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Fouling community characteristics in subtropical coastal waters of the southwestern East China Sea

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Abstract

A fouling study was conducted in coastal waters southwest of the East China Sea between December 2013 and November 2014. A total of 84 species of fouling organisms belonging to 69 genera, 49 families, and 10 phyla were recorded over the entire year. The community composition was dominated by coastal warm-water species belonging to typical subtropical inner bay communities. The prosperous stage of settlement lasted from April to September, and the adhesion strength of the fouling organisms was the highest in summer. Sessile suspension feeders constituted the main core of settlement for the fouling community. *Amphibalanus reticulatus* was the most dominant and representative species of fouling organism, and other dominant species included *Caprella equilibra*, *Ectopleura crocea*, *Anthopleura nigrescens*, *Stylochus ijimai*, *Spirobranchus kraussii*, *Crassostrea angulata*, *Perna viridis*, *Jassa falcata*, *Stenothoe valida*, *Sphaerozius nitidus*, and *Biflustra grandicella*. The individuals in the fouling community showed a mutual dependence or constraint relationship due to competition for settlement space and food, and they exhibited a particular spatiotemporal distribution in accordance with adaptation to environmental factors. Temperature was the most important environmental factor determining the geographic distribution of fouling organisms. The temperature characteristics of species essentially reflect the differences in the fouling community composition in various climate zones. The species number, settlement stage, and settlement rate of fouling organisms are closely related to water temperature. Local natural environmental conditions (salinity, water currents, light, etc.) as well as human activity (such as aquaculture production) are all important factors affecting the settlement of fouling organisms.

Key words: biofouling, coastal waters, East China Sea, community structure

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1 Introduction

The impact of marine fouling organisms has attracted wide attention in relation to marine economic development. As the pace of the development and utilization of marine resources accelerates, biofouling problems in artificial facilities in coastal waters are bound to attract attention. In recent years, extensive multi-faceted and in-depth studies have been conducted on the biofouling problems associated with ships (Callow, 1990), floats (Yan et al., 2009; Zhang et al., 2015), oil and gas drilling platforms (Sammarco et al., 2004; Yan et al., 2006), aquaculture cages (Greene and Grizzle, 2007), and other artificial facilities (Qvarfordt et al., 2006; Yang et al., 2016). These studies have mainly addressed the community composition, settlement mechanism, prevention and removal techniques, the ecological effects of fouling, and exotic species (Yan and Yan, 2003; Maruzzo et al., 2011; Pradhan et al., 2011; Zhang et al., 2011; Tasso et al., 2012; Cao et al., 2013; Oricchio et al., 2016; Al-Muhanna and Habib, 2016).

Marine fouling communities are varied, with a mutual dependence or constraint relationship being observed within or between species. The effective use of space makes the productivity of the fouling community generally higher than that of the benthos. Previous analyses of fouling community structure have long focused on the species composition and the quantitative distribution. In contrast, there is little research on fouling organisms concerning their lifestyles, functional groups, and the relationship between these two factors. The fouling community can provide a food source and living habitat (artificial reefs) for other marine organisms, which is conducive to increasing the biodiversity of local waters (Li et al., 2012). Additionally, the marine fouling community plays a role in purifying water quality by synthesizing inorganic salts in water (algal photosynthesis) and filter-feeding on plankton or organic detritus, thereby participating in the rehabilitation and reconstruction of the marine eco-environment.

In this study, an annual panel test and multivariate statistical analysis were performed to systematically analyze marine foul-

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ing organisms in coastal waters with respect to their community composition, their lifestyle, their present functional group status, the seasonal community succession, and their relationship with environmental factors. The aims of the study were to elucidate the community structure and settlement characteristics of marine fouling organisms in subtropical coastal waters and to understand the ecological functions of the fouling community in the marine ecosystem. This study provided a reference for in-depth studies of dynamic changes in local marine biomes.

2 Materials and methods

2.1 *Survey area*

An annual panel test of fouling organisms was conducted in coastal waters southwest of the East China Sea between December 2013 and November 2014 (~5 n mile northwest of the Dayushan Island). The location of the panel test is shown in Fig. 1. The study area is located in coastal waters in northeastern Fujian Province (Fuding, Ningde), China. The coastal waters are relatively open and mainly affected by coastal currents and wind-drift currents in Zhejiang and Fujian. Water depth is in the range of 6–10 m.

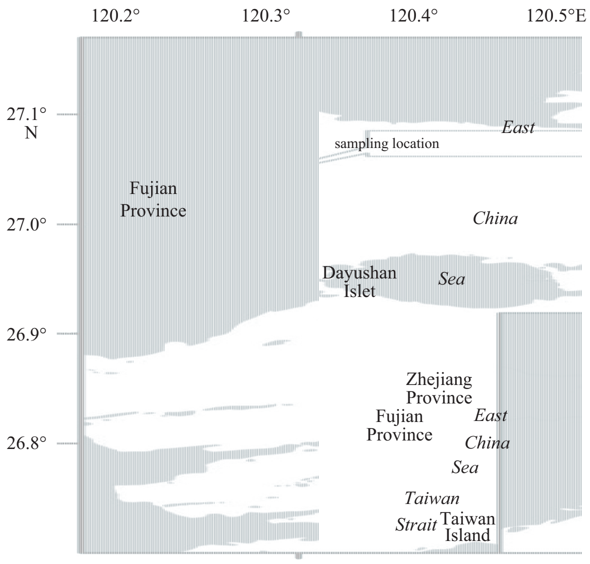

Fig. 1. Location of the marine fouling study in coastal waters southwest of the East China Sea.

