



Species composition and distribution characteristics of zoobenthos in Cua Lo coastal area, Nghe An Province

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Abstract

Due to survey data on benthic species composition in Cua Lo coastal area is limited, the article provides data on species composition, differences and distribution levels of benthic animals in coastal and island areas as well as contributing to completing research on benthic diversity and proposing management and conservation of biodiversity in the coastal area of Cua Lo (Nghe An) in particular and Vietnam in general. The research applies sampling methods in Cua Lo coastal area (Nghe An): Field research methods (collection methods, animal fixation and storage methods) and laboratory research methods (determination of nomenclature of types and data processing methods). Results of analysis of research samples have identified 86 species belonging to 3 main groups (Bivalvia, Crustacea and Gastropoda). Crustaceans have the highest number of species with 33 species, followed by gastropods with 29 species and bivalve molluscs with the lowest number of species with 24 species. 5 species with only identified genera should be kept as sp. (*Grapsus* sp.; *Neoliomera* sp.; *Alia* sp.; *Olivella* sp. and *Gibbula* sp.).

Keywords: Nghe An, Zoobenthos, Gastropoda, Crustacea, Bivalvia.

JEL Classifications: P48, Q56, Q57.

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Benthic animals in the sea have certain economic significance; many groups have been identified as having an important daily food role for coastal residents and export value such as shrimp, crabs, fiddler crabs, snails. The coastal area of Cua Lo is exploited by humans without planning and without management measures, leading to benthic resources at risk of ecological imbalance. With the important role of benthos, there have been studies relating to benthic species in the surrounding area such as: (H.N. Khac, 2021) Assessing the crab species composition in the mangrove ecosystem (Thanh Hoa), (N.T. Binh, 2022). Research on species composition and distribution of benthic animals in Vung Ang waters (Ha Tinh). Currently, in the coastal area of Cua Lo (Nghe An), there is no research data on benthic groups in this area.

Survey data on benthic species composition in Cua Lo coastal area is still limited. Therefore, this article provides data on species composition, differences and distribution levels of benthic animals in coastal and off-island areas. At the same time, it contributes to completing research on benthic diversity and proposes management and conservation of biodiversity in the coastal area of Cua Lo (Nghe An) in particular and Vietnam in general.

2. METHODS AND MATERIALS

Time: Qualitative and quantitative samples were collected in June - July 2023 in the coastal area of Cua Lo (Nghe An). Sampling points are identified, numbered and recorded (Figure 1).

Research subjects: Subjects are all species belonging to 3 groups of benthic animals (Crustacea, Gastropoda and Bivalvia).

Field research methods:

- **Sampling method:** Samples were collected from the bottom, tidal flats, substrates, including spaces above trees and deep in the bottom until all benthic animals were gone. For tidal areas, use a triangular rake with a 1mm mesh size (25 x 25cm) and drag the rake across the bottom to collect benthic animals. Samples were collected from all groups of crustaceans, gastropods and bivalve molluscs until no longer found. The location of sampling points is determined by coordinates.

- **Sample fixation and preservation:** After washing, the sample was fixed in 70° alcohol. Samples are distinguished from each other by numbered labels, clearly stating the location and location of sampling, then brought back to the laboratory for analysis.

Laboratory research methods:

- *Determine species nomenclature:* In the process of classifying 3 groups of benthic animals (Crustaceans, Gastropoda and Bivalvia) based on the morphological characteristics of the outer shell according to descriptive documents such as:

+ *Crab group (Brachyura):* According to the legal identification of crab species (Dai and Yang, 1994), (Crane, 1975);

+ *Bivalvia and Gastropoda:* Determined according to species nomenclature (Kent and Volker, 1998); (Han and Jap, 2006);

- *Data processing methods:* Data in the study were processed using Microsoft Excel 2010 software. Maps were processed and drawn using Map Info software 15.0.

All samples after analysis are separated by species, counted and stored at the laboratory of the Vietnam Environmental and Marine Science Institute.

