



Species Diversity and Community Structure of Crabs (Decapoda: Brachyura) at Jumiang Beach, Pamekasan Regency, Madura

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ABSTRACT

Crabs (Decapoda: Brachyura) play important ecological roles in coastal and intertidal ecosystems; however, information on crab diversity at Jumiang Beach, Pamekasan Regency, Madura, is still unavailable. Increasing tourism and coastal development activities may threaten intertidal habitats and biodiversity. This study aimed to identify crab species and evaluate the community structure of brachyuran crabs at Jumiang Beach based on diversity, evenness, and dominance indices. Sampling was conducted at three stations using direct collection and substrate excavation within 1×1 m quadrats along 10×10 m line transects. Specimens were preserved in 70% ethanol and identified morphologically using taxonomic references. Community structure was analysed using the Shannon-Wiener diversity index (H'), Pielou's evenness index (E), and Simpson's dominance index (D). A total of 286 individuals representing seven species and seven families were recorded, including *Tubuca dussumieri*, *Thalamita spinimana*, *Nanosesarma batavicum*, *Macrophthalmus latifrons*, *Scopimera globosa*, *Mictyris longicarpus*, and *Ashtoret lunaris*. The community showed moderate diversity ($H' = 1.72$), high evenness ($E = 0.88$), and low dominance ($D = 0.20$). *Scopimera globosa* was the most abundant species (28.67%). The presence of Macrophthalmidae and Sesarmidae represents new records for the Madura coastal region. These findings highlight the importance of baseline biodiversity surveys for sustainable coastal management.

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INTRODUCTION

Crabs (Decapoda: Brachyura) occupy a central position in coastal food webs, functioning as bioturbators, detritivores, and prey for higher trophic levels. Their burrowing activities redistribute sediment nutrients and increase soil aeration, thereby sustaining the productivity of intertidal and mangrove ecosystems (Amin et al., 2021). The presence and composition of brachyuran assemblages are sensitive indicators of habitat quality, making taxonomic inventories an essential component of coastal biodiversity monitoring (Eprilurahman et al., 2015).

Indonesia holds one of the highest levels of marine biodiversity in the world, yet systematic surveys of brachyuran crabs remain geographically uneven. Studies published in Indonesian biodiversity journals have documented crustacean diversity in mangrove habitats across Bangka Belitung (Raniah et al., 2022), the intertidal flats of the Madura Strait (Rakmawati & Ambarwati, 2020), and brachyuran crab dominance in the intertidal zone of Lamongan, East Java (Khosyi' & Andriani, 2023). These works collectively highlight the value of morphology-based species inventories combined with community-index analyses as a baseline for local conservation planning. The integration of morphological identification with downstream molecular methods has also been demonstrated for aquatic fauna from East Java (Rabbani et al., 2025), pointing toward a promising research trajectory for brachyuran taxonomy in the region.

Jumiang Beach, located in the southern part of Pamekasan Regency on Madura Island, East Java, Indonesia, offers a heterogeneous coastal landscape comprising estuarine mudflats, sandy intertidal zones, and remnant mangrove patches. Previous biodiversity assessments at this site have focused on molluscs and benthic invertebrates (Rahmasari et al., 2015; Hotimah & Yusa, 2023), while crab assemblages have not been systematically surveyed. Comparative studies across other beaches on Madura Island, Barung Toraja Beach in Sumenep (Nafiah & Purnomo, 2019), Camplong Beach in Sampang (Adhani et al., 2018), Pangpajung Beach in Bangkalan (Subono, 2016), South Coast Beach in Bangkalan (Nur & Kuntjoro, 2021) and Kamal Beach in Bangkalan (Aisyah et al., 2023) have recorded five families (Dotillidae, Portunidae, Mictyridae, Matutidae, and Ocypodidae), but the diversity of families such as Macrophthalmidae and Sesarmidae in the coastal zone of the island remains undocumented.