2.2 *Sampling methodology*

The settlement panels were composed of cement and were 15 cm (length)×15 cm (width)×2 cm (thickness) each. The panels were hung in two parallel groups on both the left and the right (Fig. 2). Thus, four parallel samples were obtained for each set of data. The intervals between the placement and the retrieval of the monthly, quarterly, semi-annual, and annual panels were one month, one quarter, half of a year, and one year, respectively. Each group of test panels was set up in top and bottom layers. The panel surface was perpendicular to the sea surface. The top edge of the top panels was level with the water surface, and the bottom panels were placed down to a depth of 5 m. The test panels and samples were preserved in 5% formalin solution. All individuals were identified to the species level or the lowest taxonomic level. Biomass was recorded in wet weight. Taxon names were cross-checked against the World Register of Marine Species (http://marinespecies.org/).

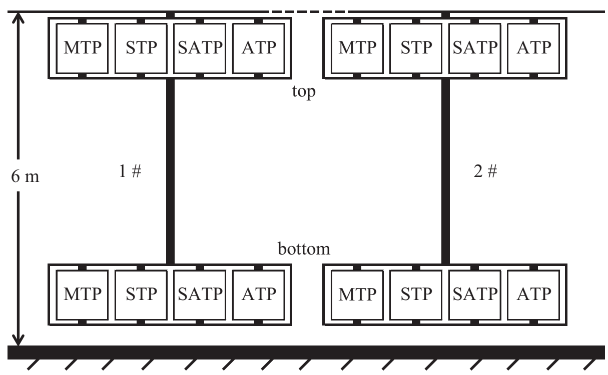

Fig. 2. Schematic diagram of the deployed test panel installation. MTP represents monthly test panel, STP seasonal test panel, SATP semiannual test panel, and ATP annual test panel.

2.3 *Environmental variables*

Water temperature and salinity were measured using a YZY4 (National Ocean Technology Center, China) temperature and salinity sensor. Ocean currents were recorded with an ADCP acoustic Doppler current profiler. Turbidity was measured using a HANNA HI 98703 turbidimeter.

2.4 *Data analysis*

The dominant species of the marine fouling community were analyzed using the index of relative importance (IRI) (Pinkas et al., 1971), as follows:

$$IRI = (W + N)F \times 10^4,$$

where W is the percentage of the biomass of a particular species within the total biomass, N is the percentage of the abundance of a particular species within the total abundance, and F is the frequency of a particular species.

Marine fouling organisms were divided into six functional groups: primary producers (PP), suspension feeders (S), herbivores (H), carnivores (C), omnivores (O), and deposit feeders (D).

Analyses of the community diversity and Bray-Curtis similarity were performed using Primer 5.0. A one-way ANOVA was conducted with SPSS 19.0 to examine the differences in parameters (such as species number, density, biomass and so on) of the marine fouling community. Diagrams were produced using ArcMap 10.0.

3 Results

3.1 *Environmental characteristics*

The temperature at the sampling station ranged from 11.0°C to 30.0°C, and the salinity ranged from 25.4 to 30.4 (Fig. 3). The current velocity ranged from 29 to 63 cm/s in summer and 31 to 79 cm/s in winter, with a greater velocity being observed in surface waters than in bottom waters (Table 1). Water turbidity ranged from 16.0° to 229.6° and was greater in the bottom layer than in the top layer (Table 2).

3.2 *Species composition*

A total of 76 test panels were retrieved over the entire year, corresponding to recovery of 100%. Eighty-four species of fouling organisms belonging to 69 genera, 49 families, and 10 phyla were recorded. There were 33 species of polychaetes, 22 species of

Table 1. Flood and ebb current velocities in surface and bottom waters

Current type	Neap tide in summer		Moderate tide in summer		Spring tide in summer		Neap tide in winter		Moderate tide in winter		Spring tide in winter	
	Top	Bottom	Top	Bottom	Top	Bottom	Top	Bottom	Top	Bottom	Top	Bottom
Flood current velocity/cm·s^{-1}	41	29	59	49	63	41	54	41	75	57	79	56
Ebb current velocity/cm·s^{-1}	40	29	51	43	58	39	43	31	57	41	63	46

Table 2. Water turbidity in surface and bottom waters

	Spring		Summer		Fall		Winter	
	Top	Bottom	Top	Bottom	Top	Bottom	Top	Bottom
Turbidity/(°)	42.3	95.0	16.0	23.3	75.7	92.5	144.4	229.6

