***Original Research Article***

**Analysis of otolith types in the stomach as an indicator of the feeding pattern of purple-spotted bigeye (*Priacanthus tayenus* Ricardson, 1846) from the waters of the Makassar Strait, Indonesia**

**ABSTRACT**

Purple-spotted bigeye is a demersal fish that has high economic value so that it is intensively utilized by coastal communities using various fishing gear. This study aims to analyze the diet of purple-spotted bigeye (*Priacanthus tayenus*) through the identification of otolith types found in the stomach. Otoliths as hard structures that are resistant to digestion and have unique morphology between species are used as taxonomic indicators to reconstruct prey types. Purple-spotted bigeye fish samples were collected from the waters of the Makassar Strait, and their stomach contents were analyzed morphologically using a descriptive and comparative approach to the otolith reference collection. The stomach samples of purple-spotted bigeye observed were 45 pieces according to the number of fish dissected. The results showed that the types of otoliths found were 16 pieces consisting of sagitta, lapillus and asteriscus types. The variety of otolith types comes from 11 families, namely Mullidae, Ariidae, Apogonidae, Cynoglossidae, Moringuidae, Plotosidae, Synodontidae, Cynoglossidae, Ambassidae and Leiognathidae. The diversity of otoliths found reflects the flexibility of Purple-spotted bigeye eating to the composition of prey available in its habitat. This finding shows that otolith analysis in the stomach can be used as an effective approach to identify predator feeding ecology. Sagitta type otoliths were found more than other types of otoliths, while food was dominated by the Mullidae family.

Keywords: Purple-spotted bigeye, diet, otolith types, stomach contents. Makassar Strait

1. **INTRODUCTION**

Information on the dynamics of predator feeding in marine ecosystems is key in assessing the balance of the food chain and determining the direction of sustainable management of biological resources. One of the predators that is quite dominant in tropical waters of Indonesia is the purple-spotted bigeye (*Priacanthus tayenus*), which is known to have an ecological role as an active predator of various types of small demersal fish (Froese & Pauly 2024). As an opportunistic predator, the purple-spotted bigeye can reflect the composition of the prey community in a habitat and be an important indicator in assessing the structure of aquatic communities.

Dietary studies generally use stomach content analysis to identify the types of food consumed by fish. However, the challenge of this method is due to the high level of digestion which can obscure the morphology of the prey, and complicate the identification process (Baker et al. 2014). Therefore, the use of hard structures that are resistant to the digestion process, such as otoliths, is a very effective alternative. Otoliths are calcium carbonate structures in the vestibular system of fish (Kantun and Budimawa 2022; Annisa et al. 2024; Kantun et al. 2024) which are not only resistant to degradation, but also have a distinctive shape that allows taxonomic identification of prey to the species level (Tuset et al. 2008)

The use of otolith analysis as an approach to reconstruct the diet of marine predators shows that morphological characteristics and otolith size can be used to estimate prey composition, even in specimens that have been completely visually degraded in the digestive tract. In addition, otolith identification can also provide temporal information about feeding activity and prey preferences across seasons or environmental conditions.

Tropical marine ecosystems are known to have very high biodiversity, including various species of small and large pelagic fish. This high biodiversity causes the food chain to be complex and dynamic, making it difficult to understand without accurate identification methods such as otolith analysis. Wainwright & Bellwood (2002) revealed that in tropical areas, many prey species have similar body sizes and morphologies, making it difficult to identify only from the remains of soft tissue in the stomach. Otoliths that are resistant to digestion are reliable indicators for specific identification of prey species.

In Indonesia, studies on the diet of predatory fish based on otolith analysis are still very limited, even though this country has very high marine biodiversity. Therefore, this study is important to fill this knowledge gap. This study aims to analyze the types of otoliths found in the stomach of the purple-spotted bigeye as indicators of diet and prey preferences in tropical waters. The results of this study are expected to enrich the biological and ecological information of this important predator species and provide a scientific basis for conservation efforts, fish stock management, and preservation of Indonesia's marine biodiversity.

1. **MATERIALS AND METHODS**

**2.1 Data collection and sample handling**

The purple-spotted bigeye used as samples amounted to 45 fish consisting of small, medium and large sizes, 15 each, which were landed at the fish landing site. Otolith extraction was carried out by splitting the stomach of the fish, then observing, separating and collecting the otoliths. Handling of otoliths using distilled water to clean the otoliths from the remaining membranes and mucus, then dried and then put into an eppendorf bottle before the otoliths were measured and weighed.

