. Metal contents of sediments, oxygen concentrations in the water and presence (+) or absence (–) of nemertines *Tetrastemma fozensis* in bivalves *Scrobicularia plana* from six estuaries in northern Spain.

	Santoña	Oriñon	Lamiako	Plencia	Guernica	Hendaye
Metals (sediment)						
Ag ($\mu\text{g g}^{-1}$ dry wt)	0.4	0.1	3.5	n.d.	0.35–0.48	1.3
Co ($\mu\text{g g}^{-1}$ dry wt)	5.0	8.0–21.0	16.0	7.5	7.0–9.0	10.8
Cu ($\mu\text{g g}^{-1}$ dry wt)	8.0	18.0–24.0	600.0	20.4	45.0–52.0	100.0
Cd ($\mu\text{g g}^{-1}$ dry wt)	2.6	1.7–6.16	14.0	n.d.	0.39–0.44	1.1
Fe (g kg ⁻¹ dry wt)	2.9	2.39–2.72	2.7	2.0	2.74–2.91	3.4
Mn ($\mu\text{g g}^{-1}$ dry wt)	142.0	171.0–189.0	235.0	309.0	267–456	309.0
Ni ($\mu\text{g g}^{-1}$ dry wt)	19.0	19.0–50.0	52.0	12.2	23.0–29.0	35.0
Pb ($\mu\text{g g}^{-1}$ dry wt)	57.0	70.0–80.0	557.0	36.6	47.0–58.0	150.0
Zn ($\mu\text{g g}^{-1}$ dry wt)	367.0	268.0–288.0	586.0	112.0	165–183	410.0
Cr ($\mu\text{g g}^{-1}$ dry wt)	6.0	11.0–13.0	139.0	13.8	52.0–79.0	56.0
Oxygen (water) (ml l ⁻¹)			0.0–6.5	5.5–11.0	3.0–6.5	0.0–6.5
Periods of severe hypoxia	–	–	+	–	–	–
Nemertines	(+)	+	–	+	+	+
Pollution scale	low	low	high	intermediate	low	intermediate
References	1	1	4, 5, 6	2, 5, 6	1, 2	2, 3, 6

1: Ruiz, 1993; 2: Villate et al., 1991; 3: Saiz-Salinas et al., 1996; 4: Saiz-Salinas et al., 1996; 4: Saiz-salinas, 1997; 5: Saiz-Salinas & Francés-Zubillaga, 1997a, b; 6: own published data.

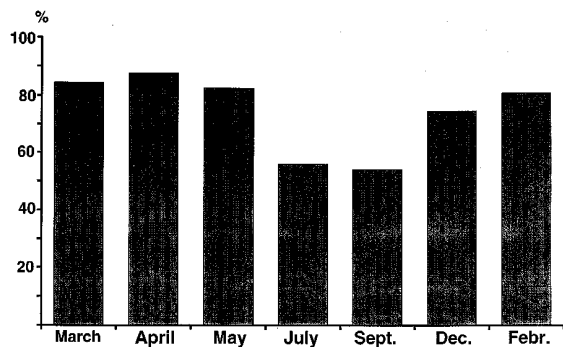


Figure 2. Percentage of bivalves *Scrobicularia plana* containing nemertines *Tetrastemma fozensis* in the estuary of Plencia (March 1994–February 1995); $n = 41$ –72 bivalves collected at each sampling date.

