



Research article

Species composition and distribution characteristics of Gastropod mollusks (Mollusca: Gastropoda) in central Vietnam

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Abstract

This study presents the results on the species composition of Gastropod mollusks distributed in Central Vietnam, employing methods including field surveys, sampling, ethanol preservation, and morphological taxonomy conducted from May 2023 to July 2024. A total of 63 species were identified, with 11 species recorded in Quang Binh province, 21 species in Hue city, 32 species in Da Nang city, and four in Quang Nam province. Additionally, six species were newly recorded in the aquatic environments of Hue city. The terrestrial Gastropods in Quang Binh province, Hue city, and Quang Nam province were distributed across three main habitat types: In Quang Binh province, the coastal habitat hosted 10 species, while the urban areas contained two species; in Hue city, the coastal habitats had 14 species, while urban areas supported 12 species; and in Quang Nam province, the coastal zone contained one species, while the urban areas supported four species.

Keywords: Central Vietnam, Diversity, Mollusca

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Funding: This research is funded by University of Education, Hue University under grant number T.23-TN.SV-04.

Article history: received manuscript: 23 May 2025,
revised manuscript: 23 June 2025,
accepted manuscript: 19 August 2025,
published online 25 August 2025,

Academic editor: Korakot Nganvongpanit

INTRODUCTION

Gastropod mollusks (Mollusca: Gastropoda) are a diverse group with many species and individuals, playing a significant role in biodiversity and natural cycles. They are widely distributed both in aquatic environments (including saltwater, freshwater, and brackish water) and on land, exhibiting diverse forms and sizes. From the coastal areas of Quang Binh to Quang Nam, the unique topography along the coastline and the tropical humid climate provide a favorable environment for the development and diversity of Gastropod mollusks in the central coastal region.

There have been several studies on the diversity of Gastropod mollusks in Vietnam, mostly focusing on distribution characteristics, morphological variation, species composition, and diversity. The earliest investigations into gastropod mollusks in Vietnam and the broader Asian region date back to the nineteenth century. [Eydoux \(1838\)](#) reported the occurrence of *Cyclostoma gibbum* in Da Nang, Vietnam, marking the first record of this taxon in the area. Subsequently, [Cross and Fischer \(1863\)](#) provided the initial account of freshwater mollusks from southern Vietnam and Cambodia, documenting 45 species of freshwater gastropods in Cochinchina. [Fischer's comprehensive synthesis \(1891\)](#) then collated all known records of bivalves and gastropods from Indochina (present-day Vietnam, Laos, Cambodia, and Thailand), enumerating 1,129 species across 203 genera: 323 freshwater and brackish-water species, 487 marine species, and 309 terrestrial species. In recent decades, several studies have described novel taxa. For example, [Do and Do \(2019\)](#) introduced new species within the genus *Cyclophorus*, and [Vermeulen et al. \(2019\)](#) added 22 new land-snail species to the Vietnamese fauna. However, there are still limited studies on Gastropod mollusks in central Vietnam. Existing research is confined to a few provinces and does not provide sufficient comparative analysis or conclusions regarding the diversity of Gastropod mollusks across the region.

The locations in Quang Binh province, Hue city, Da Nang city, and Quang Nam province represent characteristic ecosystems of central Vietnam, combining coral reefs, lagoons, rivers, and tropical forests. This region is not only rich in biological resources but also serves as a critical junction for various ocean currents, influencing the distribution of many mollusk species. However, pressures from natural resource exploitation, coastal economic development, and climate change are seriously threatening biodiversity, including Gastropod mollusks. Therefore, studying and evaluating species diversity, ecological characteristics, and their distribution in these areas is necessary to provide scientific foundations for conservation strategies and sustainable management.

MATERIALS AND METHODS

Study Area and Sampling Duration

The study focuses on Gastropod mollusks (Mollusca: Gastropoda) in the coastal regions of Quang Binh province, Hue city, Da Nang city, and Quang Nam province ([Figure 1](#)). The research was conducted from May 2023 to July 2024.

