

Ecological features of Syllidae (Polychaeta) from shallow-water benthic environments of the Aegean Sea, eastern Mediterranean

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Ecological features of Syllidae inhabiting shallow-water benthic habitats of the Aegean Sea were analysed by utilizing some univariate and multivariate statistical methods. A total of 121 benthic materials collected in a variety of substrata and depths (0–76 m) contained 90 syllid species belonging to the four subfamilies Autolytinae, Exogoninae, Eusyllinae and Syllinae. Among the subfamilies, Syllinae were characterized by a high number of species and Exogoninae by a high number of individuals. Although dominant species varied according to substrata, the two species, *Grubeosyllis clavata* and *Syllis prolifera*, accounted for up to 51% of the total syllid populations in the area. Among the biotopes sampled, *Posidonia oceanica* seems to be particularly suitable for the settlement of syllid species, whereas bare sand and mud harbour only a few species, mainly Exogoninae. The cluster- and ordination analyses detected species associations on soft and hard substrata, and suggested that syllid assemblages are strongly affected by the habitat structure. Species compositions associated with algae appear to be related to complexity of the algae, so that the ones with relatively small thalli, such as *Padina pavonica* and *Halopteris* spp., constituted a group with a high similarity-index value. Samples of *Posidonia oceanica* collected at different stations showed a high consistency in terms of syllid assemblages.

INTRODUCTION

The family Syllidae, containing almost 800 nominal species world-wide, is regarded as one of the major higher marine polychaete taxa in coastal marine assemblages in terms of species number and abundance (San Martín, 1984; Sardá, 1991; Çinar & Ergen, 1998). However, some species of the genera *Sphaerosyllis* Claparède, 1863, *Braniella* Hartman, 1963 and *Syllis* Savigny, 1818 have also occasionally been reported from deep water (Kudenov & Harris, 1995). Syllids represent a wide range of feeding habits, from detritivores to carnivores, and also constitute an excellent food for many marine benthic organisms as well as pelagic ones when they (epitokes) or their sexual products (stolons) migrate to the pelagic environment for reproduction by means of some specific modifications (i.e. swimming chaetae), transferring benthic energy to pelagic ecosystems. Since they show peculiar life-history traits and reproduction modes (Franke, 1999), syllids thus play a major role in the energy flow, recycling of organic matter and are important for population management in a given ecosystem.

The majority of Syllidae are free-living, mainly epifaunal in association with rocks, algae, phanerogams, sponges, hydroids, corals and tunicates, or infaunal (particularly the subfamily Exogoninae) on soft bottoms. Some species of the genera *Autolytus* Grube, 1850, *Branchiosyllis* Ehlers, 1887, *Haplosyllis* Langerhans, 1879, *Myrianida* Milne-Edwards, 1841 and *Procerastea* Langerhans, 1884 are parasitic on a variety of animals, from Porifera to Tunicata, whereas certain species of the genera *Amblyosyllis* Grube, 1857, *Autolytus*, *Bollandia* Glasby, 1994, *Haplosyllides* Augener, 1922, *Haplosyllis*, *Pionosyllis* Malmgren, 1867, *Proceraea*

Ehlers, 1864, *Syllis* and *Trypanosyllis* Claparède, 1864 are considered typical commensal of Porifera, Cnidaria, Decapoda, Asteroidea and Ophiuroidea (see review by Martín & Britayev, 1998).

Ecological characteristics of Syllidae have been studied as part of general ecological works in the Mediterranean, and only a few papers have paid particular attentions to their distributional aspects in near-shore communities of the western Mediterranean (San Martín, 1984; Gambi et al., 1989; Somaschini & Gravina, 1994). This concern has not been investigated in the eastern Mediterranean, with available ecological data about syllids deriving from some general ecological studies (Ben-Eliahu, 1972; Koukouras et al., 1985; Çinar & Ergen, 1998; Çinar et al., 1998; Simboura et al., 2000). However, more recently Çinar (in press) studied ecological features of this family along the coast of Cyprus and pointed out the peculiar syllid assemblages in the area.

The present study focuses on ecological characteristics of Syllidae in the Aegean Sea, with a special emphasis on their relative abundance and diversity in the shallow-water benthic habitats sampled in different locations of the Turkish Aegean coast.

MATERIALS AND METHODS

A total of 121 shallow-water benthic samples (0–76 m, both qualitative and quantitative) were collected from 31 stations located on the Turkish Aegean coast, principally in summer 1995 (Figure 1). Qualitative samples include bare small rocks or rocks with filamentous algae (0–2 m, 29 samples, at all stations except for the stations 4, 11, 12, 14–19

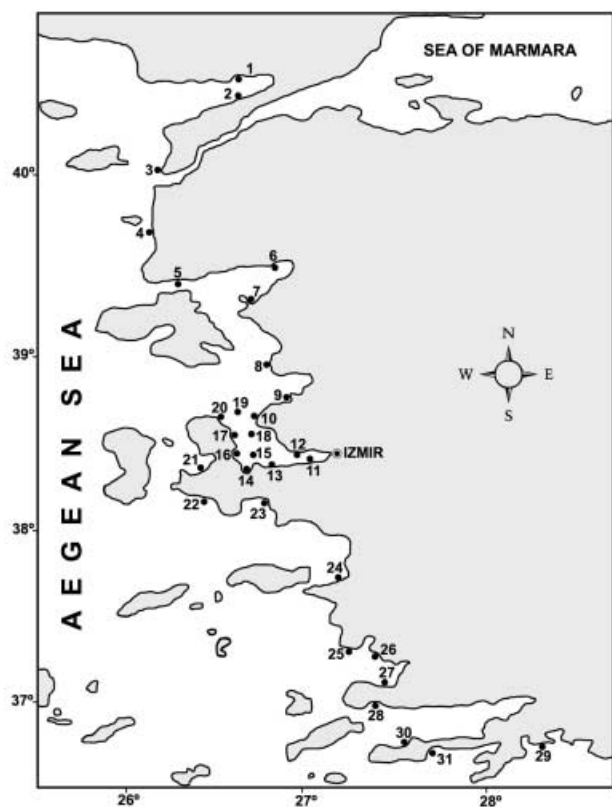


Figure 1. Map of the investigated area with the location of sampling sites.

