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Food and Feeding Habits of *Osteochilus vittatus* Valenciennes, 1842 and *Barbodes binotatus* Valenciennes, 1842, in Tamblingan Lake, Bali

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ABSTRACT Tamblingan Lake is the smallest lake in Bali and is inhabited by various species of fish, which are from the Cyprinidae family, namely bonylip barb and spotted barb. Information regarding the food and feeding habits of bonylip barb and spotted barb fish in Tamblingan Lake is unavailable. This study aims to determine and analyze the food and feeding habits of bonylip barb and spotted barb fish in Tamblingan Lake. Fish sampling was conducted from January to June 2019 in Tamblingan Lake using modified gill nets with a net size of 0.5, 1.0, 1.5, 2.0, 2.5, and 3.0 cm. Fishing was carried out at five stations with water characteristics representing the condition of Tamblingan Lake. Bonylip barb fish obtained during the study comprised 216 individuals, while the Spotted barb had 180 individuals. The average value of the relative intestinal length of bonylip barb fish ranged from 4.34 to 5.53, while that of the spotted barb fish was 0.89 to 1.30. The average value of the gastric fullness index of film fish ranges from 1.34 to 4.77, while the spotted barb is 0.32 to 0.42. The total IRI value of bonylip barb fish food in Tamblingan Lake is 924.32, while the spotted barb is 1,232.62, with the highest IRI value in both species coming from plankton. Bonylip barb and spotted barb in Tamblingan Lake developed a generalist feeding strategy with plankton food groups (planktivorous). Information related to these fishes can be used to formulate fish resource management in Tamblingan Lake.

Keywords: Feeding strategy; food; *Osteochilus vittatus*; spotted barb; Tamblingan Lake

INTRODUCTION

The Cyprinidae family is a family of fish widespread everywhere except in Madagascar, Australia, the United States, and New Zealand (Kottelat *et al*., 1993). Cyprinidae is the largest family of freshwater fish, consisting of 220 genera and 2,420 species (Putri *et al*., 2014). The large number of species from the Cyprinidae family shows their ability to adapt and reproduce quickly. The main habitat of the Cyprinidae family is in rivers, lake, and reservoir ecosystems (Beamish *et al*., 2006). The Cyprinidae family can generally be recognized by looking at a single protrusion on the head or around the eyes, there is skin on the edge of the eye socket, the position of the mouth is slightly downwards, and there are no more than four barbels around the mouth (Damayanti *et al*., 2022). Fish in the Cyprinidae family generally eat plankton, detritus, algae, and aquatic insects (Djumanto & Setyawan, 2009; Teshome *et al*., 2023).

Food, as an essential component in the environment, is an ecological factor that plays a vital role in determining population density levels, population dynamics, growth, reproduction, and condition of fish (Saikia, 2015). The type of food of a fish species usually depends on age (Afshari *et al*., 2013), place, and time (Labaro *et al*., 2021). The feeding habits of fish can be seen from the ecological relationships between organisms in the water (Oribhabor *et al*., 2019), for example, forms of predation (Chumchuen & Sukramongkol, 2022), competition (Ain *et al*., 2021) and food chains (Peel *et al*., 2019; Kwak & Park, 2020). The study of fish food will provide information regarding the primary, complementary, and additional food for fish species (Fatema *et al*., 2013; Novyanti *et al*., 2023). The type of food of a type of fish can also describe the niche and trophic level of the fish in that ecosystem (Cicala *et al*., 2020; Shalloof *et al*., 2020).

Tamblingan Lake is one of the lake ecosystems on Bali Island. Based on Pertami *et al*. (2020) found seven species of fish in Tamblingan Lake, including tilapia cichlid (*Oreochromis niloticus*), convict cichlid (*Amatitlania nigrofasciata*), green swordtail (*Xiphophorus hellerii*), millionfish (*Poecillia reticulata*), silver rasbora (*Rasbora argyrotaenia*), bonylip barb (*Osteochillus vitattus*), and spotted barb (*Barbodes binotatus*). *Osteochilus vittatus* and *Barbodes binotatus* are native fish species whose populations are still quite common in the waters of Tamblingan Lake. These two fish species belong to the Cyprinidae family.

So far, information regarding *Osteochilus vittatus* and *Barbodes binotatus* in several other aquatic ecosystems has been published. Some of them have discussed reproductive aspects (Mujtahidah *et al*., 2019; Jusmaldi *et al*., 2020[a]), growth patterns and condition factors (Jusmaldi & Hariani, 2018; Jusmaldi *et al*., 2020[b]), and morphometrics and meristics (Damayanti *et al*., 2022). Information regarding these two fish species in Tamblingan Lake has not been widely published. It is noted that only information related to the biological aspects of *Barbodes binotatus* (Putri *et al*., 2021) and the reproductive aspects of *Osteochilus vittatus* (Parawangsa *et al*., 2022) has been published.

Management of fisheries resources requires basic and holistic database information. The unavailability of information regarding the feeding and nutrition of *Osteochilus vittatus* and *Barbodes binotatus* in Tamblingan Lake makes this information important to present. Based on this, research related to the feeding and diet of *Osteochilus vittatus* and *Barbodes binotatus* in Tamblingan Lake is vital research to carry out. This research aims to reveal the food type, proportions, and feeding strategies of *Osteochilus vittatus* and *Barbodes binotatus* in Tamblingan Lake.

METHODS

Fish samplings were conducted from January to June 2019 at Tamblingan Lake, Bali. Fish sampling was carried out at five stations with water characteristics that represent the water conditions of Tamblingan Lake. A map of each station's research location and characteristics can be seen in Figure 1 and Table 1.

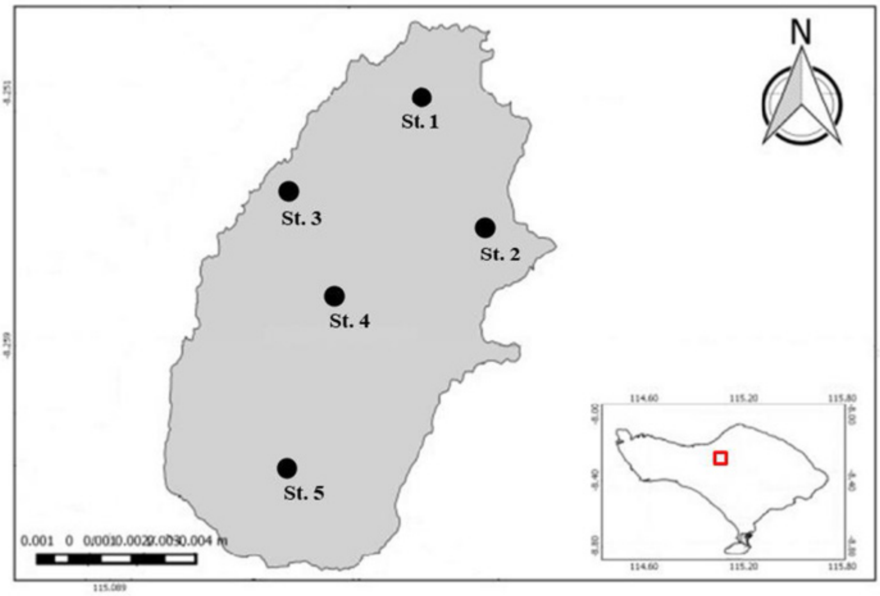


Figure 1. Sampling location of *Osteochillus vitattus* and *Barbodes binotatus* in Tamblingan Lake during January to June 2019.

