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Distribution of Gastropod Mollusks on the Intertidal Zone of Vancouver Island, Canada

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Abstract

Over time gastropod mollusk faunas have gone through significant changes caused by non-biotic and anthropogenic factors. This study documents species diversity, ecological preferences, and intraspecific shell variation of native and invasive species of gastropod mollusks in the intertidal zone along the coasts of Vancouver Island, Canada. Samples were collected from 20 species representing eight orders and thirteen families of gastropod mollusks from eight localities. In order to document the species distribution and shell variability, the samples were cleaned, sorted by locality and then shells were identified and measured. An array of localities was sampled in order to understand how the species diversity varied in different habitats. Extensive intraspecific shell variation was documented in three species of gastropod mollusks: *Littorina scutulata*, *L. sitkana* and *Nucella emarginata*. Two species, *Littorina scutulata* and *L. sitkana*, were the most abundant gastropod mollusks at all the localities. Both *Littorinas* showed variation in color and sculpture. *Nucella emarginata* varied in color (including the presence or absence of spiral bands) and in the development of spiral ribs which were often reduced. Along with the native species of gastropods an invasive species, *Batillara attramentaria* (Japanese false cerith), was discovered in the intertidal mud flats of Comox harbor and Royston beach. Originally this species was only found in Japan and the Western Pacific, but had been brought to North America in the early 20th century with the import of the pacific oyster.[1] *Batillara attramentaria* was abundant at both localities. In contrary, the native representatives of Cerithiidae, which are usually found in the same type of habitat, were extremely scarce or absent at these localities. As our study shows, the native gastropod mollusk fauna of Vancouver Island, Canada, is very diverse and abundant, but an introduction of a non-native species could jeopardize the stability of native mollusk populations.
Keywords: Gastropods, Mollusks, Intertidal Zone.

1. Introduction

Ecosystems change in time especially when they are affected by such factors as pollution, urbanization and the introduction of non-native species (i.e. species invasion). These changes are well observed in the faunas of marine gastropods, and have caused species variation as well as the decline of populations of many native species that were originally abundant. In order to study these changes it is necessary to monitor gastropod mollusk populations. This will help to identify the ongoing changes in native species populations, and to monitor the invasive species. Herein, this study will (1) document the current distribution of native species of gastropod mollusks along the intertidal regions of Vancouver Island, Canada, (2) document the amount of variation seen in native species of gastropod mollusks from the studied area, and (3) document the locations and level of species invasion.

2. Methods

Samples had been collected from eight localities on Vancouver Island in June 2005. In order to see effects from changing ecosystems, samples were collected from areas that were most populated and urbanized. Eight localities,

(Bates Beach, Chesterman Beach, Comox harbor, Miracle Beach, Royston Beach, Tofino Harbor, Tonquin Park, and Wittman Beach) where chosen to collect from. These locations were chosen in order to get a variety of different habitats that were either sheltered or unsheltered from the open ocean. The habitats varied from intertidal mud flats (Comox harbor, Royston beach) to rocky beaches with little or no sand (Bates beach, Wittman beach, Tofino harbor) to sandy beaches with little or no rocky areas (Miracle Beach, Tonquin Park, Chesterman beach). These areas are situated in the mid-island to the south island regions and from both the east and west coasts. All samples had been collected at low tide from the intertidal zone. After collecting, samples were cleaned, sorted by locality, shells identified and measured. Specimen measurements were taken with a Hempe caliper/micrometer. Then, all specimens were photographed to catalog the variation using Canon EOS D60 camera with a Canon 100 mm USM macro lens.

3. Results

The following species of gastropod mollusks were identified from the localities listed above.

Order Pleurotomariiformes
Family Fissurellidae
Diodora apera (Eschschultz, Rathke, 1833)

Common name. Rough keyhole limpet.
Locality. Chesterman Beach.
Number of specimens. 1.
Description. Shell of this species is moderately elevated with a broad oval aperture slightly in front of middle. Base is broadly oval. The exterior is grayish-white with numerous purplish-gray rays and many rough radial ribs. The interior is white.[3, 4]
Variations. None seen.
Measurements. Length - 38 mm.

Order Patelliformes
Family Acmaeidae
Acmaea limatula (Carpenter, 1864)

Common name. File limpet.
Localities. Chesterman beach.
Number of specimens. 3.
Description. Shell has an oval outline with an elevated apex that is close to the anterior end. Exterior is brown to black with numerous white speckles. Interior is bluish-white with a black border and a central brown spot.[3 4]
Variations. None seen.
Measurements. Min length – 13 mm; Max length – 15 mm.