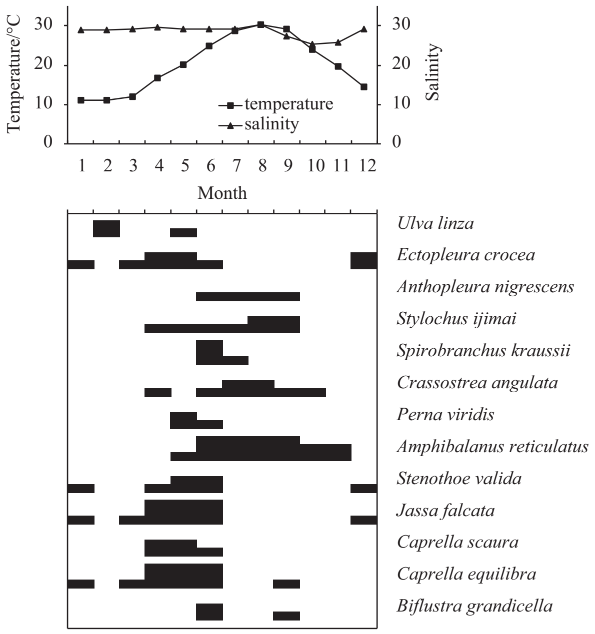

Fig. 3. The settlement stages of major species in the marine fouling community.

crustaceans, 11 species of mollusks, 7 species of cnidarians, 5 species of algae, and 6 species from other animal groups. *Amphibalanus reticulatus* (Crustacea) (*IRI*=7 742) held an absolutely dominant position in the marine fouling community in the coastal waters, followed by *Caprella equilibra* (Crustacea) (*IRI*=1 432). Other dominant species (*IRI*>25) included *Ectopleura crocea* and *Anthopleura nigrescens* (Cnidaria); *Stylochus ijimai* (Platyhelminthes); *Spirobranchus kraussii* (Polychaeta); *Crassostrea angulata* and *Perna viridis* (Mollusca); *Jassa falcata*, *Stenothoe valida*, and *Sphaerozius nitidus* (Crustacea); and *Biflustra grandicella* (Bryozoa) (Table 3).

3.3 *Settlement rate and its spatio-temporal variation*

The prosperous stage of fouling organism settlement began in April and ended in September; there were highly significant differences in density (F=28.260, p<0.001) and biomass (F=61.512, p<0.001) between the months. The adhesion strength of the fouling organisms on the seasonal panels (in terms of biomass, here and below) presented the following order: summer>fall>spring>winter, and there were highly significant differences between the seasons (F=52.030, p<0.001). The adhesion strength of the fouling organisms on the semi-annual panels was greater in the first half of the year than in the second half. The thickness of settled organisms was ~15 cm on the annual panels, with coverage of up to 100% (Tables 4 and 5). The distribution of the density and biomass of the fouling organisms showed no significant difference between the top and bottom layers.

Amphibalanus reticulatus was the most dominant and representative species in the marine fouling community. Settlement of *A. reticulatus* occurred from May to November, and the prosperous settlement stage lasted from June to September. The density of *A. reticulatus* was between 19 031 and 57 113 ind./m^2 in the prosperous settlement stage (Fig. 4). The density showed highly significant differences between months (F=76.667, p<0.001) but not between the top and bottom layers.

3.4 *Seasonal succession of the marine fouling community*

The settlement stages of major species in the marine fouling community are shown in Fig. 3. According to the clustering analysis of Bray-Curtis similarity (Fig. 5), we classified the fouling or-

Table 3. The dominant species in the marine fouling community in coastal waters southwest of the East China Sea

Species name	Mean density/ind.·m^{-2}	Mean biomass/g·m^{-2}	IRI	Lifestyle	Functional group	Reference
Amphibalanus reticulatus	11 305	1 933.6	7 742	SE	S	Wetzel et al. (2014)
Caprella equilibra	10 795	32.2	1 432	M	D	Zubikarai et al. (2014)
Crassostrea angulata	301	115.4	228	SE	S	Zubikarai et al. (2014)
Jassa falcata	1 659	3.0	157	M	S	Nair and Anger (1979)
Perna viridis	447	63.0	104	A	S	Lee (1988)
Biflustra grandicella	–	85.5	92	SE	S	Jumars et al. (2015)
Anthopleura nigrescens	428	32.2	86	A	C	Macdonald (2010)
Sphaerozius nitidus	113	41.9	63	M	O	
Spirobranchus kraussii	1 078	1.7	52	SE	S	Jumars et al. (2015)
Stenothoe valida	368	0.5	49	M	D	Macdonald (2010)
Ectopleura crocea	–	30.7	48	SE	S	Zubikarai et al. (2014)
Stylochus ijimai	191	2.1	28	M	D	Macdonald (2010)

Note: O represents omnivores, S suspension feeders, D deposit feeders, C carnivores, M motile, SE sessile, and A attached.