Table 1. Sampling location characteristic of *Osteochillus vitattus* and *Barbodes binotatus* in Tamblingan Lake during January to June 2019.

Numb.	Name Location	Characteristic
1.	Lenggang	Aquatic plants (Nymphoides sp.) and rocks, with a relatively steep topography
2.	Pura Dalem	Rocky lake shores, aquatic plants (Cyperus spp.)
3.	Tirta Mengening	The edge of the lake has cliffs and dead tree trunks.
4.	Tengah	The water current is quite strong in the location where fishermen spread their nets.
5.	Pos Nelayan	Lots of water plants (Nymphoides sp.), sloping lake edges, fishermen's location for spearing fish

Fish sampling was carried out by installing modified gill nets with mesh sizes of 0.5, 1.0, 1.5, 2.0, 2.5, and 3.0 cm with a length of 300 meters and a height of 2 meters. The nets are installed in the afternoon (17.00) and hauled the next day at 08.00. Fish samples were taken on the first day at stations 1, 2, and 3, then on the second day at stations 4 and 5. Fish samples caught were separated based on sampling stations. The fish were preserved in 10% formalin and taken to the Fisheries Laboratory, Faculty of Marine Science and Fisheries at Udayana University.

Fish samples were measured in length and weighed. The length characteristics measured include total length, fork length, and standard length (Figure 2) using a ruler with an accuracy of 0.1 mm and weights measured using a digital scale with an accuracy of 0.0001 g. Fish samples whose length and weight have been measured are then dissected to take parts of the intestine, including the stomach and intestines.

The fish intestine samples taken are then measured in length with a ruler with an accuracy of 0.1 mm and weighed using a digital scale with an accuracy of 0.01 g. The contents of the intestine are entirely expelled. Then, it was weighed using a digital scale with an accuracy of 0.0001 g, put into a microtube filled with 70% alcohol, and then homogenized. The homogenized intestine contents were dropped into a Sedgwick Rafter Counting (SRC) Cell until it was packed without bubbles. Then, the organisms were observed under a microscope using the census method without repetition. Organisms contained in the intestine will be identified by referring to the plankton identification book Davis (1955), Needham & Needham (1963), Vuuren *et al*. (2006), and Sulastri (2018), then the number and frequency of their occurrence will be recorded.

Data analysis used in this research includes laboratory analysis, relative length of the gut, Index of Stomach Content, Index of Relative Importance, and Feeding strategy. According to (Nurfadillah *et al*., 2019), the relative length of the gut (RLG) is calculated using the following formula:

$$RLG = \frac{Total\ \ lenght\ \ of\ \ gut}{Total\ \ lenght\ \ of\ \ fish}$$

The length of the intestine for carnivorous fish is 1; for omnivorous fish, it is between 1-3; and for herbivorous fish, it is >3 (Syahputra, 2014).

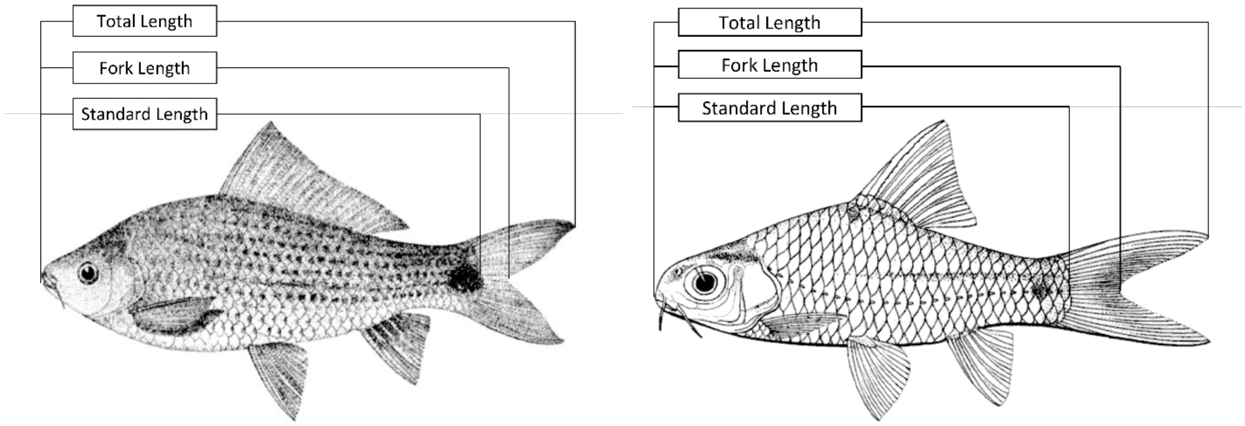


Figure 2. Measurement characteristics of bonylip barb, *Osteochillus vitattus* (left) and spotted barb, *Barbodes binotatus* (right).

Index of Stomach Content (ISC) is an analysis to calculate the fullness of natural food in the intestine. The stomach fullness index was analyzed by comparing the total weight of the fish with the weight of the stomach contents. According to Hyslop (1980), the fish stomach fullness index can be determined using the following formula:

$$ISC = \frac{SCW}{BW} \times 100$$

Where:

SCW: stomach contents weight (g).

BW: body weight of fish (g).

The Index of Relative Importance analysis aims to determine the type of fish food through the equation (Pinkas *et al.*, 1971):

$$IRI = (N + V)F$$

Where:

IRI: Index of relative importance.

N: Percentage of number from type food.

V: Percentage of volume from type food.

F: Frequency of occurrence.

The feeding strategy was determined using Costello's modified feeding strategy method (Figure 3) by plotting the percentage frequency of occurrence against the specific abundance of food organisms (Amundsen *et al.*, 1996). The frequency of occurrence is obtained by calculating the number of stomachs containing one type of food divided by the number of stomachs containing food. The specific abundance of food organisms is determined by following the following equation:

$$P_i = \frac{\sum S_i}{\sum St_i} \times 100$$

where:

P_i: specific percentage of the abundance of food organisms.

S_i: The contents of the intestine contain food.

St_i: the number of stomachs containing food.