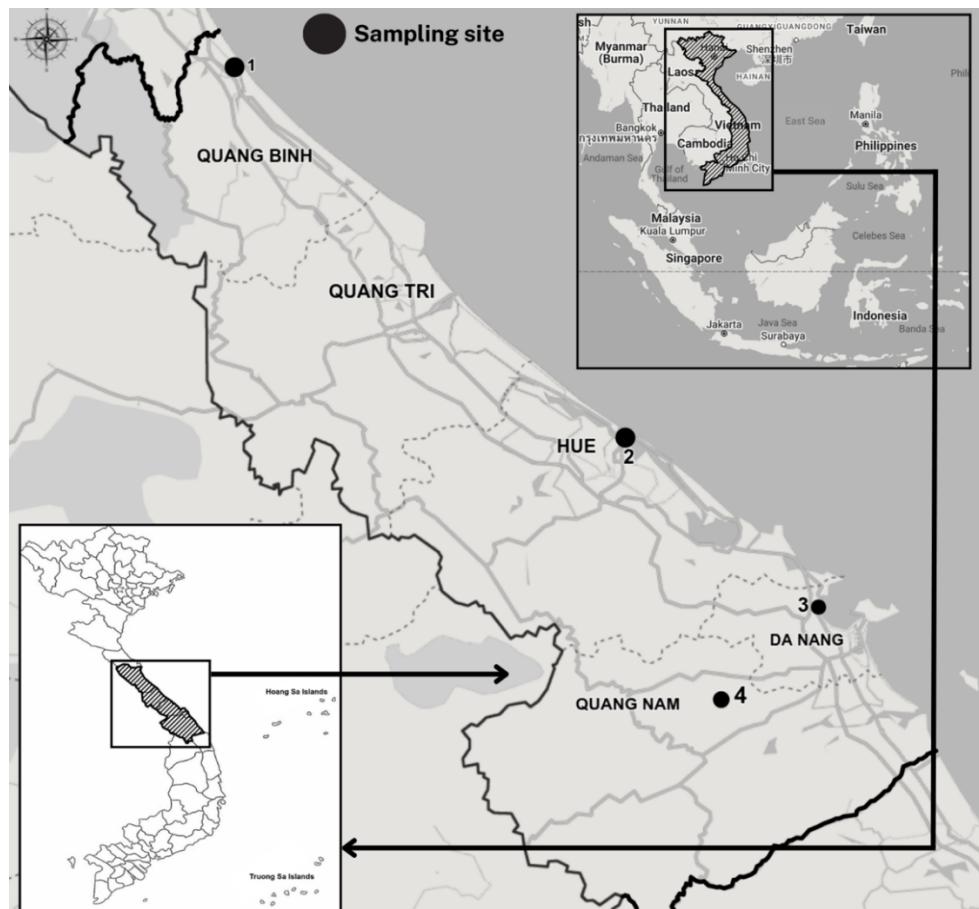


Figure 1 Sampling routes in the study area.

Field Sampling Procedures

Field surveys were conducted to collect samples from various coastal areas of Quang Binh, Hue, and the mountainous regions of Quang Nam. Larger terrestrial mollusks were collected manually. For smaller species, sieves (3-5mm mesh) were used to sift debris, leaf litter, and organic matter in caves, crevices, and cracks. Quantitative sampling was carried out in designated study plots (1m^2) by collecting all living specimens from the ground or substrate (Vermeulen and Maassen, 2003). Samples were fixed in 70% ethanol, and shells were washed and stored dry.

Samples were also gathered at local fish markets, fishing boats, and the coastal regions within the research zones along specific sampling routes.

Salinity at the sampling sites was determined using a handheld electronic salinity meter.

Sample Preservation Techniques

Samples were collected, transported to the laboratory, sorted into groups, classified, and labeled with a unique code. They were preserved in 70% ethanol, with relevant data (sample code, location, time, ecological distribution) recorded. Samples were stored in plastic containers for proper preservation.

Species abundance was calculated using the formula by Kreds (1989) ($\text{P\%} = (n_i/\Sigma n_i) \times 100$). Individual density (v) is calculated as the total number of individuals of a species divide by total area of the survey area of that species. The samples were stored in the animal laboratory of the University of Education, Hue University.

The biodiversity index was calculated using the Shannon-Weiner (1963) formula (H'): $H' = \sum(p_i \times \ln p_i)$.

Taxonomic Classification Method

Taxonomic analysis and classification of the samples were performed in the laboratory using a morphological comparison approach. External morphological features (size, shell shape, color, patterns) were used to identify the samples, following the methods of the authors: Do Van Tu et al. (2019). Classification relied on morphological features of the shells for species identification, referencing descriptions by Möllendorff (1901), Dautzenberg and Fischer (1905-1908), Nantarat et al. (2014), Páll-Gergely et al. (2014), Schileyko (2011). Key identification metrics (Figure 2) included Shell Height (H), Spire Height (SH), Shell Width (W), Aperture Height (AH), and Aperture Width (AW).

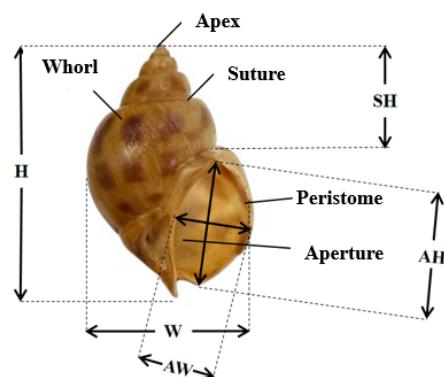


Figure 2 External structure of snail shell (H - Shell Height, W - Shell Width, AH - Aperture Height, AW - Aperture Width, SH - Spire Height).

RESULTS

Species Composition of Gastropod Mollusks in the Study Area

The research results have identified four subclasses of Caenogastropoda, Neritimorpha, Vetigastropoda, and Heterobranchia in the study. In that number, the Caenogastropoda subclass has the largest number of species, up to 50 species, the Heterobranchia subclass has seven species, the Vetigastropoda subclass has four species, and the remaining subclass has only three species. The Muricidae family is the most diverse, with 10 species, accounting for 15.62%, and the Naticidae with five species, accounting for 7.81% of the family. The Thiaridae, Ampullariidae, Nassariidae, and Trochidae families have two species, and the remaining families have only one species (1.56%).

Through the research process, the analysis of the collected samples from the study areas revealed 63 species (Table 1), with 11 species found in Quang Binh province, 21 species in Hue city, 32 species in Da Nang city, and four species in Quang Nam province. The variation in the number of species among the study areas can be attributed to the geographical location and climate of each region, which are conducive to the development of diverse flora and fauna. Notably, with its lagoon topography, the environment in Hue provides favorable conditions for terrestrial and brackish Gastropod mollusk species to thrive. Additionally, the saltwater ecosystem in Da Nang is also diverse, containing species that were not found in the other study areas.



Table 1 Species composition in the study area.