Table 4. The settlement rate of marine fouling organisms on the top test panels

Settlement stage	Thickness/ mm	Coverage/ %	Density/ ind.·m^{-2}	Biomass/ g·m^{-2}	Relative biomass/%						
					Algae	Cnidaria	Polychaeta	Mollusca	Crustacea	Bryozoa	Others
Jan.	7	3	188	5.6	75.6	6.7	0.0	0.0	17.8	0.0	0.0
Feb.	6	3	75	24.6	100.0	0.0	0.0	0.0	0.0	0.0	0.0
Mar.	6	23	250	4.0	0.0	3.1	0.0	0.0	96.9	0.0	0.0
Apr.	15	47	27 788	356.0	0.0	45.0	2.9	0.0	51.9	0.0	0.2
May	18	61	95 738	400.9	0.0	19.1	0.1	0.5	79.4	0.0	0.8
Jun.	8	100	126 825	1 774.4	0.0	0.0	2.3	53.9	38.8	4.7	0.3
Jul.	6	99	62 275	6 626.9	0.0	0.0	0.1	0.9	98.7	0.0	0.2
Aug.	3	100	53 688	3 624.3	0.0	0.0	0.0	1.1	98.8	0.0	0.1
Sep.	2	98	35 863	1 354.6	0.0	0.1	0.1	0.7	97.3	0.0	1.8
Oct.	2	70	2 000	93.1	0.0	16.8	0.0	0.0	83.2	0.0	0.0
Nov.	1	5	4 163	2.5	0.0	0.0	0.0	0.0	100.0	0.0	0.0
Dec.	14	12	175	139.8	0.0	99.3	0.0	0.0	0.7	0.0	0.0
Spring (Mar.–May)	2	95	142 013	526.4	1.1	9.9	1.1	38.4	48.4	0.6	0.5
Summer (Jun.–Aug.)	17	100	29 100	7 149.1	0.0	0.4	0.7	2.4	96.5	0.0	0.0
Autumn (Sep.–Nov.)	11	100	9 063	4 169.5	0.1	1.2	0.0	0.3	90.6	7.8	0.1
Winter (Dec.–Feb.)	16	33	1 013	101.1	21.9	74.3	0.0	0.0	3.8	0.0	0.0
First half (Dec.–May)	6	100	46 863	1 071.4	0.1	12.6	0.7	53.1	14.9	16.8	1.7
Second half (Jun.–Nov.)	14	100	15 738	6 910.1	0.0	0.6	0.1	8.5	90.4	0.4	0.0
Annual (Dec.–Nov.)	15	100	12 825	7 627.9	0.0	1.1	0.1	20.7	77.9	0.3	0.0

Table 5. The settlement rate of marine fouling organisms on the bottom test panels

Settlement stage	Thickness/ mm	Coverage/ %	Density/ ind.·m^{-2}	Biomass/ g·m^{-2}	Relative biomass/%						
					Algae	Cnidaria	Polychaeta	Mollusca	Crustacea	Bryozoa	Others
Jan.	8	7	625	8.0	0.0	75.0	0.0	0.0	25.0	0.0	0.0
Feb.	3	1	50	0.3	0.0	0.0	0.0	0.0	100.0	0.0	0.0
Mar.	0	0	0	0	–	–	–	–	–	–	–
Apr.	13	51	21 988	339.3	0.0	48.2	0.4	8.5	36.8	4.6	1.4
May	2	13	19 525	213.3	0.0	0.0	0.6	61.8	35.3	0.0	2.3
Jun.	7	95	87 463	1 834.9	0.0	0.3	0.2	0.1	97.8	1.3	0.4
Jul.	7	100	37 963	5 882.8	0.0	0.0	0.2	0.6	99.1	0.0	0.0
Aug.	3	97	65 025	5 026.8	0.0	0.0	0.0	0.2	99.5	0.0	0.2
Sep.	1	100	34 163	1 411.6	0.0	0.1	0.0	0.8	98.6	0.1	0.4
Oct.	1	37	4 150	71.1	0.0	2.1	0.0	5.3	92.6	0.0	0.0
Nov.	1	11	5 675	27.1	0.0	0.0	0.0	0.0	100.0	0.0	0.0
Dec.	12	36	213	158.8	0.0	99.4	0.0	0.0	0.6	0.0	0.0
Spring (Mar.–May)	3	54	10 513	347.0	0.0	1.3	1.0	88.1	8.1	0.1	1.4
Summer (Jun.–Aug.)	19	100	30 950	12 353.1	0.0	0.4	0.3	3.0	96.3	0.0	0.0
Autumn (Sep.–Nov.)	18	100	11 263	4 138.3	0.0	5.2	0.2	0.1	63.8	30.6	0.1
Winter (Dec.–Feb.)	12	39	875	116.6	0.0	97.6	0.1	0.0	2.3	0.0	0.0
First half (Dec.–May)	10	56	22 813	262.5	0.0	37.2	4.7	30.1	24.1	2.0	1.9
Second half (Jun.–Nov.)	17	100	16 963	7 186.8	0.0	3.5	0.1	9.8	76.9	9.6	0.0
Annual (Dec.-Nov.)	16	100	17 525	8 482.8	0.0	6.3	0.2	13.2	72.3	7.9	0.0

ganisms into four types of communities:

Community I (*Ulva linza-Ulva lactuca*): this community was dominated by algae and was relatively simple; it was suited for the cold season and was mainly distributed on the top test panels in February. Community II (*Stylochus ijimai-Nectoneanthes oxypoda-Crassostrea angulata-Amphibalanus reticulatus-Sphaerozius nitidus*): this community was characterized by considerably species diversity and a high settlement rate; it was suited for hot climatic conditions, and the prosperous settlement stage lasted from July to November; the distribution showed no significant difference between the top and bottom layers; *A. reticulatus* held an absolutely dominant position in this community. Community III (*Ectopleura crocea-Amphibalanus reticulatus-Caprella equilibra-Jassa falcata*): this community was suited for the cool season, and settlement mainly occurred from April to June; the density was significantly high for *C. equilibra*, and there was no significant difference between the top and bottom layers. Community IV (*Ectopleura crocea-Stenothoe valida-Pontogeneia rostrata*): this community was characterized by a low diversity and settlement rate; the settlement stage began in December and ended in the next March.

