Food preferences of nilem carp (Osteochilus hasselti) at paddy-fish culture pond in Kuningan, Garut and Tasikmalaya, West Java Province

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Abstract. The research aims are to determine the availability of natural feed resources and to study the food habits of nilem carp (Osteochilus hasselti) in the paddy-fish culture system in Kuningan (300 m from sea level), Garut (700 m from sea level) and Tasikmalaya (500 m from sea level) districts. The research used a survey method with descriptive analysis. The treatment was without commercial feeding so that it utilizes natural feed, and consists of two replications in each location. The research was conducted in August 2018 - May 2019. The fish used was java carp with a length of 5-7 cm and a stocking density of 2000 fish/paddy field 200 m². The results showed that there were two types of feed composition, namely phytoplankton and zooplankton. The preponderance index of nilem carp in each location generally utilizes phytoplankton from the phylum Bacillariophyta as its main feed. The index of electivity shows that the preference level of Java carp for phytoplankton has similarities in each region. Its mostly preferred phytoplankton, such as Cyclotella, Gomphonema, Gyrosigma, Navicula, Nitzschia, and Synedra from Bacillariophyta and Closterium, Coelastrum and Cosmarium from Chlorophyta.

Keywords: paddy-fish culture, nilem carp, food habits, Kuningan, Garut, Tasikmalaya

1. Introduction
West Java Province, is one of the centers of freshwater aquaculture in Indonesia. Aquaculture production in West Java increased from 2010 to 2015 by 452,299 tons [1]. But at present, land for fish-farming is decreasing, so there needs to be innovation in cultivation techniques or integrated farming systems, so that fish production in West Java continues to increase. One of them is through the combination of the rice field and fish culture, namely the "Paddy-fish" system, which is raising fish in paddy fields.

Paddy field productivity using the paddy-fish system is believed to increase fish production organically and environmentally friendly, both from the rice produced or from harvested fish. The fish species that will be cultivated in the system should be able to utilize the available food and are
generalist in using natural food so that the fish can adjust to fluctuations in natural food availability [2]. One of the fish that has a generalist nature is the nilem carp (*Osteochilus hasselti*).

In the natural habitat, nilem fish are all-eaters (omnivores), the food consists of detritus, periphyton, and epiphyton. Different types of natural food that grows on paddy fields due to other land conditions and water quality result in different kinds of food eaten by fish. Therefore it is necessary to evaluate the growth of nilem fish in the rice-fish system. The objective of this study is to find out the availability of natural food resources in paddy waters and the food preferences of nilem fish, which are raising in the rice-fish system in Kuningan, Garut, and Tasikmalaya Regency of West Java Province.

2. Materials and methods

The research was conducted in September 2018 to May 2019 in three locations in West Java. The research used survey method with descriptive analysis at three locations survey namely: 1) in Bojong Village, Kramatmulya District, Kuningan Regency (300 m above sea level / (ASL), 2) Kersamenak Village, Tarogong Kidul District, Garut Regency (700 m above sea level), and 3) Arjasari Village, Leuwisari District, Tasikmalaya Regency (500 m above sea level). Identification of natural food in fish intestines was carried out at the Laboratory of Aquatic Resource Management, Faculty of Fisheries and Marine Sciences, Universitas Padjadjaran, Jatinagor, Sumedang Regency.

The materials used in this research include nilem carp seeds (*Osteochilus hasselti*) size 5-7 cm and weight 2 g, with a stocking density of 10 fish/m$^2$ of paddy field, paddy variety GH-1 and Ciherang. The area of the paddy field is 200 m$^2$ by using a deeper channel. The fish cultivation used is without commercial feed, so that it utilizes natural food available in the paddy-field waters, for each location, there were two replications. Cultivation of fish and rice was done for 90 days with data collection for 35 days. Data was collected during the cultivation with an interval of seven days. During the cultivation process, the paddy field was regularly fertilized by organic fertilizer (chicken manure) with a period once in two weeks as much as 10 kg.

