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ความหลากชนิดของปลิงทะเลที่มีพื้นผิวตัวเป็นสีดำที่พบในทะเลอ่าวไทยและอันดามัน

Diversity of Black-Surface Sea Cucumbers in the Gulf of Thailand and Andaman Sea

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บทคัดย่อ

ปลิงทะเลเป็นสัตว์ไม่มีกระดูกสันหลังจัดอยู่ในไฟลัม Echinodermata ชั้น Holothuroidea ที่มีบทบาทสำคัญในระบบนิเวศทางทะเลและเศรษฐกิจสังคม คือ เป็นผู้ย่อยสลายอินทรีย์สารที่สำคัญในท้องทะเล และเป็นที่ต้องการทางด้านอาหารและยา ปลิงทะเลสีดำในทะเลอ่าวไทยและอันดามีความหลากหลายสามารถพบเจอได้ทั่วไปและมักก่อให้เกิดความสับสนในการระบุชนิด การศึกษานี้จึงมีวัตถุประสงค์เพื่อรวบรวมปลิงทะเลที่มีพื้นผิวตัวเป็นสีดำและจำแนกชนิดทางอนุกรมวิธาน โดยการรวบรวมตัวอย่างจากสถาบันวิทยาศาสตร์ทางทะเล มหาวิทยาลัยบูรพา และได้สำรวจเก็บตัวอย่างเพิ่มเติมในทะเลอ่าวไทยและอันดามันทั้งหมด 10 สถานี ตั้งแต่เดือนมีนาคม-พฤษภาคม 2565 นำตัวอย่างปลิงทะเลมาตัดเนื้อเยื่อเพื่อดูลักษณะของออสสิเคิลที่ใช้ในการจำแนกชนิด ผลการศึกษาพบปลิงทะเลสีดำทั้งหมด 3 อันดับ 4 วงศ์ 6 สกุล 13 ชนิด เป็นปลิงทะเลที่พบในทะเลอ่าวไทย 3 ชนิด ได้แก่ *Holothuria flavomaculata*, *H. notabilis* และ *Stolus buccalis* พบในทะเลอันดามัน 5 ชนิด ได้แก่ *Actinopyga caerulea*, *A. miliaris*, *Bohadshia atra*, *H. erinacea* และ *H. cinerascens* และพบทั้งทะเลอ่าวไทยและอันดามัน 5 ชนิด ได้แก่ *H. atra*, *H. pardalis*, *H. leucospilota*, *Stichopus chloronotus* และ *Mensamaria intercedens*

คำสำคัญ : โฮโลทูรอยเดีย ; ปลิงทะเลที่มีพื้นผิวตัวเป็นสีดำ ; เขตน้ำขึ้นน้ำลง

Abstract

Sea cucumbers are marine invertebrates in class Holothuroidea of phylum Echinodermata. They have an important role in marine ecosystems and socioeconomy as decomposers of important organic substances in the sea and they are in demand of marine foods and marine drugs. Black sea cucumbers in the Gulf of Thailand and the Andaman Sea are diverse, common and often complicated in species identification. This study aimed to collected black-surface sea cucumbers and identified them taxonomically by collecting specimens from the Institute of Marine Science, Burapha University. More samples were collected from the Gulf of Thailand and the Andaman Sea at 10 stations from March to May 2022. Sea cucumber samples were taken for biopsy to determine the characteristics of the ossicles used in species identification. The results revealed 3 orders, 4 families, 6 genera and 13 species of black sea cucumbers. Three species of sea cucumbers were found in the Gulf of Thailand, namely *Holothuria flavomaculata, H. notabilis* and *Stolus buccalis* and 5 species were observed in the Andaman sea: *Actinopyga caerulea, A. miliaris, Bohadshia atra, H. erinacea* and *H. cinerascens*. In addition, 5 species were found in both the Gulf of Thailand and the Andaman Sea: *H. atra, H. pardalis, H. leucospilota, Stichopus chloronotus* and *Mensamaria intercedens*.

Keywords : holothuroidea, black-surface sea cucumbers, intertidal zone

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Introduction

Sea cucumbers are marine invertebrates in the class Holothuroidea of the phylum Echinodermata. It has a horizontally elongated cylindrical shape. The head has tentacles that hold food in the mouth and the anus is at the end of its body. Sea cucumbers can be seen from the tidal zone to the deep sea in various marine ecosystems such as rocky beaches, sandy beaches and seagrass resources. Sea cucumbers play an important role in the ecosystem as a decomposer of organic matter in sediments by making them smaller and then releasing nutrients into the ecosystem. Sea cucumber is a nutritious food with a high protein and collagen and it is an important source of natural products with medicinal and pharmacological benefits (Putchakarn *et al*., 2017). In economy and society, sea cucumbers are processed into dried sea cucumbers. In the Indo-Pacific region, it is popular among people from China, Korea and Japan. It is caught for domestic sales and exports. The common edible black sea cucumber is *Holothuria atra* (Kunkomnoed *et al*., 2006).

