



**PRELIMINARY STUDY ON SPECIES COMPOSITION OF ZOOBENTHOS ON
COASTAL INTERTIDAL AREA IN HAI PHONG AND CAT BA**

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Gastropoda.*

Abstract:

Study on zoobenthos species composition on coastal intertidal area in Hai Phong province was conducted from 11-12/2020. The results showed that total of 152 species, of 116 genus, 71 families, 26 order belonging to 10 classes (Polychaeta, Merostomata, Thecostraca, Malacostraca, Scaphopoda, Bivalvia, Gastropoda, Cephalopoda, Holothuroidea, and Actinopteri) and 5 phyla (Annelida, Arthropoda, Mollusca, Echinodermata and Chordata). In which, Bivalve had the most species (8 orders, 22 families, 44 genera, 56 species accounting for 36.84%), followed by gastropod (with 6 orders, 25 families, 38 genera, 53 species, accounting for 34.87%), and the third was Malacostraca (3 orders, 14 families, 24 genera and 33 species, accounting for 21.71%). Other groups only 1 or 2 species. From the results showed that the coastal area of Hai Phong has a relatively diverse species composition, the main composition is Bivalvia, Gastropoda and Malacostraca accounting for about 95.4% of the total number of identified species. The biodiversity level in the coastal area of Hai Phong was medium with biodiversity index (H') about 2.39.



NGHIÊN CỨU THÀNH PHẦN LOÀI ĐỘNG VẬT ĐÁY VÙNG BỜ BIỂN HẢI PHÒNG - CÁT BÀ

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Thông tin bài viết	Tóm tắt
<p>Ngày nhận bài: 6/8/2021</p> <p>Ngày duyệt đăng: 1/12/2021</p> <p>Từ khóa:</p> <p>Hải Phòng - Cát Bà, động vật đáy, Zoobenthos, Bivalvia, Malacostraca, Crustacea, Gastropoda.</p>	<p>Thành phần động vật đáy ở khu vực bờ biển Hải Phòng - Cát Bà đã được tiến hành tháng 11-12/2020. Kết quả đã phát hiện 152 loài, thuộc 116 giống, 71 họ, 26 bộ thuộc 10 lớp (Polychaeta, Merostomata, Thecostraca, Malacostraca, Scaphopoda, Bivalvia, Gastropoda, Cephalopoda, Holothuroidea, and Actinopteri) và 5 ngành (Annelida, Arthropoda, Mollusca, Echinodermata and Chordata). Trong đó, hai mảnh vỏ có số lượng loài lớn nhất (8 bộ, 22 loài, 44 giống, 56 loài, chiếm 36.84%), tiếp theo là Thân mềm Chân bụng (6 bộ, 25 họ, 38 giống, 53 loài, chiếm 34,87%), thứ 3 là nhóm Chân khớp (3 bộ, 14 họ, 24 giống và 33 loài, chiếm 21.71%). Các nhóm khác có từ 1 đến 2 loài. Từ kết quả cho thấy, khu vực vùng bờ biển Hải Phòng - Cát Bà có thành phần loài tương đối đa dạng, thành phần chủ yếu là Bivalvia, Gastropoda và Malacostraca chiếm khoảng 95,4% tổng số loài đã xác định. Chỉ số đa dạng sinh học ở khu vực vùng bờ Hải Phòng có chỉ số đa dạng sinh học ở mức độ thấp ($H' = 2,39$).</p>

1. Introduction

Zoobenthos are organisms with a bottom-dwelling life. They have an important role in ecosystems (tidal zones, coral reefs, seagrasses,...). With a large number of species in many food chains and webs, especially food chains that begin with plant residues, that is significant in completing the organic mineralization cycle. On the other hand, benthic groups living in the bottom layer where variable flows will create high adapted characteristics to the environment in behavior and the way of feeding.

Benthic animals in coastal and offshore areas have a certain economic significance. Many groups have been valued as an important daily food for coastal inhabitants and export items such as shrimp, crab, oyster,... That has created a great economic development, and at the same time created the premise for important studies on biodiversity and ecology to find out breeding methods for large and small-scale.

Many authors have studied benthic animals including groups such as Gastropods, Bivalves and Crustaceans in coastal areas within tidal limits, which have been conducted quite thoroughly in many coastal areas of the Tonkin and South of Vietnam. Extending from Mong Cai (Quang Ninh) to Nghia Hung (Nam Dinh) as Pham Dinh Trong (1996), Do Van Nhuong (2001, 2003, 2004, 2008) [8], Hoang Ngoc Khac (2000, 2004, 2005, 2017). Central Coast from Ha Tinh to Hoi An (Do Van Nhuong et al., 2006, 2014) and Can Gio in the South (Do Van Nhuong, 1998, 2001) [5]. Most recently, Nguyen Thanh Binh et al (2019) studied the diversity of zoobenthos species composition in mangrove ecosystems in the coastal estuaries of Ba Lat, Cua Len, Ben Tre and Ca Mau [2]. However, the studies were only valid for a certain period of time, and more data and follow-up studies are needed. By 2014, a combination of survey research from heritage nomination dossiers and Cat Ba National Park Planning Report, recorded 3.956

species of flora and fauna (nearly doubled compared to the 2004 recorded figure of 2.320 species). In which, there are 658 zoobenthos species.

The coastal intertidal zone of Hai Phong is also one of the areas with many aquatic plants and mangroves. In many places, human fishing activities have altered the area's benthic fauna both in species composition and distribution, appear many groups after mining. Preliminary assessment of the current status of species composition and resources of large benthic species (Mollusks, Bivalves and Crustaceans)

distributed in coastal areas for monitoring and future conservation plans.

2. Material and Methods

Sample sites:

Samples were collected in December 2020 on the coastal area of Hai Phong city and Cat Ba, Bach Long Vi islands. The total of 36 sampling points are determined coordinates, numbered and recorded natural features (Figure 1).