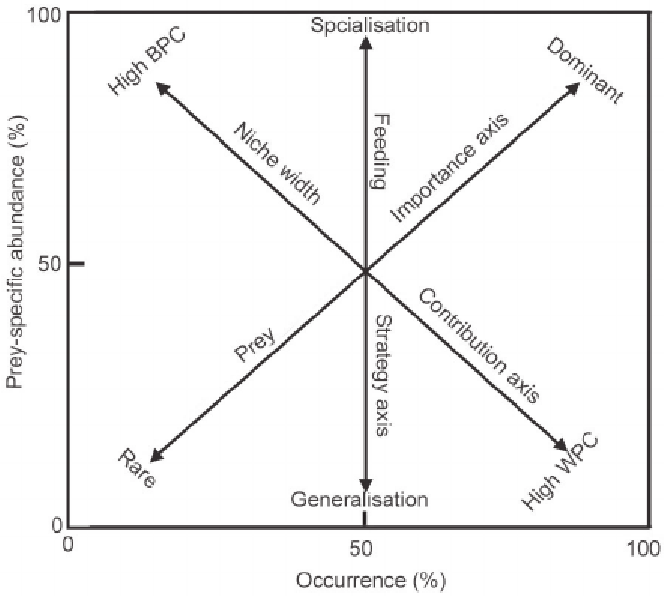
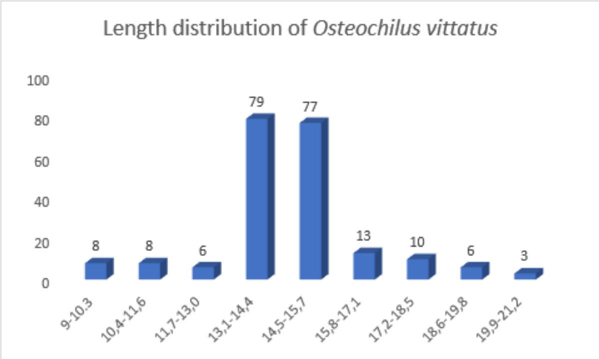


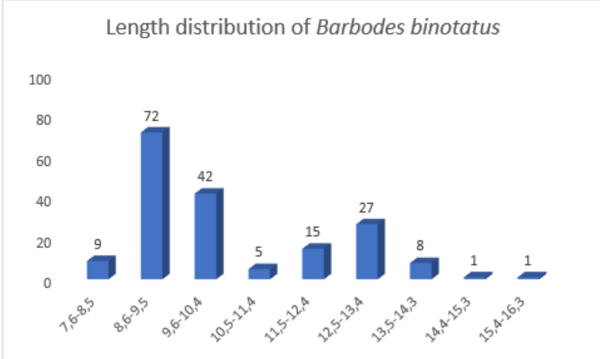
Figure 3. Costello's modified feeding strategy graphic (Amundsen *et al.*, 1996).

RESULTS AND DISCUSSION

Length and weight distribution

Bonylip barb (*Osteochilus vittatus*) caught from January to June 2019 in Tamblingan Lake had 216 individuals, while Spotted barb (*Barbodes binotatus*) had 208 individuals. Six individuals of bonylip barb and 28 individuals of spotted barb were damaged. The total of damaged samples could not be observed.





(a) (b)

Figure 4. Length distribution of bonylip barb (a) and spotted barb (b) in Tamblingan Lake.

Bonylip barbs had sizes ranging from 9 to 21.2 cm. The size of bonylip barbs of 13.1 to 14.4 cm and 14.5 to 15.7 cm were the most caught, with numbers of 79 and 77 individuals. The fewest fish caught were in the 19.9 to 21.2 cm size group, with as many as three individuals (Figure 4[a]). Furthermore, bonylip barbs caught had a weight distribution range from 7.5 to 109.1 g, with the most fish caught in a range of 30.1 to 41.3 g, as many as 96 individuals. However, at the same time, the fewest fish caught had a weight range of 97.9 to 109.1 g, with numbers of two individuals (Table 2).

Meanwhile, the spotted barb caught ranged from 7.6 to 16.3 cm. The size of the spotted barbs, 8.6 to 9.5 cm, was the most caught, with 72 individuals. The spotted barbs in the 14.4 to 15.3 cm and 15.4 to 16.3 cm size groups were the fewest caught, with one individual each (Figure 4[b]). Furthermore, spotted barb caught had a weight distribution range from 6.5 to 49.6 g, with the most fish caught in a range of 6.5 to 11.2 g, as many as 78 individuals. The fewest fish caught had weights ranging from 16.1 to 20.8 g and 44.9 to 49.6 g, with three individuals each (Table 2).

Table 2. The weight distribution of bonylip barb and spotted barb.

Osteochilus vittatus		Barbodes binotatus	
Weight ranges (g)	Quantity	Weight ranges (g)	Quantity
7.5-18.7	16	6.5-11.2	78
18.8-30.0	40	11.3-16.0	44
30.1-41.3	96	16.1-20.8	3
41.4-52.6	31	20.9-25.6	6
52.7-63.9	5	25.7-30.4	20
64.0-75.2	8	30.5-35.2	12
75.3-86.5	8	35.3-40.0	10
86.6-97.8	4	40.1-44.8	4
97.9-109.1	2	44.9-49.6	3
Total	210	Total	180

The size of the bonylip barb caught in Tamblingan Lake, on average, is almost the same as the size of the bonylip barb found in the waters of Talaga Lake, with a length of 11 to 22.7 cm (Putri *et al.*, 2015), but smaller than the bonylip barb caught in the Cirata Reservoir, with the length of 16 to 27.5 cm (Hedianto & Purnamaningtyas, 2011) and in Lake Singkarak with length between 16.2 to 28.3 cm (Uslichah & Syandri, 2003). Meanwhile, spotted barbs caught in Lake Tamblingan were longer than those found in the Barambai River, namely 4.5 – 14.6 cm (Jusmaldi & Hariani, 2018) and in Laut Tawar Lake, with lengths of 3 – 6.7 cm (Adha *et al.*, 2023).

Relative length of gut (RLG)

Based on the analysis of the relative length of gut (RLG) data, the relative length of gut and range in bonylip barb from February to June was 1.93 to 8.08 with an average of 4.74. Meanwhile, the average relative length of the gut of the spotted barb from January to June was 1.12 in the range of 0.04 to 2.05 (Table 3).

Table 3. The relative intestinal length of *Osteochilus vittatus* and *Barbodes binotatus* in Tamblingan Lake from January to June 2019.