Coastal sea cucumbers often have a black surface. Therefore, it is assumed that a black surface helps to camouflage in the environment and to avoid predators. This is because the black skin absorbs most of the light and no reflected light. The pigment called melanin, made by melanocytes in the skin of black sea cucumber, is common and varied from reddish brown to black which depending on the chemical composition and nature. In addition, melanin acts to prevent ultraviolet radiation from damaging the skin (Cordero & Casadevall, 2020). Therefore, black sea cucumbers can survive even at extreme condition such as high temperatures in tidal zone. In the Gulf of Thailand and the Andaman Sea, the black surface sea cucumber is very diverse and often complicated in species identification. The objective of this research is to investigate sea cucumbers with black body surface and taxonomically classify them for easy recognition.

Methods

The materials examined were a combination of voucher specimens from the Institute of Marine Science, Burapha University and collected specimens from the Gulf of Thailand and the Andaman Sea from 10 stations (Figure 1), namely 1 -Mae Ramphueng Beach in Rayong Province, 2 -Samae San Island and 3 -North Pattaya Beach, Chonburi Province, 4 -Tha Nun Beach, Phang Nga Province, 5 -Koh L, 6 -Koh Hey and 7 -Koh Mai Ton, Phuket Province, 8 -Ba Kan Tiang Beach, 9 -Koh Lanta, Krabi Province and 10 -Ho Si Lang, Thung Wa District, Satun Province from March to May 2022. Sea cucumber samples were collected and biopsied for classification according to Ong *et al* (2016) method. Classification of sea cucumbers was based on Clark&Rowe (1971) and Purcell *et al* (2012).

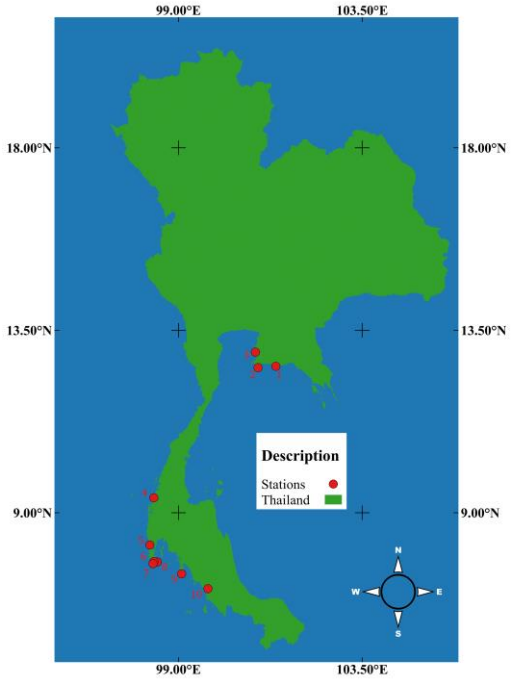

Figure 1 Map of the study areas at the Andaman Sea and the Gulf of Thailand

Results

A total of 3 orders, 4 families, 6 genera and 13 species of black sea cucumbers were found (Table 1). Among these, the sea cucumbers were reported to be found both in the Gulf of Thailand and the Andaman Sea (Putchakarn *et al*., 2017), but no samples of reported sea cucumbers had been collected. In the future, more black sea cucumbers may be discovered. This is because sea cucumber habitats in tidal zones are subject to changes in temperature and sunlight causing adaptation in sea cucumbers with a darker skin color.

Table 1 Species of black sea cucumbers in the Gulf of Thailand and the Andaman Sea

Order	Family	Scientific Name	Distribution	
			Gulf of Thailand	Andaman Sea
Holothuriida	Holothuriidae	*Actinopyga caerulea* Samyn, VandenSpiegel & Massin, 2006		x
		Actinopyga miliaris (Quoy & Gaimard, 1834)		x
		Bohadschia atra Massin, Rasolofonirina, Conand & Samyn, 1999		x
		Holothuria (Halodeima) atra Jaeger, 1833	x	x
		Holothuria (Lessonothuria) pardalis Selenka, 1867	x	x
		Holothuria (Mertensiothuria) leucospilota (Brandt, 1835)	x	x
		Holothuria (Selenkothuria) erinacea Semper, 1868		x
		Holothuria (Semperothuria) cinerascens (Brandt, 1835)		x
		Holothuria (Semperothuria) flavomaculata Semper, 1868	x	
		Holothuria (Theelothuria) notabilis Ludwig, 1875	x	
Synallactida	Stichopodidae	*Stichopus chloronotus* Brandt, 1835	x	x
Dendrochirotida	Cucumariidae	*Mensamaria intercedens* (Lampert, 1885)	x	x
	Phyllophoridae	*Stolus buccalis* (Stimpson, 1855)	x	

Key to black sea cucumber in Thai Waters.

