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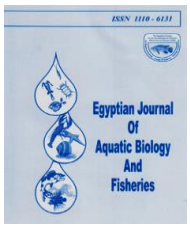

Sex Ratio, Size at First Maturity and Spawning Season of the Threadfin Rainbowfish (*Iriatherina werneri* Meinken 1974) in Rawa Biru Swamp and Wanggo River, Merauke Regency, South Papua

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ABSTRACT

The threadfin rainbowfish (*Iriatherina werneri* Meinken 1974) is the sole species of the genus *Iriatherina* and was first discovered in Merauke Regency in 1973. This research aimed to examine the sex ratio, size at first gonad maturity, and spawning season of the threadfin rainbowfish (*I. werneri*) in Rawa Biru Swamp and Wanggo River, Merauke Regency, South Papua. The research was conducted for six months, from November 2022 to April 2023. In the meantime, the research employed exploratory research where the data analyzed were sex ratio, size at first gonad maturity, and gonad maturity stages. The findings denoted that overall the sex ratio of male and female threadfin rainbowfish found in Rawa Biru is 0.87:1.00 and in the Wanggo River is 0.96:1.00. The chi-square test results showed that the number of male and female fish in Rawa Biru is balanced, following a pattern of 1.00:1.00 (χ2value = 0.1437, χ2table = 9.4877). The male threadfin rainbowfish in Rawa Biru mature their gonads at a total length of 26.23 mm, while female fish mature at 25.86 mm. In Wanggo River, male fish mature first at a size of 27.99mm and female fish at a size of 24.83mm. Based on the results of analysis of the GML threadfin rainbowfish in Rawa Biru and Wanggo River, generally the male and female fish caught are in the reproductive period. The sex ratio of the threadfin rainbowfish in Rawa Biru Swamp and Wanggo River was balanced, following a pattern of 1.00:1.00. Female fish in Rawa Biru Swamp and Wanggo River reached first gonad maturity faster than male fish. Additionally, the spawning season of the threadfin rainbowfish occurs during the rainy season. The results indicate that the sex ratio of the threadfin rainbowfish in Rawa Biru and Sungai Wanggo is balanced, following a 1.00:1.00 pattern. Female fish in both Rawa Biru and Sungai Wanggo reach gonadal maturity more quickly than males. The spawning season for threadfin rainbowfish takes place during the rainy season.

INTRODUCTION

Rawa Biru Swamp and Wanggo River are two freshwater ecosystems located in Merauke Regency and host various aquatic biological resources, including turtles, crustaceans, mollusks, fish, and even crocodiles. Various native fish species have been reported to inhabit these waters, including the Australian bonytongue (*Scleropages jardinii*), barramundi (*Lates calcarifer*), Indo-

Pacific tarpon (*Megalops cyprinoides*), Strickland River gizzard shad (*Nematalosa papuensis*), mouth almighty (*Glossamia aprion*), spotted archerfish (*Toxotes chatareus*), freshwater longtom (*Strongylura krefftii*), threadfin rainbowfish (*Iriatherina werneri*), and red-striped rainbowfish (*Melanotaenia splendida rubrostriata*). In addition to native fish, non-native species such as the Nile tilapia (*Oreochromis niloticus*), Mozambique tilapia (*Oreochromis mossambicus*), striped snakehead (*Channa striata*), and climbing perch (*Anabas testudineus*) have also been found in these ecosystems **(Wibowo *et al*., 2015; Mote & Wibowo 2016; Laratmase *et al*., 2019)**.

Moreover, the threadfin rainbowfish (*Iriatherina werneri* Meinken 1974) is abundant in Rawa Biru Swamp and Wanggo River. This species is considered an ornamental fish due to its small body size and beautiful coloration. Another unique aspect of this species is that it is the sole species of its genus and exhibits sexual dimorphism and dichromatism. Additionally, male fish have more striking colors and possess brownish and black filaments on the second dorsal and anal fins, which extend to or beyond the tail (Fig. 1) **(Tappin, 2011)**. These unique features make the threadfin rainbowfish popular among ornamental fish enthusiasts in Indonesia, although it is not well-known in its native habitat in Merauke. This lack of recognition is due to limited data and lack of information about the species.