3.5 *Functional groups and lifestyles*

Six functional groups were identified, designated Groups H, O, S, D, C, and PP (Fig. 6). Group S was predominant on most test panels, within which *Amphibalanus reticulatus* was the primary representative species. Group D was the second most predominant, while Group PP mainly occurred on the top test panels in

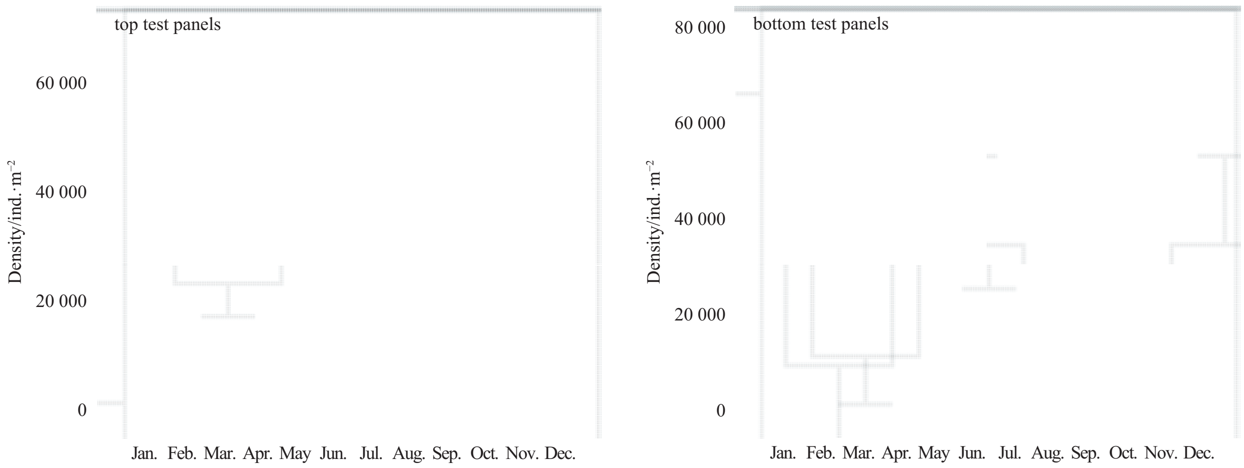

Fig. 4. Spatiotemporal changes in the average density of *Amphibalanus reticulates*.

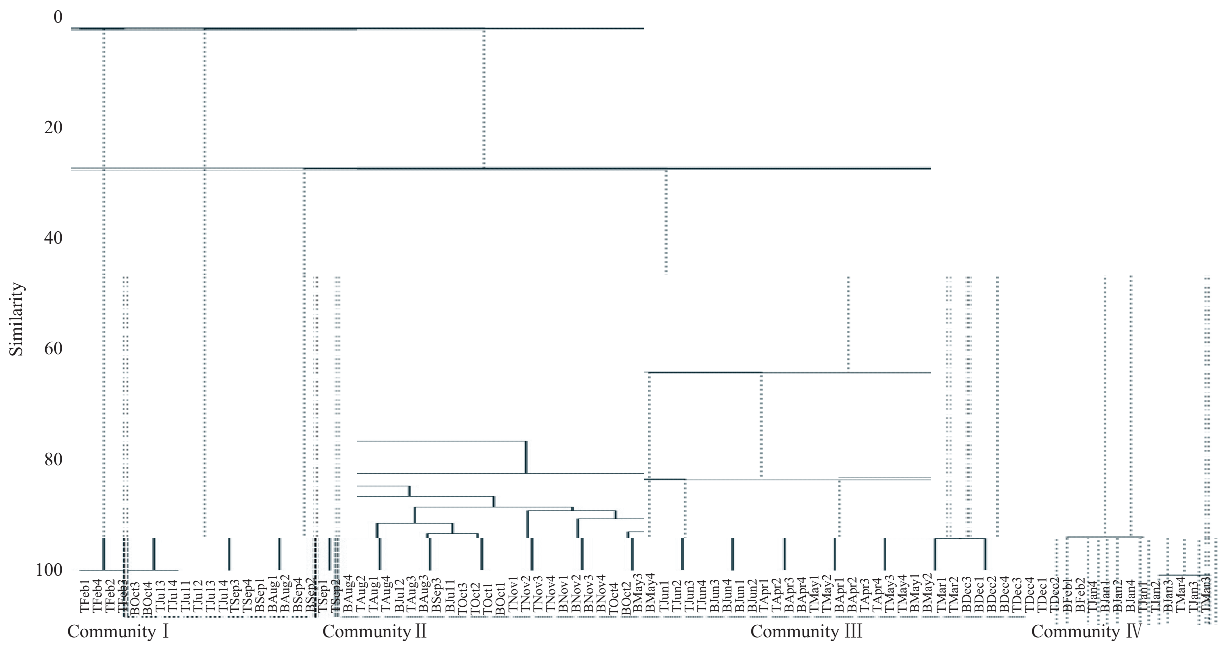

Fig. 5. Clustering of the Bray– Curtis similarity of the marine fouling communities on monthly test panels.

winter. Other functional groups accounted for a low percentage of the biomass.

