



The Existence of the Non-Native Western Mosquitofish *Gambusia affinis* (Baird & Girard, 1853) (Cyprinodontiformes: Poeciliidae) on Belitung Island, Indonesia

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ABSTRACT

The western mosquitofish, *Gambusia affinis*, is a species native to North America. This species is currently the most widely distributed freshwater fish in the world, and it is considered one of the world's 100 most invasive species. The western mosquitofish has been widely introduced as a biological agent for mosquito control and is now established in natural waters of mainland Indonesia. This research presents a first-time record of the western mosquitofish on Belitung Island, Indonesia. In February 2024, fourteen individuals of *Gambusia affinis* were captured from the waterways of East Belitung Regency, Belitung Island, Indonesia. The species is considered a potential threat to native biodiversity, as it has been classified as a "high-risk" invasive in mainland waters. More monitoring and management of western mosquitofish should be conducted in Indonesia to mitigate invasion risk and protect native fish biodiversity from this exotic species.

INTRODUCTION

Indonesia harbors an exceptional diversity of freshwater fish, exceeding 1,200 species, comprising endemic, native, introduced, and reintroduced taxa (Valen *et al.*, 2022; Robin *et al.*, 2023a). This extensive ichthyofaunal diversity is attributed to the nation's complex ecological landscapes and its distinct biogeographical evolution (Valen *et al.*, 2021; Insani *et al.*, 2022; Syarif *et al.*, 2023a). Nonetheless, the introduction of non-native species has notably altered indigenous aquatic communities. Recent analyses reveal that 54 non-native freshwater fish species have been recorded in Indonesian ecosystems (Robin *et al.*, 2023b ; Syarif *et al.*, 2025). These introductions, primarily

linked to aquaculture expansion and the ornamental fish trade, present significant ecological challenges, including interspecific competition, predation pressures, and genetic hybridization, thereby posing substantial risks to native biodiversity (**Jatayu *et al.*, 2023; Jerikho *et al.*, 2023**). Consequently, the development and implementation of effective management and conservation strategies are critical to maintaining the integrity of Indonesia's freshwater ecosystems and preserving its unique biodiversity (**Hasan *et al.*, 2021; Robin *et al.*, 2022; Syarif *et al.*, 2023a**).

The western mosquitofish (*Gambusia affinis*, Baird & Girard, 1853) is a freshwater poeciliid native to North America, and has recently been reported as an invasive species in Indonesian waterways (**Buwono *et al.*, 2021**). This species is recognized as the most widely distributed freshwater fish globally, primarily due to its intentional introduction as a biological control agent aimed at reducing mosquito populations and mitigating malaria transmission (**Wang *et al.*, 2022**). Despite its intended benefits, *Gambusia affinis* is highly invasive and poses significant ecological threats to non-native habitats. The International Union for Conservation of Nature (IUCN) has classified this species among the “100 of the World's Worst Invasive Alien Species” due to its high invasiveness and adverse impacts on local biodiversity. Its presence in new ecosystems can lead to competitive displacement of native species, predation on native larval stages, and disruption of trophic interactions, ultimately threatening the integrity of aquatic ecosystems.

In this research, we report the first record of *G. affinis* in Manggar City, Belitung Island, Indonesia. Belitung Island has a high level of endemism (**Syarif *et al.*, 2025**), particularly in east Belitung, where there is an ancient river with a wide range of aquatic biota variety (**Kusumah *et al.*, 2023; Syarif *et al.*, 2023b; Hasan *et al.*, 2024**). However, the non-native species would likely have a negative impact on aquatic diversity by predation of eggs and larvae of endemic fish and competition for food resources (**Hasan *et al.*, 2019**). In recent records, *G. affinis* became well-established in natural waters of Indonesia (mostly in Java Island) (**Rahmi *et al.*, 2023**), where they primarily occur in shallow waters with low currents. However, these new records of the presence of *G. affinis* on Belitung Island provide new information on the distribution range of this species in the country. Knowledge on the distribution range of exotic species is an important basis for designing conservation policies.

MATERIALS AND METHODS

Fish sampling was conducted in natural water bodies, including rivers, streams, and the canal of Manggar City, Belitung Island, Indonesia on 20th February 2024. Fourteen specimens of the western mosquito fish were caught using a fish trap (mesh size 50mm). The fish trap was placed in the river or canal from the afternoon to the following morning (approximately 14 hours). The specimens were measured immediately after capture for standard length (SL), total length (TL), and body weight (W). Fish were identified at the

species level according to dorsal and anal fin ray counts based on the method of **Walton *et al.* (2016)**. The specimens were fixed in 10% formaldehyde (**Hasan *et al.*, 2019**) for long-term preservation. All fixed specimens were deposited in the Ichthyological Collection of Aquaculture Laboratory, Faculty of Fisheries, Agriculture and Marine, Universitas Bangka Belitung, Bangka, Indonesia, including nine males and five females.

