

Morphometric, Meristic and Stomach Content Analyses of Selected Finfish and Shellfish Species in Brunei Darussalam

ADRIYANA SYAZWANI¹, MOHAMMAD BODRUL MUNIR*¹, NUR ANNISA SARBINI² & SYAHIRAH SHAHLEHI¹

¹Department of Aquaculture, Faculty of Agriculture, University Islam Sultan Sharif Ali, TB1741 Tutong, Brunei Darussalam; ²Faculty of Islamic Economics and Finance, University Islam Sultan Sharif Ali, TB1741 Tutong, Brunei Darussalam

*Corresponding author: mohammad.munir@unissa.edu.bn

Received: 13 March 2026

Accepted: 22 May 2026

Published: 30 June 2026

ABSTRACT

Brunei Darussalam's location in the Coral Triangle highlights the need for taxonomic baselines to support sustainable fisheries. This study includes baseline morphological, meristic and morphometric data for eight key finfish (*Siganus javus*, *Lutjanus johnii*, *Lutjanus argentimaculatus*, *Lates calcarifer*, *Epinephelus coioides*, *Toxotes jaculatrix*, *Caranx ignobilis* and *Oxyeleotris marmorata*) and five shellfish species (*Scylla olicacea*, *Scylla paramamosain*, *Mierspenaeopsis sculptilis*, *Magallana nippona* and *Penaeus vannamei*) were found in Brunei's marine and brackish waters. Limited diet analysis done through Index of Preponderance (I), revealed crustacean dominance in predatory *Lutjanus* species. Obstacles were encountered in the fish specimen due to rapid digestion, regurgitation, low feeding occurrence prior to capture and complex digestive tract in shellfish. These validate the taxonomic differences of the fish specimens while providing ecological insights. The findings provide baselines for regional monitoring for sustainable fisheries and aquaculture.

Keywords: Meristic, morphology, morphometric, marine and brackish water, stomach content

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INTRODUCTION

The country Brunei Darussalam also known as Brunei has a coastline spanning 161 kilometers (km) bordering the South China Sea (SCS) (Central Intelligence Agency, 2024). The coastal waters of Brunei supports a rich assemblage of finfish from snappers, groupers and jacks (Silvestre *et al.*, 1992). The country features a diverse coastal and estuarine habitat comprising 18,418 hectares (SEAFDEC, 2019). To date, 711 reef fishes, 331 mollusks and 17 stomatopods have been sighted in Brunei's coral reef habitats (The Forestry Department & Ministry of Industry and Primary Resources, 2014). Brunei features over 410 coral species, owing to its involvement as part of the Coral Triangle (CT) initiative, sharing a high diversity of reef habitats amounting over 76% of global coral coverage (Allen, 2009; Tanaka, 2016). Approximately 400 reef associated fish species are found in these areas, underlining the global hotspot for marine biodiversity and conservation efforts (Allen, 2009). The rich ecosystem highlights the importance in protecting the coastal environment

while supporting fishery resources and contributing to species connectivity across the Indo Pacific region.

Freshwater systems intersects with marine ecosystems, as the freshwater from the four main rivers in Brunei (Belait river, Tutong river, Brunei river and Temburong river) drains to the South China Sea and Inner Brunei Bay (IBB) (Thia-Eng *et al.*, 1987; Juanita Joseph *et al.*, 2016). Around 104 freshwater fish species have been recorded in the country (Sulaiman *et al.*, 2018). Marine and brackish water finfish species drive the fisheries production. In 2023, fishery output from capture production amounted 14,444.30 metric tons (MT) and commercial production reached 3,239.30 MT, supporting livelihood, amid Brunei's oil dependent economy (Department of Statistics & Department of Economic Planning and Statistics, 2023). Local fishermen target species such as groupers, snappers, jacks, rabbitfish and Asian seabass, highlighting the reliance of inshore fish resources. Moreover, aquaculture practices in Brunei have become prominent,

specifically for Asian seabass, white leg shrimp, tiger prawn and tilapia. However, wild caught fish species remain favored among the locals.

For decades, ichthyology and fishery science have depended on morphometric and meristic research for identification, classification and management of fish and shellfish populations. These techniques offer dependable and cost effective methods to examine phenotypic variation both within and between species by measuring and counting the external morphological traits (Strauss & Bookstein, 1982). Despite molecular progress, morphometric and meristic analysis remains crucial particularly in developing nations where advanced laboratory infrastructure remains scarce and ongoing inventories are happening (Turan, 2004).

Investigating the diet habit of fish through stomach content analysis provides important information in understanding the trophic relationships among aquatic organisms (Manko, 2016). The feeding habits of fish can vary from being herbivorous, carnivorous, omnivorous, plankton feeding and detritus feeding based on food availability, season and spawning season (Behade & Tantarapale, 2024). Furthermore, information on the food intake of fish species provides insight on predator diets. In this study, the stomach content of finfish was analyzed to understand the food intake and food consumption of each species.