and 22), the coral *Cladocora caespitosa* Linnaeus, 1767 (1.5 m, two samples, at stations 5 and 10), the bivalve *Pinna nobilis* Linnaeus, 1758 (2 m, three samples, at stations 9, 13 and 25), and the sponges *Aplysina aerophoba* Schmidt, 1862 (2 m, two samples, at stations 5 and 25) and *Sarcotragus* sp. (2 m, three samples, at stations 7, 21 and 31), which were collected randomly at stations where they occurred. The quantitative samples include the common photophilic algae of the upper infralittoral zone of the Aegean Sea such as *Cystoseira crinita* (Desf.) Bory (0.5–1.5 m, 12 samples, at stations 1, 5, 8, 10, 13, 20, 22, 25, 27, 28, 30 and 31), *C. amentacea* Bory (1 m, two samples, at stations 2 and 29), *C. compressa* (Esper) Ferloff & Nizamuddin (0.5 m, two samples, at stations 2 and 24), *C. spinosa* Sauv. (1 m, two samples, at stations 9 and 23), *C. schiffneri* (Hamel) (1 m, three samples, at stations 3, 26 and 30), *C. elegans* Sauv. (1 m, one sample, at station 7), *C. adriatica* Sauv. (0.5 m, one sample, at station 3), *Padina pavonica* (Linnaeus) Thivy (0.5–1.5 m, 14 samples, at stations 2, 3, 6–8, 10, 13, 21, 23, 24, 28, 29 and 31), *Halopteris scoparia* (Linnaeus) Sauv. (0.5–1.5 m, three samples, at stations 10 and 28) and *H. filicina* (Grateloup) Kütz. (0.5–1.5 m, four samples, at stations 13, 20 and 24), the phanerogams *Posidonia oceanica* (Linnaeus) Delile (1–5 m, 23 samples, at stations 1–4, 6–8, 10, 13, 20, 21, 23, 24, 26–28, 30 and 31), *Zostera marina* Linnaeus (2 m, four samples, at stations 7, 8, 13 and 23), *Z. nolthii* Hornemann (1.5 m, two samples, at stations 3 and 4) and *Cymodocea nodosa* (Ucria) Asc. (1 m, one sample, at station 26), and bare fine sand (0.5–38 m, three samples, at stations 17, 20 and 22), sandy mud (30 m, two samples, at stations 12 and 16) and mud substrata (30–76 m, three samples, at stations 14, 15 and

19). Quantitative samples were taken using a frame with 20×20 cm in dimension in habitats of algae, phanerogams and two samples of fine sand between 0–5 m. A van Veen grab with a capacity of 10 dm³ was used in sampling the soft substrate between 5 and 76 m.

The collected samples were first fixed in 5% formalin, rinsed in freshwater in the laboratory and then sieved through a 0.5-mm mesh. Sorted animals were preserved in 70% ethanol. Sponge samples were cut into small pieces and the infauna was removed from the canals. The syllids were separated from other taxa, identified and counted using dissecting and stereo microscopes.

In order to highlight the structure of syllid communities in the investigated biotopes, some ecological indices were used: Shannon–Wiener's diversity index (H'), Pielou's evenness index (J') and Soyer's frequency index (F) applied to the presence and abundance of the species. The Bray–Curtis cluster analysis and correspondence ordination analysis were used to distinguish species assemblages both on hard and soft substrata. Prior to the analysis the raw data expressed as number of individuals in each sample were transformed using transformation of $y_{ji} = \log(x_{ji} + 1)$.

RESULTS

Faunistic analysis of 121 benthic samples comprising a variety of substrata yielded a total of 90 syllid species and 18,957 individuals belonging to the four subfamilies: Autolytinae, Exogoninae, Eusyllinae and Syllinae. A list of the syllid species found during the study, their total number of individuals in each habitat and their distributions to the stations were presented by Çınar & Ergen (2002). Autolytinae were represented by nine species (10% of the total species) and 249 individuals (1.3% of the total individuals); Exogoninae by 30 species (33%) and 8839 individuals (46.6%); Eusyllinae by 18 species (20%) and 1610 individuals (8.4%); and Syllinae by 33 species (36%) and 8259 (43.5%) individuals.

The most dominant species within each subfamily are shown in Figure 2. *Autolytus edwardsi* Saint-Joseph, 1887 (51% of the Autolytinae population) and *A. brachycephalus* (Marenzeller, 1874) (17%) are represented by the two highest dominance values within Autolytinae; *Grubeosyllis clavata* (Claparède, 1863) and *Sphaerosyllis pirifera* Claparède, 1868 within Exogoninae; *Ehlersia ferrugina* Langerhans, 1881 and *Odontosyllis fulgurans* (Audouin & M. Edwards, 1833) within Eusyllinae; and *Syllis prolifera* Krohn, 1852 and *S. gerlachi* (Hartmann-Schröder, 1960) within Syllinae. As a whole, *G. clavata* and *S. prolifera* comprised up to 51% of the total syllid populations in the investigated area. The other most dominant species are *Sphaerosyllis pirifera*, *S. hystrix* Claparède, 1863, *S. austriaca* Banse, 1959, *Exogone naidina* Örsted, 1846, *Ehlersia ferrugina* and *Syllis gerlachi*. They constitute 73% of the total syllid populations and are considered here as typical syllid components of the shallow-water benthic assemblages of the Aegean Sea.