Month	Osteochilus vittatus				Barbodes binotatus			
	Min	Max	Average	St. Dev	Min	Max	Aver-age	St.Dev
Jan	-	-	-	-	0.40	1.36	0.89	0.35
Feb	2.84	6.15	4.34	0.97	0.61	1.78	1.30	0.28
Mar	1.93	8.08	4.74	1.26	0.04	1.93	1.15	0.32
Apr	2.04	5.80	4.18	1.05	0.70	2.05	1.26	0.30
Mei	2.62	8.07	4.91	1.25	0.68	1.53	1.16	0.24
Jun	4.07	7.71	5.53	0.94	0.52	1.79	0.97	0.30
Total	2.7	7.16	4.74	1.09	0.49	1.74	1.12	0.29

Based on these analyses, the ratio of body length and intestines of the bony lip barb in Tamblingan Lake is 1:4. This shows that bonylip barb classified as herbivorous fish. Taofiqurohman *et al*. (2007) reported that the bonylip barb is an herbivorous fish that eats plant food, including algae filaments and other plankton. The same thing was also reported by Hedianto & Purnamaningtyas (2011) that the leading food of bonylip barb is planted and categorized as herbivorous fish. According to Affandi *et al*. (2009), the intestinal length of herbivorous fish can reach many times the length of its body so that the position of the intestine forms a roll in the abdominal cavity. The intestines of herbivorous fish take longer to digest foods that contain fiber. Herbivorous fish have a gut length that is longer than their body length, while carnivorous fish have a shorter intestinal length than their body length (Rayhanu *et al*., 2004).

Meanwhile, the spotted barb (*Barbodes binotatus*) in Tamblingan Lake is classified as an omnivorous fish. This is evident from the composition of food found in the intestine, which consists of phytoplankton, zooplankton, fungi, and aquatic plants. The spotted barb has an average relative intestinal length longer than its body. Situmorang *et al*. (2013) also found that the squeeze fish (*Puntius binotatus*) synonym from *Barbodes* sp. It has a longer intestine compared to its body length, and the type of food organisms found in its intestine consists of phytoplankton, zooplankton, and detritus (pieces of insect legs), so it is stated that this fish belongs to the omnivorous fish group.

These results are appropriate with Syahputra (2014), who reported that the length of the intestine for carnivorous fish is 1, for omnivorous fish, it is between 1 and 3, and for herbivorous fish, it is >3. Zonneveld *et al*. (1991) states that the relative intestinal length of carnivorous fish ranges from 0.2 to 2.5, omnivorous fish 0.6 to 8.0, and herbivorous fish 0.8 to 15.0. Syahputra (2014) stated that the ratio of intestinal length relative to the body of fish affects the feeding properties of fish. Furthermore, Affandi *et al*. (2009) states that anatomically, the structure of the digestive apparatus of fish is related to body shape, food, feeding habits, and age of fish.

Index of stomach content

Based on body weight data of bonylip barb and spotted barb, an index of stomach content (ISC) was analysed. The average value of the fullness index of stomach content of the bonylip barb from February to June was 2.60, within the range of 0.02 to 28.01. Meanwhile, the range value of the fullness index of stomach content of spotted barb from January to June was 0.06 to 1.69, with an average of 0.37 (Table 4).

Table 4. Index of stomach content of Osteochilus vittatus and Barbodes binotatus in Tamblingan Lake from January – June 2019.

Month	Osteochilus vittatus				Barbodes binotatus			
	Min	Max	Average	St. Dev	Min	Max	Average	St.Dev
Jan	-	-	-	-	0.08	0.90	0.32	0.27
Feb	0.02	3.88	1.34	1.10	0.05	1.69	0.42	0.34
Mar	0.13	28.01	2.09	3.45	0.06	1.06	0.35	0.22
Apr	0.17	5.89	1.85	1.56	0.09	0.84	0.33	0.23
Mei	0.17	7.10	3.19	2.38	0.07	1.04	0.42	0.33
Jun	0.50	12.08	4.77	3.44	0.06	0.85	0.42	0.26
Total	0.19	11.39	2.60	2.38	0.06	1.06	0.37	0.27

The number of bonylip barb intestines observed was as many as 213 intestines that contained food. The index of fullness of the gastrointestinal tract is an indicator of the feeding activity of fish. The results of the intestine fullness index of bonylip barbs in Tamblingan Lake had the highest value in June at 4.77. The full index of stomach content of bonylip barbs ranges from 1.34 to 4.77. This suggests that food availability influences the difference in the fullness of the intestine of the bonylip barb. High appetite affects the fullness of stomach contents and fish growth. Jaenudin (2013) reported that the filled fish intestines indicated that the fish was eaten at the time before the fish was caught.

The index of fullness of the spotted barbs in Tamblingan Lake from January to June 2019 has an average range of 0.32 to 0.42. This value obtained is smaller when compared to a study conducted by Ritonga (2021) on the squeezed fish (*Cyclocheilichtys apogon*) family of Cyprinidae in the Lake River, showing that the index of fullness of the intestine ranges from 0.75 to 0.97. This indicates that spotted barbs have no specific feeding time.

According to Effendie (2002), factors that affect the stomach content are caused by external factors, namely fishing time and fish foraging time or food availability in the fish habitat. Furthermore, (Makri & Hidayah, 2019) stated that the level of fish activity to forage in an environment is caused by age, food availability, food size, and fish appetite. Internal factors such as the fishing process following the time of fish foraging and the habitat providing food for fish are also factors causing the high and low index of stomach content (Safitri *et al*., 2018).

Food habits

Based on the analysis of the stomach content of bonylip barb, there were 51 types of organisms spread in seven classes of phytoplankton, seven classes of zooplankton, and one class of aquatic plants (Table 5). Phytoplankton found in the stomach of bonylip barbs in Tamblingan Lake includes the class Bacillariophyceae (21 genera), Cyanophyceae (7 genera), Charophyceae (5 genera), Chlorophyceae (3 genera), and other classes of 1 genus each, namely Agaricomycetes, Dinophyceae, and Euglenophyceae. In comparison, the zooplankton most found in the intestine of bonylip barb was the Monogonta class (3 genera), followed by the Branchiopoda and Ciliata classes, respectively consisting of 2 genera, then Hydrozoa, Labyrinthulea, Maxillopoda, and Rhizopoda every one genus. Meanwhile, aquatic plants found are from the class Magnoliopsida (1 genera).

Table 5. Food organisms found in the intestine of bonylip barbs in Tamblingan Lake, Buleleng, Bali.