Coastal urbanisation, high tourism pressure, and unregulated extraction of aquatic organisms pose increasing threats to intertidal crab populations (Jawale, 2024; Bhuyan et al., 2025). Jumiang Beach receives substantial tourist traffic, yet remains without a faunal baseline for crabs, a gap that impedes evidence-based management. Without species-level data, declines in sensitive taxa such as endemic or habitat-specific crabs cannot be detected, and conservation interventions cannot be prioritised (Untung, 2021).

However, to date, no published study has documented the brachyuran community at Jumiang Beach, Pamekasan. This study therefore aims to (i) identify the species of Brachyura present at Jumiang Beach through morphological examination, (ii) quantify community structure using the Shannon-Wiener diversity, Pielou's evenness, and Simpson's dominance indices, and (iii) compare crab family-level diversity with adjacent beaches on Madura Island. The findings contribute new distributional records for two families Macrophthalmidae and Sesarmidae, that previously not reported from the Madura coast, and provide baseline data to support sustainable coastal management aligned with SDG 14 (Life Below Water) and SDG 15 (Life on Land).

MATERIALS AND METHODS

Study Area

Field sampling was conducted at Jumiang Beach, Pamekasan Regency, Madura, East Java, Indonesia (Figure 1). The beach occupies the southern coast of Pamekasan Regency and encompasses distinct habitat types: estuarine mudflats in the eastern stretch and sandy intertidal flats toward the western section. Three fixed sampling stations were established: Station 1 (7°14'05.87" S, 113°32'30.14" E) on muddy substrate associated with estuarine influence; Station 2 (7°14'04.00" S, 113°32'32.80" E) on sandy substrate; and Station 3 (7°13'38.14" S, 113°29'53.38" E) on sandy substrate exposed to wave action. Crab samples were collected during two separate field-sampling sessions in 2024, each within a 90–120 min low-tide window.

Specimen Collection and Preservation

At each station, four 1 × 1 m quadrats were randomly placed within a 10 × 10 m belt transect perpendicular to the waterline, giving a total of 12 quadrats per sampling session (Figure 1). Field sampling was conducted in two separate sessions, resulting in a cumulative sampling effort of 24 quadrat observations. New quadrats were randomly placed during each session; thus, the same quadrats were not repeatedly sampled. Crabs were collected by (i) direct hand capture using nitrile

gloves, and (ii) substrate excavation to a depth of 5 cm with a small trowel. This combined hand-capture and excavation approach is consistent with field-sampling techniques commonly applied for intertidal and mangrove-associated crabs, as described by Macintosh et al. (2002). Excavated substrate was examined on-site for buried individuals. Collected specimens were rinsed with running water to remove sediment, then individually placed in 50 mL polypropylene tubes containing 70% ethanol for preservation and transport to the Taxonomy Laboratory, Faculty of Mathematics and Natural Sciences, Universitas Negeri Surabaya (UNESA). Specimens were deposited in the UNESA Biology Reference Collection.