Acmaea mitra (Rathke, 1833)

Common name. White-cap limpet.
Localities. Chesterman beach.
Number of specimens. 5.
Description. The shell of this species is highly elevated with apex nearly central. The base is broadly ovate or circular. The interior and exterior are smooth and white.[2, 3, 4]
Variation. None seen.
Measurements. Min length - 13 mm; Max length - 15 mm.

Notoacmaea persona (Rathke, 1833)

Common name. Mask limpet.
Localities. Tofino harbour, Miracle beach, Chesterman beach, Wittman beach, Royston beach.
Number of specimens. 6.
Description. Generally the shell of this species is moderately elevated with apex in front of middle. The exterior is bluish to gray-brown with white speckles. The shell is oval and can be smooth or have fine vertical riblets. The

interior is white to bluish with a irregular central brown spot. The margin is either uniformly dark brown or spotted with white.[3, 4]
Variation. None seen.
Measurments. Min length - 12 mm; Max length - 15 mm.

Collisella pelta (J. Rathke, 1833)

Common name. Sheild limpet.
Localities. Bates beach, Chesterman beach, Miracle beach, Tofino harbor, Wittman beach.
Number of specimens. 9.
Description. Shell of this species is broadly ovate, moderately elevated with apex towards front. The exterior color is grayish with irregular white stripes in a radial pattern. The interior is blueish white with a dark and light alternating border. Interior also has a central dark spot.[3, 4]
Variation. None seen.
Measurements. Min length - 13 mm; Max length - 25 mm.

Order Trochiformes
Family Calliostomatidae
Calliostoma canaliculatum (Lightfoot, 1786)

Common name. Channeled top shell.
Localities. Chesterman beach.
Number of specimens. 5.
Description. Shell of this species is whitish-yellow, sharply conical with whorls flat or slightly convex. Whorls bear strong spiral cords. Grooves between spiral cords are darker in color. The body whorl is strongly angled, base almost flat.[3, 4]
Variation. None seen.
Measurements. Min length – 5 mm; SD - 4.847; Max length – 6 mm.

Family Trochidae
Tegula funebralis (A.Adams, 1855)

Common name. Black tegula.
Localities. Tofino harbour, Chesterman beach.
Number of specimens. 13.
Description. Generally the shell of this species has slightly convex whorls, and a spire that is conical to dome shaped. The whorls are smooth except for small spiral cords. The exterior is black with purple to orange apex. The aperture is round with pearly white color inside.[3, 4]
Variation. None seen.
Measurements. Min length – 12 mm; SD- 4.889mm; Max length – 23 mm.

Order Cerithiiiformes
Family Cerithiidae
Bittium attenuatum (Carpenter, 1864)

Common name. Slender bittium.
Localities. Chesterman beach.
Number of specimens. 1.
Description. Shells of this species are pale to dark brown with conical shape, and slightly convex whorls. The whorls have spiral ribs with earlier whorls showing signs of axial ribs. Aperture is broadly ovate, usually without a pronounced canal at base.[3, 4]
Variation. None seen.
Measurements. Length- 10mm.
Comment. This was the native Cerith, and was extremely rare in sampled localites.

Family Batillariidae

Batillara attramentaria (Brugière, 1792)

Common name. Japanese false cerith.
Localities. Comox harbour, Royston beach.
Number of specimens. 77.
Description. The shell of this species is tan to brown to dark brown in color sometimes with white bands above sutures. The shell has a conical shape with convex whorls. Shell has strong spiral ribs can be worn or appear to be crossed be weaker axial ribs. Aperture is ovate.
Variation. None seen.
Measurements. Min length – 16 mm; SD- 4.699mm; Max length – 34 mm.
Comments. This species is not native for the area. It was transported along with the pacific oyster from the eastern pacific in the early twentieth century.[1] This species was abundant in the intertidal mud flat habitats.