3. RESULTS AND DISCUSSIONS

3.1. Benthic fauna composition

Research results on benthic species composition collected in the coastal area of Cua Lo, Nghe An province have identified 86 species, belonging to 66 genera, 45 families and 18 orders belonging to 3 main groups (Bivalvia, Crustacea and Grastropoda). Among them, the Veneridae family is the most diverse with 7 species (accounting for 8.14% of the total number of species), the two families Arcidae and Portunidae have 6 species (accounting for 6.98% of the total number of species). The remaining families have a small number of species, less than 5 species. The species has not been identified, only the genus of 5 species has been identified (*Grapsus sp.*; *Neoliomera sp.*; *Alia sp.*; *Olivella sp.* and *Gibbula sp.*).



▲ Figure 1. Sampling routes in the coastal area of Cua Lo (Nghe An)


Table 1: Composition of benthic fauna in Cua Lo coastal area

No.	Taxon	Allocation		
		Coastwise	Lan Chau Island	Hon Ngu Island
	Arthropoda			
	Crustacea			
	Penaeidae			
1	<i>Metapenaeus ensis</i> (De Haan, 1844)	x		
2	<i>Mierspenaeopsis hardwickii</i> (Miers, 1878)	x		
3	<i>Parapenaeopsis sculptilis</i> (Heller, 1862)	x		
4	<i>Penaeus indicus</i> (H.Milne - Edwards, 1837)	x		
5	<i>Penaeus monodon</i> (Fabricius, 1798)	x		
	Sergestidae			
6	<i>Acetes japonicus</i> Kishinouye, 1905	x		
	Porcellanidae			
7	<i>Petrolisthes armatus</i> (Gibbes, 1850)		x	
	Diogenidae			
8	<i>Diogenes mixtus</i> Lanchester, 1902		x	
9	<i>Diogenes violaceus</i> Henderson, 1893		x	x
	Alpheidae			
10	<i>Alpheus dispar</i> Randall, 1840	x		
	Palaemonidae			
11	<i>Nematopalaemon tenuipes</i> (Henderson, 1893)	x		
12	<i>Macrobrachium equidens</i> (Dana, 1852)	x		
	Dorippidae			
13	<i>Paradorippe granulata</i> (De Haan, 1841)			
	Euryplacidae			
14	<i>Eucrate crenata</i> (De Haan, 1835)	x		
	Grapsidae			
15	<i>Grapsus tenuicrustatus</i> (Herbst, 1783)		x	x
16	<i>Grapsus</i> sp.			x
	Leucosiidae			
17	<i>Leucosia anatum</i> (Herbst, 1783)	x		
18	<i>Lyphira heterograna</i> Ortmann, 1892	x		
	Matutidae			
19	<i>Ashtoret lunaris</i> (Forskål, 1775)	x		
	Portunidae			
20	<i>Charybdis anisodon</i> (De Haan, 1850)	x		
21	<i>Charybdis callianassa</i> (Herbst, 1789)	x		
22	<i>Charybdis feriatus</i> (Linnaeus, 1758)	x		
23	<i>Portunus sanguinolentus</i> (Herbst, 1783)	x		
24	<i>Portunus pelagicus</i> (Linnaeus, 1766)	x		
25	<i>Portunus trituberculatus</i> Rathbun, 1902	x		
	Sesarmidae			
26	<i>Parasesarma bidens</i> (De Haan, 1835)		x	x
27	<i>Parasesarma leptosoma</i> (Hilgendorf, 1869)		x	x
28	<i>Parasesarma plicatum</i> (Latreille, 1803)			x
	Xanthidae			
29	<i>Neoliomera</i> sp.		x	
	Squillidae			
30	<i>Miyakella nepa</i> (Latreille in Latreille, Le Peletier, Serville & Guérin, 1828)	x		
31	<i>Oratosquilla oratoria</i> (de Haan, 1844)	x		
	Balanidae			
32	<i>Amphibalanus amphitrite</i> Darwin, 1854	x	x	x
	Tetraclitidae			
33	<i>Tetraclita rubescens</i> Nilsson-Cantell, 1931		x	x
	MOLLUSCA			