1a Tentacles dendritic form ……..……..……..2

1b Tentacles peltate form.....3

2a Black in color with orange tube feet interspersed with a black body, ossicles tables and supporting plates...……..…...*Mensamaria intercedens* (Lampert, 1885)

2b Tube feet spread around the dorsal, ossicles knobbed buttons……..……*Stolus buccalis* (Stimpson, 1855)

3a Body long cylindrical shape, ossicles tables, buttons, rods……..4

3b Body square cylindrical shape, ossicles c-shaped, rods……..*Stichopus chloronotus* Brandt, 1835

4a Anus contains 5 calcified teeth……..5

4b Anus does not contain 5 calcified teeth……6

5a Black body with white spots scattered on the back of the body surface, ossicles rods……*Actinopyga caerulea* Samyn, VandenSpiegel & Massin, 2006

5b Back is brown, ossicles rosettes……*Actinopyga miliaris* (Quoy & Gaimard, 1834)

6a Body quite stiff, cuvierian tubles and ossicles grains ……*Bohadschia atra* Massin, Rasolofonirina, Conand & Samyn, 1999

6b Body cylindrical, ossicles tables and buttons……7

7a Ossicles perfect table……8

7b Ossicles have not perfect table or not have table……9

8a Low tables ……10

8b High tables ……11

9a The small yellow-tipped black papillae scattered throughout the back, ossicles rods ……*Holothuria (Selenkothuria) erinacea* Semper, 1868

9b Ossicles have not perfect tables and button……12

10a The body is quite solid and ossicles table……*Holothuria (Halodeima) atra* Jaeger, 1833

10b The body is black, soft, ossicles button and table ……*Holothuria (Mertensiothuria) leucospilota* (Brandt, 1835)

11a The abdomen has small tube feet, ossicles table and rods ……*Holothuria (Semperothuria) cinerascens* (Brandt, 1835)

11b The abdomen has densely spread yellow tube feet, ossicles table and rods ……*Holothuria (Semperothuria) flavomaculata* Semper, 1868

12a There are papillae scattered all over the back area, ossicles buttons and table ……*Holothuria (Lessonothuria) pardalis* Selenka, 1867

12b The skin is smooth, ossicles button and rods ……*Holothuria (Theelothuria) notabilis* Ludwig, 1875

Order Holothuriida

Actinopyga caerulea Samyn, VandenSpiegel & Massin, 2006

External morphology. Body large cylindrical shape with slender dorsal, black body with white spots scattered on the back of the body surface, skin is thick with the tube feet are blue-white, anal area has 5 teeth.

Peltate. Tentacles are 15-18 lines.

Ecology & distribution. On the sand and rock bottom of the Andaman Sea.

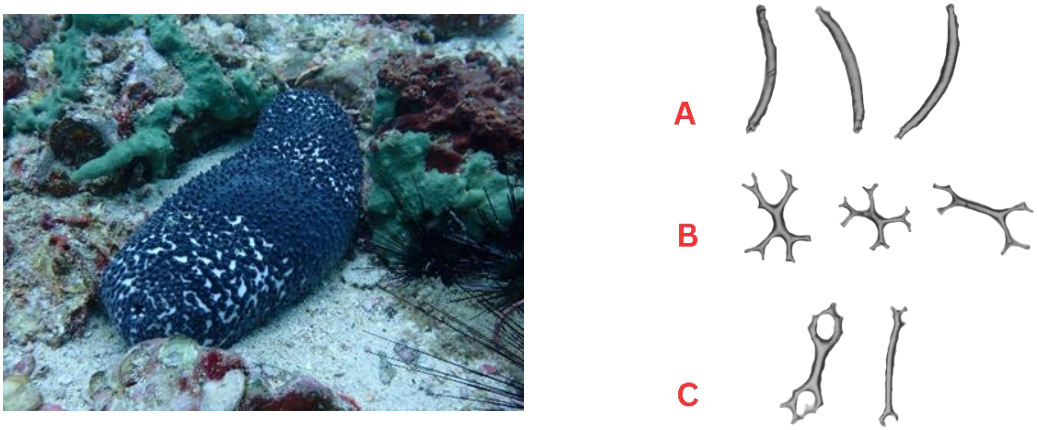

Figure 2 *Actinopyga caerulea* Samyn, VandenSpiegel & Massin, 2006. A, rods in the tentacles area (60-170 μm); B, rods in the body wall (40-130 μm); C, rods in the dorsal body wall (50-120 μm). Coll.BIMS-K001

Actinopyga miliaris (Quoy & Gaimard, 1834)

External morphology. Body cylindrical black body, dorsal is curved brown and the ventral is light brown and smooth, with long and hair-like tube feet, mouth is on the ventral, anal region has 5 triangular teeth and no cuvierian tubles.

Peltate. Tentacles are 20 lines with black or brown color.

Ecology & distribution. On the seagrass rock or coral reef in the Andaman Sea.

