

Distribution and abundance of mud crabs (Crustacea: Portunidae) in Pacific and Indian Ocean coasts of Thailand

SOFIYUDIN MAAE^{1,2}, PORNPIMON CHUADUANGPUI², SUKREE HAJISAMAE^{1,✉}, PAYAP MASNIYOM¹,
SAWEIT CHAYMONGKOL¹, SITTHISAK JANTARAT³, SUPAPORN SAENGAEW³

¹Department of Agricultural and Fishery Science, Faculty of Science and Technology, Prince of Songkla University, Pattani 94000, Thailand.
Tel./fax.: +66-73-331303, ✉email: sukree.h@psu.ac.th

²Aquatic Science and Innovative Management Division, Faculty of Natural Resources, Prince of Songkla University, Songkhla 90110, Thailand

³Department of Science, Faculty of Science and Technology, Prince of Songkla University, Pattani 94000, Thailand

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Abstract. Maae S, Chuaduangpui P, Hajisamae S, Masniyom P, Chaymongkol S, Jantararat S, Saengkaew S. 2025. Distribution and abundance of mud crabs (Crustacea: Portunidae) in Pacific and Indian Ocean coasts of Thailand. *Biodiversitas* 26: 4534-4544. Mud crabs (Crustacea: Portunidae) are economically important species found in the two oceans of Thailand's coastal waters. This study aimed to examine the species composition and size variation of *Scylla* species across two distinct coastal regions of Thailand, the Gulf of Thailand (GOT, Pacific Ocean) and the Andaman Sea (ADM, Indian Ocean), and to contextualize these findings within global distribution patterns. A total of 4,116 specimens were collected from five sampling sites during June 2022 and June 2023. Carapace Width (CW) and Body Weight (BW) were recorded for each individual. In the GOT, the species composition was dominated by *S. olivacea* (86.24%), followed by *S. paramamosain* (11.32%) and *S. tranquebarica* (2.45%). In the ADM, *S. olivacea* accounted for 99.40%, and *S. paramamosain* 0.60%; *S. tranquebarica* was absent. Size variation analysis showed that both male and female *S. olivacea*, and female *S. paramamosain* from the GOT were significantly larger ($P < 0.05$) in CW and BW than those from the ADM. No significant size difference was observed in male *S. paramamosain* ($P > 0.05$). Monthly data from the GOT revealed peak *S. olivacea* proportions in January (93.81%), April (91.85%), and June (91.02%); the lowest proportion was observed in June (74.83%). *Scylla paramamosain* peaked in June (23.18%), followed by February (19.75%) and May (16.00%). *Scylla tranquebarica* showed low occurrences, peaking in November (6.42%), followed by June (4.19%) and February (3.70%). In the ADM, *S. olivacea* was consistently dominant. These findings provide baseline data for population assessments, resource management, and aquaculture development, contributing to a broader ecological understanding of economically valuable *Scylla* species.

Keywords: Coastal fisheries, fisheries management, geographical distribution, *Scylla* species, species composition

INTRODUCTION

Mud crabs of the genus *Scylla* are incredibly important to both capture fisheries and aquaculture throughout the Indo-West Pacific (Overton et al. 1997; Le Vay 2001; Imai et al. 2004; Nurdiani and Zeng 2007; Hamasaki et al. 2011; Fazhan et al. 2017a, et al. 2020). Due to their distinctive flavor profile and nutritional value and commonly utilized as a delicacy in various regional culinary practices and hold significant value in domestic and international markets (Sathiadhas and Najmudeen 2004; Waiho et al. 2018). Despite growing interest in aquaculture, the majority of mud crab fisheries in several regions, particularly in Southeast Asia, still heavily rely on wild-caught individuals (Fazhan et al. 2017a). This widespread exploitation has sparked concerns about declining wild populations (Waiho et al. 2018). In fact, globally, wild-caught mud crabs made up only 10% of total production, with aquaculture contributing a remarkable 90%. China was the leading producer, and global aquaculture output reached nearly 300,000 metric tons in 2021 (Lovatelli et al. 2025).

Despite their high economic value, scientific data on the species composition, distribution, and abundance of *Scylla* spp., particularly in wild populations, remain limited. Such

information is essential for ecological research (Hirose et al. 2012) and provides critical insights into population structure (Kunsook and Dumrongrojwathana 2017; Fazhan et al. 2022). It also serves as a fundamental basis for assessing biodiversity, ecosystem changes, and anthropogenic impacts (Alzeny et al. 2021; Seidu et al. 2022). Moreover, such data are essential for informing conservation efforts (Desalegn and Negussie 2022), all of which underpin sustainable fisheries management and aquaculture development.

Another major challenge hindering these efforts is persistent taxonomic ambiguity. Misidentifications in earlier research, including studies in Thai waters, have caused considerable confusion in species classification (Balasubramanian et al. 2016; Sarower et al. 2017). Keenan et al. (1998) formally identified four species within the genus: *S. serrata*, *S. tranquebarica*, *S. olivacea*, and *S. paramamosain*. This classification is supported by Ng and Davie (2002), who reported all four species present on Thailand's western coast. Jirapunpipat (2008) further confirmed their occurrence of these four species in the Klong Ngao mangrove area, Ranong Province.

However, some regional discrepancies persist. For instance, Klinbunga et al. (2000) reported only three

species (*S. serrata*, *S. tranquebarica*, and a species they identified as *S. oceanica*) from eastern Thailand. It's worth noting that many specimens previously identified as *S. serrata* were later reclassified as *S. olivacea* (Keenan et al. 1998). Furthermore, the species identified by Klinbunga et al. (2000) as *S. oceanica* was described with traits favorable for aquaculture—rapid growth, desirable taste, docility, and reduced burrowing behavior (Tiensongrusmee and Pratoomchat 1999). These characteristics strongly resemble those of *S. paramamosain*, suggesting a likely misidentification.

Molecular tools have since brought greater clarity. Sarower et al. (2017), using ITS-1 and 16S rDNA markers, successfully differentiated *S. olivacea* from *S. serrata*, recommending corrections to previous records of *S. serrata* in Bangladesh. Similarly, Balasubramanian et al. (2016) genetically suggested that some populations identified as *S. tranquebarica* in India might actually be *S. serrata*.