Class	Types of organisms
PHYTOPLANKTON	
Bacillariophyceae	Achnantes, Amphora, Aulacoseira, Cerataulina, Cymatopleura, Cymbella, Diatoma, Diploneis, Epithemia, Eunotia, Fragilaria, Gomphonema, Navicula, Nitzschia, Pinnularia, Pleurosigma, Rhopalodia, Stauroneis, Surirella, Synedra, Thalassiothrix
Cyanophyceae	Anabaena, Arthrospira, Merismopedia, Microcytis, Nodularia, Oscillatoria, Planktolyngbya
Charophyceae	Closterium, Cosmarium, Penium, Pleurotaenium, Staurastrum
Chlorophyceae	Coelastrum, Ulothrix, Volvox
Agaricomycetes	Rhizoctonia
Dinophyceae	Peridinium
Euglenophyceae	Trachelomonas
ZOOPLANKTON	
Monogonta	Brachionus, Kellicottia, Keratella
Branchiopoda	Daphnia, Diaphanosoma
Ciliatea	Eutintinnus, Salpingella
Labyrinthulea	Aulacantha
Maxillopoda	Microsetella
Hydrozoa	Diphyes
Rhizopoda	Arcella
AQUATIC PLANTS	
Magnoliopsida	Myriophyllum

Furthermore, 37 organisms were found in spotted barbs, consisting of phytoplankton and zooplankton, each of six classes, and fungi and aquatic plants, each consisting of one class (Table 6). The classes of phytoplankton found include the classes Bacillariophyceae (16 Genus), Chlorophyceae and Cyanophyceae (3 Genera each), Conjugatophyceae (2 Genus), and the last one each consists of 1 genus namely Dinophyceae and Trebouxiophyceae. The zooplankton was found to consist of the classes Brachiopoda, Ciliata, and Maxillopoda (2 Genuses each), as well as Hexanauplia, Monogonanta, and Tubulinea (1 Genus each). The fungi found are from the class Tremellomycetes (1 Genus), and aquatic plants, there is the class Magnoliopsida (1 Genus).

Table 6. Food organisms are found in the intestine of spotted barbs in Tamblingan Lake, Buleleng, Bali.

Class	Types of organisms
PHYTOPLANKTON	
Bacillariophyceae	Amphora, Aulacoseira, Cymbella, Diatoma, Frustulia, Navicula, Nitzschia, Pinnularia, Pleurosigma, Rhizosolenia, Rhopalodia, Skeletonema, Stenopterobia, Surirella, Synedra, Thalassionthrix
Chlorophyceae	Eudorina, Monoraphidium, Volvox

Class	Types of organisms
Cyanophyceae	Chroococcus, Oscillatoria, Spirulina
Conjugatophyceae	Netrium, Staurastrum
Dinophyceae	Peridinium
Trebouxiophyceae	Oocystis
ZOOPLANKTON	
Branchiopoda	Acroperus, Chydorus
Ciliata	Eutintinnus, Salpingella
Maxillopoda	Microsetella, Tortanus
Hexanauplia	Cyclops
Monogonanta	Keratella
Tubulinea	Arcella
FUNGI	
Tremellomycetes	Cryptococcus*
AQUATIC PLANTS	
Magnoliopsida	Myriophyllum

Description (*): Fungi acts as food and pathogens. The genus in the terrestrial environment is pathogenic (humans and cats); for aquatic animals, there is no information related to this genus. There is tentative suspicion of this genus as food in spotted barbs.

Food is an ecological factor that is important to fish growth and population. These ecological conditions are closely related to food and water conditions. Fish that live wild in waters cause fish to eat whatever they encounter but feeding activities in fish are closely related to appetite and will ultimately determine the amount of food eaten (Anisa *et al*., 2015; Affandi *et al*., 2009). Phytoplankton of the class Bacillariophyceae are the most abundant organisms found in the intestine of both fish. This shows that the aquatic environment of Tamblingan Lake strongly supports the life of Bacillariophyceae. Sulastri (2018) stated that Bacillariophyceae are phytoplankton with cell walls from silicates, some of which can adapt by attaching to the substrate but generally have the nature of floating in water. Furthermore, Mujiyanto & Satria (2011) reported that Bacillariophyce-

Table 7. The total IRI value of bonylip barb food in Tamblingan Lake, Buleleng, Bali, for the period January – June 2019.

Numb.	Organisms	Relative Important Index
1.	Surirella	450.56
2.	Peridinium	218.06
3.	Diatoma	64.46
4.	Amphora	25.25
5.	Staurastrum	16.64
6.	Microcytis	15.68
7.	Keratella	14.33
8.	Cymatopleura	12.81
9.	Nitzschia	12.57
10.	Cymbella	10.43
11.	Pinnularia	7.06
12.	Synedra	6.83
13.	Myriophyllum	6.24
14.	Anabaena	6.16
15.	Nodularia	5.55
16.	Salpingella	5.54
17.	Oscillatoria	5.35
18.	Thalassiothrix	4.95
19.	Diploneis	4.94
20.	Lainnya	30.90
Total		924.32

ae is one of the classes of phytoplankton often found in waters. However, the abundance and distribution are not always the same, especially in relatively cold waters (Rahmadani, 2017).

The total value of the Relative Important Index (IRI) of each organism found in the intestine of bonylip barb and spotted barb in Tamblingan Lake from January to June 2019 was 924.32 and 1,232.62, respectively. *Surirella* is a type of phytoplankton with the highest IRI value in both types of fish. Meanwhile, the zooplankton type with the highest IRI value in bonylip barb is *Keratella* (Monogonta), while *Arcella* (Tubulinea) is in spotted barb. In bonylip barbs, there are 32 types of organisms (phytoplankton, zooplankton, and aquatic plants) with IRI values between 0.1 and 10 and 9 species with minimal values (< 0.1) (Table 7). In contrast, in spotted barb, there are 17 types of organisms with IRI values of 0.1-10 and 12 types of organisms with minimal values (≤ 0.1) (Table 8).

Several studies related to bonylip barb food have also been carried out, such as in Djuanda Reservoir, bonylip barb eats many periphytons, namely Bacillariophyceae and Chlorophyceae, in the upper reaches of the Cimanuk River has the leading food of phytoplankton and plants and complementary foods, zooplankton, and detritus (Tresna *et al*., 2012), in Way, Tulang Bawang eats much phytoplankton from the classes Bacillariophyceae, Chlorophyceae, and Cyanophyceae (Wijaya, 2013), in Lake Poso eats much phytoplankton from the class Cyanophyceae (Subagja *et al*., 2013), in Lake Talaga has the leading food in the form of plants (macrophytes) and additional food in the form of phytoplankton, mollusks, insectas, and detritus (Muryanto & Sumarno, 2014), and in Salatiga has the main food of algae class Bacillariophyceae, Cyanophyceae, Chlorophyceae, and Cryptophyceae (Pagilalo *et al*., 2020). Meanwhile, in spotted barbs, not much research has been done related to their food. In their research, Situmorang *et al*. (2013) stated that Bacillariophyceae is a more dominant natural organism and spotted barbs' intestines (*Puntius binotatus*). It is further explained that the primary type of food of this fish is the organisms of the Bacillariophyceae group, and complementary foods include Chlorophyceae, Monogononta, Detritus, and Ciliophora, while the supplementary food is of the Cyanophyceae type. Elinah *et al*. (2016) also stated that the leading food of benteur fish (*Puntius binotatus*), synonym from *Barbodes* sp., consists of phytoplankton of the class Bacillariophyceae.

