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Identification and diversity analysis of rabbitfish (Acanthuriformes: Siganidae) from Sedayu Lawas Coastline, Lamongan District, Indonesia

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Abstract. *Paricahya AF, Harahap MAR, Amalia E, Hidayat AN, Hidayati DA. 2026. Identification and diversity analysis of rabbitfish (Acanthuriformes: Siganidae) from Sedayu Lawas Coastline, Lamongan District, Indonesia. Indo Pac J Ocean Life 10 (1): o100104. https://doi.org/10.13057/oceanlife/o100104.* The Siganidae family has been widely studied, but the previous study still focused on a limited number of species, such as *Siganus canaliculatus*. Consequently, the potential distribution and diversity of other Siganidae species in specific regions remain poorly documented, placing their populations at high risk of overexploitation due to limited data collection and their incidental capture as bycatch. In this study, specimens were collected using several types of fishing gear, each adapted to one of three habitat types in Sedayu Lawas Coastline, Lamongan District, Indonesia: Mangrove Estuary (MaE), Muddy Beach (MuB), and Coral Beach (CoB). Data on fish catches were collected once a week for three months (January-March 2025). Species were identified using key morphological characteristics, resulting in the identification of a total of 1,046 specimens. Four of the seven recorded Siganidae species were captured, including *Siganus guttatus*, which exhibited two distinct variants. Diversity was assessed using Species Abundance (Sa), the Shannon-Wiener Index (H′), and the Simpson Dominance Index (C). The highest Sa values were 35.2% for *Siganus javus* at the CoB site, 38.4% for *S. canaliculatus* at the MaE site, and 43.4% for *S. canaliculatus* at the MuB site. The mean H′ and C values varied among sites, with 0.97, 0.99, and 1.09 for H′, and 0.39, 0.41, and 0.36 for C at MaE, MuB, and CoB, respectively. These values also differed across months, with H′ values of 1.12, 0.69, and 1.24 and C values of 0.35, 0.50, and 0.31 for January, February, and March, respectively. The results indicate that the highest abundance was observed in CoB, however, the presence of other habitats also contributes to supporting populations of various Siganidae species. Implementing habitat based management, strengthening ecological conservation, and centralizing species specific catch data are essential to enhance the sustainability of Siganidae fisheries.

Keywords: Diversity study, habitats, morphology, rabbitfish, Siganidae

INTRODUCTION

The Siganidae family (rabbitfishes) is commonly known as baronangin Indonesia, or sadar fish in the Lamongan District, East Java, and surrounding areas. Globally, at least 29 species of Siganidae have been identified (Cerim et al. 2020), with 21 species found in the Western and Central Pacific regions (Carpenter and Niem 2001), and around 19 species in the waters of the Indonesian Archipelago. Over the past 42 years, it has been confirmed that the greatest diversity of Siganidae worldwide is found in the Indo-Malay region (Woodland 1983), including North of Java Sea. Siganidae are generally utilized as a protein source, especially in local communities (Wahyuningtyas et al. 2017). Habitat studies through specific taxa, including issue of climate change by Siganidae studies is still limited and often focus only on small-bodied ornamental fishes taxa such as damselfish (Pomacentridae) (LaMonica et al. 2021) and the butterflyfish (Chaetodontidae) which has medium to large-bodied taxon that is the closest size to Siganidae family (Laikun et al. 2014; Fadli et al. 2019; Palendeng et al. 2021; Devanya et al. 2022; Gumolili 2022). Members of the Siganidae family migrate between various habitats throughout their life cycle and typically inhabit depths of 5 to 20 m (Talakua et al. 2022). However, they have also been observed to inhabit areas as shallow as 1 meter (Cerim et al. 2020), encompassing sizes from early juveniles to adults. This highlights the urgency of investigating the Siganidae family due to the limited availability of published data and their broad habitat distribution.

Studies on Siganidae diversity have been conducted in several regions in Indonesia, including the Sumatra, Lombok, and Sulawesi Coastline (Syukur et al. 2021; Awaluddin et al. 2024; Muis et al. 2024; Hasibuan et al. 2025; Patangngari et al. 2025). However, documentation of Siganidae identification in the East Java region remains very limited. Research on the Siganidae family in Indonesia focused on only a few species, such as *Siganus* *canaliculatus* (Suardi et al. 2019), leaving many other species underexplored. Siganidae production continues to depend on wild populations, as demand increases, this reliance highlights the need for sustainable solutions, such as Siganidae aquaculture and data driven approaches to sustainable capture fisheries (Wahyuningtyas et al. 2017). Despite their high market demand, Siganidae are generally considered non target species and are often undereported, commonly being classified as associated species or bycatch. This classification complicates efforts to accurately assess their wild stocks. Moreover, catch data for bycatch species are typically recorded using local or generic names that may encompass multiple species. Such practices impede species-specific conservation efforts and represent a major source of uncertainty in fisheries research (Cerbule et al. 2022), especially when discussing species with low market dominance in specific regions, such as Lamongan, East Java. Lamongan holds significant value as one of the designated minapolitan areas in East Java (Anam et al. 2021; Nurhijayat et al. 2025). Therefore, the fisheries potential in this region urgently requires a strong scientific foundation to support future management and development efforts.