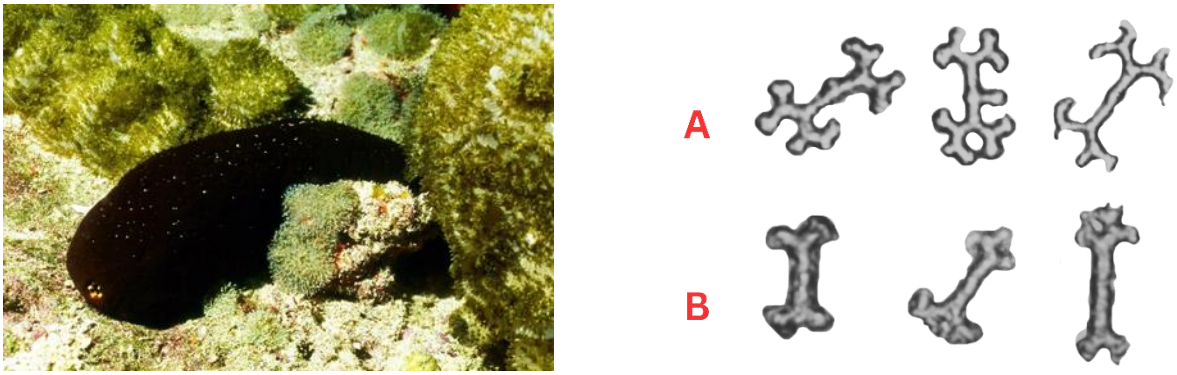

Figure 3 *Actinopyga miliaris* (Quoy & Gaimard, 1834). A, rosettes in the posterior surface of the body (±25 μm); B, rods in the body surface. (45-80 μm). Coll.BIMS-K002.

Bohadschia atra **Massin, Rasolofonirina, Conand & Samyn, 1999**

External morphology. Body shape large and long cylinder, dorsal is curved, yellowish brown to black with orange or reddish-brown spots and the flattened side is light brown to cream, body is stiff and has cuvierian tubles.

Peltate. Tentacles are 20 lines with black color.

Ecology & distribution. On sandy to muddy soil in the Andaman Sea.

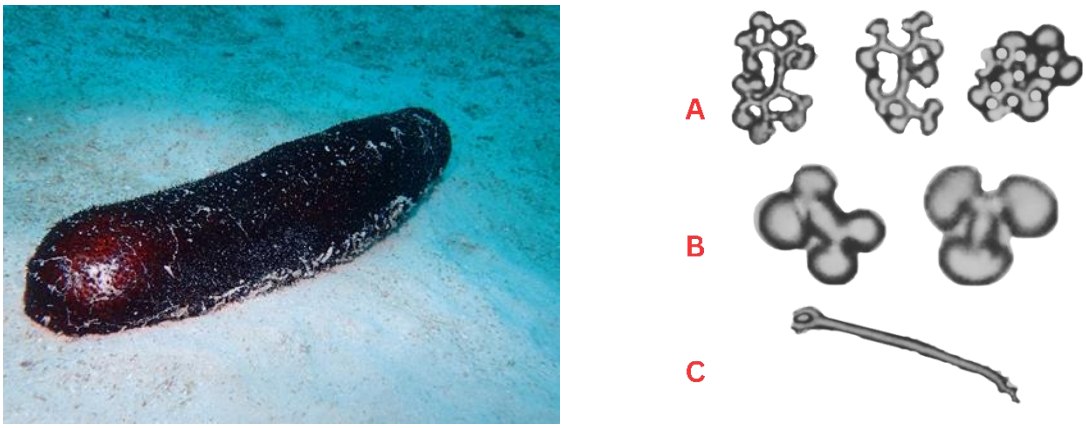

Figure 4 *Bohadschia atra* Massin, Rasolofonirina, Conand & Samyn, 1999. A, rosettes in the dorsal body (20-50μm); B, grains in the ventral body (20-50 μm); C, rods in the tube feet area. Coll.BIMS-K003.

Holothuria (Halodeima) atra Jaeger, 1833

External morphology. Body long cylindrical shape, black and smooth body covered with grains of sand, body wall is quite thick and the body is quite solid, completely black in color, no cuvierian tubles.

Peltate. Tentacles are 20 lines with black color.

Ecology & distribution. Coastal tidal zone both in the Gulf of Thailand and the Andaman sea coasts.