Brunei's finfish face threats from overfishing, habitat degradation, pollution and coastal development. The decline in stock provides a necessary baseline in obtaining morphological data for population delineation. This study addresses these gaps by integrating morphometric, meristic and stomach content analyses of selected finfish species from Brunei's coastal and brackish waters which may aid in distinguishing local populations, predicting responses to exploitation and informing aquaculture brood stock selection.

MATERIALS AND METHODS

Sample Collection

A total of 66 finfish and shellfish specimens were collected with the help of fishermen for this study. Wild samples were collected through

sighting from various sites primarily, Pudak (4.538379, 115.000694), Sungai Damuan (4.856421, 114.900331), Sungai Duwau (4.8406225, 115.0980373), Aloh Besar (4.859101, 115.142562), Sungai Selanjak (4.81667, 115.05) and Sungai Penyatang (4.754528, 114.591275). While a commercial finfish was collected from Syarikat Razky (4.877389, 114.936333). Direct sampling was conducted in sample collection. The fish samples were collected from July 2024 to January 2025 using several traps designed specifically for the fish species of interest in this study. Each specimen was transported in a polystyrene ice box to the Ibnu Sina Scientific Laboratory, Sinaut Campus, Universiti Islam Sultan Sharif Ali and where they were stored at -20 °C.

Morphometric and Meristic Analysis of Finfish

Morphological identification of the species were performed according to the fish identification keys (Mansor *et al.*, 1998). All finfish were identified to species level based on morphological including meristic diagnostic features (Allen, 2009; Seah *et al.*, 2021). A total of 51 morphometric characters of finfish was measured by the methods of Konan *et al.* (2014) and Arain *et al.* (2015). Each specimen was thawed and weighed to the nearest 0.01 g with an electronic weighing balance (Mettler Toledo New Classis MS) and all measurements were taken using digital vernier calipers with an accuracy of 0.01 mm.

Morphometric and Meristic Analysis of Shellfish

Morphological features of shrimps were identified based on Pillai (2022), while meristic analyses were according to Rebello *et al.* (2013). Mud crabs were identified following the descriptions of Keenan *et al.* (1998), Fazhan *et al.* (2020) and Sitorus *et al.* (2023). Meanwhile, oysters were identified according to the methods of Lam & Morton (2009).

Stomach Content Analysis

A subset of ($n = 3 - 4$ individuals per species) underwent stomach content analysis. The specimens underwent morphological assessments prior to the dissection, ensuring the integrated method while minimizing sampling

bias. The analysis was limited to finfish specimens with sufficient stomach content since many displayed empty stomachs due to rapid dissection, regurgitation and low feeding occurrence prior to capture. Shellfish specimens were omitted entirely due to their digestive tracts, small stomach volumes and to ensure reliable comparison. A transverse cut was done at each end of the initial dissection, allowing the exposure of the viscera. The stomach and intestines were removed and separated from the rest of the digestive tract. They were then weighed to the nearest 0.01 g with an electronic weighing balance (Mettler Toledo New Classis MS) and measured to the nearest 0.1 mm using electronic digital calipers according to Natarajan and Jhingran (1961).

Diet Analysis

To assess the dietary composition and relative importance of food items, this study combined the use of both methods to calculate the relative importance of food materials consumed by the fish through calculating the percentage of volume (%Vi) and percentage of occurrence (%Oi) to obtain the index of preponderance (I) (Natarajan & Jhingran, 1961).

RESULTS

The collected specimens of *Signaus javus* (Java rabbitfish) measured 168.00 - 197.00 mm in total length. They exhibited a compressed body with a dorsal color of dark bronze fading to white on the belly. The caudal fin was truncated and blue or grey round spots appeared on the head and dorsal portion, transitioning to ventral lines towards the belly and thorax. The head presented a grey to blue color whereas, the mouth to operculum (gill cover) region had no scales and had a yellow tinge (Figure 1A). Specimens displayed a short, blunt snout, rounded head and a small terminal mouth armed with incisor teeth. Meristic counts for *S. javus* displayed 13 dorsal spine and 10 soft rays. The pelvic fin contained two spines and three soft rays while the pectoral fin had 15 to 16 soft rays. Anal fin spines numbered seven spines with 7 - 10 soft rays. Meanwhile, the caudal fin had 17 - 19 soft rays. Mean measurements were 146.94 ± 13.73 mm for standard length, 182.00 ± 13.34 mm for total length and 101.09 ± 26.79 g for weight.