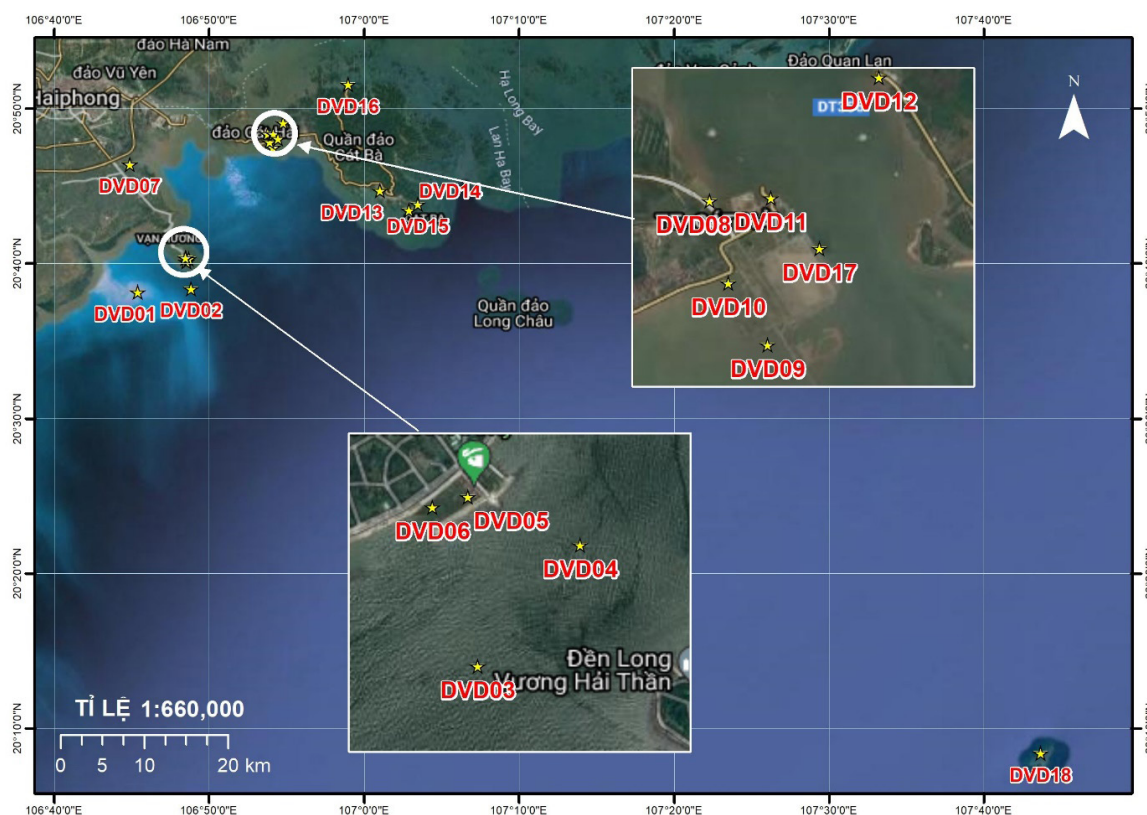


Figure 1. Routes map and sample sites

Quantitative sampling method:

Quantitative samples were taken in an area of 1m² (0.25m x 4m) at the bottom and 5cm deep at the bottom or 1m² (1m x 1m) with the coastal intertidal zone. Quantitative plots are recorded according to the ordinal number and necessary information corresponding to the coordinate position from inshore to offshore along the line perpendicular to the sea edge.

Samples were collected all groups of crustaceans, gastropods, bivalves, and polychaetes in the quantification plot until no longer found. The entire bottom sludge with an area of 1m² is treated by a sieve with a mesh of 1mm – 1.5mm to remove soil and collect benthic animals. Collected samples are placed in plastic bags or plastic containers with lids

and labeled. On the same day, the sample was washed off the mud, fixed in alcohol 70° to preserve the sample before analysis.

Qualitative sampling method:

Qualitative samples were extended the sampling plots in the study area to supplement the quantitative sample and avoid missing species composition. The locations of the sampling points are determined by coordinates.

Specimen identification and specimen preservation

Samples after washing were fixed in alcohol 70°. Sampling sites are distinguished from each other by numbered labels and quantitative or qualitative inscriptions on them. Determining the scientific name of the species for the specimens based on the external

morphological features and the following documents: Dai Ai-Yun and Yang Si-Liang (1991) [12]; Jocelyn Crane (1975) [16]; Kent E. Carpenter and Volker H. Niem (1998) [17]; Han Raven, Jap Jan Vermeulen (2006) [14]; Blakmore (2007) [11]; Menon, A. G. K. (1977) [15].

All samples after analysing were counted and weighed by electronic balance, error 0.01g. After that, they is stored in the laboratory of the Institute of Sea and Island Research.

Methods of determining biological indicators:

- Density of individual in the study plot: $v = \frac{\sum^n}{\sum^s} m^2$

In where:

V - Number of individuals /m².

Σn - Total number of individuals in the study plots (ind.).

ΣS - Total area of study plots (m²).

- Species richness (P%): $P\% = \frac{ni}{\sum^n} 100$

- Biodiversity Index or Shannon Index (H’):

$$H' = -\sum_{i=1}^n \frac{ni}{\sum^n} \ln \left(\frac{ni}{\sum^n} \right)$$

In where:

n_i - Number of individuals of species ith in the study plot.

- Biomass of organisms, unit is gram/m².

Biomass calculated according to the formula:

$$W = \frac{\sum^m}{N} g/m^2$$

In where:

W - Average mass of species.

N - Total number of benthic samples.

Σm - Total mass from sample 1 to sample n.