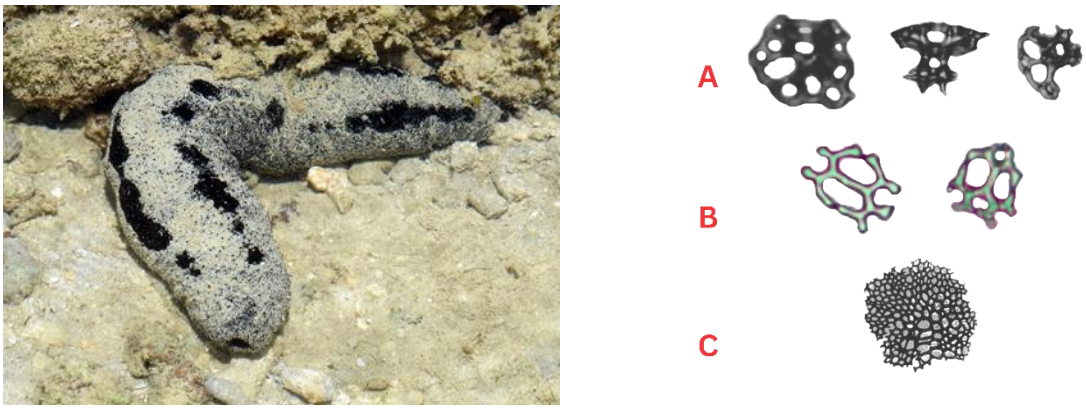

Figure 5 *Holothuria (Halodeima) atra* Jaeger, 1833. A, table in the ventral and dorsal body (50-75 μm); B, pseudobuttons in the ventral and dorsal body (40-70 μm); C, perforated plate in the tube feet (75-100 μm). Coll.Sitthichok, 2022.

Holothuria (Lessonothuria) pardalis Selenka, 1867

External morphology. Body long cylinder with black to gray color, papillae scattered all over the dorsal, on the ventral, there are densely spread short tube feet, body is relatively soft, with no cuvierian tubles.

Peltate. Tentacles are 18-22 lines.

Ecology & distribution. On sand and coral reefs both in the Gulf of Thailand and the Andaman sea coasts.

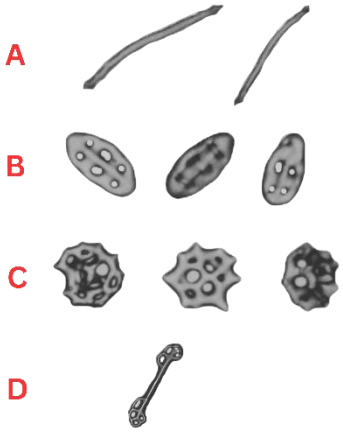

Figure 6 *Holothuria (Lessonothuria) pardalis* Selenka, 1867. A, rods in the tentacles area (80-180 μm); B, button in the ventral and dorsal body (40-70 μm); C, table in the ventral and dorsal body (50-80 μm); D, rods in the tube feet area. Coll.Sitthichok, 2022.

Holothuria (Mertensiothuria) leucospilota (Brandt, 1835)

External morphology. Body elongated cylinder, head is more slender than the tail, body is black and soft, mouth is on the ventral side, cuvierian tubles and they are released when disturbed.

Peltate. Tentacles are 20 lines.

Ecology & distribution. On the rock hiding under the sand both in the Gulf of Thailand and the Andaman Sea.

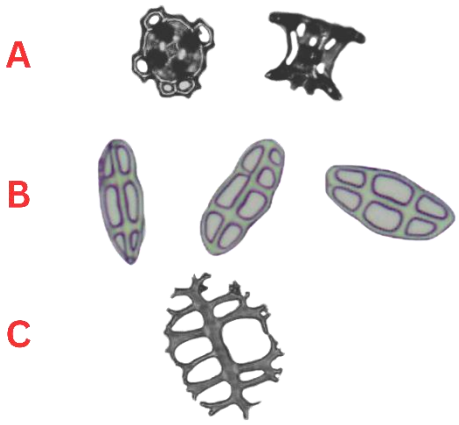

Figure 7 *Holothuria (Mertensiothuria) leucospilota* (Brandt, 1835). A, table in the ventral and dorsal. (40-70 μm); B, button in the ventral and dorsal body (40-70 μm); C, pseudo-plates in the tube feet area. (60-120 μm). Coll.Sitthichok, 2022.

Holothuria (Selenkothuria) erinacea Semper, 1868

External morphology. Body elongated cylindrical with black dorsal and small yellow-tipped black papillae scattered throughout the back, belly is brown, body wall is quite thick and hard, mouth is on the ventral side, cuvierian tubles.

Peltate. Tentacles are 17-20 lines with black color.

Ecology & distribution. On sand or rock niches in the tidal zone of the Andaman Sea.