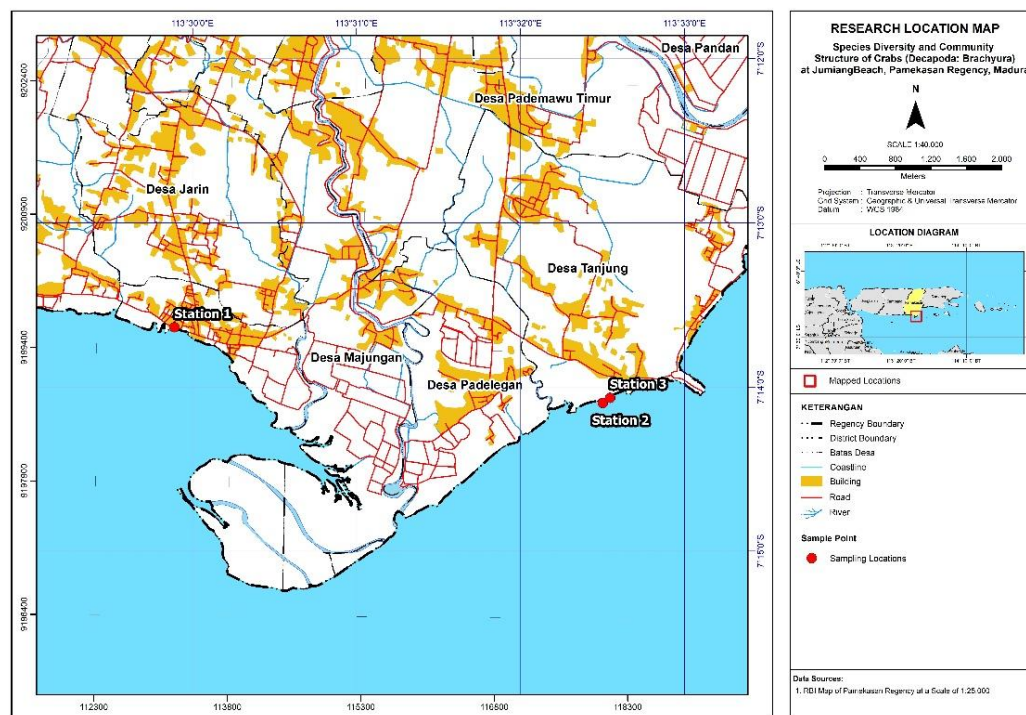


Figure 1. Sampling-location map of Jumiang Beach, Pamekasan Regency, Madura, showing Stations 1–3 with coordinate labels, scale bar, and north arrow. Produced by the authors using QGIS 3.34.]

Morphological Identification

Specimens were identified to species level using the following primary references: (i) Poore & Ah Yong (2023), *Marine Decapod Crustacea of Southern Australia*; (ii) Ng (1998), FAO species identification guide for fishery purposes (Vol. 2, Western Central Pacific); and (iii) peer-reviewed literature specific to each family (Padate et al., 2022; Wong et al., 2010; Widyastuti, 2018). Taxonomic nomenclature follows the World Register of Marine Species (WoRMS; <https://www.marinespecies.org>). Morphological characters recorded for each specimen included carapace shape, carapace width and length (digital callipers, ± 0.1 mm), carapace surface texture, coloration pattern, number and structure of chelipeds, pereopod morphology, anterolateral tooth number, frontal margin structure, and abdominal shape (for sex determination). Photographs of each specimen were taken under standardized lighting conditions.

Data Analysis

Species abundance per station was compiled to calculate three community indices. The Shannon-Wiener diversity index (H') was calculated as:

$$H' = -\sum (n_i/N) \ln(n_i/N) \quad (1)$$

where n_i is the number of individuals of species i and N is the total number of individuals (Odum, 1993). H' values are interpreted as: $H' < 1$ — low diversity; $1 \leq H' < 3$ — moderate diversity;

$H' \geq 3$ — high diversity (Basyuni et al., 2021). Pielou's evenness index (E) was calculated as $E = H'/\ln(S)$, where S is the number of species (Putra et al., 2015). E values range from 0 (maximally uneven) to 1 (perfectly even). Simpson's dominance index (D) was calculated as $D = \sum(n_i/N)^2$ with values classified as low ($D < 0.30$), moderate (0.31–0.60), or high ($D > 0.61$) (Bakus, 2007). All calculations were verified using Microsoft Excel 365.

Ethical Approval

This study did not require ethical approval because it did not involve human participants or vertebrate animals. All crab specimens were collected under Research Permit No. [2317/L/2025]. Standard taxonomic collection protocols were followed to minimize disturbance to the natural habitat.