3. Results and discussions

3.1. Species composition of zoobenthos

The species composition of zoobenthos on coastal intertidal area in Hai Phong had been recorded 152 species belonging to 116 genera, 71 families, 26 orders, 10 classes (Polychaeta, Merostomata, Thecostraca, Malacostraca, Scaphopoda, Bivalvia, Gastropoda, Cephalopoda, Holothuroidea, and Actinopteri) and 5 phyla (Annelida, Arthropoda, Mollusca, Echinodermata and Chordata). In which, 3 classes with the most diverse species: Bivalvia, Gastropoda and Malacostraca (Table 1).

Among 3 classes, Bivalve was the most abundant (8 orders, 22 families, 44 genera, 56 species accounting for 36.84%), followed by gastropod (with 6 orders,

25 families, 38 genera, 53 species, accounting for 34.87%), and the third was Malacostraca (3 orders, 14 families, 24 genera and 33 species, accounting for 21.71%). Other groups only 1or 2 species. (Table 1 and 2).

Table 1. Species composition of zoobenthos on coastal intertidal zone of Hai Phong - Cat Ba

Note: P% = Abundance; w = Biomass, v = Density.

No	Taxon	Various stats		
		(P%)	(w)	(v)
	Phylum ANNELIDA			
	Class POLYCHAETA			
	Order Eunicida			
	Family Eunicidae			
1	<i>Marphysa mossambica</i>	0.019	0.028	0.22
	Order Terebellida			
	Family Sternaspidae			
2	<i>Sternaspis scutata</i>	0.017	0.006	0.19
	Phylum ARTHROPODA			
	Class MEROSTOMATA			
	Order Xiphosurida			
	Family Limulidae			
3	<i>Limulus polyphemus</i>			
	Class THECOSTRACA			
	Order Balanomorpha			
	Family Balanidae			
4	<i>Amphibalanus amphitrite</i>	28,842	67,029	337.56
	Class MALACOSTRACA			
	Order Isopoda			
	Family Cirolanidae			
5	<i>Excitrolana kincaidi</i>	0.007	0.009	0.08
	Order Decapoda			
	Family Alpheidae			
6	<i>Alpheus euphrosyne</i>			
	Family Palaemonidae			
7	<i>Nematopalaemon tenuipes</i>	0.009	0.056	0.11
8	<i>Macrobrachium equidens</i>	0.007	0.112	0.08
9	<i>Macrobrachium nipponense</i>	0.007	0.04	0.08
10	<i>Palaemon varians</i>	0.005	0.025	0.06
	Family Pandalidae			
11	<i>Plesionika martia</i>	0.028	0.195	0.33
	Family Penaeidae			
12	<i>Metapenaeus ensis</i>			
13	<i>Metapenaeus monoceros</i>	0.04	0.313	0.47
14	<i>Parapenaeopsis hardwickii</i>	0.019	0.288	0.22
15	<i>Parapenaeopsis sculptilis</i>			
16	<i>Parapenaeopsis sinica</i>	0.005	0.016	0.06
17	<i>Penaeus chinensis</i>	0.021	0.139	0.25
	Family Sergestidae			
18	<i>Acetes japonicus</i>	2,086	0.389	24.42
19	<i>Acetes sp.</i>			
	Family Diogenidae			
20	<i>Clibanarius longitarsus</i>	0.007	0.03	0.08
21	<i>Clibanarius virescens</i>	0.007	0.029	0.08
22	<i>Diogenes mixtus</i>	0.009	0.043	0.11
	Family Dorippidae			
23	<i>Dorippoides facchino</i>			

No	Taxon	Various stats		
		(P%)	(w)	(v)
	Family Grapsidae			
24	<i>Metopograpsus thukuhar</i>	0.005	0.043	0.06
	Family Leucosiidae			
25	<i>Lyphira heterograna</i>			
	Family Ocypodidae			
26	<i>Uca arcuata</i>	0.002	0.08	0.03
	Family Portunidae			
27	<i>Charybdis annulata</i>			
28	<i>Charybdis callianassa</i>	0.005	0.164	0.06
29	<i>Charybdis feriatius</i>			
30	<i>Charybdis natator</i>			
31	<i>Scylla serrata</i>			
32	<i>Portunus sanguinolentus</i>			
33	<i>Portunus pelagicus</i>			
34	<i>Thalamita crenata</i>	0.002	0.26	0.03
	Family Xanthidae			
35	<i>Leptodius sanguineus</i>			
	Order Stomatopoda			
	Family Squillidae			
36	<i>Harpisquilla japonica</i>			
37	<i>Oratosquilla oratoria</i>			
	Phylum MOLLUSCA			
	Class SCAPHOPODA			
	Order Dentaliida			
	Family Dentaliidae			
38	<i>Antalis entalis</i>			
	Class BIVALVIA			
	Order Adapedonta			
	Family Pharidae			
39	<i>Phaxas pellucidus</i>			
40	<i>Siliqua pulchella</i>	0.017	0.015	0.19
	Family Solenidae			
41	<i>Solen grandis</i>			
	Order Arcida			
	Family Arcidae			
42	<i>Anadara antiquata</i>			
43	<i>Anadara granosa</i>			
44	<i>Anadara inaequalis</i>			
45	<i>Barbatia velata</i>	0.033	0.281	0.39
46	<i>Barbatia trapezina</i>			
47	<i>Trisidos tortuosa</i>			
	Family Parallelodontidae			
48	<i>Porterius dalli</i>	0.021	0.086	0.25
	Order Mytilida			
	Family Mytilidae			
49	<i>Brachidontes striatulus</i>	6,771	12,943	79.25
50	<i>Brachidontes pharaonis</i>	1,877	2,504	21.97
51	<i>Perna vidiris</i>			
52	<i>Xenostrobus atrata</i>	0.017	0.112	0.19
53	<i>Modiolus martorelli</i>			
54	<i>Modiolus philippinarum</i>			
	Order Ostreida			
	Family Isognomonidae			
55	<i>Isognomon ephippium</i>	0.036	0.681	0.42
	Family Margaritidae			
56	<i>Pinctada martensii</i>			
	Family Ostreidae			
57	<i>Crassostrea ariakensis</i>			
58	<i>Crassostrea gigas</i>	0.007	0.043	0.08
59	<i>Crassostrea rivularis</i>			
60	<i>Ostrea denselamellosa</i>	0.005	0.108	0.06