Discussion

The nemertine *Tetrastemma fozensis* inhabits the mantle cavity of its host *Scrobicularia plana* (Gibson & Junoy, 1991). It can commonly be found in bivalves *S. plana* from different estuaries along the coasts of northern Spain, however it was never found in the most polluted estuary. *S. plana* is abundant in the estuary of Bilbao (Ruiz, 1993; Saiz Salinas et al., 1995a), but is not host to *T. fozensis* in this location. In the

polluted estuary of Bilbao, the heavy metal concentrations in sediment, water and tissues of infaunal organisms, such as *Nereis diversicolor* and *S. plana* are much higher than those from the estuaries of Plencia, Guernica, Oriñon or Santoña (Ruiz, 1993; Ruiz et al., 1994a, 1994b; Table 1). Hypoxic and anoxic conditions frequently occur in the waters of the estuary of Bilbao (Umaran Sánchez, 1986; Urrutia Gutierrez, 1986; Consorcio de Aguas, 1993), but concentrations of dissolved oxygen below 2 ml l⁻¹ are never reported from any of the other estuaries (see e.g., Villate et al., 1991; Table 1). Particularly young stages or small individuals are sensitive to metal pollution (Timmermans et al., 1989; Ruiz et al., 1994a) or anoxic conditions. The fact that nemertines are lacking in bivalves from the highly polluted estuary of Bilbao does not clearly indicate that pollution is affecting the presence of the nemertine *T. fozensis*, but it raises founded suspicions. The average size of bivalves *S. plana* from the estuary of Bilbao was smaller than those of the other estuaries, but in the other estuaries nemertines have always been found in bivalves of the size range of those from the estuary of Bilbao.

In the estuaries where we found nemertines, the percentage of bivalves containing nemertines varied seasonally, but it rarely fell below 40%. Thus a sample size of about 50 bivalves is more than sufficient to

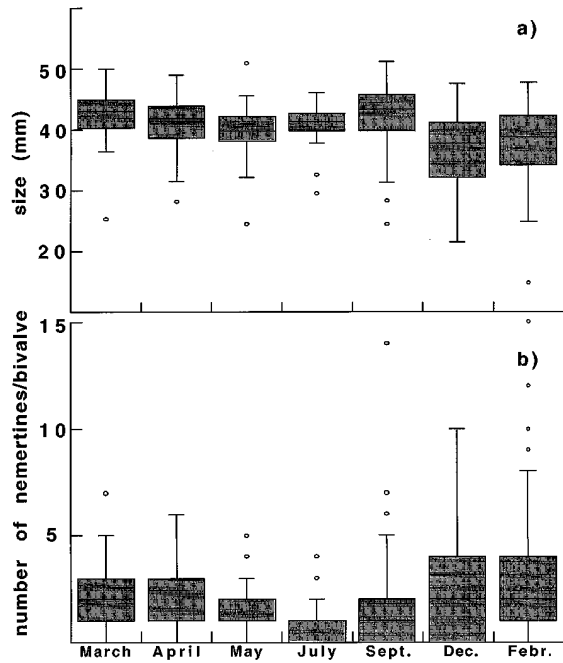


Figure 3. (a) Median size (mm) of *Scrobicularia plana* collected in the estuary of Plencia (March 1994–February 1995); boxes comprise 50% of all values, dots are outliers. (b) Median number nemertines *Tetrastemma fozensis*/bivalve *S. plana* in the estuary of Plencia (March 1994–February 1995); $n=41$ –72 bivalves collected at each sampling date; boxes comprise 50% of all values, dots are outliers.

examine whether the nemertine *T. fozensis* is present in bivalves *S. plana* or not. A sample of about 50 bivalves is easily collected and only little effort is necessary to monitor the bivalves for the presence or absence of *T. fozensis*.

The nemertine *T. fozensis* may prove to be a useful bio-indicator species for several reasons. Due to its smallness it may be very sensitive to either heavy metal pollution or hypoxic conditions in the environment. This small nemertine (1–10 mm long, 0.2–0.5 mm wide – Gibson & Junoy, 1991), may be more useful than other meiofauna organisms, because its habitat, the bivalve *S. plana*, persists in the environment for relatively long time periods (2–5 years). The life-style of *T. fozensis* within a hardy organism such as *S. plana* means, that it may be a good intermediate bio-indicator between short-lived meiofauna organisms and longer-lived macrofauna organisms such as *Nereis diversicolor* and *S. plana*. Free-living meiofauna organisms may be wiped out from certain locations by extreme seasonal events or by singular pollution events. Macrofauna organisms prove to be persistent even in conditions