Specimens of *Lutjanus argentimaculatus* (Mangrove jack) ranged from 343.00 - 394.00 mm in total length. They possessed a fusiform body, a long snout slightly upturned and a triangular head with a large terminal mouth bearing canine teeth (Figure 1B). Coloration shifted from black to brown dorsally to brown-to-red ventrally. The caudal fin was slightly forked to truncate, with 17 soft rays and black pigmentation. Scales displayed black-to-brown centers with whiter margins. The dorsal fin, continuous from the pectoral to anal region, comprised 10 strong spines and 14 soft rays. Pelvic fins had one spine and five soft rays; pectoral fins, 15 - 16 soft rays and red-to-brown hues toward the base; anal fins, typically three spines and 7 - 8 soft rays, brown paling basally. Mean measurements included standard length of 325.67 ± 26.58 mm, total length of 372.00 ± 26.21 mm and weight of 782.67 ± 206.98 g.

Specimens of *Lutjanus johnii* (Golden snapper) measured 149.00 - 227.00 mm in total length. They exhibited a fusiform body, steeply sloped head, terminal mouth slightly concave at the eye and canine teeth (Figure 1C). Dorsal coloration ranged from green to yellow, transitioning to silvery white with a pink tinge ventrally. The caudal fin was slightly forked to truncate, bearing 15 - 18 soft rays. Scales showed brown centers across the body, with a prominent black blotch on the lateral line in the dorsal posterior region. The dorsal fin, continuous, included 10 spines and 13 - 15 soft rays. Pelvic fins had one spine and five soft rays; pectoral fins, 15 - 16 soft rays and yellow pigmentation; anal fins, three spines and 7 - 8 soft rays, yellow at the base fading to pink. Mean measurements were 144.50 ± 30.69 mm for standard length and 174.00 ± 35.80 mm for total length.

Specimens of *Lates calcarifer* (Asian seabass) ranged from 353.00 - 373.00 mm in total length. They featured an elongated fusiform body, concave profile, superior mouth with the lower jaw extending beyond the upper and villiform teeth (Figure 1D). Dorsal coloration was olive brown, fading gradually to silvery white ventrally. The caudal fin was rounded with 17 - 19 soft rays. Scales were ctenoid, with olive-brown centers and white margins. The dorsal fins were separated, comprising 6 - 7 spines and 10 - 12 soft rays. Pelvic fins had one spine and five soft rays; pectoral fins, 17 - 18

soft rays; anal fins, three spines and 8 – 10 soft rays. Mean measurements included standard length of 317.50 ± 7.94 mm, total length of 366.00 ± 8.91 mm and weight of 630.87 ± 43.60 g. Body depth averaged $28.86 \pm 0.67\%$ of standard length at its maximum and $12.58 \pm 0.36\%$ at the caudal peduncle.

Specimens of *Epinephelus coioides* (Orange-spotted grouper) ranged from 229.00 – 282.00 mm in total length. They exhibited a fusiform body, large terminal mouth and straight, pointed head with jaws extending posteriorly past the eye, bearing canine teeth (Figure 1E). The anterior head was olive brown, fading to white ventrally, with orange-to-red round spots scattered across the body. Four to five dark bars ran along the body, terminating at the caudal peduncle. The caudal fin was rounded with 15 – 18 soft rays. A continuous dorsal fin comprised 11 spines and 13 – 16 soft rays. Pelvic fins had one spine and five soft rays; pectoral fins, 17 – 18 soft rays. Mean measurements were $216.00 \pm$

17.78 mm for standard length and 257.75 ± 22.17 mm for total length.

Collected specimens of *Caranx ignobilis* (Giant trevally) measured 267.00 – 333.00 mm in total length. They displayed a compressed body, blunt rounded snout, terminal mouth and canine teeth (Figure 1F). Overall silvery white with a yellow tinge on the head, ventral area and toward the anal fin. The lateral line curved initially above the pectoral fin before straightening toward the caudal fin. The caudal fin was forked with 16 – 20 soft rays; upper lobe grey with black outer margins, lower lobe grey with yellow outer margins. Dorsal fins were separated, with eight spines and 19 – 20 grey soft rays edged in black. Pelvic fins bore five soft rays; pectoral fins, 18 – 20 soft rays; anal fins, two spines and 15 – 17 soft rays, yellow with black tinges. Mean measurements included standard length of 220.67 ± 21.13 mm and total length of 295.33 ± 33.98 mm.