The physical and chemical water quality observed were temperature, turbidity, dissolved oxygen (DO), acidity (pH), nitrate (NO$_3$), ammonia (NH$_3$), and phosphate (PO$_4$), and parameter biology are plankton abundance, index of preponderance and index of electivity. Microscopic identification of food refers to the plankton identification book by Sachlan [3] and Prescott [4].

2.1. Plankton abundance

Plankton abundance is obtained using the formula of Sachlan [3]:

$$N = \frac{n \times V_r}{V_o \times 1 / V_s}$$

where N is plankton abundance (ind / L),
\(n\) is the number of plankton identified,
\(V_o\) is calculated plankton volume (ml),
\(V_s\) is the volume of filtered water (L) and
\(V_r\) is filtered plankton volume (ml).

2.2. Index of preponderance

Calculation of Index of Preponderance aims to find out what types of food are eaten by fish and can find out the main complementary foods, and supplementary foods or fish substitutes. According to Nikolsky and Birkett [5] obtained with the following formula:

$$IP_i = \frac{V_i \times O_i}{\Sigma_{i=1}^{n} V_i \times O_i} \times 100\%$$

Where \(IP_i\) is the preponderant index;
\(V_i\) is the percentage of the amount of one type of food;
\(O_i\) is the percentage of frequency of occurrence of one type of food.
2.3. Index of electivity

The preferences of each organism or type of plankton contained in a fish's digestive apparatus are determined based on the index of choice (index of electivity) in Effendi [6] as follows:

\[ E = \frac{(r_i - p_i)}{(r_i + p_i)} \]

Where \( r_i \) is the relative number of different types of organisms that are eaten; \( p_i \) is the relative number of organisms in the waters.

3. Results and discussion

3.1. Water quality

The results of the measurement of physical and chemical parameters of water taken from each plot at three locations listed in Table 1.

| Parameter          | Unit | Kuningan | Garut | Tasikmalaya | Range       | Quality standard |
|--------------------|------|----------|-------|-------------|-------------|-----------------|
|                    |      | Plot 1   | Plot 2 | Plot 1      | Plot 2      |                 |
| Temperature        | °C   | 29       | 29    | 27          | 26          | 27              | 28              | 25 - 31*         |
| DO                 | mg/L | 5.37     | 6.39  | 7.70        | 7.48        | 7.79            | 8.09            | >3 *             |
| pH                 |      | 7.28     | 7.34  | 6.70        | 6.62        | 7.22            | 7.35            | 5 - 8 *          |
| Nitrat (NO\(_3\)) | mg/L | 0.306    | 0.281 | 0.229       | 0.235       | 0.205           | 0.212           | ≤ 10**           |
| Amonia (NH\(_3\)) | mg/L | 0.0099   | 0.0084| 0.0072      | 0.0138      | 0.003           | 0.0038          | 0.02 *           |
| Fosfat (PO\(_4\)) | mg/L | 0.2338   | 0.2906| 0.2356      | 0.2472      | 0.2532          | 0.2376          | 1**              |

Source: * Technical Guide for Paddy-fish Cultivation in Indonesian [7]
** PP RI Number 82 of 2001 [8]

Water quality, in general, in all research locations in Kuningan, Garut, and Tasikmalaya districts was sufficient to support the life and development of aquatic organisms. DO range in research location was from 5.37 mg/L - 8.09 mg/L.

The range has fulfilled the optimum water quality requirements based on the Technical Guidance for Paddy-fish Cultivation in the Indonesian Ministry of Maritime Affairs and Fisheries in 2016 with a minimum DO limit of 3 mg/L and is still relatively good for aquatic organisms.

The degree of acidity (pH) value obtained during observation in each research location ranged from 7.13 - 7.34. This value is still in good condition, in the optimum range, in accordance with the Technical Guidelines for Paddy-fish Cultivation in Indonesian [7].