In addition, one of the major challenges in saline fish communities studies is the high potential for species misidentification. One of the most frequently studied groups is the mudskipper, or glodok fish (Oxudercidae) (Elviana et al. 2019; Ningsih and Santoso 2020; Velayutham et al. 2021; Baderan et al. 2023; Maghfirah et al. 2023). Despite extensive study, the basis for species identification within this family is rarely emphasized. A notable example is the unusual report of *Boleophthalmus* cf. *pectinirostris* in Indonesia (Maghfirah et al. 2023), a species that is typically distributed in the northwestern Pacific (Chen et al. 2014; Chen et al. 2015). This finding lacks a clear morphological or genetic justification, and subsequent molecular studies have revealed genetic ambiguities within Indonesian *B.* cf. *pectinirostris* populations (Shabrina et al. 2024). A similar issue occurs within the genus *Siganus*, where recent study rarely provides a detailed basis for species identification. Accurate identification of *Siganus* species is essential for effective conservation and management efforts, including size regulations, restocking, and habitat quality improvement, making this issue a significant concern (Mehanna et al. 2018). Given the limited attention to species-level identification within the Siganidae family, particularly in the study area, a preliminary assessment was undertaken to identify the species occurring in the study area. This was followed by a three-month study aimed at analyzing diversity within the family across several different habitat type in Lawas Coastline, Lamongan District.

MATERIALS AND METHODS

Study area

The study was conducted in Sedayu Lawas Village Coastline, located in the Brondong Sub-district of Lamongan District, East Java Province, Indonesia. This area features three types of habitats belonging to the Siganidae family, which guided the selection of sampling sites: Mangrove Estuary (MaE) (-6.872197161579266, 112.24252779558286), Muddy Beach (MuB) (-6.87175657179642, 112.242257), and Coral Beach (CoB) (-6.871269098609291, 112.24235691534535) (Figure 1).

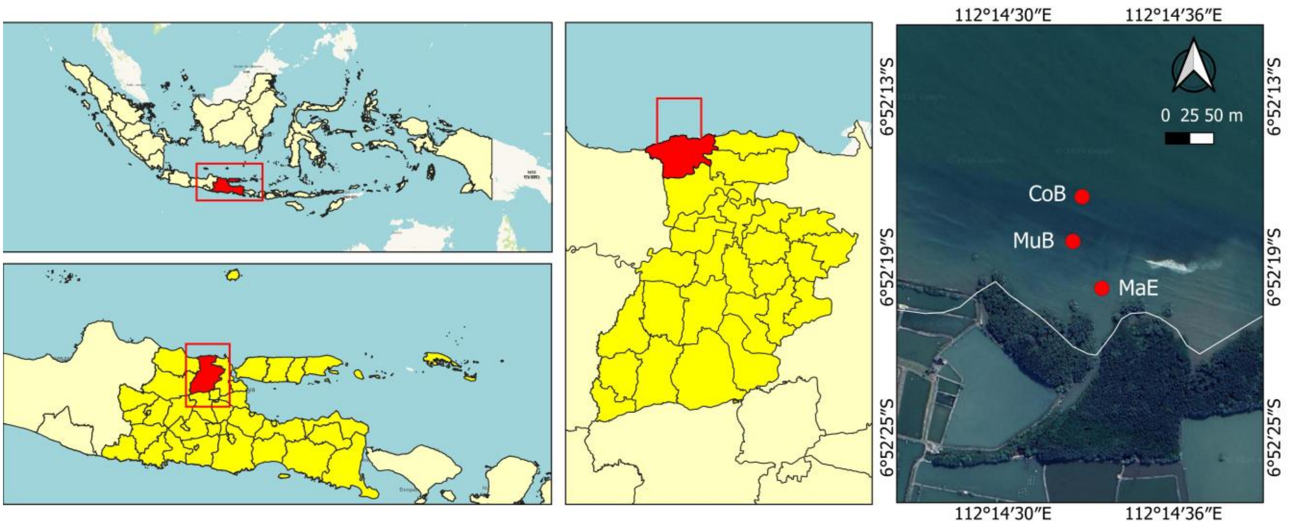

Figure 1. Study location map in Sedayu Lawas Village Coastline, Brondong Sub-district, Lamongan District, East Java Province, Indonesia. Sampling sites are categorized based on habitat type, as determined from satellite imagery. Mangrove Estuary (MaE) sites are located closest to the shoreline or within mangrove forests, Muddy Beach (MuB) sites are positioned farther inland, away from the shoreline, and Coral Beach (CoB) sites are situated farthest from the shore

Estimated substrate composition ratios (coral: rock: sand: mud) at each site were determined through visual observations and subsequently validated through discussions with local fishers, as follows: MaE 0:1:2:7, MuB 0:6:1:3, and CoB 7:2:1:0. Temperature and salinity at the three sampling locations were measured monthly, and the results showed no significant differences between sites. The temperatures level in January-March were 28-32, 25-28, and 26-30°C, respectively, while the salinity levels were 27-34, 20-25, and 24-25 ppt.

Sampling and species identification

The study was conducted over three months, from 1 January to 31 March 2025, following preliminary observations to identify local conditions since 2019. Sampling is conducted once a week at each sampling site, with 12 times in total of sampling trip, using fishing gear that adapts to the conditions of the sampling site, such as gill nets, hand nets, and/or hooks. For the domination of fishing gear used at each site, for MaE and MuB dominated with gill nets and hand nets, but for CoB dominated with hooks because lot of corals. The gill nets used in this study has three layers with 2 up to 7 inch for the mesh size, then the hand nets has one layers with about 0,5 inch for the mesh size. Each transect measured 30 × 30 m, and the sampling at each site lasted approximately three hours each week. The number of fishes that caught posibbly bias, because the variety of fishing gear used with the similar number of the fishing gear and spanding time or efforts. Number of the fishing gear that used is one per fishing gear with single local fisherman.