**2.2 Observation of otolith types**

Observation of otolith types was carried out on all otoliths that were still intact and undamaged. Otolith images were taken using an Olympus Sz61 binocular microscope because of its small size. Otoliths were separated by type and then compared with a collection of otolith references in finding the name of the fish and its scientific language.

**2.3 Data Analysis**

The results of the observations were analyzed using a descriptive narrative and comparative approach to the otolith reference collection to find the names and families of fish preyed on by the purple-spotted bigeye.

1. **RESULT AND DISCUSSION**

**3.1 Types of otoliths**

Based on the number of samples of purple-spotted bigeye whose stomachs were dissected, 16 otoliths were found, consisting of 7 sagitta otoliths (43.75%), 6 asteriscus otoliths (37.50%) and 3 lapillus otoliths (18.75%), as shown in Table 1.

Table 1. Types and forms of otoliths, types and families of fish found during the study.





The dominance of sagitta otoliths in the stomach of the purple-spotted bigeye. (*Priacanthus tayenus*) reflects a combination of feeding preferences for small-sized demersal fish, the physical resistance of sagitta to degradation in the digestive tract allowing for higher identification, the size and structure of sagitta supporting its use in studies of demersal fish diets and the adaptation of sagitta to the bottom habitat.

These findings are the basis for identifying the ecology of demersal species in analyzing the dynamics of food webs in supporting sustainable fisheries management in Indonesia and its surroundings. Ferri (2023) explained the structure of otoliths, including sagitta, as the largest and most resistant part to the digestion process in the stomach of predators, making it the main indicator in the study of fish diet and trophic ecology. Eko et al. (2024) found that *P. tayenus* is a high-level carnivore with a trophic level of ~3.9–4.2, having a main diet of fish and shrimp which strengthens the argument for the dominance of sagitta.

**3.2** **Type of Food**

Based on the data in Table 1, it also shows that based on the results of the comparison with the otolith reference collection, 11 fish families were found from the stomach of the purple-spotted bigeye, namely 4 families of Mullidae (25.00%), 2 families of Ariidae and Apogonidae (12.5%), while the others each had 1 family with 6.25%, namely Cynoglossidae, Moringuidae, Plotosidae, Synodontidae, Cynoglossidae, Ambassidae and Leiognathidae.

Stomach content analysis is a study of fish ecology to identify and analyze feeding patterns, prey selectivity, and the role of species in food webs. One important indicator in this analysis is the presence of otoliths, which are calcium carbonate structures found in the inner ear of fish, divided into three types, namely sagitta, lapillus, and asteriscus. Each has different morphological and resistance characteristics, so that their distribution in the stomach contents of predators provides specific ecological clues (Avigliano et al. 2021).

The purple-spotted bigeye is a demersal fish that is widely distributed in Indo-Pacific waters, including Indonesia, and is associated with bottom habitats such as coral reefs, muddy bottoms, and sandy substrates (Froese & Pauly 2024). As a predator, the purple-spotted bigeye preys on various types of small fish, crustaceans, and cephalopods in bottom habitats and lower water columns. The finding of the dominance of sagitta otoliths in the stomach of the purple-spotted bigeye has several important ecological and biological meanings in management, namely as an indication of the preference for hard-boned fish prey, the physical resistance of sagitta otoliths in the digestive system, a reflection of the activity of demersal predators in the bottom zone, and a contribution to the study of tropical ecology and fisheries management.

Avigliano et al. (2021). Analysis of prey otoliths, especially sagitta, is an effective method for reconstructing predator diets, identifying energy flows in bottom ecosystems, and designing tropical fisheries conservation strategies. The results of sagitta identification can be used to estimate the structure of prey communities and the impact of purple-spotted bigeye predation on the dynamics of bottom water populations.

The dominance of the Mullidae family as the main prey in the stomach contents of demersal predatory fish, especially Priacanthus tayenus, is thought to be the result of complex ecological interactions involving aspects of habitat distribution, prey behavior, resource availability, and energy efficiency (Anindhita et al. 2014; Eko et al. 2024), the characteristics of mullidae which are easily accessible and easy to catch, high abundance, body size suitable for medium predators, high energy content and minimal physical defense of mullidae.

In the study of stomach contents, it was found that families such as Cynoglossidae, Moringuidae, Plotosidae, Synodontidae, Ambassidae, and Leiognathidae were only slightly identified as prey. This is thought to be related to the fact that most members of these families have specific habitat preferences, such as: Cynoglossidae are more dominant on muddy or fine sand bottoms in shallow waters (Munroe and Jun 2022). Moringuidae and Plotosidae generally inhabit coral bottoms, crevices, or hidden rocky areas. Meanwhile, the Synodontidae family has a hiding behavior in crevices or rocky substrate bottoms (Hixon & Randal. 2019).