According to Soyer's frequency (F) categorizations, only 6 out of 90 species can be classified as Constant ($F \geq 50$), 16 species as Common (F between 25 and 49) and 68 species as Rare ($F < 25$). The two most dominant and two most frequent species on each habitat are shown in Table 1. As all data are pooled, *Syllis prolifera* ranks first with a

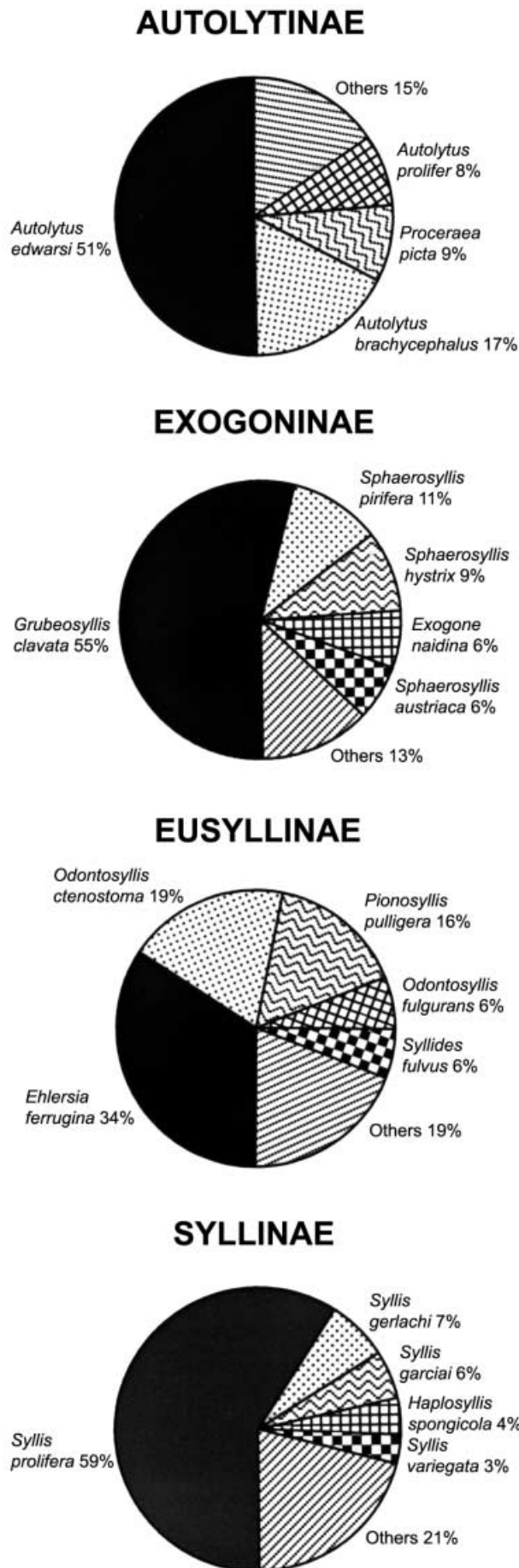


Figure 2. Relative percentages of dominant species in each subfamily.

frequency value of 81% and is followed by *Grubeosyllis clavata* (74%), *Sphaerosyllis pirifera* (63%), *S. hystrix* (58%), *Exogone naidina* (53%) and *Ehlersia ferrugina* (52%). The species with the highest frequency scores within the category Common are *Syllis garciai* (Campoy, 1982), *S. gerlachi*, *S. hyalina* Grube, 1863, *Odontosyllis ctenostoma* Claparède, 1868 and *Haplosyllis spongicola* (Grube, 1855). The species that are present in only one or two samples are *Autolytus convolutus* Cognetti, 1953, *Exogone caribensis* San Martín, 1991, *E. parahomoseta mediterranea* San Martín, 1984, *Exogone* sp., *Sphaerosyllis belizensis* Russell, 1989, *S. campoyi* San Martín, Acero, Contonente & Gómez, 1982, *Sphaerosyllis* cf. *glandulata* Perkins, 1981, *Pionosyllis anophthalma* Capaccioni & San Martín, 1990, *P. dionisi* Núñez & San Martín, 1991, *P. weissmanni* Langerhans, 1879, *Opisthosyllis brunnea* Langerhans, 1879, *Syllis amica* Quatrefages, 1865, *S. heterochaeta* Moore, 1909, *Syllis* sp. and *Xenosyllis scabra* (Ehlers, 1864).

Qualitative sampling

Outer surfaces and canals of the sponges *Aplysina aerophoba* and *Sarcotragus* sp. were occupied by a total of 28 syllid species, of which *Haplosyllis spongicola*, *Syllis prolifer* and *S. garciai* were the most frequent and dominant species. *Aplysina aerophoba* with its less complex structure sheltered only nine syllid species, whereas *Sarcotragus* sp. with a complex pore system and large outer surface contained 26 species.

Two colonies of the scleractinian coral *Cladocora caespitosa* and three individuals of the large bivalve *Pinna nobilis* were inhabited by 29 and 27 syllid species, respectively. The most frequent species were *Syllis gerlachi*, *Haplosyllis spongicola*, *S. gracilis* and *S. prolifer*. The species with the highest dominance scores were *Grubeosyllis clavata*, *H. spongicola*, *S. prolifer* and *S. gerlachi*.