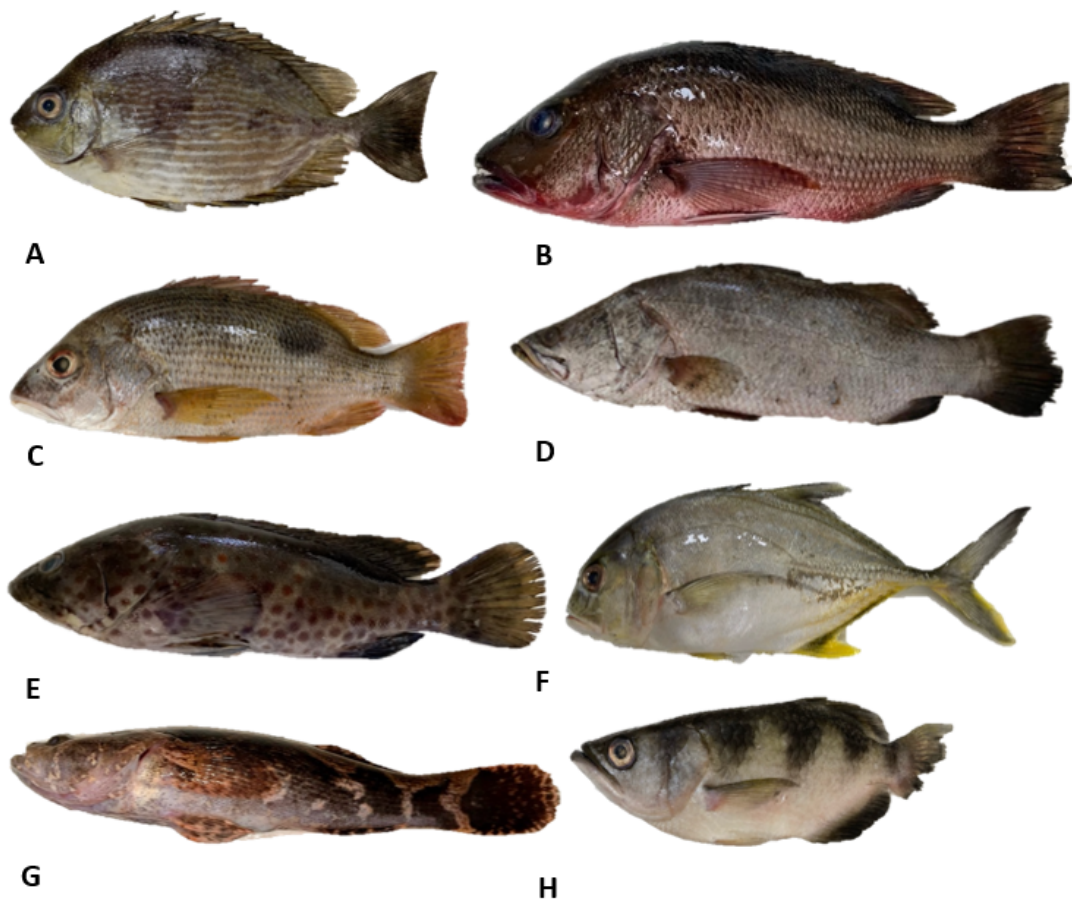


Figure 1. Finfish specimens collected from Brunei's marine and brackish waters. (A) *Siganus javus*, (B) *Lutjanus argentimaculatus*, (C) *Lutjanus johnii*, (D) *Lates calcarifer*, (E) *Epinephelus coioides*, (F) *Caranx ignobilis*, (G) *Oxyeleotris marmorata* and (H) *Toxotes jaculatrix*

Specimens of *Oxyeleotris marmorata* (Marbled goby) ranged from 188.00 – 480.00 mm in total length. They featured a fusiform body and large, terminal, flat head with canine teeth (Figure 1G). Body coloration was black with brown marbling throughout. The caudal fin was rounded, bearing 18 – 21 soft rays. Dorsal fins were separated: the first with six spines, the second with one spine and 9 – 10 soft rays. Pelvic fins had five soft rays; pectoral fins, 15 – 18 soft rays; anal fin, 9 – 10 soft rays. Mean measurements were 257.33 ± 128.38 mm for standard length and 302.67 ± 155.76 mm for total length.

Collected specimens of *Toxotes jaculatrix* (Banded archerfish) measured 154.00 – 237.00

mm in total length. They exhibited a compressed body and flattened, pointed snout (Figure 1H). Coloration was silvery green dorsally and white ventrally, with 4 – 6 dark bands on the dorsum. The caudal fin was truncated (though damaged in most specimens) and bore 16 – 19 soft rays. The dorsal fin was black, with 4 – 5 spines and 11 – 12 soft rays. Pelvic fins had 3 spines and 14 – 17 soft rays; pectoral fins, 11 – 12 soft rays. Mean measurements included standard length of 166.03 ± 32.13 mm and total length of 195.00 ± 33.49 mm.

The meristic counts of finfish specimens collected in the study (Table 1).