In the study area, seven species of the Siganidae family was recorded, based on preliminary observations. The identification of these species guided by a summarized morphological identification key, based on Carpenter and Niem (2001), which has been adjusted to field conditions, as follows:

1 a. Mid-thoracic in front of ventral fins not scaly*; dorsal and anal fin spines slender or stout → **2**

b. Mid-thoracic in front of ventral fins scaly*; dorsal and anal fin spines stout → **4**

2 a. Dorsal and anal soft-rays radius tends to be taller (compared to *Siganus canaliculatus*); anal fin spines and posterior dorsal fin spines stout; caudal fin truncate almost emarginate; distinctive labyrinth-like body pattern → ***Siganus spinus***

b. Dorsal and anal soft-rays tends to be shorter (compared to *Siganus spinus*); anal-fin spines and dorsal-fin spines slender; caudal fin sometimes emarginate when small, commonly spotted; no labyrinth-like pattern, but spots → **3**

3 Pearl-like spotted body pattern about 100-200 spots (number increases with fish size); spots below the lateral line are ovoid or rod-shaped, larger than the spots above the lateral line; have 5-6 dark brown diagonal lines → ***Siganus canaliculatus***

4 a. The closest distance between the orbital bone and the upper lip is less than equal to 1/2 the diameter of the orbital bone; more than 29 rows of scales between the lateral line to the spines of the second to fourth dorsal fin* → ***Siganus javus***

b. The closest distance between the orbital bone and the upper lip is more than 1/2 the diameter of the orbital bone; less than 29 rows of scales between the lateral ridges to the spines of the second to fourth dorsal fin* → **5**

5 a. No black bands on the head and anterior part of the body → **6**

b. Has a diagonal black band from the chin to the nape → **11**

6 a. Body fully covered with dark or light spots; caudal fin strongly forked at more than 15 cm body sized specimen→ **7**

b. Body not fully covered with spots; caudal fin emarginate to moderately forked → **8**

7 Golden or copper-coloured spots → ***Siganus punctatus***

8 a. Yellow large round spots below dorsal fin section, around soft fingers; body pattern dominated by firm golden spots and/or wavy lines, no large areas of vermiculate pattern → **9**

b. No large yellow round spots; sides with additional vermiculate pattern → **10**

9 Has no golden stripe pattern on the sides, which breaks into spots when approaching the dorsal and anal fin base → ***Siganus guttatus***

10 Entire body covered with bluish to silver vermiculating lines, on brown background body color; caudal fin emarginate, having columns of dark spots → ***Siganus vermiculatus***

11 The pattern on the dorsal side of the body to the band on the shoulders, has many different-sized blue spots, sometimes retracted to the anterior side → ***Siganus virgatus***

Note: '*' indicates that the characteristic is difficult to observe in the field, or may be difficult due to stadia differences

Diversity analysis

The catch results were identified, recorded, and analyzed using several formulas. Species composition calculated using the relative species abundance formula (Sa) (Krebs 2014; Maghfirah et al. 2023; Maturbongs et al. 2018) the diversity index is calculated using the Shannon-Wiener index (H’), and the dominance index is calculated using the Simpson dominance index (C) (Krebs 2014). The calculation formula is as follows:

Composition with Sa value

$$Sa = \frac{ni}{N} \times 100\%$$

Diversity with an H' value

$$H' = \sum \frac{ni}{N} \ln \frac{ni}{N}$$

Dominance with a C value

$$C = \sum \left[\frac{ni}{N}\right]^2$$

Where:
Sa : Composition percentage or abundance
ni : Number of individuals of a spesies
N : Total individuals of all species
H’ : Shannon-Weiner Index
C : Dominance Index

The value of H’<1 is classified as low diversity, 1<h’>3 as high diversity (Laikun et al. 2014; Maturbongs et al. 2018; Devanya et al. 2022). A C value less than 0.3 indicates low dominance; values between 0.3 and 0.6 indicate medium dominance; and values between 0.6 and 1 indicate high dominance (Palendeng et al. 2021). The obtained data were first evaluated for normality using the Shapiro-Wilk test and for homogeneity of variance using Levene’s test. When the parametric assumptions were met, mean comparisons were subsequently assessed using t-tests.

RESULTS AND DISCUSSION

Identification

During a three month sampling period, four out of seven previously recorded species were identified. Using the identification key, the species found were *S. canaliculatus, S. javus, S. guttatus,* and *S. vermiculatus* (Figure 2). However, *S. spinus*, *S. punctatus*, and *S. virgatus*, wich had been recorded previously, were not detected during the sampling period (Figure 3). Two species, *S. spinus* and *S. punctatus* were rarely documented in the preliminary study, with *S. spinus* being recorded twice at the MaE site and *S. punctatus* five times at the CoB site in 2022. *Siganus virgatus*, on the other hand, was mostly caught during the dry season, from May to September. The local community refers to the Siganidae family as "sadar" with some variations in the names of each species. *Siganus canaliculatus* is referred to as sadar lulang, *S. javus* as sadar tipis, *S. guttatus* as sadar manaring, *S. vermiculatus* as sadar batik, and *S. virgatus* as sadar kuning. Local names for *S. spinus* and *S. punctatus* are not well known, as local fishermen do not commonly catch these two species in the sampling area. The size of the captured fish varied from early juvenile stages to adults. *Siganus canaliculatus* and *S. javus* were captured at a Total Length (TL) ranging from 5 to 23 cm, while *S. guttatus* and *S. vermiculatus* had a TL ranging from 5 to 27 cm.