Some species have physical adaptations that make them less desirable or difficult to catch, such as Plotosidae which have poisonous dorsal and pectoral fin spines, which pose a risk to predators (Turan et al. 2020). Moringuidae and Cynoglossidae are elongated or flattened, allowing effective hiding in the bottom substrate (Vo et al. 2025; Smith et. 2024). Leiognathidae are known for their ability to camouflage in the sand or mud of the bottom, minimizing visual detection by predators (Pauly 2018).

Some families, such as Ambassidae and Leiognathidae, have relatively small and transparent body sizes, so they can easily escape the attention of large predators, causing predators to choose other larger or more nutritionally advantageous prey (Mihalitsis et al. 2022; Mihalitsis et al. 2024). If the fish community of these families is not abundant in the purple-spotted bigeye movement area, naturally the probability of being found as prey also decreases. Factors such as habitat degradation, fishing pressure, or local environmental conditions affect this abundance.

The low findings of the Cynoglossidae, Moringuidae, Plotosidae, Synodontidae, Ambassidae, and Leiognathidae families in the stomach of the purple-spotted bigeye may be caused by differences in habitat preferences and spatial distribution with the movement areas of the purple-spotted bigeye, morphological and behavioral adaptations such as camouflage, hiding, or body defense, small body size or shape that does not match predator preferences and low population abundance in the study area or local habitat.

**CONCLUSIONS**

Based on the results of the identification of the types of otoliths found in the stomach of the purple-spotted bigeye, the otoliths are sagitta, lapillus and asteriscus types and are dominated by sagiita type otoliths. The results of the comparison with the reference collection of otoliths found that the purple-spotted bigeye eat fish from the families Mullidae, Ariidae, Apogonidae, Cynoglossidae, Moringuidae, Plotosidae, Synodontidae, Cynoglossidae, Ambassidae and Leiognathidae. The food of the purple-spotted bigeye is dominated by the Mullidae family.

**REFERENCES**

Anindhita G. K., Saputra S. W., & Ghofar A. (2014). Some Biological Aspects of purple-spotted bigeye (Priacanthus tayenus) Landed in Morodemak. Management of Aquatic Resources Journal, 3(3): 144-152. <https://ejournal3.undip.ac.id/index.php/maquares/article/view/6666>

Annisa, S.N., Kantun, W dan Arnold, K. (2024). Otolith Shape Indices of Japanese Threadfin Bream (Nemipterus japonicus, Bloch 1791) from the Makassar Strait, Indonesia. Asian Journal of Fisheries and Aquatic Research. 26 (5): 90-96. <https://journalajfar.com/index.php/AJFAR/article/view/769/1516>

Avigliano, E., Nadia, M.A.,Rico, M.R., Claudio, O.R.,Luciana, D.A.,Ana, M., Jorge, P., Alejandra, V.V. (2021). Population structure and ontogenetic habitat use of Micropogonias furnieri in the Southwestern Atlantic Ocean inferred by otolith chemistry. 240. Page 105953. <https://www.sciencedirect.com/science/article/abs/pii/S0165783621000813>

Baker, R., Buckland, A., & Sheaves, M. (2014). Fish gut content analysis: robust measures of diet composition. Fish and Fisheries, 15(1), 170–177. <https://onlinelibrary.wiley.com/doi/abs/10.1111/faf.12026>

Bentur, Y., Altunin, S., Levdov, I., Golani, D., Spanier, E., Edelist, D., & Lurie, Y. (2018). The clinical effects of the venomous Lessepsian migrant fish Plotosus lineatus (Thunberg, 1787) in the Southeastern Mediterranean Sea. Clinical Toxicology, 56(5), 327–331. <https://pubmed.ncbi.nlm.nih.gov/28980497/>

Ferri, J. (2023). Otoliths and Their Applications in Fishery Science. University of Split Croatia. P 270. <https://archimer.ifremer.fr/doc/00833/94450/101775.pdf>

Froese, R., & Pauly, D. (Eds.). (2024). FishBase. World Wide Web electronic publication. www.fishbase.org