TT	Species composition	Distribution							
		Quang Binh		Hue		Da Nang		Quang Nam	
		P%	v	P%	v	P%	v	P%	v
	Subclass Caenogastropoda								
	Family - Bursidae								
1	<i>Bufonaria rana</i> (Linnaeus, 1758)	5.28	0.22						
2	<i>Bursina gnorma</i> (Melvill, 1918)					3.71	0.36		
	Family - Muricidae								
3	<i>Murex trapa</i> (Roding, 1798)	7.21	0.30						
4	<i>Indothais lacera</i> (Born, 1778)	12.98	0.54						
5	<i>Indothais blanfordi</i> (Melvill, 1893)			5.12	0.30				
6	<i>Rapana rapiformis</i> (Born, 1778)	7.21	0.30						
7	<i>Rapana bezoar</i> (Linnaeus, 1767)	4.32	0.18						
8	<i>Lataxiella blosvillei</i> (Deshayes, 1832)			3.07	0.18				
9	<i>Lataxiella fimbriata</i> (Hinds, 1844)			7.17	0.42				
10	<i>Arakawania granulata</i> (Duclos, 1832)			4.09	0.24				
11	<i>Reishia clavigera</i> (Küster, 1860)					4.53	0.44		
12	<i>Thais malayensis</i> (Tan and Sigurdsson, 1996)					2.68	0.26		
	Family - Turritellidae								
13	<i>Turritella bacillum</i> (Kiener, 1843)	18.26	0.76						
	Family - Pachychilidae					3.41	0.20		
14	<i>Faunus ater</i> (Linnaeus, 1758)								
	Family - Potamididae								
15	<i>Terebralia palustris</i> (Linnaeus, 1767)	5.76	0.24	1.36	0.08				
16	<i>Pirenella cingulata</i> (Gmelin, 1791)					3.09	0.30		
	Family - Babyloniidae								
17	<i>Babylonia areolata</i> (Link, 1807)	7.69	0.32			1.44	0.14		
	Family - Naticidae								
18	<i>Neverita didyma</i> (Roding, 1798)	8.65	0.36						
19	<i>Sinum javanicum</i> (Gray, 1834)			3.07	0.18				
20	<i>Polinices albumen</i> (Linnaeus, 1758)			2.04	0.12				
21	<i>Natica lineata</i> (Roding, 1798)					2.68	0.26		
22	<i>Natica vitellus</i> (Linnaeus, 1758)					2.26	0.22		
	Family - Melongenidae								
23	<i>Brunneifusus ternatanus</i> (Gmelin, 1791)	5.76	0.24						
24	<i>Hemifusus colosseus</i> (Lamarck, 1816)					3.71	0.36		
	Family Thiaridae								
25	<i>Sermyla carbonata</i> (Reeve, 1859)							15.00	0.18
26	<i>Sermyla kupaensis</i> (Lentge-Maaß, Neiber, Gimnich and Glaubrecht, 2020)							16.67	0.20
	Family - Strombidae								
27	<i>Neodilatilabrum robustum</i> (GB Sowerby III, 1875)							20.00	0.24
	Family - Ampullariidae								
28	<i>Pomacea canaliculata</i> (Lamarck, 1822)			2.39	0.14				
29	<i>Pila scutata</i> (Mousson, 1848)							48.33	0.58
	Family - Viviparidae								
30	<i>Cipangopaudina chinensis</i> (Gray, 1833)			3.77	0.28				
	Family - Littorinidae								
31	<i>Echinolittorina marquesensis</i> (Reid, 2007)					3.29	0.30		
32	<i>Echinolittorina hawaiiensis</i> (Rosewater & Kadolsky, 1981)					3.91	0.38		
33	<i>Littoraria articulata</i> (Philippi, 1846)					2.47	0.24		
34	<i>Littoraria intermedia</i> (Philippi, 1846)					4.32	0.42		
	Family - Rissoinidae								
35	<i>Stosicia annulata</i> (Dunker, 1877)					2.06	0.20		
	Family - Clavatulidae								
36	<i>Clavatula lelieuri</i> (Récluz, 1851)					1.03	0.10		
	Family - Columbellidae								

TT	Species composition	Distribution							
		Quang Binh		Hue		Da Nang		Quang Nam	
		P%	v	P%	v	P%	v	P%	v
37	<i>Mitrella turbita</i> (Duclos, 1840)					1.64	0.16		
	Family - Epitoniidae								
38	<i>Epitonium scalare</i> (Linnaeus, 1758)					1.23	0.12		
	Family - Ringiculidae								
39	<i>Ringicula buccinea</i> (Sowerby, 1823)					2.68	0.26		
	Family - Lottiidae								
40	<i>Patelloida mimula</i> (Iredale, 1924)					2.06	0.20		
	Family - Patellidae								
41	<i>Patella caerulea</i> (Linnaeus, 1758)					1.64	0.16		
	Family - Cerithiidae								
42	<i>Cerithium rappelli</i> (Philippi, 1848)					4.32	0.42		
43	<i>Clypeomorus batillariaeformis</i> (Habe & Kosuge, 1966)					2.06	0.20		
	Family - Volutidae								
44	<i>Melo Melo</i> (Lightfoot, 1786)					1.64	0.16		
	Family - Olividae								
45	<i>Olivella tehuelcha</i> (Duclos, 1835)					2.68	0.26		
	Family - Terebridae								
46	<i>Duplicaria raphanula</i> (Lamarck, 1822)					3.09	0.30		
	Family - Nassariidae								
47	<i>Nassarius cf. praematuratus</i> (Kuroda & Habe, 1960)					3.41	0.20		
48	<i>Nassarius siquijorensis</i> (A. Adams, 1852)							5.15	0.50
49	<i>Nassarius teretiusculus</i> (A. Adams, 1852)							2.26	0.22
50	<i>Tomlinia fraussenii</i> (Thach, 2014)					3.41	0.20		
	Subclass Neritimorpha								
	Family - Neritidae								
51	<i>Clithon ovalanense</i> (Lesson, 1831)	16.82	0.7	14.42	0.58	5.56	0.54		
52	<i>Neritodryas dubia</i> (Gmelin, 1791)					5.36	0.52		
53	<i>Theodoxus major</i> (Issel, 1865)					3.50	0.34		
	Subclass Vetigastropoda								
	Family - Trochidae								
54	<i>Umbonium vestiarium</i> (Linnaeus, 1758)					6.14	0.36	7.42	0.72
55	<i>Monodonta canifera</i> (Lamarck, 1816)							3.91	0.38
56	<i>Thalotia conica</i> (Gray, 1827)							2.47	0.24
57	<i>Monilea callifera</i> (Lamarck, 1822)					2.73	0.16		
	Subclass Heterobranchia								
	Family - Achatinidae								
58	<i>Lissachatina fulica</i> (Bowdich, 1822)					1.70	0.10		
59	<i>Allopeas gracile</i> (T. Hutton, 1834)					17.06	1.00		
	Family - Streptaxidae								
60	<i>Gulella bicolor</i> (T. Hutton, 1834)					0.68	0.04		
	Family - Succineidae								
61	<i>Oxyloma sarsi</i> (Esmark, 1886)					4.09	0.24		
	Family - Veronicallidae								
62	<i>Valiguna siamensis</i> (E. von Martens, 1867)					0.34	0.02		
63	<i>Simrothula paraensis</i> (SR Gomes, Picanco, Mendes & Thomé, 2006)					0.34	0.02		
						4.16	5.74	9.7	1.02
	Total					11 species	21 species	32 species	4 species