Siganus guttatus was found to have two variants in the preliminary study and sampling period. The first variant (to be referred to as *S. guttatus* var. (i) is the standard variant, according to the identification key. The second variant (*S. guttatus* var. (ii) displays a shorter, less prominent golden line along the side of the body compared with its closest relative, *Siganus lineatus*. The golden markings are partial, mainly confined to the lower body toward the anal fin and are not always symmetrical on both sides. Nevertheless, all other diagnostic morphological characters are consistent with those described in the identification key (see Figure 4). Based on the available data, the differences between these two variants do not support a clear separation at the species level. However, specimens measuring approximately 15 cm in total length were also observed to exhibit similar characteristics, suggesting that these traits are unlikely to be temporary features associated with the juvenile stage.

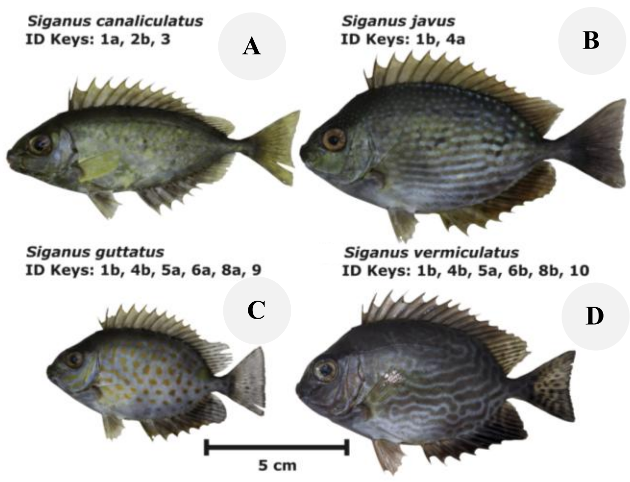

Figure 1. Siganidae species captured during the study. A. *Siganus canaliculatus* or sadar lulang, B. *Siganus javus* or sadar tipis, C. *Siganus guttatus* or sadar menaring, and D. *Siganus vermiculatus* or sadar batik. Identifying characters can be matched with the identification key in the methods section

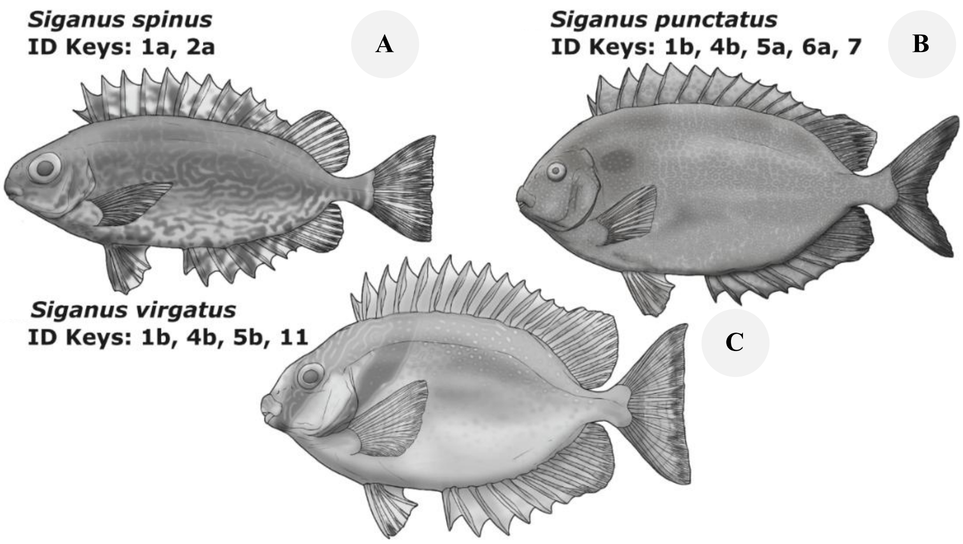

Figure 2. Illustrations of Siganidae species were recorded, but not captured during the study. A. *Siganus spinus*, B. *Siganus punctatus*, and C. *Siganus virgatus* or yellowfin. The distinguishing characters can be matched with the identification key in the methods section

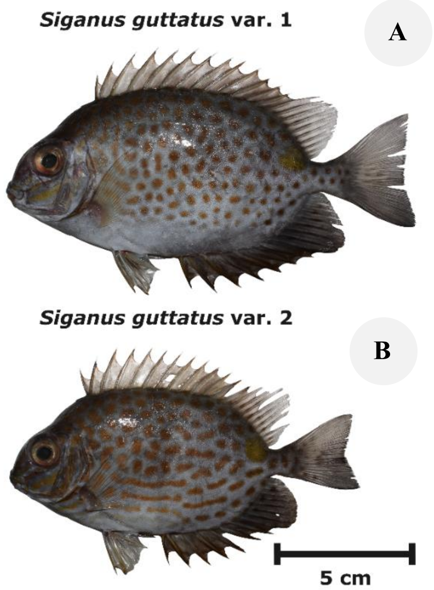

Figure 3. Variation in *S. guttatus* specimens in the study area. A. *Siganus guttatus* var. 1 and B. *Siganus guttatus* var. 2