No	Taxon	Various stats		
		(P%)	(w)	(v)
61	<i>Saccostrea cucullata</i>	46,676	426,957	546.28
62	<i>Saccostrea glomerata</i>	2,694	335,197	31.53
63	<i>Saccostrea mordax</i>	0.309	55,464	3.61
	Family Pinnidae			
64	<i>Pinna atropurpurea</i>			
	Order Pectinida			
	Family Anomiidae			
65	<i>Anomia aenigmatica</i>	0.002	0.019	0.03
66	<i>Anomia chinensis</i>	0.005	0.079	0.06
	Family Placunidae			
67	<i>Placuna placenta</i>			
	Family Pectinidae			
68	<i>Amusium japonicum</i>			
	Family Spondylidae			
69	<i>Spondylus ducalis</i>	0.014	0.141	0.17
	Order Cardiida			
	Family Cardiidae			
70	<i>Fragum hemicardium</i>			
71	<i>Vasticardium flavum flavum</i>			
	Family Solecurtidae			
72	<i>Azorinus abbreviatus</i>			
	Family Psammobiidae			
73	<i>Asaphis violascens</i>	0.017	0.328	0.19
	Family - Tellinidae			
74	<i>Nitidotellina valtonis</i>			
75	<i>Tellina fabula</i>			
	Order Myida			
	Family Corbulidae			
76	<i>Caryocorbula swiftiana</i>	0.648	1,045	7.58
77	<i>Lentidium mediterraneum</i>	0.926	0.661	10.83
	Order Venerida			
	Family Trapezidae			
78	<i>Neotrapezium sublaevigatum</i>			
	Family Cyrenidae			
79	<i>Corbicula bocourti</i>	0.064	0.08	0.75
80	<i>Geloina coaxans</i>	0.005	0.001	0.06
	Family Mactridae			
81	<i>Mactra violacea</i>			
	Family Veneridae			
82	<i>Anomalocardia squamosa</i>	0.012		0.14
83	<i>Chamelea gallina</i>			
84	<i>Chioneryx grus</i>	0.04	0.071	0.47
85	<i>Clausinella brongiartii</i>			
86	<i>Gafrarium pectinatum</i>	0.007	0.056	0.08
87	<i>Mercenaria mercenaria</i>			
88	<i>Meretrix lyrata</i>	0.021	0.164	0.25
89	<i>Meretrix meretrix</i>	0.009	0.109	0.11
90	<i>Paphia textile</i>			
91	<i>Periglypta puerpera</i>			
92	<i>Placamen calophylla</i>			
93	<i>Placamen foliaceum</i>			
94	<i>Pitar fulminatus</i>			
	Class GASTROPODA			
	Order Littorinimorpha			
	Family Cypraeidae			
95	<i>Cypraea arabica</i>	0.033	3,537	0.39
96	<i>Cypraea cylindrica</i>	0.005	0.033	0.06
97	<i>Cypraea histrio</i>	0.002	0.166	0.03
98	<i>Monetaria annulus</i>	0.005	0.058	0.06

No	Taxon	Various stats		
		(P%)	(w)	(v)
	Family Littorinidae			
99	<i>Littoraria articulata</i>	4,047	3,016	47.36
100	<i>Littorina melanostoma</i>	0.074	0.206	0.86
	Family Naticidae			
101	<i>Notocochlis tigrina</i>			
	Family Cassidae			
102	<i>Phalium glaucum</i>			
103	<i>Galeodea echinophora</i>			
	Family Eulimidae			
104	<i>Melanella cumingii</i>	0.012	0.013	0.14
	Order Caenogastropoda			
	Family Batillariidae			
105	<i>Batillaria australis</i>	0.311	0.342	3.64
	Family Cerithiidae			
106	<i>Cerithium citrinum</i>	0.005	0.056	0.06
107	<i>Clypeomorus batillariaeformis</i>	0.021	0.134	0.25
108	<i>Clypeomorus bifasciata</i>	0.005	0.025	0.06
109	<i>Clypeomorus bifasciata</i>	1,498	8,089	17.53
110	<i>Clypeomorus concisus</i>	0.316	3,748	3.69
	Family Modulidae			
111	<i>Modulus tectum</i>	0.014	0.481	0.17
	Family Planaxidae			
112	<i>Planaxis sulcatus</i>	1,429	2,289	16.72
	Family Potamididae			
113	<i>Cerithium microptera</i>			
114	<i>Terebralia sulcata</i>	0.062	0.698	0.72
	Family Thiaridae			
115	<i>Sermyla riqueti</i>	0.18	0.138	2.11
	Family Turritellidae			
116	<i>Turritella bacillum</i>			
117	<i>Turritella communis</i>			
118	<i>Turritella terebra</i>			
	Order Neogastropoda			
	Family Buccinidae			
119	<i>Afer africanus</i>			
	Family Fasciolariidae			
120	<i>Peristernia castanoleuca</i>	0.028	0.22	0.33
	Family Nassariidae			
121	<i>Nassarius siquijorensis</i>			
122	<i>Nassarius stolatus</i>			
	Family Borsoniidae			
123	<i>Microdrillia trina</i>			
	Family Clavatulidae			
124	<i>Clavatula lelieuri</i>	0.002	0.084	0.03
	Family Mangeliidae			
125	<i>Bela hispidula</i>			
	Family Terebridae			
126	<i>Partecosta bozzettii</i>			
127	<i>Terebra doellojuradoi</i>	0.007	0.012	0.08
	Family Muricidae			
128	<i>Chicoreus brunneus</i>			
129	<i>Chicoreus capucinus</i>			
130	<i>Lataxiena blosvillei</i>			
131	<i>Murex trapa</i>			
132	<i>Thais clavigera</i>	0.033	0.304	0.39
133	<i>Thais gradata</i>	0.005	0.071	0.06
134	<i>Thais (Thaisella) lacera</i>			
135	<i>Thais malayensis</i>			
	Order Ellobiida			
	Family Ellobiidae			