RESULTS

1. New record

INDONESIA – Belitung Island, Manggar City, irrigation canal; collected by F. Yusnandar using a fish trap. Fourteen specimens; photographed.



Fig. 1. Life specimen of the western mosquitofish *Gambusia affinis* from Belitung Island

2. Species identification

Based on morphometric data, the specimens found in the irrigation canal of Manggar City, Belitung island were confirmed as western mosquitofish *G. affinis* (Fig. 1). Fourteen *G. affinis* showed total length (TL) ranging from 20 to 30mm, standard length ranging from 16-25mm, and total weight (TW) between 0.08-0.20g. The following meristic characteristics were observed (**Walton *et al.*, 2016**): Total dorsal spines: 0; total dorsal soft rays: 7; anal spines: 0; anal soft rays: 9. The pelvic fin has 6 rays, and the pectoral fin has 11 rays.

The sex of *G. affinis* was determined using the morphology of the anal fin and gonads examination. We found nine males of *G. affinis*, possessing a fully developed gonopodium, and five females. Sex determination was also confirmed through the direct observation of gonads.

3. Distribution

Our study confirmed that the mosquitofish species on Belitung Island is the western mosquitofish *G. affinis*. While the species is known to have invaded other parts of

Indonesia (Buwono *et al.*, 2021; Rahmi *et al.*, 2023), our discovery on Belitung Island, which lies approximately 400km from previously known records (West Jawa) (Fig. 2), marks an expansion of the species' invasion range on Indonesian territory.