RESULTS AND DISCUSSION

Species Composition and Distribution

A total of 286 individuals from seven species representing seven families were recorded across three stations and seven sampling months (Table 1). All seven species belong to the infraorder Brachyura and collectively span the terrestrial-to-marine gradient of the intertidal zone. Estuarine associated species (Station 1) included *Tubuca dussumieri*, *Nanosesarma batavicum*, and *Macrophthalmus latifrons*, whereas open sandy-shore taxa (Stations 2–3) were represented by *Scopimera globosa*, *Mictyris longicarpus*, and *Ashtoret lunaris*. *Thalamita spinimana* was exclusively recorded at Station 3 (Table 1).

Table 1. Crab species recorded at Jumiang Beach, Pamekasan Regency, Madura, with family, primary habitat zone, and distribution by station

No.	Species	Family	Habitat Zone	St. 1	St. 2	St. 3
1	<i>Tubuca dussumieri</i> (H. Milne Edwards, 1852)	Ocypodidae	Estuarine mudflat	+	–	–
2	<i>Thalamita spinimana</i> (Dana, 1852)	Portunidae	Rocky/sandy subtidal	–	–	+
3	<i>Nanosesarma batavicum</i> (Moreira, 1903)	Sesarmidae	Mangrove fringe	+	–	–
4	<i>Macrophthalmus latifrons</i> (Haswell, 1881)	Macrophthalmidae	Mudflat	+	–	–
5	<i>Scopimera globosa</i> (De Haan, 1835)	Dotillidae	Sandy intertidal	–	+	–
6	<i>Mictyris longicarpus</i> (Latreille, 1806)	Mictyridae	Sandy intertidal	–	+	–
7	<i>Ashtoret lunaris</i> (Forsskal, 1775)	Matutidae	Sandy subtidal	–	–	+

Note: + = present; – = absent. Species names follow WoRMS (2025). Scientific names italicised in original text.

Tubuca dussumieri (H. Milne Edwards, 1852) (Figure 2) Ocypodidae. *Tubuca dussumieri* is a semiterrestrial fiddler crab with a quadrangular carapace (width 15–25 mm) coloured dark red to light brown. Males bear a single markedly enlarged, bright-red major cheliped used for mate attraction and territorial signalling, while females have bilaterally symmetrical chelipeds of proportional size (Kurniawan et al., 2020). The species filters detrital organic matter from sediment and excavates burrows that enhance soil aeration and nutrient cycling in estuarine mudflats. A total of 68 individuals were recorded exclusively at Station 1.

Thalamita spinimana (Dana, 1852) (Figure 2) — Portunidae. *Thalamita spinimana* is a swimming crab identifiable by its paddle-shaped fifth pereopods, hexagonal to transversely ovate carapace with six frontal lobes (four truncated median, two rounded lateral), and variable coloration

(bright red, green, or bicolored). Maximum carapace width reaches 12 cm (Ng, 1998). Fifteen individuals were recorded at Station 3, consistent with its association with rocky or sandy substrates. This genus has been reported to contain high protein content ($\approx 9.88\%$), conferring economic potential as a food source (Melati et al., 2021).

Nanosesarma batavicum (Moreira, 1903) (Figure 2) — Sesarmidae. *Nanosesarma batavicum* has a quadrangular carapace 1.35 times wider than long, with a dorsal surface bearing scattered pits and prominent setose frontal lobes; the external orbital tooth is triangular (Padate et al., 2022). Its dark brown to blackish coloration affords camouflage in mangrove-fringe substrates. This species functions as a detritivore that processes leaf litter and enhances organic matter cycling. Twenty-seven individuals were recorded at Station 1. Sesarmidae is reported here for the first time from the Madura coastal region, extending the known distribution of this family within Jawa–Madura coastal systems.