Fig. 1. The threadfin rainbowfish (*Iriatherina werneri* Meinken, 1974).
(a) Male and **(b)** female

Although the threadfin rainbowfish are abundant in their natural habitat, there is a possibility that their population could decline in the future. Several field observations indicate that habitat changes due to road construction, land conversion for oil palm plantations, and competition and predation from well-adapted non-native fish species are likely the causes of this potential population decline. Studies have reported that these factors can lead to population decreases, including research conducted by **Manangkalangi and Pattiasiana (2005)**, **Kartamihardja (2008)**, **Manangkalangi *et al*. (2009)**, **Siby *et al*. (2009)**, **Herder *et al*. (2012)**, **Syafei (2017)**, **Rinandha *et al*. (2020)**, **Hasanah *et al*. (2022)** and **Herder *et al*. (2022)**. Additionally, overfishing could contribute to population decline, especially if the market price for ornamental fish rises **(Kartamihardja 2008; Siby *et al*., 2009; Prianto *et al*., 2014; Omar *et al*., 2015; Syafei, 2017; Kariyanti *et al*., 2018)**. Given the pressures faced by the threadfin rainbowfish in their natural habitat and the lack of data on their reproduction, it is crucial to

conduct reproductive studies. This information can serve as a foundational dataset for the management and conservation of the threadfin rainbowfish in their native habitat in Merauke.

MATERIALS AND METHODS

Fish sampling was conducted in Rawa Biru Swamp and Wanggo River for six months, from November 2022 to April 2023 (Fig. 2). In detail, fish samples were captured using fine mesh nets and were then preserved in a 5% formalin solution for further analysis in the Department of Water Resource Management, Faculty of Agriculture, Universitas Musamus, Merauke laboratory. The equipment used included 200ml sample bottles, a digital camera, a digital scale with a precision of 0.0001g, a digital caliper with a precision of 0.01mm, a magnifying glass, a dissecting set, tissue, petri dishes, and laminated graph paper.

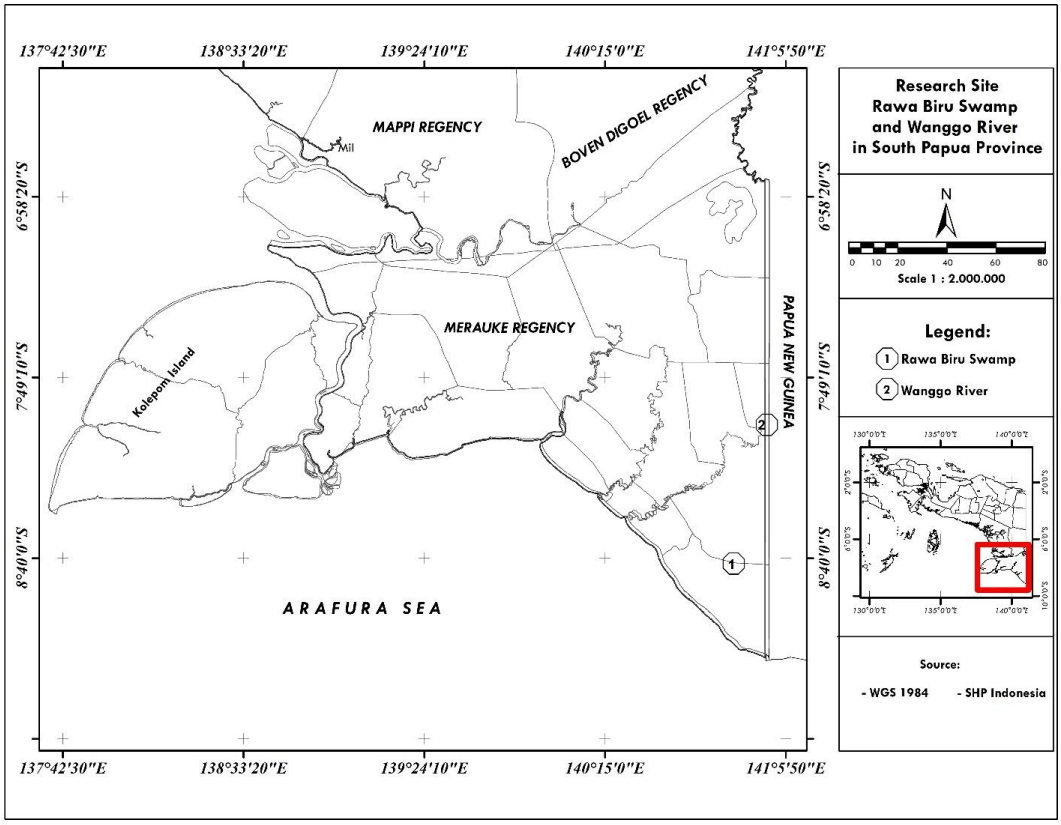

Fig. 2. Research site of the threadfin rainbowfish (*Iriatherina Werneri* Meinken, 1974) in Rawa Biru Swamp and Wanggo River, Merauke Regency, South Papua

Moreover, this research employed a survey method where the data analyzed were sex ratio, size at first gonad maturity, and gonad maturity stages. The data analysis were as follows:

1. Sex ratio

The sex ratio can be determined based on the number of male and female threadfin rainbowfish captured during each sampling period. The sex of the fish was identified after dissection of the samples. The formula used to calculate the sex ratio was:

$$SR = \frac{\Sigma M}{\Sigma F}$$

Where, SR = sex ratio; ∑M = number of male fish (ind.); ∑B = number of female fish (ind.)