Gastropods in Quang Binh province, Hue city, Da Nang city, and Quang Nam provinces are mainly distributed in three environments: marine, brackish, and freshwater. In marine areas, they are concentrated in tidal flats, coral reefs, and coastal regions. In brackish water environments, estuaries and lagoons are home to many species adapted to fluctuating salinity from 25% – 28%. In freshwater, they appear in rivers and streams on the Truong Son mountain range and limestone cave systems, especially in Phong Nha - Ke Bang. The distribution of Gastropods

in this area is influenced by topographic, hydrological, and ecological conditions, with a high level of diversity in areas with stable ecosystems.

The coastal area from Quang Binh to Quang Nam is part of the central coast of Vietnam with diverse ecosystems, including tidal flats, estuaries, lagoons, and coral reefs. The topography, hydrology, and bottom characteristics in each area have shaped the distribution of Gastropod species, reflecting the close relationship between organisms and their habitats.

Currently, the Quang Nam region has received limited attention, in research on the diversity of Gastropod mollusks, resulting in a relatively low number of recorded species. Due to the lack of conservation policies, ensuring proper exploitation, and the geographical and climatic conditions being less favorable compared to the Quang Binh to Da Nang area, the systems of lagoons, river mouths, and estuaries in Quang Nam are much fewer, resulting in a lack of habitats and less favorable environments.

Distribution characteristics of Gastropod Mollusks in the study area

Gastropods are found across various salinities, from brackish estuaries and lagoons to stable saline waters of the open ocean and coral reefs. Substrate type influences distribution, with mud-dwelling species in estuarine and lagoon plains, and sandy or coral reef species in coastal and nearshore areas. Tidal regimes shape terrain diversity, particularly in tidal flats and mangroves, which provide essential nutrients and habitats. Areas like Tam Giang and Cau Hai lagoons (Hue) and Cu Lao Cham coral reef (Quang Nam) are biodiversity hotspots, crucial for maintaining biological communities.

Quang Binh Province

The analysis results of terrestrial Mollusk individuals collected in the coastal area of Quang Binh identified 11 species, 10 genera, and eight families. Among the recorded species, *Turritella bacillum* exhibited the highest density, at 0.76 ind/m², accounting for 18.26% of the total individual count. In contrast, *Rapana bezoar* had the lowest density, at 0.18 ind/m², representing 4.32% of the total. The surveyed site showed a Shannon diversity index of 2.28 and a Pielou's evenness index of 0.953.

Hue City

The analysis results of Gastropod mollusks individuals collected in the Hue area identified 21 species, 20 genera, and 14 families. Among the identified species, *Allopea gracile* had the highest density at 1 ind/m², comprising 17.06% of the total number of individuals. In contrast, *Valiguna siamensis* and *Simrothula paraensis* exhibited the lowest densities, each at 0.02 ind/m², representing 0.34% of the total population. The surveyed site recorded a Shannon diversity index of 2.71 and a Pielou's evenness index of 0.891.

Da Nang City

Results of Gastropod mollusk individuals collected in the coastal area of Da Nang identified 32 species, 26 genera, and 20 families. Among the recorded species, *Umbonium vestiarium* showed the highest density at 0.72 ind/m², accounting for 7.42% of the total individual count. Conversely, *Epitonium scalare* had the lowest density, with 0.12 ind/m², representing 1.23% of the total. The surveyed site exhibited a Shannon diversity index of 3.37 and a Pielou's evenness index of 0.972.

Quang Nam Province

The analysis results of terrestrial Mollusk individuals collected in the coastal area of Quang Nam identified four species, three genera, and three families. At the surveyed site, *Pila scutata* had the highest density, reaching 0.4 ind/m² and accounting for 33.33% of the total number of individuals. In contrast, *Sermyla*

kupaensis recorded the lowest density at 0.18 ind/m², representing 15.00% of the total. The site exhibited a Shannon diversity index of 1.26 and a Pielou's evenness index of 0.906.

Species richness: The species with the largest number of individuals in Quang Binh is *Turritella bacillus* (P% = 18.26%), suitable for the diverse and rich marine and coral environment, and the marine ecosystem develops strongly here. Species *Allopeas gracile* is the species with the largest number (P% = 17.06%) in Hue, with a very small size, living on land, and suitable for hot and humid tropical conditions. Da Nang has the largest number of species, *Umbonium velarium* (P% = 3.29%), and Quang Nam has *Pila scutata* (P% = 33.33%) with low species diversity, but the adapted species can distribute widely, adapt, and reproduce more quickly.