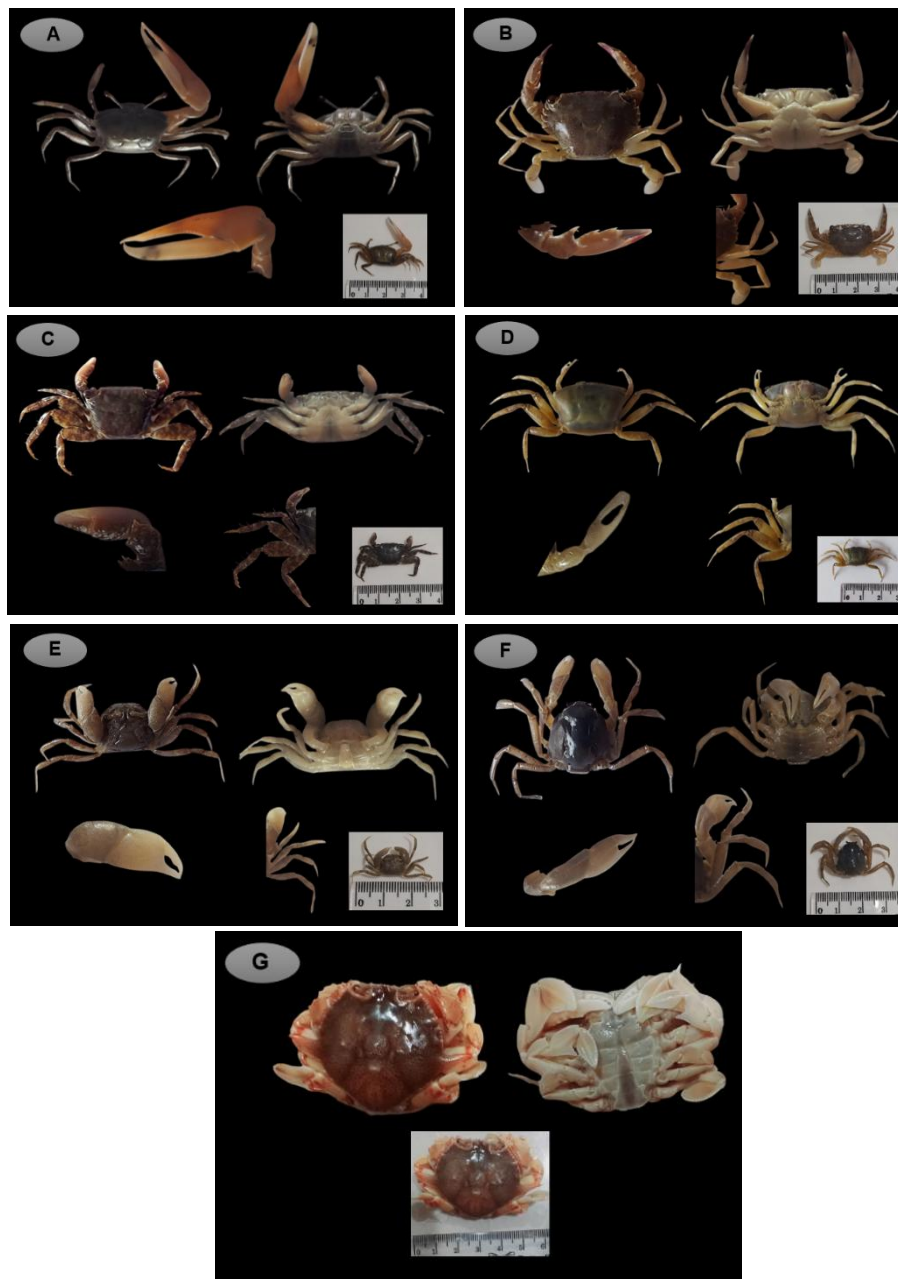


Figure 2. Photographs of the seven brachyuran species recorded at Jumiang Beach: (A) *Tubuca dussumieri*; (B) *Thalamita spinimana*; (C) *Nanosesarma batavicum*; (D) *Macrophthalmus latifrons*; (E) *Scopimera globosa*; (F) *Mictyris longicarpus*; (G) *Ashtoret lunaris*. Scale bars represent 10 mm. Source: personal documentation, 2024.