Despite ongoing research efforts, most studies in Thailand have been localized in scope, targeting either the Andaman Sea or the Gulf of Thailand as separate regions. Consequently, there is still a notable gap in regional-scale assessments, especially regarding cross-coastal comparisons between Thailand's Indian Ocean and Pacific Ocean shorelines. In Thailand, studies on *Scylla* species composition and distribution have primarily concentrated on the Gulf of Thailand (Overton and Macintosh 2002; Hamasaki et al. 2011; Koolkalya et al. 2016; Kunsook et al. 2022). Region-wide assessments of the abundance, distribution, and species composition of *Scylla* spp. remain limited, particularly across Thailand's dual coastal regions—the Gulf of Thailand and the Andaman Sea. This lack of comprehensive data at a regional scale hinders effective stock assessment and compromises the ability to develop sustainable fishery management strategies.

Therefore, this study aims to address this critical knowledge gap by providing baseline data that can inform resource planning, biodiversity conservation, and the development of more sustainable aquaculture practices. This study aims to bridge a critical knowledge gap by expanding the investigation to include both major marine ecosystems of Thailand: The Gulf of Thailand (in the Pacific Ocean) and the Andaman Sea (in the Indian Ocean). Specifically, the objectives are (i) to determine the species compositions and size variations of *Scylla* species across these two distinct oceanic regions of Thai coastal waters; (ii) to discuss the global distribution patterns of the four *Scylla* species based on our findings and existing literature. The scientific data generated from this research will be valuable for both local and global management of wild mud crab resources and will support the development of sustainable aquaculture practices.

MATERIALS AND METHODS

Study site

Five sampling sites distributed across two oceanic regions along the coasts of Thailand were selected. The sites in the Pacific Ocean region (Gulf of Thailand; GOT) included Pattani (PN), and Songkhla (SK) Provinces, while those in the Indian Ocean region (Andaman Sea; ADM) comprised Satun (ST), Trang (TR), and Ranong (RN) Provinces (Figure 1), therewith highlighting the contrasting biogeographical contexts of each region. The five sampling sites in this study exhibited distinct geographical and ecological features as follows (Table 1). Additionally, all five sites are known as main fishing areas of mud crab in Thailand.

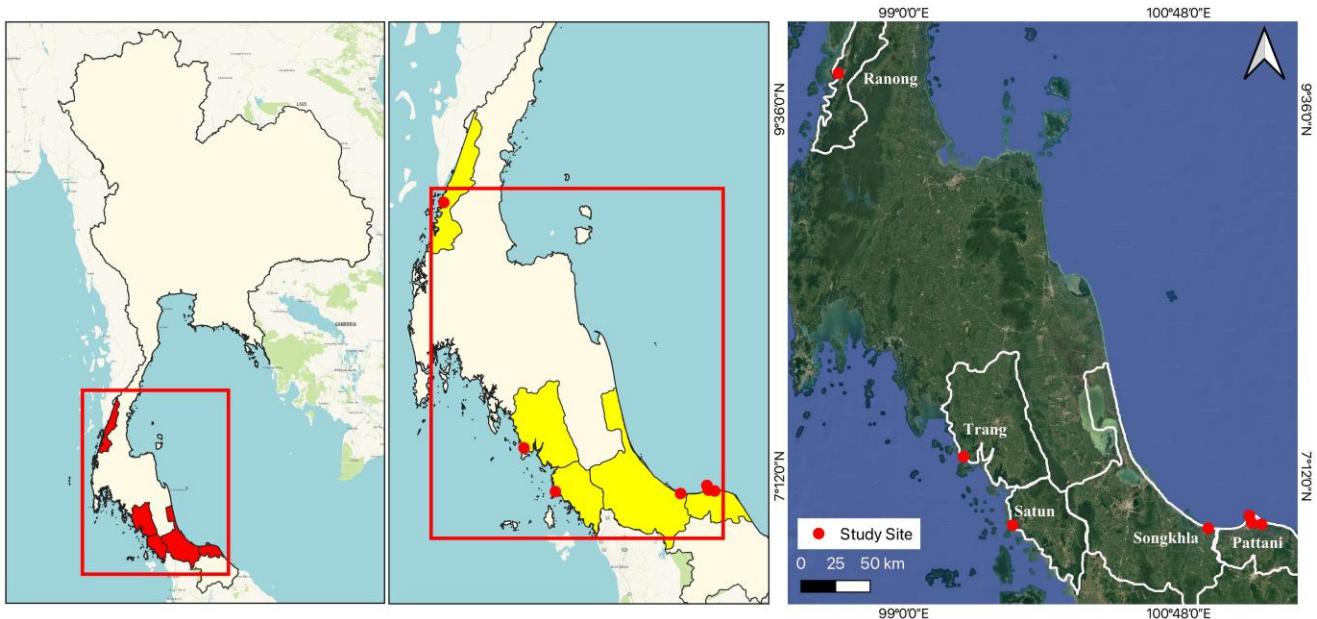


Figure 1. Map showing the study sites located along the Gulf of Thailand in the Pacific Ocean (Pattani and Songkhla) and the Andaman Sea in the Indian Ocean (Satun, Trang, and Ranong)

Table 1. Geographical and ecological features of the five sampling sites in the Gulf of Thailand (GOT: PN: Pattani, SK: Songkhla) and the Andaman Sea (ADM: ST: Satun, TR: Trang, RN: Ranong), collected from June 2022 to June 2023