No	Taxon	Various stats		
		(P%)	(w)	(v)
136	<i>Cassidula nucleus</i>	0.009	0.077	0.11
137	<i>Cassidula plecotrematoides</i>	0.185	0.168	2.17
138	<i>Ellobium aurisjudae</i>			
	Order Cycloneritida			
	Family Neritidae			
139	<i>Clithon oualaniense</i>	0.021	0.026	0.25
140	<i>Nerita albicilla</i>	0.014	0.095	0.17
141	<i>Nerita balteata</i>	0.007	0.08	0.08
	Order Trochida			
	Family Liotiidae			
142	<i>Cyclostrema cingulifera</i>	0.007	0.005	0.08
	Family Trochidae			
143	<i>Monodonta canalifera</i>	0.047	0.253	0.56
144	<i>Trochus maculatus</i>	0.012	0.432	0.14
145	<i>Umbonium vestiarium</i>	0.154	0.151	1.81
	Family Turbinidae		0	
146	<i>Lunella coronata</i>	0.043	0.605	0.5
147	<i>Turbo sandwicensis</i>	0.005	0.071	0.06
	Class CEPHALOPODA			
	Order Myopsida			
	Family Loliginidae			
148	<i>Loligo vulgaris</i>	0.002	0.096	0.03
	Order Sepiida			
	Family Sepiidae			
149	<i>Sepia recurvirostra</i>			
	Phylum ECHINODERMATA			
	Class HOLOTHUROIDEA			
	Order Holothuriida			
	Family Holothuriidae			
150	<i>Holothuria scabra</i>	0.005	7,803	0.06
	Phylum CHORDATA			
	Class ACTINOPTERI			
	Order Pleuronectiformes			
	Family Cynoglossidae			
151	<i>Cynoglossus lingua</i>	0.005	0.053	0.06
	Family Soleidae			
152	<i>Solea ovata</i>	0.005	0.049	0.06
	Total	100%	W = 940 g/m²	V = 1.170 individuals/m²

Some comments from the study results:

- The number of zoo-benthos species in the coastal ecosystem of Hai Phong - Cat Ba was relatively rich and diverse. The species composition mainly concentrated in 3 classes (Malacostraca, Gastropoda and Bivalvia), accounting for 95.4% of the total species. This was consistent with the research results of other authors (Pham Dinh Trong, 1996, Do Van Nhung & Hoang Ngoc Khac, 2001)

Table 2. Structure of taxonomy of zoo-benthic groups

No	Taxons	Oders	Families	Genera	Species	Ratio (%) number of species
1	Polychaeta	2	2	2	2	1.32
2	Merostomata	1	1	1	1	0.66
3	Thecostraca	1	1	1	1	0.66
4	Malacostraca	3	14	24	33	21.71
5	Scaphopoda	1	1	1	1	0.66
6	Bivalvia	8	22	44	56	36.84
7	Gastropoda	6	25	38	53	34.87
8	Cephalopoda	2	2	2	2	1.32
9	Holothuroidea	1	1	1	1	0.66
10	Actinopteri	1	2	2	2	1.32
Total		26	71	116	152	100%

- Among the families, Veneridae had the largest number of species (13 species), followed by the Muricidae and Portunidae with 8 species, the Ostreidae with 7 species, the Penaeidae, the Arcidae and the Mytilidae with 6 species. Other families had only 1 to 5 species.

- *General comment:* Most zoo-benthic species are widely distributed in the northern and southern coastal areas of Vietnam, some species are widely distributed in the coastal areas of South Asia and the Western Pacific. Species widely distributed in such gastropod genera as *Nassarius*, *Natica*, *Thais*, *Littoraria*, ...; and bivalve genera as *Meretrix*, *Ostrea*, *Crassostrea*, *Saccostrea*,...; Typical crustaceans are *Amphibalanus amphitrite*, several species in the family Portunidae (as *Portunus sanguinolentus*,...).

- Through preliminary research, no rare species of medium and large size were found in the coastal areas of Hai Phong - Cat Ba.

- Species richness (P%)

In quantitative samples on coastal intertidal areas of Hai Phong- Cat Ba, species with the highest richness was *Saccostrea cucullata* (46.676%), followed by *Amphibalanus amphitrite* (28.842%), *Brachidontes striatulus* (6.771%), and *Saccostrea glomerata* (2.694%). Other species richness (P% ≤ 2%) (Table 1).

- *The richness of the benthic species of Hai Phong coastal:* Among 39 species obtained in quantitative samples in Hai Phong coastal, species with the highest richness was *Saccostrea cucullata* with richness of 52.974%, followed by *Amphibalanus amphitrite* (30.684%), *Brachidontes striatulus* (7.354%), *Littoraria articulata* (3.558%), and *Acetes japonicus* (2.368%). Other species richness (P% ≤ 2%).

- *The richness of the benthic species of Cat Ba coastal:* Considering only 30 species collected in quantitative samples in coastal Cat Ba island, species with the highest richness was *Saccostrea glomerata* with richness of 27.696%, next *Brachidontes pharaonis* (18.692%), *Amphibalanus amphitrite* (18.57%), *Planaxis sulcatus* (13.519%), and *Littoraria articulata* (9.37%). Other species richness (P% ≤ 4%).

- *The richness of benthic species along the coast of Bach Long Vi island:* Among 23 species quantitatively sampled in the coastal area of Bach Long Vy Island, species with the highest richness was *Clypeomorus bifasciata* with richness of 69.265%, next *Clypeomorus concisus* (12.953%), *Planaxis sulcatus* (5.269%), and *Brachidontes pharaonis* (2.744%). Other species richness (P% ≤ 2%).