No.	Taxon	Allocation		
		Coastwise	Lan Chau Island	Hon Ngu Island
	BIVALVIA			
	Arcidae			
34	Anadara cornea (Reeve, 1844)	x		
35	Anadara inaequalis (Bruguiere, 1789)	x		
36	Anadara subcrenata (Lienschke, 1869)	x		
37	Barbatia domingensis (Lamarck, 1819)	x		
38	Barbatia foliata (Forsskål, 1775)	x		
39	Lunarca ovalis (Bruguière, 1789)	x		
	Cardiidae			
40	Vepricardium burnupi (G. B. Sowerby III, 1897)	x		
	Psammobiidae			
41	Asaphis violascens (Forsskål, 1775)	x		
	Mytilidae			
42	Perna vidiris Linnaeus, 1758			x
	Isognomonidae			
43	Isognomon ephippium (Linnaeus, 1758)		x	
	Ostreidae			
44	Ostraea belcheri G. B. Sowerby II, 1871	x		
45	Saccostrea glomerata (Gould, 1850)		x	x
46	Saccostrea scyphophilla (Peron & Lesueur, 1807)		x	x
	Pinnidae			
47	Atrina vexillum (Born, 1778)			x
	Anomiidae			
48	Anomia chinensis Philippi, 1849	x		
	Mactridae			
49	Mactra violacea Gmelin, 1791	x		
	Veneridae			
50	Circe scripta (Linnaeus, 1758)	x		
51	Clausinella brongniartii (Payraudeau, 1826)	x		
52	Globivenus toreuma (Gould, 1850)	x		
53	Meretrix lyrata (Sowerby, 1851)	x		
54	Meretrix lusoria (Röding, 1798)	x		
55	Paphia textile (Gmelin, 1791)	x		
56	Tivela planulata Broderip & Sowerby, 1829	x		
	Tellinidae			
57	Bosemprella incarnata (Linnaeus, 1758)	x		
	GASTROPODA			
	Ampullariidae			
58	Pomacea canaliculata (Lamarck, 1822)	x	x	x
	Planaxidae			
59	Planaxis sulcatus (Born, 1778)		x	x
	Turridae			
60	Gemmula gemmulina (Martens, 1902)		x	
	Turritellidae			
61	Turritella bacillum Kiener, 1843	x		
62	Turritella communis Risso, 1826	x		
	Neritidae			
63	Nerita albicilla Linnaeus, 1758	x	x	x
	Calyptraeidae			
64	Calyptraea chinensis (Linnaeus, 1758)	x		
	Littorinidae			
65	Echinolittorina reticulata (Anton, 1838)		x	x
66	Echinolittorina tuberculata (Menke, 1828)		x	x
67	Littoraria intermedia (Philippi, 1846)		x	x
	Naticidae			



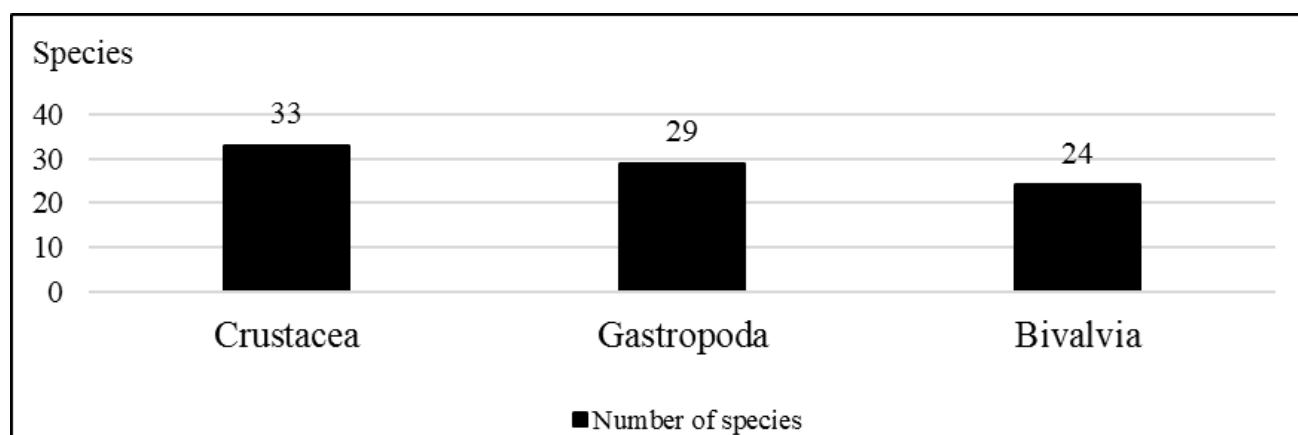
No.	Taxon	Allocation		
		Coastwise	Lan Chau Island	Hon Ngu Island
68	<i>Nerita balteata</i> Reeve, 1855	x		
69	<i>Notocochlis tigrina</i> (Roding, 1798)	x		
70	<i>Polinices didyma</i> (Röding, 1798)	x	x	x
	Stenothyridae			
71	<i>Stenothyra alba</i> Dang et Ho, 2006	x		
	Babyloniidae			
72	<i>Babylonia areolata</i> (Link, 1807)	x		
	Buccinidae			
73	<i>Alia unifasciata</i> (Sowerby, 1832)	x		x
74	<i>Alia</i> sp.	x		x
75	<i>Buccinum undatum</i> Linnaeus, 1758	x		x
	Columbellidae			
76	<i>Euplica scripta</i> (Lamarck, 1822)	x		x
	Muricidae			
77	<i>Murex trapa</i> Röding, 1798	x		x
78	<i>Thais clavigera</i> (Küster, 1860)	x	x	x
79	<i>Thais malayensis</i> Tan & Sigurdsson, 1996	x		x
	Olividae			
80	<i>Olivella</i> sp.	x		x
	Cerithiidae			
81	<i>Clypeomorus bifasciata</i> (G. B. Sowerby II, 1855)	x		x
82	<i>Clypeomorus pellucida</i> (Hombron & Jacquinot, 1848)	x		x
	Cypraeidae			
83	<i>Mauritia arabica</i> (Linnaeus, 1758)			x
	Trochidae			
84	<i>Monodonta canalifera</i> Lamarck, 1816		x	x
85	<i>Gibbula</i> sp.	x		x
86	<i>Umbonium vestiarium</i> (Linnaeus, 1758)	x	x	x
	Total	63	23	33