Site	Coordinates	Geographical and ecological features
PN	6°52'54.6"N 101°17'02.1"E 6°53'13.7"N 101°21'02.8"E 6°56'07.5"N 101°14'45.7"E	The PN site is characterized by extensive mangrove forests, primarily composed of <i>Rhizophora</i> species. It is situated around Pattani Bay, including the estuarine areas of the Yaring and Pattani Rivers, as well as the Laem Tachi Peninsula. The salinity levels in this area are relatively variable due to the influence of freshwater inputs. The bottom sediment is predominantly muddy, with some areas consisting of mud mixed with sand.
SK	6°51'03.3"N 101°01'04.9"E	The SK site features mangrove ecosystems dominated by <i>Rhizophora</i> species and is located in close proximity to open sea areas. As a result, salinity levels are generally high and more stable. The bottom sediment in this region is primarily composed of mud.
ST	6°47'32.1"N 99°50'00.8"E	ST is a large and complex mangrove forest characterized by dense stands of <i>Rhizophora</i> trees and an intricate network of small tidal creeks. The area experiences relatively high salinity levels, and the substrate consists mainly of mud.
TR	7°26'04.0"N 99°30'56.0"E	The TR site is dominated by nipa palm (<i>Nypa fruticans</i>) vegetation and is located near the mouth of a river, adjacent to a brackish water canal. The bottom sediment is largely muddy, reflecting the estuarine influence
RN	9°44'33.6"N 98°33'32.9"E	RN represents one of the largest and most established mangrove areas in the region, with dense <i>Rhizophora</i> and <i>Ceriops decandra</i> . This site serves as an important habitat for mud crab fisheries. The substrate is composed primarily of mud.

Sample collection

A total of 4,116 mud crab specimens representing three species of the genus *Scylla* including *S. olivacea*, *S. paramamosain*, and *S. tranquebarica* (Figure 2) were collected from all study sites. Monthly sampling was conducted from June 2022 to June 2023 using standard crab traps with a mesh size of 2.5-3.0 cm were set in local fishing grounds. Each trap was baited with fish, spaced 10-15 m apart during spring tides. Upon capture, the crabs were anesthetized by immersion in ice water and subsequently frozen to ensure humane euthanasia. All specimens were then transported under controlled conditions to the laboratory at the Fishery Technology Building, Faculty of Science and Technology, Prince of Songkla University, Pattani, Thailand, for species identification and further analysis.

Laboratory analysis

In the laboratory, each crab specimen was individually weighed, and its Carapace Width (CW) was measured using a standard digital vernier caliper (Mitutoyo CD-P8"S 500-753-20) with a precision of 0.01 mm. Body Weight (BW) was recorded using a precision balance (Mettler Toledo PG802-S) with an accuracy of 0.01 g. The mean±SD CW for males and females of the two *Scylla* species were as follows: *Scylla olivacea*, 89.17±15.05 mm for males and 88.73±15.82 mm, for females; *S. Paramamosain*, 104.23±19.69 mm for males and 102.72±20.99 mm for females (Table 4). Similarly, the mean BW values were 165.43±99.29 g for male and 132.37±64.83 g for female *S. olivacea*, and 258.84±164.74 g for male and 199.72±110.89 g for female *S. paramamosain* (Table 4). These measurements established crucial baseline data for subsequent analyses of morphological variation across sexes and species. In this study, three *Scylla* species were identified and classified according to their morphological traits, following the

descriptive frameworks of Keenan et al. (1998), Fazhan et al. (2020), Naim et al. (2020), and Mae et al. (2025).

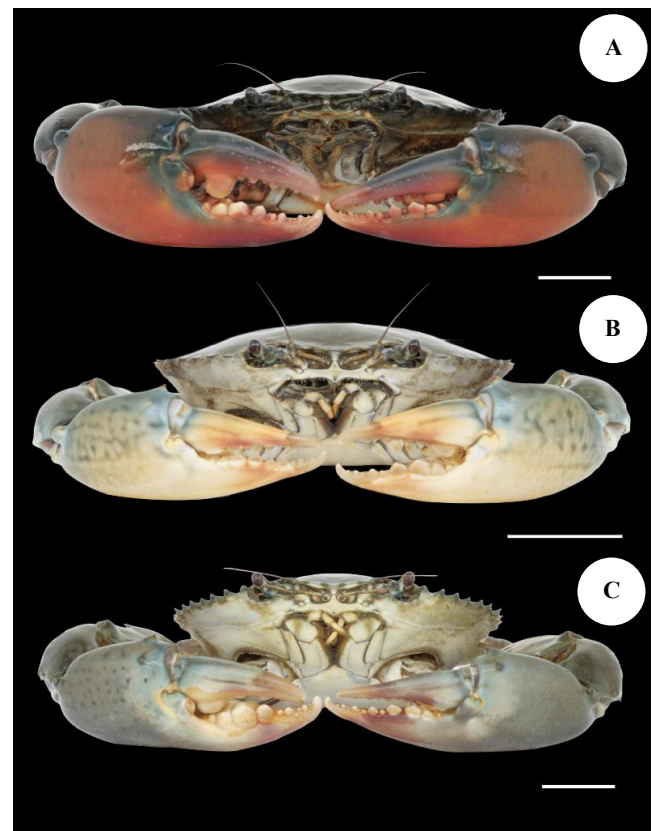


Figure 2. Mud crabs of the genus *Scylla*. A: *Scylla olivacea*, B: *Scylla paramamosain*, C: *Scylla tranquebarica*. Scale bar: 1 cm

Statistical analysis

A one-way Analysis of Variance (ANOVA) was employed to examine differences in Carapace Width (CW) and Body Weight (BW) of *Scylla* spp. across different sites, species, and sexes. Additionally, independent-samples t-tests were conducted to compare CW and BW between populations from the Gulf of Thailand (GOT) and the Andaman Sea (ADM). To address the issue of non-normal data distribution, raw data were log-transformed using the formula $\log(x + 1)$. All statistical analyses were performed using SPSS version 26. When significant differences were detected, Tukey's post hoc test was applied to identify specific group differences. Data are presented as means±Standard Deviation (SD) for size-related variables and as percentages for species composition.

RESULTS AND DISCUSSION

Species composition of *Scylla* spp.

The study on the species distribution of three *Scylla* species in the Gulf of Thailand (GOT) and the Andaman Sea (ADM) revealed that *S. olivacea* was the most predominant species across both regions, accounting for 92.40% of all collected specimens. This was followed by *S. paramamosain* at 6.30%, while *S. tranquebarica* was the least represented, comprising only 1.30% of the total sample (Table 2).