Total biomass of species

In quantitative samples on coastal areas of Hai Phong - Cat Ba, average biomass of *Saccostrea cucullata* was the highest ($w = 426.957 \text{ g/m}^2$), followed by *Saccostrea glomerata* ($w = 335.197 \text{ g/m}^2$), *Amphibalanus amphitrite* ($w = 67.029 \text{ g/m}^2$), *Saccostrea mordax* ($w = 55.464 \text{ g/m}^2$), *Brachidontes striatulus* ($w = 12.943 \text{ g/m}^2$), *Holothuria scabra* ($w = 7.803 \text{ g/m}^2$), Other species with low biomass ($w \leq 5 \text{ g/m}^2$). Mean biomass of all species in quantification plots was approximately 940.227 g/m^2 .

- *Biomass of zoo-benthic species in quantitative samples in the coastal area of Hai Phong:* The average biomass of the species *Saccostrea cucullata* was the highest ($w = 1698.657 \text{ g/m}^2$), followed by *Saccostrea mordax* ($w = 90.334 \text{ g/m}^2$), *Amphibalanus amphitrite* ($w = 98.994 \text{ g/m}^2$), *Brachidontes striatulus* ($w = 20.676 \text{ g/m}^2$), *Littoraria articulata* ($w = 4.408 \text{ g/m}^2$).

Other species have low biomass ($w \leq 2 \text{ g/m}^2$). Mean biomass of all species in quantification plots was approximately 921.086 g/m^2 .

- *Biomass of zoo-benthic species in quantitative samples in the coastal area of Cat Ba island:* The average biomass of the species *Saccostrea glomerata* was the highest ($w = 1508.385 \text{ g/m}^2$), followed by *Amphibalanus amphitrite* ($w = 29.396 \text{ g/m}^2$), *Planaxis sulcatus* ($w = 7.82 \text{ g/m}^2$), *Brachidontes pharaonis* ($w = 4.236 \text{ g/m}^2$), *Terebralia sulcata* ($w = 3.141 \text{ g/m}^2$), *Littoraria articulata* ($w = 2.44 \text{ g/m}^2$). Other species have low biomass ($w \leq 2 \text{ g/m}^2$). Mean biomass of all species in quantification plots was approximately 1573.501 g/m^2 .

- *Biomass of zoo-benthic species in quantitative samples in the coastal area of Bach Long Vỹ island:* The average biomass of the species *Holothuria scabra* was the largest ($w = 46.817 \text{ g/m}^2$), followed by *Clypeomorus bifasciata bifasciata* ($w = 48.533 \text{ g/m}^2$), *Cypraea arabica* ($w = 21.223 \text{ g/m}^2$), *Clypeomorus concisus* ($w = 420.64 \text{ g/m}^2$), *Brachidontes pharaonis* ($w = 90.377 \text{ g/m}^2$). Other species have low biomass ($w \leq 5 \text{ g/m}^2$). Mean biomass of all species in quantification plots was approximately 166.043 g/m^2 .

Density

Density of zoo-benthic species in quantitative samples in coastal Hai Phong - Cat Ba: The species with the highest density was *Saccostrea cucullata* ($v = 546.28 \text{ inds/m}^2$), followed by *Amphibalanus amphitrite* ($v = 337.56 \text{ inds/m}^2$), *Brachidontes striatulus* ($v = 79.25 \text{ inds/m}^2$), *Littoraria articulata* ($v = 47.36 \text{ inds/m}^2$), *Saccostrea glomerata* ($v = 31.53 \text{ inds/m}^2$), *Acetes japonicus* ($v = 24.42 \text{ inds/m}^2$), *Brachidontes pharaonis* ($v = 21.97 \text{ inds/m}^2$). Other species have low density ($v \leq 20 \text{ inds/m}^2$). Average density of all species in the quantification plot was approximately 1170 inds/m^2 .

- *Density of zoo-benthic species in quantitative samples in coastal Hai Phong:* The species with the highest density was *Saccostrea cucullata* ($v = 893.91 \text{ inds/m}^2$), followed by *Amphibalanus amphitrite* ($v = 517.77 \text{ inds/m}^2$), *Brachidontes striatulus* ($v = 124.09 \text{ inds/m}^2$), *Littoraria articulata* ($v = 60.05 \text{ inds/m}^2$), *Acetes japonicus* ($v = 39.95 \text{ inds/m}^2$), *Lentidium mediterraneum* ($v = 17.73 \text{ inds/m}^2$), *Caryocorbula swiftiana* ($v = 12.41 \text{ inds/m}^2$). Other species have low density ($v \leq 10 \text{ inds/m}^2$). Average density of all species in the quantification plot was approximately 1687.45 inds/m^2 .

- *Density of zoo-benthic species in quantitative samples in coastal Cat Ba island:* The species with the highest density was *Saccostrea glomerata* ($v = 141.88 \text{ inds/m}^2$), followed by *Brachidontes pharaonis* ($v = 95.75 \text{ inds/m}^2$), *Amphibalanus amphitrite* ($v = 95.13 \text{ inds/m}^2$), *Planaxis sulcatus* ($v = 69.25 \text{ inds/m}^2$), *Littoraria articulata* ($v = 48 \text{ inds/m}^2$), *Batillaria australis* ($v = 16.38 \text{ inds/m}^2$), *Brachidontes striatulus* ($v = 15.38 \text{ inds/m}^2$). Other species have low density ($v \leq 10 \text{ inds/m}^2$). Average density of all species in the quantification plot was approximately 512.25 inds/m^2 .