Nitrate content (NO\(_3\)) obtained during observation at each location ranged from 0.205 mg/L - 0.306 mg/L. These results, when compared with Government Regulation (PP) on water quality standards No. 82 of 2001 (Class III) for freshwater fish farming activities, is still very far from the specified limit of...
10 mg/L. In Kuningan District, in plot 1, the highest nitrate value was 0.306 mg/L. This condition certainly needs attention because nitrate levels of more than 0.2 mg/L can cause eutrophication of waters, and can cause blooming as well as triggering the growth of aquatic plants such as *Azola* sp. Nitrate is the main form of nitrogen in natural waters and is the main source of nutrients for the growth of phytoplankton and other aquatic plants. Ammonia (NH₃) measurements at each location ranged from 0.0030 mg/L - 0.0099. Judging from the results of the research that the ammonia levels in the Paddy-fish are still in good condition and suitable for the lives of fish and other organisms. Unlike the case, if ammonia in waters crosses the threshold, it will affect the life of fish, and even death in fish can occur. According to Schmittou [9] that the ammonia concentration of 0.1 - 0.3 mg/L will cause stress in fish.

3.2. *Plankton abundance*
Plankton found in all research locations is not much different in number. Plankton found in Kuningan Regency consisted of 43 genera divided into 5 phytoplankton phylum, including Chlorophyta, Cyanophyta, Bacillariophyta, Phyrophyta, Euglenophyta and 4 zooplankton phylum including Rotifera, Arthropoda, Protozoa and Nematoda (Table 2).

| No | Phylum          | Kuningan | Garut | Tasikmalaya |
|----|----------------|----------|-------|-------------|
|    | Phytoplankton  |          |       |             |
| 1  | Chlorophyta    | 2,080    | 9,768 | 1,097       |
| 2  | Cyanophyta     | 193      | 240   | 88          |
| 3  | Bacillariophyta| 690      | 6,446 | 4,663       |
| 4  | Phyrophyta     | 91       | -     | 1           |
| 5  | Euglenophyta   | 1,926    | 6,486 | 325         |
|    | Zooplankton    |          |       |             |
| 1  | Rotifera       | -        | 129   | 20          |
| 2  | Arthropoda     | 13       | 98    | 31          |
| 3  | Protozoa       | 76       | 108   | 8           |
| 4  | Nematoda       | -        | 17    | -           |
|    | Total          | 5,033    | 23,092| 6,233       |

Phytoplankton abundance in paddy-fish pond in Kuningan Regency ranged from 902 - 13,778 ind/L and zooplankton abundance ranged from 2 - 353 ind/L in plot 1. *Pediastrum* genera of the Chlorophyta had the highest population abundance in plot 1, which was equal to 8,487 ind/L. Chlorophyta is an algae that can synthesize its own food with the aid of sunlight because it has chlorophyll. Usually green, so it is often called green algae, for example, in the *Pediastrum* sp. species [10].
In plot 2, phytoplankton abundance ranged from 704 - 10,525 ind/L, and zooplankton abundance ranged from 2 - 405 ind/L. Vureen *et al.* [11] state that Euglenophyta is widespread and often abundant, occasionally coloring dark green pool water or forming a green filament on the surface. Euglenophyta thrives well in polluted or enriched environments, especially when there is a lot of rich organic waste (from animal or aquatic plant waste), and Euglenophyta usually prefers high water temperatures.
At the location in Garut Regency, plankton, which was found consisted of 49 genera divided into 4 phytoplankton phylum including Chlorophyta, Cyanophyta, Bacillariophyta, Euglenophyta and 4 zooplankton phyla including Rotifera, Cladocera, Copepoda, and Protozoa.

In Garut District, the type of phytoplankton found in each plot ranged from 1,454 - 44,702 ind/L in plot 1 and 1,517 - 54,181 ind/L in plot 2. The abundance of zooplankton ranged from 32 - 927 ind/L on plot 1 and 85 - 741 ind/L on plot 2. The two plots have the highest abundance of the same species, the genus Scenedesmus from the phylum Chlorophyta. Chlorophyta is one of the main groups of algae because of the abundance of species and genera and its frequency everywhere. The ability to adapt in Chlorophyta to freshwater aquatic habitats is much more successful so that the number of species of Chlorophyta is more commonly found in freshwater waters [12].