Region-specific analysis confirmed that *S. olivacea* remained the most abundant species in both areas, representing 86.24% of the population in the GOT and as high as 99.40% in the ADM. *Scylla paramamosain* was the second most common species, comprising 11.32% in the GOT but only 0.60% in the ADM. Notably, *S. tranquebarica* was found exclusively in the GOT, where it made up 2.45% of the sample (Table 2).

At a more localized level, species composition varied between sampling sites. In the GOT, the PN site exhibited a higher proportion of *S. olivacea* (88.79%) compared to the SK site (75.13%). In contrast, *S. paramamosain* was more abundant in SK (21.79%) than in PN (8.91%). Interestingly, *S. tranquebarica* was found in PN and SK,

with relatively comparable proportions of 2.30% and 3.08%, respectively (Table 2).

In the ADM, *S. olivacea* maintained a consistently high prevalence across all three sampling sites (RN, ST, and TR) with proportions of 99.88%, 99.38%, and 98.70%, respectively. Among these sites, TR had the highest proportion of *S. paramamosain* (1.30%), followed by ST (0.62%) and RN (0.12%) (Table 2).

Monthly variation in *Scylla* species

A comparative analysis of monthly variation in *Scylla* species composition between the GOT and the ADM from June 2022 to June 2023 revealed distinct temporal patterns (Table 3). In the GOT, *S. olivacea* consistently dominated the species composition the whole year round, with the highest proportions recorded in January (93.81%), April (91.85%), and June (91.02%). The lowest proportion of *S. olivacea* was observed in June (74.83%). *Scylla paramamosain* (SP) displayed an inverse pattern, with its highest occurrence in June (23.18%), followed by February (19.75%) and May (16.00%), while the lowest proportion was recorded in January (4.12%). In contrast, *S. tranquebarica* was present at considerably lower levels compared to *S. olivacea* and SP, with its peak in November (6.42%), followed by June (4.19%) and February (3.70%).

In the ADM, *S. olivacea* was the overwhelmingly dominant species throughout the study period, with most months recording *S. olivacea* as the only species present. *Scylla paramamosain* was detected only in five months, with the highest proportion in April (4.46%), followed by September (1.75%), November (0.94%), December (0.76%), and July (0.59%). Notably, *S. tranquebarica* was not observed in any month in the ADM (Table 3).

Size comparison between the Gulf of Thailand (GOT) and the Andaman Sea (ADM)

A comparative analysis of Carapace Width (CW) and body weight (BW) of *S. olivacea* (SO) between the GOT and the ADM for both sexes revealed notable differences. Overall, the mean CW of males was 89.17±15.05 mm, while that of females was 88.73±15.82 mm. The corresponding BW was 165.43±99.29 g for males and 132.37±64.83 g for females (Table 4).

Table 2. Species composition of *Scylla* spp., including *S. olivacea* (SO), *S. paramamosain* (SP), and *S. tranquebarica* (ST), was assessed in the Gulf of Thailand (GOT: PN: Pattani, SK: Songkhla) and the Andaman Sea (ADM: ST: Satun, TR: Trang, RN: Ranong), based on specimens collected from June 2022 to June 2023 (n: number of samples)

Coasts	Site	SO	SP	ST	Overall
		n (%)	n (%)	n (%)	n
GOT		1798 (86.24)	236 (11.32)	51 (2.45)	2085
	PN	1505 (88.79)	151 (8.91)	39 (2.30)	1695
	SK	293 (75.13)	85 (21.79)	12 (3.08)	390
ADM		1825 (99.40)	11 (0.60)	-	1836
	ST	478 (99.38)	3 (0.62)	-	481
	TR	530 (98.70)	7 (1.30)	-	537
	RN	817 (99.88)	1 (0.12)	-	818
Total		3623 (92.40)	247 (6.30)	51 (1.30)	3921

Table 3. Monthly variations in the occurrence of *Scylla* species, including *S. olivacea* (SO), *S. paramamosain* (SP), and *S. tranquebarica* (ST), were documented in both the Gulf of Thailand (GOT) and the Andaman Sea (ADM) from June 2022 to June 2023 (n: number of samples)

Months	GOT				ADM			
	SO n (%)	SP n (%)	ST n (%)	Overall n	SO n (%)	SP n (%)	ST n (%)	Overall n
June	152 (91.02)	8 (4.79)	7 (4.19)	167	230 (100.00)	0 (0.00)	0 (0.00)	230
July	177 (90.31)	15 (7.65)	4 (2.04)	196	169 (99.41)	1 (0.59)	0 (0.00)	170
August	218 (87.20)	26 (10.40)	6 (2.40)	250	155 (100.00)	0 (0.00)	0 (0.00)	155
September	143 (85.12)	24 (14.29)	1 (0.60)	168	168 (98.25)	3 (1.75)	0 (0.00)	171
October	168 (89.84)	15 (8.02)	4 (2.14)	187	97 (100.00)	0 (0.00)	0 (0.00)	97
November	86 (78.90)	16 (14.68)	7 (6.42)	109	105 (99.06)	1 (0.94)	0 (0.00)	106
December	125 (86.81)	14 (9.72)	5 (3.47)	144	131 (99.24)	1 (0.76)	0 (0.00)	132
January	91 (93.81)	4 (4.12)	2 (2.06)	97	106 (100.00)	0 (0.00)	0 (0.00)	106
February	124 (76.54)	32 (19.75)	6 (3.70)	162	131 (100.00)	0 (0.00)	0 (0.00)	131
March	127 (87.59)	13 (8.97)	5 (3.45)	145	118 (100.00)	0 (0.00)	0 (0.00)	118
April	169 (91.85)	14 (7.61)	1 (0.54)	184	107 (95.54)	5 (4.46)	0 (0.00)	112
May	105 (84.00)	20 (16.00)	0 (0.00)	125	120 (100.00)	0 (0.00)	0 (0.00)	120
June	113 (74.83)	35 (23.18)	3 (1.99)	151	188 (100.00)	0 (0.00)	0 (0.00)	188
Total	1798 (86.24)	236 (11.32)	51 (2.45)	2085	1825 (99.40)	11 (0.60)	0 (0.00)	1836

When comparing regions, both CW and BW of SO individuals from the GOT were consistently higher than those from the ADM across sexes. Results from independent sample t-tests indicated statistically significant differences ($P < 0.001$) between regions for both parameters (Table 4).

