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Effects of Pollution on Marine Gastrotricha in the Northwestern Adriatic Sea

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The barrier islands and coast south and east of Venice, Italy, were sampled in parallel to the work of Schrom two decades ago. Where he found 49 site records for 24 species of gastrotrichs at 8 sites, 5 littoral and 3 shallow sublittoral, we found 5 site records for 2 species at 9 sites, 5 littoral and 4 shallow sublittoral. We had no site records from littoral sites; one species, *Dolichodasys elongatus*, occurred at all sublittoral sites. From other locations (n = 15) in our present survey of the Italian coastline, where we have paired littoral:sublittoral sites, we have found 6.7 (±0.9) species in the former and 8.0 (±0.9) in the latter. The absence of gastrotrichs in samples from all five littoral sites and the dominance of *D. elongatus* in sublittoral sites is clear evidence as to the severity of pollution in this area. However, five species were found in a sample from the top of a longshore bar at one location, indicating that a type of local refugium exists from which future recolonization of the remaining habitat could proceed, if the input of pollutants can be reversed.

Pollution in the northwestern Adriatic Sea, in the Gulf of Venice, is well documented (Pavoni *et al.*, 1987; Ministero dell'Ambiente, 1989; Regione Emilia-Romagna, 1989), but never before with respect to members of the meiobenthic phylum Gastrotricha. In the process of conducting a taxonomic survey of marine gastrotrichs from the coasts of Italy, we sampled in parallel a number of sites and locations that had been studied by Heinrich Schrom during the period of 1964–1969. Inasmuch as the results of these two studies were in such striking contrast, we present a summary of both here; a more complete report of the results of our own survey is forthcoming.

Results

Schrom (1966a,b, 1972) sampled four locations (Fig. 1) along the barrier islands that fringe Venice to the south and one location further east beyond the termination of the island chain. Three of the locations were on the Litorale di Lido, two at Alberoni to the southwest (one facing the Adriatic [AA], the other facing the Laguna Veneta [AL]) and one at S. Nicolo [SN] to the northeast (facing the Adriatic). One location, Punta Sabbioni [PS], was on the western end of the Litorale del Cavallino, and the fifth and last location, Caorle W [CW], was situated some 40 km to the east; both of these faced the Adriatic. The location at Alberoni that faced the lagoon, a type locality for one species of chaetonotid gastrotrich, has been replaced by a seawall, representing habitat degradation by catastrophic extinction, a kind of pollution in its own right. All five localities were sampled by Schrom at littoral sites, but only the Adriatic-facing Alberoni, S. Nicolo, and Punta Sabbioni were also sampled at shallow sublittoral sites, at depths of 2–7 m for Alberoni and 1–2 m for the others. This yielded a total of 8 sites from 5 locations. During July 1989 we sampled the four existing locations, each with both littoral and shallow sublittoral sites, at 1.5 m depth, and added a fifth, Caorle E [CE], which was sampled only in the littoral region. At Caorle W, we found a longshore trough and bar system to be present, with the trough at 1 m depth and the bar rising

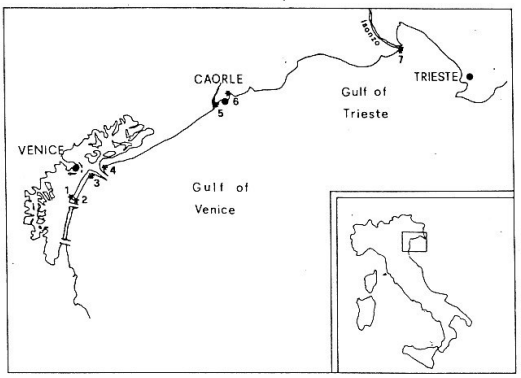

Fig. 1 The northern Adriatic Sea, including both the Gulf of Venice and the Gulf of Trieste. Key to symbols: A—Alberoni, SN—S. Nicolo, PS—Punta Sabioni, C—Caorle, FI—Foce Isonzo.

to 0.5 m depth at about 40 m from the beach, so we also sampled a tenth site at the crest of the bar [CWB]. Thus, we sampled the same number of littoral sites (5), one more shallow sublittoral site (4), plus the bar site, whose importance will be seen later in this paper.

Schrom's data and our own from the present study are given in Table 1. Schrom found 25 species from eight sites, with a total of 49 site records, most of them in the littoral sites, of which Alberoni [AA] was the best studied. From nine comparable sites, we found 2 species, with a total of 5 site records, all from sublittoral sites. Our sample from the longshore bar site at Caorle W, on the other hand, provided 5 species of chaetonotoids. Both *Dolichodasys elongatus* and *Aspidiophorus polystictos* were new to this area.

Discussion

In order to provide some perspective for these observations, we can present species numbers from our present extensive study of the Italian coasts. All represent paired littoral:shallow sublittoral (1–1.5 m, usually 1.5 m, depth) sites. Six locations in other parts of the Adriatic, one near the mouth of the Isonzo River in the Gulf of Trieste and five locations from Termoli to San Cataldo (just south of Brindisi), show 5.7 (±1.7, standard error of the mean) species in the littoral zone and 8.1 (±1.7) in the sub-littoral. Nine locations in other parts of the Italian coastline (Tyrrhenian and Ionian Seas) show 7.4 (±1.1) species in the littoral and 7.9 (±1.0) in the sublittoral.