Table 1. Meristic counts of finfish

Meristic counts	Fish species							
	<i>Lutjanus argentimaculatus</i>	<i>Siganus javus</i>	<i>Lates calcarifer</i>	<i>Epinephelus coioides</i>	<i>Lutjanus johnii</i>	<i>Caranx ignobilis</i>	<i>Toxotes jaculatrix</i>	<i>Oxyeleotris marmorata</i>
Spine on dorsal fin	10	13	6 – 7	11	10	8	4 – 5	6
Soft rays on dorsal fin	14	10	10 – 12	13 – 16	13 – 15	19 – 20	11 – 12	N/A
Spine on second dorsal fin	N/A							1
Soft rays on second dorsal fin	N/A							9 – 10
Spine on pelvic fin	1	2	1	1	1	0	1	N/A
Soft rays on pelvic fin	5	3	5	5	5	5	4 – 5	5
Spine on pectoral fin	N/A	N/A	0	0	0	0	0	N/A
Soft rays on pectoral fin	15 – 16	15 – 16	15 – 16	17 – 18	15 – 16	18 – 20	11 – 12	15 – 18
Spine on anal fin	3	7	3	3	3	2	3	N/A
Soft rays on anal fin	7 – 8	7 – 9	7 – 8	8 – 10	7 – 8	15 – 17	14 – 17	18 – 21
Soft rays on caudal fin	17	18 – 22	17 – 19	15 – 18	16 – 17	16 – 20	16 – 19	75 – 81
Lateral line scales	46 – 50	157 – 180	63 – 65	110 – 135	50 – 54	150 – 170	33 – 40	N/A
Scale rows above lateral line	4	22 – 30	3	7 – 10	3 – 5	10 – 14	4	N/A
Scale rows below lateral line	6	79 – 120	6	13 – 20	8 – 11	30 – 34	8 – 10	N/A

N/A is shown when the fish specimen does not possess the meristic counts

Specimens of *Penaeus vannamei* (Whiteleg shrimp) showed a laterally compressed, elongated body (Figure 2A), with lengths of 109 – 116 mm. The cephalothorax had a straight, moderately long rostrum with 7 – 8 dorsal spines, two ventral spines and four carapace spines. Two pairs of translucent antennae (with red or black spots) extended anteriorly: antennules (two segments) and antennae (one segment). The

translucent white to blue abdomen had six segments with small blue spots. Faintly blue pereopods (10) and pleopods (10) had yellow bases; the tail (one telson, four uropodal fans) showed a pink posterior tinge.

Specimens of *Mierspenaeopsis sculptilis* (Figure 2B) measured 73 – 114 mm in total length. The cephalothorax had a sigmoidal

rostrum with 8 – 9 dorsal spines (none ventral) and a carapace with four spines (two per side). Two pairs of elongated antennae extended anteriorly: red antennular flagellum (two segments) and black antennal flagellum (one

segment). The pale abdomen had six segments with black or brown transverse bands extending to the uropod. Pink or red pereopods (10) and pleopods (10) showed yellow bases; the tail included one telson and four uropodal fans.



Figure 2. Shellfish specimens collected from Brunei's marine and brackish waters. (A) *Penaeus vannamei*, (B) *Mierspenaeopsis sculptilis*

Scylla olivacea (orange mud crab) specimens had a carapace width of 103.28 ± 0.75 mm, colored brown to brownish green, with an oval and smooth carapace (Figure 3A). Each had six frontal margin spines; anterolateral margins featured 18 spines total (nine per side). Frontal lobe spines were rounded and moderate. Chelipeds showed reduced outer carpus spine (inner absent), reduced inner or outer propodus spines and brown to orange coloration; no polygonal leg patterns. The 4th walking leg and 5th pereopod had segments; chelipeds had five segments. Eyes present; some missing limbs.

Scylla paramamosain (green mud crab) specimens had a carapace width of $108. \pm 9.36$ mm, colored brown to brownish green (Figure 3B). Each had six frontal margin spines; anterolateral margins featured 18 spines total (nine per side). The frontal spines were triangular and tall. Chelipeds showed prominent outer carpus spine (inner absent), prominent inner/outer propodus spines and brownish green color with black polygonal patterns. Polygonal patterns on all legs; 5th pereopod weakened. The 4th walking leg and 5th pereopod had segments; chelipeds had five segments. Eyes present; some missing limbs.

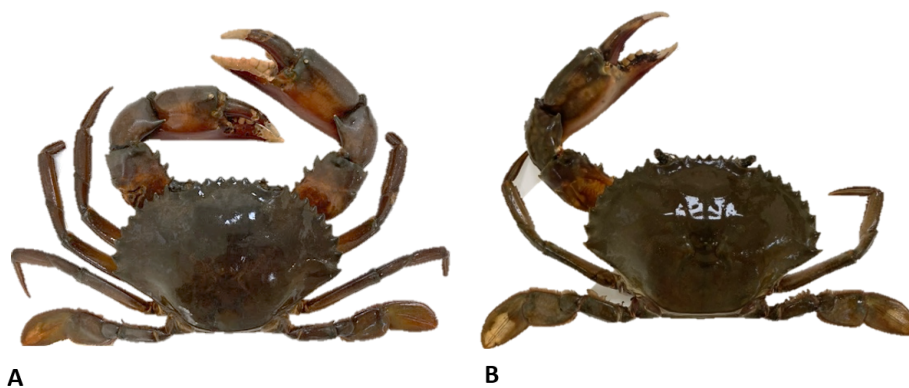


Figure 3. Shellfish specimens collected from Brunei's marine and brackish waters. (A) *Scylla olivacea*, (B) *Scylla paramamosain*

Magallana nippona (Iwagaki oyster) specimens measured 98 – 175 mm in total length (mean shell length 137.23 mm; max 175 mm), with large, often ovate valves (Figure 4). The

lower valve was cupped, upper flatter; exterior rough, green or brown with white umbo. Interior smooth, white; adductor scar white, sometimes outlined black.