Note: x - location where species appears

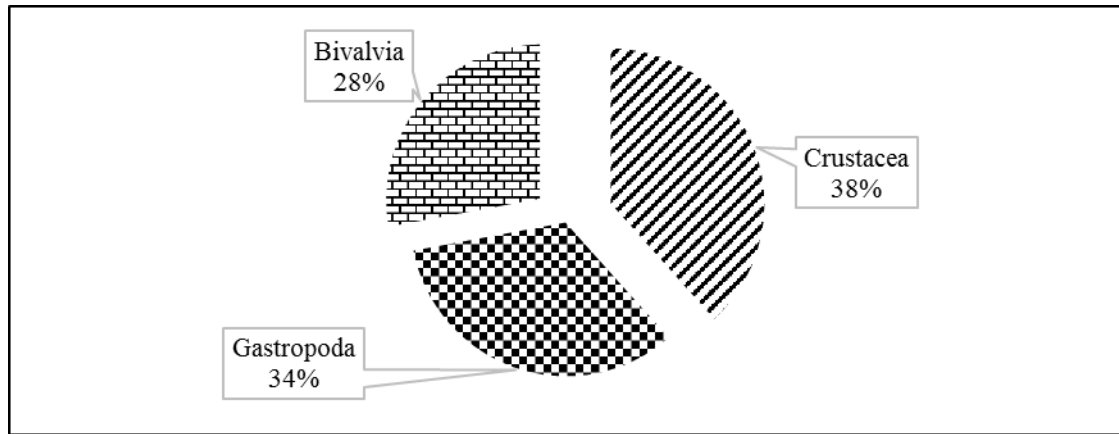
Some comments from the research results:

Among the discovered species, crustaceans have the largest number of species (3 orders, 17 families, 23 genera and 33 species, accounting for 38.37%), Next are gastropod molluscs (8

orders, 17 families, 24 genera, 29 species, accounting for 33.72%), bivalve molluscs have the lowest number of species (7 orders, 11 families, 19 genera, 24 species), accounting for 27.79%), Table 1.