The density of species in the study plots: Species individual density in Quang Binh, coastal habitat has 10 species with an average density of all species of 3.84 individuals/m²; the residential area has two species with an average density of 0.92 individuals/m²; In Hue, coastal habitat has 14 species with an average density of all species of 3.18 individuals/m²; residential area has 12 species with a density of 2.56 individuals/m²; In Quang Nam, coastal habitat has one species with an average density of all species of 0.18 and residential area has 4 species with a density of 1.02 individuals/m².

Identification characteristics and Distribution of Gastropod Mollusks

Quang Binh Province

1) *Bufonaria rana* (Linnaeus, 1758), Figure 3-A.

Synonym: *Biplex rana* (Linnaeus, 1758)

Diagnostic features: Shell medium to large (70–150 mm), cap-shaped with a bulging body and wide aperture. Prominent spiral ridges with tubercles and spines aid in camouflage. Color light brown or gray with dark spiral stripes.

Dimensions (mm): H= 74.5-82.8; W= 51.3-54.8; AH= 32.5-34.1; AW= 16.5-17.6; SH= 44.7-46.1.

Distribution: Coastal Dong Hoi, Quang Binh. Coordinates: 17°27'52.5"N 106°37'40.0"E.

2) *Murex trapa* (Röding, 1798), Figure 3-B.

Diagnostic characters: The shell exhibits thick ridges adorned with short spines, most prominently located at the shoulder region. The inter-ridge areas display regular spiral and axial striations. A pre-ventral ditch occupies 50-55% of the total shell length. The shell's coloration is typically cream or light brown, accented by darker bands along the spiral ridge margins. The aperture is large and oval, encircled by a sharp and thickened outer lip.

Dimensions (mm): H= 68.5-70.4; W= 27.8-31.2; AH= 17.3-19.7; AW= 10.4-12.7; SH= 25.2-27.6.

Distribution: Coastal Dong Hoi, Quang Binh. Coordinates: 17°27'52.5"N 106°37'40.0"E.

3) *Indothais lacera* (Born, 1778), Figure 3-C.

Diagnostic features: The spiral ridge shoulder exhibits a prominent, maximum-width ridge. In adults, the aperture is slightly thickened and curved, with a creamy yellow coloration. A shallow posterior notch is present between the outer lip and the apical wall.

Dimensions (mm): H= 45.6-47.0; W= 30.8-32.6; AH= 22.5-24.7; AW= 10.8-12.6; SH= 23.4-25.3.

Distribution: Coastal Dong Hoi, Quang Binh. Coordinates: 17°27'52.5"N 106°37'40.0"E.

4) *Rapana rapiformis* (Born, 1778), Figure 3-D.

Synonym: *Rapana bulbosa* (Dillwyn, 1817)

Diagnostic features: Light to dark brown bark ; Short papillae develop along the shoulders ; Other parts of the whorls are carved by smooth, not too rough spiral ridges .

Dimensions (mm): H= 57.8-60.3; W= 40.5-44.7; AH= 33.7-36.4; AW= 16.1-18.3; SH= 24.3-26.5.

Distribution: Coastal Dong Hoi, Quang Binh. Coordinates: 17°27'52.5"N 106°37'40.0"E.

5) *Rapana bezoar* (Linnaeus, 1767), Figure 3-E.

Diagnostic features: Spirals wrinkled with papillae on ridges and small spiral lines; inter-ridge spaces with thin translucent lamellae. Apex sharp, angle near 90 degrees; aperture interior white.

Dimensions (mm): H= 52.3-54.2; W= 40.3-42.1; AH= 29.7-32.8; AW= 17.8-19.1; SH= 21.2-23.5.

Distribution: Coastal Dong Hoi, Quang Binh. Coordinates: 17°27'52.5"N 106°37'40.0"E.

6) *Turritella bacillum* (Kiener, 1843), Figure 3-F.

Diagnostic characters: Whorls incised with sparse, distinct spirals, weakening in adults. Coloration varies (yellowish-brown to dark purple-brown). Terminal whorl sharply angled; spiral grooves with shallow longitudinal grooves. Shell elongate, spirally cylindrical (50-120mm), with regular spiral ridges distinguishing it within *Turritella*. Color typically light brown/gray with potential darker bands. Aperture small, oval, consistent with filter feeding.

Dimensions (mm): H= 55.6-67.3; W= 13.5-16.7; AH= 9.8-11.7; AW= 7.8-9.1; SH= 48.8-57.6.

Distribution: Coastal Dong Hoi, Quang Binh. Coordinates: 17°27'52.5"N 106°37'40.0"E.

7) *Terebralia palustris* (Linnaeus, 1767), Figure 3-G.

Synonym: *Potamides palustris* (Linnaeus, 1767)

Diagnostic characters: Surface with four spiral ridges, separated by narrow grooves throughout the spire. Spiral pattern intersected by thicker radiating ridges; base with finer grooves. Spirals entirely dark brown. Aperture flared in adults, not thickened in juveniles; interior shiny, darker than exterior.

Dimensions (mm): H= 25.3-27.2; W= 5.6-7.2; AH= 5.3-6.8; AW= 3..4-4.7; SH= 19.5-21.6.

Distribution: Coastal Dong Hoi, Quang Binh. Coordinates: 17°27'52.5"N 106°37'40.0"E.