Figure 4. *Magallana nippona* specimens collected from Brunei's marine and brackish waters

Finfish stomach content analysis. This investigation revealed five finfish species which represented four families which are represented in (Table 2). These included the Toxotidae (Banded archerfish *T. jaculatrix*), Lutjanidae

(Mangrove jack *L. argentimaculatus* and Golden snapper *L. johnii*), Siganidae (Java rabbitfish *S. javus*) and Carangidae (Giant trevally *C. ignobilis*).

Table 2. Species composition of the finfish samples and the number of stomachs investigated for each species

Scientific name	No. of stomach	Standard length range (mm)	Length of stomach (mm)	Weight of stomach (g)	Length of intestine (mm)	Weight of intestine (g)
<i>Toxotes jaculatrix</i>	4	170.00 – 207.00	20.16	2.61	108.72	1.31
<i>Lutjanus argentimaculatus</i>	3	295.00 – 342.00	63.04	8.65	195.66	5.40
<i>Siganus javus</i>	3	134.96 – 166.00	84.17	3.18	300.04	3.86
<i>Caranx ignobilis</i>	3	207.00 – 245.00	57.41	18.10	104.78	1.22
<i>Lutjanus johnii</i>	3	123.00 – 190.00	31.67	2.74	94.54	1.26

The analysis on food and feeding of selected finfish from this study was ranked through grading the various food items found in the stomach content of the finfishes. The percentage composition through percentage of occurrence (Oi), percentage of volume (Vi), along with the

Index of preponderance (I) are given in (Table 3). The stomach content evaluated from the five finfish species revealed the food items found in the gut consisted of crustaceans, shrimps, insects, fishes, plants and miscellaneous unidentified matter categories.

Table 3. Gut content metrics of the finfish investigated in this study

Fish sample	Food item	Percentage of Occurrence (Oi)	Percentage of volume (Vi)	ViOi	Index of Preponderance (I)	Grade
<i>Toxotes jaculatrix</i>	crustaceans	66.67%	47.62%	3174.62	64.52%	I
	shrimp	33.33%	33.33%	1111.09	22.58%	II
	miscellaneous	33.33%	9.52%	317.46	6.45%	III
	insects	33.33%	9.52%	317.46	6.45%	III
<i>Lutjanus argentimaculatus</i>	crustaceans	33.33%	50.00%	1666.65	50.00%	I
	fishes	33.33%	50.00%	1666.65	50.00%	I
	miscellaneous	33.33%	0.00%	0.00	0.00%	II
<i>Siganus javus</i>	crustaceans	100.00%	100.00%	10000.00	100.00%	I
	plants	100.00%	0.00%	0.00	0.00%	II
	miscellaneous	33.33%	0.00%	0.00	0.00%	II
<i>Caranx ignobilis</i>	fishes	66.67%	31.70%	2113.08	23.63%	II
	shrimp	100.00%	68.30%	6830.40	76.37%	I
<i>Lutjanus johnii</i>	crustaceans	66.67%	90.00%	6000.03	94.74%	I
	fishes	33.33%	10.00%	333.33	5.26%	II

DISCUSSION

Morphological, meristic and morphometric analyses are essential methods for species identification, stock discrimination and ecological interpretation (Strauss & Bond, 1990; Cadrin, 2000). These traditional methods offer a cost effective way of evaluating biodiversity and population structure. Variations in body shape and fin ray counts provide vital information in supporting precise taxonomic resolution and ecological interpretation. The morphological descriptions, meristic counts, morphometric measurements and stomach content analysis of selected finfish species from Brunei's marine and brackish waters provide critical baselines for taxonomy, ecology and fisheries management particularly in the Coral Triangle region. Prior research has shown that fish body shape and fin morphology are closely related in enabling movement (Webb, 1984; Wainwright & Bellwood, 2002). The morphometric ranges and mean values found in this investigation, generally match previous descriptions for the selected finfish species, confirm the taxonomic validity and proper identification of the investigated specimens while revealing subtle variations in local finfish species (Strauss & Bookstein, 1982; Allen & Talbot, 1985; Froese & Pauly, 2024).