Hixon, M.A., & Randal, J.E. (2019). Coral Reef Fishes. In Cochran, J. Kirk; Bokuniewicz, J. Henry; Yager, L. Patricia (Eds.) Encyclopedia of Ocean Sciences, 3rd Edition. vol. 2, pp. 142-150. <https://manoa.hawaii.edu/lifesciences/wp-content/uploads/sites/65/2023/08/Hixon-Randall-19-Ency-Ocean-Sci-coral-reef-fishes.pdf>

Kantun W. dan Budimawan. (2023) Application of autolithometry in fisheries. IPB Press. <http://ipbpress.com/product/1273-penerapan-otolitometri-dalam-perikanan>

Kantun, W., Sri. A.S. dan Sri, W. (2024). Morphometric Index Analysis of Otolith Asteriscus of purple-spotted bigeye (*Priacanthus tayenus* Ricardson, 1846) from Makassar Strait Waters. Balik Diwa Research Journal. 2 (2): 86-90. <https://ejurnal.itbm.ac.id/jbd/issue/view/8>

Lin, Y.S., & Chang, C.W. (2012). otolith Atlas of Fishes of Taiwan. National Taiwan Ocean University Press. <https://www.researchgate.net/publication/267475757_Otolith_Atlas_of_Taiwan_Fishes>

Mihalitsis, M., Morais, R. A., & Bellwood, D. R. (2022). Small predators dominate fish predation in coral reef communities PLOS Biology, 20(11): e3001898. <https://chatgpt.com/c/685fd348-480c-8011-9a66-9e96334f7616>

Mihalitsis, M.,David, R.B., & Peter, C.W. (2024). Sit and survive: predation avoidance by cryptobenthic coral reef fishes. Marine Biology, 171: 7. <https://fishlab.ucdavis.edu/wp-content/uploads/sites/397/2023/11/Mihalitsis_et_al_2023.pdf>

Munroe, T.A. & Jun, H. (2022). A new Western Pacific Tonguefish (Pleuronectiformes: Cynoglossidae): The first Pleuronectiform discovered at active Hydrothermal Vents. Zootaxa 1839: 43– 59. <https://www.mapress.com>

Pauly, D. (2018). The Leiognathidae (Teleosts): an hypothesis relating their mean depth occurrence to the intensity of their counter‑shading bioluminescence. Marine Research in Indonesia, 19, 137–146. <https://www.researchgate.net/publication/327826364_the_leiognathidae_teleosts_an_hypothesis_relating_their_mean_depth_occurrence_to_the_intensity_of_their_countershading_bioluminescence>

Eko, S., Murwantoko, Satriyo T. B., & Prastiwi F. A. (2024). Food Preference of Purple‑Spotted Bigeye (*Priacanthus tayenus* Richardson 1846) in Northern Coast of Java, Indonesia. <https://www.researchgate.net/publication/384882399_Food_Preference_of_Purple-Spotted_Bigeye_Priacanthus_tayenus_Richardson_1846_in_Northern_Coast_of_Java_Indonesia>

Smith, D.G., Alexandre, P.C.,Matheus, M.R.,Cintia, O.C. & Rodrigo, A.C. (2024). A review of the genus Neoconger (Anguilliformes: Moringuidae), with the description of a new species. Zootaxa, 5492(1), 109–128. <https://mapress.com/zt/article/view/zootaxa.5492.1.6>

Turan, C., Gürlek, M., Dağhan, H., Demirhan, S. A., & Karan, S. (2020). First clinical case of the venomous Lessepsian migrant fish Plotosus lineatus in the Iskenderun Bay, the Northeastern Mediterranean Sea. Natural and Engineering Sciences, 5(1), 50–53. <https://dergipark.org.tr/en/pub/nesciences/issue/52549/691699>

Tuset, V.M., Lombarte, A., & Assis, C.A. (2008). Otolith atlas for the western Mediterranean, north and central eastern Atlantic. Scientia Marina, 72(1), 7–198. <https://scientiamarina.revistas.csic.es/index.php/scientiamarina/article/view/1018>

Vo, Q. V., Ho, H.‑C., & Hibino, Y. (2025). Two new records of worm or spaghetti eel genus Moringua (Anguilliformes: Moringuidae) from estuaries and lagoons in Vietnam. Journal of Marine Science and Technology, 25(2), 127–140. <https://vjs.ac.vn/index.php/jmst/article/view/22728>

Wainwright, P. C., & Bellwood, D. R. (2002)."Ecomorphology of feeding in coral reef fishes."Coral Reef Fishes: Dynamics and Diversity in a Complex Ecosystem, Academic Press, 33–55. <https://fishlab.ucdavis.edu/wp-content/uploads/sites/397/2020/06/Wainwright-Bellwood-2002.pdf>