To determine whether the overall sex ratio between male and female fish, both based on the sampling time and gonad maturity level (GML), was equal to 1.00:1.00, a chi-square test was used, and organized in the form of a contingency table **(Steel & Torrie 1989)**. The formula for the chi-square test was:

$$\chi^2 = \sum_{i=1}^{k} \frac{(Oi - Ei)^2}{Ei}$$

Where, χ^2 = chi-square value; O = observed frequency of male or female fish; E = expected frequency of male or female fish.

$$\mathrm{Ei} = \frac{(n_{io} \times n_{oj})}{n}$$

Where, E_{ij} = expected theoretical frequency; n_{io} = number of rows to-i, n_{oj} - number of rows to-j; n = the number of frequencies acquired from the observation values.

To determine whether the sex ratio between male and female fish at each sampling time and at each gonad maturity level (GML) was equal to 1.00:1.00, the Yates correction for continuity (Zar 2010) was used with the following formula:

$$\chi^2 = \sum_{i=1}^{2} \frac{(|x_i - x'| - 0.5)^2}{x'}$$

Where, χ^2 = chi-square value; x_i = observed frequency; x' = expected frequency.

2. Size at first gonad maturity

Gonad maturity level (GML) was determined by visually observing the morphology of the gonads. Additionally, the gonad maturity level was categorized based on the development and maturity stages of the gonads in the Arfak rainbowfish, *Melanotaenia arfakensis* **(Manangkalangi et al., 2009)**.

Moreover, the mean size at first gonad maturity was estimated using the Spearman-Karber method **(Udupa, 1986)**. The criteria for gonad maturity were GML III, IV, and V. The formula was as follows:

$$\log m = X_k + \frac{x}{2} - (\mathrm{X} \sum Pi)$$

To calculate the minimum and maximum gonad size at first gonad maturity (with a 95% confidence level), the formula used was as follows **(Udupa, 1986)**:

$$M = antilog\left[m \pm 1{,}96\sqrt{X^2\sum\frac{(p_1 - q_1)}{(n_1 - 1)}}\right]$$

Where, M - the average length of fish at first gonad maturity; m - the logarithm of fish length at first gonad maturity; Xk - logarithm of the mean value of the length class at first gonad maturity; X - the difference in the logarithm of the middle values; p_i - proportion of fish mature gonad in class i (pi = ri / ni); ri - number of gonad mature fish in class I; ni - number of fish with mature gonads in class i, qi = 1 – pi.

RESULTS AND DISCUSSION

1. Distribution of numbers and sex ratio

The number of the threadfin rainbowfish caught in Rawa Biru Swamp during the research (November 2022 - March 2023) was 282, consisting of 131 males and 151 females, while the number seen in Wanggo River was 271, consisting of 133 males and 138 females. In contrast, the distribution of the numbers and sex ratio of the threadfin rainbowfish in Rawa Biru Swamp and Wanggo River based on sampling time is observable in Table (1). Additionally, the distribution and sex ratio of the threadfin rainbowfish in Rawa Biru Swamp and Wanggo River based on sampling time is depicted in Table (2). During the research period in Rawa Biru Swamp and Wanggo River, no fish were found at GML V, either male or female.

Table 1. Distribution of numbers and sex ratio of the threadfin rainbowfish obtained during the research in Rawa Biru Swamp and Wanggo River based on sampling time

Month	Number of fish (ind.)		Sex ratio	χ^2_{value}	Significant or not at 5% level
	Male	Female			
Rawa Biru					
November	23	27	0.85:1.00	0.1800	NS
December	27	31	0.87:1.00	0.1552	NS
January	28	30	0.93:1.00	0.0172	NS
February	27	31	0.87:1.00	0.1552	NS
March	26	32	0.81:1.00	0.4310	NS
Wanggo River					
November	25	29	0.86:1.00	0.1667	NS
December	26	31	0.84:1.00	0.2807	NS
January	27	24	1.13:1.00	0.0784	NS
February	26	28	0.93:1.00	0.0185	NS
March	29	26	1.12:1.00	0.0727	NS