A total of 61 syllid species and 1620 individuals were gathered from bare rock samples collected at 24 stations. The most frequent species were *Syllis prolifer*, *Grubeosyllis clavata*, *Eurysyllis tuberculata* Ehlers, 1864, *Ehlersia ferrugina* and *Sphaerosyllis pirifera*. Regarding their relative abundance, *G. clavata*, *S. prolifer*, *Exogone naidina* and *Odontosyllis ctenostoma* were the most important species. The highest number of species and individuals were found at station 7, the lowest ones at station 28. The algal cover and general environmental conditions seem to be determinant factors for the syllid settlement on rocky substrate. The rocks covered by filamentous algae and surrounded by different complex habitats such as macroalgae or phanerogams contained more syllid species.

Quantitative sampling

The community parameters of biotopes that were quantitatively sampled are indicated in Table 1. The highest number of species, and diversity- and evenness-index values were estimated on *Posidonia oceanica* samples, whereas mud and *Zostera marina* had the lowest scores. The highest mean syllid densities were calculated on *Halopteris scoparia* (11,225 ind m⁻²) and *Cystoseira crinita* (8979 ind m⁻²), with maximum values on *C. crinita* (28,900 ind m⁻²) and *Halopteris filicina* (14,675 ind m⁻²). Although dominant and frequent species, and their percentages varied among biotopes, algal communities were

Table 1. Mean number of species (*S*), number of individuals per square metre (*N*), and diversity index (*H'*) and evenness index (*J'*) values as well as their standard errors estimated in biotopes with their most dominant and frequent syllid components. *R*, number of replicates.

Biotopes	R	S	N (ind m ⁻²)	H'	J'	Dominant species (%)	Frequent species (%)
<i>Cystoseira amantacea</i>	2	24–26	4875–6175	2.57–3.18	0.56–0.68	<i>Syllis prolifera</i> (35) <i>Grubeosyllis clavata</i> (20)	<i>S. prolifera</i> (100) <i>G. clavata</i> (100)
<i>C. compressa</i>	2	3–6	125–8650	0.84–1.37	0.32–0.87	<i>G. clavata</i> (84) <i>Autolytus edwardsi</i> (30)	<i>S. prolifera</i> (100)
<i>C. crinita</i>	11	15.5±1.96 7–26	8979±2384 1325–28900	2.16±0.18 0.81–3.16	0.57±0.04 0.29–0.74	<i>S. prolifera</i> (35) <i>G. clavata</i> (34)	<i>S. prolifera</i> (100) <i>G. clavata</i> (34)
<i>C. schiffneri</i>	3	9.7±3.7 5–17	3675±2846 450–9350	2.04±0.12 1.88–2.27	0.70±0.11 0.48–0.81	<i>S. prolifera</i> (61) <i>G. clavata</i> (11)	<i>S. prolifera</i> (100) <i>G. clavata</i> (100)
<i>C. spinosa</i>	2	9–14	1025–3375	2.84–3.32	0.87–0.90	<i>Odontosyllis ctenostoma</i> (18) <i>S. prolifera</i> (14)	<i>S. prolifera</i> (100) <i>G. clavata</i> (100)
<i>Halopteris flicina</i>	4	16.3±2.5 8–23	8538±2213 850–14675	2.52±0.1 2.25–2.78	0.65±0.03 0.61–0.75	<i>G. clavata</i> (37) <i>S. prolifera</i> (22)	<i>G. clavata</i> (100) <i>S. prolifera</i> (100)
<i>H. scoparia</i>	3	12±1.2 10–14	11225±700 10225–12575	1.62±0.19 1.26–1.92	0.45±0.05 0.38–0.53	<i>G. clavata</i> (51) <i>S. prolifera</i> (37)	<i>G. clavata</i> (100) <i>S. prolifera</i> (100)
<i>Padina pavonica</i>	14	13.4±1.3 7–25	5663±835 850–13450	2.23±0.13 1.51–3.13	0.61±0.02 0.53–0.74	<i>S. prolifera</i> (31) <i>G. clavata</i> (30)	<i>S. prolifera</i> (100) <i>G. clavata</i> (100)
<i>Posidonia oceanica</i>	23	23±1.72 8–36	4889±813 675–13625	3.53±0.13 2.13–4.36	0.81±0.02 0.63–0.90	<i>S. prolifera</i> (12) <i>Syllis gerlachi</i> (10)	<i>Ehlersia ferrugina</i> (96) <i>S. prolifera</i> (92)
<i>Zostera marina</i>	4	3.5±1.1 1–6	156±48 100–300	1.41±0.49 0–2.13	0.69±0.23 0–1	<i>Syllis garciai</i> (36) <i>Sphaerosyllis thomasi</i> (24)	<i>S. garciai</i> (100)
<i>Z. nolthii</i>	2	5–11	100–525	2.01–3.08	0.55–0.89	<i>Brania armini</i> (28) <i>Parapionosyllis elegans</i> (18)	<i>E. ferrugina</i> (100)
Fine sand	3	4.3±0.8 3–6	1558±824 475–3175	1.14±0.69 0.42–2.53	0.44±0.23 0.25–0.9	<i>P. elegans</i> (67) <i>Streptosyllis websteri</i> (21)	<i>P. elegans</i> (100) <i>S. websteri</i> (100)
Mud and sandy mud	5	5.4±3.4 1–19	375±274 25–1450	1.18±0.65 0–3.48	0.47±0.21 0–0.82	<i>Syllis garciai</i> (25) <i>Exogone verugera</i> (5)	<i>S. garciai</i> (60) <i>Exogone cognetti</i> (60)