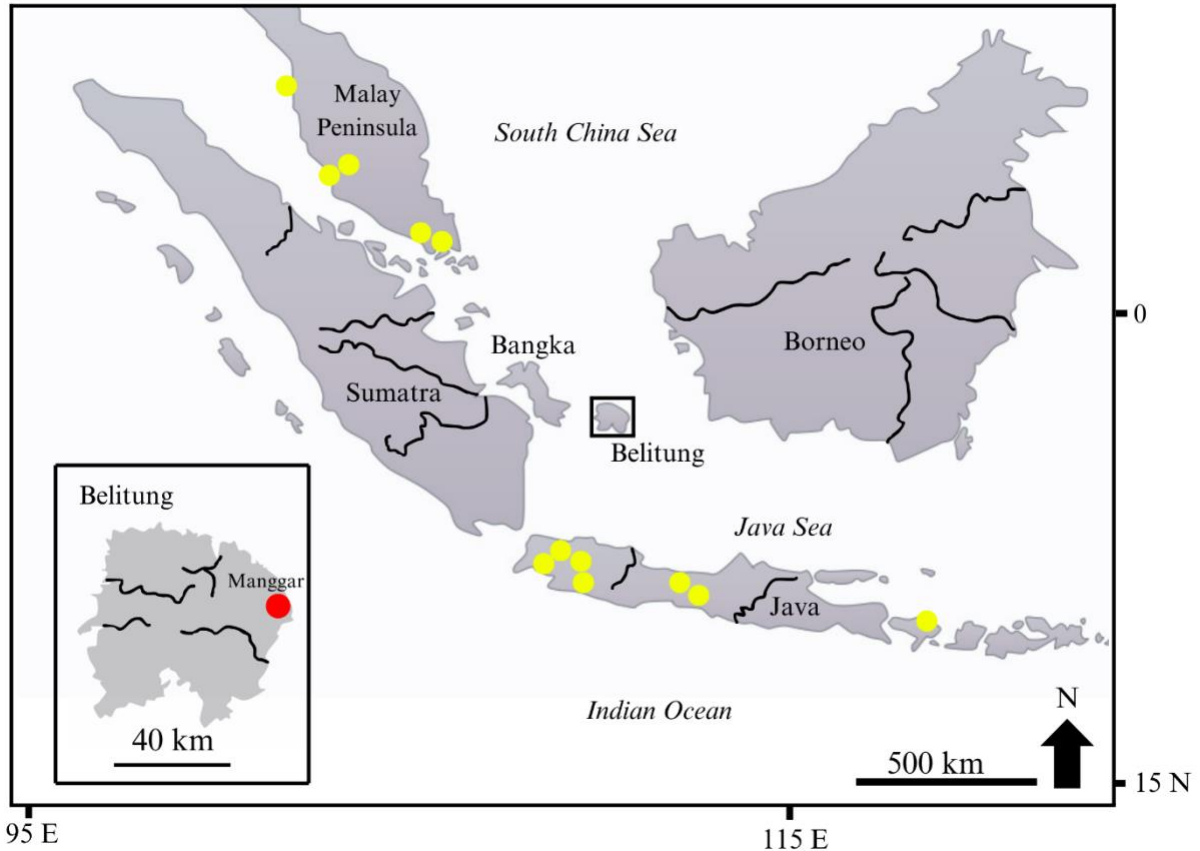


Fig. 2. Map of the known distribution of the western mosquitofish *G. affinis* in Indonesia. New record in Belitung Island, Indonesia (red dot); published records (yellow dots) are based on habitat

4. Habitat

Our findings suggest that *G. affinis* established itself in the natural waterways of Belitung Island. Our observations of *G. affinis* typically occur in calm waters (Fig. 3). The collection place was a clear water stream with a depth ranging from 0.10 to 0.20m, the water temperature was 25°C, and the pH was 5-6. We discovered several fish in the vicinity that could be affected, including *Desmopuntius gemellus*, *Brevibora cheeya*, and *Betta edithae*, *Betta foerschi* (Syarif *et al.*, 2023c; Kurniawan *et al.*, 2024).



Fig. 2. Collection site in a canal of Manggar City, Belitung Island, Indonesia

DISCUSSION

G. affinis was first introduced to Indonesia as biological mosquito control through a global malaria control program. However, the highly adaptive nature of the species and its wide environmental tolerance, where the species is able to survive in varying temperature conditions, low to moderate salinity, and low water quality with minimal dissolved oxygen content, allows *G. affinis* to spread rapidly into various natural habitats. In addition, the species is quite aggressive and has a high reproductive potential, causing it to be able to multiply rapidly. Its adaptability and rapid reproduction make *G. affinis* one of “100 of the World’s Worst Invasive Alien Species” according to the IUCN.

In this study, we confirmed that *G. affinis* spread to the public waters of Belitung Island. Its presence in the natural freshwater ecosystems of Belitung Island likely has detrimental effects on various native and endemic fish species (Serdianti *et al.*, 2020; Valen *et al.*, 2023b). In various aquatic ecosystems around the world, species are known to have the potential to disrupt ecological balance through competition and predation against local species (Serdianti *et al.*, 2021; Valen *et al.*, 2024). Its introduction can threaten the sustainability of populations of these species through direct competition for food resources, such as zooplankton and insect larvae (Insani *et al.*, 2021; Wijayanti *et al.*, 2021). *G. affinis* can also threaten local fish directly through predation on their eggs

and larvae. Research in Australia and New Zealand has shown that *G. affinis* can reduce the reproductive success of native fish through physical disturbances and living space competition, ultimately affecting the structure of local fish communities.

In addition to ecological impacts, the presence of *G. affinis* could also have an impact on the social and economic aspects of local communities. Freshwater on Belitung Island is not only ecologically important, but also economically as a source of livelihood through capture fisheries and freshwater fish farming (Hasan *et al.*, 2024; Kurniawan *et al.*, 2024). The presence of *G. affinis* can reduce the productivity of local fisheries by suppressing native fish populations with high economic value. Moreover, the decline in biodiversity and fisheries productivity can have a negative impact on local tourism that relies on natural attractions. Belitung Island, which is famous for its natural beauty and biodiversity (Hasan *et al.*, 2023; Syarif *et al.*, 2025), may experience a decrease in tourist interest if the balance of its freshwater ecosystems is disturbed due to the invasion of *G. affinis*.

To reduce the negative impact of *G. affinis*, effective control and management strategies are needed. One approach that can be done is to carry out local eradication in areas that are hotspots for the species' spread. This method can be done through selective fishing using fish traps designed specifically for *G. affinis*. In addition to eradication, a preventative approach through educating local communities about the negative impacts of *G. affinis* and the importance of local biodiversity conservation is also advised. Educational programs can increase public awareness of the importance of not moving these invasive fish to other waters on Belitung Island.

CONCLUSION

This report documents the first recorded occurrence of *G. affinis* on Belitung Island, Indonesia. Given its potential negative impact on local biodiversity, further research is needed to understand its distribution, population dynamics, and interactions with native species. Additionally, effective monitoring and management strategies are crucial to prevent further spread and minimize adverse ecological impacts.

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