There were four trophic levels according to the functional groups identified in this study (Fig. 7). PP represented the first trophic level; S, H, and D constituted the second trophic level; and O and C represented the third and fourth trophic levels, respectively.

The fouling organisms were divided into three types in accordance with their activity and lifestyle: sessile, attached, and motile. Figure 8 shows that sessile organisms were dominant in the fouling community.

4 Discussion

Sessile organisms are the main components of fouling communities, which settle on the substrate from a calcareous shell or specific organs. Examples of sessile organisms include algae, polyps, serpulid worms, oysters, balanomorph barnacles, and bryozoans, whose larvae will never move during their lifetime after settlement. The sessile lifestyle generally corresponds to two functional groups: primary producers, such as algae capable of autotrophic photosynthesis, and suspension feeders that mainly filter-feed on plankton and organic detritus in the water. Balanomorph barnacles often act as pioneers of attached (or sessile) macro-species in marine biomes and hold a key position in the succession of biofouling communities from absent to existent and simple to complex (Yan et al., 2012). Balanomorph barnacles can provide food for other carnivores and create shelter space for other small animals.

Representatives of attached organisms include anemones, mussels, and *Arcidae* spp., which settle to the substrate and attach via the bussus or basal disc and are capable of short-distance movement. Attached organisms can also be the main components of a fouling community, mostly as suspension feeders and sometimes as carnivores (e.g., sea anemones).

Motile organisms of the fouling community are generally small in size and light in mass. These organisms will not become

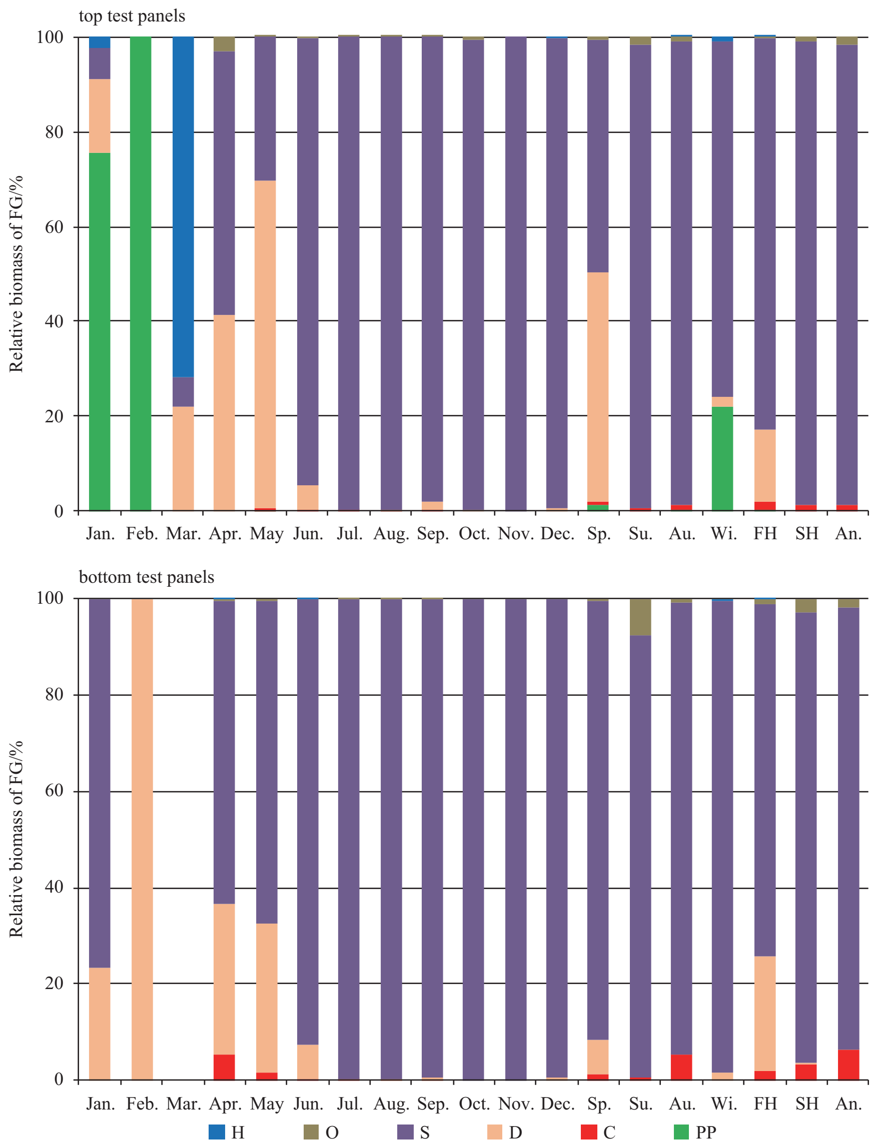

Fig. 6. The relative biomass of the functional groups. Sp. represents spring, Su. summer, Au. autumn, Wi. winter, FH first half of the year, SH second half of the year, An. annual, H herbivores, O omnivores, S suspension feeders, D deposit feeders, C carnivores, and PP primary producers.

the main components of the fouling community and only play a supporting role. Their presence and number depend on the above two types of organisms. However, motile organisms exhibit a high species diversity and a significant settlement rate, as may be observed for Caprellidae and Gammarus. These organisms inhabit and/or forage in the fouling community. They present a wide range of feeding habits, such as carnivory (e.g., Syllidae and Alpheidae), herbivory (e.g., Turbellaria and Caprellidae), and detritus feeding (e.g., Ampithoidae).