The numbers of species found by Schrom (Table 1) at least two decades ago correspond well with numbers from other parts of the Adriatic today, with respect to the littoral zone, though they are less than might be expected in the sublittoral zone. On the other hand, our numbers (Table 1) from his locations are clearly out of line in both zones, and the genus *Dolichodasys,* which

TABLE 1
Species by location and site.

		Littoral						Sublittoral			
Locations:	*AL*	*AA*	*SN*	*PS*	*CW*	*CE*	*AA*	*SN*	*PS*	*CWB*	*CW*
Species:											
SCHROM						NS				NS	NS
Order Macrodasyida: 11 spp.											
Acanthodasys aculeatus		×		×					×		
Acanthodasys sp.		×									
Macrodasys caudatus		×	×		×		×	×	×		
Paraturbanella dohrni		×		×			×		×		
Tetranchyroderma apum				×							
**Tetranchyroderma boadeni*		×									
Tetranchyroderma sp. I		×									
Tetranchyroderma sp. II		×									
Tetranchyroderma sp. III		×									
**Turbanella otti*		×			×						
**Turbanella veneziana*		×			×						
Order Chaetonotida: 14 spp.											
Aspidiophorus mediterraneus	×	×	×	×	×		×	×	×		
**Chaetonotus aequispinosus*		×	×								
**Chaetonotus angustus*		×									
**Chaetonotus hilarus*		×	×								
**Chaetonotus serenus*			×								
Halichaetonotus aculifer		×						×	×		
**Halichaetonotus riedli*		×									
**Heterolepidoderma armatum*							×				
**Heterolepidoderma loricatum*		×					×				
Heterolepidoderma sp.		×									
**Lepidodermella limogenum*	×										
Xenotrichula intermedia					×						
**Xenotrichula lineata*		×									
**Xenotrichula soikai*					×						
Locations: 8	*AL*	*AA*	*SN*	*PS*	*CW*	*CE*	*AA*	*SN*	*PS*	*CWB*	*CW*
Totals: 25 spp.	2	19	5	4	6	NS	5	3	5	NS	NS
49 site records											

		Littoral						Sublittoral			
Locations:	*AL*	*AA*	*SN*	*PS*	*CW*	*CE*	*AA*	*SN*	*PS*	*CWB*	*CW*
Species:											
PRESENT AUTHORS	NS										
Order Macrodasyida: 1 sp.											
Dolichodasys elongatus							×	×	×		×
Order Chaetonotida: 5 spp.											
Aspidiophorus polystictos										×	
Halichaetonotus aculifer									×	×	
Halichaetonotus riedli										×	
Heterolepidoderma loricatum										×	
Xenotrichula intermedia										×	
Locations: 10	*AL*	*AA*	*SN*	*PS*	*CW*	*CE*	*AA*	*SN*	*PS*	*CWB*	*CW*
Totals: 6 spp.	NS	0	0	0	0	0	1	1	2	5	1
10 site records											

AL—Alberoni, facing Laguna Veneta; AA—Alberoni, facing the Adriatic; SN—S. Nicolo; PS—Punta Sabioni; CW—Caorle west; CE—Caorle east. NS—not sampled; CE was not studied by Schrom; AL was unavailable for study by the present authors owing to habitat extinction.
*New species, described by Schrom.

had not been described when Schrom did his work, could hardly have been overlooked by him in the sublittoral zone, had it been present, because of its size and morphology. *D. elogatus* is characteristic of low energy, nutrient enriched, often detritus laden, systems (Gagne, 1977; Hummon, personal observation), and probably has been present in such habitats even when they did not characterize the shallow sublittoral zone of this shoreline. Hence, in this instance, we may consider *D. elongatus* to be an indicator of the fringes of severe organic pollution, but even this species is absent from areas of its greatest severity. The complete absence of gastrotrichs in samples from littoral sites that had previously shown several to numerous species is an experience that we have encountered only once before. The beach of Bagno Gorgona, at Marina di Pisa, near the mouth of the Arno River, is also a type locality for two species of Gastrotricha, and a locality from which 17 species have been reported in the past (Luporini *et al.*, 1970, 1971, 1973; Luporini & Tongiorgi, 1972; Tongiorgi, 1975). It is also a site that is subject to severe industrial, agricultural and domestic pollution from the Arno, but also to manipulation of the adjacent waterways by engineers. For the past several years, and again in June 1989, no gastrotrichs have been found at this site. This leads us to conclude that, while the littoral zone in the north-western Adriatic today represents a very inhospitable habitat for gastrotrichs, this is not the only area where habitat degradation by increasing levels of chronic pollution is present.

The importance of the sample from the longshore bar at Caorle W, then, becomes very important in our interpretation of the extent and severity of pollution with respect to members of this meiobenthic phylum. Had the sample not been made, our conclusions might have been even more gloomy. The presence of a trough and bar system is indicative either of an active and persistent longshore current or of a more temporary structure built by storm surges; sediments in the trough and beyond the bar usually become more organically rich and detritus laden than those on the bar. What we realize from data taken at the bar is that there is at least one type of local habitat that can serve as a refugium from localized extinction and a source for recolonization of the littoral and more sublittoral habitats, should the time come when the continued input of pollutants can be controlled and the overall situation in the northwestern Adriatic can be reversed.

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