Degrees of freedom = 1 in all cases; χ^2_{table} = 3.8415; NS: not significant

Table 2. Distribution of numbers and sex ratio of the threadfin rainbowfish obtained during the research in Rawa Biru Swamp and Wanggo River based on gonad maturity level

Gonad maturity level	Number of fish (ind.)		Sex ratio	χ^2_{value}	Significant or not at 5% level
	Male	Female			
			Rawa Biru		
I	2	5	0.40:1.00	0.5714	NS
II	22	15	1.47:1.00	0.9730	NS
III	55	66	0.83:1.00	0.8264	NS
IV	52	65	0.80:1.00	1.2308	NS
			Wanggo River		
I	5	4	1.25:1.00	0.0000	NS
II	25	17	1.47:1.00	1.1667	NS
III	69	60	1.15:1.00	0.4961	NS
IV	34	57	0.60:1.00	5.3187	S

Degrees of freedom = 1 in all cases; χ^2_{table} = 3.8415; NS: not significant; S = significant

Overall, the sex ratio of the male to the female threadfin rainbowfish found in Rawa Biru Swamp was 0.87:1.00, and in Wanggo River, it was 0.96:1.00. The chi-square test results indicated that the number of male and female fish in Rawa Biru was balanced, following a 1.00:1.00 pattern (χ^2value = 0.1437, χ^2table = 9.4877, as was the case in Wanggo River (χ^2value = 1.0572, χ^2table = 9.4877). The same pattern was found at each sampling time in both locations (Table 1). Moreover, the sex ratio of male to female threadfin rainbowfish based on gonad maturity level in Rawa Biru Swamp indicated a balanced ratio, following a 1.00:1.00 pattern (χ^2value = 3.6544, χ^2table = 7.8147). However, in Wanggo River, the sex ratio was not balanced and did not follow the 1.00:1.00 pattern (χ^2value = 7.9865, χ^2table = 7.8147). Table (2) indicates a balanced sex ratio at each gonad maturity level in Rawa Biru Swamp. In contrast, different results were obtained in Wanggo River, where the sex ratio of male to female fish at GML IV was not balanced, while it was balanced at GML I, II, and III.

According to **Allen (1991)** and **Allen *et al.* (2000)**, the reproductive behavior of the rainbowfish during spawning typically involves pairing. This has also been observed in other species of the rainbowfish, such as the Arfak rainbowfish (*M. arfakensis*) in three rivers in Kebar **(Manangkalangi & Pattiasina, 2005)**, the Arfak rainbowfish in Nimbai River and Aimasi River, Manokwari, Papua **(Manangkalangi *et al.*, 2009)**, the red rainbowfish (*Glossolepis incisa*) in Lake Sentani, Papua **(Siby *et al.*, 2009)**, the bonti-bonti fish (*Paratherina striata*) in Lake Towuti, South Sulawesi **(Omar *et al.*, 2011)**, the marmorated medaka (*Oryzias marmoratus*) in Lake Towuti **(Sulistiono, 2012)**, the Matano medaka (*Oryzias matanensis*) in Lake Towuti **(Rinandha *et al.*, 2020)**, and the Celebes rainbowfish (*Marosatherina ladigesi*) in Pattunuang River and Batu Puteh River, South Sulawesi **(Nasyrah *et al.*, 2021)**. Moreover, there are several other species of the rainbowfish found in various locations in Australia **(Pusey *et al.*,**

2001). Another unique fact is that a balanced condition indicates that these fish do not experience difficulty in finding a mate during spawning **(Manangkalangi *et al*., 2009)**.

Meanwhile, Table (1) denotes that the sex ratio of the threadfin rainbowfish in Rawa Biru Swamp and Wanggo River indicated a healthy population, as more females were caught than males. This supports the sustainability of the threadfin rainbowfish resources since sufficient female broodstocks exist in both research sites. To maintain the viability of a population, the ratio of males to females should ideally be balanced or at least have more females **(Pratama *et al*., 2019; Hasibuan & Khairul 2021)**. If the number of males and females is balanced (1.00:1.00) or there are more females, the chances of successful spawning increase, thus enhancing the ability to sustain the population **(Ambarsari, 2016)**.