Macrophthalmus latifrons (Haswell, 1881) (Figure 2) — Macrophthalmidae. *Macrophthalmus latifrons* exhibits a nearly square carapace with granulated branchial regions, slender walking legs, and elongated ocular stalks. Adult carapace length reaches approximately 26 mm. The palm of the male cheliped lacks spines but bears an elongated projection on the inner surface (Poore & Ah Yong, 2023). This species inhabits muddy intertidal zones, where it feeds on microalgae and organic detritus. Thirty-five individuals were recorded at Station 1. Macrophthalmidae is recorded here for the first time from the coastal zone of Madura Island.

Scopimera globosa (De Haan, 1835) (Figure 2) — Dotillidae. *Scopimera globosa* is a small sand-bubbler crab with a smooth, convex carapace broader than long, its surface bearing rounded tubercles particularly in the branchial region. Coloration is brownish-grey, providing cryptic concealment on sandy substrates. Adult males carry chelipeds more than twice the carapace length in total length (Wong et al., 2010). This species constructs sand-pellet clusters around its burrow openings during feeding, serving as a bioturbation agent that reduces surface organic load and is recognised as an ecological indicator of intertidal sediment quality (Seo & Koo, 2021). *S. globosa* was the most abundant species (N = 82, 28.67%) and was exclusively recorded at Station 2.

Mictyris longicarpus (Latreille, 1806) (Figure 2) — Mictyridae. *Mictyris longicarpus* has a rounded, smooth carapace (adult length 15–21 mm; males larger than females) and long, slender legs adapted for rapid movement on sandy substrates. Males (≈ 21 mm) are generally larger than females (15–17 mm). This species occupies the upper-to-mid intertidal zone, forming aggregations during foraging and breeding periods (Subono, 2016). Its burrowing activity reduces eutrophication risk by incorporating surface organic material into sediment. Fifty-four individuals were recorded at Station 2.

Ashtoret lunaris (Forsskål, 1775) (Figure 2) — Matutidae. Known commonly as the Yellow Moon Crab, *Ashtoret lunaris* has a circular carapace (maximum width 5 cm) bearing six lateral projections and coarse surface granules, with a yellowish base colour marked by red spots (Widyastuti, 2018). Its flattened walking legs function as paddles for burrowing in sandy or seagrass-associated substrates. Distribution extends from the intertidal zone to 50 m depth (Ng, 1998). Only five individuals were recorded, all at Station 3, making this the rarest species at Jumiang Beach.

Community Structure

The abundance of each species per station and the overall community indices are presented in Tables 2 and 3. Station 2 recorded the highest total abundance (N = 136), followed by Station 1 (N = 130) and Station 3 (N = 20) (Table 2). The lower abundance at Station 3 is consistent with its exposed sandy substrate subject to wave disturbance, which limits the establishment of burrowing species.

Table 2. Abundance and relative abundance of crab species per sampling station at Jumiang Beach

No.	Species	Sampling 1 (N)			Sampling 2 (N)			Total (N)	%
		St. 1	St. 2	St. 3	St. 1	St. 2	St. 3		
1	<i>Tubuca dussumieri</i>	30	—	—	38	—	—	68	23.78
2	<i>Thalamita spinimana</i>	—	—	9	—	—	6	15	5.24
3	<i>Nanosesarma batavicum</i>	9	—	—	18	—	—	27	9.44
4	<i>Macrophthalmus latifrons</i>	20	—	—	15	—	—	35	12.24
5	<i>Scopimera globosa</i>	—	39	—	—	43	—	82	28.67
6	<i>Mictyris longicarpus</i>	—	28	—	—	26	—	54	18.88
7	<i>Ashtoret lunaris</i>	—	—	2	—	—	3	5	1.75
	Total	59	67	11	71	69	9	286	100

Note: — = species not recorded at that station.