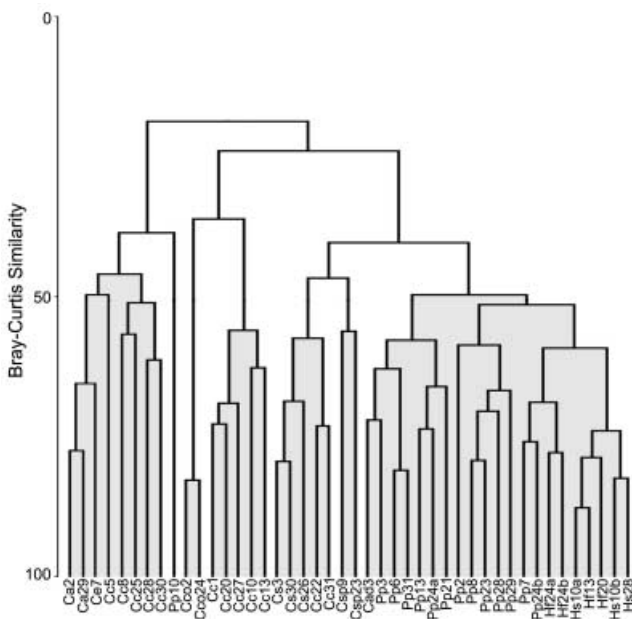


Figure 3. Bray–Curtis similarity between samples of algae examined. Ca, *Cystoseira amentacea*; Ce, *C. elegans*; Cc, *C. crinita*; Cco, *C. compressa*; Cs, *C. schiffneri*; Csp, *C. spinosa*; Cad, *C. adriatica*; Pp, *Padina pavonica*; Hf, *Halopteris filicina*; Hs, *Halopteris scoparia*. The number indicates the station.

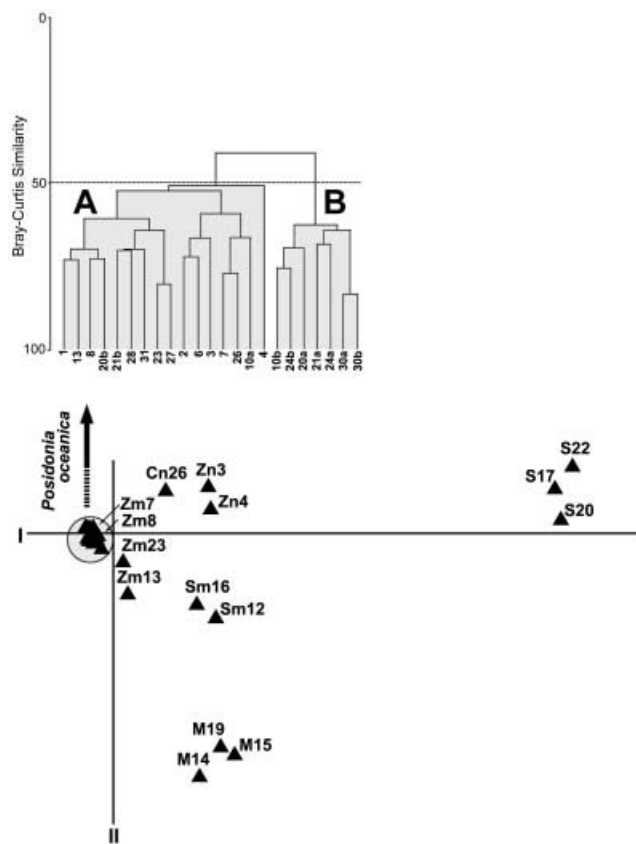


Figure 4. Correspondence analysis ordination showing soft bottom samples relative to axes I and II, with a dendrogram showing affinities among samples of *Posidonia oceanica*. Zm, *Zostera marina*; Zn, *Zostera nolthii*; Cn, *Cymodocea nodosa*; M, Mud; Sm, Sandy mud; S, Fine sand. The number indicates the station.

particularly dominated by *Grubeosyllis clavata* and *Syllis prolifera*. The latter species was also the most dominant species on *Posidonia oceanica*, but its dominance value was comparatively low. In *P. oceanica* meadows, *Syllis gerlachi* and *Ehlersia ferrugina* became important in terms of dominance and frequency values. Certain species represented particular importance on some habitats: *Syllis garciai* is dominant on *Zostera marina* and mud, and *Brania armini* (Langerhans, 1881) and *Parapionosyllis elegans* (Pierantoni, 1903) are dominant on *Zostera nolthii* and fine sand. *Streptosyllis websteri* Southern, 1914 was solely found on fine sand with high dominance and frequency values. Some syllid species seem to be characteristic of certain habitats; *Pionosyllis anophthalma* was only encountered on *Zostera nolthii*; *Exogone caribensis*, *E. cognetti* Castelli, Badalamenti & Lardicci, 1987, *E. gambiae* Lanera, Sordino & San Martín, 1994, *E. parahomoseta mediterranea*, *Exogone* sp., *Sphaerosyllis* sp., *Pionosyllis dionisi*, *P. weissmanni*, *Plakosyllis brevipes* Hartmann-Schröder, 1956 and *Syllis heterochaeta* were found only on muddy substratum.