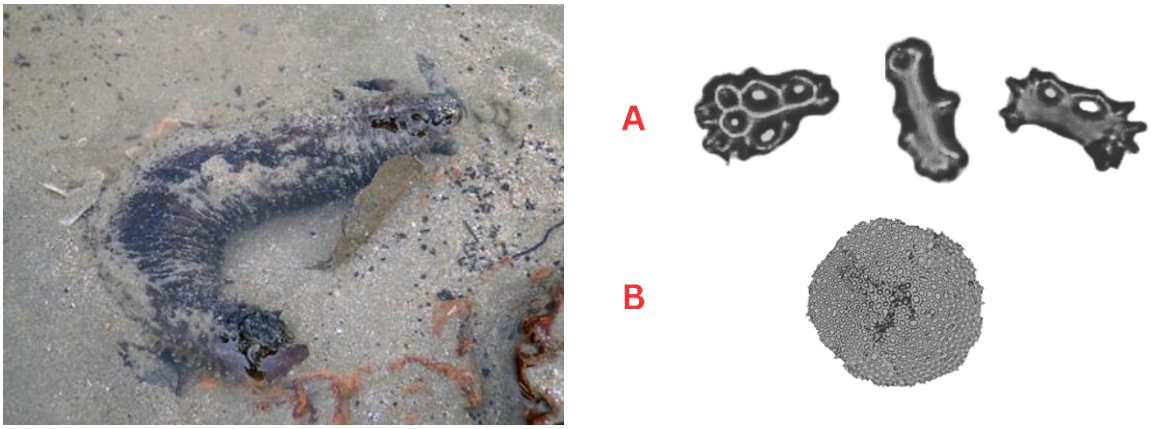

Figure 8 *Holothuria (Selenkothuria) erinacea* Semper, 1868. A, rods in the ventral and dorsal body (55-100 μm); B, perforated plate in the tube feet area (120-350 μm). Coll.BIMS-K004.

Holothuria (Semperothuria) cinerascens (Brandt, 1835)

External morphology. Body small, elongated cylinder, body is black to dark brown, small tube feet, walls of the body are quite thick and hard, no cuvierian tubles.

Peltate. Tentacles are 20 lines with brown color.

Ecology & distribution. Rocky beach in the Andaman sea coasts.

Figure 9 *Holothuria (Semperothuria) cinerascens* (Brandt, 1835). A, table in the ventral and dorsal body (35-55 μm); B, rods in the ventral and dorsal body (65-100 μm); C, perforated plate in the tube feet area (295 μm). Coll.Sitthichok, 2022.

Holothuria (Semperothuria) flavomaculata Semper, 1868

External morphology. Body elongated cylinder, body is reddish brown to black, ventral has densely spread yellow tube feet, relatively thin body walls and a soft body, no cuvierian tubles.

Peltate. Tentacles are 20 lines with black color at the end of the yellow tentacles.

Ecology & distribution. Coral reefs in the Gulf of Thailand.

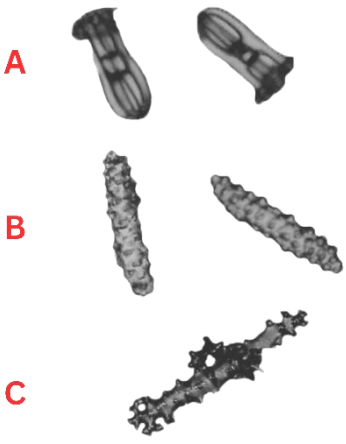

Figure 10 *Holothuria (Semperothuria) flavomaculata* Semper, 1868. A, table in the ventral and dorsal body (35-55 μm); B, rods in the ventral and dorsal body (65-100 μm); C, rods in the tube feet area. Coll.BIMS-I321.

Holothuria (Theelothuria) notabilis Ludwig, 1875

External morphology. Body elongated and cylindrical, dorsal is dark brown to black, skin is smooth, abdomen has small tube feet and the body wall is relatively thin and soft, mouth on the ventral side, cuvierian tubles

Peltate. Tentacles are 20 lines with yellow color.

Ecology & distribution. On the sand and muddy sands of the Gulf of Thailand

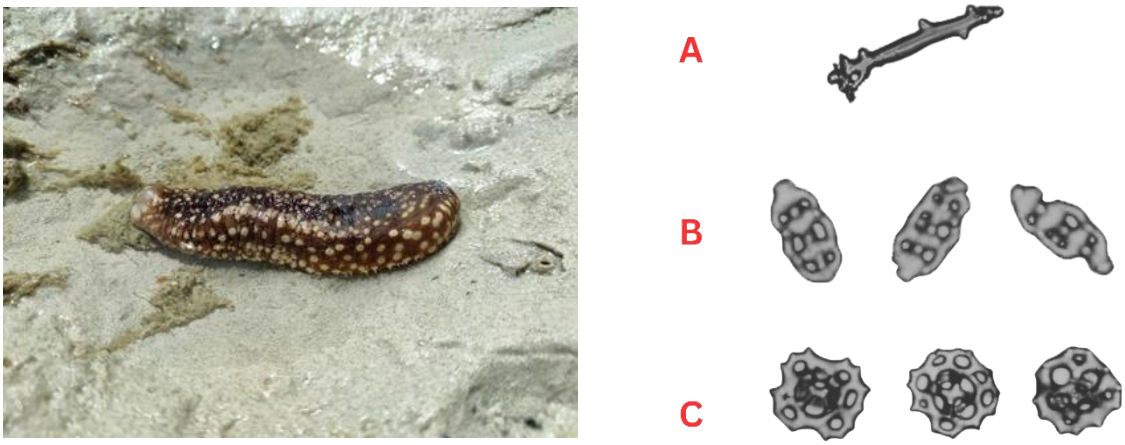

Figure 11 *Holothuria (Theelothuria) notabilis* Ludwig, 1875. A, rods in the tentacles area (25-120 μm); B, button in the ventral and dorsal body (35-50 μm); C, table in the ventral and dorsal (35-50 μm). Coll.Sitthichok, 2022.