Table 8. The total IRI value of spotted barb food in Tamblingan Lake, Buleleng, Bali, for the period January – June 2019.

Numb.	Organisms	Relative Important Index
1.	Surirella	629.52
2.	Arcella	138.64
3.	Cymbella	97.40
4.	Pinnularia	83.74
5.	Stenopterobia	71.89
6.	Navicula	66.72
7.	Peridinium	59.34
8.	Thalassiothrix	22.23
9.	Frustulia	9.20
10.	Chydorus	8.99
11.	Oscillatoria	8.70
12.	Eudorina	4.45
13.	Keratella	4.02
14.	Synedra	3.61
15.	Rhopalodia	3.42
16.	Microsetella	3.28
17.	Aulacoseira	3.27
18.	Myriophyllum	1.85
19.	Salpingella	1.83
20.	Eutintinnus	1.57
	Total	1.232.62

Bonylip barb and spotted barb have compatibility in choosing food. This is evidenced by the discovery of *Surirella* from the class Bacillariophyceae in its intestine. Herawati (2011) stated that phytoplankton from the class Bacillariophyceae can multiply quickly and adapt to their environment through morphological adaptations. The large number of phytoplankton class Bacillariophyceae in the intestine of bonylip barb and spotted barb is caused by the abundance of these phytoplankton in the waters. According to Hendiyana (2010), the class Bacillariophyceae is a group of periphyton algae that can stick easily to the substrate because it has adhesive tools and is vital in primary production. Hidayat (2013) stated that phytoplankton class Bacillariophyceae can live well on twigs washed away in waters and around waters overgrown by benthic plants. Further, Hinz *et al*. (2005) state that fish habits in utilizing and choosing food are related to food availability in waters caused by changes in the aquatic environment. A species of fish chooses the types of food eaten depending on preferences for certain types of food, size, age, season, and habitat (Situmorang *et al*., 2013).

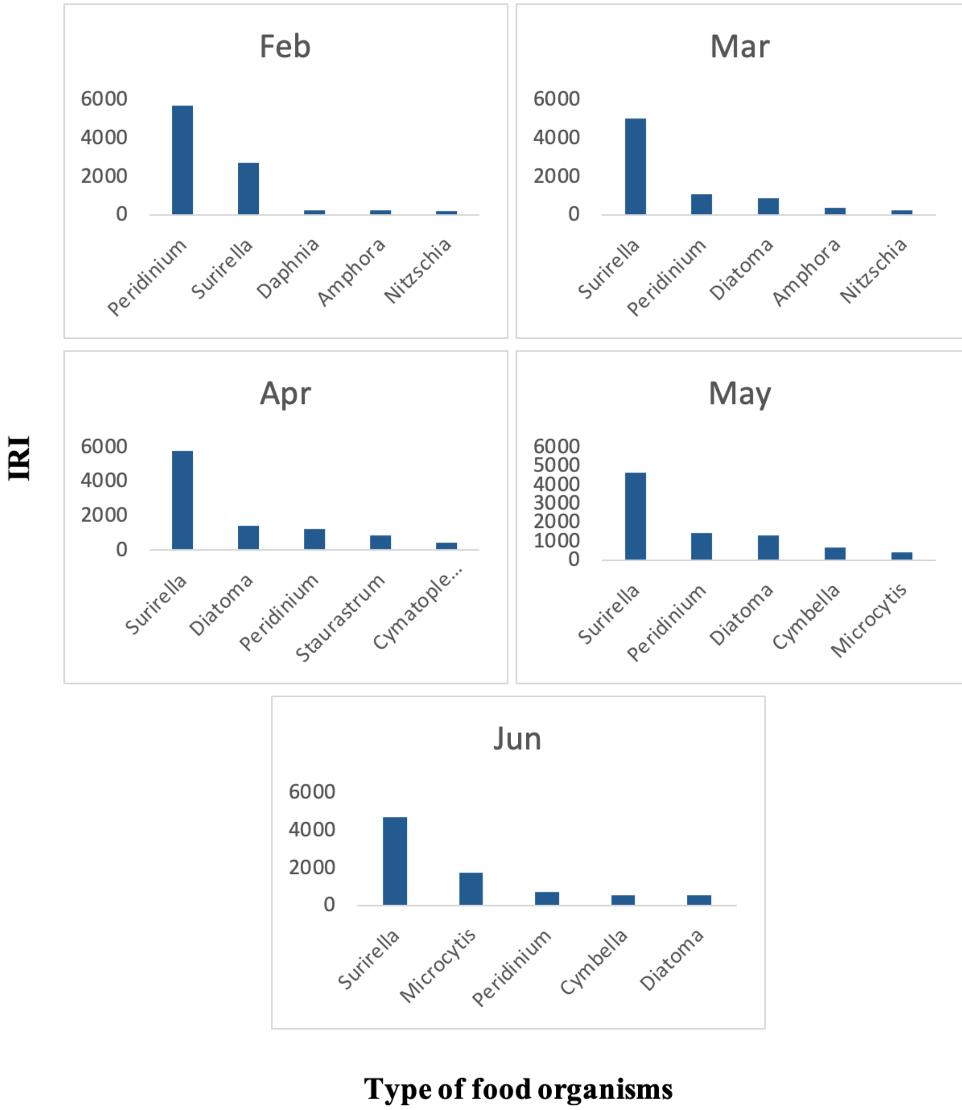


Figure 5. Comparison of five species of bonylip barb food with the most considerable IRI value in the period January – June 2019 in Tamblingan Lake, Buleleng, Bali.

Based on the month of observation, there is a change in the primary type of food eaten by the bonylip barb in Tamblingan Lake. In February, the main food of bonylip barb is Peridinium (Dinophyceae), while from March to June, it eats more Surirella (Bacillariophyceae) (Figure 5). It is suspected that there is a change in season from February to March, resulting in changes in fish food. According to Rahardjo & Simanjuntak (2005), changes in fish food are often associated with seasonal changes. The same thing was also reported by Pertami *et al*. (2019), who said that the type of organism most eaten could change depending on the season and the size of the fish (ontogenetic). Furthermore, according to Arifin *et al*. (2015), organisms belonging to the Dinophyceae class can form cysts as a resting stage, and these cysts settle on the bottom of the waters until environmental conditions support them again to grow and, at a particular time its growth will be abundant in the waters.