The Bray–Curtis cluster analysis recognized six major syllid associations on algae (Figure 3). Five samples of *Cystoseira crinita* taken from stations 5, 7, 8, 25, 28 and 30, and all samples of *C. amentacea* and *C. elegans* formed a group at the similarity level of 47%, characterized by relatively high numbers of syllid species, nearly similar population densities of the key taxa such as *Syllis prolifera*, *Grubeosyllis clavata*, *Sphaerosyllis hystrix* and *S. pirifera*, and a high dominance of *Branchiosyllis exilis* (Gravier, 1900) and *Syllis variegata* Grube, 1860. Within this group, the similarity score (~70%) between samples of *C. amentacea* and *C. elegans* is prominent, mainly due to very high population densities of *Haplosyllis spongicola* and *Pionosyllis lamelligera* Saint-Joseph, 1856, which are less important on other algae. Five samples of *C. crinita* collected at stations 1, 10, 13, 20 and 27 joined each other at the similarity level of 55% and were characterized by a relatively low number of species, a high abundance of *Autolytus brachycephalus* and *Exogone naidina*, and similar population densities of *G. clavata*, *Sphaerosyllis hystrix* and *Syllis prolifera*. The other association includes all samples of *C. schiffneri* and two samples of *C. crinita* collected at stations 22 and 31, which contained exceptionally dense populations of *Sphaerosyllis austriaca*, *Grubeosyllis vieitezi* (San Martín, 1984), *Odontosyllis ctenostoma* and *Syllis gerlachi*. All samples of *Padina pavonica*, *Halopteris filicina*, *H. scoparia* and *Cystoseira adriatica* constituted a very large group at the 50% similarity level, involving high population densities of *Exogone dispar* (Webster, 1879), *Odontosyllis ctenostoma* and *Pionosyllis pulligera* (Krohn, 1852), and almost similar numbers of individuals of the key taxa: *Sphaerosyllis austriaca*, *S. hystrix*, *S. pirifera*, *E. naidina*, *G. clavata* and *Syllis prolifera*. The small groups involving the samples of *C. compressa*, which were colonized by a total of eight syllid species, with *G. clavata* and *A. edwardsi* being the most dominant species, and the samples of *C. spinosa*, which had a small number of species with no conspicuous dominant species, are distinct from the others.

The correspondence analysis discriminates soft bottom samples according to their associated components (Figure 4). The first two axes explained 84.3% of the total variance. The bare sand and mud substrata are isolated from others, due to a profound difference in species number and abundance. Bare sand samples inhabited by a

total of seven species were mainly dominated by *Parapionosyllis elegans* and *Streptosyllis websteri*, together accounting for 88% of the total number of individuals, whereas mud substratum hosting a total of 21 species had no conspicuous dominant species with *Syllis garciai* and *Exogone verugera* (Claparède, 1868) being relatively the most important ones. Samples of sandy mud had only three species with no dominant species. The phanerogams *Zostera marina*, *Z. nolthii* and *Cymodocea nodosa* possessed also a small number of species but included dominant species such as *Syllis garciai* and *Brania armini*, which also occurred on *Posidonia oceanica*. Although *P. oceanica* samples seem to be consistent in terms of syllid assemblage (see dendrogram on Figure 4), two distinct subgroups can be distinguished. Subgroup A is dominated by *Syllis prolifera*, *Grubeosyllis clavata*, *Ehlersia ferrugina*, *S. gerlachi* and *Exogone naidina*, whereas subgroup B is dominated by *Syllis gerlachi*, *S. prolifera*, *Ehlersia ferrugina*, *Sphaerosyllis pirifera* and *Syllis garciai*.

DISCUSSION

The present study indicates that the shallow-water syllid fauna of the Aegean Sea is diverse and that many common species previously known only from the western Mediterranean also occur in the eastern Mediterranean, with high quantities in certain habitats. The benthic materials collected from 31 stations along the Turkish Aegean coast contained four species new to the Mediterranean, 27 species new to the eastern Mediterranean and 60 species new to Turkey (see Çınar & Ergen, 2002). With these records, the number of syllid species on the coast of Turkey rose from 30 to 90. Till now almost 160 nominal syllid species have been reported from the Mediterranean Sea; almost 50 species are only known from the western Mediterranean and *Syllis rosea* cf. *magna* (Westheide, 1974) only from the eastern Mediterranean (Israeli coast).

A total of 61 syllid species were found on the ten photophilic algae studied in this study, of which *Cystoseira crinita* (50 species) and *Padina pavonica* (40 species) harboured a high number of species, and *C. compressa* (8 species) a low number of species. Prior to this study, *P. pavonica* was believed to host a small number of syllid species because of its small thalli and less complex structure (Kocatas, 1978; Ergen, 1980; Tena et al., 2000), but this study shows that the alleged paucity of syllid assemblages occurring on this alga mainly comes from the lack of detailed work. Although the main syllid components of *P. pavonica*, *Grubeosyllis clavata* and *Syllis prolifera*, appear to be consistent among the studies, Tena et al. (2000) pointed out the high quantities of *S. prolifera* and *Sphaerosyllis pirifera*, and, in contrast to other studies, the low density of *G. clavata* in the Chafarinas Islands (south-west Mediterranean). The result of the cluster analysis depicted in Figure 3 suggests that the syllid assemblage of *P. pavonica* is fairly constant and represents a close affinity to that of *Halopteris* spp., both characterized by having small thalli in comparison to *Cystoseira* spp. The base and thallus of *Halopteris* spp. were dominated by the minute species of Exogoninae, which generally have direct development that gives rise to local population increments in certain habitats, like *Halopteris* spp., which probably do not allow the settlement of larger species, potential predators of Exogoninae, due to their

small and densely branched architecture that also acts as a cage system that concentrates the trapped sediment that feeds the prevailing food-web.