More importantly, information about the sex ratio is imperative for the management of the threadfin rainbowfish because it helps estimate population balance in the waters, understanding population health, and preventing population declines that could lead to extinction **(Nasution, 2007; Hasanah *et al*., 2019; Rinandha *et al*., 2020; Hasanah *et al*., 2022)**. Many factors can cause differences in sex ratios, including reproductive behavior **(Allen 1991; Allen *et al*., 2000; Omar *et al*., 2014; Hasanah *et al*., 2022)**, overfishing pressures, and habitat changes **(Manangkalangi *et al*., 2009; Siby *et al*., 2009; Umar *et al*., 2013; Pavlov *et al*., 2014; Fryxell *et al*., 2015; Rawat *et al*., 2019)**, and differences in growth patterns and age of fish **(Omar *et al*., 2014; Trisyani *et al*., 2019; Wakiah *et al*., 2019)**. Similarly, pawning behavior, habitat preferences, social interactions, and seasonal movements can also affect the sex ratio in each species **(Maturbongs *et al*., 2020)**.

Table (3) shows the sex ratios of several other species of the rainbowfish in Indonesia. It is evident that more males than females were obtained during the research for some species, or vice versa. Other species tended toward a balanced number of males and females (sex ratio around 1.00:1.00), as found in the study in Rawa Biru Swamp and Wanggo River.

2. Size at first gonad maturity

The average size at first gonad maturity of threadfin rainbowfish in Rawa Biru Swamp and Wanggo River varies, but overall, female fish reached gonad maturity faster than male fish. In Rawa Biru, male threadfin rainbowfish first reached gonad maturity at a total length of 26.23mm, while for females it was reached at 25.86mm. In Wanggo River, males first reached gonad maturity at 27.99mm and females at 24.83mm. The smallest size at which threadfin rainbowfish first reach gonad maturity (GML III) was 21.14mm for males and 20.16mm for females in Rawa Biru Swamp and 21.14mm and 18.28mm, respectively, for males and females in Wanggo River. This signifies that at the same size, female threadfin rainbowfish reached gonad maturity faster than males, both in Rawa Biru Swamp and Wanggo River. **Chadijah's (2020)** analysis also elucidated that 50% of *T. prognatha* males reached gonad maturity at 57.31mm, while females at 45.16mm. The size at first gonad maturity (GML IV) for opudi fish (*T. prognatha*) was 47.43mm for males and 39.00mm for females. These findings align with this research's finding, which indicates that female fish reach gonad maturity faster.

One imperative parameter in fisheries is the size at first gonadal maturity, which is crucial for determining the minimum size of fish that can or should be caught. This parameter helps understand population dynamics in aquatic environments. A decline in fish population may be attributed to the capture of fish that are about to spawn or have not yet spawned. To mitigate this, selective fishing gear, which regulates the mesh size of fishing nets, is an effective preventive measure to ensure the sustainable use of fish resources. Furthermore, the size at first gonadal maturity of the threadfin rainbowfish has not been previously studied, and this report provides the first such information. This dataset is vital for managing the species, as the size at first gonadal maturity can act as an indicator of population pressure, allowing for better regulation of fish capture **(Siby *et al*., 2009; Mote *et al*., 2014; Ohee *et al.,* 2020)**.

Table 3. Sex ratio of the rainbowfish in Indonesia

Species	Location	Number of fish		Sex ratio (M:F)	Reference
		Male	Female		
Glossolepis incisa	Lake Sentani, Papua	404	394	1.03:1.00	Siby, 2009
Marosatherina ladigesi	Bantimurung River, South Sulawesi	69	269	0.26:1.00	Omar et al. 2014
	Batu Puteh River, South Sulawesi	112	123	0.91:1.00	Nasyrah *et al*., 2021
	Camba River, South Sulawesi	54	173	0.31:1.00	Nasyrah *et al*., 2021
	Pattunuangase River, South Sulawesi	88	243	0.36:1.00	Omar *et al*., 2014
	Sanrego River, South Sulawesi	33	55	0.60:1.00	Nasyrah *et al*., 2021
Melanotaenia arfakensis	Aimasi River, Papua	167	189	0.88:1.00	Manangkalangi, 2009
	Nimbai River, Papua	172	169	1.02:1.00	Manangkalangi, 2009
Paratherina striata	Lake Towuti, South Sulawesi	191	145	1.32:1.00	Aminah, 2007
	Lake Towuti, South Sulawesi	67	211	0.32:1.00	Omar *et al*., 2011
Telmatherina antoniae	Lake Matano, South Sulawesi	556	228	2.44:1.00	Sumassetiyadi, 2003
	Lake Matano, South Sulawesi	1437	1270	1.13:1.00	Tantu, 2012
	Lake Matano, South Sulawesi	2355	2532	0.93:1.00	Tussadyah, 2021
	Lake Matano, South Sulawesi	922	870	1.06:1.00	Agustini, 2022