Members of the family Siganidae have been recorded across various regions of Indonesia. In Lombok, three seagrass-associated species have been reported: *Siganus guttatus*, *S. canaliculatus*, and *S. argenteus* (Syukur et al. 2021). In Tanakeke Island, South Sulawesi, six seagrass-associated species have been identified, namely *S. guttatus*, *S. canaliculatus*, *S. javus*, *S. punctatus*, *S. virgatus*, and *S. fuscescens* (Awaluddin et al. 2024). Meanwhile, five species were documented along the coastal waters of the Spelman Strait, West Buton District, Southeast Sulawesi, including *S. canaliculatus*, *S. guttatus*, *S. puellus*, *S. puelloides*, and *S. vulpinus* (Muis et al. 2024). *Siganus argenteus* and *S. fuscescens*, which were not found in Sedayu Lawas, share high morphological similarity with *S. canaliculatus*. Therefore, these three species require more detailed identification. A practical identification key is based on the shape of the caudal fin: *Siganus argenteus* has a distinctly forked fin, whereas the other two species typically have a regular fork. Even among smaller specimens, the fin tends to be emarginate in shape. These species can be further distinguished by counting the rows of spots above the lateral line toward the midpoint of the dorsal fin. *Siganus canaliculatus* generally has 2-3 rows, while *S. fuscescens* typically has 4-6 rows. Furthermore, *S. fuscescens* is characterized by having a higher number of spots (over 180 spots) (Carpenter and Niem 2001). However, both *S. canaliculatus* and *S. fuscescens* have been noted to have taxonomic issues (Zolkaply et al. 2021). Along the Sumatra coastline, a total of seven Siganidae species have been identified, comprising *S. guttatus*, *S. canaliculatus*, *S. javus*, *S. virgatus*, *S. vermiculatus*, *S. spinus*, and *S. puellus* (Hasibuan et al. 2025; Patangngari et al. 2025). *Siganus puellus, S. puelloides,* and *S. vulpinus* can generally be distinguished from one another; however, the species occurring in Sedayu Lawas that shows the closest morphological similarity to these taxa is likely *S. virgatus,* which may contribute to occasional identification uncertainty. Therfore, accurate identification of Siganidae family members is crucial for future study, utilization, and management of Siganidae populations.

The occurance of two morphological variations of *S. guttatus* in Sedayu Lawas highlights the complexity of species identification within the genus Siganus. Considering the broad distribution and ecological versatility of *S. guttatus* along the Indonesian coastline, these variations are more plausibly attributed to intraspecific variation or phenotypic plasticity, which may contribute to misidentification. The subpopulation of *S. guttatus* var. 2 exhibits line patterns that partially resemble those of *S. lineatus*. However, the lines are less extensive, and the overall pattern shows noticeable variation from the characters commonly used in identification keys. *Siganus lineatus* is rarely found on the Sunda Land coastline, it is commonly located in the eastern part of the Indonesian Archipelago, such as the Lembeh Strait and Bitung (Sampouw et al. 2022), southward to Australia (Fox et al. 2009; LaMonica et al. 2021) and northward around the Philippines (Carpenter and Niem 2001). Considering that many identification keys rely heavily on morphological characters such as body patterning, *S. guttatus* var. 2 should be considered distinct from the original variant and therefore warrants further investigation.

Genetic based study on the family Siganidae remains limited, and to date there are few studies that specifically examine genetic variation, potential hybridization, or phylogenetic relationships within *S. guttatus*. Although phylogenetic analyses of several Siganidae species have been conducted to support morphological identification (Zolkaply et al. 2021), the genetic relationship between *S. guttatus* and *S. lineatus*, which exhibit high morphological similarity, has not yet been examined in detail. Identification of *S. guttatus* generally follows established taxonomic references (Carpenter and Niem 2001); however, the observations of *S. guttatus* var. 2 in this study suggest that these references may warrant further evaluation. To date, no genetic study has explored the possibilities of speciation, hybridization, or ecomorphological patterns involving *S. lineatus*, which currently restricts our understanding of variation in *S. guttatus* to inherited morphological variation only. The morphological diversity identified in *S. guttatus* through this study suggests the need for further genetic analysis in the future, as such studies can offer valuable insight into the population health and resilience indications of this species population (Lamadi et al. 2023). Recently, genomic investigations on *S. guttatus* have been initiated in China, underscoring its potential as a high-value species among the Siganidae family for aquaculture and fisheries (Xian et al. 2025).

Diversity analysis

The Sa values recorded at each site over the three-month sampling period show significant variability (Figure 5). At the CoB site, *S. javus* was the most common species, comprising 35.2% of the sample. In contrast, *S. canaliculatus* had the highest Sa value at both the MuB site (43.4%) and the MaE site (38.4%). The rarest population observed was *S. guttatus* var. 2, which was found only at the MuB site, representing just 0.4% of the total. Additionally, *S. vermiculatus* had the lowest capture rates among non-variant species, with values ranging from 0.3 to 8.2% across all sites during the three months. In February, neither *S. guttatus* nor its variant was captured in any of the three habitats. However, in January, the population of *S. guttatus* var. 2 was not present at the MaE site. *Siganus guttatus* var. 1 was found across all sites in January and March, with population percentages ranging from 11.5 to 36.5%. Meanwhile, *S. canaliculatus* (23.5-56.5%) and *S. javus* (30.4-52.5%) were consistently found during all three months of sampling.