- *Density of zoo-benthic species in quantitative samples in coastal Bach Long Vỹ island:* The species with the highest density was *Clypeomorus bifasciata* ($v = 105.17 \text{ inds/m}^2$), followed by *Clypeomorus concisus* ($v = 19.67 \text{ inds/m}^2$), *Planaxis sulcatus* ($v = 8 \text{ inds/m}^2$), *Brachidontes pharaonis* ($v = 4.17 \text{ inds/m}^2$), *Cypraea arabica* ($v = 2.33 \text{ inds/m}^2$), *Peristernia castanoleuca* ($v = 2 \text{ inds/m}^2$). Other species have low density ($v \leq 2 \text{ inds/m}^2$). Average density of all species in the quantification plot was approximately 151.83 inds/m^2 .

Biodiversity Index

Biodiversity index in coastal areas of Hai Phong - Cat Ba was relatively low ($H' = 2.39$). This index on coastal areas of Hai Phong city, Cat Ba and Bach Long Vi islands were 1.84, 2.89 and 1.83 correspondingly.

3.2. Taxonomic structure of Gastropod

In class of Gastropod, especially the families Tornatinidae, Nassariidae, Muricidae and Naticidae with a large number of species distributed in the coastal bottom [8], [9], [16]. Typical species in this group include *Nassarius siquijorensis*, *Nassarius stolatus*, *Acteocina oryzaella*, *Thais malayensis*, *Murex trapa*, *Littoraria articulata*, *Littorina melanostoma*, *Nerita albicilla*, *Nerita albicilla*, *Turritella terebra*,...

In general, the species composition of Gastropod is quite abundant and belong in common families in coastal areas of Vietnam and neighbour countries (as Taiwan, Hong Kong, Singapore, Thailand, Indonesia) [20]. However, the number of species in each family is not much, the family Muricidae has the largest number of species with 8 species. The remaining families have only 1 to 5 species and are usually in 1 or 2 genera. The most common species are in the families Muricidae and Cerithiidae. Other families have only 1-3 species (Figure 2).

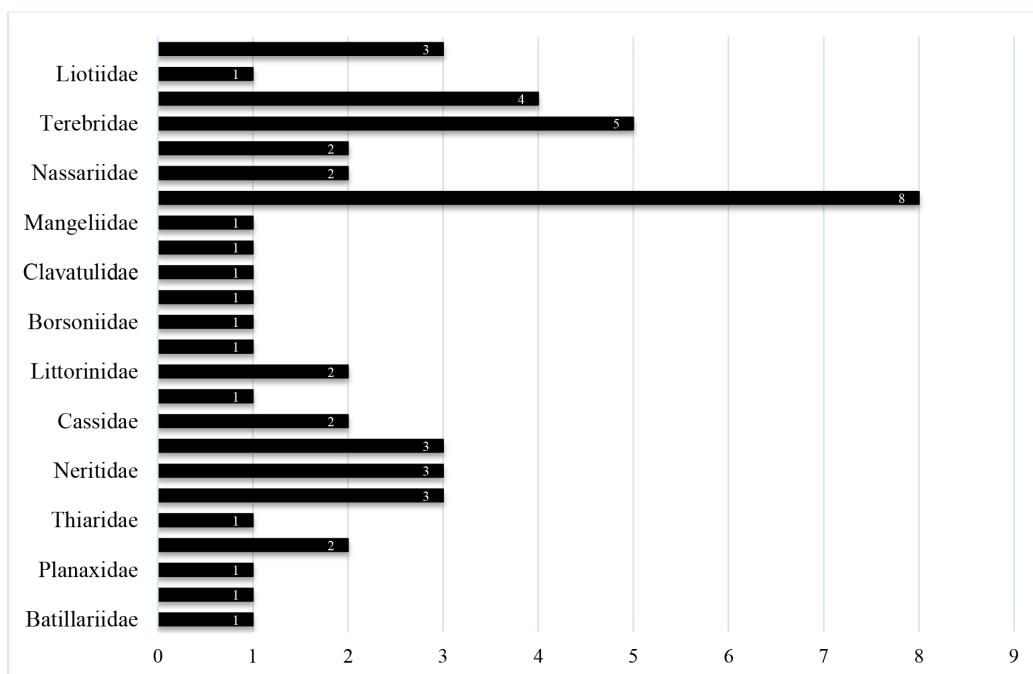


Figure 2. Number of species in the family of Gastropod

3.3. Taxonomic structure of Bivalve

Bivalve species distributed mainly in low tide areas. In this class, there are many species in the families Arcidae, Veneridae adapt the characteristics of the bottom layer and the water salinity of the estuary regions (as genus *Anadara*, ...).

The families are widely distributed in the coastal bottom such as: Arcidae, Veneridae, Tellinidae,... common on sandy bottom. Other groups, which like

burying in the sand such as *Donax striatus*,...

It can be remarked that the bivalve class in the Hai Phong - Cat Ba is relatively abundant. There was the most in number of species compared to Gastropods and Crustaceans. The family with the largest number of species is the Veneridae (13 species), followed by Ostreidae (7 species), Mytilidae and Arcidae (6 species). Other families have only 1-2 species. (Figure 3).