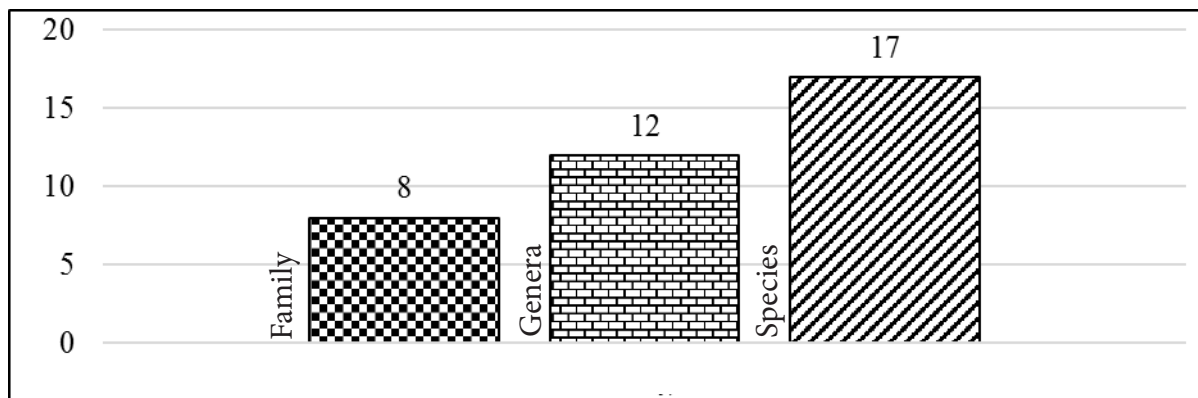
▲ Figure 2: Number of species in the benthic group in Cua Lo waters



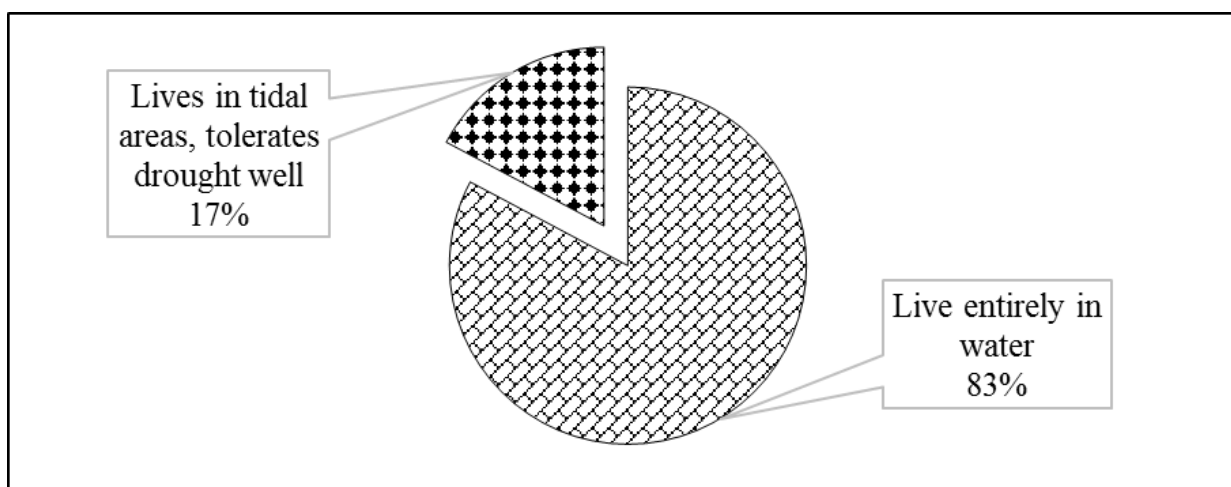
▲ Figure 3: Percentage of species in benthic groups in Cua Lo coastal area

Crustacea: Statistics (Table 1) show that the crustacean group has the most diverse species with 33 species. Among them, the group of crabs (Brachyura) has 17 species (8 species of swimming crabs: *Ashtoret lunaris*, *Charybdis anisodon*, *Charybdis*

callianassa, *Charybdis feriatus*, *Portunus sanguinolentus*, *Portunus pelagicus* and *Portunus trituberculatus*). Next is the shrimp group of 9 species. Other groups only have 1-2 species.