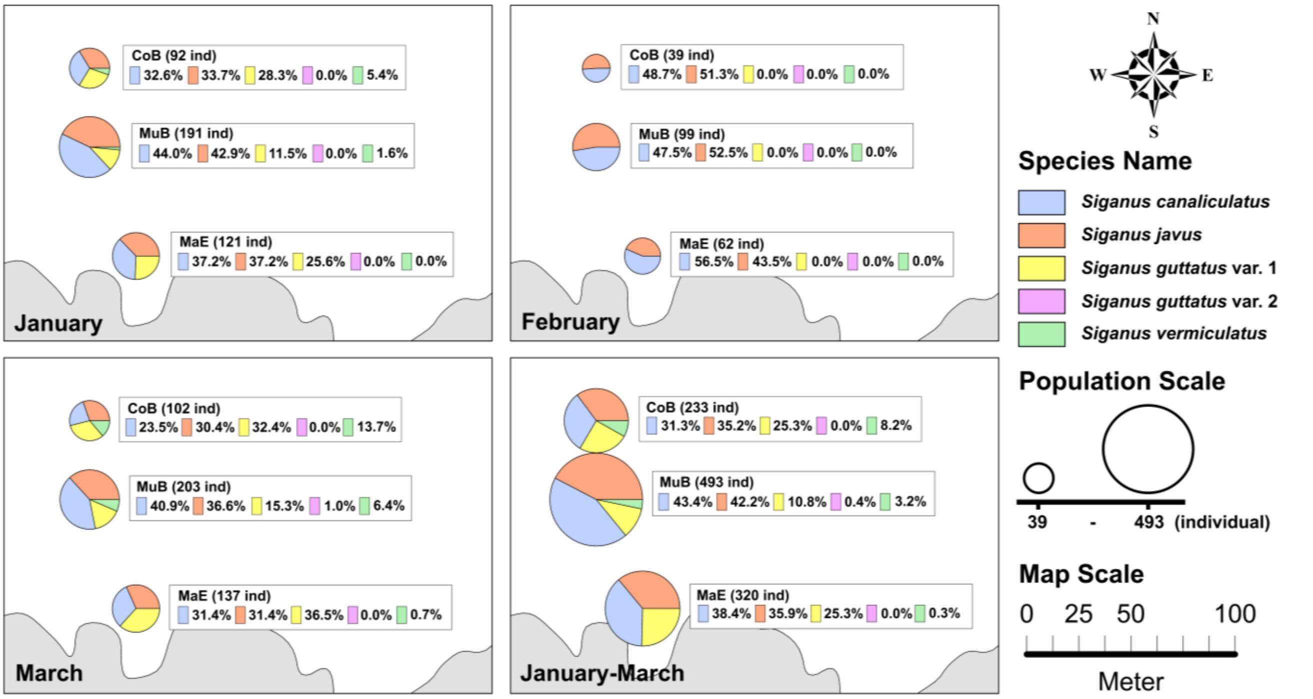

Figure 4. Spatial distribution of Siganidae abundance across three habitats during January-March 2025, with cumulative abundance over the three-month sampling period

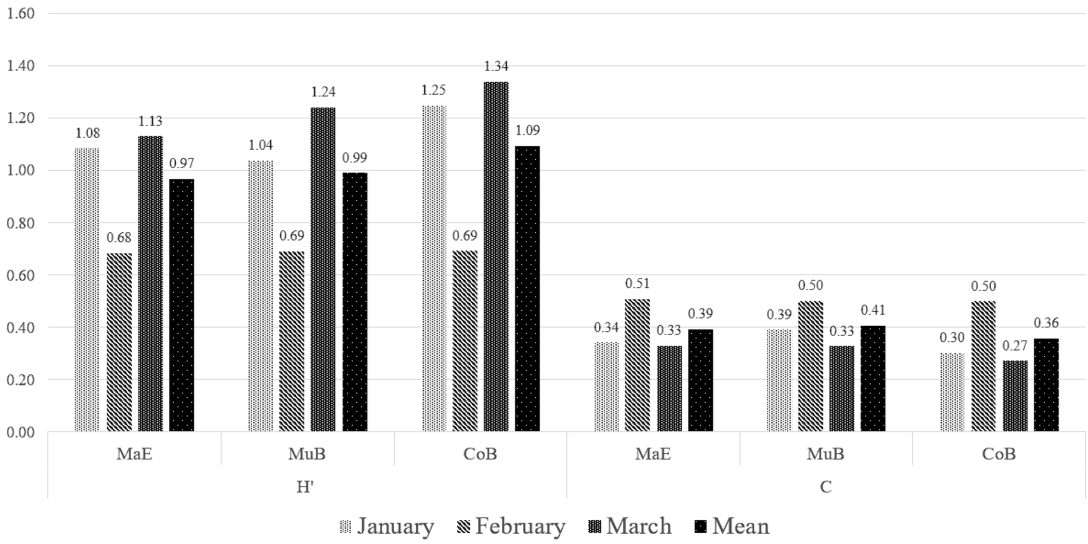

Figure 5. Monthly variation in H′ and C values of Siganidae across different habitats in Sedayu Lawas, Brondong, Lamongan, Indonesia. MaE: Mangrove Estuary, MuB: Muddy Beach, CoB: Coral Beach, H’: Shannon-Weiner Indeks, C: Dominance Index