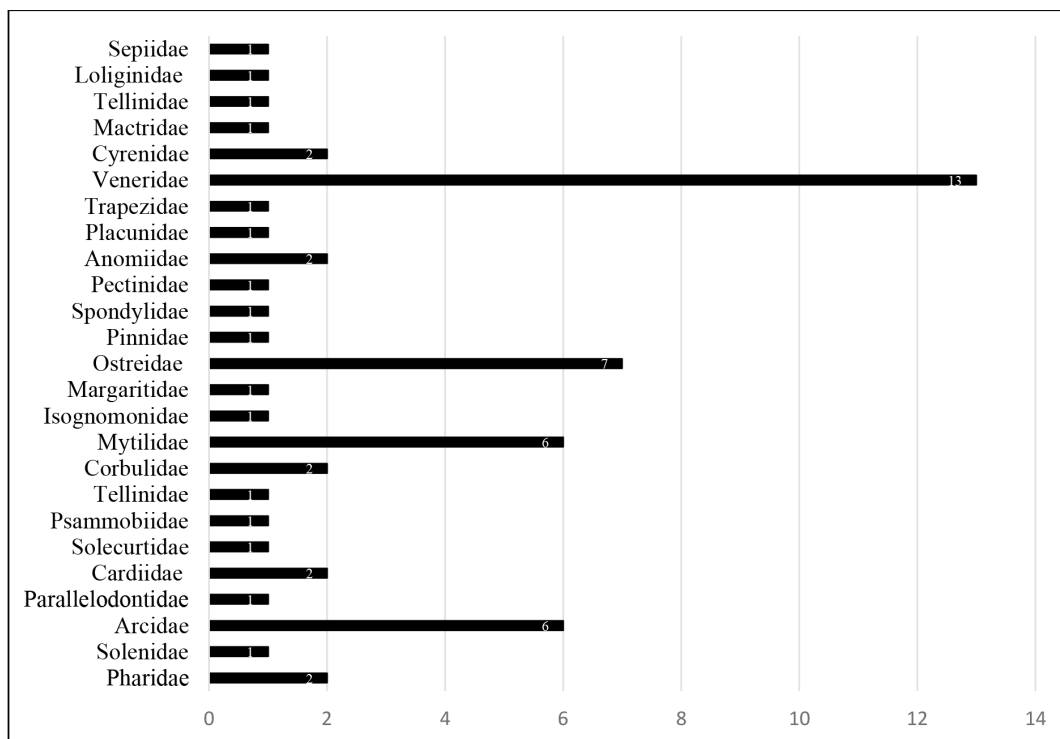


Figure 3. Number of species in the families of Bivalve

3.4. Taxonomic structure of Malacostraca

The number of crustacean species of class Malacostraca in the coastal area of Hai Phong - Cat Ba ranked after gastropods and bivalves. In which, crab species accounted for the majority with 13 species (accounting for 39.39% of the total number

of Crustacean species). There are 14 species of shrimp (accounting for 42.42% of the total number of Crustacean species) (Table 3). Family Portunidae was the most species with 8 species, followed by the Penaeidae with 6 species and other families with 1 to 4 species.

Table 3. Percentage (%) of crustacean species and genera of Malacostraca

No	Taxon	Species		Genera	
		Amount	Ratio %	Amount	Ratio %
1	Cirolanidae	1	3.03	1	4.17
2	Alpheidae	1	3.03	1	4.17
3	Palaemonidae	4	12.12	4	16.67
4	Pandalidae	1	3.03	1	4.17
5	Penaeidae	6	18.18	3	12.50
6	Sergestidae	2	6.06	1	4.17
7	Diogenidae	3	9.09	2	8.33
8	Dorippidae	1	3.03	1	4.17
9	Grapsidae	1	3.03	1	4.17
10	Leucosiidae	1	3.03	1	4.17
11	Ocypodidae	1	3.03	1	4.17
12	Portunidae	8	24.24	4	16.67
13	Xanthidae	1	3.03	1	4.17
14	Squillidae	2	6.06	2	8.33
Total		33	100%	24	100%

General assessment, Crustaceans group of Malacostraca on coastal in Hai Phong - Cat Ba was very abundant and accounted for a large proportion ranked only lower than classes Gastropods and Bivalves.

4. Conclusions

Research on species composition, abundance and density of benthic fauna in the coastal areas of Hai Phong - Cat Ba has recorded 152 species belonging to 116 genera, 71 families, 26 orders of 10 classes (Polychaeta, Merostomata, Thecostraca, Malacostraca, Scaphopoda, Bivalvia, Gastropoda, Cephalopoda, Holothuroidea, and Actinopteri) and 5 phyla (Annelida, Arthropoda, Mollusca, Echinodermata and Chordata). In which, Bivalve was the most abundant (8 orders, 22 families, 44 genera, 56 species accounting for 36.84%), followed by gastropod (with 6 orders, 25 families, 38 genera, 53 species, accounting for 34.87%), and the third was Malacostraca (3 orders, 14 families, 24 genera and 33 species, accounting for 21.71%). Other groups only for 2 species.

Among the families, Veneridae has the largest number of species (13 species), followed by the Muricidae and Portunidae with 8 species, the

Ostreidae with 7 species, the Penaeidae, the Arcidae and the Mytilidae with 6 species. Other families have 1 to 5 species.

Species richness: Species with the highest richness was *Saccostrea cucullata* (P%=46.676%), followed by *Amphibalanus amphitrite* (28.842%), *Brachidontes striatulus* (6.771%), and *Saccostrea glomerata* (2.694%). Other species richness (P% ≤ 2%).

Biomass: In quantitative samples on coastal areas of Hai Phong - Cat Ba, average biomass of *Saccostrea cucullata* was the highest (w = 426.957 g/m²), followed by *Saccostrea glomerata* (w = 335.197g/m²), *Amphibalanus amphitrite* (w = 67.029 g/m²), *Saccostrea mordax* (w = 55.464 g/m²), *Brachidontes striatulus* (w = 12.943 g/m²), *Holothuria scabra* (w = 7.803 g/m²), Other species with low biomass (w ≤ 5 g/m²). Mean biomass of all species in quantification plots was approximately 940.227 g/m².

Density of zoo-benthic species in quantitative

samples: The species with the highest density was *Saccostrea cucullata* ($v= 546.28$ inds/m²), followed by *Amphibalanus amphitrite* ($v= 337.56$ inds/m²), *Brachidontes striatulus* ($v= 79.25$ inds/m²), *Littoraria articulata* ($v= 47.36$ inds/m²), *Saccostrea glomerata* ($v= 31.53$ inds/m²), *Acetes japonicus* ($v= 24.42$ inds/m²), *Brachidontes pharaonis* ($v= 21.97$ inds/m²). Other species have low density ($v \leq 20$ inds/m²). Average density of all species in the quantification plot was approximately 1170 inds/m².

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