▲ Figure 4: Brachyura species composition in Cua Lo coastal area



▲ Figure 5: Gastropoda species composition living in seawater and species tolerant to land

Gastropoda: The group of gastropod molluscs according to statistics has 29 species. Among them, there is a group that lives entirely in the seawater

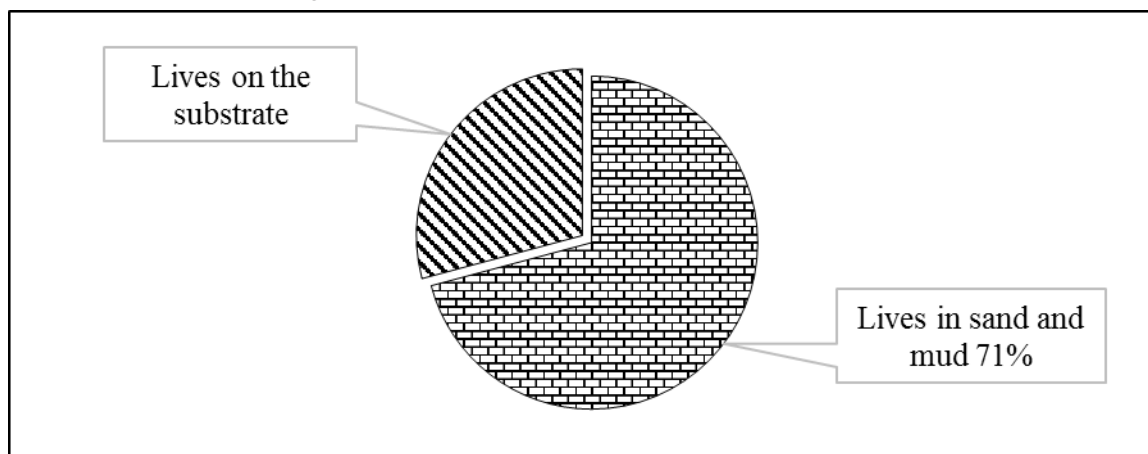
environment and a group that has good tolerance in dry land (living in tidal areas, clinging to the coastal bottom), Figure 5.



Gastropods live entirely in aquatic environments, with 24 species identified. For species that live in the intertidal zone and are drought tolerant, 5 species have been identified (*Planaxis sulcatus*, *Echinolittorina reticulata*, *Echinolittorina tuberculata*, *Littoraria intermedia* and *Monodonta canalifera*, Table 1 - Figure 5.

Bivalvia: The bivalve mollusc group has identified 24 species. Among them, the group that lives entirely on sand and mud bottoms has 17 species. There are 7 species that live on the substrate (secrete calcium or binder), filter water to get food. (*Perna vidiris*, *Isognomon ephippium*, *Ostraea belcheri*, *Saccostrea glomerata*, *Saccostrea scyphophilla*, *Atrina vexillum* and *Anomia chinensis*), Table 1 – Figure 5.

individuals with intact body conditions were collected for classification. Statistics show that there are 63 species of benthic animals (accounting for 73.26% of species recorded here). Living organisms distributed in this area: Crustacean group (*Diogenes mixtus*, *Diogenes violaceus*, *Acetes japonicus*, *Paradorippe granulata*, *Ashtoret lunaris*...); Bivalvia (*Anadara subcrenata*, *Saccostrea glomerata*, *Ostraea belcheri*...); Gastropoda (*Babylonia areolata*, *Umbonium vestiarium*, *Littoraria intermedia*...), Table 1.



▲ Figure 6: Composition of bivalve species living on sandy, muddy substrates and living on muddy substrates

3.2. Distribution characteristics

Benthic animal species are distributed in the coastal area of Cua Lo according to different habitats. Benthic animals are often distributed in places with suitable habitat and conditions. Therefore, the research team divided into 3 different habitats (Lan Chau island, Hon Ngu island and the beach).

Lan Chau island: Due to human impact, mainly infrastructure is built (tourist wharf, restaurants, hotels, parking lots). Therefore, benthic animals collected in this habitat have the least diverse species composition with 23 species (accounting for 26.74% of the species recorded here), Table 1.

Hon Ngu island: This is a strictly protected place guarded by the military and accompanying tourist activities at Song Ngu pagoda. But in coastal areas there is the impact of waves along with cliffs, so benthic animals only include species suitable to live in this environment such as: *Ostraea belcheri*, *Echinolittorina reticulata*, *Echinolittorina tuberculata*, *Littoraria intermedia*, ... Through research, statistics show that there are 33 species (accounting for 38.37% of the species recorded here) distributed on Hon Ngu island, Table 1.