Specifically, in the GOT, the average CW for males and females were 93.82 ± 14.37 mm and 93.39 ± 14.61 mm, respectively, with corresponding BW values of 189.66 ± 104.52 g for males and 151.60 ± 64.68 g for females. In contrast, *S. olivacea* individuals from the ADM exhibited smaller average CW, 84.62 ± 14.29 mm in males and 84.11 ± 15.63 mm in females, and lower BW values, with males averaging 141.74 ± 87.69 g and females 113.28 ± 59.11 g (Table 4). Overall, the average CW and BW of *S. paramamosain* (SP) collected from both the GOT and the ADM were 104.23 ± 19.69 mm and 258.84 ± 164.74 g in males and 102.72 ± 20.99 mm and 199.72 ± 110.89 g in females, respectively (Table 4).

In males, the CW and BW values were comparable between regions, with specimens from the GOT showing a CW of 104.98 ± 19.39 mm and BW of 264.32 ± 165.10 g, while those from the ADM had a CW of 85.60 ± 19.62 mm and BW of 122.55 ± 76.33 g. However, t-test analysis result revealed no significant difference between regions for male crab ($P > 0.05$) (Table 4). In contrast, female specimens exhibited statistically significant differences in both CW and BW between the two regions ($P < 0.05$). Females from the GOT had a CW of 104.03 ± 20.74 mm and BW of 206.33 ± 110.33 g, whereas those from the ADM recorded a CW of 79.91 ± 9.21 mm and BW of 84.80 ± 23.68 g (Table 4).

Result of statistical analysis of Carapace Width (CW) and body weight (BW) *Scylla* spp.

ANOVA result revealed statistically significant differences ($P < 0.001$) in Carapace Width (CW) and Body Weight (BW) of *S. olivacea* across sampling sites. The highest mean CW and BW for *S. olivacea* were observed in SK, measuring 98.47 ± 13.30 mm and 198.50 ± 95.87 g,

respectively, followed by PN, with values of 92.67 ± 14.50 mm for CW and 166.06 ± 87.46 g for BW. The smallest mean CW was recorded in Satun (ST) at 83.16 ± 16.29 mm, while the lowest BW was observed in RN at 124.85 ± 65.04 g (Table 5).

Similarly, for *S. paramamosain* (SP), both CW and BW exhibited significant variation among sites ($P < 0.01$). The largest CW was found in ST (106.36 ± 16.00 mm), followed by PN (103.65 ± 21.73 mm). Interestingly, in contrast to the trend observed in *S. olivacea*, the BW of SP in PN (244.61 ± 157.93 g) was slightly higher than that in SK (239.99 ± 134.66 g). Notably, ST continued to show a markedly lower mean CW compared to other locations (Table 5).

The results of the ANOVA analysis revealed significant variation in Carapace Width (CW) and Body Weight (BW) of *S. olivacea* across sampling sites, for both male and female specimens. In the SK site, male crabs exhibited a higher mean CW (97.55 ± 13.50 mm) and BW (217.34 ± 112.07 g) compared to those from PN, which had a mean CW of 93.05 ± 14.43 mm and BW of 183.97 ± 102.05 g. A similar pattern was observed in female crabs, with those from SK showing a larger CW (99.55 ± 13.03 mm) than those from PN (92.26 ± 14.61 mm), as well as a higher BW (176.15 ± 65.81 g in SK vs. 147.10 ± 63.50 g in PN) (Table 5).

Statistical testing confirmed that both CW and BW differed significantly among sites for both sexes, with differences highly significant ($P < 0.001$) (Table 5). The results of the ANOVA analysis revealed no significant differences ($P > 0.05$) in the Carapace Width (CW) of male *S. paramamosain* among sampling sites. Males collected from SK and PN exhibited significantly larger CW, with mean values of 108.44 ± 15.62 mm and 103.33 ± 20.83 mm, respectively, compared to those from TR and ST, which had mean CW of 99.78 ± 0.57 mm and 80.09 ± 25.43 mm, respectively (Table 5). In contrast, no statistically significant differences were observed in the CW of females or in the body weight (BW) of both males and females across the sampling sites ($P > 0.05$) (Table 5).

Table 4. Carapace Width (CW) and Body Weight (BW) of *Scylla olivacea* (SO) and *Scylla paramamosain* (SP) from the Gulf of Thailand (GOT) and the Andaman Sea (ADM) collected between June 2022 to June 2023 (n: number of samples)

SO	Males					Females				
	n	CW (mm)	min-max (mm)	BW (g)	min-max (mm)	n	CW (mm)	min-max (mm)	BW (g)	min-max (mm)
GOT	933	93.82±14.37	50.21-135.08	189.66±104.52	21.48-658.94	865	93.39±14.61	47.58-130.65	151.6±64.68	17.49-414.38
ADM	954	84.62±14.29	48.86-128.29	141.74±87.69	18.62-574.56	871	84.11±15.63	47.57-144	113.28±59.11	16.94-371.35
Overall	1887	89.17±15.05	48.86-135.08	165.43±99.29	18.62-658.94	1736	88.73±15.82	47.57-144	132.37±64.83	16.94-414.38
SP	n	CW	min-max	BW	min-max	n	CW	min-max	BW	min-max
GOT	149	104.98±19.39	44.68-149	264.32±165.1	13.66-732.75	87	104.03±20.74	54.57-146	206.33±110.33	27.19-475.34
ADM	6	85.6±19.62	63.12-109.34	122.55±76.33	43.02-235.78	5	79.91±9.21	67.43-90.81	84.8±23.68	55.22-113.68
Overall	155	104.23±19.69	44.68-149	258.84±164.74	13.66-732.75	92	102.72±20.99	54.57-146	199.72±110.89	27.19-475.34

Table 5. Result of one-way ANOVA analysis for Carapace Width (CW) and Body Weight (BW) between sites (PN: Pattani, SK: Songkhla, ST: Satun, TR: Trang, and RN: Ranong), species, and sexes in *Scylla olivacea* (SO) and *Scylla paramamosain* (SP) collected from June 2022 to June 2023 (n: number of samples)