Table 3. Shannon-Wiener diversity (H'), evenness (E), and dominance (D) indices for crab species at Jumiang Beach

Community	N	S	H'	E	D
Crab assemblage at Jumiang Beach	286	7	0.3416	0.1755	0.0565

Note: N = total number of individuals; S = total number of species; H' — Shannon-Wiener diversity index; E — Pielou's evenness index; D — Simpson's dominance index

The overall community H' of 1.72 falls within the moderate diversity range ($1 < H' < 3$), consistent with an intertidal assemblage subject to moderate physical disturbance and anthropogenic pressure. The high evenness value ($E = 0.88$) indicates that individuals were distributed relatively uniformly across the seven species, with no single taxon accounting for a disproportionate share of total abundance. The low dominance value ($D = 0.20$) (Table 3) corroborates this balanced structure. Together, these indices suggest that, despite *Scopimera globosa* being the most abundant species (28.67%), the community is not ecologically monopolized by any single taxon.

These results are comparable to those reported by Putriningtias et al. (2019) for a multi-family brachyuran assemblage comprising 15 species across 7 genera and 5 families in the Kuala Langsa mangrove ecosystem, Aceh, where moderate H' values reflected a balanced community structure without strong species dominance. The moderate H' at Jumiang Beach likely reflects the variety of substrate types across the three stations muddy estuarine at Station 1, transitional at Station 2, and sandy at Station 3 which together support taxonomically distinct guilds. This substrate heterogeneity is analogous to the intertidal zone diversity pattern documented by Rakmawati & Ambarwati (2020) in the Madura Strait, where distinct benthic communities co-existed across a mudflat-to-rocky gradient within a geographically compact area.

Regional Comparison and Novel Records

Table 4 compares family-level brachyuran diversity at Jumiang Beach with published records from adjacent beaches on Madura Island. Jumiang Beach records seven families, the highest family richness reported to date from the Madura coastal system. Camplong Beach (Adhani et al., 2018) recorded four families; Barung Toraja Beach (Nafiah & Purnomo, 2019) and Pangpajung Beach (Subono, 2016) each recorded one. The presence of Macrophthalmidae and Sesarmidae at Jumiang Beach constitutes the first documented occurrence of these families in Madura coastal surveys.

Table 4. Comparison of brachyuran family-level diversity at Jumiang Beach with nearby coastal localities on Madura Island

Location	Regency	Families Recorded	Reference
Barung Toraja Beach	Sumenep	Dotillidae	Nafiah & Purnomo, 2019
Camplong Beach	Sampang	Dotillidae, Mictyridae, Portunidae, Matutidae	Adhani et al., 2018
Pangpajung Beach	Bangkalan	Mictyridae	Subono, 2016
South Coast Beach	Bangkalan	Ocypodidae	Nur & Kuntjoro, 2021
Kamal Beach	Bangkalan	Brachyura (multiple, unresolved)	Aisyah et al., 2023
Jumiang Beach	Pamekasan	Ocypodidae, Portunidae, Sesarmidae*, Macrophthalmidae*, Dotillidae, Mictyridae, Matutidae	This study

Note: * = families recorded for the first time from the Madura coastal region

The discovery of Macrophthalmidae at Jumiang Beach is ecologically noteworthy. Mud-flat specialist crabs in this family, such as *Macrophthalmus japonicus*, have been recorded from the eastern coastal waters of Surabaya (Subagio, 2020), suggesting that Macrophthalmidae are present in East Java coastal systems but remain under-surveyed on Madura Island. Similarly, Sesarmidae are well known from mangrove ecosystems across South-East Asia, where they serve as keystone leaf-litter shredders (Padate et al., 2022). The occurrence of *Nanosesarma batavicum* at Station 1 with the highest estuarine influence and vegetation fringe is consistent with the mangrove-associated ecology of this family. These two records therefore reflect the role of Jumiang's habitat heterogeneity in supporting a broader brachyuran assemblage than previously documented anywhere on the Madura coast.