At the research locations in the Tasikmalaya Regency, plankton was found to consist of 36 genera divided into 5 phytoplankton phyla, including Chlorophyta, Cyanophyta, Bacillariophyta, Dynophyta, Euglenophyta and 4 zooplankton phyla including Rotifera, Cladocera, Protozoa, and Ciliata.

Whereas in Tasikmalaya District, the abundance of phytoplankton ranged between 622 - 30,924 ind/L in plot 1 and 225 - 15,684 ind/L in plot 2. The highest phytoplankton abundance was the Navicula genera of the Bacillariohpyta phylum, and the lowest was found in the plot of the Cyanophyta phylum. The quantity of zooplankton in plot 1 ranged from 1 – 40 ind/L and 41-311 ind/L. According to Barus [13], the amount of Bacillariophyta in water is caused by its ability to adapt to the environment, is cosmopolitan, resistant to extreme conditions, and has a high reproductive ability.

Biotic and abiotic processes determine variations in the diversity of phytoplankton species in aquatic ecosystems, the implication of which is that the diversity of phytoplankton species can vary according to time and place. According to [14], differences and changes in the composition of phytoplankton on a seasonal basis because it is closely related to changes in seasonal and temperature, input load and nutrient availability and hydro climatological factors such as wind, rain and changes in water level fluctuations, thus also dynamics imbalances and increasing the diversity of phytoplankton species depends on the magnitude of the influence of these environmental factors.

The research site location has a different height. The height of Bojong Village Kramatmulya District Kuningan Regency is 300 m ASL; Kersamenak Village Tarogong Kidul District Garut Regency is 700 m ASL; Arjasari Village Leuwisari District Tasikmalaya Regency is 500 m ASL.

Geographical differences such as differences in altitude above sea level will lead to differences in weather and overall microclimate in these places, especially temperature and humidity [15]. The height of Kuningan and Tasikmalaya District, which is lower than Garut Regency, affects the water temperature as stated in the food preferences of nilem carp.

3.3. Index of Preponderance (IP)

The index value of nilem carp preserved in Kuningan District shows that the plankton group that is widely used by nilem fish is Bacillariophyta, with an average IP of 64.35%, followed by Chlorophyta with an average IP of 18.23% and Cyanophyta with an average IP 10.34% in plot 1. In plot 2, the utilization of plankton did not differ significantly from plot 1, where nilem fish utilized Bacillariophyta with an average IP of 63.64%, followed by Chlorophyta with an average IP of 19.83% and Cyanophyta 11.11%.
Figure 1. Food preference of nilem carp in Kuningan District (a) Plot 1 (b) Plot 2

The value of preponderance of nilem carp in Garut Regency has similarities in using natural food by nilem carp. Plankton groups are widely used, namely from Bacillariophyta species with an average IP of 65.57% in plot 1 and 50.34% in plot 2, followed by Cyanophyta 14.66% in plot 1 and 26.87% in plot 2 and then Chlorophyta with an average IP of 10.36% in plot 1 and 10.26% in plot 2 (Figure 2).
Figure 2. Food habits of nilem carp in Garut Regency (a) Plot 1 (b) Plot 2

The preponderant index values in Tasikmalaya Regency are presented in Figure 3. Based on the index, the plankton group that fish widely used is Bacillariophyceae class in plot 1 and plot 2 (average IP of 84.58% and 89.83%), Chlorophyta (average IP of 9.26% in plot 1 and 723% in plot 2), then Cyanophyta (average IP of 3.55% in plot 1 and 2.26% in plot 2).
Determination of food status in fish intestines using the index of preponderance. From the above results, it is shown that at each research location in Kuningan, Garut and Tasikmalaya districts, nilem carp utilizes plankton from the Bacillariophyceae group as the main feed, the Chlorophyceae and Cyanophyceae groups are being used as supplementary feeds. Whereas the Dinophyceae, Euglenophyceae, Cladocera, Protozoa, and Siliata groups are used as feed ingredients. Research by Ekawati et al. [16] stated that the most nilem carp preponderant index value in the phylum Bacillariophyta was 44.09%, Chlorophyta 40.06%, and Cyanophyta by 15.85%. Based on the preponderant index value, nilem carp maintained in the Paddy-fish system in Kuningan, Garut and