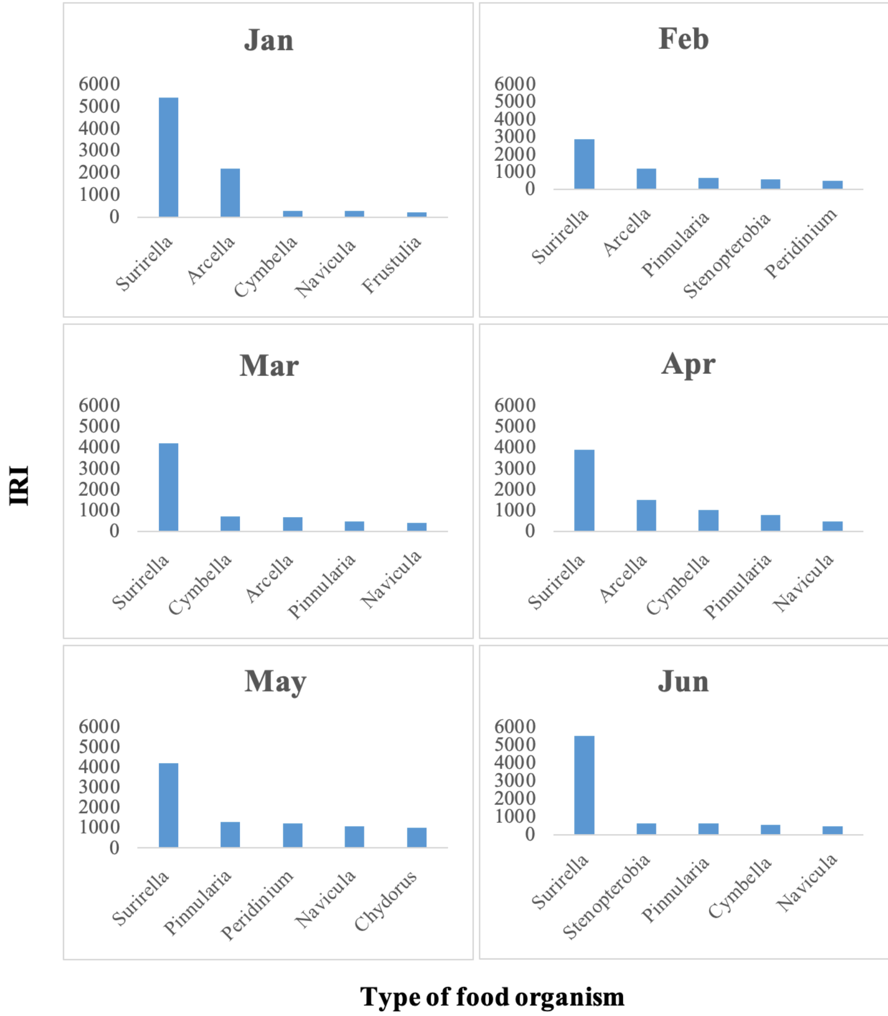


Figure 6. Comparison of five species of spotted barb food with the most considerable IRI value in the period January – June 2019 in Tamblingan Lake, Buleleng, Bali.

Meanwhile, the IRI value of spotted barb every month shows that the composition of spotted barb food is relatively the same as bonylip barb, which has the highest IRI value in the form of phytoplankton, so that spotted barb is classified as planktivorous fish (Figure 6). This follows the research of Hedianto *et al*. (2013), who found that benteur fish (*Puntius binotatus*) classified as planktivores tend to be herbivorous (phytoplankton). Effendi (2002) stated that the availability of food would affect the growth and maturity of the gonads, as well as the success of the life of each fish, while the presence of food in a body of water is affected by biotic and abiotic environmental conditions such as temperature, light, space and surface area of the waters (Fitri et al., 2019).

Feeding strategy

Based on the analysis of feeding strategies, bonylip barb and spotted barb in Tamblingan Lake developed generalist feeding strategies in each observation month. The generalist feeding strategy is shown by most types of bonylip barb food located below the diagram with a specific abundance of food less than 50% and a frequency of incidence of less than 50% to 100%. This shows that bonylip barbs and spotted barbs in Tamblingan Lake use many types of food together. Analysis of the feeding strategy of bonylip barb and spotted barb in Tamblingan Lake is presented in Figures 7 and 8.