8) *Babylonia areolata* (Link, 1807), Figure 3-H

Diagnostic characters: The shell exhibits a characteristic dark brown pattern, arranged in three spiral rows on a white background. The surface is polished with a thin outer horn layer. The spiral grooves are pronounced. The aperture is white on the interior, with the outer lip sealed by a covering. The pre-apertural groove is short; the lower edge of the pillar is sharp; the upper surface of the inner lip is corrugated; the umbilicus is deep, and the spiral ridge before the groove is thick.

Dimensions (mm): H= 42.1-44.5; W= 24.7-28.5; AH= 22.8; AW= 11.4; SH= 26.8-30.2.

Distribution: Coastal Dong Hoi, Quang Binh. Coordinates: 17°27'52.5"N 106°37'40.0"E.

9) *Brunneifusus ternatanus* (Gmelin, 1791), Figure 3-I.Synonym: *Hemifusus ternatanus* (Gmelin, 1791)

Diagnostic characters: Shell elongated longitudinally, with characteristically long pre-oral groove. The whorls are entirely dark to reddish brown in color, covered with brown velvety horn. The whorls are spirally carved by numerous small ridges; the pre-ditch spiral ridge is indistinct.

Dimensions (mm): H= 103.5-109.9; W= 55.3-58.1; AH= 38.3-42.8; AW= 17.3-20.2; SH= 43.2-46.1.

Distribution: Coastal Dong Hoi, Quang Binh. Coordinates: 17°27'52.5"N 106°37'40.0"E.



Figure 3 Morphology of species collected in Quang Binh: *Bufonaria rana*, (A); *Murex trapa*, (B); *Indothais lacera*, (C); *Rapana rapiformis*, (D); *Rapana bezoar*, (E); *Turritella bacillilum*, (F); *Terebralia palustris*, (G); *Babylonia areolata*, (H); *Brunneifusus ternatanus*, (I).

Hue City

1) *Sinum javanicum* (Gray, 1834), Figure 4-A.Synonym: *Sinum (Sinum) javanicum* (Gray, 1834).

Diagnostic features: Thin, flattened, sub-planar shell, 20-50 mm. Pale white to creamy yellow, smooth, shiny with distinct growth rings. Aperture large, semicircular, occupying most of ventral shell. Operculum thin, corneous.

Dimensions (mm): H = 22.3-24.1; W = 39.3-42.4; AH = 28.5-31.1; AW = 19.8-22.1; SH = 9.4-11.6.

Distribution: Thuan An coastal area, Hue. Coordinates: 16°33'27.5"N 107°39'26.6"E.

2) *Polinices albumen* (Linnaeus, 1758), Figure 4-B.

Diagnostic features: Shell flattened, dorsal surface light brown with white spiral along grooves; ventral surface pale. Umbilicus C-shaped, deep aperture, with tuberous body and broad tuberous margin. Oral flap corneous, reddish-brown.

Dimensions (mm): H = 20.1-22.4; W = 17.1-19.9; AH = 13.4-15.3; AW = 7.5-9.4; SH = 8.3-10.6.

Distribution: Binh An coastal area, Hue. Coordinates: 16°18'46.8"N 108°00'09.1"E.

3) *Indothais blanfordi* (Melvill, 1893), Figure 4-C.

Synonym: *Purpura (Stramonita) blanfordi* (Melvill, 1893).

Diagnostic features: Shell small, ovoid, high apex and 4 angular whorls. Outer surface covered with obtuse longitudinal filaments, consisting of 11-12 tubercles. Pores ovoid, thick outer lip with 8 folds. Body color light brown or cream, pores white to cream.

Dimensions (mm): H = 32.3-35.0; W = 19.1-22.2; AH = 10.1-12.9; AW = 5.2-7.9; SH = 13.3-16.6.

Distribution: Binh An coastal area, Hue. Coordinates: 16°18'46.5"N 108°00'12.5"E.

4) *Lataxiена blosvillei* (Deshayes, 1832), Figure 4-D.

Synonym: *Fusus blosvillei* (Deshayes, 1832).

Diagnostic characters: Shell tall, elongated; height/width about 2.4. Surface of the whorls carved with evenly spaced radiolucent ridges. Pre-mouth canal well developed and reversibly curved.

Dimensions (mm): H = 26.3-30.7; W = 15.8-19.4; AH = 11.2-13.9; AW = 4.5-6.8; SH = 11.2-13.7.

Distribution: Binh An coastal area, Hue. Coordinates: 16°18'47.7"N 107°59'57.6"E.

5) *Lataxiена fimbriata* (Hinds, 1844), Figure 4-E.

Diagnostic features: The whorls are carved with fine, evenly spaced spiral ridges, crossed by nodules to thinly layered longitudinal ridges. The color pattern is variable, often with dark brown spirals.

Dimensions (mm): H = 22.4-25.1; W = 17.5-20.4; AH = 12.3-15.6; AW = 5.4-7.3; SH = 9.3-11.9.

Distribution: Thuan An coastal area, Hue. Coordinates: 16°33'33.2"N 107°39'17.7"E.

6) *Arakawania granulata* (Duclos, 1832), Figure 4-F.

Synonym: *Purpura granulata* (Duclos, 1832).

Diagnostic characters: Shell conical, elongated, compact and veinless. Shell covered with dark brown to black obtuse knobs on white background with spiral cords between rows. Stem ring with six rows of tubercles. Outer lip serrated with four to five teeth inside. Narrow pit black. Column and inner lip white.

Dimensions (mm): H = 21.2-23.9; W = 12.2-15.5; AH = 11.3-13.7; AW = 5.4-7.6; SH = 9.3-11.2.

Distribution: Binh An coastal area, Hue. Coordinates: 16°18'46.8"N 108°00'09.1"E.

7) *Nassarius praematuratus* (Kuroda & Habe, 1960), Figure 4-G.