The *Cystoseira* species examined, except for *C. compressa* and *C. spinosa*, which hosted a relatively small number of species, represented almost similar syllid compositions but with different abundance that distinguished samples as shown in the dendrogram of Figure 3. The present study shows the diverse syllid fauna (50 species) in the *C. crinita* community and the conspicuous dominance of *Syllis prolifera* and *Grubeosyllis clavata* on this alga. Apart from *C. crinita*, syllid compositions of six other *Cystoseira* species were also studied in the Aegean Sea. Among these, a high number of species was found on *C. amentacea* and a low number of species on *C. compressa*. The difference in the syllid diversity encountered on the *Cystoseira* species could be attributed to the structural complexity of the algae. The densely branched thalli of *C. crinita* and *C. amentacea* seem to provide a suitable microhabitat for species settlement. Along the Mediterranean coast of France, Bellan (1964) reported nine syllid species on *C. crinita* and emphasized that Syllidae constituted 25% of the total macrofauna and 40% of the total meiofauna. Katzmann (1971) found 28 syllid species on six *Cystoseira* species in the Adriatic Sea and emphasized the high frequency values of *Syllis prolifera* and *S. variegata*. A relatively diverse syllid fauna (38 species) was reported on *C. mediterranea* collected on the Mediterranean coast of Spain, accounting for 44% of the total polychaete species (Alós, 1990). Further, the study showed the conspicuous dominance levels of the species *Grubeosyllis clavata*, *Exogone naidina* and *S. prolifera*. In the Aegean Sea, Ergen & Çınar (1994) noted a total of 22 syllid species in the community, of which *S. prolifera* was the most important. Along the Chafarinas Islands (south-west Mediterranean), López & Viéitez (1999) distinguished four main algal associations and considered *Cystoseira spinosa* as HP (hemiphotophilic algae) and *C. tamariscifolia* (Hudson) Papenfuss as PEW (photophilic algae in exposed waters); the former were dominated by *Exogone naidina* and *Sphaerosyllis pirifera* and the latter by *Syllis prolifera* and *G. vieitezi*. In the same area, *C. tamariscifolia* hosted a total of 24 syllid species, of which *Syllis prolifera* and *Odontosyllis ctenostoma* dominated the community (Tena et al., 2000). A more recent study on polychaetes associated with *C. amentacea* along the Apulian coast (Italy) showed that the majority of species on the alga belonged to Syllidae and that the most dominant species were *S. prolifera* and *S. truncata* Haswell, 1920 (Fraschetti et al., 2002).

The result of the Bray–Curtis cluster analysis suggests that there are relatively high similarities among syllid communities of the algae examined; however, at least six distinct syllid associations can be recognized. It seems that syllid diversity and composition differ according to algal species rather than locality, with the evidence that samples of the same alga species collected in different stations joined together. The result suggests that the complexity of algae plays a major role in structuring the syllid assemblage, and that using syllid abundance and faunistic data together seems to distinguish algal assemblages prevailing in the area, in contrast to that previously asserted. Giangrande (1988) also considered algal cover as the principal factor responsible for structuring

algal communities. However, Sardá (1991), López & Viéitez (1999) and Tena et al. (2000) reported that polychaete assemblages inhabiting different algal communities differed slightly. Katzmann (1971) concluded that species inhabiting *Cystoseira* species seem to require only small interstitial space and have no particular trophic requirements. On the other hand, he also pointed out the importance of the epiphyte production of *Cystoseira* species in the formation of the community. However, Frchetti et al. (2002) considered the depth (0–2 m), exposed to hydrodynamic forces, as the most important factor affecting species diversity on *C. amentacea*. López & Viéitez (1999) also found a low polychaete diversity on algae exposed to water movement and a high diversity on algae in calm water, and pointed out the importance of amounts of sediment accumulated by algae in the settlement of polychaetes. In contrast to these studies, Katzmann (1971) demonstrated a dense polychaete population on algae in exposed waters. The contradictory ideas reported in the previous studies addressing factors governing species assemblages associated with algae undoubtedly indicate both the lack of a long-term monitoring study and the difficulty in characterizing community structures in the shallow-water hard-bottom environment, where sharp fluctuations in abiotic and biotic factors occur both in space and time.

Other habitats for the settlement of syllid species on hard bottoms are sponges, which supply a good shelter, continuous water flow and organic matter for the associated fauna (Koukouras et al., 1985; Çinar & Ergen, 1998; Gherardi et al., 2001). Syllidae were found to be the most representative organisms associated with sponges; of these, *Haplosyllis spongicola* and *Branchiosyllis exilis* are considered as commensal or parasitic forms of sponges, feeding on sponge tissues, resulting in a decrease in growth rate of sponges and even adversely affecting their reproductive functions (Martín & Britayev, 1998). Surface and cavities of the sponges *Aplysina aerophoba* and *Sarcotragus* sp. collected in the area contained a total of 28 syllid species, with high dominance values of *Syllis prolifera* and *H. spongicola*. Amoureux et al. (1980) found a total of 21 syllid species on *Fasciospongia cavernosa* Schmidt, 1864 collected in the Red Sea and pointed out the high dominance values of the species *B. exilis* and *H. spongicola*. Alós et al. (1981) identified a total of 30 syllid species on *Petrosia ficiformis* (Poiret, 1789), *Sarcotragus fasciculata* (Pallas, 1766) and *Aplysina aerophoba*, whereas Pansini & Daglio (1980) reported only eight species on the same sponge species, emphasizing the high dominance level of *Trypanosyllis zebra* (Grube, 1860) (42% of the total populations). Koukouras et al. (1985) and Çinar & Ergen (1998) noted nine and 20 syllid species, respectively, on sponges collected in the Aegean Sea. In their recent paper, Gherardi et al. (2001) found a total of 17 syllid species on *Geodia cydonium* (Jameson, 1811), of which *Exogone dispar* formed a relatively dense population. In the present study, *E. dispar* was encountered only with low density on *Sarcotragus* sp. The structural complexity of sponge species is known to be one of the main factors affecting composition of the associated fauna (Pansini & Daglio, 1980; Alós et al., 1981; Koukouras et al., 1985). This finding is supported here in that the complex pore system of *Sarcotragus* sp. hosts more syllid species than *A. aerophoba* does.