Telmatherina celebensis	Lake Towuti, South Sulawesi	141	132	1.07:1.00	Furkon, 2003
	Lake Towuti, South Sulawesi	812	713	1.14:1.00	Nasution, 2004
Telmatherina prognatha	Lake Matano, South Sulawesi	1059	750	1.41:1.00	Chadijah, 2020
Telmatherina sarasinorum	Lake Matano, South Sulawesi	2180	985	2.21:1.00	Nilawati, 2012
	Lake Matano, South Sulawesi	1212	548	2.21:1.00	Al-Hakim, 2022

Additionally, each fish species reaches sexual maturity at different times due to various factors. Several factors can affect the size at first gonad maturity in fish, including species, size, age, adaptive capacity **(Lagler *et al.*, 1977; Rahardjo *et al.*, 2011)**, sex, season, gonad development, food availability, water quality **(Tesfahun 2019)**, as well as habitat, growth, and reproductive strategy **(Rinandha *et al.*, 2020)**. The age and size of fish at the onset of gonad maturity can vary between species. Even fish of the same species can have different sizes at the onset of gonad maturity if they live in different geographic locations. For example, the male Celebes rainbowfish (*M. ladigesi*) in the Bantimurung River reach gonad maturity earlier than females, whereas the opposite is true for the same species in the Pattunuangasue River (Table 4). Table (4) also demonstrates the average size at first gonad maturity for several rainbowfish species in Indonesia. These varying sizes at first gonad maturity are reproductive strategies fish use to restore population balance in response to changing conditions, abiotic factors, and overfishing **(Moresco & Bemvenuti 2006)**.

Table 4. Size at first maturity of the rainbowfish in Indonesia

Species	Location	Size at first maturity (mm)		Reference
		Male	Female	
Glossolepis incisa	Lake Sentani, Papua	99.5	99.2	Siby, 2009
Marosatherina ladigesi	Bantimurung River, South Sulawesi	48.10	54.24	Omar *et al*., 2014
	Pattunuangase River, South Sulawesi	47.42	44.00	Omar *et al*., 2014
Melanotaenia arfakensis	Aimasi River, Papua	28.695	30.224	Manangkalangi, 2009
	Nimbai River, Papua	25.077	31.578	Manangkalangi, 2009
Paratherina striata	Lake Towuti, South Sulawesi	167.6	146.1	Nasution, 2008
	Lake Towuti, South	134.65	108.49	Omar *et al*., 2011

	Sulawesi			
Telmatherina antoniae	Lake Matano, South Sulawesi	52.69	62.39	Agustini, 2022
Telmatherina celebensis	Lake Towuti, South Sulawesi	74.3	77.3	Nasution, 2004
Telmatherina prognatha	Lake Matano, South Sulawesi	57.31	45.16	Chadijah, 2020
Telmatherina sarasinorum	Lake Matano, South Sulawesi	75.31	68.50	Al-Hakim, 2022

3. Gonad maturity level

To determine the spawning season, information related to gonad maturity level (GML) is needed. Fish that have not matured gonads are at levels I and II, while those with mature gonads are at levels III and IV. Based on the analysis of the GML of the threadfin rainbowfish in Rawa Biru Swamp and Wanggo River, the males and females caught were generally in the reproductive phase. In detail, the male threadfin rainbowfish in Rawa Biru Swamp with mature gonads ranged from 65.22% (November 2022) to 100% (January 2023), while females ranged from 60% (January 2023) to 93.55% (December 2022 and February 2023). In Wanggo River, the mature male threadfin rainbowfish ranged from 66.67% (January 2023) to 93.10% (March 2023) and females from 65.38% (March 2023) to 100% (February 2023). The high number of fish with mature gonads, as shown in Figs. (3, 4), suggests that the research period coincided with the spawning season of the threadfin rainbowfish in Rawa Biru Swamp and Wanggo River. Thus far, there has been no information about the spawning season of this species.