Site	Species				Sex				
	SO				Males		Females		
	n	CW (mm)	BW (g)	n	CW (mm)	BW (g)	n	CW (mm)	BW (g)
PN	1505	92.67±14.52 ^c	166.06±87.46 ^b	774	93.05±14.43 ^b	183.97±102.05 ^b	731	92.26±14.61 ^c	147.1±63.5 ^b
SK	293	98.47±13.3 ^d	198.5±95.87 ^c	159	97.55±13.5 ^c	217.34±112.07 ^c	134	99.55±13.03 ^d	176.15±65.81 ^c
ST	478	83.16±16.29 ^a	131.67±91.11 ^a	267	84.87±16.6 ^a	152.23±105 ^a	211	81±15.66 ^a	105.66±60.62 ^a
TR	530	86.13±16.65 ^b	130.09±79.08 ^a	252	85.88±14.91 ^a	140.59±88.24 ^a	278	86.36±18.11 ^b	120.57±68.54 ^a
RN	817	83.94±12.7 ^{ab}	124.85±65.04 ^a	435	83.73±12.22 ^a	135.96±74.33 ^a	382	84.19±13.24 ^b	112.19±49.65 ^a
Overall	3623	88.96±15.42	149.59±86.14	1887	89.17±15.05	165.43±99.29	1736	88.73±15.82	132.37±64.83
	SP				Males		Females		
	n	CW (mm)	BW (g)	n	CW (mm)	BW (g)	n	CW (mm)	BW (g)
PN	151	103.65±21.73 ^b	244.61±157.93 ^b	101	103.33±20.83 ^a	258.49±171.05 ^a	50	104.3±23.65 ^a	216.57±124.29 ^a
SK	85	106.36±16 ^b	239.99±134.66 ^b	48	108.44±15.62 ^a	276.61±152.84 ^a	37	103.67±16.31 ^a	192.49±87.81 ^a
ST	4	76.93±21.71 ^a	97.81±92.19 ^a	3	80.09±25.43 ^a	112.01±107.42 ^a	-	-	-
TR	6	88.61±10.18 ^a	115.76±39.69 ^a	2	99.78±0.57 ^a	162.91±7.77 ^a	4	104.3±23.65 ^a	92.19±19.58 ^a
RN	-	-	-	-	-	-	-	-	-
Overall	246	103.79±20.11	237.48±149.46	154	104.43±19.61	260.04±164.59	91	103.11±20.77	201.31±110.45

Discussion

Species compositions and distribution

This study confirmed the presence of three *Scylla* species in both the GOT and ADM, with *S. olivacea* being the most abundant, followed by *S. paramamosain* and *S. tranquebarica*. Spatial variation showed a high dominance of *S. olivacea* in the ADM. These patterns align with Lovatelli et al. (2025). The high abundance of *S. olivacea* may result from its tolerance to low salinity (Keenan et al. 1998) and adaptability to mangroves of varying densities (Putri et al. 2022). In general, mud crabs of the genus *Scylla* can survive in salinities ranging from 5-40 ppt (Shelley and Lovatelli 2011). Distribution is linked to habitat characteristics (Prihadi et al. 2021), supporting this species' dominance.

Studies in the South China Sea, including the GOT, reported similar compositions. The dominance of *S. olivacea* here aligns with Overton and Macintosh (2002) and Fazhan et al. (2017c). However, its relative abundance in Terengganu (54.2%) and Ban Don Bay (52%) was much lower than the 86.24% in this study (Table 6). *Scylla paramamosain* and *S. tranquebarica* were less common, diverging from earlier findings (Keenan et al. 1998; Fazhan et al. 2017a, et al. 2022), which reported *S. tranquebarica* at 26.4% and *S. paramamosain* at 19.4%. Hamasaki et al. (2011) found high *S. paramamosain* prevalence in Ban Don Bay, located in SR. Even though the studies were conducted in the same general region, the sampling occurred nearly a decade apart, indicating that environmental changes may have favored *S. paramamosain*. Other research in Thailand also shows variation: Koolkalya et al. (2016) reported that all three species occurred in similar proportions in Trat Province in the Eastern Gulf of Thailand, whereas Kunsook et al. (2022) observed a dominance of *S. tranquebarica* in Kung Krabaen Bay, Chanthaburi Province, likely due to the high salinity (27.61±16.18 ppt), which is known to favor this species (Fazhan et al. 2022).

The ADM's pattern matches Jirapunpipat et al. (2007), who found 99.76% of crabs captured with traps were *S. olivacea*. In this study, *S. olivacea* accounted for 99.40% across sexes in the ADM: RN (99.88%), ST (99.38%), and TR (98.70%). *Scylla paramamosain* comprised only 0.60%.

Studies in Malaysia consistently report *S. olivacea* as the dominant species, including in the Setiu Wetlands (Ikhwanuddin et al. 2010; Fazhan et al. 2022), the Sematan Mangrove Forest in the Pacific Ocean (Ikhwanuddin et al. 2011), and sites along both coasts of Peninsular Malaysia (Naim et al. 2020). In contrast, the Marudu Mangrove Forest (Pacific Ocean) contained *S. paramamosain* and *S. tranquebarica* in comparable proportions (Fazhan et al. 2021), whereas *S. tranquebarica* predominated in Marudu Bay (Pacific Ocean) (Sharif et al. 2019). Kosuge (2001) reported *S. serrata* as dominant (63%) in the Matang Mangrove Forest (Indian Ocean), although Fazhan et al. (2017b) later suggested these individuals were likely non-native escapees (Figure 3, Table 6).