The individuals within a fouling community display a mutual dependence or constraint relationship, due to competition for settlement space and food. They also exhibit a particular spatio-temporal distribution in accordance with adaptability to environmental factors (Huang, 2008).

Temperature is the most important environmental factor determining the geographical distribution of fouling organisms. The temperature characteristics of different fouling organisms essentially reflect the differences in the community composition of fouling organisms in various climate zones. *Amphibalanus reticulatus* is a warm-water species that is extensively distributed in tropical and subtropical coastal waters. In the present study, *A. reticulatus* was found to be the most dominant and representative species in the marine fouling community of the coastal waters southwest of the East China Sea. Settlement of *A. reticulatus* occurred from May to November, and the prosperous settlement period lasted from June to September. The density of *A. reticulatus* reached 19 031–57 113 ind./m^2. This species is widely distributed in the coastal waters of the East China Sea and South China Sea. The Changjiang (Yangtze River) Estuary is the northern boundary for the geographic distribution of *A. reticulatus* in the coastal waters of China. The farther southward, the longer the settlement period of *A. reticulatus*; settlement of *A. reticulatus* occurs over the entire year in coastal waters of the South China Sea (Third Institute of Oceanography State Oceanic Administration, 1990; Lin et al., 2012, 2014). *A. reticulatus* is also a major fouling organism in coastal waters of southern Japan, the Gulf of Thailand, India,

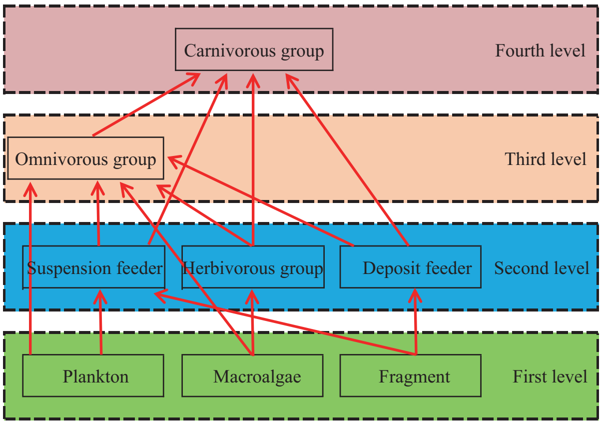

Fig. 7. Trophic levels and food webs of the marine fouling community.

and the Gulf of Mexico (Huang and Cai, 1984; Li et al., 2012).

Other representative fouling organisms that are extensively distributed in tropical and subtropical coastal waters include *Perna viridis*, *Chama* spp., *Styela plicata. Mytilus edulis*, *Amphibalanus amphitrite amphitrite*, and *A. improvisus* are dominant fouling organisms in coastal waters of the Bohai Sea and Yellow Sea. Additionally, *Semibalanus balanoides*, *Balanus crenatus*, and *Laminaria saccharina* are representative fouling species that are mainly distributed in cold and temperate waters (Huang, 2008).

The species number, settlement stage, and settlement rate of fouling organisms are closely related to latitude and water temperature. Among the four major coastal waters of China, the greatest number of species and settlement rate of fouling organisms are found in coastal waters of the South China Sea, followed by the East China Sea, and finally, the Yellow Sea and Bohai Sea. In terms of the community composition of fouling organisms, the East China Sea is more similar to the South China Sea, while the