**Figure 3.** Food habits of nilem carp in Tasikmalaya Regency (a) Plot 1 (b) Plot 2
Tasikmalaya regencies, can be categorized as herbivorous fish, because there is dominant phytoplankton compared to zooplankton in the nilem intestine. Cahyaningtyas [17] stated that based on its food preferences, nilem carp are herbivorous fish that eat plankton, periphyton, and aquatic plants.

3.4. Index of Electivity (IE)
Based on data obtained in Kuningan District, there are 25 phytoplankton genera in plot 1 and 21 genera in plot 2 found in the stomach of fish and water samples. IE value, which is getting closer to 1, indicates that the feed is very liked by fish so that the abundance of plankton species is almost entirely utilized, which is found in plankton from the genera *Fragillaria*, *Navicula* and *Nitzschia* (Bacillariophyta) and *Closterium* and *Hyalotecha* (Chlorophyta). While *Cyclotella*, *Gomphonema*, *Gyrosigma*, *Navicula*, *Nitzschia*, and *Synedra* (Bacillariophyta), *Spirulina* (Cyanophyta), *Closterium* (Chlorophyta) and *Plectonema* (Euglenophyta) were found in plot 2.

| No. | Genus        | Kuningan | Garut | Tasikmalaya |
|-----|--------------|----------|-------|-------------|
|     |              | Plot 1   | Plot 2 | Plot 1   | Plot 2 | Plot 1 | Plot 2 |
| 1   | Actinastrum  | 0.576    | 0.991 |            |        |        |        |
| 2   | Anabaena     |          |        | 0.501    | -0.755 | -0.811 |
| 3   | Closterium   | 0.873    | -0.604 | 0.150  | 0.305  | 0.957  | 0.884  |
| 4   | Coelastrum   | -0.695   | 0.719  | -0.820   | -0.172 | 0.429  |
| 5   | Cosmarium    | 0.476    | 0.279  | 0.904    | 0.748  | 0.820  |
| 6   | Cyclotella   | 0.660    | 0.998  |          |        |        |        |
| 7   | Crucigenia   |          | -0.793 | -0.926   | -0.911 |
| 8   | Epistylis    |          |        | -0.880   |        |        |        |
| 9   | Euglena      | -0.645   | -0.891 | -0.993   | -0.932 | -0.687 | -0.703 |
| 10  | Fragillaria  | 0.914    | 0.780  | -0.521   |        |        |        |
| 11  | Gomphonema   | 0.775    | 0.986  | 0.258    | 0.853  | 0.308  | 0.859  |
| 12  | Gyrosigma    | -0.127   | 0.854  | -0.768   | 0.559  | 0.300  | 0.743  |
| 13  | Hyalotheca   | 0.973    |        |          |        |        |        |
| 14  | Merismopedia | 0.376    | 0.545  | 0.956    | -0.694 | -0.553 | 0.588  |
| 15  | Melosira     |          |        | -0.623   | -0.930 | 0.049  | 0.043  |
| 16  | Navicula     | 0.938    | 0.756  | 0.259    | 0.884  | -0.202 | 0.021  |
| 17  | Nitzschia    | 0.951    | 0.898  | 0.302    | -0.513 | -0.007 | 0.103  |
| 18  | Oscillatoria | 0.576    |        |          |        |        |        |
| 19  | Pediastrum   | -0.983   | -0.627 | -0.902   | -0.975 | -0.896 | -0.894 |
| 20  | Peridinium   | -0.936   | -0.130 |          |        |        |        |
| 21  | Phacus       | -0.932   | -0.874 | -0.397   | -0.105 | -0.106 | -0.821 |
| 22  | Pinnularia   | 0.659    | 0.313  | -0.084   | 0.137  | 0.972  |
| 23  | Pleurosigma  |          |        |          | 0.341  | 0.420  |
| 24  | Scenedesmus  | -0.608   | -0.655 | -0.848   | -0.907 | -0.899 | -0.780 |
| 25  | Spirulina    | 0.665    | 0.848  |          |        |        |        |
| 26  | Staurastrum  | 0.497    |        |          | -0.993 |        |        |
| 27  | Surirella    | 0.587    | 0.069  | -0.739   | -0.014 | 0.907  | 0.551  |
| 28  | Synedra      | -0.315   | 0.838  |          |        |        |        |
| 29  | Tetraedron   | -0.783   | -0.924 | -0.938   | -0.846 | -0.748 | -0.605 |
| 30  | Trachelomonas| -0.467   | -0.953 |          |        |        |        |
In Garut Regency, the nilem carp index of electivity can be seen in Figure 5. There are 18 phytoplankton genera in plot 1 and 19 genera in plot 2 found in the intestinal contents of fish and water samples. Nilem carp in plot 1 like the plankton of the genera *Gomphonema*, *Naculica*, and *Nitzschia* (Bacillariophyta), *Coelastrum* (Chlorophyta), and *Merismopedia* (Cyanophyta). In plot 2, nilem carp like plankton from the genera *Gomphonema* and *Navicula* (Bacillariophyta) and *Cosmarium* (Chlorophyta).