In *Siganus javus* specimens, the results reported laterally compressed bodies with dark bronze dorsal coloration grading to white ventrally, truncate caudal fins and blue to grey spots while align with prior studies (Burhanuddin *et al.*, 2014; Al-Faisal *et al.*, 2019; Suwarni *et al.*, 2020). The meristic counts found in this study, especially the anal fin configuration (7–10) and dorsal fin (10), are within documented limits for *S. javus* populations in Southeast Asia (Suwarni *et al.*, 2020). This fish assemblage are able to navigate complex mangroves and seagrass beds due to its high body depth relative to standard length (Wainwright & Bellwood, 2002).

The *Lutjanus argentimaculatus* reported fusiform bodies, upturned snouts and large terminal mouths with canines, presenting similar features to ambush predator finfish (Allen, 2009; Sheaves, 2009; Chi & True, 2018). The stomach contents revealed a similar majority from crustaceans and fishes which reflects the fish as an opportunistic carnivorous. Meristic

characteristics of dorsal fin spines and soft rays (14), as well as anal fin (7–8), are fairly similar to reports from Australian and Southeast Asian populations (Allen & Talbot, 1985). The large mean body size observed in this study shows that Brunei's mangrove and estuarine systems serve as ideal nursery and growth habitats for this species (Russell *et al.*, 2003).

The *L. johnii* displayed fusiform bodies with steep heads, green to yellow dorsal to silvery to pink in the ventral portion, presence of a black spot on the lateral line presents similar findings to *L. johnii* found in Borneo (Allen, 2009). However, the observed diversity in body color of greenish yellow dorsally to silvery ventral regions may be influenced by estuary turbidity (Feitosa *et al.*, 2012). Meristic counts, especially those of soft rays (13–15) and dorsal fin spines, were similar to those seen in waters across Asia, Africa and the Middle East (Choure *et al.*, 2025).

The Asian seabass *Lates calcarifer* presented elongated fusiform bodies, superior mouths with protruding lower jaws and olive to silvery gradients which presents hallmarks for predators (Moore, 1982; Jerry, 2013). Meristic counts in this study are consistent with those reported from Australian and Southeast Asian populations (Moore, 1982).

The orange spotted grouper *Epinephelus coioides* featured robust fusiform bodies, large terminal mouths and olive brown head with orange spots and dark bars, reflecting its benthic ambush predator nature (Heemstra & Randall, 1993). Meristic features, such as dorsal fin spines and soft rays (13–16) were similar to previous reports (Heemstra & Randall, 1993).

The *Caranx ignobilis* presented compressed bodies, blunt snouts and curved to straight lateral lines, with silvery to yellow hues and forked caudal fin, enabling highly speed mobility (Smith-Vaniz, 1984). The results reflect previous studies with a small variance in fin ray counts which may be due to intraspecific variability observed in pelagic species (Turan, 2004).

The marbled goby *Oxyeleotris marmorata* exhibited fusiform bodies and marbled black to brown patterns with rounded caudal fins which are specialized predatory mechanisms to aim prey from the surface (Rainboth, 1996). The

varying range of morphometric values obtained may be related to sexual dimorphism and ontogenetic alterations, which are common in gobiid fishes (Aini *et al.*, 2020).

The *Toxotes jaculatrix*, exhibited compressed bodies, flattened snouts and four to six dark bands across the body, enabling specialized predatory mechanisms by spitting water towards their prey found on the surface (Schuster *et al.*, 2004).

The whiteleg shrimp *Penaeus vannamei*, exhibited lower morphometric variability than *Mierspenaeopsis sculptilis*, likely due to its farmed origin and selective breeding (FAO, 2020). Its straight rostrum (dorsal or ventral spines), translucent body and uniform appendages match published descriptions (Perez Farfante & Kensley, 1997). The reduced carapace or segment length diversity reflects controlled culture conditions, even in brackish waters, aligning with studies on farmed penaeid uniformity (Dimmock *et al.*, 2004).

Specimens of *M. sculptilis* features banded abdomen and sigmoidal rostrum with dorsal spines only, that matches with Indo Pacific penaeid descriptions (Perez Farfante & Kensley, 1997) however, the dark bands initially suggested *Penaeus monodon* (tiger shrimp), but absent ventral rostral spines confirm distinction. In variable brackish habitats where salinity levels fluctuate, morphometric traits in body/rostrum/carapace lengths likely reflect seasonal salinity or food changes (Dall *et al.*, 1990).