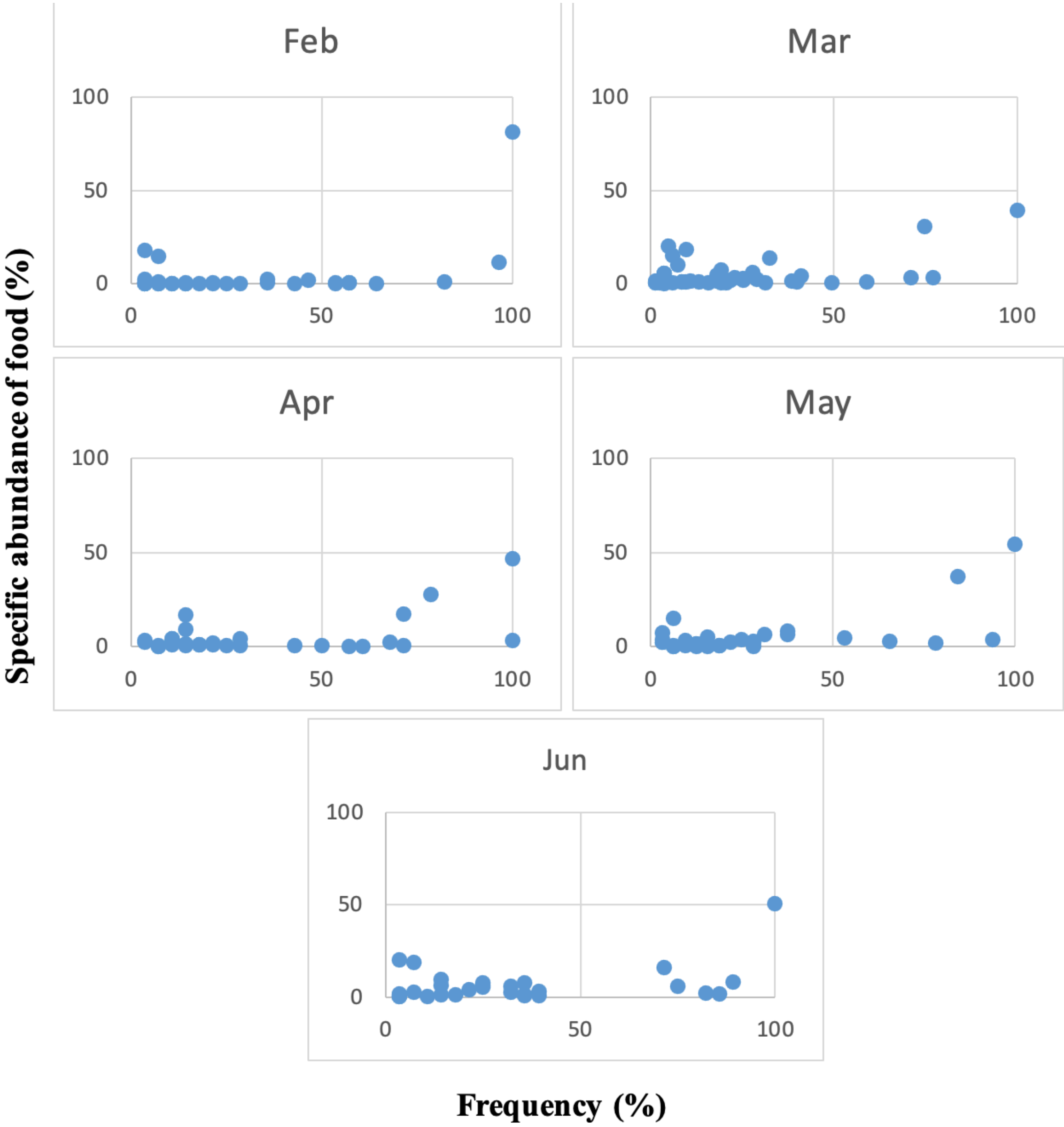


Figure 7. Bonylip barb feeding strategy in Tamblingan Lake, Buleleng, Bali from February – June 2019.

Based on the feeding strategy analysis results, bonylip barbs in Tamblingan Lake developed generalist feeding strategies or are not specialists in certain types of food. This condition is related to a relatively low abundance of specific foods (< 50%), but there is a tendency for Surirella to be the dominant food consumed by tilapia. Manangkalangi & Kaliele (2011) state that although fish species utilize a variety of foods, the highest dominance by a type of food shows its abundance in the environment. Furthermore, Asriyana & Irawati (2018) reported that the abundance of food in the water affects the feeding habits of fish species. Meanwhile, spotted barbs in Tamblingan Lake are generalists, eating 37 types of food organisms ranging from plankton, fungi, and aquatic plants, but the percentage tends to be small in each type of food. This can be seen from the plot on the Costello modified feeding strategy diagram, which shows that the selected type of food shows a relatively similar pattern at the bottom. Fish will adjust to food availability and develop feeding strategies based on the seasons (Zahid *et al*., 2009). In general, fish-feeding habits are influenced by several factors, namely their habitat, preference for certain types of food, season, food size, food color, age of the fish (Hasnarika & Kurniawan, 2020), body size and active feeding time (Pratiwi *et al*., 2020).

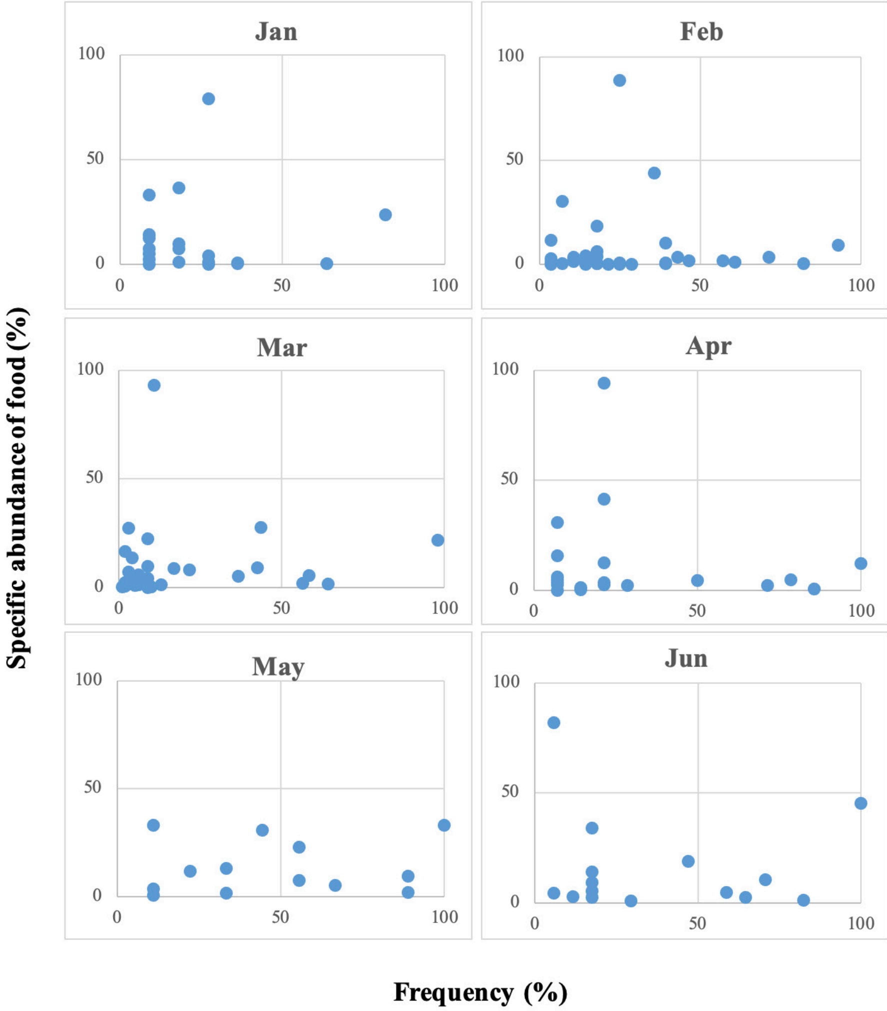


Figure 8. Spotted barb feeding strategy in Tamblingan Lake, Buleleng, Bali from January – June 2019.

Fish diet strategies are closely related to feeding habits related to obtaining these foods (Parawangsa *et al.*, 2019). A specialist feeding strategy is developed by fish with specific morphological and behavioral adaptations to their food so that fish are very efficient in foraging. Instead, generalist feeding strategies are developed if preferred foods are unavailable (Steven *et al.*, 2006). Amundsen *et al*. (1996) state that if one or several preys are located at the top right of the diagram, those positions indicate a specialist feeding strategy with a narrow niche area. However, suppose all prey is located along or below the diagonal from the top to the bottom right of the plot. In that case, this position indicates a generalist feeding strategy with a broad niche area. The main variables that determine food choices in fish are abundance and prey characteristics (Scenna *et al.*, 2006; Johnson *et al.*, 2007).

CONCLUSION AND RECOMMENDATION

Conclusion

Bonylip barb and spotted barb in Tamblingan Lake prey on food from phytoplankton, zooplankton, and aquatic plants. However, fungi are also found in the stomachs of spotted barbs. Phytoplankton of the class Bacillariophyceae dominates the main food of both fish. Both fish developed generalist feeding strategies with plankton food groups (generalists – planktivorous).

Recommendation

Further research is needed to know the seasonal cycle in one year. In addition, it is also necessary to conduct research related to the relationship between species related to foraging competition.

AUTHORS' CONTRIBUTIONS

Each author's contribution to the manuscript's analysis technique, English grammar check, and proofreading.

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