Moreover, Figs. (3, 4) demonstrate that at each sampling time from November 2022 to March 2023, male and female fish with GML III and IV were found. Concerning rainfall in the Merauke area, this sampling period corresponds to the rainy season. Hence, it can be inferred that the gonad maturity level of the threadfin rainbowfish is closely associated with the rainy season in Rawa Biru Swamp and Wanggo River. Similar observations have been made for other rainbowfish species such as the Arfak rainbowfish (*M. arfakensis*) in the Nimbai and Aimasi Rivers, Manokwari **(Manangkalangi *et al.*, 2009)**, the red rainbowfish (*G. incisa*) in Lake Sentani, Papua **(Siby *et al.*, 2009)**, and the Celebes rainbowfish (*M. ladigesi*) in the Pattunuang River and Batu Puteh River, South Sulawesi **(Nasyrah *et al.*, 2021)**. Additionally, **Rahardjo *et al.* (2011)** assert that the beginning of the rainy season is the best time for most fish to spawn due to favorable aquatic environmental conditions. The rainy season creates a fertile environment due to the availability of sufficient food for the larvae and juvenile fish, which is crucial for their survival and growth.

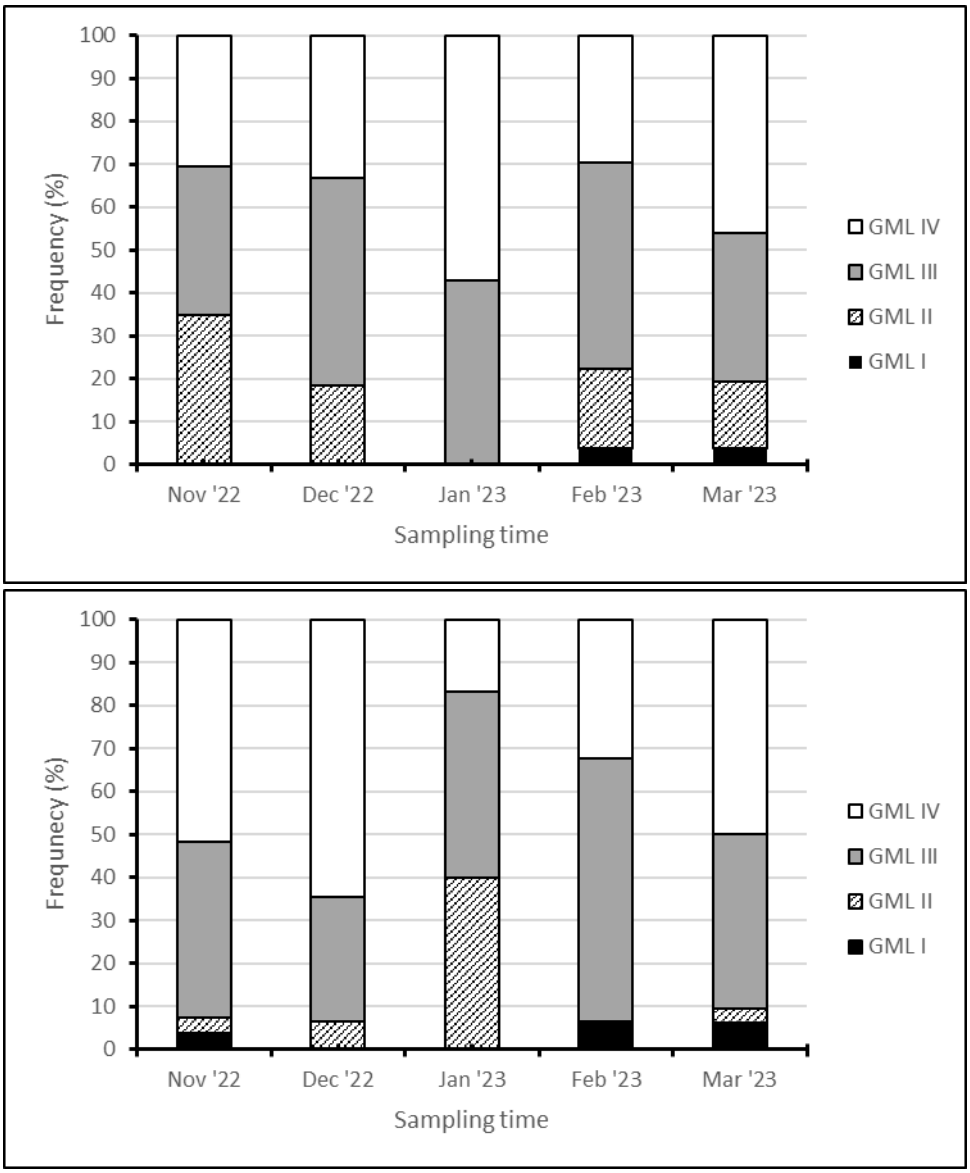

Fig. 3. Gonad maturity level of threadfin rainbowfish (*Iriatherina Werneri* Meinken, 1974) during the research period at Rawa Biru Swamp. Top Fig.: Male Fish; Bottom Fig.: Female Fish