This study validates external morphology for distinguishing *Scylla olivacea* and *Scylla paramamosain* in Brunei brackish waters, via frontal lobe shape, cheliped spines and leg patterns (Keenan *et al.*, 1998; Naim *et al.*, 2020). *S. olivacea* shows reduced cheliped spines, rounded/high frontal spines and no leg polygons, matching Southeast Asian mangrove reports (Keenan *et al.*, 1998; Ng *et al.*, 2008). Meanwhile, *S. paramamosain* has leg polygons (weakened on 5th pereopod), prominent outer carpus/propodus spines and triangular/high frontal spines (Keenan *et al.*, 1998; Ikhwanuddin *et al.*, 2011). Both share six frontal and nine anterolateral spines per side, conserving genus-level traits amid ecological divergence (Ng *et al.*, 2008). Stronger *S. paramamosain* spines link to

aggression and firmer substrates (Fazhan *et al.*, 2020). *S. paramamosain* exceeded *S. olivacea* in mean carapace widths (internal/posterior), correlating with higher fecundity and growth (Ikhwanuddin *et al.*, 2011). Larger frontal spine heights reflect stable triangular lobes; *S. olivacea*'s variability suggests salinity or sediment plasticity species (Fazhan *et al.*, 2020; Naim *et al.*, 2020). Cheliped and propodus variations stem from differences in sex, molt cycles, or injury induced regeneration, with limb loss complicating wild measurements (Hartnoll, 1982). Therefore, sample sizes of over 30 and autotomy indices for robust morphometrics are required to underscore mud crab identification.

Magallana nippona oysters presented large shells with deeply cupped lower valves and flatter upper ones, matching previous descriptions (Lam & Morton, 2003). Rough green to brown exteriors, white smooth interiors and distinct adductor scars aid identification. Morphometrics revealed high variability in shell length, width, height, thickness which are typical for dynamic brackish habitats influenced by substrate, flow, food and density (Galtsoff, 1964; Gosling, 2015). The broad size range indicates mixed ages and Brunei's location for suitable growth. Shell or meat weight ratios reflect reproductive or seasonal feeding status (Beninger & Lucas, 1985), informing population health and aquaculture potential.

Individual body proportion differences were evident, despite matching published species descriptions, likely due to phenotypic plasticity from salinity, food, flow and habitat complexity in tropical fishes (Castillo-Rivera *et al.*, 2002; Sheaves, 2009). Brunei's estuarine-coastal species like *L. argentimaculatus* show adaptive growth across mangroves, estuaries, or coastlines suggesting environmental response (Sheaves, 2009). This study's morphometric and meristic baselines aid Brunei's fisheries monitoring, catch and regulations (Cadrin *et al.*, 2013).

The Index of Preponderance (I), graded the diets of *Lutjanidae*, *Carangidae*, *Siganidae*, *Toxotidae* main food category as crustaceans or shrimps, reflecting their productivity in obtaining food in mangrove habitats (Kiso & Mahyam, 2003; Goutham-Bharathi *et al.*, 2013, 2013; Chi & True, 2018; Fernandes *et al.*, 2021; Valle-Lopez *et al.*, 2021; K. O. & Sokari, 2024).

Java rabbitfish's 100% crustacean I, deviates from herbivory norms of (Perpetua *et al.*, 2013; Metar *et al.*, 2020).

Shellfish stomach content analysis was excluded from this study due to significant methodological limitations. Unlike finfish, which typically feature well defined stomachs, shellfish species possess highly specialized and fragmented digestive systems. Additionally, stomach content analysis could not be conducted on specimens of *E. coioides* (orange-spotted grouper), *L. calcarifer* (Asian seabass) and *O. marmorata* (marbled goby) due to inadequate gut contents. The majority of specimens exhibited empty or near empty stomachs which may be due to rapid digestion rates or minimal feeding activity before capture (Mohammadi *et al.*, 2007; Hasan *et al.*, 2026). Freezing as a preservation method likely intensified this issue, where partially digested stomach contents may have been degraded. These constraints underscore the value of complementary non dietary methods for species identification and ecological insights, consisting of morphological assessments and integration of DNA barcoding.

Brunei's contribution to the Coral Triangle initiative highlights the importance of obtaining a morphometric library of finfish species found locally to prevent illegal, unreported and unregulated (IUU) mislabeling (Kroetz *et al.*, 2020). The data obtained on the diets of selected species specifically, *Lutjanidae* provides data on their relation from mangrove to reef habitat which may give insight to accumulation of fine sediment in water bodies, reflecting degraded aquatic ecosystems.

CONCLUSION

This study addresses morphological, meristic, morphometric and stomach content analyses in validating the taxonomy of key finfish and shellfish species from Brunei's marine and brackish waters. It also reveals local phenotypic differences associated with habitat complexity in the Coral Triangle. The feeding habit highlights crustaceans as a dominance in predatory fish from the *Lutjanus* genus, emphasizing the mangroves' abundance and productivity. The modest sample sizes per species limited the sensitivity of this study. Challenges encountered in the stomach content analysis due to rapid digestion, regurgitation and complex shellfish

digestive tract. Further research should include a larger sample size and assess the stomach content of fish species through DNA barcoding to obtain a more accurate result.

ACKNOWLEDGEMENTS

We would like to thank the Aquaculture Program in the Faculty of Agriculture at Universiti Islam Sultan Sharif Ali (UNISSA), TB1741 Tutong, Brunei Darussalam, for authorizing GRA under research project reference UNISSA/CRP0024.

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