Index of electivity in the location of Tasikmalaya Regency showed that phytoplankton favored by nilem carp in plot 1 were the genera *Gomphonema*, *Gyrosigma*, *Pinnularia*, and *Surirella* (Bacillariophyta) and *Closterium* and *Cosmarium* (Chlorophyta). In plot 2, nilem carp like plankton from genera *Gomphonema* and *Navicula* (Bacillariophyta) and *Cosmarium* (Chlorophyta).

Based on the results of data obtained from the three locations showed that the level of preference of nilem carp to phytoplankton has similarities in each region. The nilem carp like phytoplankton genera *Cyclotella*, *Gomphonema*, *Gyrosigma*, *Navicula*, *Nitzschia*, and *Synedra* from the phylum Bacillariophyta and genera *Closterium*, *Coelastrum*, and *Cosmarium* from the phylum Chlorophyta.

The level of preference for nilem to the Bacillariophyta phylum is because some organisms of the Bacillariophyta phylum have attachments on a substrate in the form of a gelatin stalk and tend to be passive in waters or attached to a plant stem or rocks making it easier for fish to eat it [18]. Some types of feed have an IE value close to 0 whether the feed is preferred or not. This condition indicates that the presence of a plankton genera in waters with plankton that is utilized is relatively balanced. The level of preference of fish to food varies, influencing factors such as the availability of natural food in nature, the size, and level of liking of fish to the feed [19]. Effendi [20] stated that the level of preference of fish to the available feed resources was uncertain, several factors might affect the situation such as the distribution of organisms and the availability of feed, the choice of fish, and the physical factors of these waters. Based on the comparison between abundance and utilization of plankton by fish, Bacillariophyta plankton has an abundance and high utilization of feed by nilem carp. According to Ekawati [16], Bacillariophyta is a type of plankton that is favored by nilem carp.

### 4. Conclusion

In each of the research sites in Kuningan, Garut, and Tasikmalaya districts, there were abundant natural food resources, so it is suitable for the cultivation of nilem carp with the paddy-fish (rice-fish culture) system. Nilem carp in Kuningan, Garut, and Tasikmalaya reared in paddy-fish culture system were phytoplankton-food herbivores and utilized phytoplankton from the *Bacillariophyta* group as their main feed. The level of preference of nilem carp to phytoplankton has similarities in each region where nilem carp such as phytoplankton genera *Cyclotella*, *Gomphonema*, *Gyrosigma*, *Navicula*, *Nitzschia* and *Synedra* from the *Bacillariophyta* phylum and *Closterium* genera, *Coelastrum* and *Cosmarium* from the Chlorophyta phylum.

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