Order Littoriniformes
Family Littorinidae
Littorina scutulata (Gould, 1849)

Common name. Checkered periwinkle.
Localities. Bates beach, Miracle beach, Comox harbour, Tonquin park, Tofino harbour, Wittman beach, Chesterman beach, Royston beach.
Number of specimens. 581.
Description. Shells of this species are smooth with 4-5 whorls. The body whorl is broad and convex with a sharp keel near aperture. The shell has a tall spire with a sharp apex. Colors vary from black to green more or less containing white checkers, although some appear without checkers.[2, 3, 4]
Variation. Extensive color variation was observed in this species. The shell color varied from solid black to pinkish white with several color patterns in between. The checkered pattern of the shell also varied from non-existent to extremely well-expressed. Less than 5% of the specimens also had a rough appearance. 10 % of specimens were not keeled compared to the majority of specimens that had strong keel.
Measurements. Min length – 3 mm; SD- 3.078mm: Max length – 14 mm.
Comments. This species was the most abundant species of gastropod mollusks. It appeared in every sample and in all cases was the dominant species of the locality.

Littorina sitkana (Phillipi, 1846)

Common name. Sitka periwinkle.
Localities. Bates beach, Miracle beach, Comox harbour, Tonquin park, Tofino harbour, Wittman beach, Royston beach.
Number of specimens. 162.
Description. Shell of this species has convex whorls marked with strong spiral threads, but can be smooth. The body whorl is round and as tall as spire. The exterior colors range from orange to dark grey.[2, 3, 4]
Variation. The most extensive color variation was observed in this species. The shell color varied from bright orange to solid black with many color patterns in between. Spiral ribs also varied from extremely prominent to undefined. In 30% of the specimens the steepness of the spire varied.
Measurements. Min length – 3 mm; SD- 2.957mm; Max length – 19 mm.
Comments. This species was the second most abundant species of gastropod mollusks. It appeared in all of the localities except one (Chesterman beach).

Order Buccinifformes
Family Nucellidae
Nucella emarginata (Deshayes, 1839)

Common name. Emarginate dogwinkle.
Localities. Tonquin park, Chesterman beach.
Number of specimens. 14.
Description. Shell of this species has a large body whorl with a broad conical spire. Whorls are convex, with prominent spiral ribs. The columella is curved. The outer lip is flared with wavy margin, and the canal is short and narrow. Colors range for yellowish to dark brown, usually banded.[3, 4]

Variation. The most extensive variation was shell color. Varying from dark green to two toned gray to orange. On 42% of specimens spiral ribs were not always present or appeared very reduced. 28% of specimens were not banded.
Measurements. Min length – 12 mm; SD- 4.388mm; Max length – 24 mm.

Nucella canaliculata (Duclos, 1832)

Common name. Channeled dogwinkle.
Localities. Wittman beach, Chesterman beach.
Number of specimens. 5.
Description. Shell of this species has convex whorls with deep sutures and heavy spiral ribs with irregular frill like ridges. The aperture is oval with a short narrow canal at base. The spire is about half of shell length. Color is whitish brown to tan.[3, 4]
Variation. On the less mature specimen some banding was present along with a slight variation in the expected colors.
Measurements. Min length – 10 mm; SD -12.033mm; Max length – 42 mm.

Nucella lamellosa (Gmelin, 1791)

Common Name. Frilled dogwinkle.
Localities. Wittman beach.
Number of specimens. 33.
Description. Shell of this species is elongated with a tall conical spire. Shell usually contains fine axial ridges, but can appear smooth. Exterior color ranges from white to light brown. Aperature is ovate with rounded teeth on outer lip. Canal is moderate and slightly curved.[3, 4]
Variation. None seen.
Measurements. Min length- 17.3mm; SD- 8.6819; Max length- 50.0mm.

Family Nassariidae

Nassarius fossatus (Gould, 1849)

Common name. Channeled nassa.
Localities. Chesterman beach.
Number of specimens. 5.
Description. Shell of this species has a convex spire, whorls with beaded spiral cords that cross narrow rounded axial ribs. The outer lip finely toothed at margin. The canal is short and wide with strong siphonal ridge. Color is yellowish gray to pale orange brown.[3, 4]
Variation. None seen.
Measurements. Min length- 22.6mm; Max length- 28.1mm.

Family Olividae

Olivella pedroana (Conrad, 1856)

Common name. San Pedro dwarf olive.
Localities. Chesterman beach.
Number of specimens. 8.
Description. Shell of this species is grayish brown with irregular reddish brown axial streaks that are usually darker below suture where there is often a broad yellowish white band. The spire is less than half the shell length. Body whorl is smooth and broadly ovate. The basal columnellar fold is strong with two ridges.[3, 4, 5]
Variation. None seen.
Measurements. Min length- 12 mm; SD- 1.927mm; Max length- 17 mm.