Synonym: *Nassarius (Hima) praematuratus* (Kuroda & T. Habe, 1960)

Diagnostic features: Shell small to medium, 10-25 mm long, elongated oval, with pointed base and apex. Shell with raised spiral ridges, yellowish brown or pale gray with light spots. Mouth oval, occupying 1/3 of shell length. Outer lip thick, curved; inner lip with ridges or small teeth.

Dimensions (mm): H = 19.5-22.8; W = 10.1-13.2; AH = 8.3-10.5; AW = 5.6-7.2; SH = 12.3-15.6.

Distribution: Binh An coastal area, Hue. Coordinates: 16°18'46.8"N 108°00'09.1"E.

8) *Monilea callifera* (Lamarck, 1822), Figure 4-H.

Synonym: *Trochus calliferus* (Lamarck, 1822).

Diagnostic features: Low conical shell. Surface carved with ridges and spiral grooves intersecting with very fine oblique ridges. Inside the mouth there are spiral teeth successive to spiral notches.

Dimensions (mm): H = 10.1-12.3; W = 12.8-15.1; AH = 7.6-9.1; AW = 3.8-5.6; SH = 6.5-8.8.

Distribution: Binh An coastal area, Hue. Coordinates: 16°18'46.8"N 108°00'09.1"E.

9) *Tomlinia fraussenii* (Thach, 2014), Figure 4-I.

Diagnostic features: The shell has an elongated, egg-shaped form with a smooth, glossy surface that is grayish-green in color. It is thin yet very hard. The ratio of the spire to the final whorl is approximately 20% to 80%. The apex of the shell is sharp, and the last three whorls have longitudinal ridges with deep spiral grooves.

Dimension (mm): H= 34.5-37,2; W= 14.6-17,8; AH= 17.5-19,1; AW= 5.6-7,4; SH= 20.2-23,3.

Distribution: Binh An coastal area, Hue. Coordinates: 16°18'46.8"N 108°00'09.1"E.



Figure 4 Morphology of species collected in Hue area: *Sinum javanicum*, (A); *Polinices albumen* (B); *Indothais blanfordi*, (C); *Lataxiена blosvillei*, (D); *Lataxiена fimbriata*, (E); *Arakawania granulata*, (F); *Nassarius praematuratus*, (G); *Monilea callifera*, (H); *Tomlinia fraussenii*, (I).

Quang Nam Province

1) *Sermyla carbonata* species (Reeve, 1859), Figure 5-A.

Diagnostic features: Shell is elongated, 20–40 mm high, consisting of 8–10 whorls with distinct transverse spiral ridges and the surface is usually dark brown or dark gray.

Dimensions (mm): H = 19.3-22.8; W = 6.5-8.2; AH = 6.8-8.5; AW = 2.5-3.2; SH = 1.8-2.1.

Distribution: Tien Phuoc river and stream area, Quang Nam. Coordinates: 15°25'13.7"N 108°19'03.0"E.

Comments: This species lives mainly in estuaries, lagoons and mangrove forests, on muddy or sandy bottoms, well adapted to brackish or saltwater environments with high turbidity.

2) *Sermyla kupaensis* (Lentge-Maaß, Neiber, Gimnich & Glaubrecht, 2020), Figure 5-B.

Diagnostic features: Elongate, hard shell, 30-50mm height, 10-15mm width. 8-10 whorls, each with distinct transverse ridge and small spines. Dark brown or gray coloration, providing camouflage. Aperture oval, small relative to shell height, with thick, smooth edges.

Dimensions (mm): H = 26.3-29.8; W = 5.4-8.2; AH = 5.8-7.5; AW = 3.8-5.2; SH = 3.7-5.1.

Distribution: Tien Phuoc river and stream area, Quang Nam. Coordinates: 15°25'14.8"N 108°18'41.8"E.

3) *Neodilatilabrum robustum* (GB Sowerby III, 1875), Figure 5-C.

Synonym: *Margistrombus robustus* (GB Sowerby III, 1875)

Diagnostic features: Large, thick, sturdy shell, 60-100 mm height, slightly oval. 7-9 whorls, each with prominent ridge and shallow transverse whorls. Smooth surface, color variable (pale yellow to brown) with potential white streaks/spots. Aperture wide, thick edges; interior nacreous, white/pale orange. Apex pointed, thin.

Dimensions (mm): H = 47.6-52.8; W = 25.3-28.2; AH = 36.2-39.5; AW = 17.1-20.2; SH = 7.8-10.1.

Distribution: Tien Phuoc mountainous area, Quang Nam. Coordinates: 15°25'32.7"N 108°18'45.7"E.

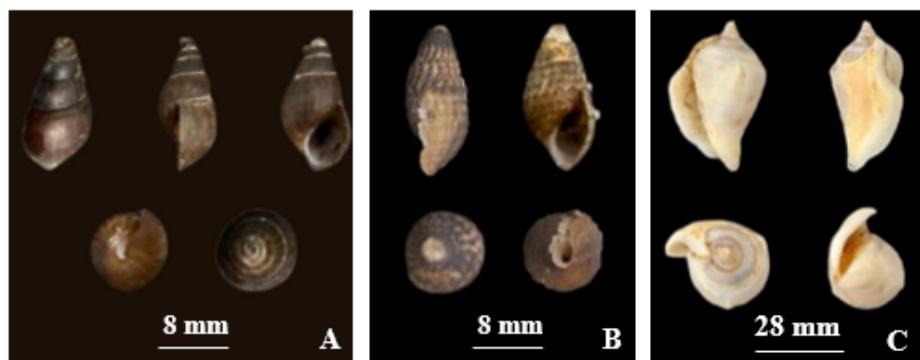


Figure 5 Morphology of species collected in Quang Nam: *Sermyla carbonata*, (A); *Sermyla kupaensis*, (B); *Neodilatilabrum robustum*, (C).