Order Synallactida

Stichopus chloronotus Brandt, 1835

External morphology. Body smooth cylindrical and rectangular with black color throughout the body, dorsal side has rows of black papillae with orange ends, ventral side has tube feet, body wall is quite thick and hard, no cuvierian tubles.

Peltate. Tentacles are 20 lines with short black color.

Ecology & distribution. Coral reefs and sandy bottoms off reefs in both the Gulf of Thailand and the Andaman sea.

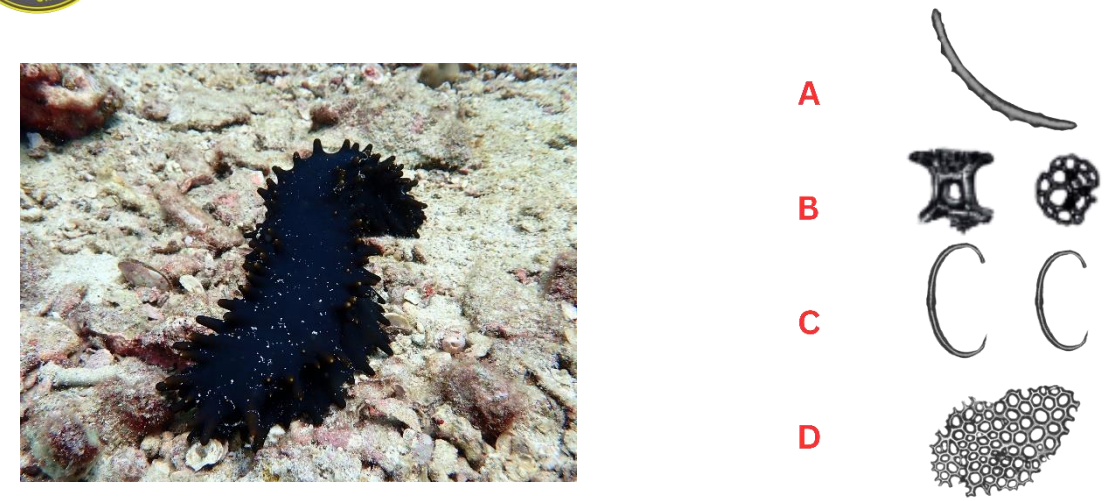

Figure 12 *Stichopus chloronotus* Brandt, 1835. A, rods in the tentacles area (270-550 μm); B, table in the ventral and dorsal body (30-45 μm); C, C-shaped rods in the ventral and dorsal body (40-50 μm); D, perforated plate in the tube feet area. (250-370 μm). Coll.Sitthichok, 2022.

Order Dendrochirotida

Mensamaria intercedens (Lampert, 1885)

External morphology. Body resembles a small shuttle, black to brown in color with orange tube feet interspersed with a black body, hard body skin, no cuvierian tubles.

Dendritic: Tentacles are 30 lines.

Ecology & distribution. Buried in sand or muddy sand on both the Gulf of Thailand and the Andaman Sea.

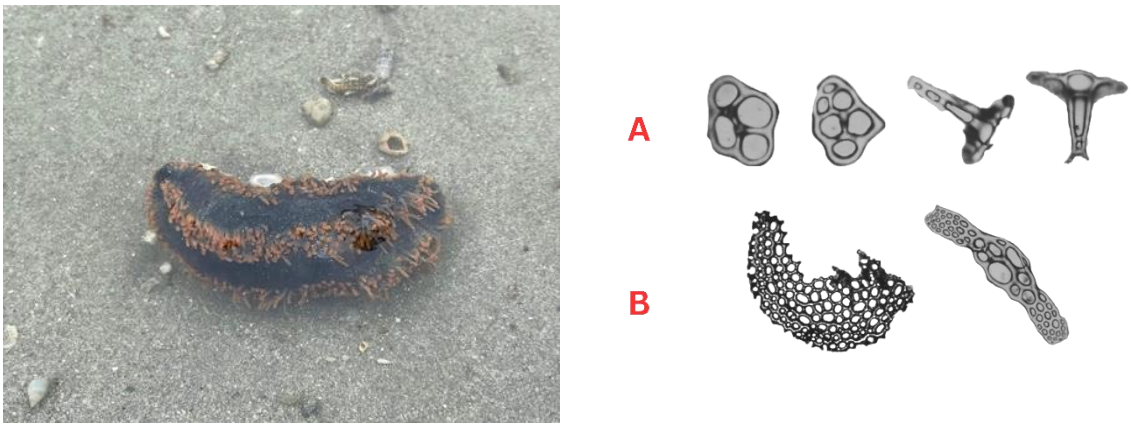

Figure 13 *Mensamaria intercedens* (Lampert, 1885). A, table in the ventral and dorsal body (70-110 μm); B, supporting plates in the tube feet area (100-250 μm). Coll.Sitthichok, 2022.

Stolus buccalis (Stimpson, 1855)

External morphology. Body small, elongated cylindrical with pointed head and foot, body is blue-purple, ventral is lighter in color than the back, with tube feet spread around the dorsal, body wall is thick and relatively hard.