Sugama and Hutapea (1999) in East Java, Lombok, and South Sulawesi of Indonesian archipelagos found *S.*

olivacea dominant, followed by *S. tranquebarica*. Fanggi et al. (2023) reported *S. olivacea* dominance in East Kalimantan, with *S. paramamosain* and *S. serrata* less common. *S. serrata* was also dominant in Serangan Island (Swasta et al. 2023) and Southeast Maluku (Abrahamsz et al. 2024). All three are near northern Australia, consistent with the known distribution of *S. serrata* in Australian waters (Keenan et al. 1998; Alberts-Hubatsch et al. 2016). In Japan, *S. serrata* was dominant near Iriomote Island (96%) (Ogawa et al. 2011), while *S. paramamosain* dominated in Urado Bay (Ogawa et al. 2012). In Southeast China and Vietnam's Mekong Delta, *S. paramamosain* made up 94% and 97% of samples, respectively (Le Vay et al. 2001; Lin et al. 2007). In the Philippines, *S. tranquebarica* was dominant in some areas (Jumawan et al. 2021), while *S. olivacea* dominated Panay Island and Ibajay, Aklan at 99% and 95% (Walton et al. 2006; Lebata et al. 2007).

In the Indian Ocean, *S. olivacea* dominated Cox's Bazar, Chittagong, and Bagerhat of Bangladesh (>80%) (Asaduzzaman et al. 2021). Indian studies (Mohanty et al. 2006; Mandal et al. 2014) found *S. serrata* dominant in Chilika Lagoon and other areas, with some *S. tranquebarica* presence. However, Balasubramanian et al. (2016) suggested these may have been misidentified *S. serrata*, emphasizing the need for molecular verification.

A geographic pattern emerges: *S. paramamosain* dominates the northern Pacific (Japan, China, and Vietnam), with few *S. olivacea*. Toward the Philippines, *S. olivacea* increases. In South China Sea areas like Thailand, the two species balance. Further south (Malaysia and Indonesia), *S. tranquebarica* is more common, with *S. serrata* appearing near Australia. In the Indian Ocean (Bangladesh and India), *S. serrata* and *S. olivacea* dominate. The high prevalence of *S. olivacea* in the eastern Indian Ocean, including the ADM coast, matches our findings.

Size of crab

Scylla olivacea and *S. paramamosain* from the GOT had significantly larger carapace widths and body weights (males and females) than those from the ADM. This matches findings from the Setiu Wetlands (Ikhwanuddin et al. 2010) and Sematan Mangrove Forest (Ikhwanuddin et al. 2011), suggesting similar growth patterns (Table 7). Smaller sizes in the ADM may result from climate change influencing environmental conditions (Siddik et al. 2016; Scott et al. 2020; Hajisamae et al. 2023) and fishing pressure, which reduces body size (Wiyono and Ihsan 2018). Such pressure can lead to earlier maturation in smaller crabs (Hamasaki et al. 2011; Olson et al. 2018; Mullowney and Baker 2021) due to selective removal of larger individuals, promoting earlier reproduction as a survival strategy.

Though upwelling wasn't directly measured, it affects biological productivity, growth rates, and species distributions (Quintana et al. 2015; Reddin et al. 2015; Vinayachandran et al. 2021; García-Huidobro et al. 2025). It may also explain size differences regionally.

Table 6. The global distribution of mud crabs of the genus *Scylla*, including *S. olivacea* (SO), *S. paramamosain* (SP), *S. tranquebarica* (ST), and *S. serrata* (SS), is presented in comparison with the findings of the present study

Country	Location	SO (%)	SP (%)	ST (%)	SS (%)	References
Japan	Iriomote Island	4	-	-	96	Ogawa et al. (2011)
	Urado Bay	3	74	-	23	Ogawa et al. (2012)
China	Coast of Southeast China	3	94	1	2	Lin et al. (2007)
Vietnam	Mekong Delta	3	97	-	-	Le vay et al. (2001)
Philippines	Panguil Bay	25	-	70	5	Jumawan et al. (2021)
	Panay Island	99	-	1	0	Walton et al. (2006)
Thailand	Ibajay, Aklan	95	-	2	3	Lebata et al. (2007)
	Gulf of Thailand	86	11	2	-	This study*
Thailand	Andaman Sea	99	1	-	-	This study*
	Ban Don Bay, Surat Thani	52	48	-	-	Overton and Macintosh (2002)
Thailand	Ban Don Bay, Surat Thani	13	87	-	-	Hamasaki et al. (2011)
	Kung Krabaen Bay, Chanthaburi	6	30	64	-	Kunsook et al. (2022)
Malaysia	Eastern Gulf of Thailand	34	35	31	-	Koolkalya et al. (2016)
	Setiu Wetland, Terengganu	54	19	26	-	Fazhan et al. (2022)
Malaysia	Setiu Wetland, Terengganu	65	22	13	-	Ikhwanuddin et al. (2010)
	Marudu Mangrove Forest, Sabah	15	39	35	-	Fazhan et al. (2021)
Malaysia	Sematan Mangrove Forest, Sarawak	78	0	22	-	Ikhwanuddin et al. (2011)
	Marudu Bay, Sabah	8	13	78	-	Sharif et al. (2019)
Malaysia	Peninsular Malaysia	55	14	30	-	Naim et al. (2020)
	Matang Mangrove Forest	37	-	-	63	Kosuge (2001)
Indonesia	Serangan Island, Bali	30	-	22	48	Swasta et al. (2023)
	East Java	42	26	32	-	Sugama and Hutapea (1999)
Indonesia	Lombok Island	53	12	35	-	Sugama and Hutapea (1999)
	South Sulawesi	51	22	27	-	Sugama and Hutapea (1999)
Indonesia	East Kalimantan	33	27	13	27	Fanggi et al. (2023)
	Southeast Maluku	44	-	-	56	Abrahamsz et al. (2024)
Bangladesh	Cox's Bazar	80	-	-	20	Asaduzzaman et al. (2021)
	Chittagong	82	-	-	19	Asaduzzaman et al. (2021)
Bangladesh	Bagerhat	86	-	-	14	Asaduzzaman et al. (2021)
	Indian Coastal Waters	43	6	1	50	Mandal et al. (2014)
India	Chilika Lagoon	-	-	18	82	Mohanty et al. (2006)