The H' and C value were vary across locations monthly (Figure 6). Normality was assessed using the Shapiro-Wilk test and indicated that all datasets were normally distributed (p-values: 0.29 to 0.89 for H' and 0.07 to 0.76 for C). Homogeneity of variances tested using Levene’s test showed homogeneous variances (p-value: 0.82 for H’ and p-value: 0.75 for C). The average H’ values over three months of observation at MaE, MuB, and CoB were 0.97; 0.99; and 1.09, respectively. The H' values are categorized as low diversity at the MaE and MuB sites, while the CoB site is categorized as having a medium diversity (Laikun et al. 2014; Maturbongs et al. 2018; Devanya et al. 2022). Differences in mean H′ values among the three sites were minimal and not statistically significant ($p > 0.05$), with the largest observed difference being only 0.12. Meanwhile, the average C values at the MaE, MuB, and CoB sites were 0.39, 0.41, and 0.36, respectively, and also did not differ significantly among sites ($p > 0.05$). The highest average C value was observed at the MuB site, whereas the lowest occurred at the CoB site. Nevertheless, all three sites were classified as having medium dominance status (Palendeng et al. 2021). The values of H′ and C showed variation across sampling periods. The average H′ values recorded over the three months were 1.12, 0.69, and 1.24, indicating medium diversity in January and March and lower diversity in February. Statistical analysis suggested that the H′ value in February tended to be lower than those in the other months ($p < 0.05$). Similarly, C values varied among months, with values of 0.35, 0.50, and 0.31, respectively, all falling within the medium dominance category. The dominance index in February appeared to be higher than in the other months, with statistical analysis indicating a significant difference ($p < 0.05$).

The diversity study using H’ and C values can be linked to various ecological factors. The H’ value is significantly influenced by the number of species present and their proportion (Roy et al. 2022). A high H' value indicates a greater diversity of taxa in an area characterized by a balanced distribution of each taxon. H′ values generally range between 1 and 3.5, with 4 regarded as an exceptional upper limit. An H′ value of 4 is rarely observed, especially in studies with a limited taxonomic scope (Paul et al. 2021). Across all sites, the mean H′ value increased from 1.12 in January to 1.24 in March, and both values were classified as medium diversity. In contrast, the lowest H′ value (0.69), recorded in February and categorized as low diversity, was associated with a temporal decline in cumulative H′ at each sampling site. Meanwhile, a high C value indicates the presence of dominant species in the community at a specific time and location (Maturbongs et al. 2018). In this study, C values at most sampling points were generally within the medium category, except at the CoB site in March, where a low C value (0.27) (Palendeng et al. 2021). In February, C values increased across all sites (0.50-0.51), coinciding with a decline in the populations of *S. guttatus* and *S. vermiculatus*

Habitats with higher diversity tend to exhibit greater ecological complexity, as reflected in the diversity analysis results. The CoB site showed the highest diversity, followed by MaE and MuB. This pattern suggests that coral reef habitats play a particularly important role for Siganidae, although each habitat contributes uniquely to their ecological requirements, with coral reefs offering abundant food resources and shelter (Martin et al. 2024). The analysis indicates that coral habitats can support a wider range of Siganidae species compared to other environments. In contrast, muddy habitats such as MuB and MaE tend to support only a few dominant species. The strong dominance observed at the MuB site may be related to its position as a transitional zone between coral reefs and mangroves. In contrast, the mangrove habitat at the MaE site exhibited higher diversity, which may be attributed to the role of mangroves as nursery grounds for numerous marine organisms (Borland et al. 2023). Variations in Siganidae community composition across these habitats may therefore serve as early indicators of future changes in environmental quality.

Siganus canaliculatus (208 specimens) and *S. javus* (214 specimens) were more frequently recorded in the MuB habitat than in the other habitats. Meanwhile, *S. guttatus* (81 specimens) was most commonly found in the MaE habitat. The MuB habitat is characterized by relatively high sediment loads and calmer water currents, whereas the MaE habitat is influenced by higher nutrient inputs from terrestrial sources. These environmental characteristics may influence local productivity and the availability of phytoplankton, zooplankton, and detritus, which are recognized as important food resources for Siganidae species (Awaluddin et al. 2024). A similar pattern was reported in the coastal waters of Uloulo, where all three species were more frequently observed in productive nearshore areas, potentially associated with feeding preferences (Suardi et al. 2019). The diet composition of Siganidae appears to be broadly similar, with macroalgae and microalgae (Bacillariophyceae, Chlorophyceae, Cyanophyceae, and Dinophyceae) forming the main components. Additional food items may include ciliates, bivalves, gastropods, and crustaceans (e.g., copepods), that are often associated with nutrient-rich and productive waters (Indriyani et al. 2020). In contrast, members of the family Siganidae (233 specimen) were least frequently recorded in the CoB habitat. This pattern may be associated with the coral area being located farther offshore, where the availability of preferred food resources could be relatively lower. Additionally, coral habitats may support higher abundances of potential predators and competitors compared to muddy and estuarine environments (Awaluddin et al. 2024).