Dendritic: Tentacles are 10 lines with dark purple color.

Ecology & distribution. Underwater rocks on the shores of the Gulf of Thailand.

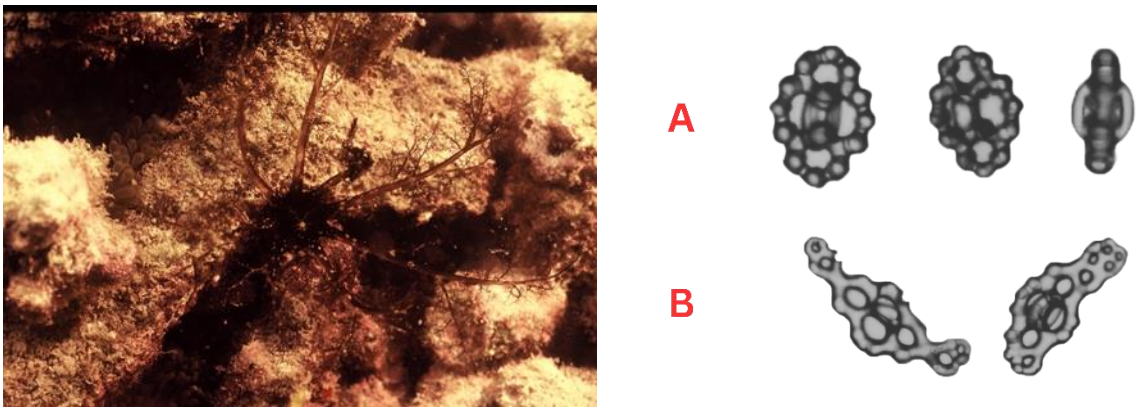

Figure 14 *Stolus buccalis* (Stimpson, 1855). A, knobbed buttons in the ventral and dorsal body (45-60 μm); B, perforated rods from dorsal and ventral body wall (100-150 μm). Coll.BIMS-9732.

Discussion

The study was conducted by collecting 13 species from field samples and from the Institute of Marine Sciences. Seven species were found from the survey, including *Holothuria atra*, *H. pardalis*, *H. leucospilota*, *H. cinerascens*, *H. notabilis*, *Stichopus chloronotus*, *Mensamaria intercedens*, and 6 species from Institute of Marine Sciences: *Actinopyga caerulea*, *A. miliaris*, *Bohadshia atra*, *H. erinacea*, *H. flavomaculata*, and *Stolus buccalis*. The type of ossicles of some specimens cannot be identified because the specimens were preserved in the institution of marine science for a long time, so some ossicles were destroyed, including *Actinopyga caerulea*, *A. miliaris* and *Stolus buccalis*.

Upon comparing the habitat distribution of sea cucumbers, namely *Holothuria atra* and *H. leucospilota*, it was observed that the majority of them inhabit the coastal regions and these two black sea cucumbers are common, its sometimes found living together. Can be found in both the Gulf of Thailand and Andaman Sea. However, there is a notable difference in their distribution within the intertidal zone. *Holothuria atra* is found residing in the sand, which is often covered with a thick layer of sand, whereas *H. leucospilota* prefers to dwell in

the crevices of rocks, with little to none of sandy or rocky cover. This is similar to the study of Bonham and Held (1963) who studied Ecological Observations on the Sea Cucumbers *H. atra* and *H. leucospilota* at Rongelap Atoll, Marshall Islands and found that two species of black sea cucumbers had similar habitats. And often found living together. The reason that *H. atra* had sand-coated in the naked black specimens is because of the reflection of light and heat by the coating of sand characteristic of this species. Therefore, the observation method used to classify the species an easy way to tell is by looking at the sand that is covered and by touch, *H. leucospilota* has thin, soft skin with Cuvierian tubles, but *H. atra* has relatively thick skin with no Cuvierian tubles.

Sea cucumber, *Holothuria notabilis* lives in the intertidal zone. Distributed and abundant in the lagoon area. It was found during low tide at night at Lan Hin Khao, Mae Ramphueng Beach, Rayong Province and it was a good food for predators such as the Three-spot swimming crab (*Portunus sanguinolentus*).

Conclusions

From the taxonomic classification of sea cucumbers with black surface, there were 3 orders, 4 families, 6 genera and 13 species of black sea cucumbers. There were 3 species of sea cucumbers found in the Gulf of Thailand, namely *Holothuria flavomaculata*, *H. notabilis* and *Stolus buccalis*. Five species were found in the Andaman Sea including *Actinopyga caerulea*, *A. miliaris*, *Bohadshia atra*, *H. erinacea* and *H. cinerascens*. In addition, 5 species found in both the Gulf of Thailand and the Andaman Sea were *H. atra*, *H. pardalis*, *H. leucospilota*, *Stichopus chloronotus* and *Mensamaria intercedens*. Only 2 species of black-surface sea cucumbers are used for aquaculture: *H. atra* and *H. leucospilota*. All specimens were collected at the Institute of Marine Science, Burapha University.

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