Olivella biplicata (Sowerby, 1825)

Common name. Purple dwarf olive.
Localities. Chesterman beach.
Number of specimens. 42.

Description. Shell of this species is characterized by a brownish gray to almost white color with a fine dark line below suture, and a brown or orange line at upper margin of the purplish siphonal band. The body whorls are broadly ovate, smooth, and convex with a sharply conical spire. Columellar fold strong and twisted with two to four ridges.[3, 4, 5]
Variation. None seen.
Measurements. Min length – 9 mm; SD- 3.679mm; Max length – 24 mm.

Family Columbellidae
Alia gausapata (Gould, 1850)

Common name. Goulds dove shell.
Localities. Chesterman beach, Bates beach.
Number of specimens. 7.
Description. Shell of this species is yellowish-white that sometimes with reddish brown spots or pattern on it. The spire is half the shell length. Whorls are gently convex separated by grooved sutures. The body whorl is convex with a obscure angle in middle and has a slightly folded outer lip.[3, 4]
Variation. None seen.
Measurements. Min length – 7 mm; SD- 1.414mm; Max length – 9 mm.

Order Naticiformes
Family Naticidae
Polinices lewisii (Gould, A.A. 1846)

Common name. Lewis' moonshell.
Localities. Royston Beach.
Number of specimens. 6.
Description. Shells of this species are thick and almost round. Whorls are flattened below suture giving a shouldered appearance. The Aperture is pointed but ovate. Color is yellowish white to pale brown.[3, 4]
Variation. None seen.
Measurements. Min length – 66 mm; SD- 11.866mm; Max length – 99 mm.

Order Epitoniiformes
Family Epitoniidae
Opalia borealis (Keep, 1881)

Common name. Boreal wentletrap.
Localities. Chesterman beach.
Number of specimen. 1.
Description. Generally the shell of this species is white with convex whorls and strong axial ribs. The sutures are of medium depth with a conical spire, and ovate aperture.[3, 4]
Variations. None seen.
Measurements. Length- 18.3mm.

4. Discussion

Our preliminary results show significant diversity of gastropod mollusks on the intertidal zone of the Vancouver Island. More than 20 species of gastropod mollusks were identified belonging to eight orders and thirteen families.

The types of localities varied from very rocky with little sand (Bates beach,Tofino harbour, Wittman beach) to sandy with some rocks (Chesterman beach, Miracle beach, Tonquin park) to intertidal mud flats (Comox harbour, Royston beach). Despite the differences in species composition at different localities due to the presence of different types of habitats, the intertidal zone of every locality was dominated by two species of *Littorinas*. A non-native gastropod species *Batillara attramentaria* was extremely abundant on the intertidal mudflats. The native species of *Cerithiidae* were extremely scarce in these areas.

Extensive variation was observed in three species *Littorina scutulata*, *Littorina sitkana*, and *Nucella emarginata*. In *Littorina scutulata* the variation was mostly seen in the coloration, although the lacking of checkers was evident

is some specimens. Some specimens also appeared rough. In *Littorina sitkana* the variation was also mostly seen in the coloration, but some specimens had prominent spiral ribs while others were undefined or appeared to be lacking them entirely. The steepness of the spire was also a variable seen throughout the *Littorina sikana* specimens. In *Nucella emarginata* the variation appeared in the coloration, and also in the presence or reduction of the spiral ribs. As well as, some *Nucella emarginata* specimens were not banded. The variation seen in these species was most likely caused by the variability of the intertidal ecosystem.

According to Byers[1] during the early part of the twentieth century *Batillara attramentaria* had been imported to North America with shipments of the Pacific Oyster, *Crassostrea gigas* [1]. Since the arrival of *Batillara attramentaria* there have been recorded declines in the population of its native equivalence from San Diego, CA, to Boundary Bay B.C. The *Batillara attramentaria* specimens I collected were found approximately 100 miles northwest of Boundary bay, which is the northern most known point of distribution of the species on the west coast of North America.

5. Conclusion

In conclusion, the native gastropod mollusk fauna of Vancouver Island, Canada, is very diverse and abundant, but an introduction of a non-native species could jeopardize the stability of native mollusk populations. Therefore, the monitoring of native species distribution and variation, as well as the monitoring of the level of species invasion and locations of invasion must be continued to track and if possible prevent future disturbance of the native faunas.

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