Habitat in the beach area: This is a place where is often affected by humans (beaches, walking places, ships scrape the seabed, etc.). Therefore, only shell samples and some

4. CONCLUSION

Research results on benthic species composition collected in the coastal area of Cua Lo have identified 86 species belonging to 3 main groups (Bivalvia, Crustacea and Grastropoda). Crustaceans have the highest number of species with 33 species, followed by gastropods with 29 species, and bivalve molluscs have the lowest number of species with 24 species. 5 species whose genus could only be identified should be kept as sp. (*Grapsus sp.*; *Neoliomera sp.*; *Alia sp.*; *Olivella sp.* and *Gibbula sp.*).

Regarding distribution: The living environment of Lan Chau island is due to human impact, mainly built with infrastructure (tourist wharf, restaurants, hotels, parking lots). Therefore, benthic animals collected in this habitat have the least abundant species composition with the least abundant species composition with 23 species; the habitat of Hon Ngu Island has 33 species. Due to the impact of waves following cliffs, benthic animals



only include species *Ostraea belcheri*, *Echinolittorina reticulata*, *Echinolittorina tuberculata*, *Littoraria intermedia*...; the habitat in the beach area has 63 species of benthic animals. Crustacea (*Diogenes mixtus*, *Diogenes violaceus*, *Acetes japonicus*, *Paradorippe granulata*, *Ashtoret lunaris*...). Bivalvia (*Anadara subcrenata*, *Saccostrea glomerata*, *Ostraea belcheri*...). Gastropoda (*Babylonia areolata*, *Umbonium vestiarium*, *Littoraria intermedia*...).

Currently, in the coastal area of Cua Lo (Nghe An), there is no research data on benthic groups in this area. Therefore, there has been no process of comparing the benthic species composition with previous data. Along with the short benthic research time, the number of species is still limited. Research shows that the Cua Lo benthic ecosystem is experiencing large-scale loss of benthic habitat, receives less attention than other ecosystems, and is under direct threat, due to exploitation, indirectly due to environmental pollution, swimming, garbage and other activities taking place on land. Therefore, there needs to be some solutions to preserve and protect benthic groups such as: Limit exploitation of benthic animals and coastal tidal flats along with educating the community to protect the ecosystem; Limit and prevent the exploitation of species at risk of biodiversity loss; build a strict conservation area for benthic animals at home and offshore; build and develop valuable domestic and international benthic groups ■

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1. INTRODUCTION

Currently, the circular economy as well as the green economy and green growth are economic models that aim to effectively use and save resources and recycle waste, contributing to economic efficiency and environmental sustainability. Circular economy is considered an inevitable trend of the times and the green industrial revolution of the 21st century. Accordingly, developing green and sustainable agriculture and processing industry is being focused on by the Government (Decision No. 687/QD-TTg dated June 7th, 2022 of the Prime Minister approving the Circular Economy Development Project in Vietnam and Decision No. 882/QD-TTg dated July 22nd, 2022 of the Prime Minister approving the National Action Plan on green growth for the period of 2021-2030). The application of useful microbial strains (bacteria, fungi, actinomycetes, yeast...) as well as their secondary products in the circular, green and sustainable production chain of livestock, crop cultivation and food processing industry, is an application direction that is being widely developed (increasing health, productivity, quality of crops, livestock, post-harvest products; treating waste water, agricultural and industrial by-products into useful products such as fertilizer, animal feed, natural materials, irrigation water...). In particular, microbial strains have the ability to biosynthesize extracellular enzymes (cellulose, proteinase, lipase, amylase...) and resist pathogenic bacteria (such as *Escherichia coli*, *Staphylococcus aureus*, *Bacillus cereus*, *Pseudomonas aeruginosa*, *Bacillus subtilis*, *B. megaterium*, *Lactobacillus casei*, *L. plantarum*, *Rhodospseudomonas*, *Azotobacter*, *Azospirillum*, *Enterobacter*...), Actinomycetes *Streptomyces*, *Actinomyces*...; microfungi such as *Trichoderma harzianum*, *Aspergillus tubingensis*... have been commonly used to replace and reduce the amount of food, fertilizer, antibiotics and other chemicals (Sindhu et al., 2018; Inamuddin et al., 2022).

However, to increase the effectiveness of practical applications, research and selection of multi-active strains is necessary. Plant endophytic fungi (especially in herbal plants) represent one of the potential alternatives as they have