Ecological Roles and Conservation Implications

Several species identified possess documented ecological and economic significance. *Tubuca dussumieri* and *Nanosesarma batavicum* function as detritivores that enhance sediment nutrient cycling and soil aeration, thereby maintaining coastal productivity (Padate et al., 2022). *Scopimera globosa* acts as a bioturbation agent and ecological indicator of intertidal sediment quality (Seo & Koo, 2021). *Thalamita spinimana*, with a protein content of approximately 15.48%, represents a potential protein source for coastal communities (Oktavia & Muzammil, 2023), while *Mictyris longicarpus* mitigates eutrophication risk through its organic-matter incorporation activity (Subono, 2016). The ecological roles of these taxa underscore that maintaining the functional integrity of Jumiang Beach's intertidal habitat directly supports both ecosystem services and local livelihoods.

These findings align with the objectives of SDG 14 (Life Below Water) and SDG 15 (Life on Land), which call for science-based coastal ecosystem management. Continued monitoring of Brachyuran community structure at Jumiang Beach, ideally incorporating molecular identification via the COI barcoding gene, as demonstrated for aquatic fauna in East Java (Rabbani et al., 2025), would provide greater taxonomic resolution and enable detection of population-level changes in response to tourism pressure and habitat modification.

A limitation of this study was the absence of quantitative measurements of abiotic parameters, including substrate grain size, water temperature, salinity, dissolved oxygen, and pH. Therefore, interpretations regarding the influence of environmental characteristics on crab distribution remain tentative and require confirmation through further environmental measurements.

CONCLUSION

Seven species of Brachyura from seven families were identified at Jumiang Beach, Pamekasan Regency, Madura: *Tubuca dussumieri* (Ocypodidae), *Thalamita spinimana* (Portunidae), *Nanosesarma batavicum* (Sesarmidae), *Macrophthalmus latifrons* (Macrophthalmidae), *Scopimera globosa* (Dotillidae), *Mictyris longicarpus* (Mictyridae), and *Ashtoret lunaris* (Matutidae). The community exhibited moderate diversity ($H' = 1.72$), high evenness ($E = 0.88$), and low dominance ($D = 0.20$), indicating a balanced assemblage with no single dominant taxon. *Scopimera globosa* was the most abundant species (28.67%), reflecting its close association with the sandy substrate at Station 2. Sesarmidae and Macrophthalmidae are reported here for the first time from the coastal zone of Madura Island, extending the known brachyuran distribution records for the region. Substrate heterogeneity across the three stations, estuarine mudflat, transitional, and sandy intertidal was the primary driver of species-level habitat partitioning.

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DECLARATIONS

- Author Contributions** : Author 1: Conceptualisation, Investigation, Writing Original Draft. Author 2: Investigation, Formal Analysis. Author 3 Putri: Formal Analysis, Writing Review & Editing. Author 4: Supervision, Methodology, Writing Review & Editing. Author 5: Supervision, Review & Editing. All authors have read and approved the final manuscript.
- Funding** : This research received no external funding.
- Conflict of Interest** : The authors declare no conflict of interest.
- Data Availability** : Morphological data and specimen records are available from the corresponding author upon reasonable request.
- Ethical Approval** : This study did not require institutional ethical approval because it involved collection of invertebrate specimens for taxonomic identification only. All collection activities complied with applicable national regulations governing scientific sampling from coastal habitats.
- Declaration of AI Use** : During the preparation of this manuscript, AI-assisted tools (Grammarly and DeepL) were used for grammar checking and language polishing. All AI-generated suggestions were reviewed and approved by the authors, who bear full responsibility for the final content.

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