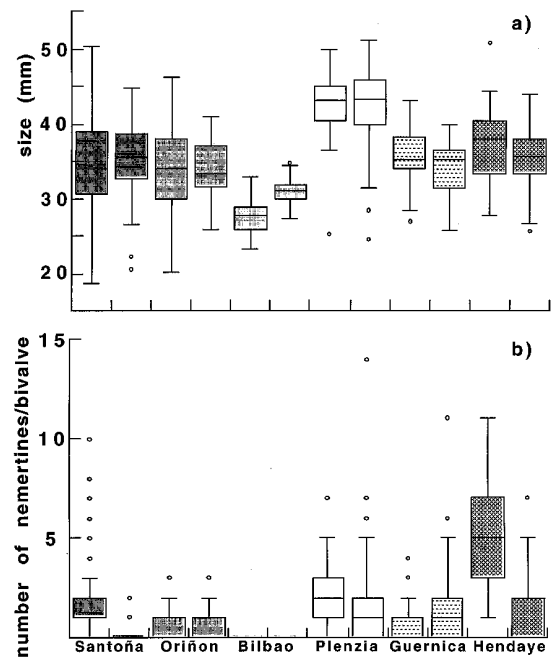


Figure 4. (a) Median size (mm) of *Scrobicularia plana* collected in six estuaries of northern Spain in March and September 1994; boxes comprise 50% of all values, dots are outliers. (b) Median number nemertines *Tetrastemma fozensis*/bivalve *S. plana* in six estuaries of northern Spain in March and September 1994; $n=45$ –72 bivalves collected at each sampling site and sampling date; boxes comprise 50% of all values, dots are outliers.

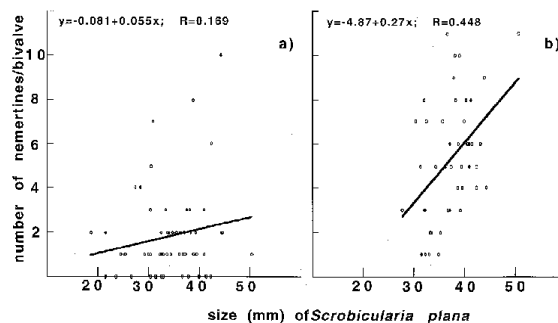


Figure 5. Number of nemertines *Tetrastemma fozensis*/bivalve *Scrobicularia plana* in relation to the size of their hosts *S. plana* from the estuaries of Santoña (a) and Hendaye (b) in March 1994; $n=60$ bivalves collected in Santoña and $n=45$ bivalves collected in Hendaye.

were long-term pollution or frequent anoxic conditions occur (Saiz Salinas et al. 1995a, 1995b).

Parasitic copepods may have detrimental effects on bivalves as is reported for *Mytilicola intestinalis* which infests commercially important bivalves (see Sindermann 1990 and references therein). The appear-

ance of parasitic copepods in *S. plana* from the estuary of Santoña between March and September 1994, when the nemertines *T. fozensis* disappeared from most bivalves, may provide some hint on the ecological role of the nemertines within the bivalves. We speculate that the nemertines may prey on these parasitic copepods or free-living meiofauna which was taken up with the feeding current of the bivalves. The ecology of the nemertines requires further investigations, and its study may contribute to solving the riddle of *S. plana* in northwestern Europe.

We have demonstrated that the presence or absence of *T. fozensis* in the bivalve *S. plana* can be easily monitored. We propose to examine the presence of *T. fozensis* in *S. plana* over the whole distributional range of the bivalve in northwestern Europe. Furthermore we encourage studies on the ecology of the nemertine *T. fozensis*. A thorough understanding of the organisms which inhabit the body of the bivalve *S. plana* is considered essential to understand the population dynamics of this bivalve (sensu Sousa, 1991).

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