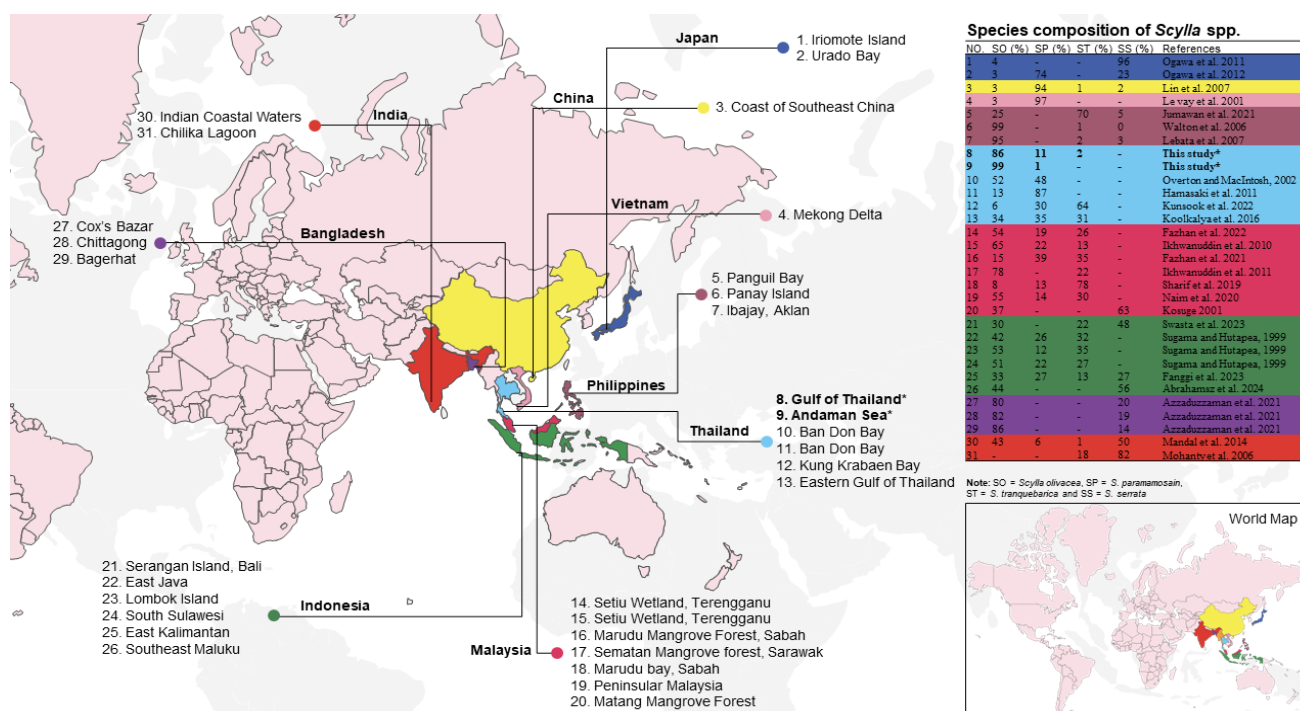


Figure 3. Global distribution map of mud crabs (*Scylla* spp.) in comparison with findings from the present study

Table 7. A comparative analysis of Carapace Width (CW) and Body Weight (BW) in *Scylla* species, including *S. olivacea* (SO), *S. paramamosain* (SP), and *S. tranquebarica* (ST), was conducted based on specimens collected from the Gulf of Thailand (GOT) and the Andaman Sea (ADM) between June 2022 and June 2023. The results were compared with data from previous studies

Species	Location	Females		Males		References
		CW (mm)	BW (g)	CW (mm)	BW (g)	
SO	GOT	93.39±14.61	151.6±64.68	93.82±14.37	189.66±104.52	This study
	ADM	84.11±15.63	113.28±59.11	84.62±14.29	141.74±87.69	This study
SP	GOT	104.03±20.74	206.33±110.33	104.98±19.39	264.32±165.1	This study
	ADM	79.91±9.21	84.8±23.68	85.6±19.62	122.55±76.33	This study
SO	Setiu Wetland	89.00±1.13	111.16±47.90	94.20±1.28	153.97±100.98	Ikhwanuddin et al. (2010)
SP	Setiu Wetland, Terengganu	94.30±1.06	135.27±48.09	93.40±1.45	148.8±96.99	Ikhwanuddin et al. (2010)
ST	Setiu Wetland, Terengganu	93.90±1.05	139.36±46.68	94.70±1.63	153.2±104.74	Ikhwanuddin et al. (2010)
SO	Sematan Mangrove Forest	94.10±1.31	145.78±58.64	92.40±1.2	177.86±95.07	Ikhwanuddin et al. (2011)
ST	Sematan Mangrove Forest	104.80±1.62	191.47±83.17	97.40±1.52	190.53±121.02	Ikhwanuddin et al. (2011)

Commercial fishing also impacts populations. Declines in *Portunus pelagicus* due to fishing (Johnston et al. 2011) and increased *S. olivacea* exploitation in Bangladesh's Sundarban mangroves (Rouf et al. 2021) illustrate this. This study is the first to report size differences (carapace width and body weight) of *S. olivacea* and *S. paramamosain* between the GOT and ADM, providing valuable baseline data for management.

In conclusion, this study demonstrates distinct differences in the distribution and abundance of mud crab species (*Scylla* spp.) between the Gulf of Thailand (GOT) and the Andaman Sea (ADM). The species composition varied notably, with three species (*S. olivacea*, *S. paramamosain*, and *S. tranquebarica*) identified on the GOT side, while only two species (*S. olivacea* and *S. paramamosain*) were found on the ADM side. *Scylla tranquebarica* was restricted to the GOT, and *S. olivacea* was dominant in both regions. Furthermore, the Carapace Width (CW) and Body Weight (BW) of both male and female *S. olivacea*, as well as female *S. paramamosain*, were significantly larger in the GOT population. In contrast, male *S. paramamosain* showed no significant size differences between the two regions. This study provides the first comparative analysis of the distribution, abundance, species composition, and size variation of *Scylla* species between the Indian and Pacific Oceans. The findings offer essential baseline data for population assessment, marine resource management, and aquaculture development, and enhance our ecological understanding of these economically important species. However, to deepen the scientific understanding, future research should focus on investigating environmental factors (such as salinity, habitat complexity, and oceanographic conditions) that may influence species composition and size variation of mud crabs across these two oceanic regions. Such studies would help clarify the underlying ecological drivers of the observed differences and support more effective conservation and fisheries management strategies.

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