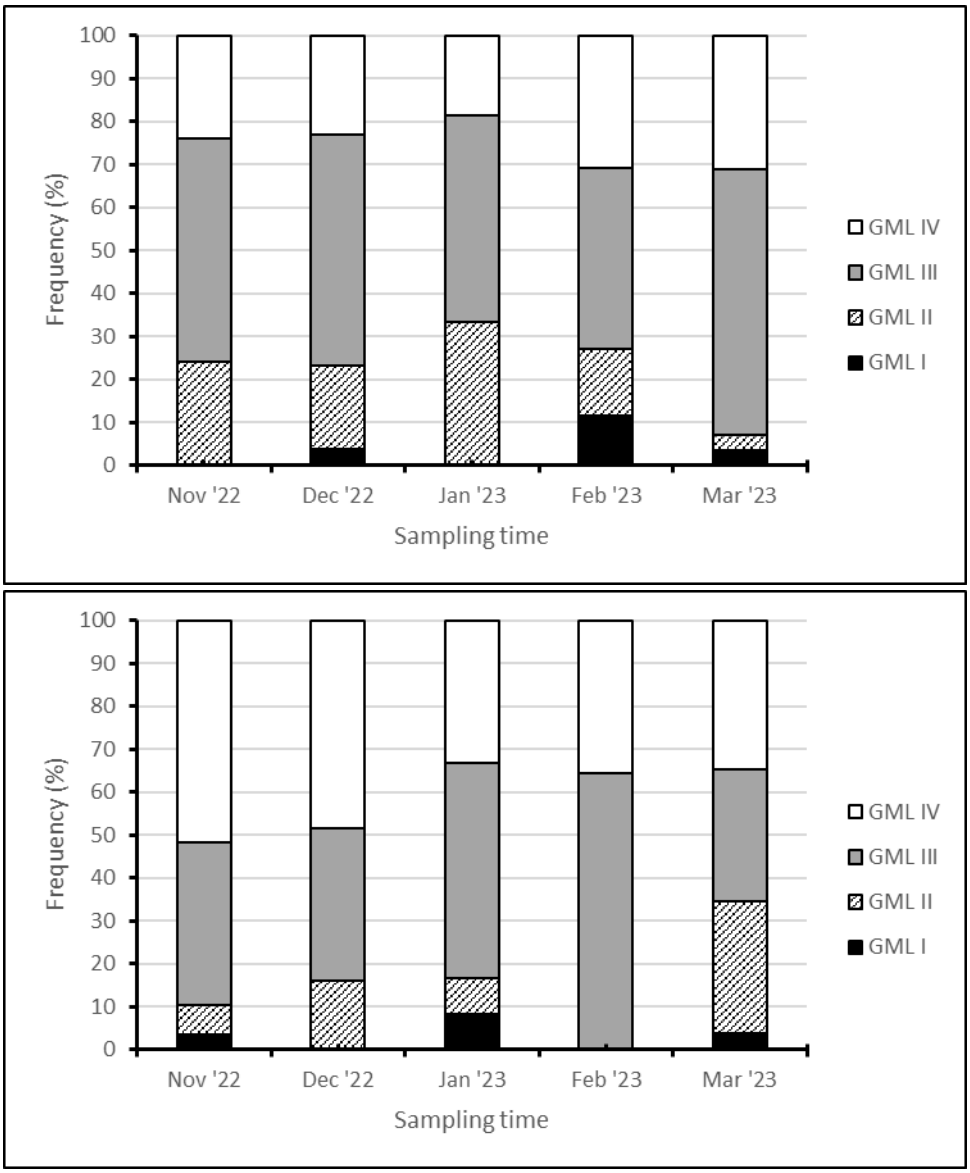

Fig. 4. Gonad maturity level of threadfin rainbowfish (*Iriatherina Werneri* Meinken, 1974) during the Research Period at Wanggo River. Top Fig.: Male Fish. Bottom Fig.: Female Fish

CONCLUSION

There are several conclusions drawn from the research, namely, the sex ratio of threadfin rainbowfish in Rawa Biru and Wanggo Rivers is balanced, following a pattern of 1.00:1.00. Female fish in Rawa Biru and Wanggo Rivers reach first gonad maturity faster than male fish. Most importantly, the spawning season of the threadfin rainbowfish occurs during the rainy season. To date, no research has provided data on the sex ratio, size at first gonadal maturity, or

spawning season of the threadfin rainbowfish in their natural habitat. The results of this study represent the first reported findings on these aspects.

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