As seen in the ordination model of Figure 4, soft-bottom samples scattered along the axes I and II form almost a triangular configuration with corners involving samples of fine sand, mud and *Posidonia oceanica*. Samples of sandy mud, *Zostera* spp., and *Cymodocea nodosa* are situated in spaces between the points of the triangle, showing a gradual affinity with the main three different syllid assemblages. *Posidonia oceanica*, a phanerogam endemic to the Mediterranean, supported a dense colonization of different syllid species, which seemed to share its microhabitats so evenly that, unlike other biotopes, no single syllid species were conspicuously dominant on this phanerogam (see Table 1). The cluster analysis also showed that *P. oceanica* samples collected at different stations consisted of almost the same species composition and abundance. The syllid assemblage of the *P. oceanica* beds found in this study proved to be more diversified than those reported in the western Mediterranean (Bellan, 1964; Alós, 1984; Gambi et al., 1989, 1995; Mazzella et al., 1989; Sardá, 1991). These studies show differences in dominant syllid components of this phanerogam; *Syllis hyalina* (Bellan, 1964), *Sphaerosyllis pirifera* (Alós, 1984), *Grubeosyllis clavata* (Gambi et al., 1989; Mazzella et al., 1989), *Syllis variegata* (Sardá, 1991), *Sphaerosyllis taylori* Perkins, 1981 (Gambi et al., 1995) and *Syllis prolifera* (this study). Somaschini & Gravina (1994) reported that Exogoninae and Syllinae were very abundant and diverse on *P. oceanica*, whereas on bare sands only Eusyllinae and Exogoninae occurred. However, this study shows that Syllinae also inhabit fine sand bottoms. *Posidonia oceanica* is defined as a climax level of sand substratum in the Mediterranean (Sardá, 1991). The faunal diversity of this phanerogam is greatly influenced by shoot density and phenological features of the meadow, as shown in the study by Mazzella et al. (1989), who also determined that the degree of epiphytic algae covering leaf substrata is a significant factor for creating a variety of microhabitats and niches that support associated species diversity and abundance. It is also evident in this study that dense and continuous meadows, which concentrate more detritus and algal cover, contained more syllid species.

The other phanerogams distributed in the Mediterranean Sea are *Cymodocea nodosa*, *Zostera marina*, *Z. nolthii* and *Halophila stipulacea* (Forsskål) Ascherson. They are known to provide respectively fewer microhabitats and represent lower structural complexity for benthic organisms, mainly due to their narrow leaf substrata and simple rhizome networks (Bellan, 1964; Harmelin, 1969; Lanera & Gambi, 1993; Gambi et al., 1998; Çinar et al., 1998). A small number of syllid species were noted in these phanerogams, except for the studies by Lanera & Gambi (1993) and Gambi et al. (1998), who reported respectively 19 and 29 syllid species on *C. nodosa* and *Z. marina*. Different dominant syllid components were encountered on these phanerogams; *Sphaerosyllis hystix* and *S. prolifera* were found to be the most dominant syllid species on *C. nodosa* and *Zostera* spp. (Bellan, 1964); *Syllis cornuta* Rathke, 1843 and *Ehlersia ferrugina* on *H. stipulacea* (Harmelin, 1969); *Sphaerosyllis thomasi* San Martín, 1984 and *S. campoyi* on *C. nodosa* (Lanera & Gambi, 1993); *Parapionosyllis elegans* and *Syllis garciai* on *C. nodosa* and *Z. marina* (Gambi et al., 1998); *E. ferrugina* and *S. garciai* on *Z. marina* (Çinar et al., 1998); *Syllis garciai* and *Sphaerosyllis thomasi* on *C. nodosa* and *Zostera* spp. (present study).

Among the stations, only station 11 is located near the point of pollution discharge and had relatively organically enriched bottoms. At this station, only three syllid species were collected: *Autolytus benazzi* Cognetti, 1953, *Exogone naidina* and *Syllis gracilis* Grube, 1840, of which *S. gracilis* dominated the area, with 220 ind m⁻². These three species have never before been reported from polluted environments. Previously, Cognetti (1972) and Koçak et al. (1999) reported respectively *Syllides edentulus* (Claparède, 1863) and *Syllis armillaris* (Müller, 1776) in such conditions. However, Bellan (1982) accepted representatives of Syllidae as pollution sentinel species and an indicator of undisturbed marine environments.

The Aegean Sea is a possible colonization area for lessepsian migrants (i.e. Red Sea species that have penetrated into the Mediterranean through the Suez Canal) due to its closeness to the Levant Sea, where ~10% of the total fauna consist of lessepsian species (Zibrowius, 1991). Up to now only two syllid species, namely *Branchiosyllis exilis* and *Opisthosyllis brunnea*, have been reported to be lessepsian migrants (Ben-Eliahu, 1995). However, the recent studies showed that these two species are not restricted to the lessepsian province, are also distributed throughout the Mediterranean, and are even in the Atlantic Ocean (San Martín, 1984; Núñez et al., 1992). Their updated zoogeographical distributions clearly show that these species should be excluded from the list of lessepsian species. The Aegean Sea material contained four new species for the Mediterranean fauna, one of which, *Syllis heterochaeta*, is a common species of shallow-water habitats in the Pacific Ocean (Licher, 1999). At this stage, it is very difficult to decide whether this is a new exotic species or a very rare species of the Mediterranean that has been hitherto unnoticed or probably misidentified in the region. Therefore, its possible occurrence in the other parts of the Mediterranean, especially in the Levant Sea, should be investigated.

The present study sheds more light on the syllid fauna and its ecological features in the shallow-water benthic environments of the Aegean Sea, where no detailed ecological study of this family has been undertaken. The number of species given here in fact do not reflect the real syllid diversity of the Aegean Sea since many biotopes and depths, especially deep water and coralligenous habitats at moderate depths, still remain largely unexplored.

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