The low H′ value together with a high C value in February reflects strong dominance by a limited number of taxa within the Sa assemblage. The absence of two species previously recorded appears to have created ecological space for *S. canaliculatus* and *S. javus* to dominate catches across all sampling sites. In February, the average Sa values of *S. canaliculatus* and *S. javus* accounted for 50.88 and 49.12% of the total catch, respectively. The dominance of these two species, together with the absence of three additional taxa in February. This result may reflect changes in local environmental conditions (Palendeng et al. 2021), potentially associated with rainfall observed during the study period. Rainfall is known to influence the distribution and catchability of Siganidae, as certain species may become less frequently recorded under varying hydrological conditions. Comparable patterns have been reported in previous studies. For example, *S. canaliculatus* and *S. guttatus* were not recorded during periods of lower rainfall in the Spelman Strait Coast, Central Buton District, Southeast Sulawesi (Muis et al. 2024). Similar trends were observed at the Sedayu Lawas sampling site, where S. vermiculatus was generally absent during periods characterized by lower rainfall, while *S. virgatus* was not recorded during periods of higher rainfall. In addition, catches of *S. guttatus* have been reported to decline during rainy conditions, likely due to increased water turbidity, as documented in Sei Carang, Tanjungpinang City, Riau Province (Indriyani et al. 2020). The calculations used in diversity analysis are not absolute and may vary depending on their application. Nevertheless, the findings of this study offer valuable insights and recommendations for promoting the sustainability of Siganidae fisheries. The H′ values can be further supported by complementary analyses, such as species richness and evenness assessments (Strong 2016). It is important to note that the dataset can significantly influence the study outcomes. The diverse data collection methods applied in this study effectively address challenges arising from habitat variability. However, these methods may also be influenced by sample size. The validity of most diversity analyses including widely used indices such as Shannon-Wiener, Simpson, and Margalef depends on sufficient sample sizes. Among these indices, Simpson's Index is the least sensitive to sample size variation, whereas Margalef's Index is the most sensitive (Kunakh et al. 2023). The distribution of Siganidae is influenced by several factors, including stage differences (Lin et al. 2019; Talakua et al. 2022) and food preferences (Hoey et al. 2013), which vary by species. This potential mapping and diversity analysis cannot be separated from anthropogenic issues such as destructive fishing practices (Uar et al. 2016), coastal development and pollution (Eddy et al. 2016), all of which damage Siganidae habitats on local, national, and global scales.

Effective management of environmental threats to Siganidae is crucial. This includes implementing size regulations to prevent the capture of individuals before they reach sexual maturity (Rumagia et al. 2021). To promote sustainable Siganidae fisheries, measures should include multihabitat and multispecies protection strategies aimed at mitigating anthropogenic impacts (Kennish 2022), systematic data collection, and catch size restrictions for Siganidae and related species should be considered. Catch quotas should be adjusted according to the relative abundance of each species. More abundant species, such as *S. canaliculatus* and *S. javus*, may allow for more flexible quota allocations, whereas less abundant species, such as *S. guttatus*, require stricter catch limitations. For seasonal species, including *S. vermiculatus* and *S. virgatus*, quotas should be carefully regulated and aligned with their seasonal occurrence patterns. Further study on the biology of each species in Sedayu Lawas, particularly their feeding behavior and reproductive biology is essential to support effective conservation planning. Such information will help inform adaptive fisheries management policies and contribute to the advancement of Siganidae aquaculture. Overall, these measures aim to ensure the long-term sustainability of Siganidae fisheries in the Brondong Sub-district, Lamongan District (Nurhijayat et al. 2025).

Sedayu Lawas is located within Fisheries Management Area (FMA) 712, where several fishery commodities have been identified as overexploited. This situation underscores the urgency of conducting comprehensive studies and implementing effective policy interventions. As a designated minapolitan area, Lamongan possesses substantial potential to drive economic growth through both capture fisheries and aquaculture, in alignment with the principles of a sustainable blue economy (Nurhijayat et al. 2025). Implementing strategies such as enhanced data monitoring and regulated fishing seasons can greatly improve the reproductive success of Siganidae species. Study on their biological and reproductive characteristics serves as a critical foundation for developing effective fisheries management policies. For instance, *S. canaliculatus* populations in South Sulawesi exhibit peak fecundity in September, which contrasts with observations from Saudi Arabia, where the highest reproductive activity occurs between March to May (Suwarni et al. 2019). Implementing fishing regulations based on breeding seasons and fish size should be specifically adapted to the ecological and management conditions of FMA 712, or localized to areas such as Lamongan. These measures should be designed to reflect the species composition identified in the present study. In addition, limiting the catch of less abundant species while promoting the domestication and cultivation of Siganidae species offers a promising approach, particularly given Lamongan's strong potential to advance sustainable fisheries and aquaculture development.

This study on the Siganidae population across three habitats in Sedayu Lawas, Lamongan, East Java, provides several key insights that can inform future management of the area. There are four species of Siganidae in Sedayu Lawas caught within January to March 2025, which is *S. canaliculatus*, *S. javus*, *S. vermiculatus*, and two variations of *S. guttatus*. The higest Sa values were recorded in two species, which is *S. javus* at CoB site (35.2%), followed by *S. canaliculatus* at MaE site (38.4%) and MuB site (43.4%). Based on three months of data, the CoB site exhibited the highest mean H′ value (1.09), whereas the MuB site showed the highest mean C value (0.41). The results show that coral habitats exhibit the highest diversity in Sedayu Lawas. However, species such as *S. canaliculatus* and *S. javus* depend strongly on the other habitats, indicating that capture fisheries management should adopt a holistic approach that considers all three habitat types. The findings of this study can serve as a scientific foundation for evidence-based policy-making and the development of Siganidae aquaculture in Lamongan and throughout Fisheries Management Area (FMA) 712. Further comprehensive study is recommended to examine the biological and reproductive characteristics of Siganidae in greater detail, as such data are essential for strengthening conservation efforts and guiding sustainable management. Key policy priorities should include improving the accuracy of catch data, establishing species-specific quotas, and initiating aquaculture practice for Siganidae to avoid dependence on wild stock.

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