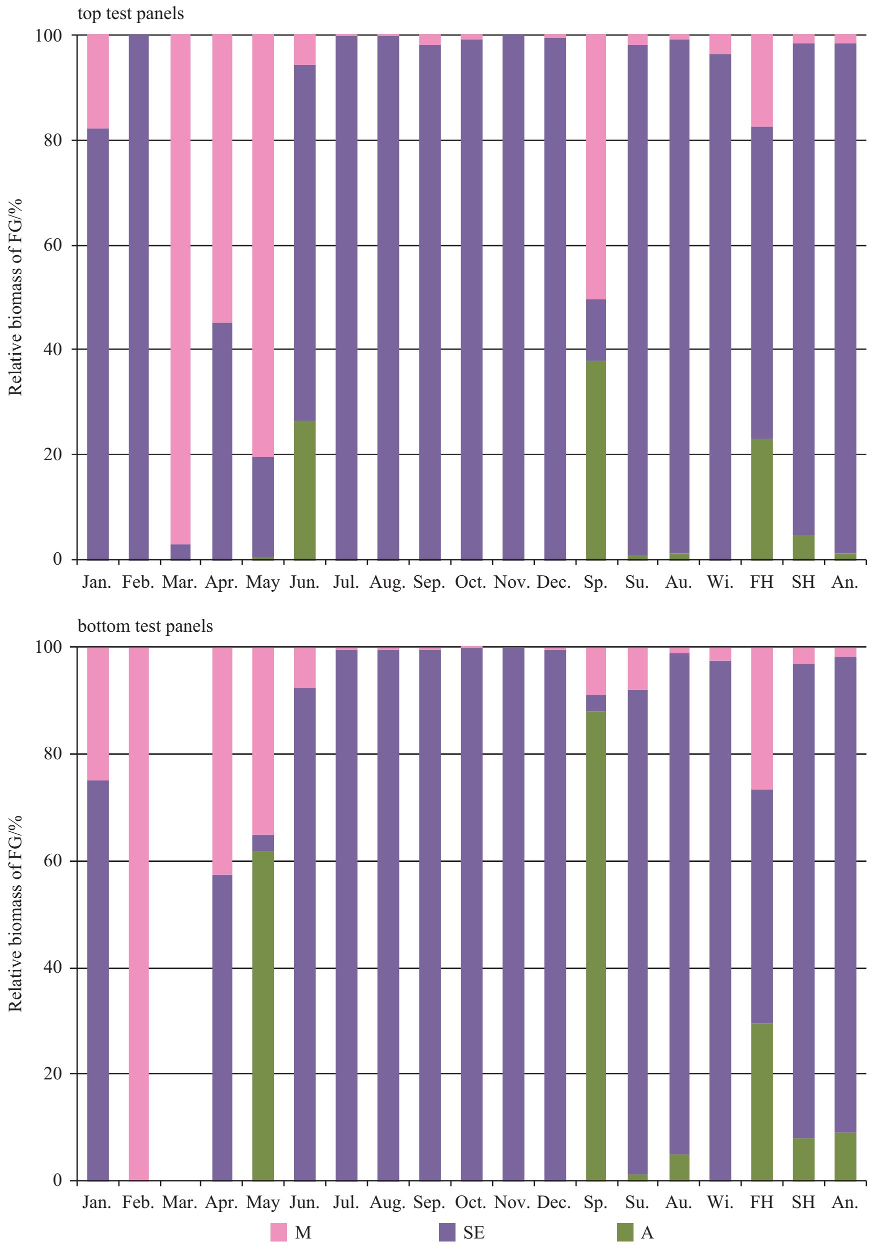

Fig. 8. The relative biomass of different lifestyle groups. M represents motile, SE sessile, and A attached.

Yellow Sea is similar to the Bohai Sea. From south to north, the settlement stage is markedly shortened with decreasing water temperature. Settlement of fouling organisms occurs in every month of the year in coastal waters of the South China Sea and almost in every month in the East China Sea. However, no settlement of fouling organisms occurs during winter in the Yellow Sea and Bohai Sea.

Adaptation to salinity is the most basic physical property of marine organisms. There are great differences in the community composition of fouling organisms at varying levels of salinity. For instance, *Fistulobalanus kondakovi* is adapted to low-salinity estuarine waters in China, whereas *Balanus trigonus*, *Megabalanus rosa*, and *Megabalanus tintinnabulum tintinnabulum* are suited for high-salinity coastal waters in the East China Sea and South China Sea (Huang and Cai, 1984).

The effect of water currents on fouling organisms is mainly reflected in two aspects; current direction and light jointly determine the directional settlement of balanomorph barnacles (Cai and Huang, 1988). Current direction mainly affects the community composition and settlement rate of fouling organisms, and the species number and settlement rate of fouling organisms are closely related to the smoothness of the water current (Huang and Cai, 1984; Lin et al., 2014).

Temperature, salinity, and water currents primarily affect the planar distribution of fouling organisms, while light affects the vertical distribution of fouling organisms. Due to the high turbidity of coastal waters, algae are generally found only in the surface water. Accordingly, algal settlement was not prosperous in the coastal waters examined in the present study, which exhibited high turbidity. Given the shallow depth of the coastal waters sampled in the present study, there was no significant difference in the distribution of fouling organisms (except algae) between the top and bottom waters.

Fouling organisms are certainly affected by not only single environmental factors. They are a result of adaptation to integrated natural environmental factors, including local temperature, salinity, tides, geographical location, and coastal openness. Moreover, fouling organisms are influenced by surface runoff and aquaculture, among other human-related factors.

5 Conclusions

This study was conducted in coastal waters southwest of the East China Sea, which is subjected to the constraints of both offshore and coastal water systems. The community composition of fouling organisms was dominated by coastal warm-water species belonging to a typical subtropical inner-bay community. A total of 84 species from 69 genera, 49 families, and 10 phyla were recorded across the entire year. The prosperous settlement stage lasted from April to September, and the adhesion strength of the fouling organisms was the highest in summer. Sessile suspension feeders served as the main core of settlement for the fouling community in the coastal waters. *Amphibalanus reticulatus* was the most dominant and representative species, and other dominant fouling organisms included *Caprella equilibra*, *Ectopleura crocea*, *Anthopleura nigrescens*, *Stylochus ijimai*, *Spirobranchus kraussii*, *Crassostrea angulata*, *Perna viridis*, *Jassa falcata*, *Stenothoe valida*, *Sphaerozius nitidus*, and *Biflustra grandicella*.

The individuals of the marine fouling community shared a mutual dependence or constraint relationship due to competition for settlement space and food; they also exhibited a particular spatio-temporal distribution in accordance with adaptation to environmental factors. Temperature was the most important environmental determinant for the geographic distribution of fouling organisms. The temperature characteristics of species essentially reflect the differences in the fouling community composition in various climate zones. The species number, settlement stage, and settlement rate of fouling organisms are closely related to water temperature. Other natural environmental or human-related factors, such as salinity, water currents, light, and aquaculture production, also affect the settlement of fouling organisms.

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