DISCUSSION

In the sampling area, which encompasses three distinct geomorphological settings, the marine environment—with coral reef formations providing a variety of habitat structures—and the salinity gradients among the beaches at the study sites (Quang Binh, Hue, and Da Nang) have resulted in differences in species density and assemblage composition across these regions. Moreover, when combined with the naturally favorable tropical climatic conditions (high temperature, elevated humidity, and substantial rainfall), these factors underpin the rich biodiversity of the gastropod fauna.

Furthermore, the salinity analysis across the study areas revealed significant spatial variation. The mean salinities were 32.2‰ in the coastal waters of Quang Binh, 22.9‰ in the marine and brackish lagoon systems of Hue, 35.1‰ in the sea of Da Nang, and 0.4‰ in the mountainous region of Quang Nam. These salinity gradients likely reflect habitat heterogeneity, and may explain the differing distribution and diversity patterns of gastropod molluscs across these distinct environmental settings.

Through the process of sampling, analyzing, and processing data, the diversity coefficient of the coastal area of Quang Binh is $H' = 2.28$; the Hue area with an index of $H' = 2.61$; the Quang Nam area with an index of $H' = 1.26$. Thus, the coastal area of Hue has the largest number of species and the highest diversity among the research areas.

The diversity of Gastropods in the central coastal region of Vietnam, including Quang Binh, Hue, and Quang Nam, clearly shows the richness of the number of species and the level of adaptation to different environmental conditions. The Quang Binh area has many species of Gastropods living in estuaries and tidal

flats, suitable for brackish water and sandy mud bottom environments. In Hue, the Tam Giang - Cau Hai lagoon system plays a special role as a habitat where species thrive thanks to their high salinity tolerance.

Comparison with the previous study at Nhat Le Beach, Quang Binh by [Dinh Thi Thanh Trà et al. \(2024\)](#) revealed that five species were common to both investigations, and the following taxa were newly recorded: *Bufonaria rana*, *Indothais lacera*, *Rapana rapiformis*, *Rapana bezoar*, *Turritella bacillum*, *Terebralia palustris*, *Brunneifusus ternatanus*, and *Clithon ovalaniense*.

For the study area from Hue to Quang Nam regions, sampling and analysis predominantly yielded marine gastropod species not previously reported, as past investigations have largely focused on terrestrial and freshwater taxa. Conversely, the terrestrial and freshwater species encountered here correspond closely with those of earlier studies, underscoring both the hitherto underexplored nature of marine gastropods in these areas and the accuracy of our methodology as reflected by the corroboration of terrestrial and freshwater records.

The Gastropod mollusks in this area not only play an important ecological role in maintaining the food chain and cleaning the marine environment but also have great economic value, especially with species exploited for food, scientific specimens, or decoration. However, their biodiversity is under great pressure from unsustainable exploitation activities, environmental pollution, and coral reef degradation due to climate change. Measures to protect the marine environment, manage exploitation appropriately, and build protected areas are necessary to conserve resources and maintain ecological stability in the coastal area of central Vietnam.

CONCLUSIONS

The Gastropod mollusk fauna in the study area was identified with 63 species, belonging to 55 genera, 32 families, and four subclasses in the study area. Distributed in three main habitat types: coastal habitat with 10 species with an average density of all species of 3.84 ind/m^2 ; densely populated areas with two species with an average density of 0.92 ind/m^2 (Quang Binh); In coastal habitat, there are 14 species with an average density of all species of 3.18 ind/m^2 ; densely populated areas with six species with a density of 0.88 ind/m^2 (Hue); In coastal habitat there is one species with an average density of all species of 0.18 and densely populated areas with four species with a density of 1.02 ind/m^2 (Quang Nam).

Research on the biodiversity of Gastropods in central Vietnam (including Quang Binh Province, Hue City, and Quang Nam Province) has recorded a high level of species richness and diversity, morphological characteristics, and ecological distribution. This area is the intersection of many types of marine habitats, from estuaries, mountainsides, lagoons, and tidal flats to coral reefs, creating favorable conditions for the emergence and development of many different species groups and the emergence of new species.

The Gastropod mollusk fauna in the coastal area from Quang Binh to Hue exhibits a high level of ecological diversity, with a wide distribution in tidal flats, coral reefs, estuaries, and coastal areas. The distribution and ecological diversity of Gastropod mollusks in the central coastal region reflect the environmental characteristics and specific ecological conditions of each region. Marine, brackish, terrestrial, and freshwater ecosystems all have typical species, contributing to the rich biodiversity of the region, while also showing the influence of geographical, climatic, and hydrological factors on the distribution of this group of animals.

AUTHOR CONTRIBUTIONS

Hoi Truong Cong, Hao Nguyen Thi, Bui Thanh Long and Minh Le Hoang Duy:
 Contributed to sample preparation, conceptualisation and data methodology.
Minh Nguyen Hoang Nhat: Data curation, analysis, writing original draft and english proofreading.
Binh Nguyen Thanh and Giang Tran Van: Supervision, reviewing and final editing

CONFLICT OF INTEREST STATEMENT

We have no conflict of interest.

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How to cite this article;

Minh Nguyen Hoang Nhat, Hoi Truong Cong, Hao Nguyen Thi, Minh Le Hoang Duy, Binh Nguyen Thanh and Giang Tran Van. Species composition and distribution characteristics of Gastropod mollusks (Mollusca: Gastropoda) in central Vietnam. *Veterinary Integrative Sciences*. 2026; 24(2): e2026038-1-17.
